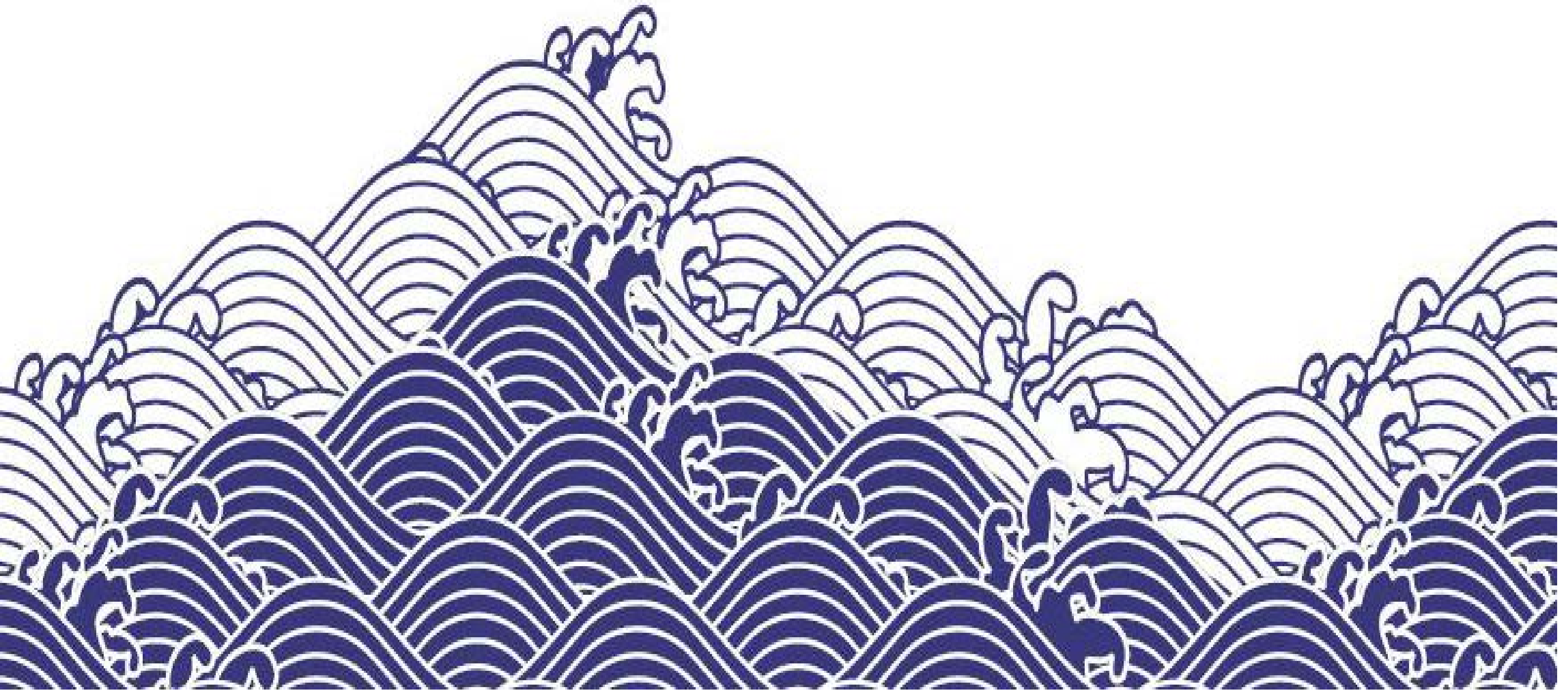
INPEX

2D Seismic Survey
WA-532-P, WA-533-P and WA-50-L

Environment Plan



Change log

Section reference	**Material Change**	**Reason**
All	Document number updated	Internal department change
Table 1-1	Amend timing to commence 1 Nov 2021 and remain valid to be completed in any calendar year from 2021 -2025	Work program delayed at least 12 months due to COVID-19 travel restrictions and lack of ability to contract international vessels. It is possible that the survey may not commence in November 2021. As such the survey would then be postponed a further 12 months to commence 1 November 2022. INPEX intends to conduct the acquisition in a single survey mobilisation and will not exceed the proposed duration of activity.
3.2.2	Amend timing to commence 1 Nov 2021 at the earliest. Included contingency on actual commencement date as it is unknown if COVID-19 international/interstate travel restrictions will be in force in November 2021. In event that the survey is unable to commence on 1 November 2021, further provision to commence the survey in November 2022 or November 2023 has been allowed for. Therefore the time period applicable to the EP will be as follows: - 1 November 2021 – 31 May 2022 - 1 November 2022 – 31 May 2023 (contingency only) - 1 November 2023 – 31 December 2023 (contingency only)	Work program delayed at least 12 months due to COVID-19 travel restrictions and lack of ability to contract international vessels.
4.9.4	Update includes a change to groups have identified as holding a title within the wider EMBA. These are: • Mayala Inninalang Aboriginal Corporation Registered Native Title Body Corporate (RNTBCC)	Since the EP was accepted in Q1 2020, three additional groups have have been identified as holding a title within the wider EMBA.

	• Jabirr Jabirr Nations Aboriginal Corporation (representing interests of Jabirr Jabirr and Ngumbarl people) • Nyul Nyul Prescribed Bodies Corporate (PBC) Aboriginal Corporation RNTBC	
Table 5-4	Updated to include key points from stakeholder engagement update conducted Sept 2020- November 2020	
Section 7.3 and Table 7-27	Amended (removed) three planned seismic surveys that may have occurred within 200 km of the originally planned INPEX 2D seismic survey. With the revised dates of the INPEX survey now postponed by at least 12 months to 1 November 2021 only two other potential new surveys have been identified that could occur between Q4 2021 and Q4 2023. The risk assessments in this section have all been updated to reflect the new updated potential cumulative impact associated with these other surveys.	Work program delayed at least 12 months due to COVID-19 travel restrictions and lack of ability to contract international vessels.
Appendix F – OPEP	Updates to internal document numbers and WA DoT contact numbers and guidance materials.	Change in document control system resulting in new numbers. WA DoT feedback from other EP (OPEP) consultations incorporated into all affected OPEPs.

Environment Plan Summary

This 2D Seismic Survey WA-532-P, WA-533-P and WA-50-L Environment Plan Summary has been prepared from material provided in this Environment Plan (EP). The summary consists of the following as required by regulation 11(4):

EP Summary material requirement	Relevant section of EP containing EP Summary material
The location of the activity	Section 3.2.1
A description of the receiving environment	Section 4
A description of the activity	Section 3
Details of the environmental impacts and risks	Sections 7 and 8
The control measures for the activity	Sections 7 and 8
The arrangements for ongoing monitoring of the titleholder's environmental performance	Sections 9.11.1, 9.12 and 9.13
Response arrangements in the oil pollution emergency plan	Sections 8.4 and 8.5 and Appendix F
Consultation already undertaken and plans for ongoing consultation	Sections 5 and 9.8.3
Details of the titleholders nominated liaison person for the activity.	Section 1.4

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Term, abbreviation or acronym	Meaning
°C	degrees Celsius
%	percent
μg/L	micrograms per litre
μm/s^2	Micrometre per second-squared
μPa	micropascal
2D	two-dimensional
2D seismic survey	a seismic survey comprising broadly-spaced seismic acquisition lines, each providing data for a vertical section of underlying geology.
3D	three-dimensional
3D seismic survey	a seismic survey comprising multiple, closely-spaced seismic acquisition lines to produce a complete 3D image of the surveyed geology.
AASM	Airgun Array Source Model
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ADF	Australian Defence Force
AFMA	Australian Fisheries Management Authority (Cwlth)
AHO	Australian Hydrographic Office
AIMS	Australian Institute of Marine Science
AIS	automatic identification system
ALARP	as low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian marine park formerly Commonwealth marine reserve
AMSA	Australian Maritime Safety Authority (Cwlth)
ANSI	American National Standards Institute
APPEA	Australian Petroleum Production and Exploration Association
ARP	applied research program
AS/NZS	Australian/New Zealand Standard
ASBTIA	Australian Southern Bluefin Tuna Industry Association

Term, abbreviation or acronym	Meaning
ATSB	Australian Transport Safety Bureau
BIA	Biologically Important Area
BoM	Bureau of Meteorology
BPMF	Broome Prawn Managed Fishery
Bq/L	becquerels per litre
BWM	ballast water management
CAES	Catch and Effort System
CAMBA	China-Australia Migratory Bird Agreement
CASA	Civil Aviation Safety Authority
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMST	Centre for Marine Science and Technology
CMT	crisis management team
COLREGs	International Regulations for Preventing Collisions at Sea 1972
cP	centipoise
CPUE	catch-per-unit-effort
CRWG	Community Relations Working Group
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cwlth	Commonwealth
DAWR	Department of Agriculture and Water Resources (Cwlth)
dB	decibel
DBCA	Department of Biodiversity, Conservation and Attractions (WA) formerly the Department of Parks and Wildlife (DPaW)
DEE	Department of the Environment and Energy (Cwlth) (formerly the Cwlth Department of the Environment)
DER	Department of Environment Regulation (WA)
DEWHA	Department of the Environment, Water, Heritage and the Arts, now known as DEE
DIIS	Department of Industry, Innovation and Science

Term, abbreviation or acronym	Meaning
DMIRS	Department of Mines, Industry Regulation and Safety (WA) (formerly Department of Mines and Petroleum)
DNP	Director of National Parks
DoE	Department of the Environment, now known as DEE
DPaW	Department of Parks and Wildlife, now known as DBCA
DPIR	Department of Primary Industry and Resources formerly the Department of Primary Industries and Fisheries DPIF (NT)
DPIRD	Department of Primary Industries and Regional Development (WA)
DSWEPaC	Department of Sustainability, Environment, Water, Population and Communities, now known as DEE
EEA Flyway	East Asian–Australasian Flyway
EEZ	exclusive economic zone
EIAPP	Engine International Air Pollution Prevention
EIS	environmental impact statement
EMBA	environment that may be affected
ENVID	environmental impact identification
EP	environment plan
EPA	Environmental Protection Authority (WA)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)
ERA	ecological risk assessment
ERP	emergency response plan
ERT	emergency response team
ESD	ecologically sustainable development
FPSO	floating production, storage and offloading
g/m^2	grams per square metre
g/m^3	grams per cubic metre
GHG	greenhouse gas
GT	gross tonnes

Term, abbreviation or acronym	Meaning
ha	hectare
HAZID	identification of drilling operations risks and hazards
HFC	High-frequency cetacean
HSE	health, safety and environment
HSEQ-MS	health, safety, environment and quality management system
HPZ	Habitat Protection Zone
Hz	hertz
IAGC	International Association of Geophysical Contractors
IAP	incident action plan
IAPP	International Air Pollution Prevention
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMO	International Maritime Organization
IMS	invasive marine species
IMT	incident management team
in^3	cubic inches
INPEX	INPEX Browse E&P Pty Ltd
IOGP	International Association of Oil and Gas Producers
IOPP	International Oil Pollution Prevention
IPA	Indigenous Protected Area
IPIECA	International Petroleum Industry Environmental Conservation Association
ISPPC	International Sewage Pollution Prevention Certificate
ISO	International Organization for Standardization
ITOPF	International Tanker Owners Pollution Federation Limited
IUCN	International Union for Conservation of Nature
JAMBA	Japan–Australia Migratory Birds Agreement
JANSF	Joint Authority Northern Shark Fishery
JRCC	Joint Rescue Coordination Centre

Term, abbreviation or acronym	Meaning
KEF	key ecological feature
kg	kilogram(s)
kg/m^3	kilograms per cubic metre
kHz	kilohertz
km	kilometre(s)
km^2	square kilometres
KPMF	Kimberley Prawn Managed Fishery
L	litre(s)
LAT	lowest astronomical tide
LC_{50}	Lethal concentration 50. Lethal concentration in which 50% of the population will be killed in a given period of time
LFC	low-frequency cetacean
LLR	lower limits of reporting
L_p	pressure level
L_{pk}	peak pressure level
L_{pk-pk}	peak-to-peak pressure level
L_s	source level
m	metre(s)
m^2	square metres
m^3	cubic metres
mm	millimetre(s)
m/m	mass-for-mass
m/s	metres per second
m/s^2	metres per second-squared
'make good', 'claim' and 'compensation'	Within this document the terms 'make good', 'compensation' and 'claim' process are used to describe a future document setting out the process for assessing genuine claims for directly attributable negative impact from a seismic survey. In Section 9.6, INPEX has provided its preferred wording to describe the proposed claim process. Terms such as 'make good' and 'compensation' shall

Term, abbreviation or acronym	Meaning
	not be considered in any way as an admission of liability or an entitlement to any payment.
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973/1978
MFC	mid-frequency cetacean
MFO	marine fauna observer
MGO	marine gas oil (marine diesel)
mg/L	milligrams per litre
MMF	Mackerel Managed Fishery
MMSI	Maritime Mobile Service Identity
MNES	Matters of National Environmental Significance
MoC	management of change
MoU	memorandum of understanding
MP	marine park
MSS	marine seismic survey
MUZ	Multiple Use Zone
NatPlan	National Plan for Maritime Environmental Emergencies
NDSMF	Northern Demersal Scalefish Managed Fishery
nm	nanometre
nm/s	nanometre per second
Nm	nautical mile(s)
NNTT	National Native Title Tribunal
NOAA	United States National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NOx	mono-nitrogen oxides
NPZ	National Park Zone
NT	Northern Territory
NWCS	North West Cable System

Term, abbreviation or acronym	**Meaning**
NWMR	north-west marine region
NWS	North West Shelf
NWSTF	North West Slope Trawl Fishery
ODS(s)	ozone-depleting substance(s)
OGP	Oil and Gas Producers
OPEP	oil pollution emergency plan
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cwlth)
OPGGS (E) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cwlth)
OSMP	Operational and Scientific Monitoring Program
OSPAR	The 1992 OSPAR Convention (“Convention for the protection of the marine environment of the north-east Atlantic”)
OSRL	Oil Spill Response Limited
OSTM	oil spill trajectory modelling
OWS	oil-water separator
PAH(s)	polycyclic aromatic hydrocarbon(s)
PAM	passive acoustic monitoring
PK	peak pressure level (also called zero-to-peak pressure level)
PK-PK	peak-to-peak pressure level
pm	picometre
POB	persons on board
POMF	Pearl Oyster Managed Fishery
POLREP	(marine) pollution report
POTS Act	Protection of the Sea (Prevention of Pollution from Ships) Act 1983
ppb	Parts per billion
ppm	parts per million
ppt	parts per thousand
PSD	particle size distribution

Term, abbreviation or acronym	Meaning
psi	pounds per square inch
PTS	permanent threshold shift
Ramsar Convention	The Convention on Wetlands of International Importance, especially as Waterfowl Habitat (the Ramsar Convention)
RNTCB	Registered Native Title Body Corporate
R_{max}	maximum range to a given sound level in all directions
$R_{95\%}$	range to the given sound level in 95% of all directions, after the 5% farthest points have been excluded
ROKAMBA	Republic of Korea- Australia Migratory Bird Agreement
s	seconds
SEEMP	Ship Energy Efficiency Management Plan
SEL	sound exposure level
SEL_{cum}	accumulated sound exposure level
SEL_{24hr}	sound exposure level accumulated over 24 hours
SIMA	spill impact mitigation assessment
SIMOPs	simultaneous operations
SITREP	situation report
SOLAS	International Convention for the Safety of Life at Sea
SOPEP	shipboard oil pollution emergency plan
SOx	sulfur oxides
SPL	time-mean-square sound pressure level
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
T	tonne
TTS	temporary threshold shift
U.S. NMFS	United States National Marine Fisheries Service
VHFC	very-high-frequency cetacean
WA	Western Australia

Term, abbreviation or acronym	Meaning
WA-532-P	Exploration permit area within the Browse basin
WA-533-P	Exploration permit area within the Browse basin
WA-50-L	Production licence area within the Browse basin
WA DoT	Department of Transport (WA)
WA EPA	Western Australian Environmental Protection Authority
WAFIC	Western Australian Fishing Industry Council
WAMSI	Western Australian Marine Science Institution
WANCSF	WA North Coast Shark Fishery
WTBF	Western Tuna and Billfish Fishery
WTO	World Trade Organisation

1 Introduction

1.1 Scope

As titleholder, INPEX Browse E&P Pty Ltd. (INPEX) is proposing to undertake a two-dimensional (2D) seismic survey of Exploration Permits WA-532-P and WA-533-P in the Browse and Offshore Canning Basins. The 2D seismic survey will also include the acquisition of seismic data in Production Licence WA-50-L, also within the Browse Basin (Figure 1-1).

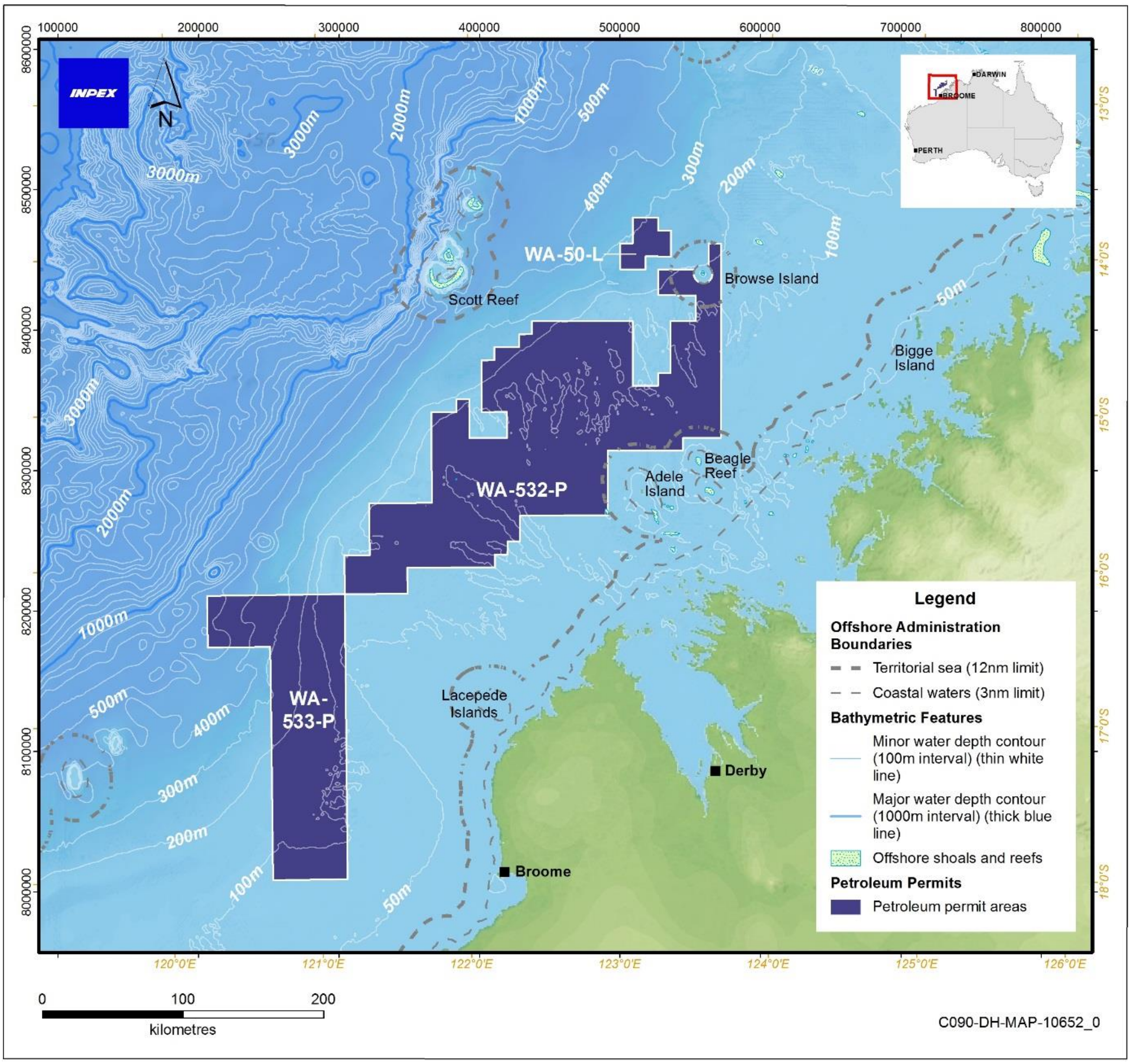


Figure 1-1: Location of WA-532-P, WA-533-P and WA-50-L permit areas

The permit areas are located wholly within Commonwealth waters. At the closest point, the survey activity will be undertaken over 87 km west of Broome and 42 km offshore from the Dampier Peninsula.

The petroleum exploration activity will consist of 2D seismic data acquisition by a single seismic survey vessel within a defined Acquisition Area, and the associated line run-ins, run-outs, line turns, seismic testing and support activities within a defined Operational Area (Section 3.2). It is anticipated that the seismic survey vessel will also be accompanied by one or two support vessels, which will assist with on-the-water communication with other marine users, refuelling, re-supply and other support functions. A small work-boat may assist the survey vessel during deployment, testing and recovery of the seismic equipment. Personnel transfers to and from the seismic survey vessel may also be undertaken by helicopter.

The scope of the petroleum activity and this Environment Plan (EP) is defined as commencing at the point when the seismic array equipment is deployed and within the defined Operational Area, until the survey vessel has demobilised and departed the Operational Area following completion of the survey. The EP does not include any required movement of vessels or helicopters outside of the Operational Area (e.g. travel to and from port). These activities will be undertaken in accordance with relevant maritime and aviation legislation; most notably, the *Navigation Act 2012* (Cwlth).

1.2 Objectives

The objectives of this EP are to:

- demonstrate that the environmental impacts and risks associated with the petroleum activity have been reduced to 'as low as reasonably practicable' (ALARP) and are of an acceptable level, in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations)
- establish appropriate environmental performance outcomes, environmental performance standards and measurement criteria in relation to the operation of the survey vessels
- define an appropriate implementation strategy and monitoring, recording and reporting arrangements, whereby compliance with this EP, the OPGGS (E) Regulations, and other relevant legislative requirements, can be demonstrated
- demonstrate that INPEX has carried out the consultations required by the OPGGS (E) Regulations
- demonstrate that the measures adopted by INPEX, arising from the consultation process, are appropriate
- demonstrate that the petroleum activity complies with the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act) and the OPGGS (E) Regulations.

1.3 Overview of activity description

Table 1-1: Overview of the activity description

Item	Description
INPEX exploration permit / production licence areas	WA-532-P, WA-533-P and WA-50-L
Other titleholders' exploration permit / licence areas within the Acquisition Area that survey lines may enter (subject to Access Authority)	WA-479-P, WA-487-P, WA-281-P, WA-51-L, WA-285-P, WA-424-P, WA-471-P. The survey may also enter vacant acreage which may be awarded in future rounds of acreage release.
Basins	Browse Basin Offshore Canning Basin
Location	The Operational Area is located over 87 km west of Broome and 42 km offshore from the Dampier Peninsula at the closest point. The Acquisition Area is approximately 20 km further offshore than the Operational Area, over 105 km west of Broome and 61 km offshore from the Dampier Peninsula at the closest point.
Vessels	1 x survey vessel 1 to 2 x supply/support vessels 1 to 2 x work boats (small launch from survey vessel)
Activities	2D seismic survey

Item	Description
Activity timing	The 2D seismic survey (i.e. seismic acquisition) is proposed to commence 1 November 2021 at its earliest. Based on the environmental risk assessment presented in Section 7, the acceptable window of opportunity was determined to be from 1 November to 31 May. No seismic acquisition would occur between the June to October period in any year. At the time of writing, it is unknown if COVID-19 international/interstate travel restrictions will still apply in November 2021. In event that seismic acquisition is unable to commence on 1 November 2021, further provision to commence the activity in November 2022 or November 2023 has been allowed for. Therefore, the time period applicable to the EP is as follows: • 1 November 2021 – 31 May 2022 • 1 November 2022 – 31 May 2023 (contingency only) • 1 November 2023 – 31 December 2023 (contingency only). Further, whilst seismic acquisition is intended to be executed over a single campaign (e.g. November 2021 – May 2022), remobilisation in the following window of opportunity may be required in the event the full acquisition scope cannot be achieved.
Duration	Seismic data acquisition duration: 105-140 days Total survey duration (allowing for adverse weather and operational downtime): Up to 210 days

1.4 Titleholder details

INPEX Browse E&P Pty Ltd is the sole titleholder of Exploration Permits WA-532-P and WA-533-P. Seismic data acquisition within Production Licence WA-50-L will be undertaken on behalf of INPEX Ichthys Pty Ltd. Any seismic data acquisition that occurs in the permit / licence areas granted to other petroleum titleholders will also be undertaken subject to an Access Authority granted by NOPTA.

In accordance with Regulation 15(1) of the OPGGS (E) Regulations 2009, details of the titleholder are described in Table 1-2. INPEX will be responsible for ensuring that activities covered in this EP are carried out in accordance with the OPGGS (E) Regulations 2009, this EP and other applicable Australian legislation.

Table 1-2: Titleholder details

Name	INPEX Browse E&P Pty Ltd (INPEX)
Business address	Level 22, 100 St Georges Tce, Perth, WA 6000
Telephone number	+61 8 6213 6000
Fax number	+61 8 6213 6455

Email address	enquiries@inpex.com.au
ABN	61 165 711 017

In accordance with Regulation 15(2) of the OPGGS (E) Regulations 2009, details of the titleholder's nominated liaison person are provided in Table 1-3.

Table 1-3: Titleholder nominated liaison officer

Name	Jake Prout
Position	Environmental Operations Team Lead
Business address	INPEX Australia, Level 22, 100 St Georges Terrace, Perth, WA, 6000
Telephone number	+61 8 9213 6201
Email address	jake.prout@inpex.com.au

1.4.1 Notification arrangements

In the event that the titleholder, nominated liaison person or contact details for the nominated liaison person change, INPEX will notify the regulator in accordance with Regulation 15(3) of the OPGGS (E) Regulations 2009.

1.5 Financial assurance

Financial assurance for the titleholder's liabilities for cleaning up, remediating and monitoring the impact of a petroleum release has been calculated using the Australian Petroleum Production and Exploration Association (APPEA) methodology based on the maximum credible loss scenario.

A declaration of financial assurance will be provided in relation to titles WA-532-P, WA-533-P and WA-50-L prior to acceptance. These forms have not been attached for public comment in Appendix A.

2 Environmental management framework

In accordance with Regulation 13(4) of the OPGGS (E) Regulations 2009, the requirements, including legislative requirements that apply to the activity and are relevant to environmental management, are described in this section with reference to demonstration of how those requirements will be met.

2.1.1 Corporate framework

The INPEX Australia health safety, environment and quality management system (HSEQ-MS) is part of the INPEX's Business Management System (BMS), an integrated framework of policies, standards and procedures that describe how business activities at INPEX are governed and managed.

The INPEX Environmental Policy sets the direction and minimum expectations for environmental performance, and is implemented through the standards and procedures of the HSEQ-MS. This system and policy are further described in Section 9 in accordance with Regulation 16(a) of the OPGGS (E) Regulations 2009.

2.1.2 Legislative framework

In accordance with Regulation 13(4) of the OPGGS (E) Regulations 2009, the legislative framework relevant to the petroleum activity is listed in Table 2-1. A summary of applicable industry standards and guidelines is also presented in Table 2-2. Ongoing management of legislative and other requirements is described further in in Section 9.8.1.

2.1.3 Seismic survey and underwater noise assessment guidelines

A summary of policies and guidelines applicable to the assessment and management of seismic surveys and underwater noise impacts in Australia is presented in Table 2-3.

Table 2-1: Summary of applicable legislation

Legislation	Description	Requirements	Demonstration of how requirements are met in EP
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act; Cwlth) and Environment Protection and Biodiversity Conservation Regulations 2000 (EPBC Regulations)	Provides for the protection and management of nationally and internationally important flora, fauna, ecological communities, and heritage places.	The OPGGS (E) Regulations were revised in February 2014 to include the requirement that matters protected under Part 3 of the *EPBC Act* are considered and any impacts are at acceptable levels. Part 8 of the EPBC Regulations outlines requirements for vessel when interacting with cetaceans. EPBC Act Policy Statement 2.1 provides a framework for minimising the risk of injury to whales by outlining requirements for vertical seismic profiling. The EPBC Act provides for protection of 'matters of national environmental significance' including not only listed species but also heritage properties and Ramsar wetlands. There are exemptions covering provisions of Part 3 and 13 of the *EPBC Act*, for the undertaking of activities when responding to maritime environmental emergencies, in accordance with the National Plan for Maritime Environmental Emergencies (NatPlan – AMSA 2019b). Australian Marine Parks (AMPs) are proclaimed under this Act and associated management plans are enacted under this legislation.	Section 4.3 – Australian Marine Parks. Section 7.1 – Noise and vibration. Section 7.4.2 – Physical presence of vessels and interaction with marine fauna. Section 7.2.5 – Australian Marine Park values. A demonstration of how this EP addresses the relevant conservation management documents related to EPBC-listed species has been presented in Appendix B.

Legislation	Description	Requirements	Demonstration of how requirements are met in EP
OPGGS Act and OPGGS (E) Regulations (Cwlth)	The OPGGS (E) Regulations under the OPGGS Act require a titleholder to have an accepted plan in place for a petroleum activity.	The OPGGS (E) Regulations require that the petroleum activity is undertaken in an ecologically sustainable manner, and in accordance with an accepted EP.	Throughout this EP and implementation of the HSEQ-MS.
Navigation Act 2012 (Cwlth)	The primary legislation that regulates ship and seafarer safety, shipboard aspects of protection of the marine environment, and employment conditions for Australian seafarers.	The *Navigation Act 2012* includes specific requirements for safe navigation, including systems, equipment and practices consistent with the International Convention for the Safety of Life at Sea (SOLAS) and the International Regulations for Preventing Collisions at Sea (COLREGS), as implemented as maritime law in Australia through a series of Marine Orders, including Marine Orders – Part 21 – Safety of navigation and emergency procedures and Marine Orders – Part 30 – Prevention of collisions. The *Navigation Act 2012*, in conjunction with the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and through legislative Marine Orders, also requires vessels to have pollution prevention certificates (see below).	Section 7.2.4 – Physical presence – disruption to other marine users. Section 8.2- Vessel collision. Implementation of the HSEQ-MS.
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (POTS Act; Cwlth)	The *POTS Act* provides for the prevention of pollution from vessels, including pollution by oil, noxious liquid substances, packaged harmful substances,	The requirements of the POTS Act and the *Navigation Act 2012* are implemented as maritime law in Australia through a series of Marine Orders and legislative instruments, made and administered by the Australian Maritime Safety Authority (AMSA). The requirements of each Marine Order made	Section 7 and Section 8. Implementation of the HSEQ-MS.

Legislation	Description	Requirements	Demonstration of how requirements are met in EP
	sewage, garbage, and air pollution. In conjunction with Chapter 4 of the *Navigation Act 2012*, the POTS Act gives effect to relevant requirements of the International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL 73/78) in Australia.	under the POTS Act and the *Navigation Act 2012* and their relevance to the activity are outlined separately below.	
Marine Orders Part 91 – Marine pollution prevention — oil	Marine Orders Part 91 implements Part II of the POTS Act, Chapter 4 of the *Navigation Act 2012*, and Annex I of MARPOL 73/78 (oil pollution). The Marine Orders provide standards for the discharge of certain oily mixtures or oily residues and associated equipment and include duties to manage bunkering and transfers of oil between vessels; to maintain Oil Record Books and Shipboard Oil Pollution Emergency Plans (SOPEPs); and to report oil pollution.	The survey vessels ≥400 gross tonnes (GT) are required to maintain: International Oil Pollution Prevention (IOPP) certificates to demonstrate that the vessel or facility and onboard equipment comply with the requirements of Annex I of MARPOL 73/78 (as applicable to vessel size, type and class). Oil Record Books to record activities, such as fuel/oil bunkering and discharges of oil, oily water, mixtures and residues. SOPEPs outlining the procedures to be followed during an oil pollution incident. Discharges must also comply with Annex I of MARPOL 73/78, and oil pollution incidents must also be reported to AMSA.	Section 7.5.3 – Routine discharges. Section 7.7 – Loss of containment. Section 8 - Emergency Conditions - Impact and Risk Evaluation. OPEP (Appendix F). Implementation of the HSEQ-MS.

Legislation	Description	Requirements	Demonstration of how requirements are met in EP
Marine Orders Part 94 – Marine pollution prevention — packaged harmful substances	Marine Orders Part 94, – Marine pollution prevention — packaged harmful substances, and the *POTS Act* relating to packaged harmful substances as defined by Annex III of MARPOL 73/78.	INPEX and vessel contractor will comply with the *Navigation Act 2012* – Marine Orders – Part 94: Marine Pollution Prevention– Packaged Harmful Substances (as appropriate to vessel class), through reporting the loss or discharge to sea of any harmful materials.	Section 7.6– Waste management.
Marine Orders Part 96 – Marine pollution prevention — sewage	Marine Orders Part 96 – Marine pollution prevention — sewage implements Part IIIB of the POTS Act, Chapter 4 of the *Navigation Act 2012*, and Annex IV of MARPOL 73/78 (sewage). The Marine Orders include requirements for the treatment, storage and discharge of sewage and associated sewage systems, and for an International Sewage Pollution Prevention (ISPP) certificate to be maintained on board.	Survey vessels ≥400 GT are required to maintain International Sewage Pollution Prevention (ISPP) certificates to demonstrate that vessels and their onboard sewage systems comply with the requirements of Annex IV of MARPOL 73/78. Discharges of sewage must also comply with Annex I of MARPOL 73/78, and oil pollution incidents must also be reported to AMSA.	Section 7.5.3 – Routine discharges. Implementation of the HSEQ-MS.
Marine Orders Part 95 – Marine pollution prevention — garbage	Marine Orders Part 95 – Marine pollution prevention — garbage implements Part IIIC of the POTS Act, Chapter 4 of the *Navigation Act 2012*, and	Survey vessels ≥100 GT, or vessels certified to carry 15 persons or more, are required to maintain a Garbage Management Plan. Survey vessels ≥400 GT are required to maintain a Garbage Record Book.	Section 7.6 – Waste Management. Implementation of the HSEQ-MS.

Legislation	Description	Requirements	Demonstration of how requirements are met in EP
	Annex V of MARPOL 73/78 (garbage). The Marine Orders provide for the discharge of certain types of garbage at sea, waste storage, waste incineration, and the comminution and discharge of food waste. They also set out requirements for garbage management and recording.	The requirements will apply to the vessels (as appropriate to their size, type and class) at all times.	
Marine Orders Part 97 – Marine pollution prevention — air pollution	Marine Orders Part 97 – Marine pollution prevention — air pollution implements Part IIID of the POTS Act, Chapter 4 of the *Navigation Act 2012*, and Annex VI of MARPOL 73/78 (air pollution). The Marine Orders set requirements for marine diesel engines and associated emissions, waste incineration on board vessels, engine fuel quality, and equipment and systems containing ozone-depleting substances (ODS).	Survey vessels ≥400 GT are required to have International Air Pollution Prevention (IAPP) certificates and Engine International Air Pollution Prevention (EIAPP) certificates to demonstrate that the vessel and onboard marine diesel engines comply with the requirements of Annex VI of MARPOL 73/78. Low-sulfur fuel oil / marine diesel with and 0.5% m/m sulfur content on and after 1 January 2020. Vessels ≥400 GT are required to have an Internal Maritime Organization (IMO)-approved waste incinerator, as confirmed by the IAPP certificate. The Marine Orders require vessels ≥400 GT with rechargeable systems containing ODS to maintain an ODS Record Book.	Section 7.5.2 – Atmospheric emissions. Implementation of the HSEQ-MS.

Legislation	Description	Requirements	Demonstration of how requirements are met in EP
Biosecurity Act 2015 (Cwlth)	The Act and subordinate legislation are the primary legislative means for managing risk of pests and diseases entering Australian territory and seas and causing harm to animals, plant and human health, the environment and/or the economy.	Of specific relevance to this EP, the Act requires that ballast is managed within Australian seas; as such the Biosecurity Act now defines Australian seas as: • for domestic and international vessels whose Flag State Administration is party to the BWM Convention – the waters (including the internal waters of Australia) that are within the outer limits of the exclusive economic zone (EEZ) of Australia (all waters within 200 nm) or • for all other international vessels – the Australian territorial seas (all waters within 12 nm).	Section 7.4.1 - Invasive marine species. Implementation of the HSEQ-MS.
Biodiversity Conservation Act 2018 (WA) *Animal Welfare Act 2002* (WA)	Ensures the protection of biodiversity and humane treatment of native fauna. Ensures appropriate treatment and management of wildlife in the event of a potential hydrocarbon spill and response activities.	Consult with WA Department of Biodiversity, Conservation and Attractions (DBCA) and obtain relevant permit(s) before a wildlife hazing (the use of deterrents or other techniques to keep wildlife away from contaminated areas) and post contact wildlife response, if applicable following a hydrocarbon spill.	Section 8 – Emergency conditions. OPEP (Appendix F).
Fish Resources Management Act 1994 (WA)* * *The Aquatic Resources Management Act 2016* (ARM Act) will	The *Fish Resources Management Act* is administered by the WA Department of Primary Industry and Regional Development (WA DPIRD)	INPEX will manage its operations in accordance with the Act and the associated Fish Resources Management Regulations (1995) with respect to managing potential invasive marine species (IMS) risks.	Section 7.4.1 - Invasive marine species. Implementation of the HSEQ-MS.

Legislation	Description	Requirements	Demonstration of how requirements are met in EP
supersede this Act as the primary legislation used to manage fishing, aquaculture, pearling and aquatic resources in WA. This EP will be updated to reflect this once the ARM Act comes into effect.	that has powers to deal with incursions of marine pests.		

Table 2-2: Summary of applicable industry standards and guidelines

Guideline	Description
Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ 2000)	These guidelines provide a framework for water resource management and state specific water quality guidelines for environmental values, and the context within which they should be applied.
International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL 73/78)	This convention is designed to reduce pollution of the seas, including dumping, oil and exhaust pollution. MARPOL 73/78 currently includes six technical annexes. Special areas with strict controls on operational discharges are included in most annexes.
International Convention on the Control of Harmful Anti-fouling Systems	This convention prohibits the use of harmful organotins in antifouling paints used on ships and establishes a mechanism to prevent the potential future use of other harmful substances in antifouling systems.
International Convention for the Safety of Life at Sea (SOLAS) 1974	In the event of an offshore emergency event that endangers the life of personnel, the International Convention for the Safety of Life at Sea (SOLAS) 1974 may take precedence over environmental management.
Bonn Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil and other harmful substances (Bonn Agreement)	The Bonn Agreement is the mechanism by which the North Sea states, and the European Union (the Contracting Parties), work together to help each other in combating pollution in the North Sea area from maritime disasters and chronic pollution from ships and offshore installations; and to carry out surveillance as an aid to detecting and combating pollution at sea. The Bonn Agreement Oil Appearance Code may be used during spill response activities.
The Australian Petroleum Production and Exploration Association (APPEA) *Code of Environmental Practice* (APPEA 2008)	Recognising the need to avoid or minimise and manage impacts to the environment, this code of environmental practice includes four basic recommendations to APPEA members undertaking activities: Assess the risks to, and impacts on, the environment as an integral part of the planning process. Reduce the impact of operations on the environment, public health and safety to as low as reasonably practicable (ALARP) and to an acceptable level by using the best available technology and management practices. Consult with stakeholders regarding industry activities. Develop and maintain a corporate culture of environmental awareness and commitment that

Guideline	Description
	supports the necessary management practices and technology, and their continuous improvement.
Australian Ballast Water Requirements, Version 7 (DAWR 2017)	Australian Ballast Water Management Requirements outline the mandatory ballast water management requirements to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ballast water from international vessels. These requirements are enforceable under the *Biosecurity Act 2015*.
National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry (MPSC 2018)	A voluntary biofouling management guidance document developed under the National System for the Prevention and management of Marine Pest Incursions. Its purpose is to provide tools to operators to minimise the amount of biofouling accumulating on their vessels, infrastructure and submersible equipment and thereby to minimise the risk of spreading marine pests.
International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) (IMO 2009)	All vessels are required to manage their ballast water and sediments in accordance with the Convention and *Biosecurity Act 2015*. The convention came into force on 8 September 2017 and Australia's ballast water policy and legislation align with the convention.
Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (IMO 2012)	The guidelines provide a globally consistent approach to the management of biofouling. They aim to reduce the risk of translocation of marine pests from biofouling present on immersed areas of vessels. It was adopted by IMO marine environment committee in the form of Resolution MEPC.207 (62) in 2011.

Table 2-3: Summary of policies and guidelines applicable to the assessment and management of underwater noise impacts and marine seismic surveys

Policy / Guideline	Description
EPBC Act Policy Statement 2.1 (DEWHA 2008a)	The policy statement encourages industry to minimise the likelihood of seismic activities causing injury or hearing impairment to whales in Australian waters. The policy statement outlines sound exposure criteria for determining appropriate precaution zones and outlines recommended management procedures. Part A of the policy statement outlines standard management procedures, which include: • pre-start-up visual observations • soft-start procedures • start-up delay procedures • operations and shut-down procedures • night-time and low visibility procedures.

Policy / Guideline	Description
	Part B of the policy statement outlines additional optional management procedures for consideration for seismic surveys in areas where there is a moderate to high likelihood of encountering whales.
NOPSEMA (2018) Information Paper IPI765: Acoustic Impact Evaluation and Management	The information paper provides advice to titleholders to assist with preparing EPs for marine seismic survey activities, and in particular the components of an EP that relate to detailing, evaluating and managing impacts from acoustic emissions.
WA DPIRD Fisheries Research Report No. 288: Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia (Webster et al. 2018)	The Fisheries Division of the WA DPIRD undertook an ecological risk assessment (ERA) of the potential effects of seismic surveys on marine finfish and invertebrates. The ERA assessed different categories of seismic source volume and the potential exposure of different types of finfish and invertebrates in different water depths. The ERA was undertaken at the level of *individual* adult finfish and invertebrate organisms closest to the seismic source and it was assumed that an individual organism remains stationary (i.e. does not flee) and is positioned directly in the path of the vessel, thus experiencing numerous pulses with varying degrees of intensity as the vessel approaches, passes overhead and moves further away. Therefore, the WA DPIRD ERA represents a highly conservative worst-case scenario that is not representative of real-life exposures in all cases, as it does not account for any avoidance response by mobile organisms. The WA DPIRD ERA identified that overall the greater the intensity of sound and shallower the water depth the greater the assigned risk. The organisms classified as most at risk from seismic impacts were immobile invertebrates (e.g. molluscs) while pelagic fish were rated as the least at risk. The 2D seismic exploration survey environmental impact and risk assessment in Section 7.1 of this EP has applied additional activity-specific and situation-specific context to assess potential risks to individuals and populations. A guidance statement is currently being developed by the WA DPIRD Fisheries Division on the assessment of impacts at the population level.

3 Activity description

As per the requirements of Regulation 13(1) of the OPGGS (E) Regulations, the following subsections provide a comprehensive description of the petroleum activity, including location, operational details, and any additional information relevant for consideration of the environmental risks and impacts associated with the activity.

3.1 Activity overview

The proposed 2D seismic survey will be undertaken in Exploration Permits WA-532-P and WA-533-P, and in Production Licence WA-50-L. The purpose of the 2D seismic survey is to collect geophysical data about rock formations and structures beneath the seabed for the following purposes:

- to assess the potential to discover new oil and gas resources in WA-532-P and WA-533-P
- to provide preliminary data to inform an assessment of the status of the Ichthys gas resource in WA-50-L and how it may have changed following commencement of Ichthys LNG Project production in 2018.

The survey will be undertaken by a seismic survey vessel towing an underwater seismic source and a single streamer behind it. 2D seismic data will be acquired along a grid of broadly-spaced, approximately orthogonal lines (spaced approximately three to six kilometres apart) within the 'Acquisition Area' with associated vessel movements and support activities undertaken within the 'Operational Area' (Figure 3-1).

3.2 Location and timing

3.2.1 Acquisition Area and Operational Area

The Acquisition Area (Figure 3-1) defines where seismic data acquisition will occur. At the closest points, the Acquisition Area is located approximately:

- 105 km from Broome
- 60 km from the Lacepede Islands
- 61 km from the Dampier Peninsula
- 24 km from Adele Island
- 10 km from Beagle Reef
- 30 km from Scott Reef
- 17 km from Browse Island.

Most of the Acquisition Area is in water depths between approximately 50 m and 600 m below mean sea level. Water depths less than 50 m are located at Lynher Bank in the southern part of WA-532-P where the shallowest water depth is approximately 30 m, and east of WA-533-P where the shallowest water depth is approximately 37 m.

The Operational Area (Figure 3-1) generally includes 15-20 km of space surrounding the Acquisition Area, required for vessel line run-ins, run-outs and line turns, and for the deployment, recovery and testing of equipment. Support activities such as vessel reprovisioning, refuelling and personnel transfers may also take place in the Operational Area.

Note, there is not a 15-20 km Operational Area surrounding the Acquisition Area adjacent to the Habitat Protection Zone (HPZ) and National Park Zone (NPZ) of the Kimberley

Australian Marine park (AMP). No seismic survey activities are permitted within these zones and so the Operational Area is excluded (Figure 3-1).

The seismic vessel, support vessels or towed survey equipment will not enter the HPZ or NPZ at any time during the petroleum activity.

At the closest points, the Operational Area is located approximately:

- 87 km from Broome
- 39 km from the Lacepede Islands
- 42 km from the Dampier Peninsula
- 12 km from Scott Reef.

The Operational Area boundary is contiguous with the 3 nm (5.5 km) State coastal waters boundary surrounding Browse Island.

3.2.2 Survey timing

The 2D seismic survey (i.e. seismic acquisition) is proposed to commence 1 November 2021 at its earliest. Based on the environmental risk assessment presented in Section 7, the acceptable window of opportunity was determined to be from 1 November to 31 May. No seismic acquisition would occur between the June to October period in any year.

At the time of writing, it is unknown if COVID-19 international/interstate travel restrictions will still apply in November 2021. In event that seismic acquisition is unable to commence on 1 November 2021, further provision to commence the activity in November 2022 or November 2023 has been allowed for. Therefore, the time period applicable to the EP is as follows:

- 1 November 2021 – 31 May 2022
- 1 November 2022 – 31 May 2023 (contingency only)
- 1 November 2023 – 31 December 2023 (contingency only).

Further, whilst seismic acquisition is intended to be executed over a single campaign (e.g. November 2021 – May 2022), remobilisation in the following window of opportunity may be required in the event the full acquisition scope cannot be achieved.

As such, the actual timing of the activity is dependent upon COVID-19 travel restrictions to enter Western Australia, vessel availability, contracting, and avoidance of environmentally sensitive time periods where specified as management measure in this EP.

Regardless of the year the survey commences, the survey activity will comprise approximately 140 days of seismic data acquisition. To allow for potential adverse weather and operational downtime, the survey may occur over a longer period, and so the survey vessel may be present in the Operational Area for up to 210 days.

3.3 Seismic survey activities

Key details of the INPEX 2D seismic survey are summarised in Table 3-1 and described in the following subsections.

Table 3-1: Key seismic survey details

Feature / Parameter	Description
2D Seismic Data Acquisition	
Total acquisition line kms	10,000 – 12,000 kms

Feature / Parameter	Description
Total acquisition duration	Up to 140 days
Seismic source volume	Approximately 3,000 cubic inches
Source discharge pressure	Approximately 2,000 psi
Source point interval (SPI)	18.75 m (approximately every 8 seconds)
Source tow depth	5 – 10 m
Streamer length	6 – 10 km
Number of streamers	1
Streamer tow depth	5 – 15 m
Vessel acquisition speed	Approximately 4.5 knots (~8 km/hour)
Seismic Survey Vessel	
Number of seismic vessels	One
Fuel type	Marine diesel (marine gas oil; MGO)
Largest fuel tank volume	284 m^3
Support Activities	
Number of support / supply vessels	One to two vessels will assist with on-the-water communications with other marine users, refuelling, re-supply and other support functions. One to two small work boats (typically 5-10 m in length) launched from the seismic vessel will be used to assist with equipment deployment, maintenance and recovery.
Refuelling and resupply	In port or at sea (approximately every 5 – 8 weeks)
Crew changes	In port or at sea via helicopter or supply vessel

3.3.1 Seismic source

The 2D seismic survey will be acquired using a seismic source with an approximate total volume of 3,000 cubic inches with an operating pressure of approximately 2,000 psi. The seismic source specifications were selected following a feasibility study, review of legacy seismic survey parameters, and using information provided by experienced seismic contractors. The source specifications have considered the range of water depths within the Acquisition Area and depth of the targets within the subsurface geology to ensure adequate seismic imaging.

INPEX has not yet selected a seismic contractor to undertake the seismic survey. Therefore, to account for different seismic source options and maximum potential underwater sound outputs, INPEX has evaluated three seismic sources (2970, 3000 and 3080 cubic inches) available from three potential 2D seismic contractors to account for representative sound levels in the assessment of environmental impacts and risks (Section 7.1.2).

3.3.2 Acquisition line plan

The 2D seismic survey will include:

- 5,185 line kms of 2D seismic data within WA-532-P (revised minimum work requirement under the title)
- 5,005 line kms of 2D seismic data within WA-533-P (minimum work requirement under the title)
- a limited number of well-to-seismic tie lines that extend beyond the WA-532-P and WA-533-P permit area boundaries to link INPEX 2D data acquisition with exploration data available at existing well locations in the region
- a limited number of acquisition lines that extend across the WA-50-L Production Licence.

In total, between 10,000 and 12,000 line kms of 2D seismic data will be acquired within the Acquisition Area.

The acquisition lines will be spaced approximately 3-6 km apart. Acquisition lines that span WA-532-P will be orientated approximately northeast-southwest and northwest-southeast. Acquisition lines that span WA-533-P may also be of a similar orientation to WA-532-P, but for operational efficiency, may instead be orientated north-south and east-west. Two indicative line orientation examples are presented in Figure 3-2.

The final line plan orientation will be designed following a detailed seismic acquisition feasibility study and will consider the environmental management measures outlined in this EP.

3.3.3 Seismic data acquisition

The INPEX 2D seismic survey will be undertaken by a seismic survey vessel towing the seismic source and a single streamer beneath the water surface. A typical seismic survey vessel is approximately 60-120 m in length, although 2D survey vessels are usually in the smaller end of this size range.

The seismic source will be towed behind the vessel at water depths of approximately 5-10 m. The seismic source will use compressed air to emit regular pulses of sound which reflect off the seabed and underlying geological rock formations and structure boundary. The reflected sound will be received by the streamer, which may be up to 6-10 km in length and will be towed behind the survey vessel at a water depth of approximately 5-15 m.

During the survey, the survey vessel will sail along the pre-determined acquisition lines at a speed of approximately 4.5 knots (approximately 8 km/hr), discharging the seismic source approximately every 18.75 m (approximately every 8 seconds). Once the survey vessel completes an acquisition line, it will undertake a 'run-out', a turn and a 'run-in', before commencing acquisition along the next line. The run-out requires operating the seismic source for approximately 4-5 km beyond the end of each acquisition line. Following the vessel turn, a run-in of several kilometres is undertaken to straighten the streamer prior to commencing the next line.

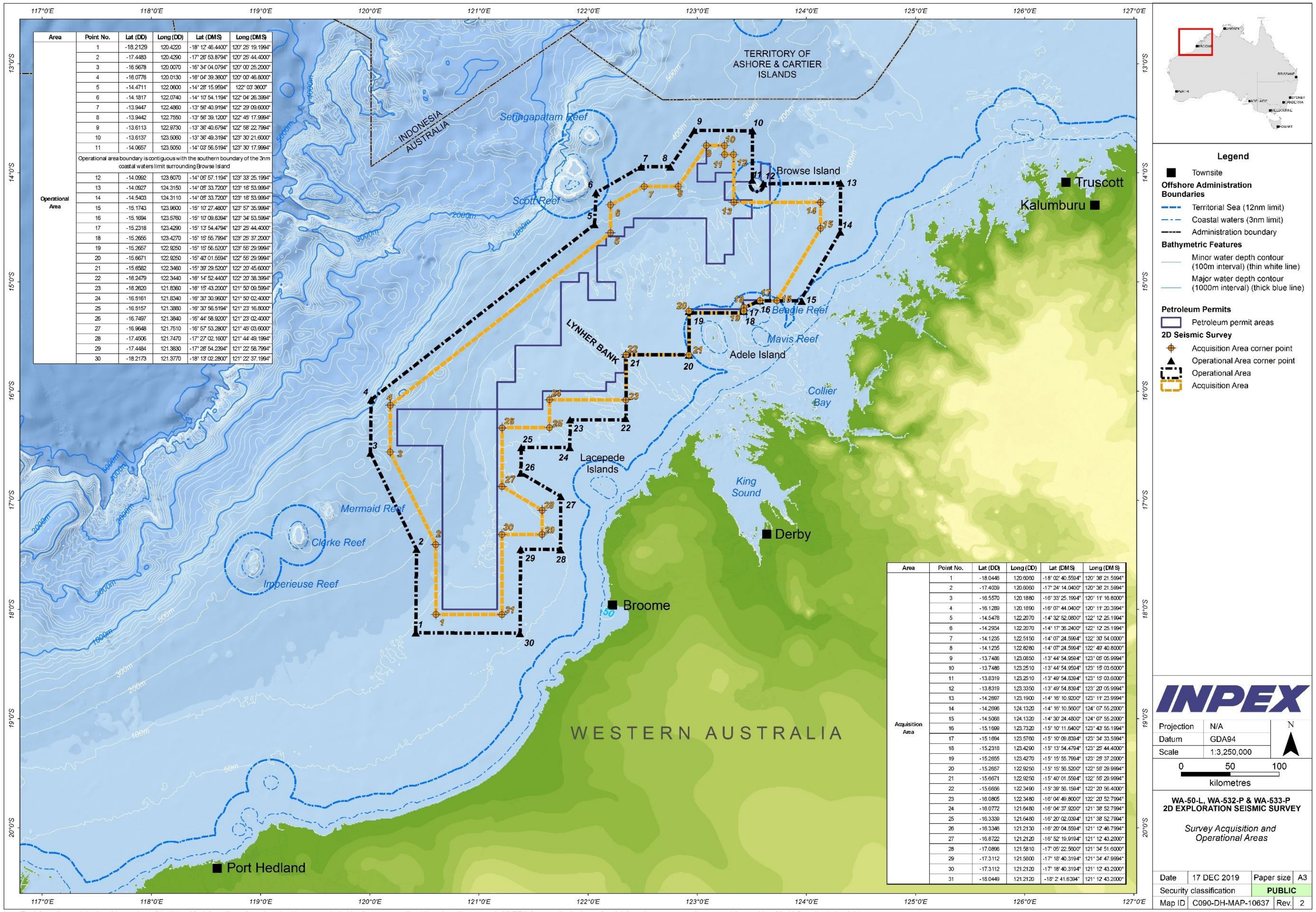
"Soft starts", where the seismic source is gradually increased from low power to the full required power level, will be undertaken during the run-ins to reduce the potential impact on marine fauna. Therefore, the seismic source may be operated approximately 4–5 km beyond the defined Acquisition Area boundary in some instances. All run-outs, turns and run-ins will be completed within the defined Operational Area.

3.4 Support vessels and aircraft

The seismic survey vessel will be accompanied by one to two support vessels, which will assist with on-the-water communication with other marine users, refuelling, re-supply and other support functions. A small work-boat (typically 5-10 m in length which can be deployed from the seismic survey vessel) may also assist the survey vessel within the Operational Area during deployment and recovery of the seismic source and streamer.

Refuelling and re-supply will occur approximately every 5-8 weeks, either at sea or in port. Crew changes are also expected to occur approximately every 5-8 weeks, which will involve either the vessels returning to port or personnel transfers via helicopter or supply vessels.

Vessels are expected to operate from the Port of Broome.



Area	Point No.	Lat (DD)	Long (DD)	Lat (DMS)	Long (DMS)
Operational Area	1	-18.2129	120.4220	-18° 12' 46.4400"	120° 25' 19.1994"
	2	-17.4483	120.4290	-17° 26' 53.8794"	120° 25' 44.4000"
	3	-16.5678	120.0070	-16° 34' 04.0794"	120° 00' 25.2000"
	4	-16.0776	120.0130	-16° 04' 39.3600"	120° 00' 46.8000"
	5	-14.4711	122.0600	-14° 28' 15.9594"	122° 03' 3600"
	6	-14.1817	122.0740	-14° 10' 54.1194"	122° 04' 26.3994"
	7	-13.9447	122.4860	-13° 56' 40.9194"	122° 29' 09.6000"
	8	-13.9442	122.7550	-13° 56' 39.1200"	122° 45' 17.9994"
	9	-13.6113	122.9730	-13° 36' 40.6794"	122° 58' 22.7994"
	10	-13.6137	123.5060	-13° 36' 49.3194"	123° 30' 21.6000"
	11	-14.0657	123.5050	-14° 03' 56.5194"	123° 30' 17.9994"
	Operational area boundary is contiguous with the southern boundary of the 3nm coastal waters limit surrounding Browse Island				
	12	-14.0992	123.6070	-14° 05' 57.1194"	123° 33' 25.1994"
	13	-14.0927	124.3150	-14° 05' 33.7200"	123° 18' 53.9994"
	14	-14.5403	124.3110	-14° 05' 33.7200"	123° 18' 53.9994"
	15	-15.1743	123.9600	-15° 10' 27.4800"	123° 57' 35.9994"
	16	-15.1694	123.5760	-15° 10' 09.8394"	123° 34' 53.5994"
	17	-15.2318	123.4290	-15° 13' 54.4794"	123° 25' 44.4000"
	18	-15.2655	123.4270	-15° 15' 55.7994"	123° 25' 37.2000"
	19	-15.2657	122.9250	-15° 15' 56.5200"	123° 55' 29.9994"
	20	-15.6671	122.9250	-15° 40' 01.5594"	122° 55' 29.9994"
	21	-15.6582	122.3460	-15° 39' 29.5200"	122° 20' 45.6000"
	22	-16.2479	122.3440	-16° 14' 52.4400"	122° 20' 38.3994"
	23	-16.2620	121.8360	-16° 15' 43.2000"	121° 50' 09.5994"
	24	-16.5161	121.8340	-16° 30' 30.9600"	121° 50' 02.4000"
	25	-16.5157	121.3880	-16° 30' 56.5194"	121° 23' 16.8000"
	26	-16.7497	121.3840	-16° 44' 58.9200"	121° 23' 02.4000"
	27	-16.9648	121.7510	-16° 57' 53.2800"	121° 45' 03.6000"
	28	-17.4506	121.7470	-17° 27' 02.1600"	121° 44' 49.1994"
	29	-17.4484	121.3830	-17° 26' 54.2394"	121° 22' 58.7994"
	30	-18.2173	121.3770	-18° 13' 02.2800"	121° 22' 37.1994"

Area	Point No.	Lat (DD)	Long (DD)	Lat (DMS)	Long (DMS)
Acquisition Area	1	-18.0446	120.6060	-18° 02' 40.5594"	120° 36' 21.5994"
	2	-17.4039	120.6060	-17° 24' 14.0400"	120° 36' 21.5994"
	3	-16.5570	120.1880	-16° 33' 25.1994"	120° 11' 16.8000"
	4	-16.1289	120.1890	-16° 07' 44.0400"	120° 11' 20.3994"
	5	-14.5478	122.2070	-14° 32' 52.0800"	122° 12' 25.1994"
	6	-14.2934	122.2070	-14° 17' 36.2400"	122° 12' 25.1994"
	7	-14.1235	122.5150	-14° 07' 24.5994"	122° 30' 54.0000"
	8	-14.1235	122.8280	-14° 07' 24.5994"	122° 49' 40.8000"
	9	-13.7486	123.0850	-13° 44' 54.9594"	123° 05' 05.9994"
	10	-13.7486	123.2510	-13° 44' 54.9594"	123° 15' 03.6000"
	11	-13.8319	123.2510	-13° 49' 54.8394"	123° 15' 03.6000"
	12	-13.8319	123.3350	-13° 49' 54.8394"	123° 20' 05.9994"
	13	-14.2697	123.1900	-14° 16' 10.9200"	123° 11' 23.9994"
	14	-14.2696	124.1320	-14° 16' 10.5600"	124° 07' 55.2000"
	15	-14.5068	124.1320	-14° 30' 24.4800"	124° 07' 55.2000"
	16	-15.1699	123.7320	-15° 10' 11.6400"	123° 43' 55.1994"
	17	-15.1694	123.5760	-15° 10' 09.8394"	123° 34' 33.5994"
	18	-15.2318	123.4290	-15° 13' 54.4794"	123° 25' 44.4000"
	19	-15.2655	123.4270	-15° 15' 55.7994"	123° 25' 37.2000"
	20	-15.2657	122.9250	-15° 15' 56.5200"	122° 55' 29.9994"
	21	-15.6671	122.9250	-15° 40' 01.5594"	122° 55' 29.9994"
	22	-15.6656	122.3490	-15° 39' 56.1594"	122° 20' 56.4000"
	23	-16.0805	122.3480	-16° 04' 49.8000"	122° 20' 52.7994"
	24	-16.0772	121.6480	-16° 04' 37.9200"	121° 38' 52.7994"
	25	-16.3339	121.6480	-16° 20' 02.0394"	121° 38' 52.7994"
	26	-16.3346	121.2130	-16° 20' 04.5594"	121° 12' 46.7994"
	27	-16.8722	121.2120	-16° 52' 19.9194"	121° 12' 43.2000"
	28	-17.0896	121.5810	-17° 05' 22.5600"	121° 34' 51.6000"
	29	-17.3112	121.5800	-17° 18' 40.3194"	121° 34' 47.9994"
	30	-17.3112	121.2120	-17° 18' 40.3194"	121° 12' 43.2000"
	31	-18.0449	121.2120	-18° 2' 41.6394"	121° 12' 43.2000"

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While every effort has been made to ensure the accuracy and completeness of the information presented, no guarantee is given nor responsibility taken by INPEX for any errors or omissions. INPEX accepts no liability for any use of the said information or reliance placed on it.

Figure 3-1 Map showing the proposed 2D seismic survey Acquisition Area and Operational Area

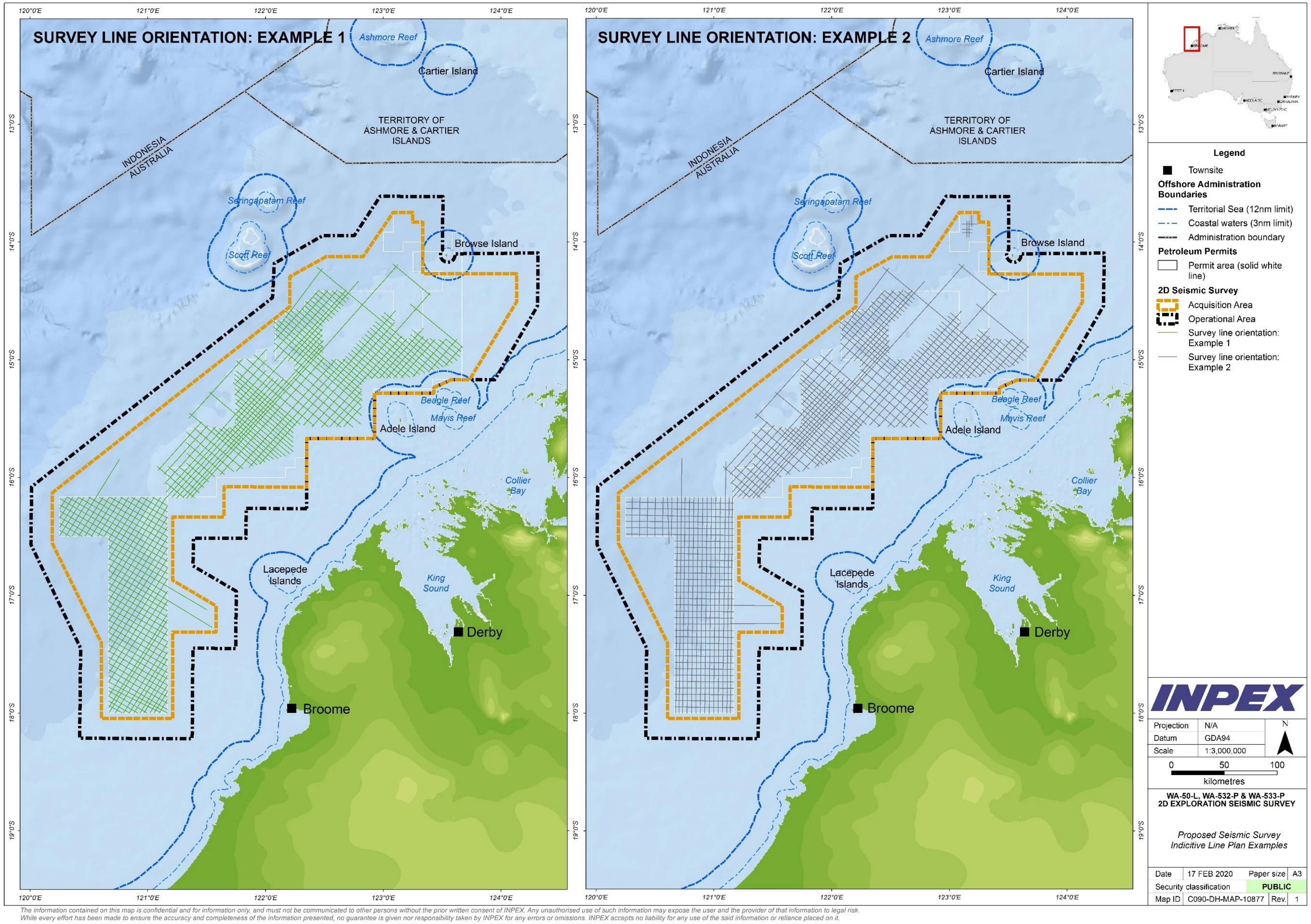

Figure 3-2 Example survey (Acquisition) line orientations

3.5 Summary of emissions, discharges and wastes

A summary of the emissions, discharges, and wastes resulting from the activities covered in this EP are identified in Table 3-2. Relevant monitoring and measurement conducted on the emissions and discharges detailed below are described within the respective subsections of Section 7.

Table 3-2: Emissions (E), discharges (D) and wastes (W) generated during the petroleum activity

Activity/system	E, D, W	Description	
2D seismic survey	E	Seismic source	Sound emissions (pulses) from the seismic source during the survey. Seismic source volume: ~ 3,000 cubic inches. Source point interval: ~18.75 m (8 secs) Sound levels and exposures are described in Section 7.1.2. Records of seismic source activation(on/off) will be retained by the survey contractor.
Power generation	E	Vessels	Combustion emissions from vessels and diesel-powered generators onboard emitted to the atmosphere. Records of diesel consumed will be retained by vessels oil record book.
Cooling water	D	Vessels	Treated seawater used as heat-exchange medium for machinery and engines is returned to sea.
Vessel deck drainage	D	Vessels	Vessel deck drainage water will be discharged to sea.
Bilge system	D	Vessels	Treated contaminated bilge water with <15 ppm (v) oil in water (OIW) is discharged to sea. Records of discharges will be recorded in vessels oil record book.
Sewage, grey water and macerated food waste effluent	D	Vessels	Effluent produced by vessel sewage systems is discharged to sea. Records of waste disposal, including discharge of sewage, will be recorded in the vessel's garbage record book.
Ballast system	D	Vessels	N/A. No ballast exchange will occur within the Operational Area during the survey.
Waste incineration	E	Vessels	Combustion gas emissions from on board incineration of permitted wastes.
	W		Ash from incinerators will be stored as waste for disposal on the mainland.

Activity/system	E, D, W	Description	
			Records of waste disposal, including incinerator ash (if applicable), will be recorded in the vessel's garbage record book.
Miscellaneous	E	Vessels	Light emissions from deck and navigation lights on vessels.
	W		Solid and liquid wastes from general maintenance operations, equipment replacement, etc., and domestic wastes are transported to the mainland for disposal. Records of waste disposal, will be recorded in the vessel's garbage record book.

4 Existing environment

4.1 Regional setting

The Operational Area is situated in the offshore Canning and Browse Basins, approximately 42 km from the mainland of Western Australia at its closest point and contiguous with the State coastal waters limit surrounding Browse Island. The Acquisition Area, where seismic data will be acquired, is located within the Operational Area and adjoins the boundary of the Habitat Protection Zone (HPZ) and National Park Zone (NPZ) of the Kimberley Australian Marine Park (AMP) (Figure 3-1).

The EMBA is the sum of 100 overlayed modelling runs for the worst-case spill scenario (marine diesel spill) at six locations within the Operational Area boundary, and under different hydrodynamic conditions (e.g. currents, winds, tides, etc.). As such, the actual area that may be affected from any single spill event would be considerably smaller than that represented by the EMBA.

The proposed 2D seismic survey will be undertaken by vessels fuelled with marine diesel. As with any marine vessel movement in the region, there is a small risk of an unplanned release from a vessel fuel tank. The spatial extent of the EMBA was determined using stochastic spill modelling. Defined hydrocarbon exposure thresholds were used to determine impacts to fauna and/or habitats (refer Section 8, Table 8-1) for surface hydrocarbons, entrained oil and dissolved aromatic hydrocarbons. Further, as an unplanned spill could potentially occur at any location within the Operational Area the model was run at six separate locations within this area. The release locations were selected to be representative of a release in different parts of the Operational Area and in closest proximity to sensitive receptors.

Note that the release locations were selected based on a draft version of the Operational Area, which incorporated the areas of the Kimberley AMP, HPZ and NPZ. As such, modelling inputs included a release location adjacent to State waters surrounding Adele Island, which is within the HPZ of the Kimberley AMP. The revised Operational Area excludes the HPZ and NPZ of the Kimberley AMP, therefore, the stochastic spill modelling and resultant EMBA near the north-west Kimberley coastline is conservative in context of the revised Operational Area presented in the EP.

The EMBA has been used to identify relevant values and sensitivities that may be affected and has been used as the basis for the EPBC Protected Matters Database search (Appendix B).

4.1.1 North-west Marine Region

Australia’s offshore waters have been divided by the Australian Government into six marine regions in order to facilitate their management under the EPBC Act. The Operational Area and EMBA are located entirely within the North-west Marine Region (NWMR). The NWMR comprises Commonwealth waters, from the WA–NT border in the north, to Kalbarri in the south. The NWMR encompasses a number of regionally important marine communities and habitats which support a high biodiversity of marine life and feeding and breeding aggregations.

4.2 Key ecological features

The Australian Government has identified parts of the marine ecosystem that are considered to be of importance for a marine region’s biodiversity or ecosystem function and integrity, referred to as key ecological features (KEFs; DSEWPaC 2012). As shown in Figure 4-1, the following KEFs occur within the Operational Area or EMBA:

- Ancient coastline at 125 m depth contour (within Operational Area)

- Continental slope demersal fish communities (within Operational Area)
- Seringapatam Reef and Commonwealth waters in the Scott Reef Complex
- Mermaid Reef and Commonwealth waters surrounding Rowley Shoals
- Ashmore Reef and Cartier Island and surrounding Commonwealth waters
- Carbonate bank and terrace system of the Sahul Shelf
- Canyons linking the Argo Abyssal Plain with the Scott Plateau.

4.2.1 Ancient Coastline at 125m Depth Contour

The ancient coastline runs diagonally in a north-easterly direction and overlaps with the north-west part of WA-532-P, and the central part of WA-533-P (Figure 4-1). Parts of the ancient coastline, particularly where it exists as a rocky escarpment, are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of the escarpments may facilitate vertical mixing of the water column, providing relatively nutrient rich local environments. The coastline is an area of enhanced productivity, attracting baitfish which, in turn, supplies food for migrating species (DSEWPaC 2012).

While there is little information available on the fauna associated with the hard substrate of the escarpment, it is likely to include sponges, soft corals, crinoids, molluscs, echinoderms and other benthic invertebrates representative of hard substrate fauna in the NWMR (DSEWPaC 2012).

4.2.2 Continental Slope Demersal Fish Communities

The continental slope demersal fish community overlaps with the deep, north-west portion of the Operational Area (Figure 4-1). The level of endemism (i.e. unique to a location) of demersal fish species in this community is the highest among Australian continental slope environments.

The demersal fish species occupy two distinct demersal community types associated with the upper slope (water depth of 225–500 m) and the mid-slope (750–1000 m) (DEE 2018a). Although research is limited, it is suggested that the demersal-slope communities rely on bacteria and detritus-based systems comprised of infauna and epifauna, which in turn become prey for a range of teleost fish, molluscs and crustaceans (Brewer et al. 2007). Higher-order consumers may include carnivorous fish, deepwater sharks, large squid and toothed whales (Brewer et al. 2007). Pelagic production is phytoplankton based, with hot spots around oceanic reefs and islands (Brewer et al. 2007). Bacteria and fauna present on the continental slope are the basis of the food web for demersal fish and higher-order consumers in this system (DSEWPaC 2012).

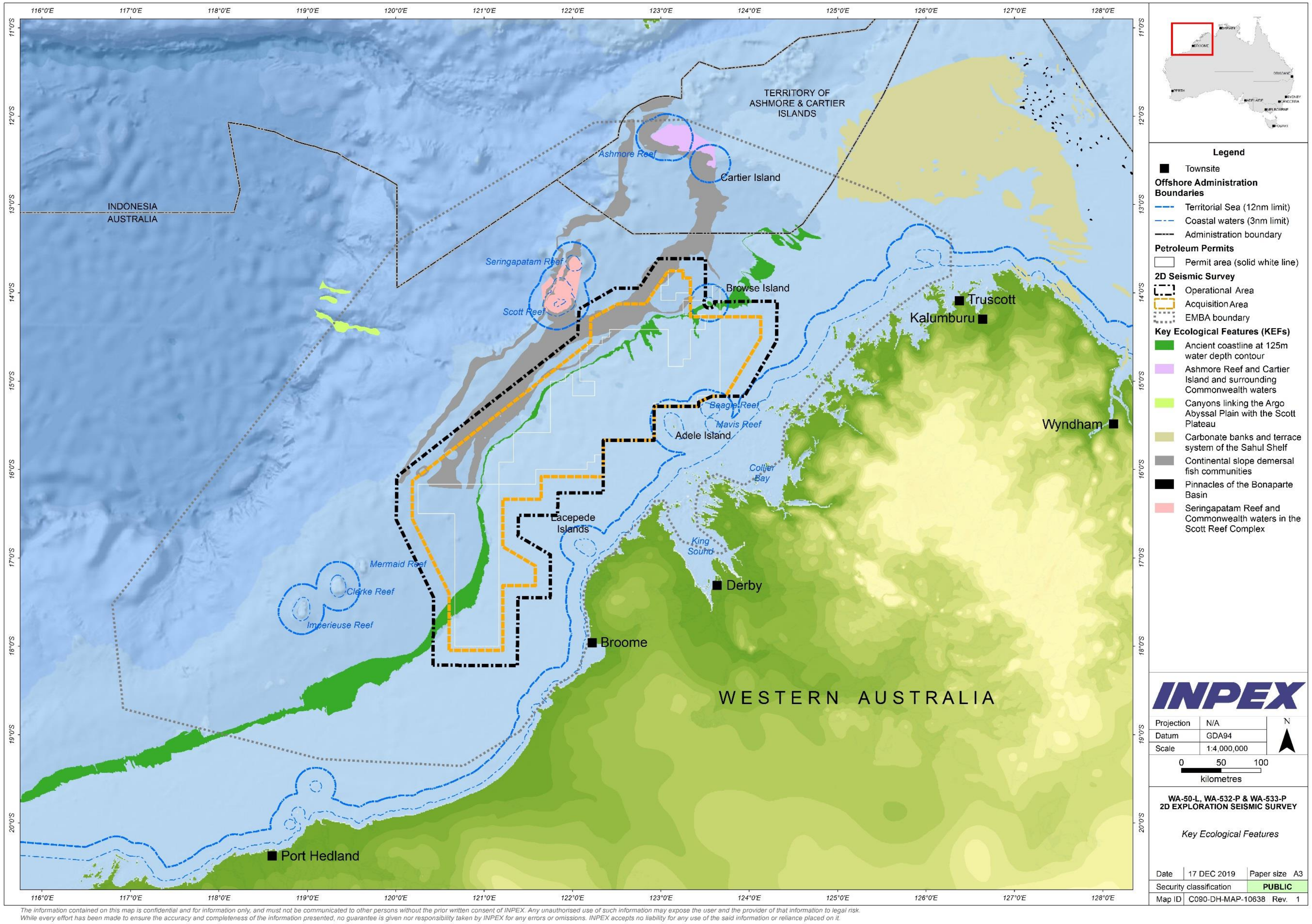

Figure 4-1 Key ecological features relevant to the EMBA

4.2.3 Seringapatam Reef and Commonwealth waters in the Scott Reef Complex

This KEF comprises Seringapatam Reef, Scott Reef North and Scott Reef South, and at its nearest point is approximately 19 km north-west of the Operational Area (Figure 4-1). Scott and Seringapatam reefs are part of a series of submerged reef platforms that rise steeply from the seafloor. The total area of this KEF is approximately 2,400 km^2 (DSEWPaC 2012).

Scott and Seringapatam reefs are regionally significant because of their high representation of species not found in coastal waters off Western Australia, and for the unusual nature of their fauna which has affinities with the oceanic reef habitats of the Indo West Pacific, as well as the reefs of the Indonesian region. The coral communities at Scott and Seringapatam reefs play a key role in maintaining the species richness and subsequent aggregations of marine life identified as conservation values for this KEF. Scott Reef is a particularly biologically diverse system and includes more than 300 species of reef building corals, approximately 400 mollusc species, 118 crustacean species, 117 echinoderm species, and around 720 fish species (Woodside 2009).

Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life, including humpback whales and other cetacean species, whale sharks and seasnakes (Donovan et al. 2008; Jenner et al. 2008; Woodside 2009). Two species of marine turtle, the green and hawksbill, nest during the summer months on Sandy Islet (a small sand cay), located on Scott Reef South. These species also internest and forage in the surrounding waters (Guinea 2006). The reef also provides foraging areas for seabird species, including the lesser frigatebird, wedge tailed shearwater, brown booby and roseate tern (Donovan et al. 2008).

4.2.4 Mermaid Reef and Commonwealth waters surrounding Rowley Shoals

The Rowley Shoals are a collection of three atoll reefs, Clerke, Imperieuse and Mermaid, which are located about 300 km north-west of Broome and 45 km south west of the Operational Area (Figure 4-1). Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals are regionally important in supporting high species richness, higher productivity and aggregations of marine life associated with the adjoining reefs themselves (Done et al. 1994). The reefs provide a distinctive biophysical environment in the region as there are few offshore reefs in the north-west. They have steep and distinct reef slopes and associated fish communities. In evolutionary terms, the reefs may play a role in supplying coral and fish larvae to reefs further south via the southward flowing Indonesian Throughflow. Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Done et al. 1994).

The reefs provide a distinctive biophysical environment in the region as there are few offshore reefs in the north-west. The KEF provides enhanced productivity and high species richness, that apply to both the benthic and pelagic habitats within the feature. The steep changes in slope around the reef also attract a range of migratory pelagic species including dolphins, tuna, billfish and sharks (DSEWPaC 2012).

4.2.5 Ashmore Reef and Cartier Island and surrounding Commonwealth waters

The Ashmore Reef and Cartier Island and surrounding Commonwealth waters KEF is located approximately 112 km north of the Operational Area (Figure 4-1). The KEF is recognised for its ecological functioning and integrity (high productivity), and biodiversity (aggregations of marine life) values, which apply to both the benthic and pelagic habitats within the feature.

Ashmore Reef is the largest of only three emergent oceanic reefs in the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. The waters surrounding Ashmore Reef and Cartier Island are important because they are areas of enhanced productivity in relatively unproductive waters (DSEWPaC 2012).

Further details regarding this KEF are provided in Section 4.3 which describes Australian marine parks.

4.2.6 Carbonate Bank and Terrace System of the Sahul Shelf

The Carbonate Bank and Terrace System of the Sahul Shelf KEF is located approximately 150 km north east of the Operational Area and partially overlaps with the EMBA (Figure 4-1). The KEF forms a nearly continuous chain of complex submerged algal banks on the middle and outside shelf, providing a hard substrate required for colonisation by reef-building organisms (DSEWPaC 2012). They are believed to be areas of enhanced productivity and biodiversity due to upwellings of cold nutrient-rich water at the heads of the channels (Brewer et al. 2007).

The banks of the KEF are known foraging areas for loggerhead, flatback and olive ridley turtles (Donovan et al. 2008). The banks support a high diversity of organisms including reef fish, sponges, soft and hard corals, gorgonians, bryozoans, ascidians and other sessile feeders (Brewer et al. 2007). Humpback whales, green and freshwater sawfish also potentially occur within the area.

4.2.7 Canyons Linking the Argo Abyssal Plain and Scott Plateau

The Canyons Linking the Argo Abyssal Plain and Scott Plateau KEF are located approximately 150 km north-west of the Operational Area on the border of the EMBA (Figure 4-1). The canyons are located at the south west margin of the Scott Plateau at an approximate depth of 2000 – 3000 m. They also facilitate the transportation of sediment to depths of more than 5500 metres on the Argo Abyssal Plain (Falkner et al. 2009). At these depths benthic communities are most likely reliant on particulate matter from the pelagic zone falling to the sea floor (DSEWPaC 2012). The KEF is historically associated with sperm whale aggregations (DSEWPaC 2012).

4.3 Australian Marine Parks

Australian Marine Parks (AMPs) have been established around Australia as part of the National Representative System of Marine Protected Areas, the primary goal of which is to establish and effectively manage a comprehensive, adequate and representative system of marine reserves to contribute to the long term conservation of marine ecosystems and protect marine biodiversity.

AMPs under the EPBC Act, and any zones within them, are assigned to an International Union for Conservation of Nature (IUCN) Category (Environment Australia 2002). The IUCN categories that are Table 4-1, include:

- IUCN Category Ia – Sanctuary Zone – The primary objective of this category is to conserve regionally, nationally or globally outstanding ecosystems, species (occurrences or aggregations) and/or geodiversity features.
- IUCN Category II – National Park Zone (NPZ) – The primary objective of this category is to protect natural biodiversity along with its underlying ecological structure and supporting environmental processes, and to promote education and recreation.
- IUCN Category IV – Habitat Protection Zone (HPZ) – The primary objective of this category is to maintain, conserve and restore species and habitats.
- IUCN Category IV – Recreational Use Zone (RUZ) – The primary objective of this category is to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while providing for recreational use.

- IUCN Category VI – Multiple Use Zone (MUZ) – The primary objective of this category is to protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.
- IUCN Category VI – Special Purpose Zone (SPZ) – The primary objective of this category is to protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.

The Director of National Parks may make, amend and revoke prohibitions, restrictions and determinations under regulation 12.23, 12.23A, 12.26, 12.56 and 12.58 of the EPBC Regulations where it is considered necessary to:

- protect and conserve biodiversity and other natural, cultural and heritage values; or
- to ensure human safety or visitor amenity; or
- where it is otherwise necessary to give effect to the management plan.

The Commonwealth Director of National Parks (DNP) has issued a general approval under Section 359B of the EPBC Act allowing a range of activities to occur within these AMPs. The activities approved including 'mining operations' in Multiple Use Zones and some Special Purpose Zones which, as defined under the EPBC Act, also includes all petroleum activities. No other approvals relating to this activity are required from the Director of National Parks.

Actions to respond to oil pollution incidents (including environmental monitoring and remediation) in AMPs, can be undertaken without an authorisation issued by the DNP, provided that the actions are undertaken in accordance with an EP that has been accepted by NOPSEMA. However, the DNP is to be notified of the pollution event or proposed spill response actions within AMPs prior to the activity being undertaken where practicable.

Table 4-1: Australian Marine Park and IUCN categories within the EMBA

Australian Marine Park	**Sanctuary Zone (IUCN Ia)**	**National Park Zone (IUCN II)**	**Habitat Protection Zone (IUCN IV)**	**Recreational Use Zone (IUCN IV)**	**Multiple Use Zone (IUCN VI)**	**Special Purpose Zone (IUCN VI)**
Kimberley		X	X		X	
Argo-Rowley Terrace		X			X	X
Eighty Mile Beach					X	
Mermaid Reef		X				
Roebuck					X	
Ashmore Reef	X			X		
Cartier Island	X					

4.3.1 Kimberley Marine Park

The Kimberley Marine Park occupies an area of approximately 74,500 km^2 and comprises an IUCN Category II National Park Zone, a Category IV Habitat Protection Zone, and a Category VI Multiple Use Zone (Parks Australia 2018a). The Acquisition Area and Operational Area overlaps with the Multiple Use Zone and lies adjacent to the Marine National Park Zone and Habitat Protection Zone (Figure 4-2).

The Kimberley Marine Park includes examples of ecosystems representative of the Northwest Shelf Province, Northwest Shelf Transition and Timor Province (DNP 2018). The Marine Park connects inshore waters of the adjacent state marine parks (Section 4.4) and deeper offshore waters. Two KEFs are included in the Kimberley Marine Park, namely the Ancient coastline at the 125 m depth contour and the Continental slope demersal fish communities, both previously described in Section 4.2 above.

A range of species, including those listed under the EPBC Act, occur within the Kimberley Marine Park. The Marine Park provides an important migration pathway and nursery areas for the protected humpback whale, pygmy blue whale migration routes, foraging areas for migratory seabirds and dugongs, dolphins and nesting sites for marine turtles. (DNP 2018).

The Kimberley Marine Park contains waters belonging to the Wunambal Gaambera, Dambimangari, Bardi Jawi and Nyul people, who value the land as an important part of Indigenous cultural identity (DNP 2018).

4.3.2 Argo-Rowley Terrace Marine Park

The Argo Rowley Terrace Marine Park is located approximately 26 km west of the Operational Area. This AMP covers an area of 146,099 km^2 and includes an 83,379 km^2 Marine National Park Zone (IUCN II) and a 62,720 km^2 Multiple Use Zone (IUCN VI) (Parks Australia 2018b). The EMBA overlaps with the Multiple Use Zone and National Parks Zones of the AMP (Figure 4-2).

The reserve is an important area for sharks, which are found in abundance around the Rowley Shoals, and provides important foraging areas for migratory seabirds and the endangered loggerhead turtle (DNP 2018). Two KEFs are included within this AMP: the canyons linking the Argo Abyssal Plain with the Scott Plateau, and Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals, both previously described in Section 4.2.

4.3.3 Mermaid Reef Marine Park

Mermaid Reef Marine Park is located approximately 46 km west of the Operational Area, 290 km north-west of Broome and is listed as an IUCN Category Ia – Sanctuary Zone (Parks Australia 2018c). Mermaid Reef AMP covers an area of approximately 540 km^2 and is the most north-easterly of three reef systems forming the Rowley Shoals. The AMP is near the edge of Australia’s continental slope and is surrounded by waters that extend to a depth of over 500 m. Mermaid Reef is totally submerged at high tide and therefore falls under Australian Government jurisdiction. The other two reefs of the Rowley Shoals, Clerke Reef and Imperieuse Reef, are managed by the Western Australian Government as part of the Rowley Shoals Marine Park (DNP 2018).

Mermaid Reef (and the other Shoals) supports over 200 species of hard corals and 12 classes of soft corals with coral formations in pristine condition. The shoals are an important area for sharks, including the grey reef shark, the whitetip reef shark and the silvertip whaler; important foraging area for marine turtles; toothed whales; dolphins; tuna and billfish; and an important resting and feeding site for migratory seabirds (DNP 2018).

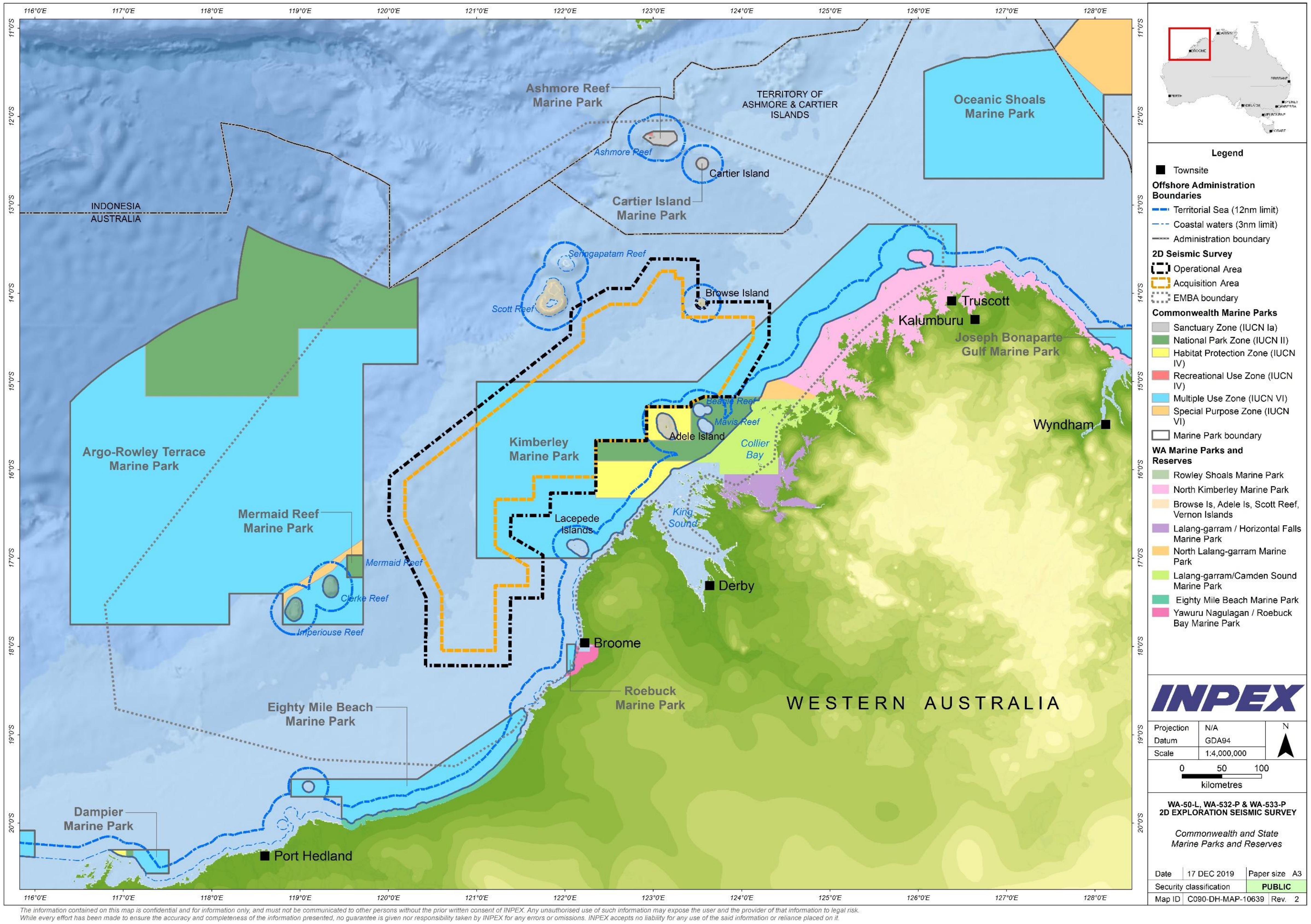

Figure 4-2: Australian and State marine parks

The environmental values include its biodiversity, the marine ecosystems on which the biodiversity depends and the high water quality. The two major currents affecting the area are the Indonesian Throughflow which transports warm, nutrient poor water from the Pacific Ocean to the Indian Ocean, and the South Equatorial Current, which recirculates Indian Ocean waters. Mermaid Reef experiences demi diurnal tides and a spring tidal range of about 4.5 metres.

4.3.4 Roebuck Marine Park

Roebuck Marine Park is located approximately 59 km east of the Operational Area, 12 km south-west of Broome and covers an area of 304 km^2 with depths ranging from 15 to 70 metres. The AMP is listed as an IUCN Category VI – Multiple Use Zone (Parks Australia 2018d). It consists entirely of shallow continental shelf habitat and contains habitats, species and ecological communities associated with the Northwest Shelf Province (DNP 2018).

Roebuck Marine Park is adjacent to the Roebuck Bay Ramsar site, recognised as one of the most important areas for migratory shorebirds in Australia. The AMP provides important foraging areas to the adjacent nesting areas for marine turtles and seabirds, foraging habitat for dugong and includes part of the migratory pathway of the protected humpback whale (DNP 2018).

4.3.5 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park is approximately 56 km south-east of Operational Area and is listed as an IUCN Category VI – Multiple Use Zone (Parks Australia 2018e). The AMP covers an area of 10,785 km^2 and ranges in depths of less than 15 m to 70 m.

The Marine Park includes examples of ecosystems representative of the Northwest Shelf Province. BIAs within the Marine Park include foraging, breeding and resting habitat for avifauna, nesting and internesting habitat for marine turtles, foraging, nursing and pupping habitat for sawfish, and also includes part of the migratory pathway of the protected humpback whale. The Eighty Mile Beach Ramsar site lies adjacent to the AMP and is recognised as one of the most important areas for migratory shorebirds in Australia.

4.3.6 Ashmore Reef Marine Park

Ashmore Reef Marine Park is approximately 142 km north of the Operational Area and within the wider EMBA. The AMP is mostly comprised of an IUCN Category Ia – Sanctuary Zone, and also includes a small IUCN Category IV – Recreational Use Zone (Parks Australia 2018f). Ashmore Reef is within an area subject to a Memorandum of Understanding between the Australian and Indonesian Government related to traditional fishing, which is described in Section 4.9.7. On the emergent island and within the boundary of the Marine Park is the Ashmore Reef Ramsar site. The site was listed under the Ramsar Convention in 2002 and is a wetland of international importance under the EPBC Act.

The Marine Park includes habitats, species and ecological communities associated with the Timor Province. There are two KEFs within the AMP: Ashmore Reef and Cartier Island and waters surrounding Commonwealth waters and the continental slope demersal fish communities. Ashmore reef is the largest of three emergent oceanic reefs in the region and the only one with vegetated islands (DNP 2018). The AMP is an area of enhanced biological productivity, supporting a range of pelagic and benthic marine species and facilitating the transport of biological material to other reef systems along the WA coast via the Leeuwin Current (DNP 2018).

4.3.7 Cartier Island Marine Park

Cartier Island Marine Park is approximately 112 km north of the Operational Area and within the EMBA. The AMP is listed as IUCN Category Ia – Sanctuary Zone (Parks Australia 2018g). Ashmore Reef is within an area subject to a Memorandum of Understanding between the Australian and Indonesian Government related to traditional fishing, which is described in Section 4.9.7.

The Marine Park includes habitats, species and ecological communities associated with the Timor Province. There are two KEFs within the AMP: Ashmore Reef and Cartier Island and surrounding Commonwealth waters and the continental slope demersal fish communities. Cartier Island AMP is an area of high biodiversity and provides supports the transport of biological material to other reef systems along the WA coast via the Leeuwin Current (DNP 2018).

4.4 State reserves and marine parks

There are no state marine parks/reserves within the Operational Area. Within the EMBA, eight state marine parks occur, as follows:

- North Kimberley Marine Park
- North Lalang-garram Marine Park
- Lalang-garram/Camden Sound Marine Park
- Lalang-garram/Horizontal Falls Marine Park
- Yawuru Nagulagun/Roebuck Bay Marine Park
- Rowley Shoals Marine Park
- Adele Island Nature Reserve (including Unnamed Reserve WA44673 and Unnamed Reserve WA44674)
- Browse Island Nature Reserve (including Unnamed Reserve WA41775).

These are discussed in detail in the following sections and are shown in Figure 4-2.

4.4.1 Browse Island Nature Reserve

Browse Island is the nearest landform to the Operational Area and is a Class C nature reserve. It is an isolated sand cay surrounded by an intertidal reef platform and shallow fringing reef. The purpose of this reserve (#41775) is conservation, navigation, communication, meteorology and survey, with a lighthouse present on the island.

The island is triangular, standing just a few metres above high-tide level and measures approximately 700 m by 400 m. The Browse Island reef complex is an outer shelf, biohermic structure rising from a depth of approximately 200 m. It is an oval-shaped platform reef with a maximum diameter of approximately 2.2 km.

Rocky shore habitat is represented only by exposed beach rock, and there are no intertidal sand flats. The lagoon habitat is poorly developed, with poor water circulation, and it shows evidence of recent infill and high mortality. The shallow, subtidal zone is narrow, and supports relatively small areas of well-developed coral assemblages (INPEX 2010). Green and flatback turtle nesting occurs during the summer months and Browse Island also provides habitat for seabirds and shorebirds, including breeding habitat for the crested tern (INPEX 2011).

Browse Island (including a 20 km buffer) has been classified as habitat critical to the survival of marine turtles in the Recovery Plan for Marine Turtles, due to the occurrence of nesting during November to March (DEE 2017).

It is not a regionally significant habitat for seabirds, with previous surveys finding a lack of diversity of seabirds breeding there (Clarke 2010).

4.4.2 Adele Island Nature Reserve

Adele Island (which is also Unnamed reserve #WA44679 and Unnamed reserve #WA44674) is a declared nature reserve to protect the seabird breeding colonies. It is a hook shaped island off the central Kimberley coast, located around 97 km north northwest from Cape Leveque. The island measures 2.9 km by 1.6 km with an area of 2.17 km^2. The islands surrounding sand banks sit atop a shallow-water limestone platform, surrounded by an extensive reef system. Adele Island Nature Reserve is located approximately 24 km from the Operational Area and Acquisition Area.

Adele Island is an important site for breeding seabirds with several species listed under the Japan–Australia Migratory Birds Agreement (JAMBA), China-Australia Migratory Birds Agreement (CAMBA) and Republic of Korea Migratory Birds Agreement (ROKAMBA) breeding there, with rookeries of cormorants (*Phalacrocorax spp*.), Australian pelicans (Pelecanus conspicillatus), lesser frigatebirds (Fregata ariel), brown booby (*Sula leucogaster*), red footed booby (Sula sula) and masked booby (*Sula dactylatra*), grey tailed tattler (*Tringa brevipes*) and red-necked stint (*Calidris ruficollis*).

The seabird colonies at Adele Island tend to have peak breeding periods from May to July; however, birds may also be present during the non-breeding season (DEWHA 2008b).

Adele Island (including a 20 km buffer) has also been classified as a habitat critical to the survival of marine turtles in the Recovery Plan for Maine Turtles, due to the occurrence of nesting during November to March (DEE 2017).

4.4.3 North Kimberley Marine Park

The North Kimberley Marine Park is the largest State marine park, covering an area of approximately 18, 450 km^2, and is located in state waters from York Sound to the WA/NT border (DPaW 2016a). The Marine Park is part of a joint management plan between the Department of Parks and Wildlife and the Uunguu, Balangarra, Miriuwung Gajerrong and Wilinggin traditional owners (DPaW 2016a). At its closest point, the North Kimberley Marine Park is located approximately 35 km from the Operational Area and approximately 55 km from the Acquisition Area.

The North Kimberley Marine Park covers a large variety of marine habitats including coral reefs, seagrass and macroalgal communities. More than one thousand islands and associated intertidal and subtidal habitats are contained within its boundaries. Seagrass beds found around Cape Londonderry provide foraging areas for dugong and marine turtles (DPaW 2016a).

4.4.4 North Lalang-garram Marine Park

The North Lalang-garram Marine Park is located approximately 25 km south-east of the Operational Area and includes the waters from the edge of Cape Wellington (WA mainland) to the WA state waters boundary, and several islands, including Booby Island, Duguesclin Island and Jackson Island. Its northern boundary adjoins the North Kimberley Marine Park, and its southern boundary adjoins the Lalang-garram / Camden Sound Marine Park. The North Lalang-garram Marine Park is gazetted as a class 'A' reserve. The Marine Park contains a number of islands with fringing coral reefs. This Marine Park's geology, wide variety of habitats, ecological values and sensitivities (DPaW 2016b) are virtually identical to that described above for the North Kimberley Marine Park (DPaW 2016a).

4.4.5 Lalang-garram/Camden Sound Marine Park

The Lalang-garram / Camden Sound Marine Park is located in the Buccaneer Archipelago of the Kimberley coast, approximately 20 km from the Operational Area and 40 km from the Acquisition Area. The subtidal portion of the marine park has been proclaimed and covers an area of approximately 6730 km^2. The intent is to also include the intertidal area within the marine park which will extend the marine park to approximately 7,050 km^2 (DPaW 2013). The marine park is located about 150 km north of Derby, 300 km north of Broome, and lies within the traditional country of three Aboriginal native title groups. The park is under the joint management of WA DBCA and the Traditional Owners.

The marine park includes a principal calving habitat for the humpback whale (*Megaptera novaeangliae*) and a wide range of other protected species, including marine turtles, snubfin and Indo-Pacific humpback dolphins, dugong, saltwater crocodiles and several species of sawfish. The park also includes a wide range of marine habitats and associated marine life, such as coral reef communities, rocky shoal and extensive mangrove forests (DPaW 2013).

Within the marine park, mangroves and their associated invertebrate-rich mudflats are an important habitat for migratory shorebirds from the northern hemisphere. Up to 35 species of migratory shorebirds potentially occur in the marine park, which are subject to the JAMBA, CAMBA and ROKAMBA migratory bird agreements and are listed as migratory species under the EPBC Act. Many other bird species may also be found in mangrove habitat including the mangrove grey fantail (Rhipidura phasiana), broad-billed flycatcher (*Myiagra ruficollis*) and red-headed honeyeater (*Myzomela erythrocephala*). Striated herons (*Butorides striata*), black-necked storks and brahminy kites (*Milvus indus*) nest in the dense mangrove foliage and seek prey around the roots of mangrove trees. (DPaW 2013).

4.4.6 Lalang-garram/Horizontal Falls Marine Park

The Lalang-garram Marine Park covers an area of approximately 3,530 km^2 from Talbot Bay in the West to Walcott Inlet and Glenelg River in the east (DPaW 2016b). The Marine Park lies outside of the Operational Area but within the wider EMBA. The Marine Park is gazetted as a class 'A' reserve. The horizontal falls are a waterfall effect created by strong tidal currents (up to 11 m) moving through narrow coastal gorges (DPaW 2016b). Strong currents of up to 3 m/s facilitate the transportation and dispersion of nutrients.

4.4.7 Yawuru Nagulagun/Roebuck Bay Marine Park

The Yawuru Nagulagun/Roebuck Bay Marine Park is located south of Broome, outside of the Operational Area but within the wider EMBA. The Marine Park covers an area of approximately 788 km^2 from Gantheuame Point in the north to Cape Villaret in the south. The Yawuru Nagulagun Marine Park is gazetted as a class 'A' reserve.

The Marine Park contains a range of geomorphic features including extensive intertidal sand and mudflats, intertidal creeks, fossil dinosaur footprints, carbonate shoals and the Roebuck Deeps (DPaW 2016c). The Yawuru Nagulagun Marine Park has significant seagrass and macroalgal communities that support primary productivity and provide habitat for fish and invertebrates. Along the coastline of the Marine Park mangroves are commonly found, with the majority around Dampier Creek and Crab Creek. These mangroves provide a critical habitat for important marine and terrestrial species (DPaW 2016c). Intertidal sand and mudflats also occur along the coastline within the Marine Park, supporting invertebrate communities and providing an important area for shorebird populations. Roebuck Bay is an important stopover for 38 migratory shorebird species and is part of the East Asian – Australasian Flyway.

4.4.8 Rowley Shoals Marine Park

The subtidal values and sensitivities of the Rowley Shoals Marine Park are virtually identical to the Mermaid Reef AMP described above in Section 4.3.3 Bedwell Island, in Clerke Reef, is home to one of only two colonies of red-tailed tropicbirds in WA. The tropicbirds nest on the island, along with wedge-tailed shearwaters, white bellied sea eagles, ruddy turnstones, various terns, sand plovers, eastern reef egrets and white-tailed tropicbirds. Bedwell Island is also an important resting area for migratory birds. Hawksbill and green turtles sometimes nest on this sandy cay (DEC 2007) and is likely to provide foraging habitat (DEE 2017a).

4.4.9 Scott Reef Nature Reserve

Sandy Island is a C class nature reserve (under Western Australian legislation) for conservation (No. 42749), declared to Low Water Mark (LWM). It has an approximate area of 11,658 hectares and is located approximately 11 km north west from the Operational Area. This encompasses much of the South Scott lagoon, and the south-western reef flat of North Scott Reef. The remainder of the South Scott Reef lagoon and North Scott Reef are Commonwealth waters and Commonwealth jurisdiction applies.

Scott Reef (including a 20 km buffer) has been classified as habitat critical to the survival of marine turtles in the Recovery Plan for Marine Turtles, due to the occurrence of nesting during November to March (DEE 2017).

4.4.10 Lacepede Islands Nature Reserve

The Lacepede Islands are a Class C nature reserve, located approximately 65 km south-east of the Operational Area, and 120 km north west of Broome. The purpose of this reserve is the conservation of flora and fauna, navigation, communication, meteorology and survey. The Lacepede Islands are a 12 km long chain of four islands known as West Island, Middle Island, Sandy Island and East Island. They are all small, low spits of coarse sand and coral rubble, lying atop a platform coral reef. They are treeless but support low vegetation.

INPEX (2010) identified these islands as the largest green turtle breeding rookery along the Kimberley coastline. This was recognised in the Recovery Plan for Marine Turtles in Australia which identified the nesting area as habitat critical to the survival of marine turtles (DEE 2017a). The Recovery Plan has provided a 60 km internesting buffer around the Lacepede Islands for flatback turtle nesting occurring from October to March, with a peak in December and January. A 20 km interesting buffer has also been provided for green turtle nesting, occurring from November to March each year.

The Lacepede Islands support over 1 per cent of the world populations of brown boobies and roseate terns. The breeding colony of brown boobies, of up to 18 000 breeding pairs, is possibly the largest in the world. Up to 20,000 roseate terns have been recorded there (Birdlife International 2018). Other birds breeding on the islands include masked boobies, Australian pelicans, lesser frigatebirds, eastern reef egrets, silver gulls, crested, bridled and lesser crested terns, common noddies, and pied and sooty oystercatchers. Visiting waders include grey-tailed tattlers, ruddy turnstones, great knots and greater sand plovers (Birdlife International 2018).

4.5 Wetlands of conservation significance

Australia is a signatory of the Convention on Wetlands of International Importance (the Ramsar Convention). Ramsar wetlands are those that are representative, rare or unique wetlands, or are important for conserving biological diversity. A search of the protected matters listed under the EPBC Act identified Ashmore reef national nature reserve as a Ramsar site within the EMBA.

The Ashmore Reef Ramsar Site shares the same boundaries as the Ashmore Reef Australian Marine Park (Section 4.3.6), approximately 142 km north of the Operational Area at the extent of the EMBA. The Ramsar site regularly supports more than one per cent of at least six species of waterbird including the sooty tern, bar-tailed godwit, grey-tailed tattler, ruddy turnstone, sanderling and greater sand plover.

4.6 Physical environment

4.6.1 Climate

Air temperature

Air temperatures recorded at Cape Leveque, the closest Bureau of Meteorology (BOM) climatological station to the Operational Area, shows a maximum mean temperature of 32.5 degrees Celsius (°C) and a minimum mean temperature of 18.9 °C (BOM 2018). Air temperatures recorded at Browse Island shows a maximum temperature of 33.3 °C and a minimum of 21.6 °C (BOM 2018). Air temperatures in the Browse Basin remain warm throughout the year with means and maxima ranging from 26–30 °C and 32–35 °C, respectively (INPEX 2010).

Winds

The climate of northern Australia shows two distinct seasons: winter, from April to September; and summer, from October to March. There are rapid transitional periods between the two main seasons, generally in April and September/October (RPS MetOcean Pty Ltd 2011).

The winter season is characterised by steady north-east to south-east winds of 5 metres per second (m/s) to 12 m/s, driven by south-east trade winds. The prevailing south-east winds bring predominantly fine conditions throughout the north of Australia. The summer season is the period of the predominant north-west monsoon. It is characterised by north-west to south-west winds of 5 m/s for periods of five to ten days with surges in airflow of 8 m/s to 12 m/s for periods of one to three days.

During the summer season, the weather in the north is largely determined by the position of the monsoon trough, which can be in either an active or an inactive phase. The active phase is usually associated with broad areas of cloud and rain, with sustained moderate to fresh north-westerly winds on the north side of the trough. Widespread heavy rainfall can result if the trough is close to, or over, land. An inactive phase occurs when the monsoon trough is temporarily weakened or retreats north of Australia. It is characterised by light winds, isolated showers, and thunderstorm activity, sometimes with gusty squall lines.

Tropical cyclones can also develop off the coast in the northern wet season, usually forming within an active monsoon trough. Heavy rain and strong winds, sometimes of destructive strength, can be experienced along the coast within several hundred km of the centre of the cyclone. The Browse Basin is prone to tropical cyclones, mostly during the tropical wet season from December to March (INPEX 2010). Under extreme cyclone conditions, winds can reach 300 km/h.

Rainfall

The region has a pronounced monsoon season between December and March, which brings with it heavy rainfall. Heaviest rainfall is typically associated with tropical cyclones.

Cape Leveque located on the Kimberley coastline is the closest location to the Operational Area with a historical rainfall record. Historical rainfall data shows the highest maximum

(219.9 mm) and mean (>85 mm) monthly rainfalls occur from December to March (BOM 2018).

Air quality

There is no publicly available data on air quality within the proposed survey location. However, given the distance from land and the limited development within the Operational area, air quality is expected to be relatively high. Potential sources of air pollution associated with anthropogenic influences are expected to be emissions generated by shipping, and oil and gas activities, and therefore considered to be localised in relation to the regional setting.

4.6.2 Oceanography

Currents

Broad-scale oceanography in the NWMR is complex, with major surface currents influencing the region, including the Indonesian Throughflow, the Leeuwin Current, the South Equatorial Current, and the Holloway Current (Figure 4-3). The Indonesian Throughflow current is generally strongest during the south-east monsoon from May to September (Qiu et al. 1999). The Indonesian Throughflow is a key link in the global exchange of water and heat between ocean basins. It brings warm, low-nutrient, low-salinity water from the western Pacific Ocean, through the Indonesian archipelago to the Indian Ocean. It is the primary driver of the oceanographic and ecological processes in the region (DSEWPaC 2012).

The Holloway current is a narrow boundary current present almost year-round, carrying water along the continental shelf edge in depths ranging between 100 m and 200 m. There is a strong seasonal variation where the Holloway current transects with the Indonesian Throughflow, with north easterly flow during the monsoon season and south westerly flow during the dry season (DSEWPaC 2012).

The Operational Area is typified by strong tidal flows over the shallower regions, particularly along the inshore region of the Kimberley coast. Offshore regions with water depths exceeding 100-200 m tend to experience significant large-scale drift currents. These drift currents can be relatively strong (1-2 knots) and complex, manifesting as a series of eddies, meandering currents and connecting flows. Wind shear at the surface also generates local-scale currents that can persist for extended periods (hours to days) (RPS 2019).

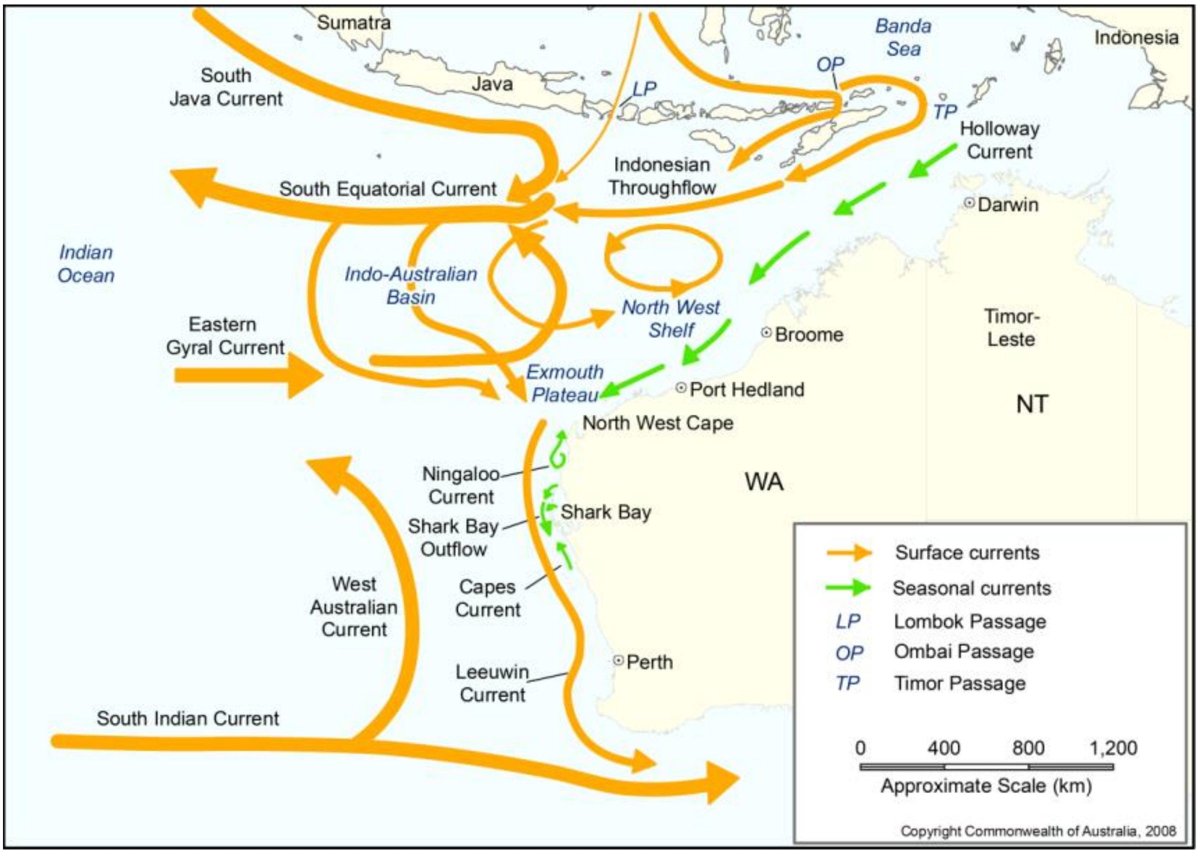

Figure 4-3: Surface currents for Western Australian waters

Tides

The NWMR experiences some of the largest tides along a coastline adjoining any open ocean in the world. The tides are semidiurnal, with two daily high tides and two daily low tides (McLoughlin et al. 1988). Both the semidiurnal and diurnal tides appear to travel north-eastwards in the deep water leading to the Timor Trough before propagation eastwards and southwards across the wide continental shelf.

Along the central Kimberley coast, tidal ranges of up to 11 m near Walcott Inlet and Doubtful Bay can produce tidal current speeds in the order of 3 m/s (DPaW 2016a). Similarly, at King Sound, peak currents often reach 3 m/s (Condie & Andrewartha 2008; Ivey et al. 2016). The Pilbara coast around Eighty Mile Beach experiences semidiurnal flows of approximately 1 m/s and tidal ranges of up to 6 m (Condie & Andrewartha 2008).

Maximum tidal current speeds in the Operational Area have been predicted by RPS (2019) to be approximately:

- 3.0 m/s near Adele Island to the south of the Operational Area surrounding WA-532-P;
- 1.2 – 1.6 m/s on the eastern boundary of the Operational Area surrounding WA-533-P;
- 0.6 m/s on the north-eastern boundary of the Operational Area, near Browse Island; and
- 0.4 – 0.5 m/s on the northern and western boundaries of the Operational Area, in deep waters along the continental slope and near Scott Reef.

Cross-shore transport near the Eighty Mile Beach and the Broome coast is driven by strong tidal oscillations, which results in the back and forth movement of water up to 20 km offshore from coastal waters (Condie et al. 2006). Recent studies at Collie Bay and Camden Sound in the west Kimberley have also found that maximum outward movement of water from inshore locations towards offshore open waters, as a result of the strong tidal currents in the region, is approximately 18 – 23 km (Ivey et al. 2016).

Waves

The sea wave climate within the Operational Area reflects the seasonal wind regime, with waves predominantly from the west in summer and from the east in winter. Summertime tropical cyclones generate waves propagating radially out from the storm centre. Depending upon the storm size, intensity, relative location and forward speed, tropical cyclones may generate swell with periods of 6–10 seconds (s) from any direction and with wave heights of 0.5–9.0 m. During severe tropical cyclones, which can generate major short-term fluctuations in current patterns and coastal sea levels (Fandry & Steedman 1994; Hearn & Holloway 1990), current speeds may reach 1.0 m/s and occasionally exceed 2.0 m/s in the near-surface water layer. Such events are likely to have significant impacts on sediment distributions and other aspects of the benthic habitat.

4.6.3 Bathymetry and seabed habitats

The Acquisition Area and Operational Area are located on the middle and outer continental shelf and the upper continental slope. Water depths within the Acquisition Area mostly range from approximately 50 – 600 m below mean sea level. Water depths less than 50 m within the Acquisition Area are located at Lynher Bank in the southern part of WA-532-P where there are small areas with water depths of approximately 30 m (the shallowest water depth is approximately 28 m). Areas shallower than 50 m water depth are also located in the eastern part of the Acquisition Area surrounding WA-533-P, where the shallowest water depth is approximately 37 m (refer Figure 4-4 and Figure 4-5).

Table 4-2 provides a breakdown of the seabed areas within the Acquisition Area and Operational Area that are less than 50 m.

Table 4-2 Seabed areas and water depths within the Acquisition / Operational Areas

	Acquisition Area		Operational Area	
	Area (km²)	% total area	Area (km²)	% total area
Total area	66,887.93	100%	93,224.10	100%
<30 m depth	76.63	0.11%	82.34	0.09%
30 – 40 m depth	939.52	1.40%	1,164.56	1.25%
40 – 50 m depth	1,877.41	2.81%	3,516.17	3.77%
50+ m depth	63,994.37	95.67%	88,461.03	94.89%

The bathymetry in the Operational Area reflects several large-scale geomorphic features, as defined by Heap and Harris (2008) and Baker et al. (2008) (Figure 4-6).

The south of the Operational Area, encompassing WA-533-P, includes the Rowley Depression to the west of Broome (Figure 4-6), with water depths gradually decreasing from approximately 50 m to 200 m at the edge of the continental shelf and the upper continental slope. The depression is bounded by shelf to the north and south including the Leveque Rise, a feature that extends to the north-west of the Dampier Peninsula and the

Lacepede Islands (Figure 4-6). It is on the southern margin of the Leveque Rise where the eastern boundary of the Acquisition Area surrounding WA-533-P is at its shallowest (approximately 37 m).

The continental shelf within the Operational Area surrounding WA-532-P includes low relief plateau and terrace. A number of valleys lie on the southern margin near Adele Island as well as along the continental shelf edge. Lynher Bank (Figure 4-6) represents the shallowest area, where the minimum water depth in the Acquisition Area is approximately 30 m.

The northern and western parts of the Acquisition Area and Operational Area, including the deepest parts of WA-532-P and WA-533-P, and all of WA-50-L, include deep slope and terrace features extending to approximately 600 m (Acquisition Area) and 1,000 m depth (Operational Area).

Seabed habitats within the Acquisition Area and Operational Area are predominantly featureless plains of unconsolidated soft sediments, comprising sands and gravels on the continental shelf and muddy sediments on the continental slope (DEWHA 2008b; Brewer et al. 2007). Some areas of hard substrate and more varied topographic relief are predicted to be associated with the Ancient coastline at the 125 m depth contour KEF (Section 4.2.1), which broadly lies between the 115 m and 135 m depth contours.

The relatively shallow shelf areas at Lynher Bank and on the Leveque Rise also provide some localised areas of hard substrate and relief. However, surveys of these features have found them to be predominantly sand (Nicholas et al. 2016; Heyward et al. 2018a). Nicholas et al. (2016) noted that 98% of the areas surveyed on the Leveque Rise were unconsolidated sediment and 97% were areas of flat relief. Hard substrate was rare (3%). Similarly, a recent survey at Lynher Bank and adjacent areas found that 94% was bare sand with only occasional hard substrate (Heyward et al. 2018a). This is reflective of the depositional processes on the continental shelf in this region (DEWHA 2008b).

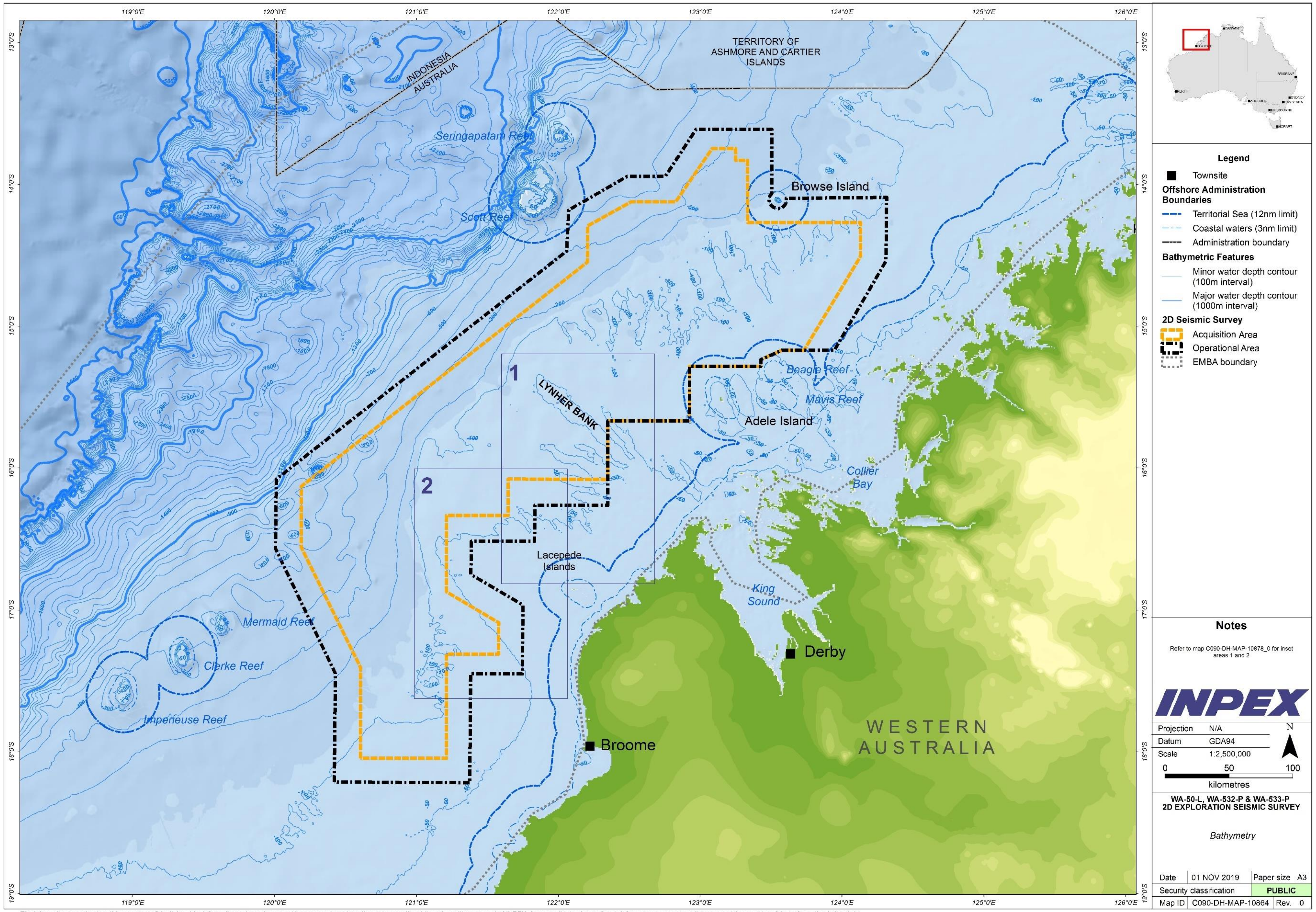

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Figure 4-4 Seafloor bathymetry of the Acquisition Area and Operational Area (refer to Figure 4-5 for map inlays)

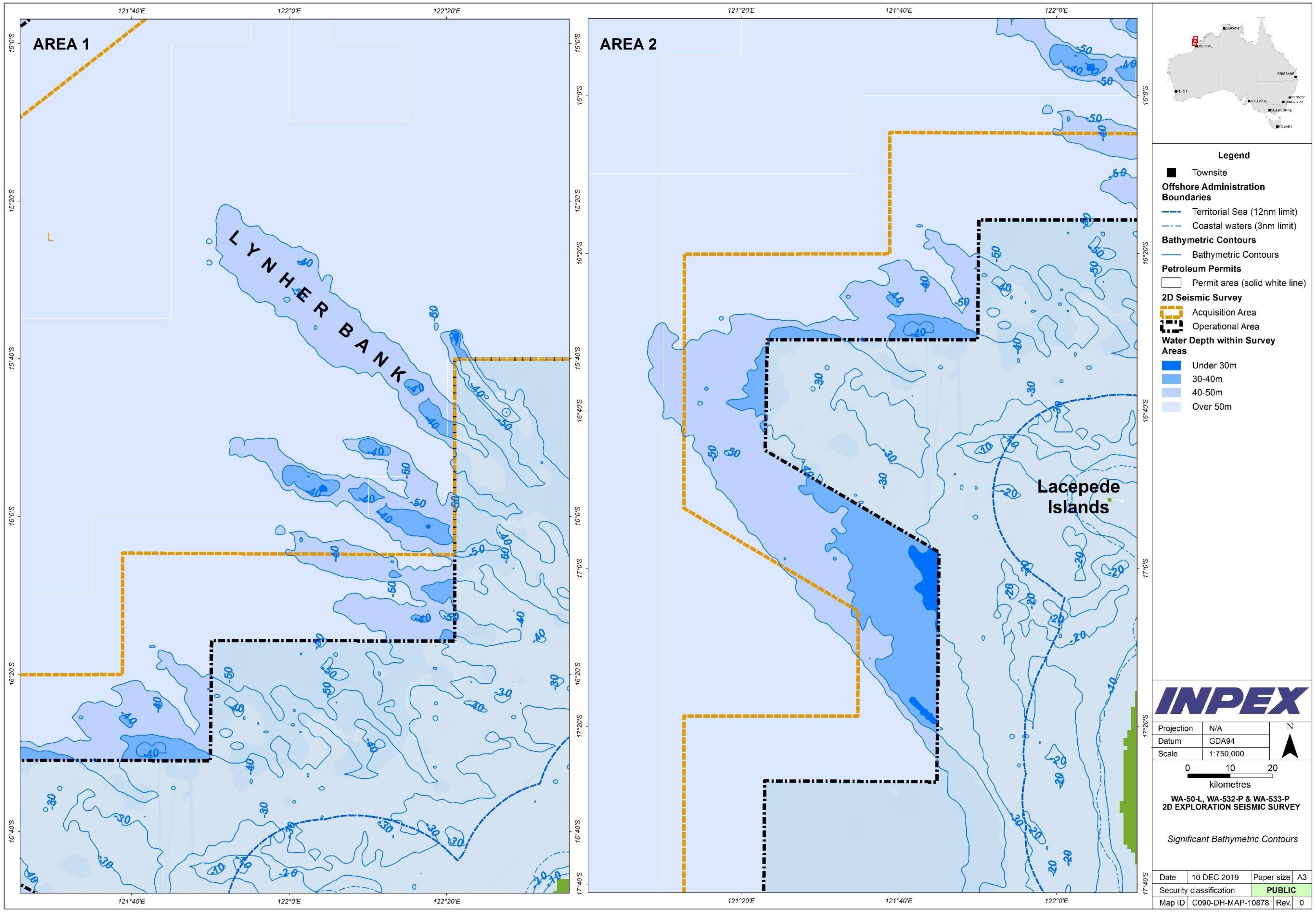


Figure 4-5 Bathymetric contours at 10 m intervals in areas with water depths less than 50 m

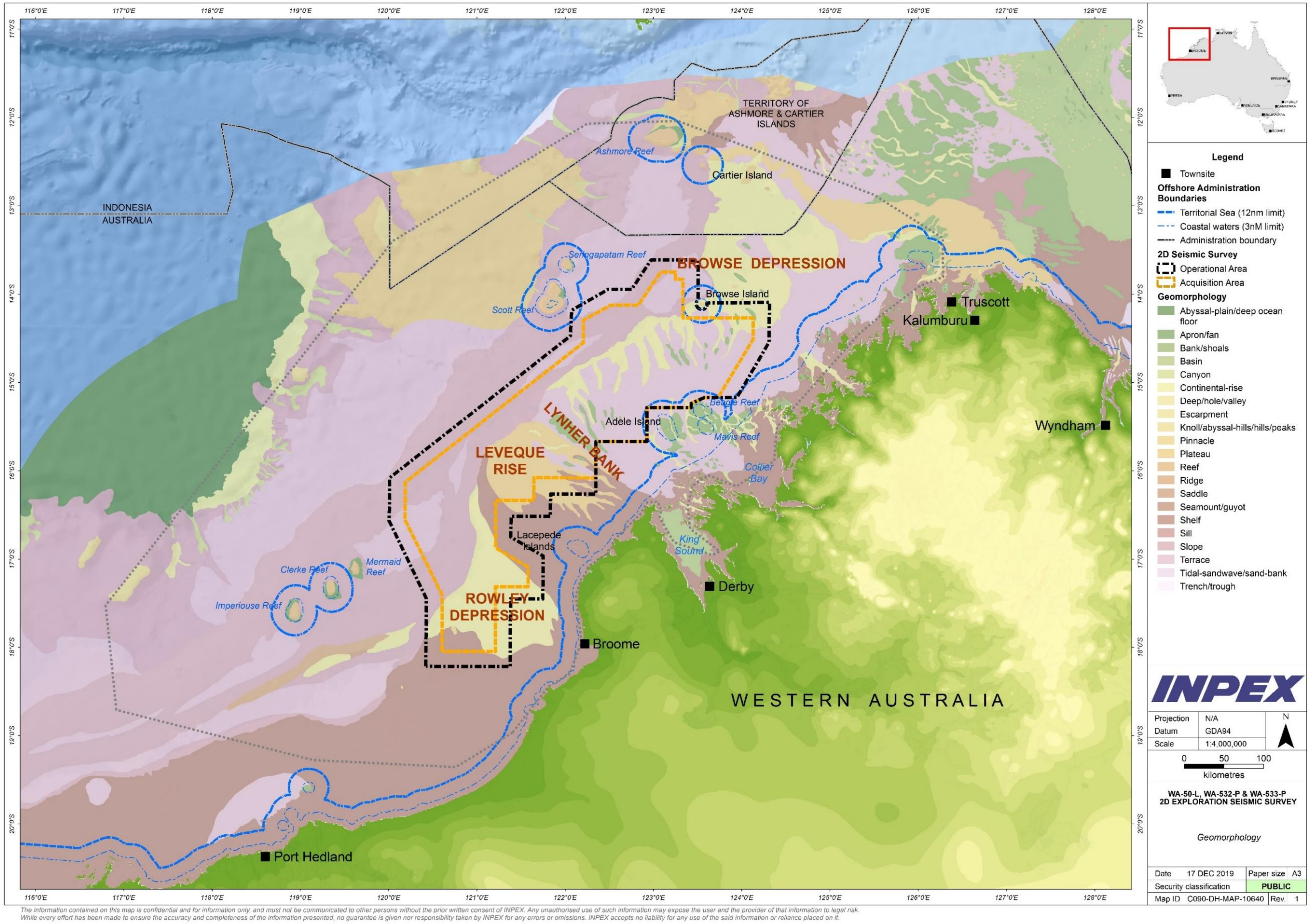


Figure 4-6 Geomorphic features

4.6.4 Water quality

Water quality has been measured by INPEX during numerous surveys to describe the natural water quality conditions in the Ichthys Field in WA-50-L and in surrounding areas. This data is relevant for offshore waters throughout the Operational Area given its relative proximity and similar remote open ocean location. An overview of the water quality studies undertaken are as follows:

- Water quality sampling was conducted at 27 offshore locations near the Ichthys Field, Echuca Shoal and their surrounds between March 2005 to June 2007 as a part of the INPEX Ichthys Environmental Impact Statement studies.
- Information on conductivity, temperature and dissolved oxygen was collected in offshore waters of petroleum exploration permit area WA-344-P during exploratory drilling in July 2008.
- Near-seabed temperature and salinity profiles were obtained along the proposed pipeline route from the Ichthys Field to Darwin Harbour during geophysical and geotechnical surveys conducted between August and October 2008.

The results of these studies, as relevant to this EP, are summarised in Table 4-3.

Furthermore, as part of the Applied Research Program (ARP) between INPEX and Shell in the Browse Basin, a significant amount of environmental baseline data has been collected. This included 66 water quality profiles and more than 1,300 water samples collected from 56 locations around the Ichthys Field in 2015.

Sampling locations were based on a gradient design away from a central point in the Ichthys Field and also included increased sampling around Browse Island, Echuca and Heywood shoals. Samples were analysed for metals and hydrocarbons. In addition to the May 2015 survey, ad hoc water quality samples have been collected from sampling locations during other ARP field surveys to increase the dataset and knowledge. An interpretive report of all the aforementioned ARP water quality results was delivered in 2017 (Ross et al. 2017).

Offshore surface waters are typically oligotrophic. This has been confirmed by studies recording low nitrate concentrations and low phytoplankton abundance. In general, the region experiences an influx of comparatively nutrient-rich waters at depth in summer and a variety of processes, such as tidal currents, internal waves and cyclone mixing, are known to carry these nutrients into the bottom waters of the shelf (Hallegraeff 1995).

Inshore coastal waters tend to be more turbid than offshore open ocean waters due to suspension of sediments by wave action and sediment laden runoff from the land. Higher total suspended solids (TSS) concentrations tend to occur during spring tide conditions due to stronger tidal currents and meteorological perturbations, such as periods of strong winds.

Table 4-3: Summary of water quality parameters in the vicinity of the Operational area

Parameter	Description
Surface-water temperature	The surface waters of the region are tropical year-round, with surface temperatures of ~26 °C in summer and ~22 °C in winter (DSEWPaC 2012). The baseline monitoring in the Ichthys Field area recorded surface water temperatures of ~30 °C in summer (March) and ~26–27 °C in winter (July) (INPEX 2010). Offshore waters in the region are typified by thermal stratification, with the start of the thermocline generally

Parameter	Description
	around 60 m below sea surface (but ranging from 30-80 m) (Ross et al. 2017). Temperature decays rapidly through the water column to 14 °C at approximately 200 m and then decays more slowly to a minimum of circa 8 °C recorded at the deepest sites (Ross et al. 2017).
Salinity	Salinity was spatially and temporally consistent at 34 to 35 parts per thousand (ppt) across all sampling sites and can reasonably be expected to be similar within the wider area, given the distance from major freshwater discharges (INPEX 2010). Minor variations in the salinity profile were identified however data indicated lower salinity values were recorded in the top layer of the water column with higher salinity values corresponding to deeper within the water column (Ross et al. 2017).
Dissolved oxygen	Dissolved oxygen concentrations in the Ichthys Field mirrored water temperatures, with concentrations varying considerably between the surface and subsurface layers. The surface mixed layer was generally well oxygenated throughout; however, below the thermocline (starting at approximately 60 m through to 200 m water depth), the concentration of dissolved oxygen decreased consistently with depth (RPS 2007; Ross et al. 2017). Dissolved oxygen concentrations were recorded at constant levels of 6.0 to 6.5 ppm at or above the thermocline in both summer and winter. In the cooler waters below the thermocline, dissolved oxygen decreased with increasing depth, with levels as low as 4.5 to 5.0 ppm recorded at a depth of 93 m and 3 ppm at a depth of 250 m (INPEX 2010). This indicates that the strong thermal stratification at the offshore locations results in limited oxygen replenishment of subsurface waters due to the lack of regular mixing between water layers (RPS 2007).
pH	The average pH of waters was measured at approximately 8.4 (RPS 2007), which is slightly higher (more alkaline) than normally encountered in the marine environment and is above the default criteria given in the Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ 2000).
Turbidity and light attenuation	Turbidity is generally higher in the shallow continental shelf and towards the base of many of the deeper water column profiles. This has been attributed to re-suspension of fine sediments in these higher energy environments (Ross et al. 2017). The re-suspension of materials from the seafloor includes organic material which could comprise a pathway for hydrocarbon materials to become incorporated into sediments.
Petroleum hydrocarbons	Baseline sampling has indicated low levels of naturally occurring hydrocarbons released by organic matter decay or higher trophic level organisms. Shallow water sites showed a constant hydrocarbon concentration through the profile. Deep water sites showing a low and constant concentration above

Parameter	Description
	the thermocline, with a peak of 0.2-0.25 µg/L at the thermocline before slowly diminishing (Ross et al. 2017).
Radionuclides	Water-column sampling for radionuclides in the Ichthys Field area indicated concentrations of radium-226 ranging from below lower limits of reporting (LLR) to 0.034 (±0.012) becquerels per litre (Bq/L) and concentrations of radium-228 ranging from below LLR to 0.167 (±0.128) Bq/L. With the exception of one mid-depth sample, all samples returned gross alpha-particle and gross beta-particle radiation levels below the Australian Drinking Water Guidelines screening criterion of 0.5 Bq/L provided by the National Health and Medical Research Council and the Natural Resource Management Ministerial Council (NHMRC & NRMMC 2018).
Metals	Total metal concentrations in the offshore waters sampled were below the 99% species protection level for marine waters (ANZECC/ARMCANZ 2000), with the exception of zinc and cobalt at one site each. The reason for these two slightly elevated readings is unknown (INPEX 2010). Ultra-trace-level analysis methods were used to assess metal concentrations in surface waters because ANZECC/ARMCANZ (2000) guideline trigger values at the 99% species protection level are lower than the limits of standard laboratory methods. Mercury was the only metal not detected above the LLR, while cobalt was marginally above the LLR at only one site. Concentrations of arsenic, nickel, chromium and zinc were consistent across all sites, but the concentrations of cadmium, copper and lead showed greater variability (INPEX 2010).

4.6.5 Sediment quality

Similar to water quality, offshore marine sediments have been sampled for INPEX during numerous surveys in order to characterise the marine sediments in the Ichthys Field and surrounding areas (URS 2009a). Overviews of the studies are listed below, with the results as relevant to this EP summarised in Table 4-4:

- Sampling and characterisation of marine sediments in the Ichthys development area was conducted at 10 sites in September 2005 and May 2007. This included five sites within 20 km of the Ichthys Venturer FPSO location and another five sites between 36 km and 134 km. A further 10 sites were also sampled for particle size distribution (PSD) between 24 km and 66 km of the FPSO location and therefore this data is considered to be relevant for the Operational Area given its relative proximity and similar remote open ocean location.
- Seabed sediment sampling along the proposed pipeline route from the Ichthys Field to Darwin Harbour was also conducted at approximately 10 km intervals during geophysical and geotechnical surveys between August and October 2008.

Furthermore, as a part of the ARP, a 133 sediment samples at 56 locations were collected around the Ichthys Field in May 2015. Sampling locations were based on a gradient design away from a central point in the Ichthys Field and also included increased sampling around Browse Island, Echuca and Heywood shoals. Samples have been analysed for metals and hydrocarbons. In addition to the May 2015 survey, ad hoc sediment samples have also been collected from sampling locations during other ARP field surveys to increase the dataset and knowledge. An interpretive report of all the aforementioned ARP sediment sample results was delivered in 2017 (Ross et al. 2017).

Table 4-4: Summary of sediment quality parameters in the vicinity of the Operational Area

Parameter	Description
Particle size distribution (PSD)	The seabed in offshore locations on the continental shelf is known to consist of generally flat, relatively featureless plains characterised by soft sandy-silt marine sediments that are easily resuspended. Similarly, the substrate of the Scott Reef – Rowley Shoals Platform, located in water depths of 200–600 m, is considered to be a depositional area with predominantly fine and muddy sediments (INPEX 2010). The composition of sediments varied across the Ichthys development area, with the most variation occurring in the vicinity of the Echuca Shoal (approximately 19 km from the Operational Area). In this area, sediments consisted mainly of calcareous shell grit and coral debris along with varying minor proportions of silts and fine-to-medium sands. In general, the proportion of silts, clays and fine sands increased rapidly with increasing distance from the shoal (RPS 2007; INPEX 2010). The PSD of sediment at sites located within the Ichthys Field was primarily sand, with some silts. The two samples collected adjacent to Echuca Shoal contained a large (30–37%) component of gravel relative to the other sampling locations (≤3%).
Petroleum hydrocarbons	Concentrations of BTEX and PAH compounds in sediments in the vicinity of the sampling sites were very low (Ross et al. 2017; RPS 2007). The components of the more prevalent alkane compounds found indicated that the concentrations observed were likely to have originated from biogenic sources (Ross et al. 2017).
Radionuclides	Naturally occurring radioactive materials for the majority of results were below or close to LLR. Radium-226 was detected at one site but all other samples were below LLR for each radium isotope. The concentration of uranium and thorium was consistent across all sites (RPS 2007).
Metals	Concentrations of all metals were consistent across the sampling sites and well below the interim sediment quality guidelines low screening level (ANZECC/ARMCANZ 2000), with the majority also below their respective LLR (RPS 2007). Organometallics (i.e. tributyltin (TBT) were below ANZECC/ARMCANZ (2000) guidelines and lower than the LLR at all sampling locations.

4.6.6 Underwater noise

Ambient noise refers to the overall continuum of background noise such that the contribution from specific sources is not readily identifiable from one another. Ambient noise may comprise of sound from multiple different sources, including wind, waves, rain, tidal turbulence, movement of sediments on the seabed, biological noise (e.g. snapping shrimp, fish choruses, marine mammal vocalisations) and anthropogenic noise sources (e.g. distant shipping noise). Therefore, background noise levels will vary between locations, including deep waters versus coastal waters (Cato and McCauley 2002; Harland et al. 2005).

The Centre for Marine Science and Technology at Curtin University undertook a study on behalf of INPEX from September 2006 to August 2008 to assess ambient biological and anthropogenic sea noise sources in the Browse Basin. Ambient noise in the Ichthys Field was measured using a sea noise logger deployed at a depth of 240 m on the seabed 45 km north-west of Browse Island. The monitoring revealed the average ambient noise level of 90 dB re 1 µPa under low sea states, although the level was greater than 100 dB re 1 µPa for 70% of the time as a result of anthropogenic noise contributions (McCauley 2009). Biological noise sources recorded in the Ichthys Field included regular fish choruses and several calls from humpback whales, pygmy blue whales, minke whales and other unidentified species (McCauley 2009).

Monitoring of underwater noise at other offshore locations in the region include monitoring in the Timor Sea approximately 300 km north of Darwin (McPherson et al. 2016a) recorded ambient noise varying between approximately 80 and 115 dB re 1 µPa (96 dB re 1 µPa average). Variations in ambient sound were primarily affected by weather events, with notable contributions from fish, whales and occasional anthropogenic noise sources.

Noise monitoring at various sites in and around Scott Reef indicates a greater background noise contribution from fish chorusing on the reef and within the lagoon compared with monitoring sites located in open waters away from the reef. Whale vocalisations were also detected, including pygmy blue, humpback, Bryde’s and minke whales (McCauley 2011).

Ambient noise was also measured on behalf of INPEX at an inshore site near the Maret Islands in 45 m of water. Under low sea states, the average ambient noise level was 85 dB re 1 µPa, although periodic increases in noise levels of almost 60 dB above lowest ambient noise levels occurred as a result of increased wind and fish chorusing (McCauley 2009).

A series of sea noise loggers deployed in the coastal waters and inner continental shelf of the Kimberley region (Maret Islands, Pender Bay, James Price Point, Gourdon Bay and at a site west of the Lacepede Islands) indicate relatively high but also highly variable ambient noise levels with significant contributions from humpback whales and fish chorusing, which fluctuate with the seasons and phases of the moon (McCauley 2011, 2012; McPherson et al. 2016b). Ambient noise levels of between approximately 85 and 110 dB re 1 µPa, increasing to levels more than 130 dB re 1 µPa have been observed (McCauley 2012; McPherson et al. 2016b). URS (2009b) report that ambient noise in coastal embayments in the Kimberley that contain coarse gravely sediments can exceed 110-120 dB re 1 µPa on a daily basis, particularly during spring ebb and flood tides.

Results from the various surveys in the region are considered to be indicative of typical background underwater noise levels within the Operational Area and adjacent waters of the Kimberley. Therefore, background noise levels in offshore, open water locations may be between approximately 90 and 100 dB re 1 µPa in low wind conditions. These levels may increase significantly during weather events and during fish and whale vocalisations, particularly at offshore reefs such as Scott Reef. Noise levels in WA-533-P are likely to be slightly higher than in WA-532-P and WA-50-L due to the presence of heavier shipping traffic (see Section 4.9.9).

Background noise levels in the coastal waters of the Kimberley are consistently between 85-110 dB re 1 µPa, increasing at times to more than 130 dB re 1 µPa as a result of biological sounds (e.g. fish choruses), wind, tidal currents and movement of sediment, and other anthropogenic noise sources (e.g. boat noise).

4.7 Biological environment

4.7.1 Planktonic communities

Plankton communities comprise phytoplankton and zooplankton, including fish eggs and larvae. Phytoplankton and zooplankton are a source of primary and secondary productivity, and key food sources for other organisms in the oceans (Brewer et al. 2007). Eggs and larvae may be dispersed throughout the water column and throughout the region, playing an important role in species recruitment.

The primary driver of planktonic primary productivity in the NWMR is from seasonal influences, including large scale currents, cyclones, inputs of freshwater, and localised mixing and upwelling. The Indonesian Throughflow generally suppresses upwellings along the coast, but there are some localised areas of enhanced biological productivity (Brewer et al. 2007; DEWHA 2008b). The processes underlying this productivity are unclear, although productivity may be associated with a unique combination of bathymetry and oceanography, where a strong current running along the coastline interacts with the 50 m depth contour, which runs perpendicular to the coast. This interaction is likely to cause mixing of deeper, more nutrient-rich water with surface waters. Sporadic mixing of nutrient rich waters with the surface layer along the Kimberley shelf has also been found to result in a deep chlorophyll maximum in the upper mixed layer in depths of less than 70 m (Brewer et al. 2007). Phytoplankton production above background values stimulates blooms of zooplankton which feed on the phytoplankton, which in turn attract predators that feed on the zooplankton. Localised upwelling and mixing are also thought to occur around Browse Island and in water surrounding Scott Reef which attract a number of marine species, including cetaceans (DEWHA 2008b).

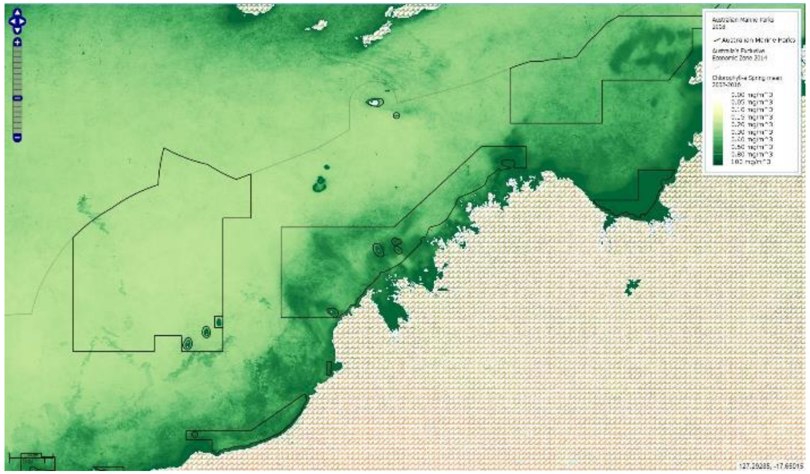
Chlorophyll-a and phytoplankton concentrations are highly variable (Brewer et al. 2007; DEWHA 2008b). Higher phytoplankton concentrations in the region, as indicated by surface chlorophyll-a concentrations, generally occur during the winter months (June to August) and are lower in summer (December to February) (Hayes et al. 2005), although there is some variability. This trend is evident in Figure 4-7, which shows the mean seasonal chlorophyll-a concentration (Parks Australia 2018). Between spring and autumn, the areas of greatest productivity are associated with nearshore continental shelf waters of approximately 50 - 70 m depth or less, where the greatest mixing occurs, and around offshore islands and reefs (Figure 4-7). The relatively greater abundance in phytoplankton in nearshore waters of the Kimberley, less than 50 m depth, has also been reported by Thompson and Bonham (2011). Increased productivity during the winter months sees increased chlorophyll-a concentrations in water depths up to approximately 100 m (Figure 4-7). The winter months show relatively consistent chlorophyll-a concentrations on the Kimberley shelf, compared with other seasons which have more variable concentrations (Parks Australia 2018h).

Zooplankton biomass over tropical continental shelves is generally greatest in coastal waters (Nair et al. 1981; Wilson et al. 2003; Munk et al. 2004) and associated with areas of higher phytoplankton biomass (Wilson et al. 2003; Lamb & Peterson 2005; Stenseth et al. 2006). Zooplankton biomass in the Kimberley region has also been found to be highest within coastal waters and within the 50 m depth contour where the areas of greater phytoplankton biomass occur and decreases offshore (Holliday et al. 2011). Offshore, the correlation between phytoplankton and zooplankton biomass is known to be generally weaker due to the influence of physical processes which introduce strong variability to the distribution of planktonic biomass (Gibbons & Hutchings 1996; Holliday et al. 2011).

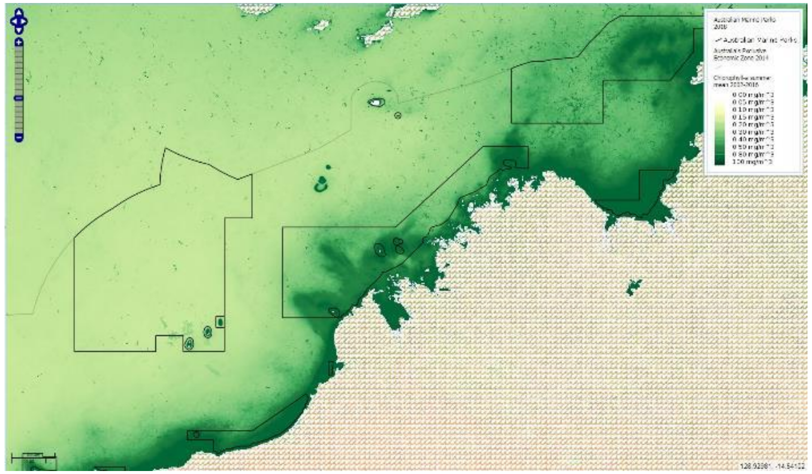
The spawning of fishes and invertebrates throughout the region also contributes to the biomass of planktonic communities in the waters of the NWMR. Fish spawning is described further in Section 4.7.4. Coral spawning at nearshore reefs in the Kimberley region and at offshore reefs such as Scott Reef and the Rowley Shoals mainly occurs in autumn

(March/April) with a lesser spawning event in spring (October/November) (Gilmour et al. 2009; Rosser 2013). Research into coral larval dispersal (Gilmour et al. 2009, 2010, 2011; Underwood et al. 2009, 2017; Cook et al. 2017; Waples et al. 2019) has indicated that dispersal and recruitment is predominately local and limited to within a few kilometres to a few tens of kilometres from natal reef patches.

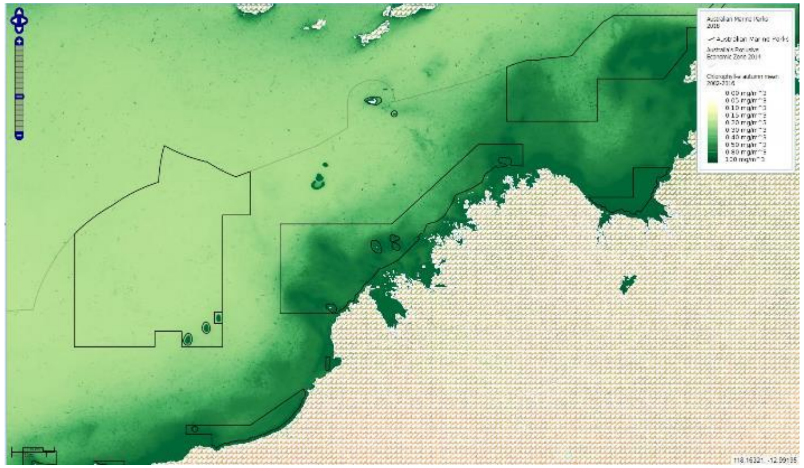
Spring (September – November)



Summer (December – February)



Autumn (March – May)



Winter (June – August)

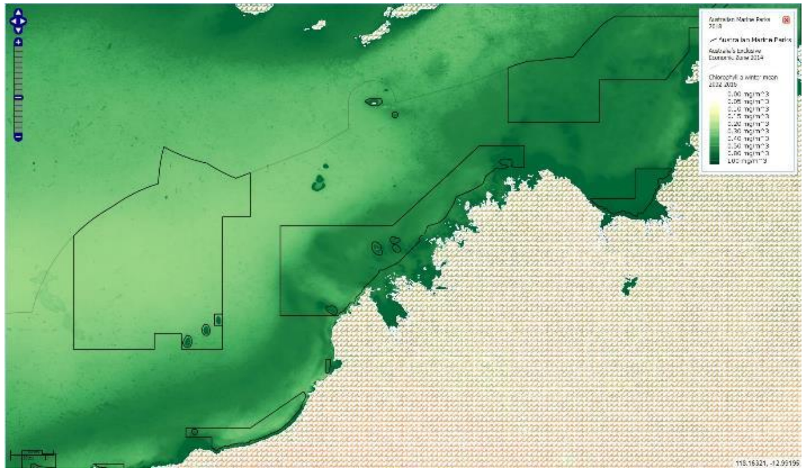


Figure 4-7 Average seasonal concentration of chlorophyll-a in the NWMR (2002-2016) (Parks Australia 2018h)

4.7.2 Benthic communities

Soft-bottom benthos and filter feeder communities

By area, soft-bottom benthos is the dominant environment within the Operational Area, comprising of sands and gravels on the continental shelf and muddy sediments on the continental slope (DEWHA 2008b; Brewer et al. 2007). Macrotidal stirring and high seasonal inputs from terrestrial runoff make the Kimberley shelf a highly dynamic and relatively turbid region, which favours filter feeder invertebrate communities such as sponges instead of photosynthetic communities such as hard corals and algae (Brewer et al. 2007).

The mid and outer shelf habitats of the Kimberley shelf have been described from trawl surveys (Nowara & Newman 2001). These surveys indicate relatively sparse populations of infauna and epibenthos that inhabit the sandy-mud substrates. A wide range of benthic fauna can be found, including crabs, shrimps and echinoderms (Brewer et al. 2007). Infauna typically found in the relatively low nutrient sediments in the NWMR includes nematodes, copepods, polychaete worms and isopods (Brewer et al. 2007).

Benthic surveys undertaken in the Operational Area include surveys on the Leveque Rise, in water depths of 47 to 102 m, which involved multibeam echosounder, towed video and still images, and infauna sampling (Nicholas et al. 2016). Based on still towed-video imagery, it was observed that the seabed is dominated by unconsolidated sediment (98% of all locations observed) and mostly in areas of flat relief (97%). Rare occurrences of hard substrates comprising consolidated boulders (1%) and rock (2%) were observed. The rocky outcrops and some areas of thin sand veneer over hard substrate support locally abundant octocorals and sponges, interspersed with areas of soft sediment and low epifaunal cover (Nicholas et al. 2016). Some bare sediments showed evidence of bioturbation from infauna, including polychaete worms.

Recent surveys at Lynher Bank, in water depths of approximately 30 m to 108 m, involved multibeam echosounder, towed video and still images, and benthic sled trawls (Heyward et al. 2018a). Abiotic substrates were overwhelmingly prevalent, representing average cover of 94% across all transects. Sediment was predominantly sand, with only occasional outcrops of low-relief hard substrate. The faunal composition at Lynher Bank reflects habitats dominated by sessile organisms associated with soft sediment environments characterised by moderate to high water movement (Heyward et al. 2018a). Light dependent organisms were rare due to strong light attenuation in the Kimberley region associated with high water turbidity (Heyward et al. 2018a). Rock outcrops and areas of thin sand veneer over hard substrate supported predominantly filter feeder communities, including sponges, soft corals, bryozoans and other invertebrates, but generally had very low presence overall. Transects noted as being of interest due to higher than average cover of biota, including sponges, bryozoans and soft corals, were found in association with a rock platform and other rocky outcrops in water depths between approximately 33 m and 51 m, although one transect in this category extended to a depth of 57 m. The filter feeder communities at Lynher Bank are likely constrained by the limited hard substrate availability and low seabed geomorphic complexity (Heyward et al. 2018a). Other organisms collected in the sled trawls included a diversity of crustaceans, molluscs (mainly bivalves and gastropods) and echinoderms such as crabs, nudibranchs, feather stars and brittle stars (Heyward et al. 2018a; Puotinen and Thums 2016).

It is noted that some shallow areas of the Leveque Rise and Lynher Bank may provide suitable substrate within the upper limits of the depth range where pearl oysters (*Pinctada maxima*) occur. However, neither of the surveys at the Leveque Rise or Lynher Bank report any pearl oysters. Therefore, significant populations of pearl oyster are not expected to be present within the Operational Area.

Varied relief and outcrops of hard substrate are also likely to be present on the outer continental shelf in association with the Ancient coastline at the 125 m depth contour KEF. Little is known about fauna associated with the hard substrate of the escarpment, but it is likely to include sponges, soft corals, crinoids, molluscs, echinoderms and other benthic invertebrates representative of hard substrate fauna in the NWMR (DSEWPaC 2012).

On the deeper continental slope, the continental slope demersal fish communities KEF occupies two distinct community types associated with the upper slope (225–500 m depth) and the mid-slope (750–1,000 m depth). Although poorly known, it is suggested that the demersal-slope communities rely on bacteria and detritus-based systems comprised of infauna and epifauna, which in turn become prey for a range of teleost fish, molluscs and crustaceans (DEE 2018a; Brewer et al. 2007). Commercially targeted scampi occur in this upper slope region, commonly associated with Globigerina ooze-type sediments at depths of 420-500 m (AFMA 2018).

Inshore of the Operational Area, parts of the shallower coastal turbid zone support more significant filter feeder communities than offshore (Brewer et al. 2007; Miller 2017; Heyward et al. 2018a). Surveys in Camden Sound and the Bonaparte Archipelago observed patchy but widespread and diverse filter feeder communities dominated by sponges, bryozoans, soft corals, ascidians and hydroids, with a diversity of crustacean, mollusc and other invertebrate species also present (Miller 2017; Heyward et al. 2018a). Surveys off the west coast of the Dampier Peninsular in water depths less than 25 m were undertaken between Coulomb Point, James Price Point, Quandong Point and Cape Boileau (SKM 2010). Sandy sediments were present throughout the study area, often overlaying hard substrate. Biota was relatively sparse but sponges, sea whips, gorgonians, ascidians, sea pens and non-photosynthesising soft corals, were the most extensive biota mapped throughout the study area (SKM 2010).

Coral Reefs

Coral reefs within the region can be categorised into three general groups: fringing reefs, large platform reefs, and intertidal reefs. Corals are significant benthic primary producers that play a key ecosystem role in many reef environments and have an iconic status in the environments where they occur.

No coral reefs are present in the Operational Area. The Operational Area, inner shelf and coastal waters of the Kimberley are generally unsuitable for coral development, due to high terrestrial sediment input, macrotidal regimes, highly turbid water and raised sea surface temperatures. Even in the shallowest parts of the Operational Area, coral and other light dependent organisms are rare due to strong light attenuation associated with high water turbidity (Heyward et al. 2018a).

However, despite the turbid conditions, fringing coral reefs exist around the margins of a number coastal islands as well as a number of emergent platform reefs (Collins et al. 2015; Miller 2017; Waples et al. 2019).

Coral reefs considered to have significant value within the EMBA include:

- Scott Reef and Seringapatam Reef
- Rowley Shoals, including Mermaid Reef
- Ashmore Reef and Cartier Island
- Browse Island
- Adele Island
- Beagle and Mavis Reefs
- Outer islands of the Buccaneer Archipelago and Bonaparte Archipelago, including the Maret Islands

- Montgomery Reef
- Lacepede Islands.

These reefs, in particular Ashmore Reef, are recognised as having the highest richness and diversity of coral species in Western Australia (Mustoe & Edmunds 2008). The Rowley Shoals and Scott Reef also support very high coral species diversity, as discussed in Section 4.2. The intertidal reefs surrounding the outer islands of the Bonaparte and Buccaneer Archipelago also exhibit very high coral species diversity (INPEX 2010). More than 210 species of hard coral have been identified at the Maret Islands (Richards et al. 2015).

Seagrass

The largest known seagrass locations for the NWMR have been reported from around the Buccaneer Archipelago located north of the Dampier Peninsula (Wells et al. 1995). However, coastal shallow-water seagrass habitats are generally rare in the region, accounting for only 11.5 km or 0.2 per cent of the total coastline surveyed by Duke et al. (2010). The regionally dominant genera are Halophila and Halodule.

A strip north and south of Broome has a high coverage of seagrass (Whiting & Guinea 2005) and has been identified as a dugong foraging area.

4.7.3 Shoreline habitats

There are no islands or shorelines within the Operational Area, with the closest intertidal habitat located at Browse Island (5.5 km from the Operational Area). However, within the EMBA there are numerous small islands. The Kimberley coast generally comprises sandy beach, rocky shorelines, and mangrove/estuarine mudflat habitat.

In the offshore waters of the EMBA there are multiple islands which have an associated Commonwealth or State marine park/reserve status. The values and sensitivities associated with the shorelines of these islands are described in Sections 4.3, 4.4 and 4.5.

Emergent intertidal coral reef occurs within the EMBA at Rowley Shoals, Ashmore Reef, Cartier Island and Browse Island. Fringing coastal reefs may also be exposed at low tide.

Sandy Beaches

Sandy beaches are the dominant shoreline habitat on all the offshore islands within the EMBA and provide significant habitat for turtles and seabird nesting above the high tide line (Section 4.8.2). Sandy beaches are present within the EMBA at the sandy cays of Ashmore Reef, Cartier Island, Browse Island and Scott Reef.

Generally, sands are highly mobile and therefore do no support a high level of biodiversity. Fauna within sandy beach habitats usually consists of polychaete worms, crustaceans and bivalves. These fauna provide a valuable food source for resident and migratory sea and shorebirds (DEC/MPRA 2005). Natural processes tend to supply fresh sediments and larval stock (food source) with each tidal influx.

Mangroves

Mangrove communities make up a common shoreline habitat along the northern Western Australian coastlines with extensive mangrove communities within the EMBA. They commonly occur in sheltered coastal areas in tropical and sub-tropical latitudes. Mangroves play an important role in connecting the terrestrial and marine environments and reducing coastal erosion. They also play an important ecosystem role in nutrient cycling and carbon fixing (NOAA 2010).

More than a quarter of the world's species of mangroves can be found along the Kimberley coast, covering an area of approximately 1,400 km^2. During 2009, shoreline ecological aerial and ground surveys were conducted from Darwin in the NT to Broome in WA in response to the Montara oil spill (Duke et al. 2010). Approximately 5,100 km of shoreline was surveyed, analysed and mapped to quantitatively characterise coastal ecological features. Mangroves were found to grow along 63 per cent of the surveyed shoreline and salt marshes occurred over 23.8 per cent of the shoreline.

Regionally significant mangrove habitat habitats are located at Eighty Mile Beach, Lalang-garram / Camden Sound, Roebuck Bay, Lalang-garram / Horizontal Falls and North Kimberley marine parks.

4.7.4 Fishes

Fish assemblages of the continental shelf and slope

A large range of pelagic and demersal fish species are likely to be present in the Operational Area and wider EMBA. The benthic habitats on the continental shelf support various demersal fish species, including snappers and emperors (e.g. goldband snapper *Pristipomoides multidens*, red emperor *Lutjanus sebae*, saddletail snapper *L. malabaricus*, spangled emperor *Lethrinus nebulosus*) and rock cods and groupers (*Serranidae*, e.g. rankin cod *Epinephelus multinotatus*) (Brewer et al. 2007; Newman et al. 2018). These fish are particularly common over hard substrate where ridges, rises, reefs and large epibenthos occur (Brewer et al. 2007), including the Ancient coastline at the 125 m depth contour KEF, which is considered to provide an area of enhanced productivity along the outer continental shelf of the NWMR (see Section 4.2.1).

Large pelagic species such as tuna and mackerel (*Scombridae*) and billfish species (*Xiphiidae, Istiophoridae*) also occur across the continental shelf (DEWHA 2008b). Tuna and billfish have a wide geographic distribution across the region and Indian Ocean basin, moving great distances in open ocean waters beyond the continental shelf (Williams et al. 2018).

Sharks and rays also occur, including whale sharks, which forage in the region in spring (September to November) (Section 4.8). Other species of shark include blacktip, sandbar, dusky whaler, tiger and hammerhead sharks. Sawfish and the northern river shark may also occur in the EMBA, but these species are limited to shallow coastal and estuarine waters and are not expected to occur offshore in the Operational Area.

The deeper continental slope supports over 400 species of deep-water fishes, sharks and rays, of which 64 species are considered endemic (Last et al. 2005). The continental slope demersal fish communities have been identified as a key ecological feature due to this diversity and endemism (see Section 4.2.2).

Small pelagic fish (e.g. lantern fish, members of the family *Myctophidae*) are believed to comprise a significant proportion of the total fish biomass in the NWMR (Bulman 2006; DEWHA 2008b). Small pelagic fish inhabit continental shelf waters, feeding on pelagic phytoplankton and zooplankton and providing a food source for a wide variety of predators including large pelagic fish, sharks, seabirds and marine mammals (Mackie et al. 2007; DEWHA 2008b). Other small pelagic baitfish are common in shallow nearshore waters, including members of the family *Clupeidae* such as pilchards (e.g. northern pilchard *Amblygaster sirm*), and possibly a number of other species (e.g. smooth-belly sardine *Amblygaster leiogaster*, slender sardine *Dussumieria elopsoides*, bluestripe herring *Herklosichthys quadrimaculatus*, Goldstripe sardine *Sardinella* gibbosa). The baitfish feed on phytoplankton and zooplankton concentrations in coastal waters, which are influenced by currents and mixing on the inner continental shelf (Sainsbury et al. 1985; Brewer et al. 2007; Wright and Pyke 2010; Bray 2019a, 2019b). Movements of these baitfish along the coast near Eighty Mile Beach, Roebuck Bay, Broome and the Dampier Peninsula are thought to attract large predatory pelagic fish, such as marlin and sailfish, which are present throughout the year, but peak from June to September when productivity and baitfish activity in the region are highest (Wright & Pyke 2010; Pepperell et al. 2011).

Coral reef-associated and site-attached fish assemblages

Coral reefs, such as Scott Reef, Beagle Reef and fringing coastal reefs at Browse Island, Adele Island and the Lacepede Islands (located outside of the Operational Area) support a high abundance and diversity of fish species, including tropical reef fish assemblages, small pelagic fish, parrotfish and groupers as well as larger species such as trevally, coral trout, emperors, snappers, dolphinfish, marlin and sailfish (DEWHA 2008b).

Coral reef-associated fish assemblages also include a high abundance and diversity of highly site-attached species (e.g. damselfish), meaning that they rely on the benthic habitat, have limited mobility and demonstrate a very high degree of site fidelity (Ault & Johnson 1998). These site-attached fish assemblages typically comprise small to medium species and are most abundant in the shallow photic zone (e.g. 30 – 40 m depth) and in association with hard coral coverage, while the abundance and composition of reef fish assemblages usually changes in favour of less site-attached species towards greater depths (e.g. 50 – 80 m) (Colin 1974, 1976; Feitoza et al. 2005; Brokovich et al. 2008; García-Sais 2010; Heyward et al. 2011; Bryan et al. 2013; Bejarano et al. 2014; Baker et al. 2016).

The biomass, diversity and abundance of fishes is typically greatest in the shallow photic (<30 m) and upper meso-photic (30 - 60 m depth) zones, where light dependent organisms and habitats such as corals are most abundant. The reduction in abundance disappearance of live coral cover and corresponding lower fish diversity is often reported in water depths greater than 50 – 60 m (Colin 1974, 1976; Feitoza et al. 2005; Brokovich et al. 2008; García-Sais 2010; Bryan et al. 2013; Bejarano et al. 2014; Baker et al. 2016; Lesser et al. 2009; Kahng et al. 2010, 2014; Lindfield et al. 2016; Fukunaga et al. 2016; Abdul Wahab 2018). In north-west Australia, examples of this transition from diverse habitat cover and associated fish assemblages has been reported to occur at offshore banks and shoals in the offshore waters of the Sahul Shelf and Timor Sea below depths of approximately 60 m due to good light availability (Heyward et al. 2011; ERM 2012). Elsewhere in the NWMR, where turbidity is slightly higher, a similar transition from significant coral cover and associated fish abundance and diversity has been noted at Glomar Shoal in water depths of 40 – 60 m (Abdul Wahab 2018).

Despite the presence of some hard, rocky substrate, filter feeder communities and other patchy epibenthos that provide habitat structures for fish, the high tidal flow, dynamic seabed, turbid waters and predominantly abiotic substrates present in even the shallowest parts of the Operational Area. As summarised in Section 4.7.2, surveyed areas of Lynher Bank and Leveque Rise are reported to comprise approximately 94 – 97% abiotic substrates, with only occasional hard substrate and biota (Heyward et al. 2018a). The limited areas where some low profile, hard substrate supporting significant levels of benthos occur are in water depths of 33-57 m (Heyward et al. 2018a). The most common families of fishes observed in the shallow waters of Lynher Bank are typical of soft bottom fishes that are widely occurring across northern Australia (Heyward et al. 2018a). The fish assemblages are typical of Indo-West Pacific benthic fishes from soft-bottom habitats that likely includes some occasional low-profile hard substrate (Heyward et al. 2018a).

Such soft-bottom habitats do not support the same diverse site-attached fish assemblages as are typically associated with the coral reefs and oceanic banks and shoals found elsewhere in the NWMR. Therefore, the shallow parts of the 2D seismic survey Acquisition Area are unlikely to provide any significant areas of suitable habitat for site-attached fish assemblages, although it is recognised that small areas of insignificant habitat within water depths less than approximately 60 m (and predominantly less than 50 m given the turbid conditions) could theoretically support some individual site-attached fishes.

Pipefish, pipe horses, seahorses and sea dragons (family *Syngnathidae*) are potentially present in the EMBA (Section 4.8). These listed species are site-attached species that display a preference for shallow water habitats such as seagrass and macroalgal beds, coral reefs, mangroves and sponge gardens (Foster & Vincent 2004; Lourie et al. 1999; Scales 2010). Most seahorses are found in at depths of 1-15 m, occurring in relatively protected environments, although a few species inhabit open sand or muddy bottoms, as well as areas influenced by strong currents and tidal flow, and deeper reef environments (15-60 m depth) (CITES 2001). Seahorses tend to be patchily distributed at low densities (Lourie et al. 2004). Given the water depths present in the Acquisition Area are predominantly greater than 50 m depth (approximately 96% of the Acquisition Area), the limited coverage of suitable habitat, and the predominantly shallow water preference and sparse distribution of *Syngnathids*, they are unlikely to be present in significant numbers in this area.

Fish spawning and recruitment

Fish reproduction and population recruitment occurs via spawning of eggs, distribution and settlement of larvae, and the development and recruitment of juvenile fishes to maturity. Shark species on the continental shelf give birth to live young, and tend to do so in coastal waters. Coastal waters provide important nursery habitat for the initial stages of many fish species.

The demersal and pelagic fish assemblages that are typical of the continental shelf in the Operational Area spawn throughout their ranges. Many are broadcast spawners that release millions of eggs over multiple spawning events and over many months. Recruitment (the process of juvenile fish moving into adult populations) and population connectivity varies; some demersal and pelagic fishes within the Kimberley region show genetic connectivity within hundreds of kilometres (Underwood et al. 2012; Berry et al. 2016; Depczynski et al. 2017), while other species are known to comprise populations with genetic connectivity throughout waters of northern Australia and the Indian Ocean. The larvae of many continental shelf species (e.g. snappers, emperors and mackerels) settle in shallow coastal nursery habitats such as mangroves, estuaries, seagrasses, intertidal pools and coral reefs, and juvenile fishes gradually move offshore again as they mature (Jenkins et al. 1984; Leis and Carson-Ewart 2000; Begg et al. 2006; Cowen et al. 2007; Newman et al. 2008). The larvae of some other species that occur in more intermediate and deeper waters (e.g. goldband snapper) potentially spend their entire life, from larval settlement, through juvenile stages to adulthood, in the same depth ranges, although some adult and juvenile habitat separation may still occur (Lloyd et al. 2000; Lloyd 2006). The spawning periods of many key indicator fish species for the commercial fisheries in the region varies significantly between species, as presented in Table 4-5.

4.7.5 Fish and invertebrate species of commercial and recreational significance

The Operational Area overlaps with the known distribution and habitat of several commercially and recreationally significant fish and invertebrate species, as summarised in Table 4-5. Information has been sourced from the WA Department of Primary Industries and Regional Development (WA DPIRD) during stakeholder consultation and from other references cited in the table.

Table 4-5 Key fish and invertebrate species of commercial and recreational significance

Species	**Distribution and habitat**	**Reproduction and recruitment**	**Food / Prey**	**Stock Status**	**References**
Demersal species					
Goldband snapper *Pristipomoides multidens*	• Goldband snapper typically occur in 50 – 200 m water depths, and often concentrated in depths from 80 – 150 m. • Adults occur around offshore reefs, shoals, and areas of hard flat bottom with occasional benthos or vertical relief. • Juvenile fish may remain in deep offshore waters but occur in association with different habitats, over uniform sandy and gravelly substrate. • Goldband snapper occur in waters throughout the tropical Indo-Pacific region. • Goldband snapper are widely distributed throughout northern Australia, from the Gascoyne region of WA to SE Queensland. • The Australian population occurs as a single biological stock separate from goldband snapper in SE Asia.	• There is limited movement and mixing of adult goldband snapper between different regions in Australia. There is also evidence that the northern Kimberley population (extending from the Northern Territory and Timor Sea to at least 122^{o}E [Lynher Bank]) may be distinct from other regions. Therefore, although Australian populations of goldband snapper are likely to form a single biological stock, the populations are treated as separate management units (Kimberley, Pilbara, Gascoyne Northern Australia [Northern Territory and Queensland], and East Coast Queensland). • Broadcast, serial/multiple spawners, producing millions of eggs per season. • Goldband snapper spawn throughout their range (rather than aggregating at specific locations). • Spawning occurs consistently during the following months: ○ Pilbara: October – May (extended peak spawning period) ○ Kimberley: November – May (extended peak spawning period) • Larval settlement and juvenile development is likely to occur in similar water depths to adults, although juveniles are associated with different habitat. • Fish are estimated to reach maturity after approximately 4.6 years.	Goldband snapper feed on the bottom and in the water column, consuming fish, crustaceans, gastropods, squid and scallops.	Sustainable	DPIRD finfish advice received 17th June 2019 Lloyd et al. (2000) Lloyd (2006) Ovenden et al. (2002) Newman (2003) Newman et al. (2000) Newman et al. (2008) Newman et al. (2018a) Saunders et al. (2018)
Red emperor *Lutjanus sebae*	• Red emperor typically occur in 10 – 180 m water depths, and are often concentrated in depths from 60 – 120 m. • The WA stock occurs from Cape Naturaliste to the NT border. • Adult fish occur in a range of habitats including coral reef lagoons, reefs, banks, limestone sand flats and gravel patches.	• Lethrinids are broadcast, serial/multiple spawners, producing millions of eggs per season. • Red emperor spawn throughout their range (rather than aggregating at specific locations). • Red emperor spawn multiple times between September – June (with bimodal peaks from September – November and January – March) • There is limited movement and mixing of adult red emperor between the Gascoyne, Pilbara and Kimberley regions. Red emperor in these regions are, therefore, treated as separate management units. However, there is extensive connectivity and gene flow among populations across northern Australia, indicating a single genetic stock. • Juvenile fish are more common in nearshore waters and move offshore as they mature. • Fish are estimated to reach maturity after approximately 4 – 6 years.	Lethrinids are carnivorous bottom feeders. Red emperor feed mainly on fish, benthic crustaceans and cephalopods.	Sustainable	DPIRD finfish advice received 17th June 2019 Newman et al. (2008) Newman et al. (2018b) Van Herwerden et al. (2009)

Species	Distribution and habitat	Reproduction and recruitment	Food / Prey	Stock Status	References
Blue spotted emperor *Lethrinus punctulatus*	• Blue spotted emperor typically occur in water depths of 5 – 110 m. • This species is endemic to Australia, ranging from Exmouth to possibly Darwin.	• Lethrinids are broadcast, serial/multiple spawners, producing millions of eggs per season. • Spawn throughout their range (rather than aggregating at specific locations). • Blue spotted emperor spawn from July to March. • Fish are estimated to reach maturity after approximately 1.6 years.	Lethrinids are carnivorous bottom feeders	Sustainable	DPIRD finfish advice received 17th June 2019 Newman et al. (2008) Newman et al. (2018c)
Spangled emperor *Lethrinus nebulosus*	• Spangled emperor typically occur in water depths of 1 – 80 m+. • Widespread throughout the Indo-West Pacific. • Spangled Emperor inhabit inshore and offshore coral and rocky reefs, coralline lagoons, seagrass beds, mangrove swamps, and nearshore sandy and rocky areas. • Adults are usually solitary or form small groups, while juveniles form large schools.	• Lethrinids are broadcast, serial/multiple spawners, producing millions of eggs per season. • Most likely to exhibit a peak spawning period from October – May. • Fish are estimated to reach maturity after approximately 3.6 years.	Lethrinids are carnivorous bottom feeders	Sustainable	DPIRD finfish advice received 17th June 2019 Newman et al. (2008) Newman et al. (2018d)
Rankin cod *Epinephelus multinotatus*	• Rankin cod typically occur in water depths of 10 – 150 m. • This species is found in continental shelf waters throughout the Indian Ocean, including tropical and sub-tropical northern Australia.	• Broadcast, serial/multiple spawners, producing millions of eggs per season. • Spawn throughout their range (rather than aggregating at specific locations). • Rankin cod spawn from June to December and in March (peak spawning occurs from August to October). • Although adults do not mix extensively between regions, they all contribute to the total adult spawning biomass and larval dispersal of a single biological stock. • Fish are estimated to reach maturity after approximately 2 years.	Small fishes, crabs and other benthic invertebrates.	Sustainable	DPIRD finfish advice received 17th June 2019 Newman et al. (2008) Newman et al. (2018e)
Giant ruby snapper *Etelis carbunculus*	• Occurs in water depths of 150 – 480 m across the Indo-West pacific region. • In Australia it is recorded from north-western Western Australia and off north-eastern Queensland.	• Spawn throughout their range (rather than aggregating at specific locations). • Spawn December to April (peak spawning period January – March).	Various fishes, squid and crustaceans.	Sustainable	Australian Museum (2019) DPIRD finfish advice received 17th June 2019
Other demersal species	Variable	• Most likely to exhibit a peak spawning period from October – May.	Various	Sustainable	DPIRD finfish advice received 17th June 2019
Pelagic species					
Spanish mackerel *Scomberomorus commerson*	• Occur throughout the Indo-West Pacific. • Spanish mackerel occur in continental shelf waters and congregate in coastal waters around reefs, shoals and headlands to feed and spawn in winter and spring. • WA DPIRD, they occur in water depths from 1 m to at least 50 m.	• Form spawning schools around inshore reefs in north coast bioregion • Congregate in coastal waters from approximately June onwards, but the peak spawning period is: • Pilbara: September – December • Kimberley: September – January	Pelagic baitfish such as sardines, anchovies and pilchards, as well as squids and prawns.	Sustainable	Begg et al. (2006) DPIRD finfish advice received 17th June 2019 Langstreth et al. (2018) Lewis and Jones (2017)

Species	Distribution and habitat	Reproduction and recruitment	Food / Prey	Stock Status	References
	• Information provided by mackerel fishery stakeholders indicates that mackerel occur in water depths up to 70 – 100 m.	• Females are capable of producing a batch of hundreds of thousands of eggs every 1-3 days during the spawning season. • Larvae are commonly associated with reef lagoonal areas, before juveniles move to estuary and foreshore nursery and feeding grounds where they tend to remain for the first year of life. • Fish are estimated to reach maturity after approximately 2 years.			Lewis and Jones (2018) Mackie et al. (2010)
Grey mackerel *Scomberomorus semifasciatus*	• Grey mackerel area a highly mobile schooling fish species, which can be found on the continental shelf, although its preferred habitat in shallow inshore waters around rocky reefs and headlands. • Grey Mackerel are dependent on near-shore waters for breeding and feeding.	• Spawning may extend from approximately August to February, with a peak between August and December. • Fish are estimated to reach maturity after approximately 1-2 years. • Females produce approximately 250,000 eggs per spawning event and will spawn multiple times over the spawning season. • Larval and juvenile life history stages of grey mackerel are found inshore, often in estuarine environments.	Pelagic baitfishes such as anchovies and sardines.	Sustainable	Bray and Schultz (2018) Cameron and Begg (2002) Helmke et al. (2018) Mackie et al. (2010) Roelofs et al. (2014) Welch et al. (2014)
Southern bluefin tuna *Thunnus maccoyii*	• Southern bluefin tuna are circumglobal in temperate and cold temperate waters of the southern hemisphere, ranging across the Pacific, Indian, Southern and south-eastern Atlantic oceans, mostly between 30°S and 50°S.	• A single spawning ground is known for this species, located in waters south of Java. • Spawning mainly occurs from September to April, with females spawning daily and producing 14–15 million eggs per spawning season. • Juveniles migrate south over the continental shelf of WA during their first year. Some then head westwards into the Indian Ocean, while others head eastwards into the Great Australian Bight.	Pelagic fishes, crustaceans and squid.	Recovering	Australian Fisheries Management Authority (2018) Bray and Gomon (2019) Patterson and Nicol (2018)
Bigeye tuna *Thunnus obesus*	• Bigeye tuna occur in the tropical waters of the Pacific, Atlantic and Indian Oceans. • The Indian Ocean stock is considered to be a single biological stock. • Bigeye tuna are highly migratory and travel over thousands of kilometres. • They are typically found to depths of 500 m throughout the oceans.	• Spawning occurs throughout the year, with peak spawning in summer and autumn. • Females spawn every 2-3 days producing 2.9–6.3 million eggs per spawning event.	Pelagic fishes, crustaceans and squid.	Sustainable	Australian Fisheries Management Authority (2018) Kailola et al. (1993) Schaefer et al. (2014) Williams et al. (2018)
Yellowfin tuna *Thunnus albacares*	• Yellowfin tuna occur throughout the Pacific, Atlantic and Indian Oceans. • The Indian Ocean stock is considered to be a single biological stock. • Yellowfin tuna are highly migratory and travel long distances. They are typically found to depths of 250 m.	• Spawning occurs throughout the year in tropical waters, with peak spawning in summer. • Females spawn almost daily producing 0.2–8 million eggs per spawning event.	Pelagic fishes, crustaceans and squid.	Sustainable biomass, subject to overfishing	Australian Fisheries Management Authority (2018) Kailola et al. (1993) Williams et al. (2018)
Skipjack tuna	• Skipjack tuna are circumglobal in tropical seas. • Found in all Australian states and territories.	• Spawning occurs throughout the year in tropical waters, with females spawning almost daily to produce 0.8–2 million eggs per spawning season.	Pelagic fishes, crustaceans and squid.	Sustainable	Schultz (2019)

Species	Distribution and habitat	Reproduction and recruitment	Food / Prey	Stock Status	References
Katsuwonus pelamis					
Albacore tuna *Thunnus alalunga*	• Albacore tuna occur throughout the Pacific and Indian Oceans. • The Indian Ocean stock is assumed to be a single biological stock. • Albacore tuna are highly migratory and travel long distances. • They are typically found to depths of 200 m.	• Peak spawning occurs in summer with females producing 2–3 million eggs per season.	Pelagic fishes, crustaceans and squid.	Sustainable	Australian Fisheries Management Authority (2018) Kailola et al. (1993) Williams et al. (2018)
Broadbill swordfish *Xiphias gladius*	• Broadbill swordfish occur throughout the Pacific, Atlantic and Indian Oceans. • The Indian Ocean stock is considered to be a single biological stock. • Broadbill swordfish are highly migratory and are typically found to depths of 550 m.	• Spawning occurs throughout the year in tropical waters. • Females spawn every 2–3 days producing 1.2–2.5 million eggs per spawning event.	Pelagic fishes such as tuna, flying fish and barracudas. Demersal prey includes hakes, gempylids and myctophids.	Sustainable – Not overfished	Australian Fisheries Management Authority (2018) Kailola et al. (1993) Williams et al. (2018)
Striped marlin *Kajikia audax*	• Striped marlin occur in tropical to temperate waters of the Pacific and Indian Oceans. • The Indian Ocean stock is considered to be a single biological stock. • They are highly migratory and are typically found to depths of 290 m.	• Spawning occurs in summer. • Females release eggs every few days, producing up to 120 million eggs per spawning season.	Pelagic fishes, crustaceans and squid.	Uncertain biomass, subject to overfishing (Western stock)	Australian Fisheries Management Authority (2018) Kailola et al. (1993) Williams et al. (2018)
Black marlin *Istiompax indica*	• Black marlin occur circum-Australia and throughout tropical and subtropical Indo-Pacific waters, occasionally entering temperate waters. • An epipelagic, oceanic species often found near shore in coastal waters, around islands and coral reefs. • Highly migratory. • Common in nearshore waters off Eighty Mile Beach, Roebuck Bay, Broome and the Dampier Peninsula from June to September when productivity and baitfish activity in the region are highest.	• Spawns from August to November, with females capable of producing 40 million eggs.	Pelagic fishes (e.g. small tunas), crustaceans and squid.	N/A – Stock not assessed	Pepperell et al. (2011) Wright and Pyke (2010)
Indo-Pacific sailfish *Istiophorus platypterus*	• Indo-Pacific sailfish are common and widespread in the tropical and sub-tropical Atlantic and Indo-Pacific oceans, ranging into temperate waters. • Epipelagic usually in oceanic waters and also found near continental coasts, islands and reefs. • Common in nearshore waters off Eighty Mile Beach, Roebuck Bay, Broome and the Dampier Peninsula from June to September when productivity and baitfish activity in the region are highest.	• Spawning occurs throughout the year, peaking in summer	Pelagic fishes, crustaceans and squid.	N/A – Stock not assessed	Pepperell et al. (2011) Wright and Pyke (2010)

Species	Distribution and habitat	Reproduction and recruitment	Food / Prey	Stock Status	References
Shark species					
Sandbar shark *Carcharhinus plumbeus*	• The sandbar shark inhabits tropical and temperate coastal waters, including shallow estuaries with sandy or muddy bottoms, bays, estuaries and around offshore islands, banks and reef flats across the continental shelf out to 280 m depth, but typically in waters less than 100 m • In WA, the species is primarily found between the west Kimberley (Cape Leveque) and Albany. • Adults are most commonly found in depths greater than 40 m between the Eighty Mile Beach and the Houtman Abrolhos Islands.	• Pupping occurs between North West Cape and Albany. • Adults reproduce every two years. Mating may begin as early as October, with peaks between January and April. This is followed by an 11-12-month gestation period, with pupping between February and April. Litter sizes range from 4 to 10 pups. • Unlike most other carcharhinid shark species in WA, juveniles move from shallow waters out to deeper, temperate continental shelf waters (80-130 m) south of Shark Bay and move into shallower waters (50–100 m) between summer and early winter. These movements separate them from adult sharks and the potential for predation and competition for food. • Juvenile sharks are largely absent from waters further north in WA but move northward to these waters as they mature.	Small bottom dwelling fishes, crustaceans and molluscs	Transitional, recovering	Braccini et al. (2018) Bray (2019c) Compagno (1984) Compagno (2001) Department of Fisheries (2005) McAuley and Gaughan (2005) McAuley et al. (2005) McAuley et al. (2007) Newman et al. (2003)
Australian blacktip shark *Carcharhinus tilstoni*	• The Australian blacktip shark is endemic to the tropical continental shelf waters of northern Australia. • Adults occur across the continental shelf up to 150 m water depth, while newborn and juvenile sharks are found in shallow nearshore habitats. • Blacktip sharks are highly mobile animals, enabling them to readily move between preferred habitats.	• Adult females move inshore during the summer months when ready to give birth, and the young are also usually found in warm, shallow nearshore nursery areas. • Individuals breed each year. Mating occurs in February – March, giving birth to 1-6 pups in December – January after a ten-month gestation period.	Pelagic and benthic fishes, cephalopods and crustaceans	Sustainable	Compagno and Niem (1998) Harry et al. (2011) Harry et al. (2012) Harry et al. (2013) Johnson et al. (2018) Knip et al. (2010) Last and Stevens (2009) Stevens and Wiley (1986) Welch et al. (2014)
Common blacktip shark *Carcharhinus limbatus*	• Common blacktip sharks are found in tropical and sub-tropical continental shelf waters up to 150 m water depth, in bays, estuaries, over coral reefs and off river mouths. • Adults prefer deeper shelf waters while newborn and juvenile sharks are found in shallow, nearshore habitats. • Blacktip sharks are highly mobile animals, enabling them to readily move between preferred habitats.	• Adult females move inshore during the summer months when ready to give birth, and the young are also usually found in warm, shallow nearshore nursery areas. • Adults breed every two years with a ten to 12-month gestation period. • Females move into coastal waters to give birth to 4-10 pups between October and March, peaking in November.	Pelagic and benthic fishes, cephalopods and crustaceans	Sustainable	Burgess and Branstetter (2009) Davenport and Stevens (1988) Harry et al. (2011) Harry et al. (2012) Harry et al. (2013) Johnson et al. (2018) Knip et al. (2010) Last and Stevens (2009) Macbeth et al. (2009)

Species	Distribution and habitat	Reproduction and recruitment	Food / Prey	Stock Status	References
					Ovenden et al. (2010) Welch et al. (2014)
Spot-tail shark *Carcharhinus sorrah*	• The spot-tail shark are a highly mobile coastal, shallow-water tropical shark, found at depths from the intertidal zone to 140 m, but most common in depths between 20 m and 50 m around coral reefs and over sand and mud flats. • Young spot-tail sharks occur in quiet, shallow water, separate from the adults. • Spot-tail sharks are highly mobile animals, enabling them to readily move between preferred habitats.	• Adult females move inshore during the summer months when ready to give birth, and the young are also usually found in warm, shallow nearshore nursery areas. • The reproductive cycle is similar to that of Australian blacktip sharks. Females typically give birth annually to 1-8 pups between late November and early February, peaking in December/January. • Mating is likely to occur soon after pupping, in late summer, with a 9-10-month gestation period before giving birth again (Stevens & Wiley 1986; Harry et al. 2013).	Pelagic and benthic fishes, cephalopods and crustaceans	Sustainable	Compagno (2001) Compagno and Niem (1998) Davenport and Stevens (1988) Harry et al. (2013) Johnson et al. (2018) Knip et al. (2010) Last and Stevens (1994) Pillans et al. (2009) Stevens and Wiley (1986) Stevens and Davenport (1991) Welch et al. (2014) White et al. (2006)
Blacktip reef shark *Carcharhinus melanopterus*	• The blacktip reef shark occurs in close association with tropical reefs in water depths of 0-75 m and usually in shallow waters less than 40 m depth.	• In northern Australia mating probably occurs in January and February, giving birth to 2-4 pups in November and December, following an 8-9-month gestation period.	Small fishes, molluscs and crustaceans	N/A – Stock not assessed	Bray (2019d) Lyle (1987) Last and Stevens (2009)
Invertebrate species					
Silver-lipped pearl oyster *Pinctada maxima*	• Pearl oysters are typically associated with stone and coral rubble or hard flat rocky bottom covered by a fine layer of sediment with occasional sponges, soft corals, sea fans, hydroids, ascidians and other fauna. • Habitat range off the WA coast is known to extend from the shallow waters of the sub-tidal zone, to water depths of up to 50 metres or more.	• The breeding season starts in September/October extending to April/May. • Although there is variability from month to month, the primary spawning occurs from the middle of October to December. A smaller secondary spawning period occurs in February and March. • Recruitment is highly variable due to environmental factors. • The movements of pearl oyster larvae prior to settlement on the seabed are dictated to by wave action, prevailing winds and currents. The currents off Eighty Mile Beach result in alongshore dispersion. • Spawning of oysters off Eighty Mile Beach has been predicted to be concentrated mostly between 8-15 metre water depths with smaller contributions of spawn from deeper water, resulting in recruitment locally and alongshore. • Larvae on WA's north-west shelf are predominantly transported alongshore less than 30 kilometres, however some as far as 60 kilometres.	Suspension feeders - particulate organic matter / nutrients	Sustainable	Benzie and Smith (2006) Condie et al. (2006) Department of Fisheries (2015a) Department of Fisheries (2016) Fletcher et al. (2006) Hart and Friedman (2004) Hart et al. (2018) Hart et al. (2016) Johnson and Joll (1993) Wada and Tëmkin (2008)

Species	Distribution and habitat	Reproduction and recruitment	Food / Prey	Stock Status	References
Australian scampi *Metanephrops australiensis*	• Scampi live on the seabed in deep continental slope waters. • They are usually found on Globigerina ooze (deep sea muds rich in the shells of planktonic organisms) at depths of 420-500 metres.	• Timing of spawning is uncertain but is thought to occur annually and studies of similar species suggest that spawning occurs in September-October.	Other crustaceans, fish and squid	Sustainable	Australian Fisheries Management Authority (2018) Harte and Curtotti (2018)
Banana prawn *Penaeus indicus / Penaeus merguiensis*	• Inhabit coastal waters over muddy and sandy seabed. • Banana prawns are widely distributed within tropical and subtropical waters. • White banana prawns are typically found in water depths of 16-25 metres. • Redleg banana prawns are found in deeper waters of 35-90 metres, however they are schooling species and can occasionally form dense aggregations near the surface.	• Prawn spawning occurs in shallow coastal waters near estuaries. • Prawn nursery areas in the fisheries are known to be located in and around Roebuck Bay, Collier Bay, York Sound and Admiralty Gulf.	Small bivalve molluscs, crustaceans, polychaete worms, and foraminifera	Sustainable	Australian Fisheries Management Authority (2018) Department of Fisheries (2004) Kangas (2018) Sporer et al. (2015)
Western king prawn *Penaeus latisulcatus*	• Western king prawns are distributed throughout the Indo-West Pacific. • Inhabit coastal waters over muddy and sandy seabed.	• Prawn spawning occurs in shallow coastal waters near estuaries. • Prawn nursery areas in the fisheries are known to be located in and around Roebuck Bay, Collier Bay, York Sound and Admiralty Gulf.	Small bivalve molluscs, crustaceans, polychaete worms, and foraminifera	Sustainable	Australian Fisheries Management Authority (2018) Department of Fisheries (2004) Kangas (2018) Sporer et al. (2015)
Tiger prawn *Penaeus esculentus*	• Tiger prawns are endemic to Australian coastal waters, occurring in Northern Australia from Shark Bay to NSW. • Tiger prawns are found in depths up to 200 metres. • Adults are typically found over coarse sediments. Adult grooved prawns are found in fine mud sediments. Juveniles are found in shallower waters.	• Prawn spawning occurs in shallow coastal waters near estuaries. • Prawn nursery areas in the fisheries are known to be located in and around Roebuck Bay, Collier Bay, York Sound and Admiralty Gulf.	Small bivalve molluscs, crustaceans, polychaete worms, and foraminifera	Sustainable	Australian Fisheries Management Authority (2018) Department of Fisheries (2004) Kangas (2018) Sporer et al. (2015)
Trochus *Tectus niloticus*	• Trochus is typically found in intertidal and shallow, nearshore sub-tidal reefs where it grazes on algae.	• Recruitment and connectivity in trochus in Kimberley coastal waters is highly localised because of having a short larval life-expectancy (3-5 days). • Trochus recruitment along the Kimberley coast occurs locally (≤ 75km) and there is limited genetic connectivity with isolated oceanic reefs such as Scott Reef and the Rowley Shoals.	Coralline and fleshy algae	N/A – Stock not assessed	Berry et al. (2017) Lawrence (1995)

4.8 Species of conservation significance

Species of conservation significance within the Operational Area and EMBA were identified through a search of the EPBC Act Protected Matters Database. A precautionary 20 km buffer was applied to the Operational Area search to account for sound propagation outside of the Operational Area. The search identified a total of 47 "listed threatened" species and 74 "listed migratory" species that potentially use, or pass through, the EMBA. In addition, 132 "listed marine" species were identified, of which 29 are "whales and other cetaceans" that may occur at, or immediately adjacent to the area. The full search results for both the Operational Area and EMBA are contained in Appendix B. Note that true terrestrial species have not been listed in Table 4-6, although species that typically inhabit coastal environments have been included.

Table 4-6: Listed threatened and/or migratory species under the EPBC Act potentially occurring within the EMBA

Species	Common name	Conservation status	Migratory	Operational Area	EMBA
Mammals					
Balaenoptera musculus	Blue whale	Endangered	Yes	Yes	Yes
Megaptera novaeangliae	Humpback whale	Vulnerable	Yes	Yes	Yes
Balaenoptera borealis	Sei whale	Vulnerable	Yes	Yes	Yes
Balaenoptera physalus	Fin whale	Vulnerable	Yes	Yes	Yes
Balaenoptera edeni	Bryde's whale	Nil	Yes	Yes	Yes
Orcinus orca	Killer whale	Nil	Yes	Yes	Yes
Physeter macrocephalus	Sperm whale	Nil	Yes	Yes	Yes
Tursiops aduncus	Spotted bottlenose dolphin (Arafura/ Timor Sea populations)	Nil	Yes	Yes	Yes
Orcaella heinsohni	Australian Snubfin Dolphin	Nil	Yes	Yes	Yes
Sousa chinensis	Indo-pacific humpback dolphin	Nil	Yes	Yes	Yes
Dugong dugon	Dugong	Nil	Yes	Yes	Yes

Species	Common name	Conservation status	Migratory	Operational Area	EMBA
Marine reptiles					
Caretta	Loggerhead turtle	Endangered	Yes	Yes	Yes
Chelonia mydas	Green turtle	Vulnerable	Yes	Yes	Yes
Dermochelys coriacea	Leatherback turtle	Endangered	Yes	Yes	Yes
Eretmochelys imbricate	Hawksbill turtle	Vulnerable	Yes	Yes	Yes
Lepidochelys olivacea	Olive riley turtle	Endangered	Yes	Yes	Yes
Natator depressus	Flatback turtle	Vulnerable	Yes	Yes	Yes
Aipysurus apraefrontalis	Short-nosed sea snake	Critically Endangered	No	Yes	Yes
Aipysurus foliosquama	Leaf-scaled seasnake	Critically endangered	No	No	Yes
Ctenotus angusticeps	Northwestern Coastal Ctenotus	Vulnerable	No	No	Yes
Crocodylus porosus	Saltwater crocodile	Nil	Yes	No	Yes
Shark, fish and rays					
Carcharodon carcharias	White shark	Vulnerable	Yes	Yes	Yes
Rhincodon typus	Whale shark	Vulnerable	Yes	Yes	Yes
Pristis	Largetooth sawfish	Vulnerable	No	Yes	Yes
Pristis zijsron	Green sawfish	Vulnerable	No	Yes	Yes
Pristis clavata	Dwarf sawfish	Vulnerable	Yes	Yes	Yes
Anoxypristis cuspidate	Narrow sawfish	Nil	Yes	Yes	Yes
Glyphis garricki	Northern river shark	Endangered	No	Yes	Yes
Isurus oxyrinchus	Shortfin mako	Nil	Yes	Yes	Yes

Species	Common name	Conservation status	Migratory	Operational Area	EMBA
Isurus paucus	Longfin mako	Nil	Yes	Yes	Yes
Manta birostris	Giant manta ray	Nil	Yes	Yes	Yes
Manta alfredi	Reef manta ray	Nil	Yes	Yes	Yes
Marine avifauna					
Anous tenuirostris melanops	Australian lesser noddy	Vulnerable	No	Yes	Yes
Calonectris leucomelas	Streaked shearwater	Nil	Yes	Yes	Yes
Fregata ariel	Lesser frigatebird	Nil	Yes	Yes	Yes
Fregata minor	Great frigatebird	Nil	Yes	Yes	Yes
Hydroprogne caspia	Caspian tern	Nil	Yes	Yes	Yes
Sternula albifrons	Little tern	Nil	Yes	Yes	Yes
Onychoprion anaethetus	Bridled tern	Nil	Yes	Yes	Yes
Sterna dougallii	Roseate tern	Nil	Yes	Yes	Yes
Thalasseus bergii	Crested tern	Nil	Yes	Yes	Yes
Tringa brevipes	Grey-tailed tattler	Nil	Yes	Yes	Yes
Charadrius leschenaultia	Greater sand plover	Vulnerable	No	Yes	Yes
Charadruis mongolus	Lesser sand plover	Endangered	No	Yes	Yes
Pluvialis fluva	Pacific golden plover	Nil	Yes	Yes	Yes
Pluvialis squatarola	Grey plover	Nil	Yes	Yes	Yes
Phaethon lepturus	White-tailed tropicbird	Nil	Yes	Yes	Yes

Species	Common name	Conservation status	Migratory	Operational Area	EMBA
Calidris ferruginea	Curlew sandpiper	Critically Endangered	Yes	Yes	Yes
Numenius madagascariensis	Eastern curlew	Critically Endangered	Yes	Yes	Yes
Calidris Canutus	Red knot	Endangered	Yes	Yes	Yes
Calidris tenuirostris	Great knot	Critically Endangered	No	Yes	Yes
Apus pacificus	Fork-tailed swift	Nil	Yes	Yes	Yes
Papasula abbotti	Abbott's booby	Endangered	No	Yes	Yes
Sula dactylatra	Masked booby	Nil	Yes	Yes	Yes
Sula leucogaster	Brown booby	Nil	Yes	Yes	Yes
Sula	Ret-footed booby	Nil	Yes	Yes	Yes
Anous stolidus	Common noddy	Nil	Yes	Yes	Yes
Arenaria interpres	Ruddy turnstone	Nil	Yes	Yes	Yes
Calidris alba	Sanderling	Nil	Yes	Yes	Yes
Numenius phaeopus	Whimbrel	Nil	Yes	Yes	Yes
Erythrotriorchis radiates	Red goshawk	Vulnerable	No	Yes	Yes
Limosa lapponica bauera	Bar-tailed godwit	Vulnerable	Yes	Yes	Yes
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	Critically Endangered	Yes	Yes	Yes
Limosa	Black-tailed godwit	Nil	Yes	Yes	Yes
Actitis hypoleucos	Common sandpiper	Nil	Yes	Yes	Yes
Calidris acuminata	Sharp-tailed sandpiper	Nil	Yes	Yes	Yes

Species	Common name	Conservation status	Migratory	Operational Area	EMBA
Calidris melanotos	Pectoral sandpiper	Nil	Yes	Yes	Yes
Xenus cinereus	Terek sandpiper	Nil	Yes	Yes	Yes
Acrocephalus orientalis	Oriental reed-warbler	Nil	Yes	Yes	Yes
Tringa nebularia	Common greenshank	Nil	Yes	Yes	Yes
Tringa totanus	Common redshank	Nil	Yes	Yes	Yes
Calidris ruficollis	Red-necked stint	Nil	Yes	Yes	Yes
Cuculus optatus	Oriental cuckoo	Nil	Yes	Yes	Yes
Pandion haliaetus	Osprey	Nil	Yes	Yes	Yes
Rostratula australis	Australian painted snipe	Endangered	Yes	No	Yes
Ardenna pacifica	Wedge-tailed shearwater	Nil	Yes	No	Yes
Charadrius veredus	Oriental Plover	Nil	Yes	No	Yes
Glareola maldivarum	Oriental pratincole	Nil	Yes	No	Yes

4.8.1 Conservation management documents

In addition to species being identified as threatened or migratory and matters of national environmental significance (MNES), depending on the threat classification, the Department of the Environment and Energy (DEE) has established management policies, guidelines, plans and other materials for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the EPBC Act.

In particular, the objectives of DEE recovery plans and conservation advice, seek to support the long-term recovery of various species outlining research and management measures that must be undertaken to stop the decline of, and support the recovery of a species, including the management of threatening processes.

A demonstration of how this EP addresses the relevant conservation management documents related to EPBC listed species has been presented in Appendix B.

4.8.2 Biologically important habitats

The DEE has, through the marine bioregional planning program, identified, described and mapped biologically important areas (BIAs) for protected species under the EPBC Act. BIAs spatially and temporally define areas where protected species display biologically important behaviours (including breeding, foraging, resting or migration), based on the best available scientific information. These areas are those parts of a marine region that are particularly important for the conservation of protected species.

In addition, in 2017 the DEE released the Recovery Plan for Marine Turtles in Australia which identified 'habitat critical to the survival of a species' (Habitat Critical). It is important to note that the Recovery Plan did not identify "Critical Habitat" as defined under Section 207A of the EPBC Act). Habitat critical to the survival of a species is discussed in conjunction with the BIAs each relevant turtle species.

This section provides an overview of the EPBC-listed species, identified by the EPBC Act Protected Matters search, that are associated with a BIA or habitat critical to the survival of a marine species occurring within either the Operational Area or EMBA (Table 4-7). Further detail on the BIAs and/or Habitat Critical is described in the following sections.

Table 4-7: BIAs and habitat critical to the survival of a marine turtle species intersecting the EMBA

Species	Biologically Important Area / Habitat Critical	Operational Area	EMBA
Humpback whale	Migration BIA	Yes	Yes
	Resting BIA	Yes	Yes
	Calving BIA	Yes	Yes
	Nursing BIA	Yes	Yes
Pygmy blue whale	Migration BIA	Yes	Yes
	Foraging BIA	-	Yes
	Distribution BIA	Yes	Yes
Indo-Pacific humpback dolphin	Foraging BIA	-	Yes
	Breeding BIA	-	Yes
	Calving BIA	-	Yes
Indo-Pacific bottlenose dolphin	Foraging BIA	-	Yes
	Calving BIA	-	Yes
Australian snubfin dolphin	Breeding BIA	-	Yes
	Foraging BIA	-	Yes
	Calving BIA	-	Yes
Dugong	Migration BIA	-	Yes
	Foraging BIA	-	Yes
Flatback Turtle	Foraging BIA	Yes	Yes
	Internesting BIA	Yes	Yes

Species	Biologically Important Area / Habitat Critical	Operational Area	EMBA
	Nesting BIA	-	Yes
	Habitat critical to the survival of a marine turtle species - Internesting	Yes	Yes
Green turtle	Foraging BIA	Yes	Yes
	Internesting BIA	-	Yes
	Habitat critical to the survival of a marine turtle species - Internesting	-	Yes
Hawksbill turtle	Internesting BIA	-	Yes
Loggerhead turtle	Foraging BIA	Yes	Yes
Olive Ridley Turtle	Habitat critical to the survival of a marine turtle species - Internesting	-	Yes
Whale shark	Foraging BIA	Yes	Yes
Green sawfish	Nursing BIA	-	Yes
	Pupping BIA	-	Yes
Dwarf Sawfish	Pupping BIA	-	Yes
	Nursing BIA	-	Yes
	Foraging BIA	-	Yes
Freshwater sawfish	Foraging BIA	-	Yes
	Pupping BIA	-	Yes
Avifauna	Foraging BIA	Yes	Yes
	Resting BIA	Yes	Yes
	Breeding BIA	-	Yes

4.8.3 Marine mammals

Humpback whale

The humpback whale (*Megaptera novaeangliae*) is a moderately large baleen whale with a fragmented global distribution and two Australian populations, known as the east Australian and west Australian populations. The Kimberley region marks the northern terminus of the species' migration. These waters are used by humpback whales as an important area for resting calving and nursing before migrating south again towards the Southern Ocean (Jenner et al. 2001).

Humpback whales typically occur in the Kimberley region between June and October, with peak ingress during July. The population increases up to mid-August when whales begin to depart on their southern migration. Peak egress occurs around September and the final groups of whales tend to have departed by late October (Jenner et al. 2001; Thums et al. 2018).

The migratory habitat for the humpback whale around mainland Australia is primarily coastal waters less than 200 m in depth and generally within 20 km of the coast (Jenner et al. 2001). Camden Sound is considered the northern most limit and is considered an important calving and breeding area (Jenner et al. 2001).

BIAs have been designated for humpback whales within 100 km of the Kimberley coastline, including a migration BIA and BIAs for resting, calving and nursing which extend from the Dampier Peninsula to Camden Sound (Figure 4-8). Well documented aggregation sites in the BIAs are located at Camden Sound, Tasmanian Shoal and Pender Bay. A recent study as part of the Kimberley Marine Research Project (Thums et al. 2018) analysed three decades of satellite, aerial, boat-based sightings and determined that the greatest densities of whales occur at Pender Bay. Abundance was greatest in nearshore waters in water depths of approximately 35 m. Gourdon Bay to the south of Broome and to the south of the designated for resting, calving and nursing BIAs has now also been identified as an important area where whales occur in high density (Thums et al. 2018). However, whales (including cows and calves) may also occur in lower abundance elsewhere within and further offshore from the BIAs, with whales having been recorded in offshore locations such as Browse Island and Scott Reef (e.g. McCauley 2009).

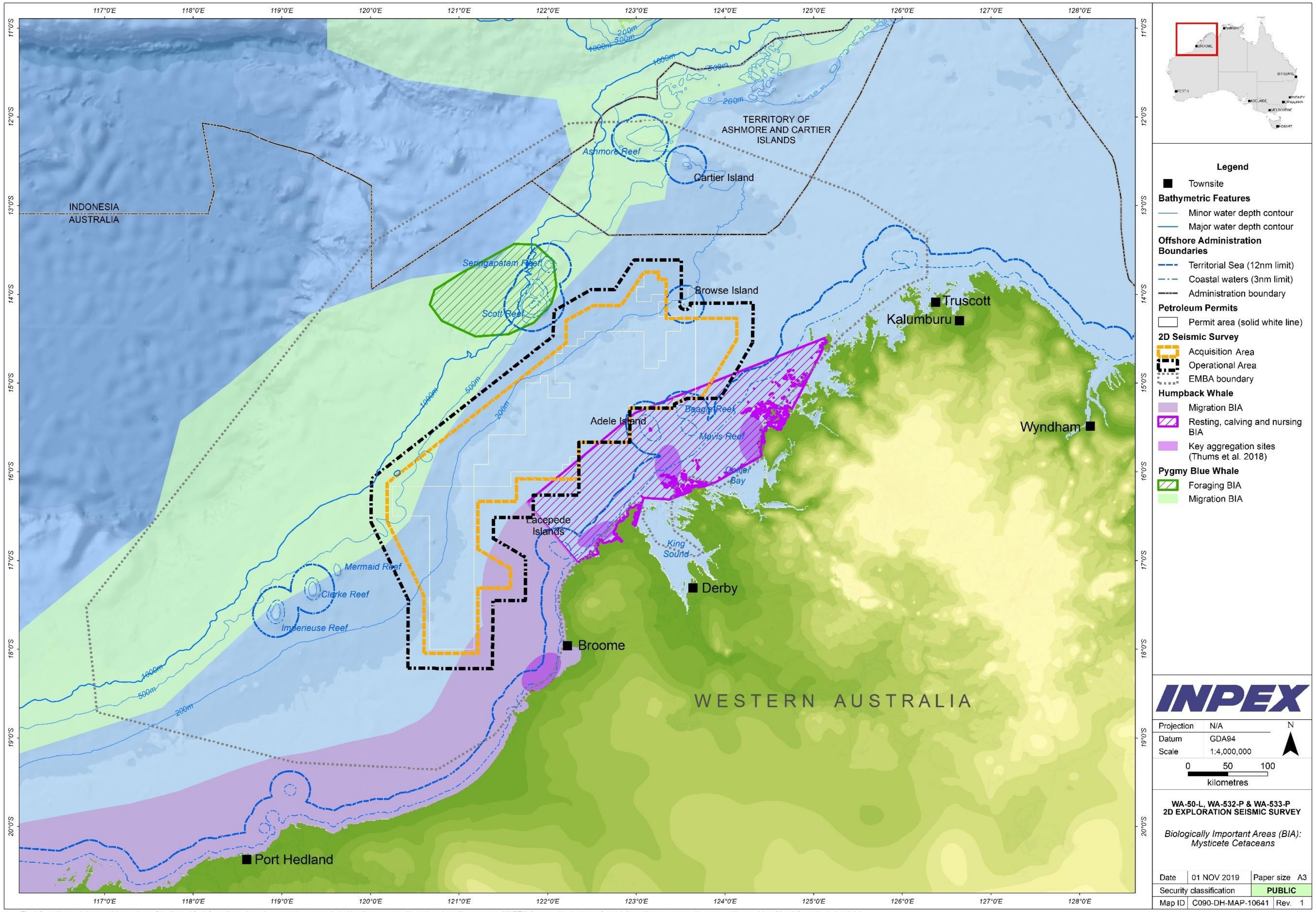


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Figure 4-8 Biologically important areas for humpback whales and pygmy blue whales

Pygmy blue whale

The pygmy blue whale (*Balaenoptera musculus brevicauda*) is a subspecies of the blue whale, of which there are four species. Pygmy blue whales migrate as solitary animals or in small groups along the continental shelf break, typically at depths between 500 m and 1,000 m on the way to grounds the Banda and Molucca Seas near Indonesia, where calving is understood to occur (Double et al. 2014) (Figure 4-8).

The annual northbound migration past Exmouth and north-western Australia has been detected between April and August, with the return southbound migration from October to the end of December, peaking in November and early December (McCauley & Jenner 2010; McCauley & Duncan 2011; Double et al. 2012; Double et al. 2014).

McCauley (2011) observed a lower number of animals migrating past Scott Reef than Exmouth during both northbound and southbound migrations. The lower numbers of pygmy blue whales recorded off Scott Reef than off Exmouth suggest that only a fraction of animals which pass up and down the WA coast utilise the shelf break further north, and that the other animals may move into deeper areas of the Indian Ocean further to the west (McCauley 2011).

A study by Gavrilov et al. (2018), undertaken between December 2014 and January 2015, recorded pygmy blue whales passing north-west of the North West Cape in late November and mid-December during their southbound migration. Gavrilov et al. (2018) noted that the highest detection of animals was approximately 200 km offshore from the continental shelf edge and in water depths between approximately 930 m and 2,410 m, suggesting that whales may travel further offshore and in deeper waters during the southbound migration than during the northbound migration.

BIAs have been identified by the DAWE for pygmy blue whales that overlap with the EMBA. A small part of the migration BIA is overlapped by the western part of the Operational Area. A wider 'distribution' BIA also overlaps the Operational Area and the EMBA, which indicates where pygmy blue whales may occur, but in low abundance. Waters surrounding Scott Reef and Seringapatam Reef have been identified by the DAWE as a BIA for pygmy blue whale foraging (Figure 4-8).

The designated foraging BIA at Scott Reef is not a recognised feeding area for the species but is considered a possible foraging area. Evidence for feeding is based on limited direct observations or other data (Department of the Environment 2015). However, it is noted that pygmy blue whales have been recorded in deep waters west of Scott Reef (McCauley 2011; Double et al. 2012).

Australian snubfin dolphin

All available data on the distribution and habitat preferences of Australian snubfin dolphins indicate that they mainly occur in shallow coastal and estuarine waters in Northern Australia between Broome and Brisbane (Beasley et al. 2005). They are primarily found close to the coast in waters less than 20 metres deep, close to river mouths and in proximity to seagrass beds. There are no data to estimate any past or potential future declines in the area of occupancy for snubfin dolphins in Australia; however, incidental catches in gillnets (albeit at unknown levels), plus habitat degradation, may lead to a reduction of area of occupancy over the next three generations for Australian snubfin dolphins (DEE 2019). No BIAs for Australian snubfin dolphin occur within the Operational Area; however, several occur within the EMBA (Figure 4-9). This includes breeding, calving and foraging in Roebuck Bay and King Sound, as well as foraging at Pender, Canton and Beagle Bay.

A recent study of snubfin and humpback dolphins in the Kimberley region (Brown et al. 2017; Waples et al. 2019) confirmed that snubfin dolphins are relatively abundant in the coastal waters of Roebuck Bay and also noted their presence along the north Kimberley coast at Cygnet Bay (King Sound), Cone Bay and Yampi Sound (Buccaneer Archipelago), the Prince Regent River area, and Cambridge Gulf.

Indo-pacific humpback dolphin

The Indo-pacific humpback dolphin has a distribution from north of Ningaloo in Western Australia to as far south as Sydney, New South Wales. They are generally found in association with river mouths, mangroves, tidal channels and inshore reefs in depths of less than 20 metres, although some have been recorded in waters up to 40 metres deep and 55 kilometres offshore. While no BIAs for the Indo-Pacific humpback dolphin occur within the Operational Area, several occur within the EMBA (Figure 4-9). These include breeding, calving and foraging in Roebuck Bay, Willie Creek and King Sound, as well as foraging at Pender, Canton and Beagle Bay.

A recent study of snubfin and humpback dolphins in the Kimberley region (Brown et al. 2017; Waples et al. 2019) confirmed the presence of humpback dolphins in the coastal waters of Roebuck Bay, Cygnet Bay (King Sound), Cone Bay and Yampi Sound (Buccaneer Archipelago), the Prince Regent River area, and Cambridge Gulf.

Indo-pacific/Spotted bottlenose dolphin

Indo-Pacific Bottlenose Dolphins are distributed continuously around the Australian mainland and are found within inshore areas including bays and estuaries, nearshore waters, open coast environments and around oceanic islands (DEE 2018b). No BIAs for the Indo-Pacific humpback dolphin occur within the Operational Area; however, BIAs are present within EMBA (Figure 4-9). This includes breeding, calving and foraging at Roebuck Bay and King Sound, as well as foraging at Pender Bay.

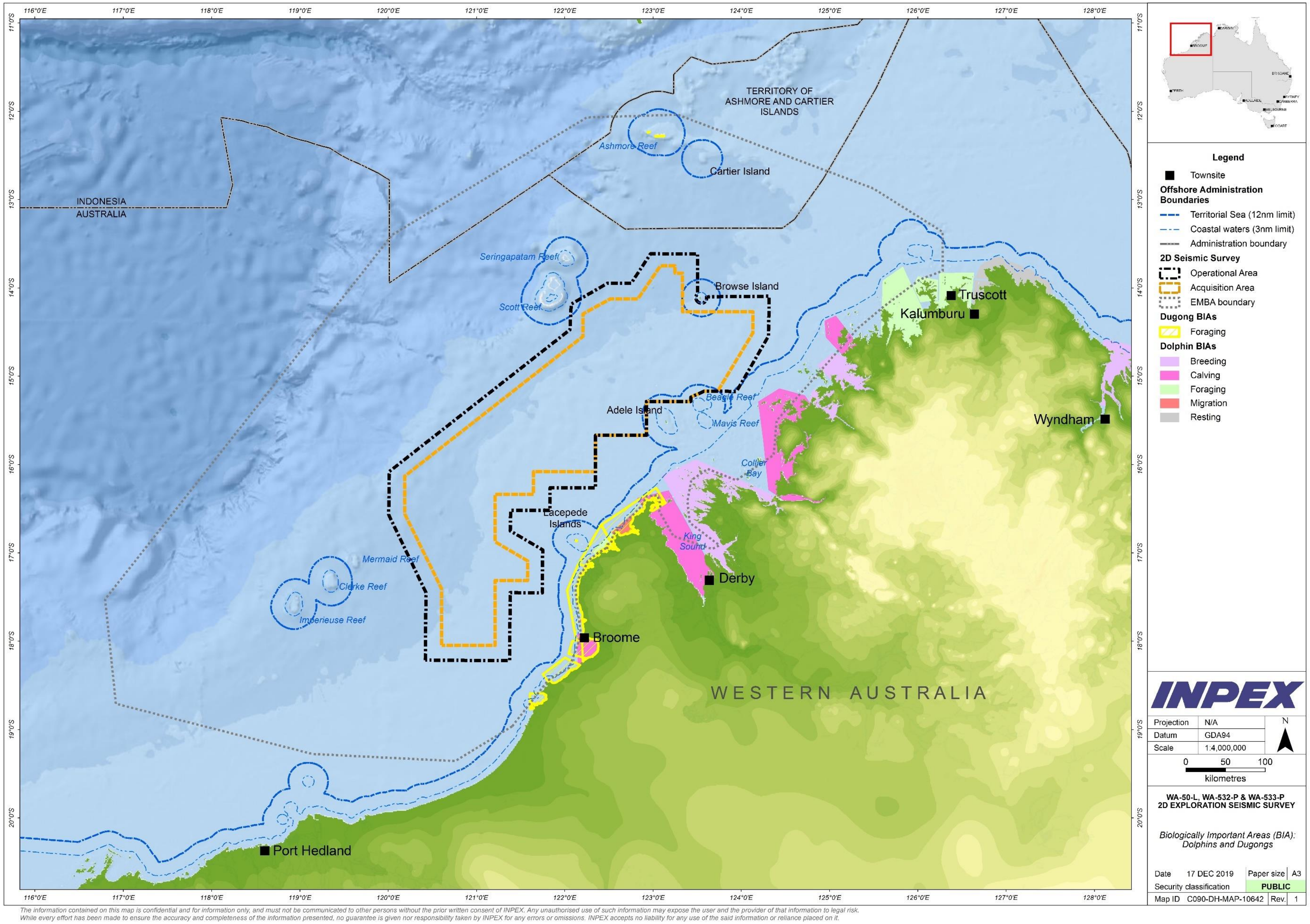

Figure 4-9 Biologically important areas for inshore dolphin species and dugongs

Dugongs

Dugongs are listed as Specially Protected under the Biodiversity Conservation Act (WA) and are listed as migratory species under the EPBC Act. A significant proportion of the world's dugong population occurs in the coastal waters of the west-Pilbara, as well as at Ningaloo Reef and in the Exmouth Gulf (Marsh et al. 2011), which are outside of the EMBA. Dugongs generally inhabit shallow waters and are commonly found in mangrove channels of inshore islands and shallow areas near the seagrass habitats on which they feed (DEE 2018c). A number of BIAs have been designated along the coast in recognition of significant dugong foraging habitat, including at Gourdon Bay, Roebuck Bay and the coast of Broome and Cape Leveque (Figure 4-9).

A recent study of dugongs in the Kimberley (Bayliss and Hutton 2017; Waples et al. 2019) found that the highest densities of dugongs in the Kimberley were found in areas with extensive seagrass habitat in sheltered, shallow waters (<20 m). Roebuck Bay, Montgomery Reef (near Camden Sound) and coastal waters between the Maret Islands and Kalumburu were noted as supporting relatively high densities of dugongs.

4.8.4 Marine reptiles

The EPBC Act Protected Matters search identified five species of marine turtle which may occur within the EMBA: the flatback turtle, green turtle, loggerhead turtle, hawksbill turtle and olive ridley turtle.

Four of the turtle species (green, loggerhead, flatback and hawksbill) have nesting rookeries on beaches along the mainland coast and internesting areas associated with islands in the wider region. Key nesting beaches within the EMBA have been identified at Eighty Mile Beach, the Lacepede Islands, Adele Island, Browse Island, Scott Reef, Ashmore Reef, Cartier Island, and at beaches along the coastline and at various islands in the north Kimberley (DEE 2017a). The internesting habitats of flatback and green turtles, as described in DEE (2017a), overlap with the Operational Area. Flatback turtles in particular may swim relatively large distances from nesting beaches during the internesting period and, therefore, internesting BIAs and Habitat Critical areas are larger than for other turtle species and are of most relevance to activities within the Operational Area (Figure 4-10 and Figure 4-11). Details on each species with biologically important areas occurring within the EMBA are discussed in detail below.

Species of sea snakes, including short-nosed sea snakes, may also be present in the EMBA.

Flatback turtle

The flatback turtle has a restricted distribution, occurring only in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya (Spring 1982; Zangerl et al. 1988). Adult flatback turtles inhabit soft bottom habitat over the continental shelf of northern Australia, extending into Papua New Guinea and Irian Jaya (Spring 1982; Zangerl et al. 1988). Three genetically distinct stocks occur within the Kimberley: Cape Domett stock (outside of the EMBA), the south-west Kimberley stock and recently identified genetic stocks in the northern Kimberley (DEE 2017a). The north Kimberley may also comprise a number of other smaller, genetically distinct stocks (Whiting et al. 2018; Waples et al. 2019).

Key nesting beaches and surrounding internesting habitat occur in the following locations:

- Eighty Mile Beach and Eco Beach (nesting October to March, with peak nesting in December and January)
- Lacepede Islands (nesting October to March, with peak nesting in December and January)

- the coast and islands of the north Kimberley (nesting May to July).

After leaving their natal beach and swimming offshore, flatback turtle hatchlings do not undertake oceanic migrations like the juveniles of other turtle species do but spend their juvenile life phase within continental shelf waters (Limpus 2009).

Internesting BIAs and Habitat Critical areas have been defined for Eighty Mile Beach, Eco Beach and the Lacepede Islands. The internesting buffer assigned to these Habitat Critical areas is define in DEE (2017) as 60 km from the nesting beaches, although the BIAs extend to 90 km. The internesting habitat defined in DEE (2017) has not been formally spatially defined as a BIA or Habitat Critical area, but is recognised in the Recovery Plan as important internesting habitat with a buffer of 60 km. All of these internesting habitats overlap with the nearshore boundaries of the Operational Area (Figure 4-10). A foraging BIA is also defined in waters offshore from Broome and James Price Point, which extends to the edge of the Operational Area (Figure 4-10).

Tagging studies by Whittock et al. (2016a, 2016b) and Thums et al. (2017) have also identified waters utilised during post-nesting migration and foraging. Flatback turtles from the Pilbara region migrated north-east along the inner continental shelf, foraging in waters west of Broome and James Price Pint Quondong Point, the Lacepede Islands, Lynher Bank, and at the Holothuria Banks in the Timor Sea (Whittock et al. 2016a, 2016b). Foraging areas were typically located in 50 m water depth (36.5 m mean depth) and 66 km from shore, but could occur in water depths up to 130 m. Heyward et al. (2018a) studied the foraging habitats identified in Whittock et al. (2016a). Turtles spent most of their time in the inshore near Cape Leveque and the most individual turtles were recorded around the Lacepede Islands. A survey of benthic habitats at the less utilised area of Lynher Bank identified areas of hard substrate supporting soft corals and filter feeder invertebrate communities at low to moderate levels, although in lower abundance than sites nearer shore. Abiotic substrate was recorded over 94% of the survey area (Heyward et al. 2018a). However, areas of filter feeder communities at Lynher Bank may provide suitable foraging habitat for flatback turtles.

Thums et al. (2017) studied flatback turtles during their post-nesting migration from the Lacepede Islands and during foraging. The study found that flatback turtles migrated along the coast in water depths of 63 ± 5 m, passing near Adele Island on the way to foraging grounds on the Sahul Shelf in the Timor Sea. Therefore, flatback turtles migrating from the Lacepede Islands and other nesting beaches may occur in the Operational Area, including along the southern boundary of WA-532-P in water depths of approximately 60 m.

Green turtle

Green turtles generally occur in tropical and subtropical waters between the 20oC isotherms; however, individuals have been found in more temperate waters (Marquez 1990; Cogger et al. 1993). The north-west region of Australia supports three distinct genetic stocks: the North West Shelf stock, the Scott Reef stock and the Ashmore stock (Dethmers et al. 2006). The North West Shelf stock shows some genetic differentiation between the Pilbara region and the Kimberley region, with the stocks associated with offshore reefs and islands (Ashmore Reef, Scott Reef, and Browse Island) being isolated from the coastal population (Whiting et al. 2018; Waples et al. 2019). The Operational Area overlaps with the western extent of a BIA for green turtle foraging near Broome. A green turtle nesting and internesting BIA at the Lacepede Islands occurs within the EMBA (Figure 4-11).

Green turtle nesting is known to occur at Browse Island, Adele Island, the Lacepede Islands and Scott Reef (Sandy Islet). These nesting locations, inclusive of a 20 km interesting buffer, have been listed as habitat critical to the survival of the species in the Recovery Plan for Marine Turtles in Australia (DEE 2017a). Green turtle nesting occurs from

November to March and peaks from December - February for the NWS stock and in January - February for the Scott Reef and Browse Island stock.

Green turtles feed predominantly on seagrass and algae and therefore foraging sites occur in shallow and predictable coastal habitats. Green turtle foraging occurs along the Kimberley coast. Montgomery Reef and Long Reef, located approximately 90 km and 150 km from the Operational Area respectively, are known to support significant numbers of green turtles. The turtle foraging BIA offshore from Broome and James Price Point also supports foraging by green turtles (Figure 4-11).

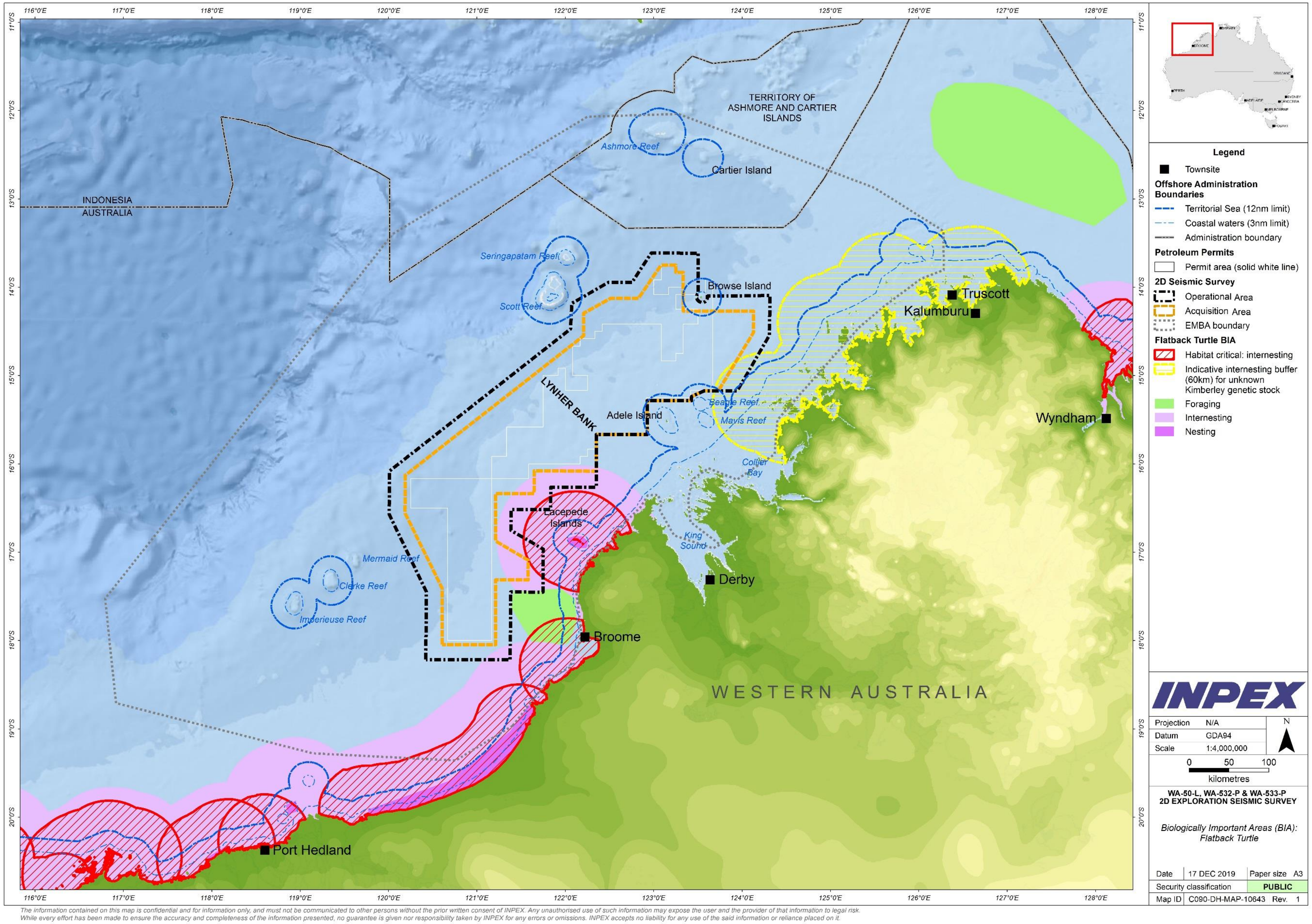

Figure 4-10 Flatback turtle BIAs and Habitat Critical

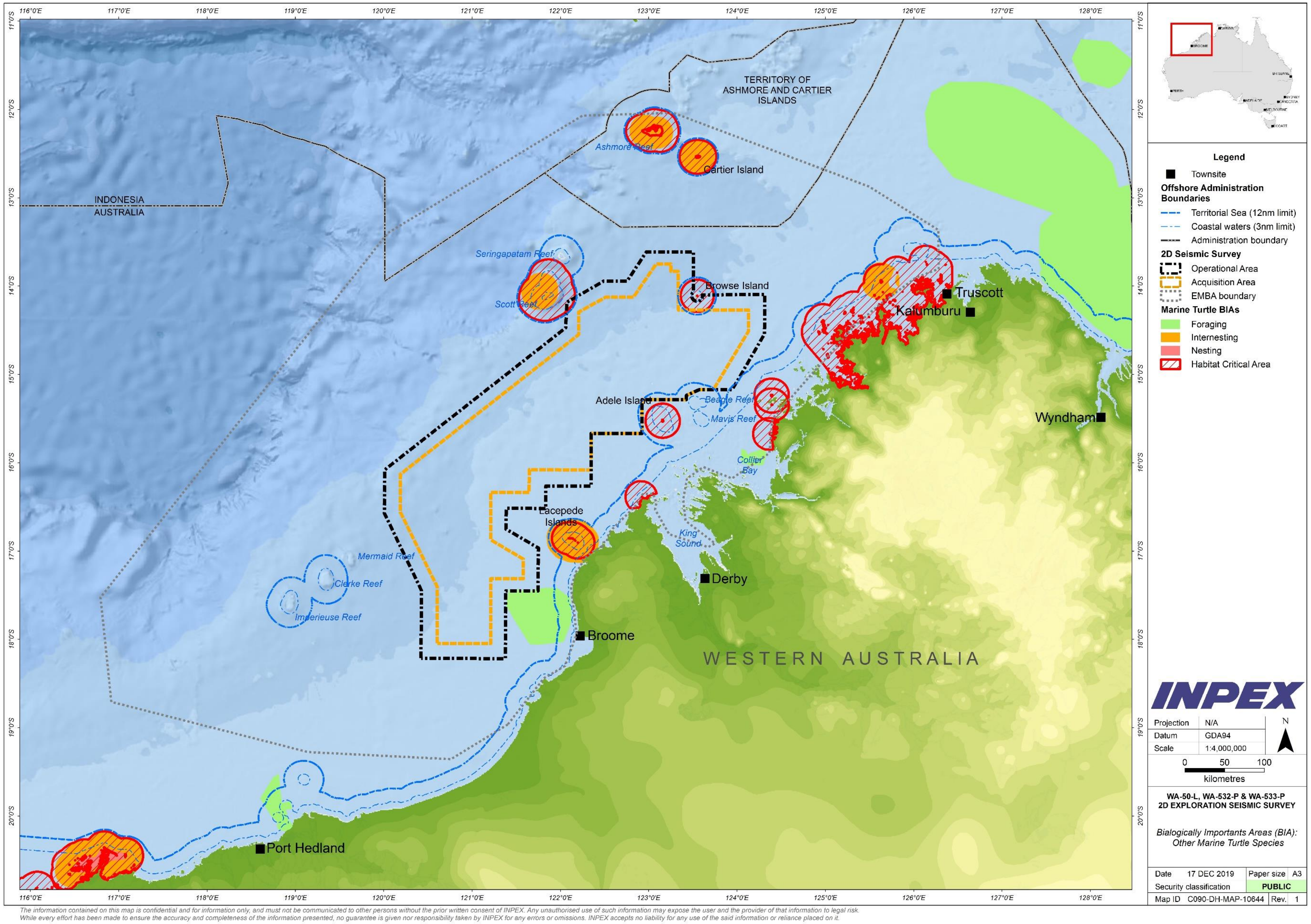

Figure 4-11 BIAs and Habitat Critical for green, hawksbill, loggerhead and olive ridley turtles

Hawksbill turtle

Hawksbill turtles are found in tropical, subtropical and temperate waters in all the oceans of the world (DEE 2017). Hawksbill nesting in WA is centred on the Pilbara (Dampier Archipelago), approximately 410 km south-west of the Operational Area.

Scott Reef (including a 20 km buffer) has been identified as a BIA for hawksbill turtle internesting (Figure 4-11). Internesting occurs in October – February each year, and peaks in December and January.

No habitat critical to the survival of the hawksbill turtle occurs within the Operational Area or the EMBA. The closest habitat critical to the survival of the species are the nesting beaches of the Dampier Archipelago.

Despite there being no known significant nesting beaches adjacent to the Operational Area, hawksbill turtles are likely to be found foraging around coral, sponge and algal communities throughout Kimberley waters (Waples et al. 2019).

Loggerhead turtle

Loggerhead turtles occur in tropical, sub-tropical and temperate waters (Bolten & Witherington 2003; Marquez 1990), although they usually nest in temperate coastal areas (Whiting et al. 2018). Within Australia the species inhabits coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western waters. Loggerhead turtles are likely to feed throughout the Kimberley over a wide depth range (10-60 m) and wide range of habitats including across the mid-continental shelf (Whiting et al. 2018).

The Operational Area partially overlaps with the north-western extent of a foraging BIA for loggerhead turtle near Broome and James Price Point (Figure 4-11). No habitat critical to the survival of loggerhead turtles has been identified in the Recovery Plan for Marine Turtles Australia (DEE 2017a).

Olive Ridley turtle

The Olive Ridley turtle has a circumtropical distribution and is the most numerous of all marine turtles (Pritchard 1997). Two genetic stocks have been identified within Australia: the North-west Cape York stock and the Northern Territory stock. Some incidental nesting occurs in the Kimberley, but these turtles have not been determined as a stock (Whiting et al. 2018).

The closest BIA for the species is a foraging area in the Joseph Bonaparte Gulf, approximately 330 km north east of the Operational Area. While no BIAs for the Olive Ridley turtle occur within the EMBA, low density nesting has been recorded at Cape Leveque, Darcy Island, Vulcan Island, Prior Point and Llanggi. These nesting locations, inclusive of a 20 km interesting buffer, have been listed as habitat critical to the survival of the species in the Recovery Plan for Marine Turtles in Australia (DEE 2017a). The nesting period for individuals in the Kimberley occurs from May to July each year.

Foraging habitats range from 10 to 200 m in depth in both nearshore and offshore locations (Whiting et al. 2018).

Leatherback turtle

Leatherback turtles do not regularly nest in Australian waters, with very low densities recorded in the Northern Territory. Leatherbacks are pelagic feeders and are not expected to occur frequently in the Kimberley region (Whiting et al. 2018).

Sea snakes

The EPBC search identified 21 sea snakes within the EMBA. There are no reported BIAs for sea snakes. Most of the knowledge of sea snakes in Australian waters comes from trawler bycatch (Milton et al. 2009; Ward 1996). These studies indicate that sea snakes in northern regions of Australia tend to breed in shallow waters around reefs, embayments and estuaries which are only represented in the EMBA. Therefore, these species may be seen in the open waters of the Operational Area, but their presence is unlikely to be common.

Crocodiles

The salt-water crocodile has a tropical distribution that extends across the northern coastline of Australia, where it can be found in coastal waters, estuaries, freshwater lakes, inland swamps and marshes, as well as far out to sea (Webb et al. 1987). There are no reported BIAs for crocodiles. Due to the species preference for estuaries and swamps and coastal waters it is unlikely to occur in the open waters of the Operational Area and is more likely to be observed in the EMBA where these preferred habitats occur.

4.8.5 Fishes and sharks

Whale shark

The whale shark is a solitary planktivorous species that spends the greater part of its foraging time at water depths above 100 m, often near the surface (Brunnschweiler and Sims 2011; Nelson and Eckert 2007; Wilson et al. 2006). However, whale sharks are also known to engage in mesopelagic and even bathypelagic diving when in bathymetrically unconstrained habitats (Brunnschweiler et al. 2009; Wilson et al. 2006).

This species is widely distributed in tropical Australian waters. Within Western Australia, whale sharks aggregate to feed in the coastal waters off Ningaloo Reef between March and July, sometimes extending into August and September (Wilson et al. 2006; Anderson et al. 2014; Norman et al. 2016; Norman and Stevens, 2007; Reynolds et al. 2017). Individuals tagged at Ningaloo Reef have been shown to migrate north, north-east or north-west into Indonesian waters, using both inshore and offshore habitats (Sleeman et al. 2010; Wilson et al. 2006; Reynolds et al. 2017) (Figure 4-12). Tagged sharks have displayed a preference for shallower, warmer waters, but are also found in very deep waters distant from any coastline (Reynolds et al. 2017).

Tagged whale shark data includes records of whale sharks departing from Ningaloo in spring and travelling north-west, following the 200 m isobath on the edge of the continental shelf. This route has been designated by the DEE for whale shark foraging between July and November, which extends from Ningaloo Reef to waters in the Timor Sea. The Operational Area and EMBA overlaps with this BIA for whale shark foraging (Figure 4-13).

Other sharks and rays

Eight shark species (including whale shark described above) and two ray species were identified as having the potential to occur within the EMBA. Species such as the great white, grey nurse and mako sharks may transit through the Operational Area and EMBA. However, the Operational Area is not considered to provide habitat that is of breeding or feeding importance. The potential for great white sharks to occur in the tropical waters of the Kimberley region is low.

Listed manta rays have been observed within the EMBA. For the reef manta ray, the species or species habitat may occur throughout the Operational Area (DEE 2018i). Along the ancient coastline at 125 m KEF, species habitat is likely to occur. Less is known about the distribution of the giant manta ray within the North West Shelf; however, it is acknowledged that this species may be present as transitory individuals, but are unlikely to be resident within the Operational Area.

Sawfish

Four species of sawfish (largetooth/freshwater/northern, narrow, dwarf and green sawfish) were identified in the EPBC search. While sawfish are identified as being found within the EMBA due to their ecology (generally estuarine rather than open ocean- species) it is expected that they will only be present on the periphery of the EMBA. As described in Section 4.3, environments found in the EMBA such as Roebuck Marine Park provide protection for shallow shelf habitats that are important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish (Parks Australia 2018) (Figure 4-13).

Sawfish are not expected to be common within the offshore location of the Operational Area.

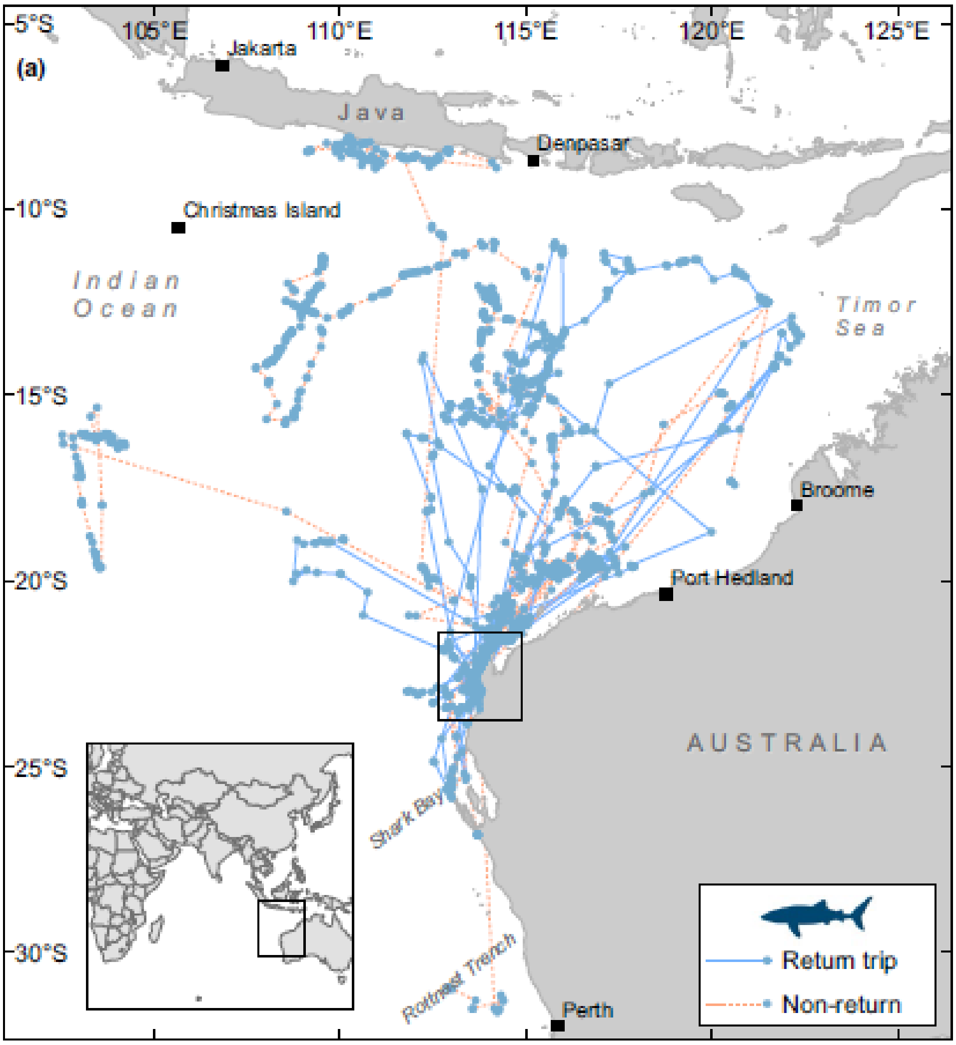

Figure 4-12 Tracks of 25 whale sharks tagged at Ningaloo Reef from 2010 to 2015 (Reynolds et al. 2017).

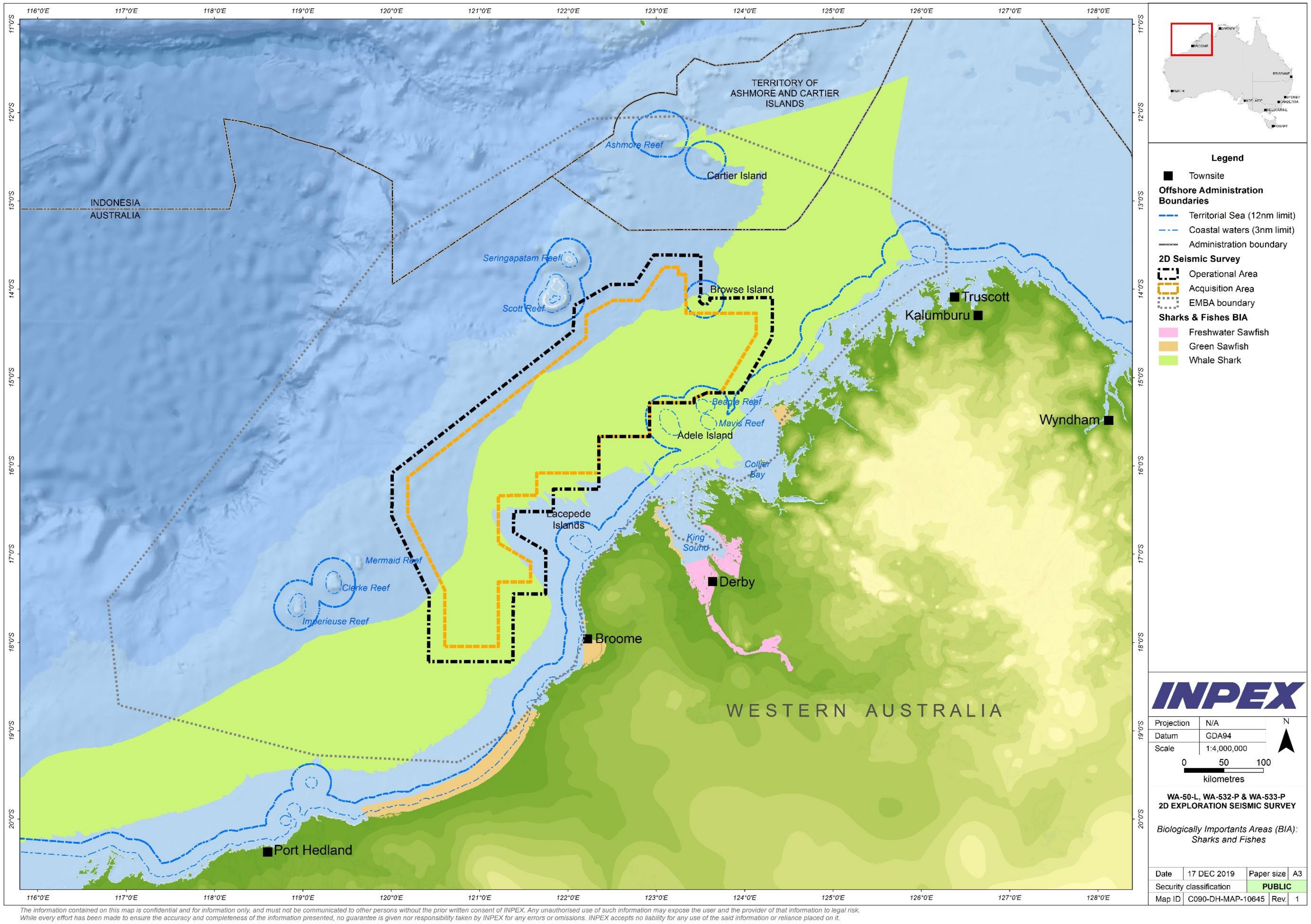

Figure 4-13 Biologically important areas for whale sharks and sawfish

Pipefish and seahorses

The EPBC search identified 56 species of the family Syngnathidae potentially present within the EMBA. Syngnathidae is a group of bony fishes that includes seahorses, pipefishes, pipehorses and sea dragons. Although none of the Syngnathidae species within the EMBA are listed as threatened or migratory, they are listed as a protected marine species under the EPBC Act. Seahorses and pipefishes are a diverse group and occupy a wide range of habitats. However, the species identified in the EPBC search (Appendix B) generally display a preference for shallow water habitats such as seagrass and macroalgal beds, coral reefs, mangroves and sponge gardens (Foster & Vincent 2004; Lourie et al. 1999; Scales 2010). These habitats can be found in the shallower areas of the EMBA.

4.8.6 Marine avifauna

The Operational Area is within what is known as the East Asian–Australasian Flyway (EEA Flyway), an internationally recognised migratory bird pathway that covers the whole of Australia and its surrounding waters. 'Flyway' is the term used to describe a geographic region that supports a group of populations of migratory waterbirds throughout their annual cycle. There are 54 species of migratory shorebirds that are known to specifically follow migration paths within the EAA Flyway (Bamford et al. 2008).

The annual cycle for migratory shorebirds in the EEA Flyway has four periods, broadly defined as follows:

- breeding (northern hemisphere) - May to August
- southward migration (to southern hemisphere / Australia) - August to November
- non-breeding (Australia) - December to February
- northward migration (from southern hemisphere / Australia) - March to May.

The extent of each period is considered to be approximate as migratory patterns vary between species (Bamford et al. 2008).

Several marine avifauna species utilise the Kimberley coast, islands and offshore reefs which provides biologically important areas for activities such as resting, breeding and foraging. Significant locations include the Rowley Shoals, Eighty Mile Beach, Roebuck Bay, the Lacepede Islands, the Dampier Peninsula, Adele Island and Scott Reef.

Avifauna BIAs that overlap with the Operational Area (Figure 4-14) include[1]:

- Greater frigatebird foraging BIA surrounding a breeding site at Adele Island. The foraging BIA extends up to 175 km from the island.
- Lesser frigatebird foraging BIAs surrounding breeding sites at Adele Island and the Lacepede Islands. Foraging typically occurs up to approximately 30 km from the breeding sites, but the BIAs extend to 175 km.
- Lesser crested tern foraging BIAs up to 30 km from breeding sites at Adele Island and the Lacepede Islands.
- Little tern resting BIA near Adele Island – Resting occurs near Adele Island and near breeding sites in the northern Kimberley.
- Red-footed booby foraging in waters surrounding Adele Island.
- Roseate tern breeding and foraging BIAs at the Lacepede Islands. Breeding occurs from mid-March to July.

[1] Important areas for avifauna and information about their usage has been derived from the Australian Government's National Conservation Values Atlas.

Within the EMBA, the following additional BIAs occur for the following avifauna species (Figure 4-14)[1]:

- Greater frigate bird breeding at Adele Island. The island supports a small breeding population of 2 – 300 pairs, with breeding occurring in May-June and August.
- Brown booby breeding and foraging BIAs at the Lacepede Islands and Adele Island, as well as the Coronation and surrounding Islands. Breeding occurs from February to October but mainly in Autumn.
- Lesser crested tern breeding at Adele Island and the Lacepede Islands. Breeding occurs between March and June.
- Lesser frigate bird breeding BIAs at the Lacepede Islands and Adele Island. Breeding occurs from March to September.
- Little Tern resting in water surrounding the Rowley Shoals, Roebuck Bay and Scott Reef.
- Little tern breeding occurs at multiple locations along the Pilbara, Kimberley and Gascoyne coast and islands. Mainly a non-breeding visitor with small resident population in the Kimberley, breeding has been recorded in June, July and October.
- Red-footed booby breeding BIA at Adele Island. Small numbers have been recorded to breed on Adele Island between May and June.
- White-tailed tropicbird breeding and foraging at the Rowley Shoals. Breeding occurs from May to October.

Other birds may forage elsewhere in the Operational Area, but likely in fewer numbers than the waters surrounding these islands.

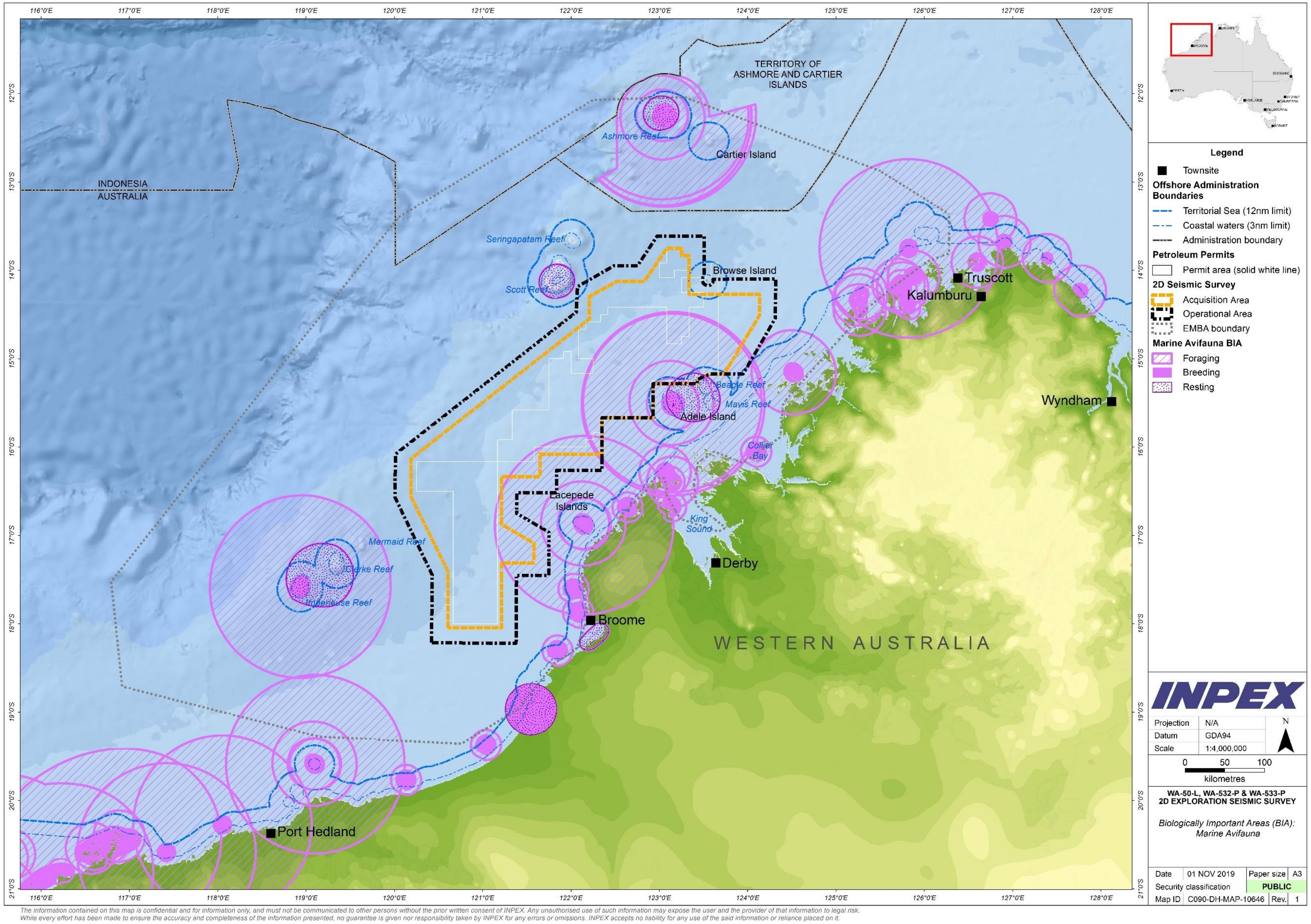

Figure 4-14 Biologically important areas for marine avifauna

4.9 Socio-economic and cultural environment

4.9.1 World heritage areas

World heritage areas are locations that represent the best examples of the world's cultural and natural heritage. The EPBC protected matters search identified no world heritage areas occurring within the Operational Area. The closest marine world heritage area is the Ningaloo Coast, approximately 734 km south west of the WA-533-P Operational Area. Since this occurs well outside of the EMBA, world heritage areas will not be considered further in this EP.

4.9.2 Commonwealth heritage places

The Commonwealth Heritage List contains places with Indigenous, historic and natural value and are protected under provisions of the EPBC Act. No Commonwealth heritage places occur within the Operational Area; however, three occur within the EMBA: Scott Reef and Surrounds, Yampi Defence Area and Mermaid Reef.

Scott Reef and Surrounds is located approximately 7 km north-west of the Operational Area and comprising the Commonwealth Marine Area wholly within the Western Australian Coastal Waters surrounding North and South Scott Reef. It has been listed due to its high representation of species not found in coastal waters of Western Australia and for fauna which are representative of the Indo-West Pacific as well as the reefs of the Indonesian Region (DEE 2018d).

The Yampi Defence Area is a large terrestrial Commonwealth heritage place covering approximately 5,728 km^2 and located approximately 80 km south-east of the Operational Area. The Defence Area is currently used as an Army training area/range adjacent to Yampi Sound. The coastal boundary of the Yampi Defence Area adjoins the EMBA and is therefore considered relevant to this EP.

Mermaid Reef is a Commonwealth heritage place located approximately 60 km south-west of the Operational Area and is the northernmost of the trio of coral reefs atolls that make up the Rowley Shoals. Mermaid Reef is thought to act as a stepping stone for genetic material between the Indonesian archipelago and reefs to the south Reef (DEE 2018e).

4.9.3 National Heritage Places

The National Heritage List contains places of natural, historic and Indigenous significance to the nation. While there are no national heritage places within the Operational Area, the EMBA overlaps with the West Kimberley, a national heritage place. The West Kimberley is predominantly a terrestrial area; however, it includes WA state waters from the Dampier Peninsula to Scambridge Gulf in the Joseph Bonaparte Gulf, and includes the intertidal areas between Roebuck Bay and the Dampier Peninsula. The protected area also includes Lacepede Islands and a small area within Lagrange Bay.

The West Kimberley was included on the National Heritage List in 2011 and has numerous values which contribute to the significance of the property, including indigenous, historic, aesthetic, cultural and natural heritage values (DEE 2018f). The West Kimberley is characterised by a diversity of landscapes and biological richness found in its cliffs, headlands, sandy beaches, rivers, waterfalls and islands. Of these values, the most relevant to the marine environment is Roebuck Bay, a migratory hub for shorebirds.

4.9.4 Native Title Determinations and Indigenous Protected Areas

The Kimberley region is known for its rich and diverse Indigenous heritage. As an acknowledgement of this heritage, several areas have been acknowledged under Australian law through native title determinations and the establishment of Indigenous Protected Areas (IPAs).

Native title is the recognition that Aboriginal and Torres Strait Islander peoples have rights and interests to land and waters according to their traditional lore and customs as set out in Australian Law. Native Title is governed by the Native Title Act 1993 (Cth). Native title may include rights and interests to:

- maintain and protect sites;
- use the land for hunting or ceremony;
- camp and live on the land;
- share in money from any development of the land; and
- have a say in the management or development of the land.

The Native Title Act 1993, states that when a native title determination is made, native title holders must establish a corporation called a Prescribed Bodies Corporate (PBC) to manage and protect their native title rights and interests. All PBCs must be registered with the National Native Title Tribunal (NNTT). When a PBC is officially registered, it becomes a Registered Native Title Body Corporate (RNTBC). Along the Kimberley coastline native titles often include fringing islands and surrounding sea country. While no recognised native title claims overlap with the Operational Area, several overlap with EMBA. The following RNTBCs have been identified as holding a title within the wider EMBA:

- Wanjina-Wunggurr (Native Title) Aboriginal Corporation (represents interests of Dambimangari, Wilinggin and Uunguu people);
- Bardi and Jawi Niimidiman Aboriginal Corporation;
- Yawuru Native Title Holders Aboriginal Corporation;
- Mayala Inninalang Aboriginal Corporation RNTBC;
- Jabirr Jabirr Nations Aboriginal Corporation (representing interests of Jabirr Jabirr and Ngumbarl people); and
- Nyul Nyul PBC Aboriginal Corporation RNTBC.

The Wunambal Gaambera (Uunguu) people, Wororra (Dambimangari) people, and Ngarinyin (Willinggin) people share common Wanjina Wunggurr ancestors. Together they make up the Wanjina Wunggurr Community, with each group managing its own Country.

Title extends into deeper waters with approximately 3,400 km^2 within the Kimberley Marine Park. At its closest point, the title boundary is approximately 6 km from the Operational Area.

Indigenous Protected Areas (IPAs) recognise Aboriginal people as landowners and managers and supports them to look after biodiversity hotspots and highly sensitive areas they want to see protected. Most IPAs are dedicated under International Union for Conservation of Nature Categories 5 and 6 which promote a balance between conservation and other sustainable uses to deliver social, cultural and economic benefits for local Aboriginal communities. form. Several IPAs located along the Kimberley Coastline partially overlap or lie adjacent to the EMBA. These include the Uunguu, Dambimangari, Bardi and Jawi, Yawuru and Karajarri IPAs.

4.9.5 Commercial fisheries

The licence areas of four Commonwealth-managed commercial fisheries, twenty-one State-managed commercial fisheries and one joint authority commercial fishery occur within EMBA. Theses fisheries are:

- North West Slope Trawl Fishery (Cwlth)
- Western Tuna and Billfish Fishery (Cwlth)
- Western Skipjack Fishery (Cwlth)
- Southern Bluefin Tuna Fishery (Cwlth)
- Northern Demersal Scalefish Managed Fishery (WA)
- Mackerel Managed Fishery (WA)
- Pearl Oyster Managed Fishery (WA)
- Broome Prawn Managed Fishery (WA)
- Kimberley Prawn Managed Fishery (WA)
- Nickol Bay Prawn Managed Fishery (WA)
- Specimen Shell Managed Fishery (WA)
- West Coast Deep Sea Crustacean Managed Fishery (WA)
- Abalone Managed Fishery (WA)
- Beche-de-Mer Fishery (WA)
- Hermit Crab Fishery (WA)
- Kimberley Gillnet and Barramundi Managed Fishery (WA)
- Kimberley Mud Crab Managed Fishery (WA)
- Marine Aquarium Fish Managed Fishery (WA)
- Pilbara Fish Trawl Managed Fishery (WA)
- Pilbara Line (WA)
- Pilbara Trap Managed Fishery (WA)
- Pilbara Crab Managed Fishery (WA)
- Trochus Fishery (WA)
- North Coast Shark Fishery (WA)
- Joint Authority Northern Shark Fishery (Joint Authority)
- South West Coast Salmon Managed Fishery (WA).

However, not all of the above fisheries operate within or have target species that occur within the Operational Area or EMBA. The commercial fisheries that are considered to be relevant to the planned 2D seismic survey activities, due to operating in the area or having their target fish resources overlap with the Operational Area, are summarised in Table 4-8 below.

4.9.6 Pearling and aquaculture

The WA pearling industry is the world's top producer of the highly-prized, silver-white South Sea Pearls, which come from the silver-lipped pearl oyster, *P. maxima*. The pearls produced in WA are well regarded in the industry worldwide, with the value of cultured pearls and other related products considered to be tens of millions of dollars per year (Hart et al. 2016).

The Kimberley region is of particular significance to the pearling industry, with wild oyster collection, holding and farming activities occurring along the coast and concentrated in nearshore waters around Eighty Mile Beach, Broome and Cape Leveque. The Pearl Oyster Managed Fishery is summarised in Table 4-8 below.

Other licenced aquaculture activities in the EMBA include farmed barramundi at Cone Bay Barramundi in the Buccaneer Archipelago and the Bardi Ardyaloon Trochus Hatchery and Aquaculture Centre at One Arm Point.

Table 4-8: Commonwealth, Joint and State managed commercial fisheries

Fishery	Licence Area Description	Gear Types and Usage	Target Species	Summary of Fishing Activities	Potential Overlap with the Survey
State-Managed Fisheries					
Northern Demersal Scalefish Managed Fishery (Figure 4-15)	The Northern Demersal Scalefish Managed Fishery licence area includes waters off the northwest coast of Western Australia (WA) in the waters east of 120° E longitude, extending from Eighty Mile Beach to the WA-Northern Territory (NT) border and out to the edge of the Australian Fishing Zone (200 nautical miles). The fishery is divided into two fishing areas; an inshore sector (Area 1) and an offshore sector (Area 2). Area 2 extends offshore from the 30 metres depth contour and is further subdivided into Zones A, B and C. The survey Acquisition Area and Operational Area overlap the offshore sector.	Primarily fish traps. Fish traps are deployed for 2-5 hours or overnight and are pulled daily. Handlines and droplines also permitted in the fishery.	Key target species: • goldband snapper. • red emperor. • Other demersal snapper, emperor, cod and grouper species are also caught, including but not limited to bluespotted emperor, spangled emperor, saddletail snapper, crimson snapper and rankin cod.	The fishery principally operates in depths of 60–150 metres water. The majority of catch occurs in Zone B of the Offshore Sector. Fishing occurs year-round. Vessels in the fishery operate out of Broome and Darwin. The offshore fishing grounds occurring in the vicinity of the proposed 2D seismic survey (between Broome and Browse Island) are understood to accessed primarily by vessels operating out of Broome, rather than Darwin. Fishers travel long distances to fishing grounds and typically fish at multiple sites over a period of 4-10 days. Including steaming time, vessels are typically away from port for 1-2 weeks at a time. Eight vessels operated in the fishery between 2013 and 2015, reducing to seven vessels 2015 and 2017.	The 2D seismic survey Acquisition Area and Operational Area overlaps with the offshore sector (Area 2) of the fishery. Therefore, the seismic survey vessel could potentially encounter vessels / gear from this fishery.
Mackerel Managed Fishery (Figure 4-16)	The Mackerel Managed Fishery licence area extends from Cape Leeuwin in the south west of WA to the WA/NT border. Management Area 1 of the fishery (Kimberley sector) extends from 121º E to the WA/NT border. Management Area 2 of the fishery (Pilbara sector) extends from 114° E near the North West Cape to 121° E. Management Area 3 of the fishery (Gascoyne/West Coast sector) extends south from 114° E to Cape Leeuwin. The survey Acquisition Area and Operational Area overlap the Kimberley and Pilbara sectors.	Primarily surface or mid-water trolling by line. Jigging methods are also used.	Key target species: • Spanish mackerel. • Grey mackerel (also called broad-barred Spanish mackerel), school mackerel, spotted mackerel, shark mackerel and other pelagic species are also caught as bycatch species.	Mackerel fishers troll for mackerel in coastal waters in less than 100 metres of water and typically in depths less than 70 metres (as advised by WAFIC and MMF licence holders). The fishery operates year-round, however, most fishing effort occurs from April/May to November (as advised by MMF licence holders), with peak fishing effort between June and October when mackerel congregate in coastal waters. The commercial catch of Spanish mackerel from all sectors of the fishery has been 270-330 tonnes per year since 2006. The catch in the Kimberley sector catch makes up the largest portion of the catch making up 191 tonnes of the 276 tonnes landed by the overall fishery in 2016. In 2013 and 2014, three vessels operated in the Kimberly sector and four vessels operated in the Pilbara sector.	The 2D seismic survey Acquisition Area and Operational Area overlaps the Kimberly sector of the Mackerel Managed Fishery in water depths less than 100 m. Commercial fishers may be active in the shallower, nearer-shore parts of the survey. There is limited overlap between the survey and the Pilbara sector of the Mackerel Managed Fishery in water depths less than 100 m and interaction with fishers in this sector is unlikely.
Pearl Oyster Fishery (Figure 4-17)	The Pearl Oyster Fishery licence area extends from 114° 10’ E near Exmouth to the WA/NT border, and out to the edge of the Australian Fishing Zone (200 nautical miles). The licence area is subdivided into four zones.	Drift diving, with divers towed behind vessels, allows collection of legal-sized pearl oysters from the seabed by hand.	Indo-Pacific, silver-lipped pearl oysters (*Pinctada maxima*).	The principal fishing grounds for pearl oyster collection are located off Eighty Mile Beach and a channel between the mainland the Lacepede Islands within water depths of approximately 20 metres. A deeper water collection site called ‘Compass Rose’ lies approximately 40 kilometres offshore from Eighty Mile Beach in water depths of approximately 35 metres.	The 2D seismic survey Acquisition Area is located over 60 kilometres from the Lacepede Channel fishing grounds and approximately 100 kilometres from the Compass Rose and Eighty

	Zone 1 extends from 114° 10' E to 119° 30' E. Zone 2 extends from 118° 10' E and includes the Eighty Mile Beach region out to 18° 14' S. Zone 3 include waters offshore from Broome and the North Kimberley coast, north of 18° 14' S and between 119° 00' E and 125° 20' E. Zone 4 extends from 125° 20' E to the WA/NT border. The survey Acquisition Area and Operational Area are located in Zone 3.	Following collection, pearl oysters are kept in wire mesh panels on the seabed at holding sites near fishing grounds. After 2-3 months, oysters are transferred from holding sites to pearl farm leases for cultivating pearls.		Holding sites are located near the fishing grounds in water depths up to 30 metres. Fishing grounds for 'mother of pearl' shell are also primarily located off Eighty Mile Beach, with smaller catches being taken off the coast of Broome and near the Lacepede Islands. Fishing usually commences in March/April, and ceases in June/July. Seeding of the pearl oysters is undertaken during winter months (June – August). This may occur at holding sites or at pearl farms. The majority of farm leases occur in waters of less than 30 metres depth, and no farm leases are located in waters deeper than 40 metres depth. The number of vessels in the fishing fleet across the entire fishery has ranged from 16 in 1997 to only two vessels in 2009 as a result of the Global Financial Crisis (GFC). Six vessels fished in 2016.	Mile Beach fishing grounds. The Acquisition Area is also located over 50 kilometres from the nearest pearl farm lease. No interaction between the 2D seismic survey and pearling activities is expected.
Broome Prawn Managed Fishery (Figure 4-18)	The boundaries of the Broome Prawn Managed Fishery licence area are 'all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200 m isobath'.	Otter trawl. Trawl shots average between approximately 50 and 100 minutes in duration and can occur over 24 hours.	Key target species: • banana prawns • western king prawns • brown tiger prawns • endeavour prawns	The majority of the Broome Prawn Managed Fishery is permanently closed to trawling and is not fished. The Broome Prawn Managed Fishery operates in a small designated trawl zone off Broome. Only trial fishing was undertaken by one boat during 2016 to investigate whether commercial fishing was warranted. This resulted in negligible landings.	The 2D seismic survey Acquisition Area and Operational Area overlap the licence area for this fishery. However, actual prawn trawling activities are limited and do not take place in the proposed survey area. No interaction between the survey and fishing vessels is expected.
Kimberley Prawn Managed Fishery (Figure 4-18)	The Kimberley Prawn Managed Fishery licence area includes waters between Koolan Island and Cape Londonderry covering all Western Australian waters of the Indian Ocean lying east of 123°45´ east longitude and west of 126°58´ east longitude.			Fishing occurs in coastal waters less than 50 m depth. Trawl depths are generally between 15 and 45 m. There are two fishing periods (April and May, then August to December). The total landings in 2016 were 155 tonnes, similar to the levels caught during the past 8 years.	The 2D seismic survey Acquisition Area and Operational Area overlap the licence area for this fishery. However, actual prawn trawling activities do not typically take place in the proposed survey area and no interaction between the survey and fishing vessels is expected.
State- / Joint Authority-Managed Fisheries					
WA North Coast Shark Fishery / Joint Authority Northern Shark Fishery (Figure 4-19)	The 'northern shark fisheries' comprise the State-managed WA North Coast Shark Fishery (WANCSF) in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery (JANSF) in the eastern Kimberley.	Primarily demersal longlining. A relatively small amount of pelagic gillnetting was	Key target species: • sandbar shark • Australian and common blacktip sharks • Spot-tail sharks	No fishing effort has occurred in the fishery since 2008/09. However, WAFIC and a JANSF licence holder advise there is potential for this fishery to be active again in the future.	The 2D seismic survey Acquisition Area and Operational Area overlap continental shelf waters within the licence area for this fishery.

	The WANCSF extends from longitude 114°06' E (North West Cape) to 123°45' E (Koolan Island), and the JANSF from longitude 123°45' E to the WA/NT border.	previously used in the JANSF.	• Tiger shark, hammerhead shark and lemon shark have also been caught in the past		In the event that fishing activities recommence in these fisheries, there is potential for interaction between the survey and fishing vessels.
Commonwealth-Managed Fisheries					
North West Slope Trawl Fishery (Figure 4-20)	The North-West Slope Trawl Fishery is in deep water from the coast of the Prince Regent National Park to Exmouth between the 200-metre depth contour to the outer limit of the Australian Fishing Zone.	Deep water demersal trawling	Key target species: • Australian scampi • Smaller quantities of velvet scampi and Boschma's scampi are also harvested. • Mixed deep-water snappers are also a component of the catch. Deep water prawns have historically been caught, although since the 1990s deep water prawns have no longer been targeted	Fishing occurs on the continental slope in water depths greater than 200 metres. Fishing effort has typically occurred along the slope offshore from the Pilbara region, in the Rowley Shoals area and north-east towards and around Scott Reef. Fishing occurs year-round. The number of vessels involved in the fishery has been one or two vessels each year since 2008/2009. The primary landing ports are Point Samson in WA and Darwin in the NT. Total effort in the 2015/2016 fishing season was 117 days resulting in a total catch of 54.8 tonnes. 33 tonnes of this catch was scampi. Total effort in the 2016/2017 fishing season was 114 days resulting in a total catch of 57.8 tonnes. 37.6 tonnes of this catch was scampi.	The 2D seismic survey Acquisition Area and Operational Area overlap some continental slope waters >200 metres water depth within the licence area for this fishery. Commercial fishing vessels may be active in low numbers along the continental slope in these areas.
Western Tuna and Billfish Fishery	The Western Tuna and Billfish Fishery covers the sea area west from the tip of Cape York in Queensland, around Western Australia, to the border between Victoria and South Australia.	Primarily pelagic longline. Minor line (including handline, troll, rod and reel) and purse seine are also used.	Key target species: • Bigeye tuna • Yellowfin tuna • Broadbill swordfish • Striped marlin • Some albacore tuna are also taken.	Fishing occurs in both the Australian Fishing Zone and adjacent high seas of the Indian Ocean. Fishing occurs year-round. In recent years, fishing effort has concentrated off south-west Western Australia and South Australia. Between 2014 and 2017, fishing effort has consistently focussed on waters west of Carnarvon and to the south off south-west WA. The main landing ports are Geraldton and Fremantle. Since 2005, fewer than five vessels have been active in the fishery each year (3 vessels in 2016, 4 vessels in 2017).	The 2D seismic survey Acquisition Area and Operational Area overlap the licence area of this fishery, but fishing activity occurs over 1,000 km away off the west coast of WA. Therefore, interaction between the survey and fishing vessels is not expected. Target species occur in the Operational Area.

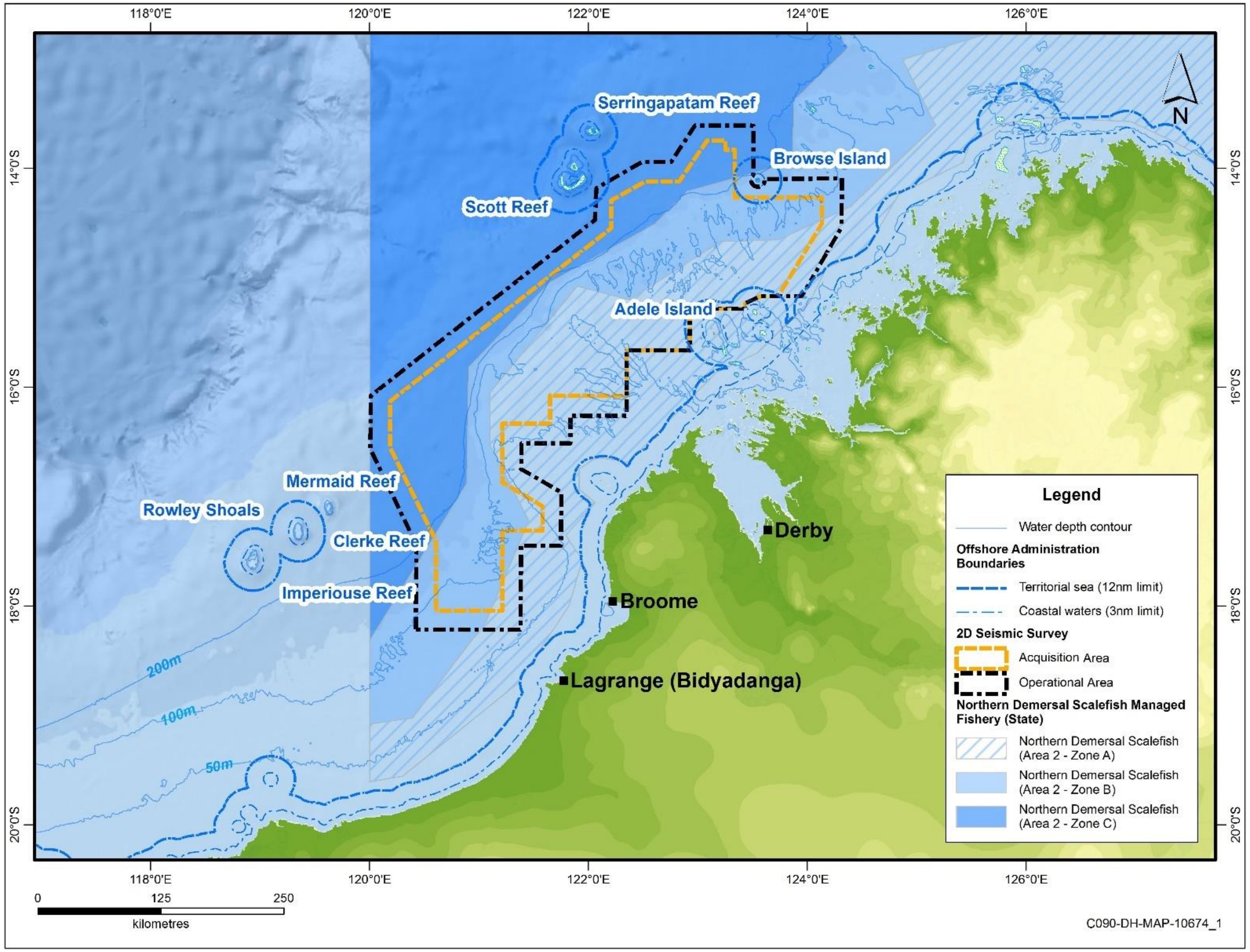

Figure 4-15 Northern Demersal Scalefish Managed Fishery licence areas and zones

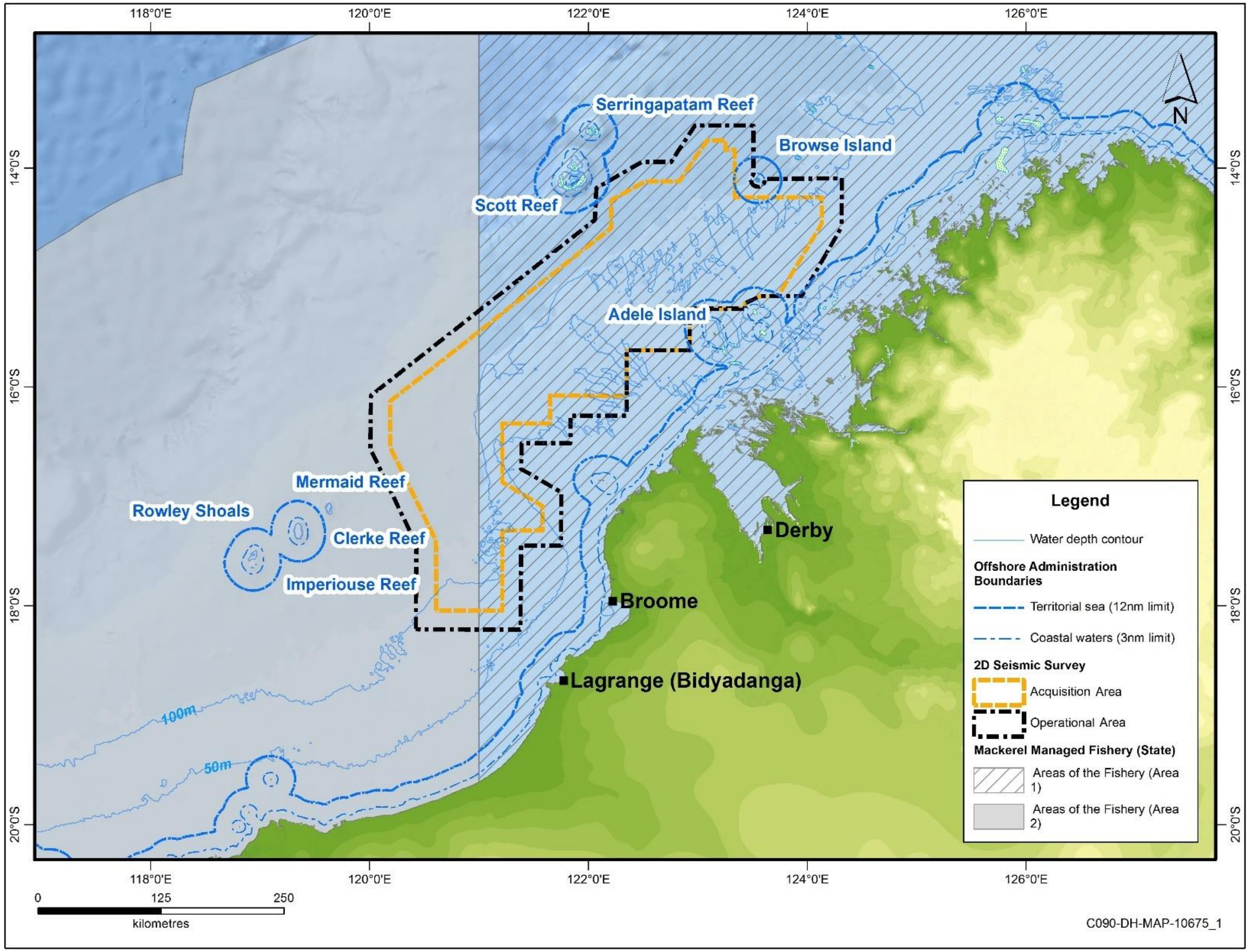

Figure 4-16 Mackerel Managed Fishery licence areas 1 (Kimberley) and 2 (Pilbara)

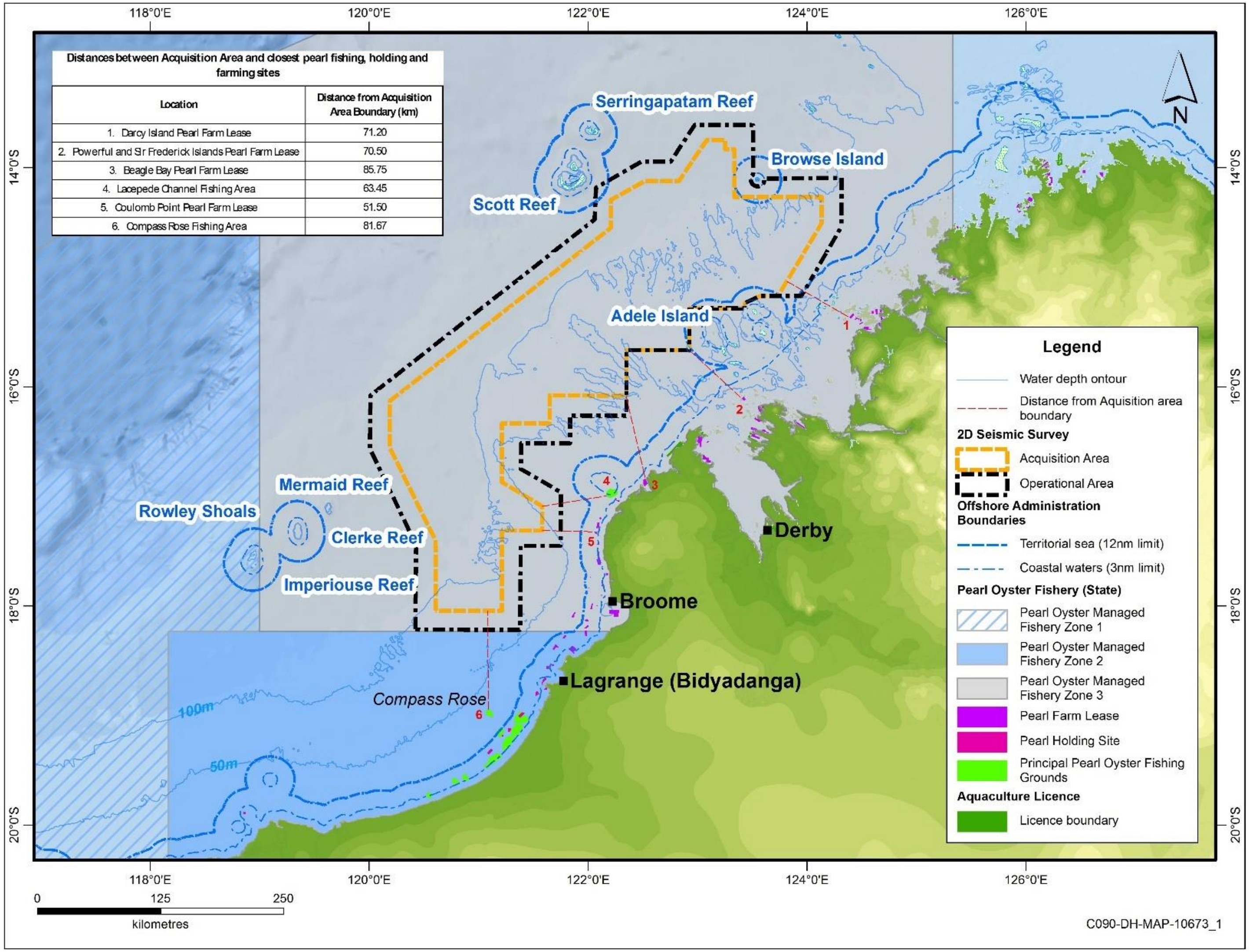

Figure 4-17 Pearl Oyster managed Fishery zones, principal fishing grounds, holding sites and farm leases, as well as aquaculture licences

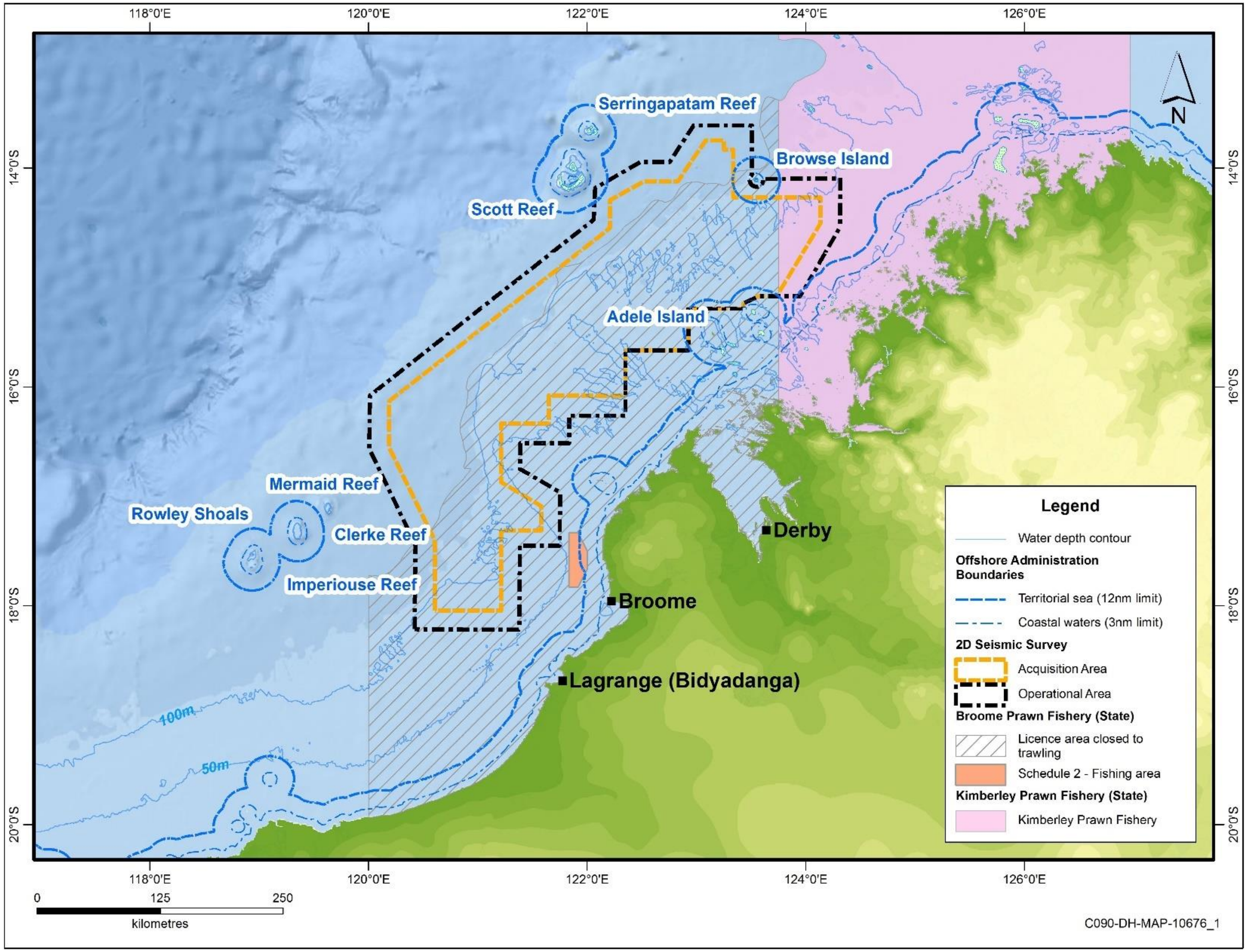

Figure 4-18 Broome Prawn Managed Fishery and Kimberley Prawn Managed Fishery licence areas

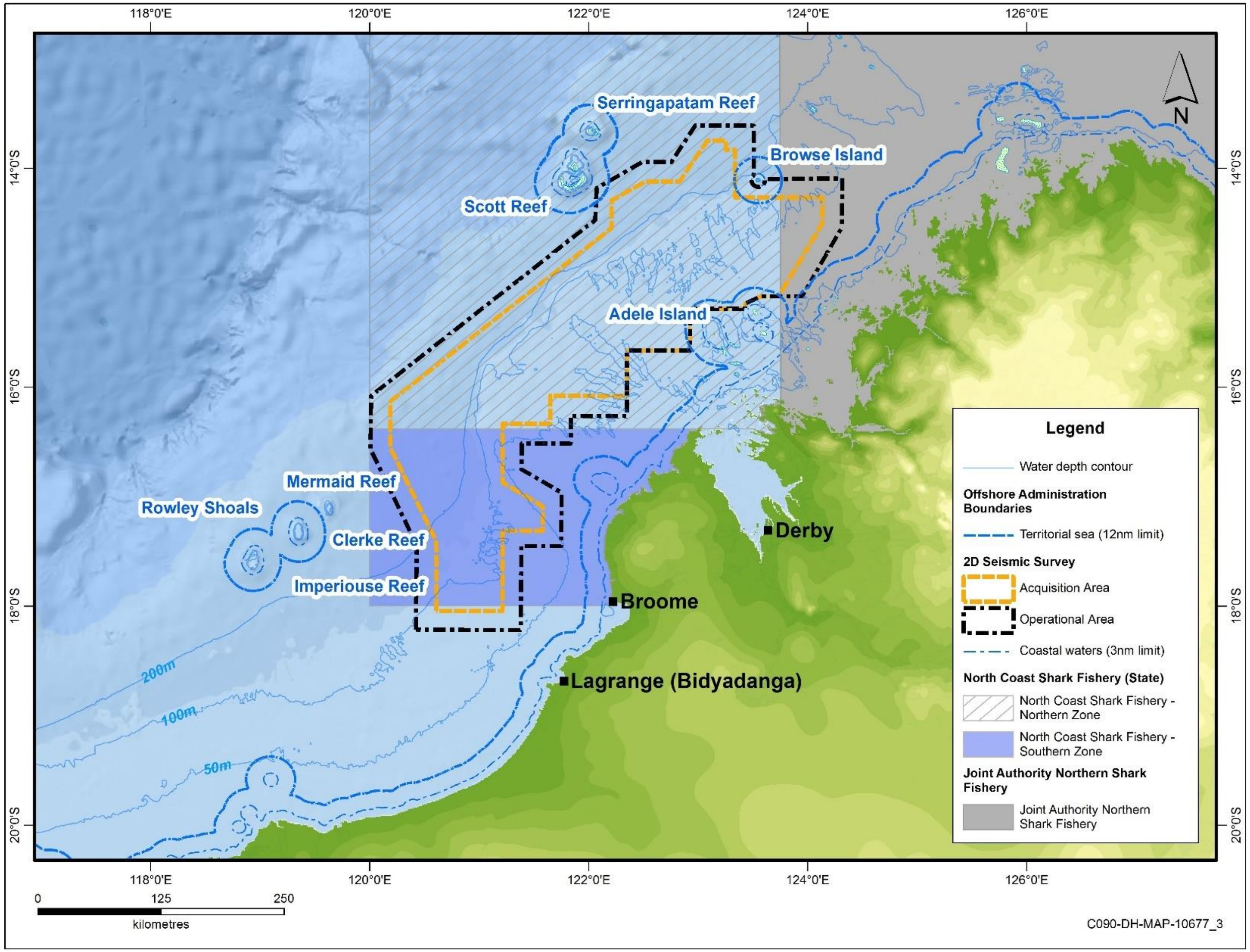

Figure 4-19 WA North Coast Shark Fishery (WANCSF) and Joint Authority Northern Shark Fishery (JANSF) licence areas

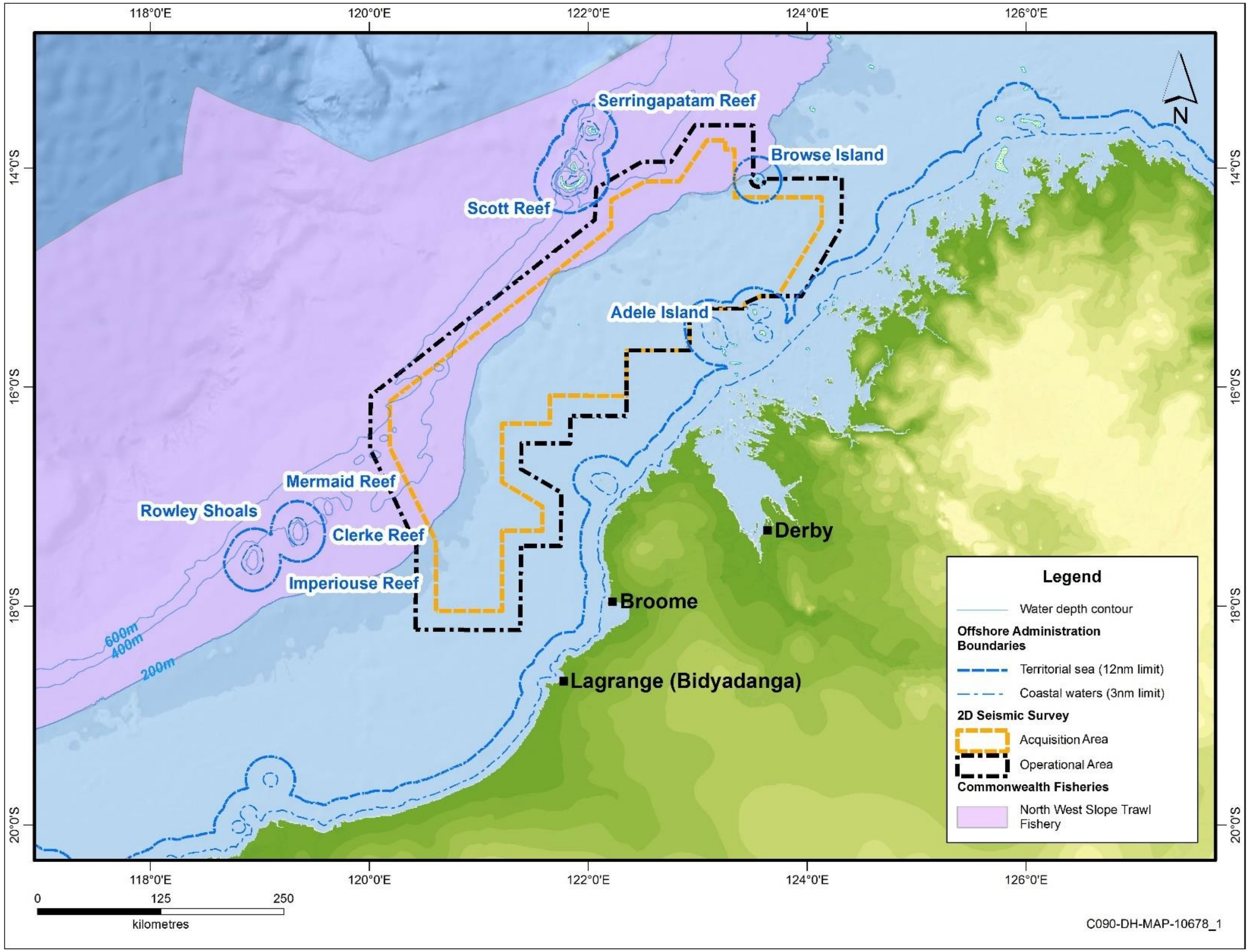

Figure 4-20 North West Slope Trawl Fishery licence area

4.9.7 Traditional Fishing

Traditional fishing occurs along most of the Kimberley coastline. Traditional fishing includes taking turtles, dugong, fish and other marine life (DEE 2018g) using methods such as line fishing, spearing, cast net and hand collection. The EPBC protected matters search identified the following Indigenous Protected Areas (IPAs) within the EMBA in which the owners can practice traditional fishing:

- Uunguu
- Dambimangari
- Bardi and Jawi
- Yawuru
- Karajarri.

In 1974 the Australian and Indonesian Governments signed a memorandum of understanding (MoU) which permits fishing by traditional Indonesian and Timorese fisherman within an area of Australian waters. The area, known as the MoU Box, covers an area of approximately 50,000 km^2 and includes Scott Reef and surrounds, Seringapatam Reef, Browse Island, Ashmore Reef, Cartier Island and various banks and shoals. Traditional fisherman target several species, including reef fish, sharks, beche-de-mer and trochus. The MoU Box partially overlaps the Operational Area.

4.9.8 Recreational Fishing

Recreational fishing activities in the Kimberley region peak in the winter months (dry season) and are mainly concentrated in coastal waters along the Kimberley coastlines, generally around the populations of Broome and Wyndham. Offshore islands, coral reef systems and continental shelf waters are increasingly targeted by fishing based charter vessels (Gaughan & Santoro 2018). Extended fishing charters are known to operate during certain times of the year to fishing spots off the WA coast. Common destinations for multi-day charters include Scott Reef and the Rowley Shoals. Adele Island is occasionally visited by amateur fisherman; however, appears to be less popular with charter operators than other locations in the region.

The annual Broome Billfish Classic tournament occurs in waters off Quondong Point, north of Broome, usually in July each year.

INPEX has consulted with recreational fishing stakeholders and confirmed that no significant recreational fishing is expected to occur in the Operational Area, although occasional charter vessels may fish opportunistically in the Operational Area on the way from Broome to destinations such as the Rowley Shoals or Scott Reef.

4.9.9 Shipping and ports

There is significant commercial shipping activity within the NWMR, a large portion of which is associated with resource industries. The Port of Broome provides supply facilities for the petroleum industry operating in the Browse Basin and will be the primary port supporting this seismic survey.

WA-532-P is bisected in a north-east direction by a shipping route of moderate intensity. associated with the vessels travelling from Broome to service the Ichthys offshore facility and other petroleum facilities and activities in the Browse and Bonaparte Basins and the Timor Sea. The far north-western corner of WA-533-P is intersected by a charted shipping fairway where vessel traffic travels to and from Port Hedland and the Port of Dampier (Figure 4-21).

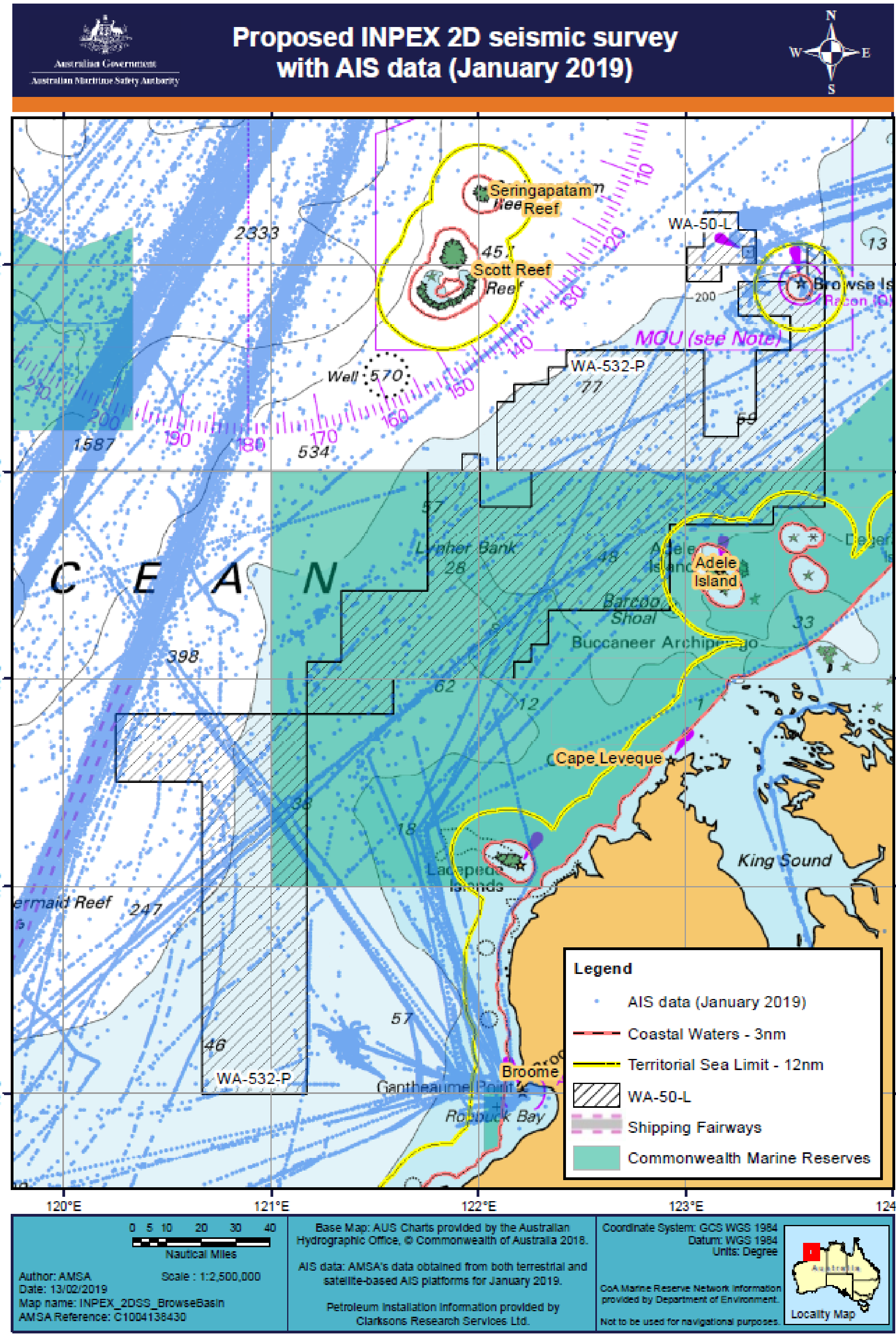

Figure 4-21 Shipping traffic intersecting permits WA-532-P, WA-533-P and WA-50-L represented by one month of AIS data (AMSA nautical advice)

4.9.10 Defence

The Operational Area overlaps with a section of the Australian Defence Force (ADF) Curtin Air-to-Air Air Weapons Range (indicative area presented in Figure 4-22). The Curtin Air-to-Air Air Weapons Range contains 63,200 km^2 of mostly ocean terrain and overlaps with the Operational Area. The ADF Yampi Sound Training Area is a terrestrial area that lies adjacent to the EMBA on the eastern side of King Sound.

4.9.11 Oil and gas industry

Petroleum permits, fields and infrastructure in the region are presented in Figure 4-23. Infrastructure is largely absent within the Operational Area. The only commissioned surface infrastructure within the Operational Area are the production facilities associated with Shell's Prelude floating LNG facility and INPEX's Ichthys project at the northern extent of the Operational Area in WA-50-L. The Shell and INPEX floating facilities are associated with Petroleum Safety Zones to restrict access.

PTTEP's Montara project lies 138 km north-east of the Operational Area and is within the wider EMBA.

4.9.12 Telecommunications

The North West Cable System (NWCS) is a 2,000 km fibre optic cable which connects Port Hedland and Darwin, extending through the open ocean waters of the Kimberley to the north of Adele Island. The NWCS cable traverses the Operational Area within the south east flank at depths ranging from approximately 40 m to 170 m. The NWCS system is managed by Vocus Communications and was built as a cooperation between the Telecommunications industry and Oil and Gas industries to connect offshore facilities in the Browse, Bonaparte and Carnarvon Basins to onshore datacentres (Vocus Communications 2019). The cable connects to numerous oil and gas facilities including the INPEX Ichthys offshore facilities in WA-50-L and with the Shell Prelude floating LNG facility (Figure 4-23).

Consultation with Vocus determined that there were no concerns with the 2D seismic survey as no subsea repeater equipment is located in WA-50-L.

4.9.13 Tourism

The tourism industry in the Kimberley region includes wildlife cruises and a focus on the local pearling industry. Both typically operate in waters nearer to shore than the Operational Area, such as near Broome, Cape Leveque, the Lacepede Islands, King Sound, Montgomery Reef and Camden Sound. However, some birdwatching tours may occasionally visit Adele Island and some other cruises may pass through Operational Area to offshore locations such as such as the Rowley Shoals, Scott Reef or Ashmore Reef.

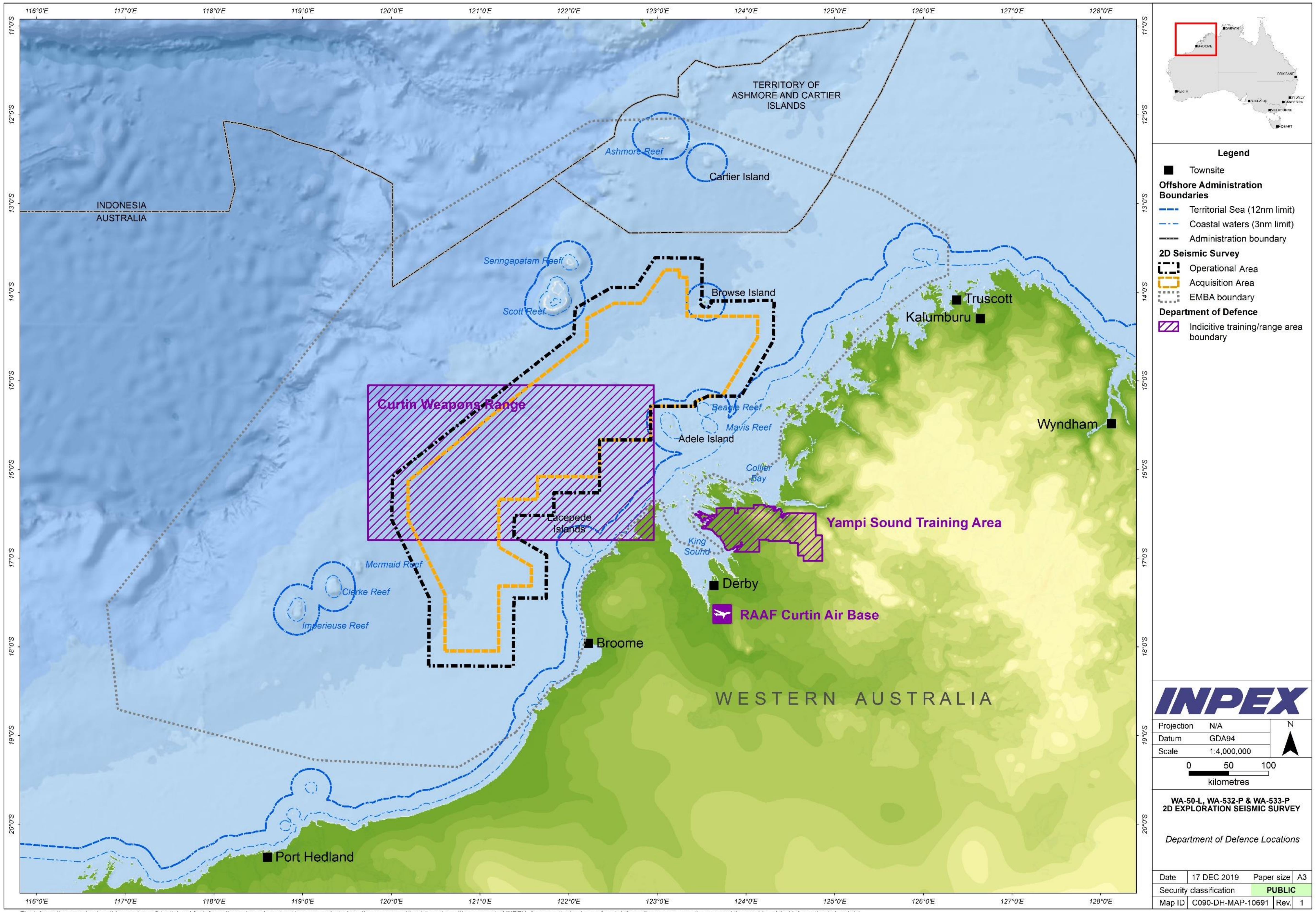

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Figure 4-22 Australian Defence training and exercise areas

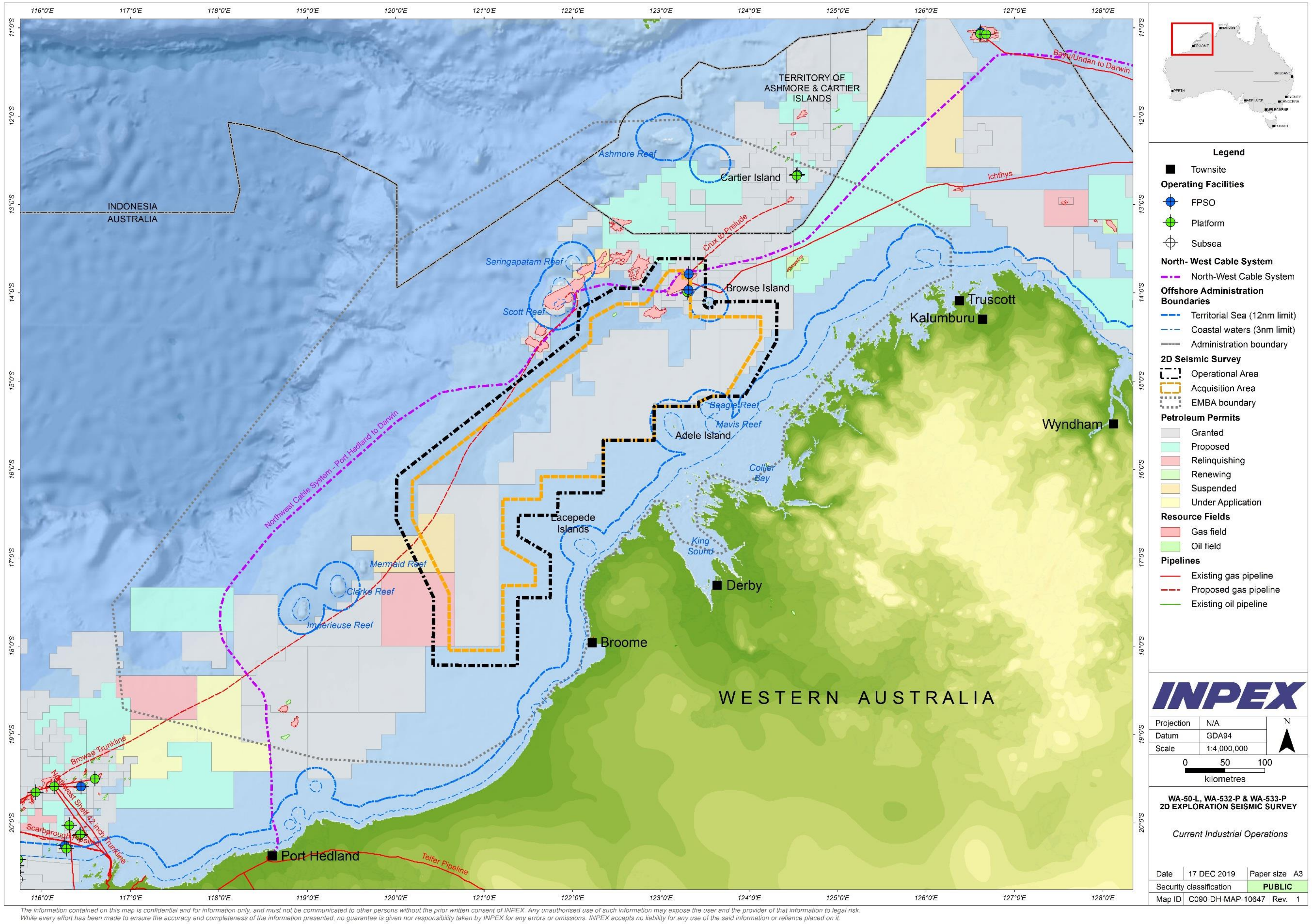

Figure 4-23 Petroleum titles and facilities

4.10 Timing of key ecological and socio-economic sensitivities

The timings of the key ecological and socio-economic sensitivities described in Section 4.1 to Section 4.9 are summarised in Table 4-9 below.

Table 4-9 Timing of key ecological and socio-economic sensitivities

Legend:

- Shading indicates an activity or lifestage occurs at this time
- Dashed lines indicate a peak period
- Red outline indicates the period the 2D seismic survey will avoid

		January	February	March	April	May	June	July	August	September	October	November	December
Proposed INPEX 2D seismic survey window of opportunity													
Ecological Receptors													
Plankton	Phytoplankton and zooplankton abundance (most abundant in nearshore waters)							Greatest (June-August)					
Benthic Invertebrates	Pearl oyster (*Pinctada maxima*): Spawning		Secondary								Primary		
	Scampi: Spawning (continental slope)												
	Coral reefs: Spawning												
Commercially Targeted Fish Stocks	Goldband snapper: Spawning (Pilbara: October-May; Kimberley: September-May)												
	Red emperor: Spawning												
	Rankin cod: Spawning												
	Blue spotted emperor: Spawning												
	Spangled emperor: Spawning												
	Giant ruby snapper: Spawning												
	Other demersal species: Spawning												
	Spanish mackerel: Congregate in shallow and coastal waters from approximately June; Peak spawning: Pilbara: September-December; Peak spawning: Kimberley: September-January)												

		January	February	March	April	May	June	July	August	September	October	November	December
Commercially Targeted Fish Stocks	Grey mackerel: Spawning												
	Common blacktip shark: Mating and pupping (October to March, peak pupping in November)												
	Autralian blacktip shark: Mating (February to March), pupping (December to January)												
	Spot-tail shark: Breeding (February to March/April), pupping (late November to early February)												
	Blacktip reef sharks: Mating (January-February), pupping (November to December)												
	Sandbar shark: Breeding and pupping (pupping primarily south of North West Cape)												
	Bigeye tuna: Spawning												
	Yellowfin tuna: Spawning												
	Skipjack tuna: Spawning												
	Southern bluefin tuna: Spawning (primarily south of Java, Indonesia)												
	Broadbill swordfish: Spawning												
	Striped marlin: Spawning (summer)												
	Black marlin: Spawning												
Marine Mammals	Humpback whale: Northern migration (ingress into Kimberley region)												
	Humpback whale: Resting and calving (Kimberley region)												
	Humpback whale: Southern migration (egress from Kimberley region)												
	Pygmy blue whale: Northern migration - migration north through NWMR												
	Pygmy blue whale: Southern migration - migration south through NWMR												
	Inshore dolphins: Breeding, calving and roraging (Kimberley coastal waters)												
	Dugong: Foraging (Kimberley coastal waters)												

		January	February	March	April	May	June	July	August	September	October	November	December
Marine Turtles	Flatback turtle: Internesting (south-west Kimberley stock, including Lacepede Is., Eco Beach and Eighty Mile Beach)												
	Flatback turtle: Internesting (unknown genetic Kimberley stock, including Maret Islands, Montilivet Islands, Cassini Island, Coronation Islands, Napier‑ Broome Bay, Camden Sound)												
	Green turtle: Internesting (NWS stock, incl. Adele, Maret, Cassini, and Lacepede Islands)												
	Green turtle: Internesting (Scott Reef and Browse Island stock)												
	Green turtle: Internesting (mainland east of Mary Island to mainland adjacent to Murrara Island including all offshore islands)												
	Hawksbill turtle: Internesting (Scott Reef)												
	Olive Ridley turtle: Internesting (unknown genetic Kimberley stock, including Prior Point, Vulcan Island, Darcy Island, Llangi, Cape Leveque)												
	Green, flatback, and loggerhead turtle: Foraging (Broome - James Price Point)												
	Green turtle: Foraging (Montgomery Reef, Camden Sound)												
Sharks	Whale shark: migration and foraging BIA												
Socio-economic Receptors													
Commercial Fishing	Northern Demersal Scalefish Managed Fishery												
	Mackerel Managed Fishery (Area 1 - Kimberley sector) - Mainly April/May to November, peaking June to October												
	Northern Shark Fisheries (Western Australia North Coast Shark Fishery and Joint Authority Northern Shark Fishery) - No fishing has occurred since 2008/09												
	North West Slope Trawl Fishery												
	Pearl Oyster Managed Fishery: Collection of wildstock												
	Pearl Oyster Managed Fishery: Seeding												
	Pearl Oyster Managed Fishery: Farming, grow-out and pearl production												
	Pearl Oyster Managed Fishery: Pearl harvesting												
	Kimberley Prawn Managed Fishery												
	Broome Prawn Managed Fishery												
Recreational Fishing	Recreational fishing and charter boat activity in the Kimberley region												
	Broome Billfish Classic tournament												

5 Stakeholder consultation

INPEX has been a member of the Australian business community since 1986 and, during this time, has engaged on a regular basis with stakeholders in WA and in federal jurisdictions on a broad range of activities. INPEX maintains a corporate webpage (http://www.inpex.com.au) to provide company and project-related information to the public. INPEX also participates in industry forums, conferences and community meetings to facilitate opportunities for meaningful engagement about current and future activities.

INPEX acknowledges the importance of consultation to ensure that persons who may be affected by a proposed petroleum activity ('relevant persons') are informed about the proposed activity and have the opportunity to inform INPEX of any functions, interests or activities that could be impacted by the proposed activity.

INPEX's awareness of the functions, interests or activities of relevant persons supports the development of management plans that consider and address any objections or claims about the proposed activity of an environmental, social or economic nature.

INPEX's process for stakeholder engagement (consultation) in the development and implementation of an EP and relevant management plans, shown in Figure 5-1Figure 5-1 is further described in this chapter.

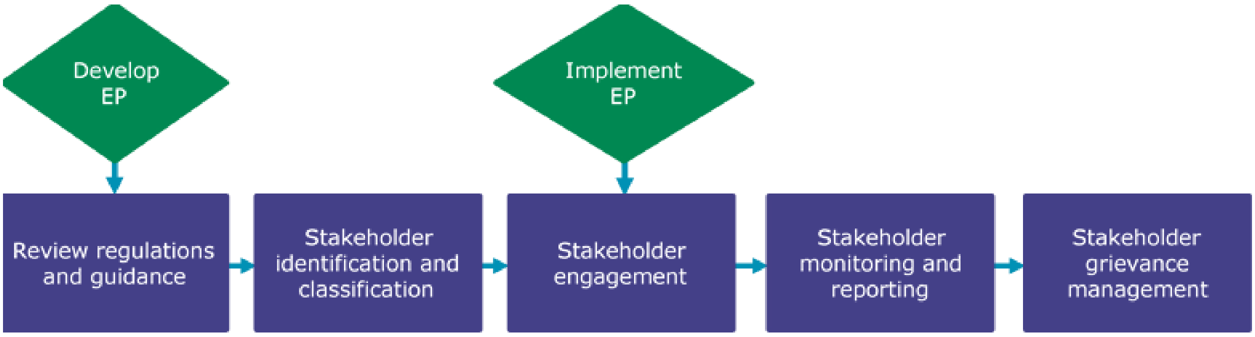

Figure 5-1 Process for stakeholder engagement (consultation) for development and implementation of an EP

5.1 Regulatory requirements and guidelines

As a first step in EP development, INPEX reviewed the following documents to prepare for stakeholder consultation on the proposed offshore petroleum activity:

- Offshore Petroleum Greenhouse Gas Storage (Environment) Regulations
- NOPSEMA policies, guidance and information papers related to environment plan development, including:
  - GL1721 - Environment plan decision making - Rev 5 - June 2018
  - GN1344 - Environment plan content requirements - Rev 4 - April 2019
  - GN1488 - Oil pollution risk management - Rev 2 - February 2018
  - IP1411 - Consultation requirements under the OPGGS Environment Regulations 2009 - Rev 2
- guidance issued by relevant stakeholders (as known or provided to INPEX), including:
  - Australian Government Guidance: Offshore Petroleum and Greenhouse Gas Activities: Consultation with Australian Government agencies with responsibilities in the Commonwealth Marine Area

- Australian Fisheries Management Authority: Petroleum industry consultation with the commercial fishing industry
- WA Department of Primary Industry and Regional Development (DPIRD): Guidance statement for oil and gas industry consultation with the Department of Fisheries
- WA Department of Transport (WA DoT): Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements

INPEX acknowledges its responsibility under the various legislative instruments and other guidance to ensure that relevant persons are appropriately identified and consulted in the development of its environment plans and in the conduct of its offshore activities.

5.2 Stakeholder identification and classification

With an understanding of the general requirements and expectations for consultation, INPEX conducted stakeholder identification and classification activities.

As an initial exercise, 'relevant persons' were identified, then classified, to determine a suitable engagement priority and method. Key INPEX personnel met in a workshop to outline the requirement for engagement, established the context of the proposed activities, and identified relevant persons in accordance with Regulation 11A(1) of the OPPGS (E) Regulations 2009 and NOPSEMA's additional clarifications of Regulation 11A(1) as provided in Issues Paper IP1411 (NOPSEMA 2014).

INPEX treats stakeholder identification (and subsequent activities) as an iterative process whereby the company may become aware of relevant persons both during the process of consultation on, and also after the development and submission of, an EP. INPEX acknowledges that relevant persons may be identified during the public comment and assessment periods associated with this EP, and also in the lead up to and conduct of an accepted petroleum activity.

5.2.1 Definition of 'relevant persons'/relevant stakeholders

In identifying relevant persons to be consulted on the proposed petroleum activity, INPEX prescribes to the definition provided under Subregulation 11A(1) of the Environment Regulations, being:

> *(a) each Department or agency of the Commonwealth to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant;*
>
> *(b) each Department or agency of a State or the Northern Territory to which the activities to be carried out under the environment plan, or the revision of the environment plan, may be relevant;*
>
> *(c) the Department of the responsible State Minister, or the responsible Northern Territory Minister;*
>
> *(d) a person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the environment plan, or the revision of the environment plan;*
>
> *(e) any other person or organisation that the titleholder considers relevant.*

5.2.2 Relevant activity

In determining who is a relevant stakeholder, it was necessary for INPEX to determine what constitutes a relevant activity, and for which activities a stakeholder should be engaged.

Petroleum activity (planned activity)

The Environment Regulations require that consultation be undertaken to ensure that persons who may be affected by a petroleum activity are given the opportunity to inform the titleholder how they may be affected and to allow the titleholder to assess and address any objections or claims about that activity in the preparation of environment submissions.

Regulation 4 of the Environmental Regulations defines a petroleum activity as "any operations or works in an offshore area carried out for the purpose of:

(a) exercising a right conferred on a petroleum titleholder under the Act by a petroleum title; or

(b) discharging an obligation imposed on a petroleum titleholder by the Act or a legislative instrument under the Act."

When identifying relevant persons, INPEX considers which stakeholders perform a function in the relation to – or have a function, activity or interest that may be impacted by – the planned, physical petroleum activity.

The planned activity for this EP is the 2D seismic survey activity to be undertaken in Commonwealth waters. Therefore, in determining who was a relevant person for engagement on the petroleum activity, INPEX sought to identify and engage with stakeholders whose functions, interests or activities could be affected by the seismic survey activity.

Unplanned event/activity (emergency conditions)

INPEX undertakes a more targeted approach to consultation with stakeholders in relation to unplanned – and highly improbable – emergency conditions, e.g. loss of diesel from a vessel collision.

Stakeholders who may perform a function in INPEX's planning for, or management of an unplanned activity, and whose information is integral to the development of those management plans, are engaged during the development of the EP and OPEP.

Stakeholders whose functions, interests or activities otherwise fall within the EMBA for the unplanned activity are not engaged during the development of those plans, but may be engaged in the event of an unplanned emergency condition.

This approach has been adopted to reduce consultation fatigue for stakeholders who will not be impacted by the (physical) petroleum activity.

INPEX will engage contrary to this approach where a stakeholder has expressed a significant (high to very high) level of concern about loss of containment events and wishes to understand more about the potential impact and planned response activities.

INPEX maintains an extended stakeholder list which includes stakeholders who may have a function, activity or interest that falls within for the EMBA, but for the purpose of the development of these plans, engages with stakeholders as outlined in Table 5-1.

Table 5-1 Classification and method of engagement with stakeholders in relation to an unplanned oil pollution emergency event

Stakeholder category	Method of engagement	Stakeholders
Government departments, agencies or organisations with functions or roles directly relevant to emergency and oil spill preparedness and response	Involve / consult regarding the proposed activity and potential unplanned emergency conditions during the preparation of the EP and OPEP.	• Australian Maritime Safety Authority (AMSA) • WA Department of Transport (DoT) • WA Department of Primary Industries and Regional Development (DPIRD) • WA Department of Biodiversity, Conservation and Attractions (DBCA) • Australian Marine Oil Spill Centre (AMOSC)
Stakeholders where land access is required to be agreed prior to the activity commencing	Involve / consult regarding the proposed activity and potential unplanned emergency conditions during the preparation of the EP and OPEP.	• Landowners • Native Title holders • Aboriginal and Torres Strait Islander communities
Stakeholders whose level of interest (or expectation) in relation to a potential oil spills and oil spill response for the planned activity is high or very high.	Inform regarding the proposed activity and potential unplanned emergency conditions during the preparation of the EP and OPEP.	As determined during stakeholder identification workshop.
Stakeholders whose level of interest (or expectation) in relation to a potential oil spills and oil spill response for the planned activity is low or medium.	To be informed only in the event of an unplanned emergency condition (i.e. oil spill) that has the potential to affect their functions, activities or interests.	As determined during stakeholder identification workshop.

Stakeholders were then classified based on their level of interest in/potential impact by, and influence over, the proposed petroleum activity. The purpose of this activity was to determine a 'priority' for consultation that was appropriate to the classification. Priority levels are shown in Table 5-2.

Table 5-2 Engagement classification

Priority	Interest/potential impact and/or Influence level	Stakeholder classification (engagement priority)

Level 1	(Both) High to very high	**Collaborate/empower**: partner with stakeholder on each aspect of the decision; allow stakeholder (regulatory or approvals bodies) to make the final decision
Level 2	(Either) High to very high	**Consult/involve**: ensure stakeholder concerns and expectations are consistently understood and considered, and obtain feedback from stakeholders on analysis, alternatives and/or decisions
Level 3	(Both) Low to medium	**Inform**: provide balanced, objective, timely and consistent information to stakeholder

5.2.3 Commercial fishery stakeholder classification

In addition to the stakeholder identification and classification process outlined above for planned activities and unplanned events, identification of relevant commercial fishing stakeholders distinguishes between:

- fisheries that overlap the planned petroleum activity; and
- fisheries that overlap the EMBA but not the location of the planned petroleum activity.

INPEX used a variety of resources (e.g. data files and fishery reports) to identify and classify stakeholders according to these criteria. These lists were then confirmed with the Western Australian Fishing Industry Council (WAFIC), whose consultation services INPEX contracted to engage with relevant fishing industry stakeholders.

With the view to minimise stakeholder fatigue, WAFIC restricted engagement activities to licence holders in fisheries with activities or resources that overlap the area of the planned petroleum activity (location of the physical activity). INPEX and WAFIC considered if and where licence holders are active (or potentially active) within a fishery to assess whether that licence holder should be engaged.

In addition, INPEX worked with WAFIC to provide tailored information for each fishery.

INPEX informed the Western Australian Department of Primary Industries and Regional Development (WA DPIRD), Australian Fisheries Management Authority (AFMA), the Commonwealth Department of Agriculture and Water Resources (DAWR) of the proposed approach to engage with all commercial fishing stakeholders using WAFIC's proposed consultation service. No objections were received.

In summary, identification of and engagement with commercial fishing stakeholders was conducted as follows:

- Government authorities (AFMA, DAWR and WA DPIRD) were engaged regarding the proposed activity and engagement with commercial and recreational fishing stakeholders. Materials made available by government authorities, e.g. data files and fishing reports, were used in fisheries determinations.
- WAFIC was contracted to provide a consultation service to INPEX, to review and confirm relevant fisheries and provide information on the proposed petroleum activity to relevant stakeholders.
- Fishing industry associations that represent fisheries with licence areas that overlap the proposed activity (e.g. WAFIC and Australian Southern Bluefin Tuna Industry Association) were consulted regarding the proposed activity and engagement with their members. Much of this consultation was conducted through WAFIC.

- Licence holders in commercial fisheries were engaged/not engaged according to the following criteria:
  - Active or potentially active licence holders in commercial fisheries that overlap or are very close to the proposed petroleum activity were considered to be relevant stakeholders, and were accordingly engaged by WAFIC during the development of the EP. Where required, WAFIC followed up with each stakeholder to close out the engagement loop.
  - Licence holders in commercial fisheries with target fish resources (i.e. key target species) that overlap the planned petroleum activity were also considered to be relevant stakeholders, even if their fishing activities did not overlap with the planned petroleum activity. Licence holders were accordingly engaged by WAFIC during the development of the EP. Where required, WAFIC followed up with each stakeholder to close out the engagement loop.
  - Licence holders in commercial fisheries that overlap or are close to the planned petroleum activity but whose activities or interests are not expected to be affected by the planned petroleum activity are not considered to be relevant stakeholders. Such licence holders were not engaged during the development of the EP, but the industry associations representing these fisheries were informed. An example would be where the licence holder fishes in a distant part of that fishery, e.g. off the southern coast of Australia.
  - Licence holders in commercial fisheries that overlap the broader EMBA but not the area of the proposed petroleum activity are not considered affected parties/relevant stakeholders and were therefore not informed during the development of the EP.

Licence holders that are not considered to be relevant to the planned petroleum activity are included in the expanded list of stakeholders who would be informed in the event of an unplanned emergency condition.

Table 5-3 presents the commercial fisheries classified according to their relevance to the planned petroleum activity or an unplanned emergency condition.

Details on the location and activities of each fishery and rationale for engagement are outlined in WAFIC's Stakeholder Engagement Report (Appendix C).

Table 5-3: Classification of commercial fishery licence holders

Fishery	**Relevance and process of engagement**
Commercial fisheries overlapping or close to the planned petroleum activity area and with licence holder activities or interests/fish resource that may be affected by the planned petroleum activity.	
Northern Demersal Scalefish Fishery (WA)	Relevant. Licence holders directly consulted.
Mackerel Managed Fishery – Area 1 and 2 (WA)	
Pearl Oyster Managed Fishery - Zone 2 and 3 (WA)	
North Coast Shark Fishery (Northern and Southern Zones) (WA)	
Joint Authority Northern Shark Fishery	
North West Slope Trawl Fishery (Cwth)	

Fishery	**Relevance and process of engagement**
Western Tuna and Billfish Fishery (Cwth) *	
Australian Southern Bluefin Tuna Fishery (Cwth) *	
* Fisheries are not active in or close to the planned petroleum activity, but their target fish species overlap or are close to the planned petroleum activity.	
Commercial fisheries overlapping the planned petroleum activity area, but licence holder activities or interests are not expected to be affected by the planned petroleum activity.	
Broome Prawn Managed Fishery (WA)	Not affected. Licence holders not consulted during the development of the EP; however, representative industry associations were informed, and each fishery's interests considered in the development of the EP. Licence holders to be informed in the event of an unplanned emergency condition.
Kimberley Prawn Managed Fishery (WA)	
Specimen Shell Managed Fishery (WA)	
West Coast Deep Sea Crustacean Managed Fishery (WA)	
Western Skipjack Fishery (Cwth)	
Commercial fisheries overlapping the EMBA but not the proposed petroleum activity area.	
Abalone Managed Fishery – Area 8 (WA)	Not affected. Licence holders not consulted during the development of the EP, but each fishery's interests considered in the development of the EP. Licence holders to be informed in the event of an unplanned emergency condition.
Beche-de-Mer Fishery (WA)	
Hermit Crab Fishery (WA)	
Kimberley Gillnet and Barramundi Managed Fishery (WA)	
Kimberley Mud Crab Managed Fishery (WA)	
Mackerel Managed Fishery – Area 3 (WA)	
Marine Aquarium Fish Managed Fishery (WA)	
Nickol Bay Prawn Managed Fishery (WA)	
Pearl Oyster Managed Fishery – Zones 1 and 4 (WA)	
Pilbara Fish Trawl Managed Fishery (WA)	
Pilbara Line (WA)	
Pilbara Trap Managed Fishery (WA)	
South West Coast Salmon Managed Fishery (WA)	
Trochus Fishery (WA)	

5.3 Stakeholder engagement

Following the stakeholder identification and classification exercise, an engagement plan was developed to register identified stakeholders and the following information:

- the activity/ies (planned and unplanned) for which they have been identified as relevant;
- the activities on which they should be engaged;
- the function, activity or interest that may be affected by the relevant activity;
- their assigned classification (priority for engagement); and
- the proposed manner of engagement (i.e. modes, timing, and by whom).

Those responsible for engagement were provided with a copy of the plan and instructions on how to carry out the necessary engagement.

INPEX prepared a consultation information sheet to provide relevant stakeholders with important details of the proposed petroleum activity. The document (Appendix C) includes the following information:

- description of the activity, including location and map;
- schedule;
- methodology (i.e. how the activity will be undertaken, as well as general logistics and safety information);
- environmental management approach; and
- enquiries and feedback information.

The accompanying email (or cover letter) may provide more information relevant to the functions, activities or interests of the stakeholder receiving the information sheet. Additional information was also sent to stakeholders in subsequent communications, as requested by the stakeholder and/or as the information became available.

A stakeholder briefing was offered to several key stakeholders to discuss the proposed activity and any questions or concerns the stakeholder may have. Briefings were subsequently provided to the following stakeholder groups:

- Aboriginal and Torres Strait Islander Native Title and community representatives in Broome and on the Dampier Peninsula;
- Broome Fishing Club and Broome North Fishing Club;
- Broome-based pearl producers;
- Recfishwest; and
- the Western Australian Fishing Industry Council Inc (WAFIC).

5.4 Stakeholder monitoring and reporting

Using the stakeholder engagement plan as a guide, INPEX retains a record of all communications sent and received as part of the stakeholder engagement activity. This includes email correspondence, telephone call logs, letters and minutes of meetings.

All queries and feedback from stakeholders were logged, and where applicable, forwarded for follow up, where applicable. All responses provided to stakeholders were appropriate to the nature of their communication, e.g. technical queries were investigated by area experts and responses provided.

5.5 Relevant matters, objections and claims

During stakeholder consultation, each meeting, phone call or piece of correspondence received from a stakeholder was assessed by INPEX for relevant information or for objections, claims or concerns raised regarding the activity. The INPEX assessment of relevance and assessment of merit considered four broad categories:

- *Objection, claim or concern has merit* – The objection, claim or concern raised is relevant to both the planned petroleum activity and the stakeholder's functions, activities or interests. The matter has merit if there is a reasonable / scientific basis for related effects or impacts to occur and/or there is reasonable basis for the matter to be addressed in the EP.
- *Objection, claim, or concern does not have merit* – The objection, claim or concern raised may be relevant to the planned petroleum activity or the stakeholder's functions, activities or interests, however, the matter raised has no credible or scientific basis.
- *Relevant matter* – The matter raised does not fit the criteria descriptions for objections, claims or concerns with/without merit. However, the matter raised is relevant to the planned petroleum activity, comprises a request to INPEX for further relevant information, or provides information to INPEX that is relevant to the petroleum activity or the EP.
- *Not a relevant matter* – Correspondence does not relate to the planned petroleum activity or the stakeholder's functions, interests or activities being affected by the petroleum activity. Non-relevant matters may also be generic in nature with no specific issues raised (e.g. salutations, acknowledgements, meeting arrangements, etc.).

INPEX noted that matters were often raised by stakeholders that were relevant to seismic surveys generally and not necessarily specific to the proposed INPEX 2D seismic survey. However, where these matters were relevant, they were considered by INPEX.

Relevant matters, objections, claims and concerns with merit were addressed by INPEX in this EP. Stakeholders were provided with a response to each matter raised, including an explanation of how the matter has been addressed.

A summary of the initial stakeholder consultation undertaken for the EP accepted in January 2020 and the follow up engagement conducted in October 2020, and the full assessment relevance and merit are provided in Appendix C. The actual records of correspondence, are provided in a 'Sensitive Matters Report' that is submitted to the Regulator separately to this EP.

In September 2021, INPEX commenced preparation of this EP revision. The first step was to review the stakeholder register for currency and then provide an update explaining the proposed chages to timing of commencement of this Activity.

INPEX also engaged WAFIC on a fee for service basis to provide the update to licence holders and seek feedback on the proposed amendment for this revision.

An overview of feedback received from stakeholders that resulted in material inputs to the initially accepted EP and this EP revison is provided in Table 5-4.

Table 5-4: Summary of stakeholder consultation and INPEX response

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
Australian Maritime Safety Authority (AMSA)	AMSA provided information related to: • Vessel traffic in the Operational Area. • The need for vessels to maintain communications with other vessels and a visual and radar watch at all times. • The need for the seismic vessel to display appropriate day shapes, lights and signals, and for streamers to have reflective tail buoys to indicate the vessel is towing and is therefore restricted in her ability to manoeuvre. • Requested the AMSA Joint Rescue Coordination Centre (JRCC) be notified 24-48 hours before operations commence, and the Australian Hydrographic Office (AHO) be notified at least 4 weeks prior to the commencement of activities for the promulgation of Notices to Mariners.	INPEX incorporated the information provided in to the existing environment and risk assessment sections of the EP. Navigational safety and communication protocols have been captured as control measures and/or required notifications.
Australian Fisheries Management Authority (AFMA)	AFMA provided information related to: • Identification of Commonwealth managed fisheries relevant to the activity. • Contact details for Indonesia's Ministry for Marine Affairs and Fisheries (MMAF) for notification of activities potentially occurring in the Australia-Indonesia Fisheries MOU Box.	INPEX incorporated the information provided in to the Existing environment and risk assessment sections of the EP, as well as notifications in ongoing consultation.
Department of Defence (Directorate of Property Acquisition, Mining and Native Title)	Defence provided the following information/requests: • INPEX advise Defence within 90 days of the seismic activity to deconflict activities. • Advised there may be unexploded ordinance (UXO) within the survey area. • Requested the AHO be notified at least 3 weeks prior to the commencement of activities for the promulgation of Notices to Mariners.	INPEX confirmed that the seismic array is not expected to interact with the seabed during the proposed 2D seismic survey activity. INPEX advised it will aim to provide sufficient notice to Defence, however providing 90 days advance notice may be challenging due to operational and logistical factors. INPEX confirmed information about the commencement of the activity will be provided to

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
		the AHO no fewer than four working weeks before operations commence for the promulgation of related Notices to Mariners.
Office of the Director of National Parks (DNP)	The DNP noted the proposed survey overlaps with Kimberley Marine Park, which forms part of the North-west Network of Marine Parks. The DNP also noted the activity is located within 100 kilometres of Roebuck Bay, Eighty Mile Beach, Mermaid Reef and Argo-Rowley Terrace marine parks. The DNP acknowledged that the North-west Marine Parks Network Management Plan 2018 allows for mining authorisation to be given through a class approval for the Multiple Use Zone of the Kimberley Marine Park. The DNP noted class approval requires an accepted EP. The DNP advised that INPEX need to be aware of obligations under the class approval (including conditions) and referred to the Petroleum Activities and Australian Marine Parks Guidance Note. The DNP identified the specific natural values for the Kimberley Marine Park, as defined in the North-west Marine Parks Network Management Plan 2018. The DNP identified the need for INPEX to notify the DNP of any oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park as soon as possible. The DNP requested notification if the EP is approved, when the activity commences and the date that the survey begins and ends within the Kimberley Marine Park.	INPEX incorporated the provided information within the existing environment section and risk assessments. INPEX has acknowledged the request for notifications and included these in the EP.
	DNP amended their previous advice and confirmed that towing a seismic array behind a survey vessel when conducting run-outs and line turns is not considered ‘transiting’ and is therefore not permitted in the Kimberley HPZ and NPZ.	In November 2019 INPEX requested clarification on permitted activities and zoning rules in the Kimberley AMP HPZ and NPZ.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
		INPEX subsequently adjusted the Operational Area and amended the EP to remove run-outs and line turns within the Kimberley HPZ and NPZ. As such, no activities related to the Petroleum Activity will occur in the HPZ and NPZ.
WA Department of Transport (DoT) – Marine Safety Branch	INPEX engaged with WA DoT in relation to potential spill response matters in State waters and the content of the OPEP. WA DoT confirmed that as the Controlling Agency in WA State Waters, it would deploy its own equipment and personnel (including SCAT, shoreline clean-up, inshore booming kits and Divisional staging area kit and inshore support vessels) to supplement the resources provided by the Petroleum Titleholder (PT). However, DoT expects the PT would immediately commence deploying pre-determined response equipment and personnel to the nominated Divisional Staging area, in accordance with its OPEP. Nov 2020 WaDot requested that the OPEP be provided once the EP revison is accepted.	INPEX has incorporated WA DOT's feedback in Section 8.5 and within the OPEP provided in Appendix F. Nov 2020 INPEX will provide a copy of the revised OPEP once the EP revison is accepted.
Department of Primary Industries and Regional Development (WA DPIRD) – Fisheries branch,	DPIRD: • Advised on the method for determining relevant fisheries and understanding the fish stock in the proposed area, including the availability and use of FishCube catch and effort data, highlighting concerns and limitations with the data and how it may be interpreted and presented in the EP.	INPEX: • Noted DPIRD advice regarding the interpretation of FishCube data and subsequently amended content in the EP to better describe the data and highlight the limitations and assumptions made.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
Aquatic Environment unit	• Noted Fisheries Research Report No. 288 (Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia) and highlighted particular concerns regarding the potential risk to immobile and mobile invertebrates and demersal finfish. • Identified spawning grounds as particularly sensitive and requested no seismic acquisition occurs during spawning periods for key species, requesting INPEX review the survey timing to consider their latest spawning information. • Advised that they do not consider the risk to goldband snapper or the Northern Demersal Scalefish managed Fishery to be acceptable. • Requested that INPEX consults with WAFIC, PPA, Recfishwest, and relevant Traditional Owner groups and relevant fishers.	• Acknowledged the outcomes of Fisheries Research Report No. 288 (Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia) in the EP, noting that it considers the risk to *individual* fish and invertebrates and assuming the organism remains stationary relative to the seismic source. INPEX has applied additional activity-specific and situation-specific context and scientific research to assess potential risks at a *population* level. • Incorporated the DPIRD's latest advice regarding key indicator species and spawning into the existing environment and risk assessment in the EP. However, no further control measures were identified, and the risk is reduced to an acceptable level. • Consulted with relevant fisheries stakeholders and traditional owner groups during the development of the EP. • Incorporated claims and feedback within the EP prior to submission.
Western Australian Fishing Industry Council (WAFIC) * Note WAFIC is both a relevant stakeholder (commercial	WAFIC's response to INPEX's in the capacity of an industry representative/authority is provided here. WAFIC: • Noted that the commercial fishing sector will experience the largest impacts of any stakeholder. • Requested specific engagement material (i.e. risk assessments to be provided)	INPEX: • Provided draft impact assessment to fish stocks and fisheries including a thorough review of available scientific information. • Provided an overview of the potential effects to spawning aggregations, fish resources and commercial fisheries, specific to each fishery.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
fishing industry representative) for the proposed offshore activity, but also provided consultation services to INPEX to coordinate engagement with the commercial fishing industry (relevant individual licence holders and other industry associations).	• Concerned about the potential impact on the key indicator species for each fishery, including spawning and the sustainability of the stocks. • Appreciate INPEX is avoiding peak spawning for some key indicator species but is not in position to avoid all. • WAFIC defers to DPIRD as the absolute key source of relevant and timely knowledge for commercial fisheries in Western Australia. • Dispute that the INPEX interpretation of FishCube Data is appropriate to inform the risk assessment. • Dispute that potential impacts to fish spawning, especially in the Northern Demersal Scalefish Goldband snapper have been reduced to as low as reasonably practicable from a commercial fishing perspective. • Noted extensive observations / anecdotal knowledge of fishers regarding the negative impacts of seismic on fish resources. • Noted limited and conflicting research on seismic impacts on fish resources. • Requested no recreational fishing occurs from project vessels. • Requested that cumulative impacts be assessed • Requested INPEX's communication strategy is implemented by all subcontractors and project vessels. • Requests that INPEX acknowledge the right of access for commercial fishers. • Acknowledge that it is not possible to exclude every single impact into a survey timeframe (and hence request the need for an equitable 'compensation' process).	• Acknowledged that relocating fishing activities in response to seismic surveys is a difficult issue for fishers and proposed to 'break' the seismic acquisition in to two separate areas thus providing an option to limit the potential for interactions between fishers and the seismic activity. • Proposed timing and method of a series of communication initiatives in order to avoid potential conflict on water. • Acknowledged that both the petroleum industry and the fishing industry have rights to access resources in the Australian Exclusive Economic Zone. • Acknowledged fishers' anecdotal knowledge of negative impacts of seismic surveys on fish resources in the risk assessments in the EP. • Acknowledged and presented the findings of a range of available scientific research, including research provided to INPEX by WAFIC. • Incorporated claims and feedback within the EP prior to submission. • Assessed cumulative impacts from potential consecutive and concurrent seismic surveys in the region. • Committed to development of a claim process.

Stakeholder	**Summary of material stakeholder feedback**	**Summary of INPEX action and response**
	• Considered the initial consultation was complete, acknowledged that a claim process could be developed (as a commercial agreement) outside of the scope of the 2D Seismic EP) and requested that INPEX provide a summary that cross references to relevant sections of the EP for commercial fishing in the final published EP. Sept 2020 • WAFIC suggsted maps to be provided to licence holders to display potential cumulative impacts as a result of other approved seismic survey EPs and or postponed approved seismic survey EPs. Nov 2020 • WAFIC advised that informal feedback was received from a stakeholder noting the November to May period overlaps with key spawning periods, as per the initial environment plan and that there is ongoing frustration for stakeholders and peak bodies and their members in other jurisdictions around Australia, especially in the context of potential cumulative impacts on fishing activities and the commercial fishing resource. • Thanked INPEX for reconfirming commitment to a claim process in the event that this survey results in economic impacts to a commercial fishery.	• Once published INPEX immediately articulated the key sections/tables of the EP that could be reviewed during public comment period and provided a link to the document The summary included Commercial fishing risk assessments, proposed controls and specific reference to the commitment to developing a claim process which detailed the proposed performance standards and measurement criteria. • Post the public review period, INPEX updated the stakeholder regarding progress made in relation to the claim process development and advised that no comments were received on the published EP during the 30 day period. Nov 2020 • INPEX provided map showing overlaps and cumulative impact to be issued to licence holders. • INPEX has acknowedlged cumulative impacts and amended this revision based on other surveys that may potentially result in a cumulative impact if surveys are completed within planned timeframes.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Confirmed the 2D seismic survey is outside of the known activities and sensitivities for the Southern Bluefin Tuna fishery. Advised the ASBTIA does not need to receive updates on the survey.	INPEX incorporated the provided information within the existing environment section and risk assessments.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
Northern Demersal Scalefish Managed Fishery (NDSMF) Licence holder A	A NDSMF licence holder objected to the proposed survey, claiming the schedule of the activity is too broad and INPEX had not confirmed whether the activity will avoid spawning aggregations and timing. The licence holder challenged information provided in the INPEX factsheet, which stated that "red emperor spawn multiple times between August and May, with peaks in October and March." The licence holder cited Western Australia Fisheries Publication No. 112 of 2013, which identifies peak spawning for red emperor as occurring in January, March and October. The licence holder noted that the paper also acknowledges the possible effects of seismic activity on all life stages of fish, as well as the avoidance of areas by, or dispersal of, spawning aggregations as a consequence of seismic.	INPEX explained that the timeframe is intentionally broad in the early planning stages as it is difficult to anticipate when acceptance of the EP may be achieved by, or when a seismic survey vessel may be in Australian waters. INPEX advised that the window of opportunity was primarily chosen to avoid the period from June to October, when humpback whales are present in the Kimberley region for calving, nursing and resting. INPEX noted this period also happens avoid the peak spawning periods of some (but not all) demersal fish species targeted by the NDSMF. INPEX amended spawning information within the risk assessments in line with feedback provided by DPIRD in 2019 to ensure it reflects DPIRD's current position.
Northern Demersal Scalefish Fishery Licence holder B	A NDSMF licence holder provided the following information, comments, and/or concerns/objections: • Concerned that the impact assessment focuses too heavily on the spawning period, and not the juvenile stages. • Concerned about the lack of available science and application of the precautionary principle. • Notes anecdotal evidence that fishing is less productive after a seismic survey (particularly gold band snapper). • Notes the need for a mitigation and "make good" policy.	INPEX responded, providing: • The draft impact assessment to fish stocks and fisheries. • Clarification on where the information is sourced for the impact assessment, and how spawning events and juvenile stages are considered during the assessment. • Acknowledgement that there is scope for further research. Noted a significant amount of research has occurred on the impacts of fish behaviours and life cycle.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
		• INPEX confirmed precautionary principle is a key consideration throughout the development of the EP. • Confirmation that the licence holder's observation of seismic impacts on goldband snapper after a seismic pass in the vicinity of fishing activities has been noted in the risk assessment in the EP. • Confirmation that INPEX will consider – on a case-by-case basis – claims received from stakeholders in accordance with a claim process.
Mackerel Managed Fishery (MMF; Area 1) Licence holder A	On 8 April 2019 the MMF licence holder provided the following information, comments, and/or concerns/objections: • Provided anecdotal evidence of the negative impacts that seismic surveys have on the fishing resource and actual commercial fishing activity. • Questioned the legitimacy of industry-funded research on the impacts of seismic on marine life. Requested consideration of research which states there are negative impacts. • Urged seismic operators to consider the knowledge of commercial fishers, including fishing activities, where to fish and when to fish. • Provided information on their fishing patterns and activity. • Notes mackerel fishing occurs near shallow inshore reef fishing in water less than 70 metres depth. • Noted the importance of the Lynher Bank is a popular commercial mackerel fishing area. The licence holder requested:	INPEX provided: • The draft impact assessment to fish stocks and fisheries. • An overview of the overlap with mackerel fishing activities in Mackerel Area 1 (Kimberley sector). • Acknowledgement of the licence holder's personal experience and observations of the negative impacts of seismic surveys on fish. • Further information on the proposed survey timing. • Further information on the proposed management measures and proposed development of a claim process.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
	• No interactions with commercial fishing during peak fishing periods; and • No seismic activity during peak mackerel spawning periods.	
Mackerel Managed Fishery (Area 1) Licence holder B	The MMF licence holder provided the following information, comments, and/or concerns/objections: • Noted appreciation of the engagement and desire to achieve an agreed outcome for the EP. • Notes confusion around fisheries' understanding of environment plans while they are in development. • Provided information on their fishing patterns and activity. • Notes mackerel fishing occurs near shallow inshore reef fishing in water less than 70 metres depth. • Noted the importance of the Lynher Bank is a popular commercial mackerel fishing area. The licence holder requested: • No interactions with commercial fishing during peak fishing periods; and • no seismic activity during peak mackerel spawning periods.	INPEX, provided: • The draft impact assessment to fish stocks and fisheries. • An overview of the overlap with mackerel fishing activities in Mackerel Area 1 (Kimberley sector). • Further information on the proposed survey timing. • Further information on the proposed management measures and proposed development of a claim process.
Mackerel Managed Fishery (Area 1) Licence holder C	The MMF licence holder provided the following information, comments, and/or concerns/objections: • Confirmed the survey is located outside of their fishing area and will not impact their actual fishing activities. • Raised concerns on the impact seismic has on the mackerel resource (i.e. on breeding / spawning). Noted that that as a migratory species, spawning activities (and impacts to spawning in Area 1), could potentially impact the resource sustainability in Area 2.	On 7 May 2019 INPEX responded, providing: • The draft impact assessment to fish stocks and fisheries. • Clarification of the overlap with mackerel fishing activities in Mackerel Area 2 (Pilbara sector) • An overview of the potential effects to spawning aggregations and the mackerel resource.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
		• Further information on the proposed survey timing. • Further information on the proposed management measures and proposed development of a claim process.
Mackerel Managed Fishery (Area 2) Licence holder D	The MMF licence holder provided the following information, comments, and/or concerns/objections: • Advised the licence is not currently in use and at this point in time, this seismic survey will not impact actual fishing activities (licence holder retains the option to lease their licence to a third-party). • Raised concerns on the impact seismic has on the mackerel resource (i.e. on breeding / spawning). Also concerned about impacts to the Pilbara Line target species. The licence holder requested: • the seismic survey avoids peak mackerel spawning periods.	INPEX provided: • The draft impact assessment to fish stocks and fisheries. • An overview of the potential effects to spawning aggregations and the mackerel resource. • Further information on the proposed survey timing. • Further information on the proposed management measures and proposed development of a claim process.
Mackerel Managed Fishery (Area 2) Licence holder E	The MMF licence holder provided the following information, comments, and/or concerns/objections: • Confirmed the survey is located outside of their fishing area and will not impact their actual fishing activities. • Raised concerns on the impact seismic has on the mackerel resource (i.e. on breeding / spawning). • Notes mackerel in the Kimberley stock may make extensive southern migrations during the summer months. Notes this would make any disruption to the Kimberley stock of mackerel of significant interest to Area 3 fishers, and also to recreational fishers who target mackerel off Perth during the summer months. The licence holder requested:	INPEX responded, providing: • The draft impact assessment to fish stocks and fisheries. • An overview of the potential effects to spawning aggregations and the mackerel resource, with particular attention given to mackerel in the Kimberley. • Further information on the proposed survey timing. • Further information on the proposed management measures and proposed development of a claim process.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
	• the seismic survey avoids peak mackerel spawning periods.	
Mackerel Managed Fishery (Area 2) Licence holder F	The MMF licence holder provided the following information, comments, and/or concerns/objections: • Confirmed the survey is located outside of their fishing area and will not impact their actual fishing activities. • Raised concerns on the impact seismic has on the mackerel resource (i.e. on breeding / spawning). • Notes extensive anecdotal knowledge regarding the negative impacts of seismic on fish resources. The licence holder requested: • INPEX and other oil, gas and seismic companies invest in comprehensive and legitimate research assessing the impacts of seismic activities on the environment and on the commercial fishing resource with specific focus on WA fisheries.	INPEX provided: • The draft impact assessment to fish stocks and fisheries. • Clarification of the overlap with mackerel fishing activities in Mackerel Area 2 (Pilbara sector). • An overview of the potential effects to spawning aggregations and the mackerel resource. • Acknowledgement of the licence holder's personal experience and observations of the negative impacts of seismic surveys on fish. • Further information on the proposed survey timing. • Further information on the proposed management measures and proposed development of a claim process.
Pearl Oyster Managed Fishery licence holders	Pearling operators met with INPEX in Broome to review details of the proposed 2D seismic survey activity. One pearl producer raised concerns regarding the risk of seismic surveys on pearl oyster larvae/juvenile spat growth and the impacts to the food. One pearling operator asked if pearl divers may be affected.	INPEX provided: • The draft impact assessment to plankton communities, benthic communities, pearl oyster and pearling operations. • An overview of the potential effects to pearl oysters, pearl quality, recruitment of larvae and spat settlement, the food chain, and pearl divers.
Joint Authority Northern Shark Fishery	The JANSF licence holder provided the following information, comments, and/or concerns/objections:	INPEX incorporated the provided information within the existing environment section and risk assessments.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
Licence holder	• Acknowledged low catch effort within the fishery, but noted the fishery was not closed. • Advised that fishing activity is low due to the fishery not having a Wildlife Trade Operation (WTO) accreditation that allows export of product. The licence holder advised they are in the process of applying for a WTO, but were unable to provide insight on the timing of the survey with actual fishing activities. • Raised concern on the protection of their main target species. • The licence holder requested to know whether INPEX has identified pupping areas of the two Blacktip shark species and Spot tail shark, and mackerel spawning areas. The licence holder requested to know what measures INPEX have taken to mitigate any potential impacts on the reproduction of these species.	INPEX responded, providing: • The draft impact assessment to fish stocks and fisheries. • An overview of the potential effects to spawning aggregations and the shark and mackerel resource. • Confirmation that, should activities recommence in the near future, the potential for the survey to overlap with JANSF fishing activities is limited, as the proposed seismic acquisition that overlaps the JANSF is likely to comprise a single acquisition line and some vessel line turns at the western boundary of the fishery. • Further information on the proposed survey timing. • Further information on the proposed management measures and proposed development of a claim process.
North West Slope Trawl Fishery licence holders	Two of three licence holders in the fishery acknowledged that they do not fish in the proposed Operational Area, but noted a third licence holder may be active in the area.	INPEX: • Incorporated the provided information within the existing environment section and risk assessments. • Provided the draft impact assessment relevant to fish stocks and fisheries, as well as an overview of the potential effects to the scampi resource and catch. • Further information on the proposed management measures and proposed development of a claim process.

Stakeholder	Summary of material stakeholder feedback	Summary of INPEX action and response
Recreational fishing stakeholders: • Recfishwest • Western Australian Game Fishing Association • Broome Fishing Club • Broome North Fishing Club	Recreational fishing stakeholders: • Provided information on the location of recreational fishing activities in the region. • Provided information about the Broome Billfish Classic tournament, held in July each year. • Noted limited concerns for impacts to recreational fishing activities in the region.	INPEX incorporated the provided information within the existing environment section and risk assessments.
Vocus Communications	Vocus advised that there is no risk from this seismic activity and the survey will not have any effect on the North West Cable System.	INPEX incorporated the provided information within the existing environment section and risk assessments.

5.6 Stakeholder grievance management

For the development of an EP or OPEP and subsequent performance of the activities described therein, a grievance is a complex stakeholder objection or claim ('relevant matter') which has progressed beyond management through the Stakeholder Monitoring and Reporting process.

In line with grievance management as described in the INPEX Community Grievance Management Procedure, a relevant matter that cannot be resolved with the concerned stakeholder (grievant) by the applicable contact person (supported by area experts where required) will be referred to the INPEX Community Relations Working Group (CRWG) for advice and resolution before a response is made to the grievant.

If the resolution proposed by the INPEX CRWG is unacceptable to the grievant, a third-party mediator may become involved to facilitate a resolution between the parties.

In relation to engagement activities for this EP, all stakeholder enquiries were either dealt with as outlined under Section 5.4, or are ongoing due to the iterative process of engagement being applied.

5.7 Ongoing consultation

Ongoing consultation activities ensure that INPEX develops and maintains a current and comprehensive view of stakeholder functions, interests and activities, and provide a forum for enquiries, objections or claims by relevant persons in the lead up to and during the conduct of a petroleum activity.

Ongoing consultation for the proposed activity is outlined in the implementation strategy (Section 9.8.3).

6 Environmental impact and risk assessment methodology

In accordance with Division 2.3, Regulation 13(5) of the OPGGS (E) Regulations 2009, an environmental risk assessment was undertaken to evaluate impacts and risks arising from the activities described in Section 3. This section describes the process in which impacts and risks were identified. A summary of the outcomes from this process are included in Section 7 and Section 8.

An environmental hazard identification (HAZID) workshop was undertaken for the petroleum activity. The workshop involved numerous environmental advisors and geophysical exploration personnel.

The workshop was undertaken in accordance with INPEX health, safety and environment (HSE) Risk Management processes. The approach generally aligned to the processes outlined in ISO 31000:2009 *Risk Management – Principles and guidelines* (Standards Australia/ Standards New Zealand, 2009) and Handbook 203:2012 *Managing environment-related risk* (Standards Australia/Standards New Zealand 2012).

The environmental impact and risk evaluation process has been undertaken in nine distinct stages:

1. the establishment of context
2. the identification of aspects, hazards and threats
3. the identification of potential consequences (severity)
4. the identification of existing design safeguards and control measures
5. proposal of additional safeguards (ALARP evaluation)
6. an assessment of the likelihood
7. an assessment of the residual risk
8. an assessment of the acceptability of the residual risk
9. the definition of environmental performance outcomes, standards and measurement criteria.

6.1 Establishment of context

The first stage in the process involved defining the activity, characterising the environment and identifying the particular values and sensitivities of that environment. The outcomes of these are presented in Section 3 Description of Activity and Section 4 Existing Environment, of this EP.

6.2 Identification of aspects, hazards and threats

An assessment was undertaken to identify the aspects associated with the petroleum activity. An aspect is defined by ISO 14001: 2015 *Environmental Management Systems (EMS)* as:

"An element or characteristic of an activity, product, or service that interacts or can interact with the environment".

The aspects were grouped to align with the INPEX HSEQ-MS environment standards. A summary of the aspects identified for the petroleum activity were as follows:

- emissions and discharges;
- waste management;
- noise and vibration;

- loss of containment;
- biodiversity and conservation protection;
- land disturbance (or seabed disturbance); and
- social and cultural heritage protection.

Hazards are defined by the INPEX HSE Hazard and Risk Management Standard as:

"A physical situation with the potential to cause harm to people, damage to property, damage to the environment".

As the definition suggests, for an environmental risk or impact to be realised, there needs to be a chance of exposing an environmental value or sensitivity to a hazard.

Given the various receptors present in the environment, they have been refined to environmentally sensitive or biologically important receptors (values and sensitivities). They have been selected using regulations, government guidance and stakeholder feedback.

For the purposes of the evaluation, environmental values and sensitivities to be considered include the following:

- receptors that are considered socially important as identified during stakeholder engagement (including social and cultural heritage);
- benthic primary producer habitat, defined by the Western Australian Environmental Protection Authority (WA EPA) Environmental Assessment Guideline No. 3 *Environmental Assessment Guidelines for Protection of Benthic Primary Producer Habitat in Western Australia's Marine Environment* as functional ecological communities that inhabit the seabed within which algae (e.g. macroalgae, turf and benthic microalgae), seagrass, mangroves, corals, or mixtures of these groups, are prominent components;
- regionally important areas of high diversity (such as shoals and banks);
- particular values and sensitivities as defined by Regulation 13(3) of the OPGGS(E) Regulations 2009:
  - the world heritage values of a declared World Heritage property within the meaning of the EPBC Act
  - the national heritage values of a National Heritage place within the meaning of the EPBC Act
  - the ecological character of a declared Ramsar wetland within the meaning of the EPBC Act
  - the presence of a listed threatened species or listed threatened ecological community within the meaning of the EPBC Act
  - the presence of a listed migratory species within the meaning of the EPBC Act
  - any values and sensitivities that exist in, or in relation to, part or all of:
    - a Commonwealth marine area within the meaning of the EPBC Act – Note that this value and sensitivity includes receptors (e.g. planktonic and benthic communities) that, when exposed, have the potential to affect regionally significant ecological diversity and productivity from benthic and planktonic communities
    - Commonwealth land within the meaning of the EPBC Act; and
- biologically important areas associated with EPBC-listed species.

6.3 Identify potential consequence

In sections 7 and 8, for each aspect, the greatest consequence (or potential impact) of an activity, is evaluated with no additional safeguards or control measures in place. This allows the assessment to be made on the maximum foreseeable exposure of identified values and sensitivities to the hazard taking into account the extent and duration of potential exposure. The consequence is defined using the INPEX Risk Matrix (Figure 6-1).

Given that the receptors, identified as particular values and sensitivities are the most regionally significant or sensitive to exposure, these are considered to present a credible worst-case level of consequence to assess against.

6.4 Identify existing design safeguards/controls

Control measures associated with existing design are then identified to prevent or mitigate the threat and/or its consequence(s).

6.5 Propose additional safeguards (ALARP evaluation)

Where existing safeguards or controls have been judged as inadequate to manage the identified hazards (on the basis that the criteria for acceptability is not met as defined in Section 6.8), additional safeguards or controls are proposed.

The INPEX *HSE Hazard and Risk Management Standard* describes the process in which additional engineering and management control measures are identified, taking account of the principle of preferences illustrated in Figure 6-2. The options were then systematically evaluated in terms of risk reduction. Where the level of risk reduction achieved by their selection was determined to be grossly disproportionate to the "cost" of implementing the identified control measures, the control measure will not be implemented, and the risk is considered ALARP. Cost includes financial cost, time or duration, effort, occupational health and safety risks, or environmental impacts associated with implementing the control.

6.6 Assess the likelihood

The likelihood (or probability) of a consequence occurring was determined, taking into account the control measures in place. The likelihood of a particular consequence occurring was identified using one of the six likelihood categories shown in Figure 6-1.

6.7 Assess residual risk

Where additional controls/safeguards are identified, the residual risk is then evaluated and ranked.

Risk Matrix

LIKELIHOOD TABLE

Time Frame Could be experienced	100 year timeframe or less	50 year timeframe	10 - 20 year timeframe	5 year strategic planning time frame	1 -2 year budget timeframe	Once or more during the next year
Experience History of occurrence in Company or Industry	Unheard of in the industry or in Projects	Has occurred once or twice in the industry or rarely occurs in Projects	Has occurred many times in the industry but not in the company or in <1 out of 100 Projects	Has occurred once or twice in the company or in <1 out of 10 Projects	Has occurred frequently in the company or in many Projects	Has occurred frequently at the location or in every Project
Frequency Continuous Operation	Once every 10 000 – 100 000 years at location	Once every 1,000 – 10 000 years at location	Once every 100 - 1000 years at location	Once every 10 - 100 years at location	Once every 1 - 10 years at location	More than once a year at location or continuously
Probability Single activity	1 in 100 000 – 1 000 000	1 in 10 000 – 100 000	1 in 1000 – 10 000	1 in 100 - 1000	1 in 10 - 100	>1 in 10

CONSEQUENCE TABLE

CONSEQUENCES

Severity Level	Financial NPV	Financial A$	Health & Safety	Environment	Reputation	Cultural & Social Heritage	Legal
A	>$1B	> $5B **Project Schedule** >24 months	>20 fatalities or permanent total disabilities	Regional scale event, permanent impact on environment. Eradication of local populations of protected species	Prolonged international multi-NGO and media and by public protests. Loss of host government support and/ or social licence to operate. Company reputation severely tarnished	Permanent, long-term impact on social structure, and destruction of highly-valued heritage, aesthetic, economic or recreational items	Criminal prosecution, potential jail sentences for directors and senior officers. Civil prosecution, class actions. Heavy fines, threat to licence to operate or future approvals
B	$100M – $1B	$1B – $5B **Project Schedule** 12 – 24 months	2 – 20 fatalities or permanent total disabilities	Large scale event, long term impact on environment. Extensive impact on populations of protected species	International multi-NGO and media condemnation. Host government registers concerns. Prolonged large protests. Company reputation seriously impacted	Widespread disruption to a number of communities with damage to highly-valued heritage, aesthetic, economic or recreational items	Criminal prosecution for directors and senior officers. Civil prosecution and class actions. Heavy fines, threat to licence to operate
C	$10M – $100M	$100M – $1B **Project Schedule** 6 – 12 months	Single fatality or Permanent Total Disability	Medium to large scale event, medium term impact on environment. No threat to overall population viability of protected species	Serious public or national media outcry. Damaging NGO campaign. Large protests. Company reputation impacted	Significant impact to regional communities, and to heritage, aesthetic, economic or recreational items of significant value	Significant, multiple breaches of regulation or licence conditions. Significant litigation and fines
D	$1M – $10M	$10M – $100M **Project Schedule** 1 - 6 months	Major injury or illness, permanent partial disability, lost time injury	Local to medium scale event with short to medium term impact on environment. No threat to overall population viability of protected species	Major adverse national media, public or NGO attention. Significant protests. Asset reputation impacted	Regional community disruption with moderate impact on heritage, aesthetic, economic or recreational values	Serious breach of regulation. Investigation by regulatory authorities. Potential litigation and moderate fines
E	$100K– $1M	$1M – $10M **Project Schedule** 2 - 4 weeks	Minor injury or illness, alternative duties injury, medical treatment injury	Local scale event with short term impact on the environment. Minor and temporary impact on a small portion of the population of protected species	Attention from regional media with heightened concern with local community. Criticism by community or NGOs	Isolated community disruption with limited adverse impact on heritage, aesthetic, economic or recreational values	Minor legal issues. Report provided to regulatory authorities. Potential for minor fines
F	<$100K	<$1M **Project Schedule** <2 weeks	Slight injury or illness, first aid injury	Local scale event with temporary impact on environment. Behavioural responses inconsequential ecological significance to protected species	Short term local concern or complaints. Low level media or regulatory issue	Minor impact on heritage, aesthetic, economic or recreational values	Breach of internal standards. Potential scrutiny by regulatory authorities

Likelihood Level

Severity	6 Remote	5 Highly Unlikely	4 Unlikely	3 Possible	2 Likely	1 Highly Likely
A Catastrophic	6	5	4 Critical Risk	3	2	1
B Major	7	6	5	4	3	2
C Significant	8	7	6 High Risk	5	4	3
D Moderate	9	8	7	6	5	4
E Minor	10	9	8 Moderate Risk	7	6	5
F Insignificant	10	10	9 Low Risk	8	7	6

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Figure 6-1: INPEX risk matrix

Most Preferred	**Elimination**		Removal of the hazard or sensitive receptor
	Substitution		Replacement of highly hazardous materials / approaches with less hazardous materials / approaches
	Engineering	**Prevention**	Design measures that reduce the likelihood of a hazardous event occuring
		Detection	Design measures that facilitate early detection of a hazardous event
		Control	Design measures that limit the extent/escalation potential of a hazardous event
		Mitigation	Design measures that protect the environment should a hazardous event occur
		Response Equipment	Design measures or safeguards that enable clean-up / response following the realisation of a hazardous event
	Procedures & Administration		Management systems and work instructions used to prevent or mitigate environmental exposure to hazards
Least Preferred	**Sensitive Receptor Protection**		The lowest level in the hazard management hierarchy which should only be considered when all higher controls in the hierarchy have been exhausted e.g. physical barriers located at the sensitive receptor

Figure 6-2: ALARP options preferences

6.8 Assess residual risk acceptability

Potential environmental impacts and risks are only deemed acceptable once all reasonably practicable alternatives and additional measures have been taken to reduce the potential impacts and risks to ALARP.

INPEX has determined that risks rated as “Critical” are considered too significant to proceed and are therefore, in general, unacceptable. In alignment with NOPSEMA’s *Environment Plan Decision Making Guideline* (GL1721 Rev5 June 2018), INPEX considers that when a risk rating of “Low” or “Moderate” applies, where the consequence does not exceed “C” (Significant) and where it can be demonstrated that the risk has been reduced to ALARP, that this defines an acceptable level of impact.

Through implementation of this EP, impacts to the environment will be managed to ALARP and acceptable levels and will meet the requirements of Section 3A of the EPBC Act (Principles of ecologically sustainable development (ESD)) as shown in Table 6-1.

Table 6-1: Principles of ecological sustainable development

Principles of ESD	Demonstration
a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;	The INPEX environmental policy (INPEX **Environmental Pol** **Objective** INPEX is a worldwide oil and gas exploration, development and production company committed to conducting each of its activities in a manner that is environmentally responsible. Our objective is to develop an environment culture that is recognised as amongst "best in industry" that will exceed the performance expectations of our stakeholders. We recognise our responsibility to adhere to the principles of sustainable development and w acknowledge that we owe a duty of care to both the natural environment and the communitie in which we operate. **Strategy** To accomplish this, INPEX will: • comply with applicable laws and regulations, environmental plans and commitments anc apply appropriate INPEX standards • maintain a culture where people are empowered to intervene to prevent environmental harm • set, measure and review environmental performance objectives and targets and ensure appropriate management of change processes are followed • ensure our personnel have the necessary awareness, training, knowledge, resources anc support, to meet environmental objectives and targets • identify, manage and review environmental hazards and risks associated with our currer and future business activities and manage these to levels that are 'as low as reasonably practicable' (ALARP) • implement, maintain and regularly test control measures associated with major environmental events • maintain and regularly test emergency management processes and procedures, includin industry and government emergency response partners • engage with and communicate openly on environmental issues with internal and extern stakeholders • provide clearly defined environmental performance expectations for our contractors and suppliers, and work collaboratively with them to attain these • endeavour to prevent pollution and seek continual improvement with respect to emissions, discharges, wastes, energy efficiency and resource consumption • actively promote the reduction of greenhouse gas emissions across our operations in a safe, technically and commercially viable manner • endeavour to protect biodiversity and to contribute to increased understanding of our natural environment • drive continual improvement in environmental performance through monitoring, auditin and reviews. **Application** This policy applies to all INPEX controlled activities in Australia and related project locations. will be displayed at all company workplaces and on the company's intranet and it will be reviewed regularly. **Hitoshi Okawa** President Director, Australia Rev: 3 April 2019 Document No.: 0000-AH-POL-60002 This document has been approved and the audit history is recorded on

Principles of ESD	Demonstration
	Figure 9-2), INPEX *HSE Hazard and Risk Management Standard* and the INPEX HSEQ-MS (Section 9.1) consider both long-term and short-term economic, environmental, social and equitable considerations.
b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;	No threat of serious or irreversible environmental damage is expected from the activity. Scientific knowledge is available to support this, and processes are in place to ensure that INPEX remains up-to-date with scientific publications (Section 9.13).
c) the principle of inter-generational equity - that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;	The health, diversity and productivity of the environment shall be maintained and not impacted by the activity.
d) the conservation of biological diversity and ecological integrity should be a fundamental	Biological diversity and ecological integrity will not be compromised by the proposed activity.

Principles of ESD	Demonstration
consideration in decision making;	
e) improved valuation, pricing and incentive mechanisms should be promoted.	N/A

Consequently, the potential environmental impacts and risks associated with implementing the activity were determined to be acceptable if the activity:

- complies with relevant environmental legislation and corporate policies, standards, and procedures specific to the operational environment;
- takes into consideration stakeholder feedback;
- takes into consideration conservation management documents;
- does not compromise the relevant principles of ESD; and
- does not exceed the defined acceptable level, in that the environmental risk has been assessed as "Low" or "Moderate", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

6.9 Definition of performance outcomes, standards and measurement criteria

As defined in Regulation 4 of the OPGGS (E) Regulations 2009, INPEX has used environmental performance outcomes and performance standards to address potential environmental impacts and risks identified during the risk assessment.

Environmental performance outcomes, standards, and measurement criteria that relate to the management of the identified environmental impacts and risks are defined as follows:

- Environmental performance outcome means a measurable level of performance required for the management of environmental aspects of an activity to ensure that environmental impacts and risks will be of an acceptable level.
- Environmental performance standard means a statement of the performance required of a control measure.

Measurement criteria are used to determine whether each environmental performance outcome and environmental performance standard has been met.

7 Impact and risk assessment

Following the environmental impact and risk assessment methodology described in Section 6, the aspects, hazards and threats have been systematically identified. The aspects (and associated hazards) with the potential for impact or risk in relation to relevant identified values and sensitivities are discussed in this section and in Section 8.

7.1 Noise and vibration

The seismic source will emit short-duration, high-amplitude pulses of sound. The peak sound energy is typically at frequencies below 200 Hz, although higher frequency and broadband components of the sound are also produced. The sound produced by the seismic source is directed downwards, towards the seabed, to obtain information about the geology underlying the seabed. However, some horizontal sound propagation will also occur, which has the potential to affect environmental and socio-economic receptors.

To assess all potential environmental impacts and risks of the activity and demonstrate that they will be reduced to an acceptable level and ALARP, INPEX has assessed ecological receptors at different trophic levels. The assessments consider the direct impacts to these receptors, and also secondary impacts, by assessing impacts to the food chain and key life stages such as reproduction (e.g. whale calving, turtle internesting, fish spawning and larval stages).

The assessment of underwater noise impacts is divided into the following sections:

- Planktonic communities – Section 7.1.4
- Benthic communities – Section 7.1.5
- Fishes – Section 7.1.6
- Marine mammals – Section 7.1.7
- Marine reptiles – Section 7.1.8
- Marine avifauna – Section 7.1.9.

Potential impacts to fisheries, pearling and aquaculture, and Australian Marine Park values from underwater noise and physical interactions with the survey vessel are assessed separately in Section 7.2.

Of relevance to all receptors is that the seismic source is transient (i.e. moving) throughout the survey, meaning that environmental receptors at any given location are typically only exposed to significant sound levels produced by the seismic source for a short period of time as the survey vessel passes nearby before moving away again. The survey vessel may return after many hours or days to a parallel acquisition line within a few kilometres of the same location, or along a perpendicular line that crosses nearby, but generally the seismic source will move steadily across the Acquisition Area only resulting in temporary sound exposures at any one location.

The following subsections present the assessment of impacts and risks from seismic sound exposure.

7.1.1 Fundamentals of underwater noise

Sound levels and the decibel scale

The decibel (dB) scale is used to measure the amplitude or 'loudness' of a sound wave. For underwater sounds, the dB scale is denoted relative to the reference pressure of 1 micropascal (µPa) e.g. dB re 1 µPa, whereas the reference pressure level used in air is 20 µPa, which was selected to match human hearing sensitivity. Because of these differences in reference standards, dB sound levels in air are not comparable to underwater sound levels i.e. dB sound levels underwater are much quieter than the same dB sound levels in air (Carroll et al. 2017).

Sound metric terminology

Marine seismic surveys emit pulses of underwater sound. These sounds are termed 'impulsive' sounds as they are brief and intermittent with rapid rise times and decay back to ambient levels (within a few seconds).

There are four main metrics used to measure and describe underwater sound pressure and energy that are applied to the assessment of these types of sound, all of which use the decibel scale (adapted from ISO/DIS 18405.2:2017):

- **Zero-to-peak sound pressure (PK)**, the greatest magnitude of the sound pressure during a specified time interval (Figure 7-1); unit: dB re 1 µPa; PK levels are relevant to the assessment of potential physical injury and impairment impacts to marine fauna and biota resulting from a single seismic pulse.
- **Peak-to-peak sound pressure (PK-PK)**, sum of the peak compressional pressure and the peak rarefactional pressure during a specified time interval (approximately double the zero-to-peak pressure) (Figure 7-1); unit: dB re 1 µPa; PK-PK levels, like PK levels, are relevant to the assessment of potential physical injury and impairment impacts to marine fauna and biota resulting from a single seismic pulse.
- **Root-mean-square sound pressure level (SPL)**, the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure over the duration of an acoustic event (i.e. the duration of a single seismic pulse) (Figure 7-1); unit: dB re 1 µPa; because the SPL represents the effective sound pressure over the full duration of the acoustic event rather than the maximum instantaneous peak pressure, it is regularly used to represent the effective loudness of a sound and to assess the potential for a behavioural response from marine fauna.
- **Sound exposure level (SEL)**, a measure related to the sound energy (instead of the sound pressure) in one or more pulses, or the ratio of the time-integrated squared sound pressure to the specified reference value; unit: dB re 1 $\mu Pa^2 \cdot s$; SEL is specified in terms of either a per-pulse SEL or an accumulated SEL (SEL_{cum}) from multiple pulses over a given period. SEL recognises that the effects of sound can be a function of exposure duration as well as maximum instantaneous peak pressure. SEL can therefore be considered a dose-type measurement with SEL_{cum} being used to assess dose-type impacts such as the potential for the gradual onset of temporary threshold shift (TTS) in marine fauna hearing because of prolonged exposure to high sound levels.

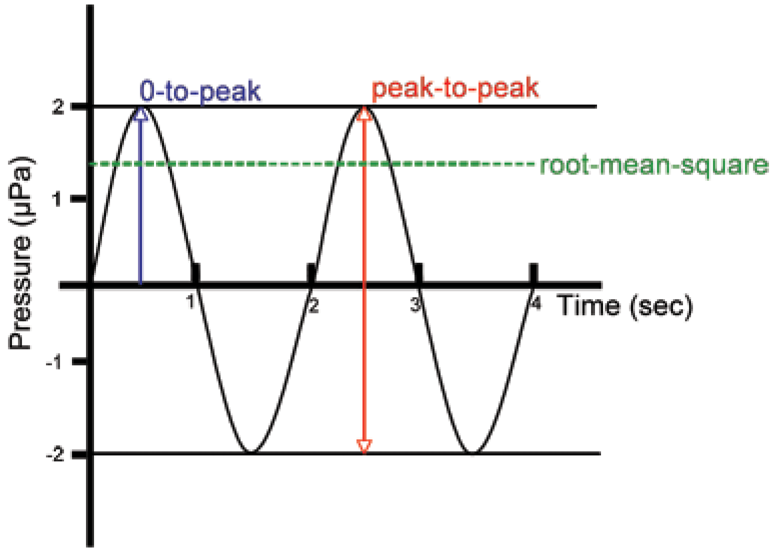


Figure 7-1 Simplified sound wave and sound pressure metrics (University of Rhode Island and Inner Space Center 2017)

Particle motion

The particle motion component of sound is also relevant to the assessment of potential impacts to marine fauna. Acoustic particle motion refers to the physical motion caused by a sound wave within the water, seabed or other medium. Unlike pressure, particle motion is directional in nature, although the actual to-and-fro particle displacements that constitute sound are extremely small, in the order of nanometres (Popper & Hawkins 2018). Particle motion can be described in terms of particle displacement (m), velocity (m/s), or acceleration (m/s^2) (Popper et al. 2014; Carroll et al. 2017). Alternatively, it is sometimes expressed in dB with respect to a reference value of displacement (dB re 1 pm), velocity (dB re 1 nm/s) or acceleration (dB re 1 $\mu m/s^2$) (Nedelec et al. 2016).

Particle motion is important because marine invertebrates and most fishes are primarily sensitive to particle motion rather than sound pressure and, therefore, particle motion is the most relevant metric for perceiving underwater sound by invertebrates and most fish species (Popper & Hawkins 2019). However, there is currently limited information available to quantify the particle motion sensitivity of fishes and invertebrates. It is complex and challenging to directly measure particle motion compared to sound pressure, hence most research is presented in the context of sound pressure or exposure levels instead of particle motion (Carroll et al. 2017; Popper & Hawkins 2018). Therefore, while the assessment of underwater noise impacts in this EP considers the role of particle motion and its effect on fishes and invertebrates, the acoustic modelling and impact threshold criteria are based upon sound pressure and sound exposure metrics.

It should be noted that particle motion is most relevant close to the source where it is the dominant component of a sound wave, while pressure will dominate a sound wave propagating over distance (Radford et al. 2012; Morley et al. 2014; Nedelec et al. 2016; Popper & Hawkins 2018). Sound pressure levels received at increasing distance from a source do not, therefore, provide a reliable representation of particle motion. Organisms that are sensitive only to particle motion have typically been found to be sensitive only at close range where these particle motions are greatest (Popper et al. 2014; Edmonds et al. 2016; Popper & Hawkins 2018).

Sound frequency and hearing sensitivity

Different animals are sensitive to different sound frequencies, which are measured in Hertz (Hz) and kilohertz (kHz). Therefore, if an animal is sensitive to a particular frequency range, a sound in that frequency range will seem louder to that animal than to a different animal which is less sensitive to those frequencies. For example, some large baleen whales are sensitive to very low frequency sounds (7 Hz to 35 kHz), while other toothed whales and dolphin species are considered more sensitive to mid-high frequency sounds (150 Hz to 160 kHz) with their peak hearing frequency somewhere between these frequency ranges (National Marine Fisheries Service 2018). Therefore, how loud a sound will be perceived will differ between species.

In some cases, a sound level is specified relative to a given frequency range or is weighted according to the auditory sensitivity of an animal. This has the advantage of placing the sound into a more biologically relevant context for that animal. If a frequency range or weighting is not specified, the frequency of the sound is generally referred to as “broadband” sound i.e. the sound level accounts for sound across all frequencies, noting again that a particular animal may not be able to detect all of the sound frequencies and associated energy that are emitted.

Therefore, the frequency of a sound and how sensitive different animals are to sound can make a considerable difference to how loud the sound is perceived to be and any resultant impact.

7.1.2 Acoustic modelling

To assess the potential magnitude and extent of impacts from underwater noise produced during the 2D seismic survey, INPEX commissioned JASCO Applied Sciences (JASCO) to model the source levels and sound propagation at several locations that were representative of the different water depths, bathymetry and seabed properties within the Acquisition Area (McPherson et al. 2019; Appendix D).

The modelling study first undertook a comparison of the acoustic source levels and directivity of three potential seismic sources. The seismic source with the greatest source levels was then selected to provide the most conservative estimates for modelling sound propagation. This included modelling both single-pulse sound metrics and cumulative sound exposures in order to assess potential behavioural and physical impacts against various threshold criteria for different marine fauna.

Acoustic source level comparison

Source modelling considered three different seismic sources provided by three 2D seismic contractors. The sources were all selected as being approximately 3,000 cubic inches and the minimum required to ensure adequate seismic imaging of the predicted exploration targets.

A source model was used to predict the horizontal and vertical overpressure signatures and corresponding power spectrum levels for the three different seismic sources. Table 7-1 presents the PK source levels corresponding with each seismic source in the broadside (perpendicular to the tow direction), endfire (along the tow direction), and vertical directions. Horizontal directivity plots were also reviewed to assess which source had the potential for the greatest horizontal sound propagation.

The three seismic sources produced similar source levels (±2.5dB) but the source with the loudest far-field source level specifications was the 3,080 cubic inch source. This source also resulted in the greatest directivity in sound levels in the broadside direction, indicating that greater horizontal sound propagation would likely occur from the source compared with the other two seismic sources. Therefore, the 3,080 cubic inch source was selected to provide conservative predictions of sound propagation.

Table 7-1 Per-pulse peak source level comparison for three seismic source options (McPherson et al. 2019)

	Peak source pressure level ($L_{s,\ pk}$) (dB re 1 μPa^{2}m^2)		
	3,080 cubic inches	**3,000 cubic inches**	**2,970 cubic inches**
Broadside	249.6	249.3	247.1
Endfire	246.4	245.8	246.5
Vertical	255.9	255.2	255.8
Vertical (surface affected source level)	255.9	255.2	255.8

Single pulse modelling locations

The acoustic modelling study comprised modelling of twelve single pulse modelling sites at different locations and water depths within the Acquisition Area (Figure 7-2). The different sites account for variations in sound propagation as a result of pulses emitted in a range of different water depths and in areas of different bathymetry and geoacoustic (seabed sediment) characteristics that are representative of the overall Acquisition Area.

The locations of the single pulse modelling sites were selected to represent the shallow, intermediate and deep waters in the proposed Acquisition Area, and also considered their proximity to biologically relevant and socio-economically important values and sensitivities of the Kimberley region, including:

- zones of the Kimberley Australian Marine Park;
- humpback whale migration corridors and aggregation sites for resting, calving and nursing;
- turtle internesting habitat surrounding important nesting beaches and islands;
- continental shelf waters relevant to a range of different fish species and benthic communities, including commercially targeted demersal and pelagic fish species;
- continental slope waters relevant to pygmy blue whale migration and foraging, as well as commercially targeted scampi; and
- a number of other sensitivities located outside of the 2D seismic survey Operational Area in Kimberley coastal waters, including inshore dolphin and dugong habitat, pearl oyster fishing grounds and farming leases, and aquaculture sites.

The single pulse modelling sites cover water depths ranging from 37 m in the shallowest areas of Lynher Bank, to 451 m in the deeper waters of the continental slope. While slightly shallower and deeper water depths occur within the Acquisition Area (approximately 30 m to 600 m) the modelled sites are representative of the potential sound propagation that may occur from operation of the seismic source during the survey.

The orientation of the seismic source at the single pulse sites was purposefully chosen to be representative of the range of potential acquisition line orientations presented in the potential line plan options in Figure 3-2, and to account for the maximum horizontal sound propagation towards key environmental sensitivities. Proximity and orientation towards key environmental sensitivities ensured that the modelling provided biologically relevant results for use in the environmental risk assessment.

Given that sound propagation from seismic sources produces the greatest source levels and horizontal sound propagation in the broadside direction, most of the single pulse sites were orientated so that the source tow direction was approximately parallel with the bathymetric contours of the continental shelf and slope. This was selected in order to yield the maximum potential sound propagation across the continental shelf towards shallow water sensitivities (e.g. humpback whale migration, resting and calving habitat, and turtle interesting habitats), as well as the maximum sound propagation down the continental slope towards deep water sensitivities (e.g. the pygmy blue whale migration).

Downslope sound propagation is well documented in both modelling and field measurements. It is most apparent when a near-surface sound source such as a seismic source is discharged over the continental slope, then in the downslope direction consecutive reflections from the seabed flatten the sound rays, allowing them to refract towards the 'Deep Sound Channel' where sound propagates over great distances (Salgado Kent et al. 2016). It was therefore anticipated that some downslope sound propagation would occur from seismic pulses in the north-western part of the Acquisition Area, which is located on the shelf break and continental slope.

The highly directional nature of the modelled 3,080 in^3 seismic source, coupled with the effects of bathymetry on sound propagation, results in sound propagation and exceedance of impact thresholds over relatively long distances. Therefore, the sound propagation modelling results are expected to provide a worst-case compared with the other seismic source options that have been evaluated, as well as many other seismic sources of equivalent volume and source output.

The locations and orientations of the single pulse sites also informed the accumulated (multiple pulse) sound exposure scenarios, as described below.

Accumulated (multiple pulse) sound exposure scenarios

The three SEL_{24hr} scenarios (Figure 7-2) were selected to provide representative and conservative cumulative sound exposures for potential acquisition line plan options in WA-532-P and WA-533-P. The SEL_{24hr} scenarios include:

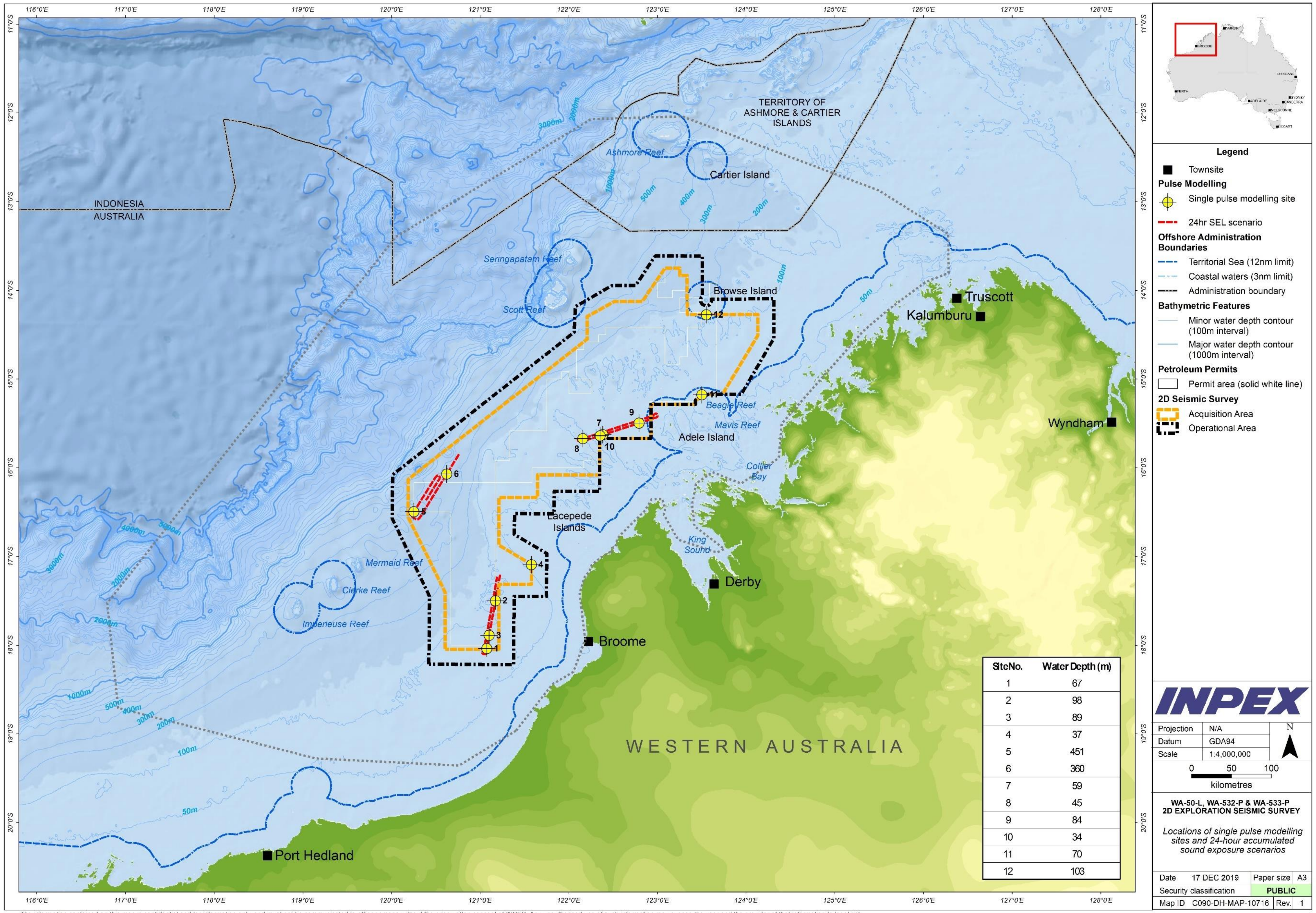
- Scenario 1: South-eastern part of WA-533-P – The scenario was selected to represent sound accumulation in the shallow waters of WA-533-P, adjacent to areas that support humpback whales, marine turtles and nearshore receptors.
- Scenario 2: Western boundary of WA-533-P – The scenario was selected to represent sound accumulation in deep waters on the continental slope, with particular relevance to migrating pygmy blue whales.
- Scenario 3: Southern boundary of WA-532-P – The scenario was selected to represent sound accumulation in the shallow waters of WA-532-P, including Lynher Bank, waters adjacent to the Kimberley AMP National Park and Habitat Protection zones, and areas that support humpback whales and marine turtles.

Similar to the single pulse modelling, all scenarios were designed so that the acquisition lines were broadly parallel to the bathymetric contours and environmentally sensitive locations to account for the maximum-possible broadside sound propagation and sound energy accumulation. Noting that the final acquisition line plan is not yet finalised, it was important to orientate the modelling scenarios in this way to account for the worst-case sound propagation and accumulation. The selected scenarios are slightly more closely aligned with line plan option 1 than line plan option 2 (Figure 3-2) for this reason. Acquisition lines that are aligned more orthogonally with the bathymetric contours and environmental receptor locations (i.e. they approach from head on or move away), as is the case with line plan option 2 (Figure 3-2), will result in lesser accumulated sound energy radiating towards shallow and deep waters because horizontal sound propagation from seismic sources is typically less in the endfire direction than in the broadside direction.

Each modelled SEL_{24hr} scenario incorporated at least one line turn to account for sound energy accumulated from multiple parallel lines. Accumulated SEL is measured at a fixed location and reflects a dosimetric effect based on the assumption that a receptor is consistently exposed to sound levels at a fixed position relative to the survey lines; therefore, inclusion of multiple lines in the models results in a greater accumulation of sound energy than from a single acquisition line. Considering multiple parallel lines in this way has, therefore, provided more conservative results than from a single line.

The spacing of lines in the SEL_{24hr} scenarios was also representative of the intended acquisition line spacing (approximately 3 – 6 km). The line spacing of the two SEL_{24hr} scenarios in shallow waters used a line spacing of approximately 3 km. The SEL_{24hr} scenario located in the deeper continental shelf waters, which includes three parallel lines, used line spacings of 4.5 km and 5 km.

In addition, the order in which line acquisition occurs during 2D seismic surveys does not always result in adjacent parallel lines being acquired consecutively; a dip line may often be followed by a perpendicular strike line which would result in the seismic source moving away to a different part of the Acquisition Area and, therefore, accumulated sound energy at a fixed location would often be less than for the parallel line scenarios that were selected for modelling.



Site No.	Water Depth (m)
1	67
2	98
3	89
4	37
5	451
6	360
7	59
8	45
9	84
10	34
11	70
12	103

Figure 7-2 Locations of single pulse acoustic modelling sites and 24-hour accumulated sound exposure scenarios

Acoustic Modelling Results

Figure 7-3 presents unweighted SPL isopleths (contours of equal sound level) for six representative single pulse modelling locations. The SPLs represent the maximum levels at any depth within the water column (maximum-over-depth SPL isopleths). The corresponding horizontal distances (R_{max} and $R_{95\%}$) associated with these SPL isopleths are presented in Table 7-2.

R_{max} refers to the maximum range to the given sound level in all directions. $R_{95\%}$ is the range to the given sound level in 95% of all directions, after the 5% farthest points have been excluded. For example, in some cases, a sound level contour might have small or anomalous protrusions in some directions. In cases such as this, R_{max} can over-represent the area exposed to such sound levels, and $R_{95\%}$ may be more representative. R_{max} better represents the sound levels received in the specific directions that the maximum sound levels extend towards.

The strong directionality and asymmetry of the seismic source is clearly apparent from the modelling results (Figure 7-3). The influence of the bathymetry and downslope sound propagation is also evident, with sound extending to greater distances in areas where the bathymetry slopes downward, such as subsea valleys, basins and the continental slope. Conversely, sound propagation towards shallow water results in more rapid attenuation of sound as well as the reflection and shielding effects caused by bathymetric features and islands in coastal waters (e.g. site 10 in Figure 7-3).

The single pulse and cumulative sound exposure modelling results are discussed in more detail in the context of different receptors in the relevant risk assessment sections below.

Table 7-2 Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3,080 cubic inch array to modelled maximum-over-depth SPL isopleths from the modelled single impulse sites shown in Figure 7-3

SPL (Lp; dB re 1 µPa)	Site 1 (67 m depth)		Site 2 (98 m depth)		Site 3 (89 m depth)		Site 4 (37 m depth)		Site 5 (451 m depth)		Site 6 (360 m depth)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04
190	0.23	0.20	0.18	0.15	0.21	0.18	0.22	0.20	0.15	0.13	0.15	0.13
180	0.73	0.62	0.67	0.57	0.68	0.58	0.80	0.70	0.48	0.40	0.88	0.79
170	2.60	2.13	2.36	2.08	2.79	2.19	2.59	2.10	2.82	2.31	3.06	2.59
160	6.73	5.57	7.22	5.96	6.73	5.81	6.55	5.41	7.74	6.51	8.04	6.69
150	17.96	14.88	17.64	14.67	17.06	14.52	18.85	15.29	24.32	19.46	23.90	18.83
140	49.41	40.75	44.19	37.79	44.96	38.80	69.50	60.78	112.80	66.18	120.30	65.62
130	101.45	76.56	79.64	66.57	93.77	72.85	139.36 *	112.61 *	141.39 *	109.96 *	139.61 *	112.51 *
SPL (Lp; dB re 1 µPa)	**Site 7 (59 m depth)**		**Site 8 (45 m depth)**		**Site 9 (84 m depth)**		**Site 10 (34 m depth)**		**Site 11 (70 m depth)**		**Site 12 (103 m depth)**	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
190	0.31	0.27	0.24	0.21	0.19	0.15	0.23	0.21	0.30	0.26	0.31	0.28
180	1.35	1.17	0.81	0.70	0.68	0.58	0.91	0.74	1.35	1.15	1.24	1.09
170	3.77	3.15	2.19	1.91	2.35	2.06	2.50	1.99	4.01	3.29	4.09	3.56
160	10.84	8.62	5.52	4.35	6.80	5.16	7.11	5.70	10.32	8.19	11.19	9.14
150	33.85	27.13	14.58	11.51	14.77	11.80	20.37	16.23	27.45	22.64	28.25	24.19
140	90.49	75.93	29.85	23.96	40.71	32.01	55.04	42.43	75.51	57.72	78.18	62.97
130	112.26	94.57	61.14	45.10	87.13	69.86	93.07	75.72	114.92 *	96.09	131.72 *	102.65 *
* Radii extend beyond modelling boundary.												

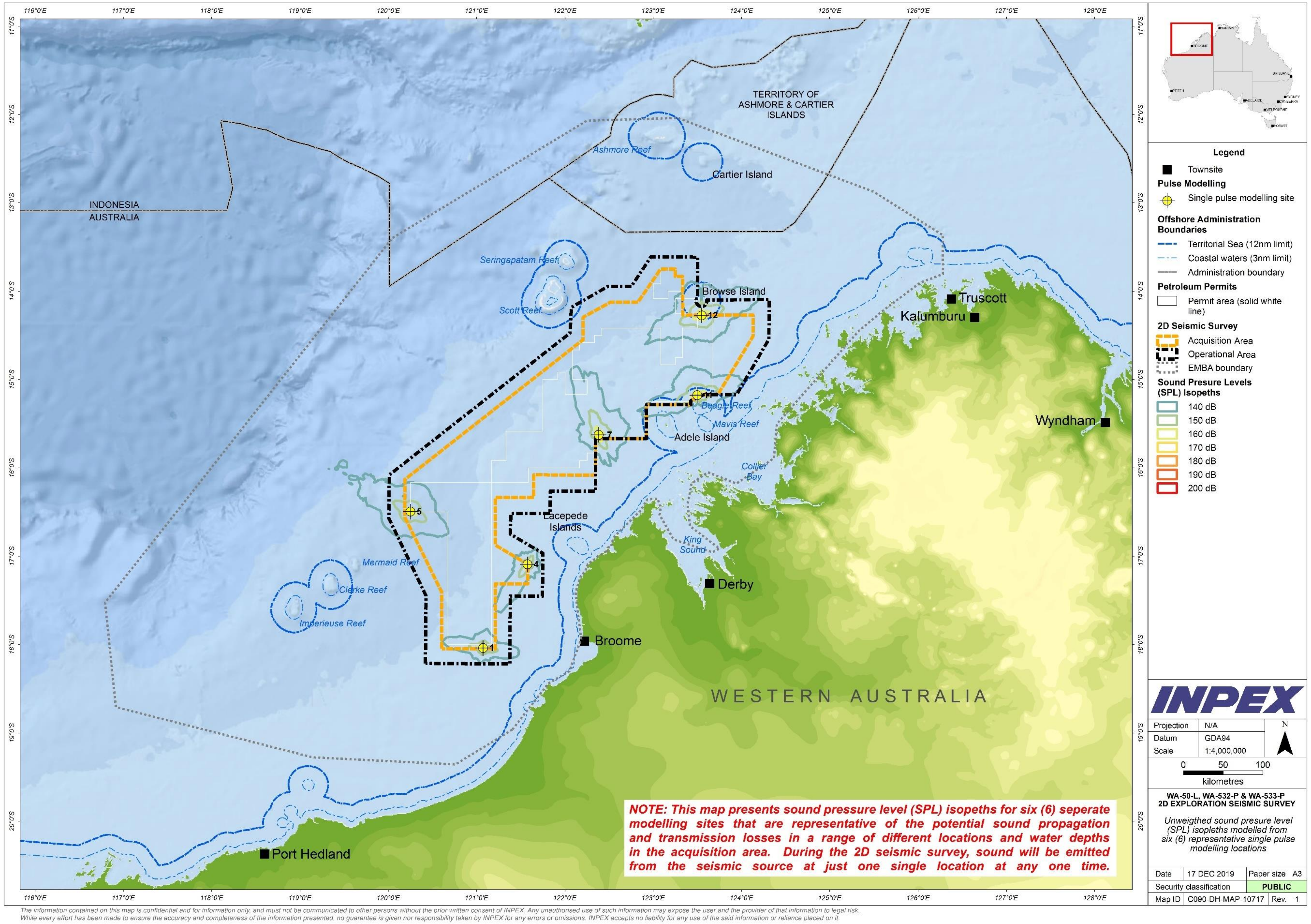


Figure 7-3 Unweighted SPL isopleths modelled from six representative single pulse modelling locations

7.1.3 Acoustic sound source verification and assurance

At the time of preparing this EP, the seismic contractor and the specific seismic source are not confirmed, but are intended to be approximately 3,000 cubic inches with a 2,000 psi firing pressure.

INPEX has evaluated three likely seismic source options and modelled the sound propagation from the worst-case seismic source option. INPEX will also implement a control measure to verify that the seismic source selected for the 2D seismic survey will have an acoustic output that is comparable to or less than the source levels assessed and deemed to be acceptable in this EP.

This is considered to be an appropriate and practicable control measure to implement to manage the potential impact and risk to all receptors exposed to the effects of underwater noise. An ALARP assessment has been undertaken of the available sound source verification options and an environmental performance standard is provided in Table 7-3.

Table 7-3: ALARP evaluation – sound source verification

Proposed sound source verification control measures (ALARP Evaluation)		
Control measure	Used?	Justification
Define the maximum source volume for the survey	No	The 2D seismic survey will be acquired using a source volume of approximately 3,000 in^3. At present, a seismic contractor has not been selected. Potential contractors have provided details of potential source volumes which vary from slightly less to slightly more than 3,000 in^3. It is not possible to commit to an exact source volume at this stage. The source levels and directivity of sound as it propagates is not determined by source volume alone. The volume and position of individual source elements within the array (the source layout and geometry) influences the source levels and the propagated sound levels. i.e. a larger source volume does not necessarily mean it is the loudest or the worst-case. Therefore, it is more meaningful to implement a control whereby the source levels of the selected seismic source will be validated against the source modelled and used for the risk assessment in this EP (see below).
Undertake acoustic source modelling to confirm that the far-field source level specifications of the seismic source selected for the 2D seismic survey are consistent with those assessed in this EP.	Yes	In the event that seismic source options considered for the 2D seismic survey have not already been evaluated in Table 7-1, INPEX will undertake source modelling using the same JASCO Airgun Array Source Model (AASM) to confirm if the source specifications are appropriate. The three sources evaluated in Table 7-1 have peak far-field source levels ranging from 247.1 to 249.6 dB re 1 $\mu Pa^2 m^2$ in the horizontal plane. Sound propagation modelling was based upon a 3,080 cubic inch source with a far-field source specification of 249.6 dB re 1 $\mu Pa^2 m^2$ in the broadside direction. The modelled seismic source was also highly directional, resulting in strong horizontal sound

Proposed sound source verification control measures (ALARP Evaluation)		
		propagation in the broadside direction and is, therefore, likely to conservatively estimate horizontal sound propagation. Predictions from JASCO's AASM and propagation models have been extensively validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally, including Australia, the United States, Canada, Greenland and Russia (e.g. Hannay & Racca 2005; Aerts et al. 2008; Funk et al. 2008; Ireland et al. 2009; O'Neill et al. 2010; Warner et al. 2010; Racca et al. 2012a, 2012b; Matthews & MacGillivray 2013; Martin et al. 2015; Racca et al. 2015; Martin et al. 2017a, 2017b; Warner et al. 2017; MacGillivray 2018; McPherson et al. 2018). The large number of measurement programs conducted by JASCO across a range of environments has allowed for a rigorous assessment of the performance of acoustic source and propagation models, and a process of continuous improvement to be in place. The models are consistently found to provide reliable predictions. A recent verification study was also undertaken by JASCO for four different seismic sources ranging up to 3,090 cubic inches in north-western Australian waters and the measured data showed good agreement with the modelling in all cases (McPherson et al. 2018). With regards to the airgun array sound source specifications, there is little to no uncertainty in the source model when the airgun array is a standard type (MacGillivray 2018; McPherson et al. 2018), as is the case for the 2D seismic survey. Therefore, if modelling of the selected seismic source confirms that it does not exceed peak source pressure levels of 250 dB re 1 μPa^2m^2 in the horizontal plane, it can be concluded that the acoustic output is consistent with the three sources already evaluated (within less than 0.5 dB) and provides reasonable confidence that propagated sound levels will be comparable to those assessed and found to be acceptable in this EP.

Proposed sound source verification control measures (ALARP Evaluation)		
In-situ sound source verification / ground-truthing measurements	No	In-situ measurement campaigns may involve either verification of source levels or ground truthing of received (i.e. propagated) levels. Sound source verification involves conducting a field measurement program which concentrates on understanding the sound source levels in order to compare and verify them against the far-field source specifications predicted by the source model. As indicated above, the JASCO AASM has already been extensively verified globally and has recently been verified in waters off north-western Australia for four different seismic sources ranging up to 3,090 cubic inches, all showing good agreement with the modelling (McPherson et al. 2018). There is little to no uncertainty when the airgun array is a standard type (MacGillivray 2018; McPherson et al. 2018), as is the case for the 2D seismic survey. Ground-truthing of received levels is highly complex and sensitive to differences in the regional environment, including sound speed profile, seabed geology and bathymetry and so requires measurements to be undertaken in the same location as the modelling or at a location with similar characteristics in order to be relevant. A reliable and meaningful comparison is also difficult without interrogation of the measured data to validate and re-run the model; inevitably, there may be circumstances where variations in environmental parameters (e.g. localised bathymetric features) may result in occasional exceedances of predicted received levels along some azimuths but may be within predicted levels at other times. However, relatively small disparities between in-situ measurements and model predictions do not necessarily equate to an increased magnitude of impact and the process of establishing meaningful acceptance criteria for any differences is a complex one. While it is possible to conduct ground-truthing of received levels (e.g. Racca et al. 2015; Bröker et al. 2015; Nowacek & Southall 2016), it is not possible to conduct ground-truthing methods in short timeframes to inform adaptive mitigation during a seismic survey.

Proposed sound source verification control measures (ALARP Evaluation)		
		The merits and limitations of different in-situ sound measurement methods are addressed in further detail in the Report of the Acoustic Ground-Truthing Technical Working Group as part of New Zealand's 2015–2016 Seismic Code of Conduct Review process (Department of Conservation 2016). The overall consensus of the technical working group was that in-situ measurements should not be required for adaptive management during all surveys, but may be applied in unique or specific circumstances. In-situ measurements can be implemented, if appropriate, to verify modelling and implement adaptive management if the model predictions, or the effectiveness of a particular control measure, or the acceptable level of impact is heavily dependent upon a high level of model precision and accuracy. Otherwise, the cost and time spent conducting the measurements is not commensurate with the level of risk. In the case of the INPEX 2D seismic survey, the proposed control measures outlined in the following sections of this EP do not rely on very high levels of model precision (e.g. tens or hundreds of metres), nor are adaptive management measures deemed necessary given the other control measures proposed. An in-situ sound source verification or received level measurement campaign would require days-to-weeks to complete in advance of the survey commencing and could potentially cost in the order of many hundreds of thousands of dollars, depending on the methods to be implemented and the vessels and time required. The potential cost and delay to the survey is disproportionate to the level of risk given the minimal environmental benefit that would be gained in the case of the 2D seismic survey. Therefore, in-situ measurements are not considered necessary or practicable.

Proposed sound source verification control measures (ALARP Evaluation)			
Environmental performance outcomes	**Environmental performance standards**	**Measurement criteria**	**Responsibility**
Operate the minimum seismic source required to meet the geophysical objectives of the survey but prevent excess sound propagation.	Prior to commencement of the INPEX 2D seismic survey, acoustic source modelling will confirm that the far-field source level specifications of the selected seismic source, as determined using JASCO's Airgun Array Source Model, do not exceed peak source pressure levels of 250 dB re 1 μPa^2m^2 in the horizontal plane.	Seismic source characteristics (source element types, volumes and x, y, z positions) to be provided by prospective seismic contractors during the contract tender and evaluation stage. Documentation demonstrates that acoustic source modelling confirms that the far-field source levels for the selected seismic source do not exceed peak source pressure levels of 250 dB re 1 μPa^2m^2 in the horizontal plane.	INPEX Exploration Project Manager

7.1.4 Underwater noise and vibration – Planktonic communities

Receptor sensitivity to sound and sound exposure thresholds

Planktonic organisms have limited or no swimming ability and are transported by currents and winds. They therefore have limited or no ability to avoid seismic sound sources.

Similar to invertebrates and a number of types of fishes; plankton, eggs and larvae will be sensitive to particle motion effects associated with rapid pressure changes at close range to the seismic source (Larson 1985; Wardle et al*.* 2011; Popper et al. 2014). Phytoplankton are mostly single-celled plant organisms that do not have hearing structures and are generally considered to have the same density as the surrounding water; so sudden pressure changes associated with seismic activity are not known to cause significant physical damage. Some zooplankton are able to sense pressure changes to some degree. Swim bladders may also develop during the larval stages of some fish species, rendering larvae susceptible to pressure-related injuries such as barotrauma (Popper et al. 2014). Data on the effects of sound upon eggs and larvae containing gas bubbles is, therefore, largely focused on barotrauma rather than actual hearing. Very few publications have considered the effects of particle motion or vibration on plankton (Popper et al. 2014).

Few studies have found significant negative impacts on zooplankton, fish eggs, larvae or fry, and most have reported that impacts occur within a few metres or tens of metres from the source (Kostyuchenko 1973; Dalen & Knutsen 1987; Holliday et al. 1987; Kosheleva 1992 cited in Parry et al*.* 2002; Pearson et al. 1994; Turnpenny & Nedwell 1994; Booman et al. 1996; Payne 2004; Payne et al. 2009). These studies included exposures to sound pressures up to approximately 242 dB re 1 µPa, comparable to those considered for the INPEX 2D seismic survey. Larval stages of fish are often perceived to be more sensitive to stressors than adult stages, but exposure to seismic sound does not appear to result in any differences in larval mortality or abundance for fishes, crabs or scallops (Carroll et al. 2017).

Kostyuchenko (1973) found up to a 17% increase in mortality of fish eggs of various species exposed to a seismic source, but no effect beyond 10 m. Kosheleva (1992, cited in Turnpenny & Nedwell 1994) also reported that eggs and larvae died within 1 m of a seismic source producing sound pressures of 220-240 dB re 1 µPa, but no injuries were reported at greater distances. Dalen and Knutsen (1987) exposed eggs, larvae and post-larval stages of cod exposed to seismic source elements with source levels of 222 – 231 dB re 1 µPa at 1 m. At ranges of 1 – 10 m from the source, some specimens indicated temporarily impaired balance following exposure but with rapid recovery. Mortality was only observed in just one of the three exposure experiments, with 90% mortality when exposed at a distance of 2 m from the seismic source, but no significant impacts at a distance of 6 m. Overall, there was no significant change in the survival of eggs.

Holliday et al. (1987) obtained mixed results during studies undertaken over a two-year period, with eggs and larvae exposed to sound pressures of 221 – 235 dB re 1 µPa at 1.5 m from a seismic source. Either no significant impact was observed or a 9% reduction in the survival of eggs. Pearson et al. (1994) reported no effects to crab larvae exposed to sound pressures up to 231 dB re 1 µPa at 1 m from a seismic source. Booman et al. (1996) exposed fish eggs and larvae to sound pressures of 220 – 242 dB re 1 µPa. High rates of mortality were observed at distances of 1.4 m from the seismic source, but low or now mortality rates at distances of 5 m.

In a review of the above studies, Payne et al*.* (2004) noted that injury and mortality to eggs and larvae is likely to be limited to within 5 m of the seismic source. Payne et al. (2009) found no statistical differences between controls and exposed larvae following exposure to mean sound pressure levels of 205 dB re 1 µPa PK-PK, positioned 0.5 m from the seismic source element.

The effects of an operating 3D seismic array on plankton were investigated by Parry et al. (2002). Vertical plankton tows (0 – 20 m depth) were taken along transects running parallel and adjacent to seismic survey lines. Plankton tows along the impact transect were made within 30–60 minutes of the seismic pass. Parry et al. (2002) found no detectable impacts on plankton based on their species composition and live/dead state but did concede that their statistical power to detect any impacts was low, requiring decreases in abundance of >30–40% for copepods and >80–90% for most other taxa.

Day et al. (2016a) found no effects on the mortality, abnormality, competency, or energy content of lobster larvae after exposure of early embryonic stages to 209-212 dB re 1μPa PK-PK. Pearson et al. (1994) exposed crab larvae to single pulses from a seismic source array. For immediate and long-term survival and time to moult, this study did not reveal any statistically significant differences between the exposed and unexposed larvae, even those exposed within 1 m of the seismic source.

Impacts to larvae have been identified following intense and lengthy periods of exposure to low-frequency sound. Tank experiments by Aguilar de Soto et al. (2013) showed evidence of morphological abnormalities in early stage scallop larvae from simulated seismic signals. However, the lengthy exposure period of 3 second pulse intervals for an exposure duration of 90 hours and at 1 m distance from sound source is not realistic of an actual survey. Christian et al. (2003) found major developmental differences between control and treatment groups of snow crab eggs exposed to a peak pressure level of 216 dB re 1 μPa every 10 seconds for 33 minutes. Again, the exposure to a constant peak pressure level for a prolonged period is not realistic of an actual survey where the source is moving and so does not remain in one place.

Hawkins (2014) used continuous sonar to record zooplankton layers, comprising copepods, cladocerans, decapod larvae, gastropod larvae and bivalve larvae, exposed to playback of pile driving sound (pile driving sound typically has a more rapid rise time, more frequent strike rates and therefore a greater sound exposure regime than a seismic survey). Zooplankton layers responded to sound by showing a 'dent' in the top of the layer at the onset of the sound sequence, although the change in depth often did not persist for the whole duration of the sound exposure and zooplankton distribution quickly returned to normal.

Therefore, physical impacts to planktonic organisms have typically been found to be limited to within approximately 10 m of the seismic source. Using this 10 m impact range, a study by McCauley (1994) calculated the impact in a seismic survey area, assuming plankton mortality of 100% within 10 m of a seismic source. This suggested that the total mortality due to seismic testing would impact less than 1% of plankton in the survey area. DNV Energy (2007) and Hawkins & Popper (2012) conducted comprehensive reviews of a number of scientific studies, including those by Kostyuchenko (1973), Dalen & Knutsen (1987), Booman et al. (1996) and Saetre & Ona (1996); the effects of seismic activities on eggs and larvae were predicted to result in average and worst-case mortality rates of 0.0012% and 0.45% per day respectively, which were not deemed significant when compared to a natural mortality rate of 5-15% per day, as applicable to most species during early life stages.

Based on the available data, Popper et al. (2014) proposed a precautionary threshold for mortality of fish eggs and larvae of >207 dB re 1 μPa PK, which the authors note is likely to be conservative.

However, a study by McCauley et al. (2017) received notable media attention for suggesting the potential for zooplankton mortality to increase two- to three-fold out to a distance of 1.2 km from a single seismic source element, with an estimated decline in zooplankton abundance of up to 64% and a "hole" in the zooplankton backscatter observed via acoustic detection methods. The 1.2 km range corresponded with pressure levels of

178 dB re 1 µPa PK-PK (McCauley et al. 2017). However, the extent of such impacts are inconsistent with previously documented effects to plankton.

The authors highlight some limitations to the findings of this research that have raised further questions from industry and the scientific community (e.g. Richardson et al. 2017; IAGC 2017) and a need for the study to be replicated before conclusions regarding effects to zooplankton can be made, particularly in relation to the following:

- There was no evidence of attenuation of impacts with distance from the source with no consistent decline in the proportion of zooplankton that were killed with increasing distance from the source.
- Sonar backscatter data indicated an immediate decline in zooplankton abundance (the "hole" in the data). However, if the zooplankton had been killed, they would not have sunk from the surface layers of the water column immediately, suggesting that some zooplankton may have moved, or they may have simply reorientated themselves to the sonar in response to the seismic pulses, which raises questions over the occurrence, magnitude and extent of mortal impacts.
- The study was based on a relatively small number of tow samples on two separate days. On the second day, even before the use of the seismic source element, the zooplankton net tow abundance counts were significantly lower than the first day and, therefore, it is difficult to draw reliable conclusions from this data. On the second day almost all values at 80 metres range presented greater plankton abundance from exposed samples and lower abundance of control samples, indicative of a potential flaw in the sampling scheme and analysis protocol.

Further research, including duplication of the McCauley et al. (2017) experiments, is therefore proposed by industry to explore these matters further, but is yet to be completed.

A recent study by Fields et al. (2019) exposed zooplankton (copepods) to seismic pulses at various distances up to 25 m from a seismic source. The source levels produced were estimated to be 221 dB re 1 µPa^2.s SEL and comparable to the far-field source levels predicted for the source options being considered for the INPEX 2D seismic survey (which range between approximately 222 and 225 221 dB re 1 µPa^2.s SEL in the horizontal plane). The study observed an increase in immediate mortality rates of up to 30% of copepods in samples compared to controls at distances of 5 m or less from the airguns. Mortality one week after exposure was significantly higher by 9% relative to controls in the copepods placed 10 m from the airguns. Fields et al. (2019) also reported that no sublethal effects occurred at any distance greater than 5 m from the seismic source. The findings of the study are consistent with numerous other field studies, as referenced previously, indicating that the potential effects of seismic pulses to zooplankton are limited to within approximately 10 m from the seismic source. Fields et al. (2019) note that the findings of the McCauley et al. (2017) study are difficult to reconcile with the body of other available research. The findings of the McCauley et al. (2017) study may, therefore, provide an overly conservative estimate of the potential effects of seismic pulses to zooplankton.

While research generally suggests limited impacts to plankton beyond approximately 10 m distance from seismic sources, the precautionary Popper et al. (2014) threshold for larval mortality of >207 dB PK has been selected to indicate the magnitude and extent of potential impacts from the INPEX 2D seismic survey. The research by McCauley et al. (2017) is also discussed in the assessment of impacts and risks in this EP, in order to address any scientific uncertainty and provide another level of conservatism.

Table 7-4: Impact and risk evaluation – underwater noise and vibration – planktonic communities

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">Impulsive sound emitted from the seismic source has the potential to result in the mortality or physical impairment of plankton, including eggs and larvae. If changes to planktonic communities are extensive, they may indirectly affect higher trophic level species such as invertebrates, fishes and marine mammals that target plankton as a food source or result in potential impacts to the eggs and larvae of various organisms, which could in turn impact recruitment.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>Summary of receptors

Planktonic communities comprise phytoplankton and zooplankton, including fish eggs and larvae. Phytoplankton and zooplankton are a source of primary and secondary productivity, and key food sources for other organisms in the oceans. Phytoplankton and zooplankton abundance in the continental shelf waters of the NWMR is highly variable. Higher phytoplankton concentrations generally occur in the Kimberley region during the winter months (June to August) and in water depths less than 100 m. Between spring and autumn (September to May), phytoplankton concentrations are reduced and more variable, with the areas of greatest productivity associated with nearshore continental shelf waters of approximately 50 - 70 m depth or less, where there is the greatest mixing of waters (Hayes et al. 2005; Brewer et al. 2007; Thompson & Bonham 2011; Parks Australia 2018h). Localised upwelling and mixing also occur around reefs and islands in the region, including Browse Island and Scott Reef (DEWHA 2008b). Zooplankton abundance in the Kimberley region has also been found to be highest in coastal waters and within the 50 m depth contour, associated with the areas of greater phytoplankton biomass, and decreases offshore (Gibbons & Hutchings 1996; Holliday et al. 2011).

The spawning of fishes and invertebrates throughout the region also contributes to the biomass of planktonic communities in the waters of the NWMR. Eggs and larvae may be dispersed in their millions throughout the water column and throughout the region, playing an important role in species recruitment. Fish larvae concentrations are greatest in inner shelf waters less than 50 m water depth, although the larvae of commercially significant fishes may occur within the water column across the continental shelf and beyond the continental shelf break (Section 4.7.4).

Evaluation of potential consequence

Potential impacts and risks to plankton are generally understood to be limited and highly localised (see above). Applying the likely-precautionary impact thresholds proposed by Popper et al. (2014), the acoustic modelling</td><td>Insignificant (F)</td></tr>
</table>

undertaken by JASCO (McPherson et al. 2019; Appendix D) for the 2D seismic survey indicates that potential for mortality to eggs and larvae could occur within approximately 160 – 230 m from the seismic source, depending on location and water depth. The magnitude of such localised impacts is negligible and is not expected to be discernible at the regional scale when considering the large natural spatial and temporal variability and scale of plankton and spawning biomass in the NWMR. In particular, phytoplankton and zooplankton biomass in the oceans can vary significantly at spatial scales ranging from hundreds of metres to hundreds of kilometres and temporal scales of hours, days, seasons and inter-annually, due to tidal and large scale currents, bathymetry, temperature, salinity, water chemistry parameters and other environmental factors (Gibbons & Hutchings 1996; Holliday et al. 2011; McKinnon et al. 2008; Pearce et al. 2000; Sutton & Beckley 2017). The natural life span, growth, reproduction and mortality rates are important factors that influence this natural variability. Copepods have been found to comprise up to 75 – 85 % of zooplankton communities in the continental shelf waters of the Kimberley region, with chaetognaths, euphausiids and cladocerans also common in tropical Australian waters (Timms 1988; Holliday et al. 2011; McKinnon et al. 2015, Richardson et al. 2017). Information on life spans in the open ocean is limited, but under favourable conditions in tropical and sub-tropical environments these common zooplankton taxa have lifespans in the order of a few weeks and sometimes to several months, during which reproduction occurs frequently (Hawkins 1962; Gómez-Gutierrez et al. 1995; Delbare et al*.* 1996; Yamaguchi & Ikeda 2000; Pietrzak et al*.* 2013; Terazaki et al*.* 2013; Escribano et al*.* 2013; Tang et al. 2014). The embryonic and pelagic larval durations of numerous broadcast spawning fish species typical of the Kimberley region is in the order of days to weeks, for example tropical snappers and emperors such as red emperor, goldband snapper and stripey snapper have a planktonic phase of approximately 30-40 days prior to settlement on suitable habitat, with regular replenishment from multiple spawning events in a season (Stobutzki & Bellwood 1997; Zapata & Herrón 2002; DiBattista et al*.* 2017). However, due to environmental factors such as predation, food availability, and water temperature, the life spans of zooplankton are often significantly shorter and natural mortality rates can be high. In a review of natural mortality estimates by Houde & Zastrow (1993), the mean mortality rate for marine fish larvae was estimated to be 21.3% per day. Saetre & Ona (1996) estimated 5-15% zooplankton mortality per day based on available research. Richardson et al. (2017) determined a natural mortality rate of 19% per day, derived from data in McCauley et al. (2017). Tang et al. (2014) reported mortality rates of 11.6% (average minimum) to 59.8% (average maximum) in marine environments based on a review of available research, and in some instances 100% of samples were found to die within a day. These mortalities are only partly the result of predation; non-predatory factors have been estimated to account for 25% to 33% of the total mortality	

among marine copepods on average (and higher in some instances) (Hirst & Kiørboe 2002; Tang et al. 2014; Dubovskaya et al. 2015). Given the level of natural variability in planktonic communities, the effect of the seismic source is expected to be negligible. The seismic source will be transient (i.e. continually moving across the Acquisition Area) and, if operation of the seismic source coincides with areas of increased plankton or larvae biomass, the extent of potential mortality (up to 160 – 230 m) is minimal. However, the study by McCauley et al. (2017) implies that the extent of impacts to plankton, eggs and larvae could be significantly greater than the 160 – 230 m ranges indicated by the application of the Popper et al. (2014) threshold. Impacts to zooplankton in the McCauley et al. (2017) study corresponded with a sound pressure of just 178 dB re 1 µPa PK-PK. Using this value, the modelling indicates that mortality could occur within approximately 8 – 12 km (R_{max}) from the seismic source, which is highly unrealistic given the physiology and limited sensitivity of plankton, eggs and larvae. Even so, to apply a precautionary approach to this assessment, the McCauley et al. (2017) results are discussed, but it is important to put these distances and impacts into a real-world context. A study by the Commonwealth Scientific and Industrial Research Organisation (CSIRO; Richardson et al. 2017) estimated the spatial and temporal impact of seismic activity on zooplankton biomass on the Northwest Shelf from a large-scale 3D seismic survey, considering the mortality estimates in McCauley et al. (2017) study while also accounting for typical growth rates, natural mortality rates, and the ocean circulation in the region. Richardson et al. (2017) took into account that the seismic source and associated impact radii for zooplankton would be constantly moving across the survey area, and would not return along a parallel line for several hours, during which time the movement of zooplankton with currents would have introduced new zooplankton to the survey area, while any "holes" would move down current and also gradually become re-populated by zooplankton from non-impacted areas. The results of the simulations showed that the impact of the seismic survey on zooplankton biomass was greatest in the immediate vicinity of the survey area where 22% of the zooplankton biomass was removed. Further, it was predicted that a reduction of 14% and 2% in zooplankton biomass would occur at distances of 15 km and 150 km from the survey area, respectively. Relative to the natural mortality rates described above, impacts do occur but the reduction in plankton biomass is limited and is likely to be within natural variation. For example, the natural mortality rate of 19% plus the 22% reduction observed to occur in the immediate vicinity of the survey area (41%) is still within the 5 – 60% range of natural mortality rates observed in other studies. Taking into account natural recovery and recruitment rates, the time to recovery within 15 km of the survey area was predicted to be approximately three days after the end of the survey (Richardson et al. 2017). This	

relatively quick recovery was due to the fast growth rates of zooplankton, and the dispersal and mixing of zooplankton from both inside and outside of the impacted region (Richardson et al. 2017). Richardson et al. (2017) also observed that zooplankton biomass generally showed a decline within the survey area until Day 22 of the simulations, and then increased relatively until the end of the simulated survey on Day 36; this reflects the movement of water through the survey area and the recovery of the zooplankton biomass as it moves into non-impacted areas, which indicates that beyond ~22 days, the duration of a seismic survey may not contribute any additional change in overall biomass in the region relative to natural mortality rates and rates of recovery. The main finding of the CSIRO study (Richardson et al. 2017) was there was a significant impact from seismic activity to zooplankton populations on a local scale only, but on a regional scale the impacts were minimal and were not discernible over the NWMR. This is important given that the distribution of planktonic communities and the spawning of fish stocks in these continental shelf waters typically occurs on a regional scale. It is also important to note that the example modelled by Richardson et al. (2017) was a 3D seismic survey covering an area of 80 km x 36 km with adjacent acquisition lines spaced 600 m apart, therefore resulting in the seismic source remaining in the same area and passing along a parallel line approximately every 8 – 10 hours. The repeated exposures to zooplankton populations within the survey area gradually resulted in the reduced biomass observed around the survey area. By comparison, the INPEX 2D seismic survey will comprise orthogonal lines over a significantly larger area than the 3D seismic survey scenario considered by Richardson et al. (2017), spaced a much greater distance apart (approximately 3-6 km line spacing) and in some cases extending greater than 100 km in length. Given this, the seismic source may not operate within the same area again for one or two days, and in some instances, potentially many days after. Therefore, zooplankton populations generally won't experience repeated exposures to the seismic source, with impacted areas becoming repopulated with plankton brought by currents from non-impacted areas, and from the reproduction of zooplankton and larvae. Any reduction in plankton biomass as a result of the 2D seismic survey is likely to be incidental and at lower levels than the reductions predicted for 3D seismic survey scenario modelled by Richardson et al. (2017). Therefore, even adopting a highly precautionary sound exposure threshold and the impact ranges inferred by the McCauley et al. (2017) study, impacts on plankton biomass will be only be discernible locally. Impacts are expected to be insignificant at a regional scale relative to the natural spatial and temporal variability in plankton abundance, and the very high rates of natural mortality. Impacts to zooplankton as a food resource for other species is also expected to be localised and short-term. Even after plankton die, their carcasses remain in the water column for several days where they are scavenged before any remaining carcasses sink to the seafloor to be consumed by opportunistic benthic organisms (Kirillin et al. 2012; Tang et al. 2014; Dubovskaya et al. 2015). Therefore, zooplankton are still available as a food	

source for other organisms after they die. Notably, the areas of greatest primary and secondary productivity in the region are located nearshore in water depths less than approximately 50 – 70 m as well as around oceanic reefs and islands, which the survey Acquisition Area mostly avoids. Productivity is greater in the winter months (June to August), evident on the continental shelf in water depths up to approximately 100 m; however, as described in Section 7.1.7, the 2D seismic survey will not occur during the months of June to October to avoid impacts to humpback whale calving aggregations. Therefore, with regards to planktonic communities the survey will completely avoid the most productive areas and months of the year.

In terms of the potential indirect impacts to the recruitment of fishes and invertebrates, various species spawn and release eggs on the continental shelf at various times throughout the year. These life stage events typically occur at a regional or sub-regional scale and over many months, with individuals spawning regularly throughout their respective spawning seasons and releasing millions of eggs each season (Section 4.7.4). The most abundant fish larvae concentrations occur in inner-shelf waters up to approximately 50 m water depth, with concentrations decreasing with distance offshore (Holliday et al. 2011). Connectivity between some nearshore fish species in the Kimberley can be limited to closed demographic units on small spatial scales (within a few kilometres), whereas others may remain connected over hundreds of kilometres (DiBattista et al. 2017). The Acquisition Area avoids these nearshore areas and mostly avoids areas shallower than 50 m, although there is some overlap in the shallowest parts of the Acquisition Area (e.g. Lynher Bank and parts of the Leveque Rise to the west of Cape Leveque).

Commercially significant fish larvae occur across the continental shelf and in the deeper waters beyond the continental shelf break (Holliday et al. 2011). Many of these species (i.e. demersal snapper, emperor, rock cods and groupers, and pelagic tuna, billfish and mackerel) show evidence of biological connectivity and stock recruitment over hundreds and even thousands of kilometres, and in some cases across northern Australia (Section 4.7.4). It is acknowledged that some commercially important fish stocks are understood to be more constrained geographically, but they are not expected to be significantly impacted either. For example, goldband snapper is a key demersal species targeted in the region that may have geographically distinct genetic stocks in different parts of the NWMR. The Kimberley stock of goldband snapper is potentially a distinct genetic stock extending from the Timor Sea to at least 122^{0}E (Lynher Bank). There is evidence that there is only limited genetic connectivity between goldband snapper in the Kimberley and goldband snapper in other locations (e.g. Timor Sea and the Pilbara) (Lloyd et al. 2000; Newman et al. 2000; Ovenden et al. 2002). However, goldband snapper spawns throughout its range along the outer continental shelf (principally 80-150 m), releasing numerous batches of pelagic eggs into the water column over several months (Lloyd 2006; Newman et al. 2008). Spawning of the Kimberley stock occurs across several hundred kilometres of continental shelf; therefore, fish stock recruitment is not expected to be significantly impacted as a result of

localised mortalities associated with the transient seismic source; especially when compared with mortalities from other natural causes that will occur ubiquitously across the entire region. As with impacts to other zooplankton, impacts to the eggs and larvae of the various fish stocks over the distances and timeframes associated with spawning events are not expected to be significant at a regional level. Some localised mortality to eggs and larvae may occur as the seismic source transits across the Acquisition Area, but this is unlikely to be discernible from the natural variability in mortality rates, such as from predation and other environmental factors. Therefore, no discernible impacts on larval populations and fish stock recruitment are expected. Impacts to key commercial fish species, including impacts to spawning fishes, are assessed in more detail in Section 7.1.6. Commercially targeted prawns spawn in nursery grounds located in shallow embayments along the Kimberley coast, including in and around Roebuck Bay, Collier Bay, York Sound and Admiralty Gulf. Given these locations are many tens of kilometres from the Acquisition Area, no impacts to larvae and recruitment are expected. Other commercially significant invertebrate species in the region include pearl oysters and trochus in nearshore waters. Due to limited connectivity between stocks in nearshore waters and the offshore waters overlapped by the Acquisition Area, no significant impacts are expected. Impacts to pearl oysters and trochus are assessed further in Section 7.2.3. Coral larval dispersal and recruitment occurs locally and is generally limited to within less than a few kilometres to a few tens of kilometres from natal reef patches (Gilmour et al. 2011; Underwood et al. 2009; Underwood et al. 2017; Cook et al. 2017). Therefore, the offshore reefs in the region are generally sustained through self-recruitment. At the closest point, the Acquisition Area is located several kilometres from the nearest coral reefs at Browse Island, Adele Island and Beagle Reef and so no impact to larval dispersal, connectivity and recruitment is expected. Overall, potential impacts to planktonic communities are expected to be localised and temporary. Most scientific studies indicate that plankton will only be impacted within tens of metres of the seismic source; however, the assessment of impacts and risks has also considered highly conservative estimates of potential impacts over several kilometres from the seismic source. Even at these ranges, impacts are expected to be insignificant at a regional scale relative to the natural spatial and temporal variability in plankton abundance and the very high rates of natural mortality. The short life cycle and rapid turnover of many zooplankton also means there is potential for subsequent recruitment and rapid recovery. No long-term population or community level impacts are expected. As such, the consequence of seismic source exposure to planktonic communities is considered to be Insignificant (F).	

Identify existing design and safeguards/controls measures
The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3). INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.

Propose additional safeguards/control measures (ALARP Evaluation)

Hierarchy of control	Control measure	Used?	Justification
Elimination	None identified	No	The 2D seismic survey cannot be achieved without using a seismic source. Elimination of the seismic source is not possible.
Substitution	None identified	N/A	No additional substitution controls were identified that would practicably reduce the risk to planktonic communities.
Engineering	Design the 2D seismic survey so that lines are only acquired perpendicular to the prevailing current direction	No	As identified by Richardson et al. (2017), surveys conducted into or across the prevailing current direction are theoretically less likely to impact the same zooplankton populations multiple times. Impacts to zooplankton are greater when ocean circulation carries zooplankton in the same direction that a seismic survey is acquired, as the zooplankton will be exposed multiple times to the seismic source. The prevailing currents relevant to the Operational Area show seasonal variation, with the Holloway current interacting with the Indonesian Throughflow Current, resulting in north-easterly flow during the summer monsoon season and south-westerly flow during the winter dry season. However, wind shear also influences the

			direction of currents in the upper water column. Therefore, the current direction is likely to vary considerably during the survey. Attempting to design and acquire the survey into or across the prevailing current direction is not possible. In particular, the 2D seismic survey will be acquired along a grid of orthogonal lines and it is therefore inevitable that some lines will be broadly aligned with the currents in at least one direction. The costs and complexity of attempting to implement this option are grossly disproportionate and highly impracticable when compared to the low level of risk posed by the survey to planktonic communities.
Procedures & administration	Limit seismic acquisition to daylight hours only	No	As identified by Richardson et al. (2017), conducting survey activities during the day rather than the night may minimise impacts on zooplankton. This is because zooplankton migrate vertically in the water column to balance food intake and predation risks, and are generally found at greater depths during the day. Therefore, fewer zooplankton may occur near the surface during the day than at night. Although some vertical attenuation of sound with depth beneath seismic sources does occur, sound pressure levels near the seismic source will only be slightly reduced over the depth ranges that zooplankton migrate in the vertical plane (in the order of 10–100 m) and so limited differences in received sound pressure levels and ranges to impact are expected. Such a control would also add major scheduling constraints, potentially doubling the overall survey duration. The costs of implementing this, as well as the increased potential for other impacts and risks as a result of the extended survey duration, is grossly disproportionate when compared to the

			already low level of risk to planktonic communities. This option is not practicable.

Identify the likelihood

Research into the effects of seismic on planktonic communities generally indicates impact may occur within a few metres or a few tens of metres from the seismic source. The assessment of consequence to planktonic communities assumes more conservative ranges to impact over hundreds of metres to several kilometres from the seismic source. Impacts to planktonic communities over these ranges is unlikely, but the likelihood of the Insignificant consequences occurring is conservatively ranked as Possible (3).

Residual risk summary

Based on a consequence of Insignificant (F) and a worst-case likelihood of Possible (3) the residual risk is Low (8).

Consequence	Likelihood	Residual risk
Insignificant (F)	Possible (3)	Low (8)

Assess residual risk acceptability

Legislative requirements

N/A – There are no specific legislative requirements applicable to managing the effects of seismic surveys in relation to planktonic communities.

Stakeholder consultation

Feedback was received by the WA DPIRD, WAFIC and fisheries licence holders (Table 5-4) highlighting the concerns of the fishing industry about the potential impacts of seismic to plankton and secondary impacts to the food chain for commercially targeted fishes and invertebrate species. These concerns have been considered in this EP through the demonstration that impacts will be managed to ALARP and acceptable levels.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts are expected to occur to the planktonic communities that forms part of the ecosystem value of the Kimberley AMP.

- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. No survey activities will occur in the Habitat Protection Zone, and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. No survey activities will occur in the National Park Zone, and the ecosystems, habitats and native species within the National Park Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. However, none of the recovery plans or conservation advice documents are specifically relevant to the effects of seismic or other anthropogenic noise on planktonic communities. Instead, INPEX has considered Department of Fisheries (2013) guidance and WA DPIRD’s recently published ecological risk assessment of seismic impacts to marine finfish and invertebrates (Webster et al. 2018) during this assessment.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond the existing design can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;

• the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values; • the activity is managed in a manner that is consistent with the intent of conservation management documents; • the activity does not compromise the relevant principles of ESD; and • the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as “Low”, the consequence does not exceed “C – Significant” and the risk has been reduced to ALARP.

Environmental performance outcomes	**Environmental performance standards**	**Measurement criteria**	**Responsibility**
N/A no controls identified			

7.1.5 Underwater noise and vibration – Benthic communities

Receptor sensitivity to sound and sound exposure thresholds

Marine invertebrates, and particularly fixed or sessile organisms, generally have far lower mobility than pelagic vertebrates, and are often limited to particular habitats. As such, they generally have less ability to avoid an approaching seismic sound source. However, marine invertebrates are generally considered to have limited sensitivity to sound. Marine invertebrates lack a gas-filled bladder and are unable to detect the pressure component of sound waves (Parry & Gason 2006; Carroll et al. 2017) or "hear" sound in the way that mammals and fish are able to. Instead, invertebrates detect sound by sensing the particle motion component of sound in water and seabed sediments through physiological structures such as sensory hairs, statocysts and muscles, and therefore detect sound at close range (McCauley 1994; Parry & Gason 2006; André et al. 2016; Roberts et al. 2016; Edmonds et al. 2016; Carroll et al. 2017; Popper & Hawkins 2018). Statocysts, found in a wide range of invertebrates, are utilised by animals to maintain their orientation, direct their movements through the water and may play a key role in controlling the behaviour responses of invertebrates to a wide range of stimuli. Although directly sensitive to particle motion and not to sound pressure, most available research on seismic impacts to invertebrates characterises received sound levels in terms of the sound pressure.

A range of physiological responses have been identified in some studies; however, the received sound levels are typically at levels that would be received within tens or a few hundred metres from the sound source or have been from repeated exposure at the same sound levels, which is not typical of an actual seismic survey (Carroll et al. 2017; Edmonds et al. 2016; Salgado Kent et al. 2016; Webster et al. 2018).

Published exposure criteria do not currently exist for acoustic impacts to invertebrates but the available literature provides an indication of the sound levels and distances within which impacts may occur.

Crustaceans

Crustaceans (including crabs, shrimps, prawns and scampi) detect sound vibrations at close range through their statocysts. Research on the effects of seismic sound has been undertaken on a number of different crab and lobster species, both in Australia and internationally, and outcomes of key studies are summarised below.

A pilot study on snow crabs (Christian et al. 2003) exposed captive adult male crabs and egg-bearing female crabs to approximately 197–237 dB re 1 µPa PK-PK and SELs of <130–187 dB re 1 μPa^2.s. The crabs were exposed to 200 pulses over a 33-minute period. No acute or chronic (12 weeks post-exposure) mortality impacts were observed in the adult crabs. Stress indicators in the snow crabs also showed no evidence of significant acute or chronic impacts. The crabs also did not exhibit any overt startle response during the exposure period or avoidance of the area following exposure.

DFO (2004) also exposed caged egg-bearing crabs to 132 hours of impulses from a seismic survey with maximum received sound levels of approximately 190 dB re 1 µPa PK. Neither acute nor chronic lethal or sub-lethal injury to the female crabs or crab embryos were observed up to five months following exposure.

Payne et al. (2007) conducted a pilot study of the effects of exposure to seismic sound on various health indicators of American lobster. Adult lobsters were exposed at approximately 2 m range from a seismic source for either 20 or 200 times to average pressures of 202 dB re 1µPa PK-PK or 50 times to 227 dB re 1µPa PK-PK, and then monitored over several months for changes to survival, food consumption, turnover rate, and serum biochemistry. No immediate or delayed mortality was observed, nor damage to mechano-sensory systems and the ability of lobsters to right themselves when turned over.

There was evidence of a decrease in serum enzymes and increases in food consumption in the weeks to months post exposure, which may indicate stress effects or potential osmo-regulatory disturbance. The results therefore indicate the potential for sub-lethal effects but there were no obvious impacts to long-term survival and, therefore, limited ecological implications. Payne et al. (2008) did not observe any startle responses in aquarium experiments with lobsters and shrimp exposed to approximately 200 dB re 1µPa PK-PK.

Robert & Elliot (2017) reviewed research on particle motion effects to invertebrates, specifically vibration in the seabed, noting studies on particle motion reception in crustaceans, including Goodall et al. (1990) who studied the response threshold of Norwegian scampi *Nephrops norvegicus* to acoustic stimuli. It was found that the source of the vibration had to be <1 m away (in the acoustic near field) to initiate a response, confirming that the subjects were detecting particle motion, greater in the near field, rather than pressure. Distinct and reliable responses were exhibited in both the laboratory and the field in response to certain stimuli at low frequencies of 20–200 Hz and ground accelerations of 0.01 – 1.4 m/s^2. The sensitivity of the receptor systems in crustaceans has been noted to be much less compared to fish (up to 10^5 times lower in terms of particle velocity) (Goodall et al. 1990; Fay & Simmons 1998).

Research undertaken by Day et al*.* (2016a, 2016b) over three years in Australian waters, exposed captive southern rock lobster *Jasus edwardsii* to multiple passes of a seismic source element in 10-12 m water depths. Maximum received sound exposures were 209-212 dB re 1µPa PK-PK, 186 to 190 dB re 1 µPa^2.s per-pulse SEL, and SEL_{cum} of 192 to 199 dB re 1µPa^2.s. Exposed lobsters and control lobsters were sampled up to a year post-exposure. The findings of the study are as follows:

- Exposure to seismic sound did not result in any mortalities to adult lobsters.
- The condition or development of eggs carried by female lobsters at the time of exposure, even at close proximity directly beneath the seismic source, were not affected.
- Some potential sub-lethal changes in adult lobsters were observed, including some long-term impairment to lobsters’ statocysts, which was also linked to a short delay in the lobsters’ ability to right themselves when upturned.
- Haemocyte count (indicative of immune response function) also showed some evidence of decline over time.

The significance of the seismic exposures and whether the sub-lethal effects may have wider ecological implications (e.g. ability to feed, avoid predators and resist disease) warrants further consideration. Day et al. (2016a, 2016b) reported that some of the control lobsters used in the experiments were collected from a marine reserve and were found to have a high level of pre-existing impairment to statocysts similar to that induced by the seismic exposure experiments. This statocyst impairment was considered to be the result of long-term exposure to shipping noise. Some experiments showed no significant differences in righting times between control and exposed lobsters, while in some instances the control lobsters demonstrated slower righting times than exposed lobsters. Lobsters with pre-existing statocyst impairment demonstrated the fastest righting times of all experiments, which Day et al*.* (2016a, 2016b) suggested may indicate that lobsters are able to adapt or compensate for long-term statocyst impairment. Therefore, the level of statocyst impairment resulting from seismic exposure is not clear. Monitoring of the lobster population at the same reserve where the lobsters with pre-existing statocyst impairment were taken from showed that the rock lobster population within the reserve was thriving and at carrying capacity (Green & Gardner 2009; Kordjazi et al*.* 2015). Therefore, the levels of statocyst impairment reported in the Day et al. (2016a, 2016b) study appear not to be impacting on the survival of the lobster population. Therefore, any population-level survivability effects from statocyst impairment are not significant and wider ecological implications are likely to be negligible.

The implications of the reduced haemocyte counts reported by Day et al. (2016a, 2016b) as an indicator for immune function are difficult to predict. It is noted that haemocyte counts in some lobsters in the experiment recovered to double the number of haemocytes observed in control lobsters at 365 days post-exposure, which may indicate possible recovery of immune function in response to pathogens. Other research has shown considerable variation in crustacean haemocyte counts in response to changes in environmental parameters such as salinity, temperature, dissolved oxygen, water quality and bacteria (Verghese et al. 2007; Phillips 2008; Leema et al. 2010), nutritional status (Pascuel et al. 2006), sickness (Fotedar & Evans 2011; Sequeira et al. 1996), and other anthropogenic sound such as vessel noise (Celi et al. 2014; Filiciotto et al. 2014). Chandrapavan et al. (2011) observed decreases in haemocyte levels in lobsters of between approximately 57% to 72% during their natural moult cycle, which are proportionally comparable or higher than the 23% to 60% decreases reported by Day et al. (2016a). Jussila et al. (1997) found that the stress of fishing, capture, handling and transporting live lobsters increased haemocyte counts by 200% in the short-term and then led to a decline of up to 55%. Therefore, while the physiological changes observed by Day et al. (2016a, 2016b) as a result of seismic exposures are linked to immune function and stress response, the changes are likely within the range of variation that can occur from a range of other common natural and anthropogenic stressors, which generally do not affect survival.

Molluscs and echinoderms

Molluscs include benthic invertebrates such as marine bivalves (e.g. scallops, oysters, mussels and clams) and gastropods (e.g. sea snails/trochus, sea slugs and nudibranchs). Echinoderms include feather stars, sea stars, brittle stars, sea urchins and sea cucumbers. Like crustaceans, the mechanism of impacts for molluscs and echinoderms are unlikely to be from sound pressure, but rather from particle motion. The physiology and sensory structures of different marine bivalves and echinoderms is similar and so results of studies on the effects of seismic are considered to be broadly representative for species other than those studied.

Wardle et al. (2001) monitored molluscs and echinoderms on a shallow water reef exposed to seismic sound with peak sound pressure levels of 218, 210 and 195 dB re 1 µPa at distances of 5 m, 16 m and 109 m respectively. Video observations made over two weeks indicated that the sound did not result in invertebrates moving away from the reef and there was little effect on their day-to-day behaviour.

Kosheleva (1992; cited in Parry & Gason 2006) identified no detectable effects to marine bivalves and gastropods (mussels and periwinkles) after exposure to a single seismic source element of source level 233 dB re 1µPa at a distance of 0.5 m or greater from the source. Conversely, Matishov (1992; cited in Parry & Gason 2006) reported a single scallop shell splitting in a sample of three scallops, but this was located 2 m beneath a seismic source element and therefore exposed to maximum sources levels, which would not occur during the INPEX 2D seismic survey.

Recent Australian studies (Przeslawski et al. 2016, 2018; Day et al. 2016b, 2017) have focussed on commercial scallops (*Pecten fumatus*). Przeslawski et al. (2016, 2018) examined the short-term impacts on scallops and other marine invertebrates from a 2,530 cubic inch seismic array and found no evidence of mortality or change in condition following exposure to a seismic survey. Analysis of images and samples revealed some site-specific differences in scallop abundance, size, condition and assemblages, but these were not related to seismic operations.

Day et al. (2016b, 2017) exposed scallops to maximum received sound exposures of up to 213 dB re 1µPa PK-PK, 181 to 188 dB re 1 µPa^2.s per-pulse SEL, and SEL_{cum} of 188 to 198 dB re 1µPa^2.s. The study also predicted ground acceleration of up to 37.57 m/s^2. Day et al. (2016b, 2017) concluded that exposures did not result in any immediate mass mortalities, however, repeated exposures resulted in a chronic increase in mortality over timeframes of approximately four months post-exposure, though not beyond naturally occurring rates of mortality. Separate experiments undertaken in 2013 and 2014 yielded mortalities of 3.6-3.8% in control scallops (no seismic exposure), 9.4-11.3% mortality in scallops exposed to a single pass of the seismic source, 11.3-16.1% mortality in scallops exposed to two passes of the seismic source, and 14.8-17.5% mortality in scallops exposed to four passes of the seismic source. The mortality rates were at the low end of the range of naturally occurring mortality rates documented in the wild, which range from 11-51% with a 6-year mean of 38% (Day et al. 2017). A third experiment in 2015 resulted in 100% mortality to both control scallops and exposed scallops, and accordingly was attributed to other causes and not to seismic exposure (Day et al. 2016b, 2017).

Sub-lethal effects to exposed scallops were also observed by Day et al. (2016b, 2017) indicating a compromised capacity for homeostasis and potential immunodeficiency over acute (hours to days) and chronic (months) timescales post exposure. Exposures did not elicit energetically expensive behaviours (i.e. extensive swimming or long periods of valve closure), but scallops showed significant changes in behavioural patterns during exposure, through a reduction in classic behaviours and demonstration of a non-classic "flinch" response to seismic signals. Furthermore, following exposure scallops showed an increase in recessing into sediment following exposure (Day et al. 2017).

Corals, sponges and soft filter feeders

The primary mechanisms for injury of corals from exposure to high amplitude sound are understood to be: (1) breaking of the external coral skeleton that could also damage the polyp tissue, and (2) rupture or tearing of polyp tissues (Hastings 2008). The forces required to cause such injuries were predicted by Hastings (2008) to be in excess of 260 dB re 1 µPa PK-PK. Sponges and soft filter feeder invertebrates are a similar density as water and do not contain air cavities that might respond to rapid pressure changes.

Hastings et al. (2008), Battershill et al. (2008) and Heyward et al. (2018b) investigated the effects of the Woodside Maxima 3D MSS on hard corals in water depths of approximately 40-60 m within south Scott Reef lagoon. Corals received maximum sound pressure levels of 226-232 dB re 1µPa PK-PK. No mortality, damage to soft tissue or skeletal integrity, visible signs of stress, change in abundance or community structure was detected immediately after, and up to four months following exposure. Soft corals were also examined, with particular notice taken of soft coral morphology and polyp extension immediately after seismic passes. No change on soft coral abundance was detected and there was no evidence of a behavioural response, such as polyp withdrawal or flaccidity (Battershill et al. 2008; Heyward et al. 2018b).

The Gigas 2D Pilot OBC MSS coral monitoring study (SKM 2008) examined the potential for physical damage to a range of shallow water corals in north Scott Reef lagoon from seismic source emissions. This survey had a measured at source SEL of 206 dB re 1 µPa^2.s (McCauley 2008). The study concluded that sound emissions did not cause significant injury, tissue damage, sub-lethal stress or mortality to coral colonies, even when colonies are within a few metres of the seismic source (SKM 2008).

Similarly, a survey of coral reefs in Brunei that were subjected to seismic noise did not detect any damage to hard or soft corals, sponges or other sessile benthic organisms (IEC 2003).

Table 7-5: Impact and risk evaluation – underwater noise and vibration – benthic communities

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">Impulsive sound emitted from the seismic source has the potential to result in physical injury or physiological changes to marine invertebrates in close proximity to the seismic source. If changes to invertebrate communities are extensive, they may indirectly affect higher trophic level species such as fish and marine turtles that target invertebrates as a food source.

The following assessment considers the potential risk to benthic invertebrate communities. The risk to individual commercially targeted invertebrate species in the Kimberley region, including pearl oysters, prawns, scampi, trochus and their respective commercial operations, are assessed separately. Please refer to Section 7.2.1 Commercial fisheries and Section 7.2.3 Pearling and aquaculture.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>Summary of receptors

Benthic communities known to occur within the Operational Area are predominantly abiotic soft sediments, with infauna and sparse epifauna on unconsolidated sand, gravel and mud. Rocky escarpment associated with the submerged ancient coastline of the outer continental shelf and other rock outcrops and localised areas of varied topographic relief support denser and more diverse sponge and filter-feeder communities. Biota associated with these areas of relief includes sponges, soft corals, bryozoans and other invertebrates, which occur widely throughout the Kimberley region.

Sponge-dominated communities are also present in localised patches in the vicinity of Lynher Bank and the Leveque Rise, in the shallowest parts of the Acquisition Area; although even in these shallow areas, occurrence is patchy and lower than in shallower coastal areas outside of the Operational Area (Heyward et al 2018a; Nicholas et al. 2016). Crustaceans and echinoderms such as crabs, brittle stars and feather stars are also present in association with sponge communities.

Given the relatively high turbidity in shallow waters, hard coral reef communities are understood to be absent from the Operational Area, with the closest coral reefs being located several kilometres or tens of kilometres away at Scott Reef, Beagle Reef, Mavis Reef and the fringing reefs around Browse Island, Adele Island and the Lacepede Islands.

In deeper waters on the continental slope, benthic communities are dominated by bacteria and detritus-based systems comprised of infauna and epifauna in muddy sediments and calcareous ooze, which in turn support molluscs and crustaceans.</td><td>Insignificant (F)</td></tr>
</table>

Evaluation of potential consequence Although formal 'no impact' threshold criteria do not currently exist for benthic invertebrates exposed to seismic sound emissions, the research detailed above provides an indication of the types of impacts that may occur and the associated sound pressures. Table 7-6 provides PK-PK levels relevant to invertebrates and the horizontal distances over which these sound levels are predicted to be exceeded at the seabed, based on the modelling completed for INPEX by JASCO (McPherson et al*.* 2019; Appendix D). The majority of research indicates that impacts to marine invertebrates (if any) are limited to within a few metres or a few tens of metres of the seismic source, at most. However, the levels reported by Day et al. (2016a, 2016b, 2017) and Payne et al. (2007) are presented to provide the most conservative estimates for potential sub-lethal effects or mortality to some invertebrates, noting that research by other authors (e.g. Kosheleva 1992; Christian et al. 2003; Wardle et al. 2001; Przeslawski et al*.* 2016, 2018) found no evidence of impacts to invertebrates following exposure to higher sound levels than those presented in Table 7-6. Impacts to sponges and soft filter feeders are not expected as the physical structure of sponges and soft filter feeders are not sensitive to rapid sound pressure changes. The lower sound level of 226 dB re 1µPa PK-PK reported by Heyward et al*.* (2018b) as having no impact on hard and soft corals is only predicted to be exceeded at the seabed directly beneath the seismic source (within approximately 7-12 m of the centre of the source) and only in water depths shallower than approximately 45 m (McPherson et al. 2019). However, given that the seismic source array is not a point source (approximately 14 m x 10 m), the actual distance from the edge of the source array to exceedance of the 226 dB re 1µPa PK-PK level will be smaller than the distance from the centre (i.e. directly beneath the source). When conservatively applying a 12 m radius to the proposed 3-6 km survey line spacing, only 0.8 – 1.6% of the seabed within water depths less than 45 m may be exposed to sound levels greater than 226 dB re 1µPa PK-PK. Therefore, >98% of the seabed within these water depths will not be exposed to these levels. Noting also that the seabed in these shallow areas is likely to be comprised of approximately 94-97% abiotic substrate (Heyward et al. 2018a; Nicholas et al. 2016), the proportion of exposed seabed that may support corals or sponges is negligible (0.002 – 0.024%). The 226 dB re 1µPa PK-PK level represents 'no impact' according to Heyward et al*.* (2018b) and so any areas exposed to higher levels will not necessarily experience any effects. In this respect, it should also be noted that the higher sound level of 232 dB re 1µPa PK-PK reported by Heyward et al*.* (2018b) as also having no impact on hard and soft corals may only be exceeded within the water column around the source array but is not expected to be exceeded at the seabed in any water depth. In addition, the source levels of the seismic array do not exceed the 260 dB re 1 µPa PK-PK level predicted by Hastings (2008) as necessary to impact corals. Therefore, the health and structural integrity of the sponges, filter feeders and soft corals found in association with the rock escarpment of the Ancient coastline at 125 m depth contour KEF and occasional outcrops in shallow shelf waters (e.g. Lynher Bank and Leveque Rise) will not be impacted. These types of epibenthos provide habitat	

for a range of other benthic invertebrates and so the habitat structures underpinning these benthic communities will not be affected.

Table 7-6 Maximum (R_{max}) horizontal distances (in m) from the 3080 cubic inch array to modelled seafloor PK-PK relevant to benthic invertebrates in continental shelf waters (McPherson et al. 2019)

PK-PK (L_{pk-pk}) (dB re 1 µPa)	Relevance	Distance R_{max} (m)				
		Site 1 (67 m depth)	Site 4 (37 m depth)	Site 7 (59 m depth)	Site 11 (70 m depth)	Site 12 (103 m depth)
226	Corals (hard and soft) – No impact (Heyward et al. 2018b)	-	7	-	-	-
213	Mollusc bivalves – Sublethal effects and chronic mortality (Day et al. 2016b, 2017)	190	161	181	177	212
209	Crustaceans – No mortality; sub-lethal effects (Day et al. 2016a, 2016b)	257	195	304	231	310
202	Crustaceans – No mortality; chronic sub-lethal effects (Payne et al. 2007)	559	461	536	536	666
A dash indicates that the sound pressure level is not reached.						

No impacts will occur to coral reefs in the region such as Scott Reef, Beagle Reef, Mavis Reef or fringing reefs surrounding Browse Island, Adele Island or other islands, all of which are located many kilometres from the Acquisition Area and waters where the seismic source may be operated during run-ins and run-outs (i.e. in the Operational Area).

Benthic invertebrates associated with the hard rock substrate and sponge communities of the Ancient coastline at 125 m depth contour KEF, as well as other shallow sponge communities in the vicinity of Lynher Bank and shallow areas of the Leveque Rise, include crustaceans (e.g. crabs), molluscs, echinoderms (sea stars and brittle stars) and other invertebrates. The abiotic soft sediment communities that cover much of the Acquisition Area support lower diversity and species richness than these hard substrates, but typically include infauna such as bivalves, polychaete worms and nematodes. Based on the above body of research, some benthic invertebrate species may experience sub-lethal effects or a small increase in mortality rates following seismic exposure at close range. Sessile (immobile) invertebrates may be most vulnerable as they cannot avoid the approaching seismic source. Based on the modelling results presented in Table 7-6, such effects may occur at distances in the order of approximately 161 m to 666 m from the seismic source, depending on water depth and bathymetry. Given the wide acquisition line spacing (~3-6 km) that is planned for the INPEX 2D seismic survey, approximately 8-22% of the overall area covered by the 2D seismic survey may be exposed to sub-lethal effects at some point in time during the survey with the remaining 78-92% of the seabed unaffected. This is estimated based on applying the smallest and largest impact radii associated with the Payne et al. (2009) levels in Table 7-6 to 3 km and 6 km line spacing. By applying the same estimation using the levels associated with chronic mortality from (Day et al. 2016b, 2017), approximately 3-7% of benthic invertebrate communities will be exposed at some point in time during the survey. Noting also that even shallow areas such as Lynher Bank and adjacent terrace and shelf features of the Leveque Rise are comprised of approximately 94-97% abiotic substrate (Heyward et al. 2018a; Nicholas et al. 2016), the proportion of seabed overlapped by seismic survey acquisition lines and supporting more diverse invertebrate communities is likely to be very small. Should chronic lethal and sub-lethal effects occur in a small proportion of sessile invertebrates in the weeks and months following exposure, the continuous natural cycle of death, recovery and recruitment of invertebrates from adjacent sediments will occur in parallel over these same timescales, and therefore it is questionable whether any impacts from seismic exposure would be detectable from natural fluctuations in relative abundance, benthic community composition and structure. Day et al. (2017) and Payne et al. (2007, 2008) acknowledge that the changes observed in their research are likely within the range of variation that can occur from other common natural and anthropogenic stressors. The ecological implications of such impacts on benthic invertebrate communities are not expected to be significant or long term. Consequently, indirect impacts on higher trophic level species that target benthic invertebrates as a food source are also not expected. For example, benthic organisms are a key food source for demersal fish species such as snappers, emperors and groupers; following the passing of the seismic source, benthic invertebrates are still available to	

be foraged and any chronic mortality that occurs over the weeks or months following exposure is expected to be negligible in the context or natural mortality and recruitment. The habitat structure and condition of the Ancient coastline at the 125 m depth contour KEF and the Continental slope demersal fish communities KEF will not be affected. Impacts to benthic invertebrate biota such as sponges are not expected and impacts to other invertebrates that inhabit these areas, such as crabs, molluscs and echinoderms, are predicted to be localised. Changes to these communities are unlikely to be discernible from natural variation. Therefore, the ecological function and values of these KEFs will not be impacted. Given the localised extent and temporary nature of potential impacts to benthic invertebrate communities, and the potential for subsequent recruitment and recovery (over weeks or months), no long-term population or community level impacts are expected. As such, the consequence of seismic exposures to benthic invertebrate communities is considered to be Insignificant (F).	

Identify existing design and safeguards/controls measures

The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3).

INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.

Propose additional safeguards/control measures (ALARP Evaluation)

Hierarchy of control	Control measure	Used?	Justification
Elimination	None identified	No	The 2D seismic survey cannot be achieved without using a seismic source. Elimination of the seismic source is not possible.
Substitution	None identified	N/A	No additional substitution controls were identified that would practicably reduce the risk to benthic communities.
Engineering	Design the acquisition line plan to exclude KEFs and shallow areas (e.g.	No	INPEX has given consideration to the exclusion or reduction of acquisition lines in order to minimise impacts to benthic

	wider line spacing or complete exclusion) where relatively diverse sponge communities may occur.		invertebrate communities. This included considering if existing legacy data is available that can be used instead of undertaking new seismic data acquisition. Unfortunately, any legacy data that is available that INPEX has not already accounted for is old and of too poor a quality to be able to evaluate the subsurface geology at the required depths. Excluding survey lines or increasing line spacing would also result in significant loss of data quality in areas that are important for evaluating the potential of hydrocarbon targets. It is impossible to identify the exact locations of rock outcrops and sponge communities and differentiate them from abiotic substrates without undertaking comprehensive surveys (e.g. using multibeam echosounder and side scan sonar equipment). This would involve extensive and costly survey or scouting work over many months. This option is impracticable and achieves a very limited environmental benefit. The costs are grossly disproportionate to the Insignificant consequence and low level of risk posed to benthic invertebrate communities.
	Include a time interval prior to repeat survey of overlapping sail lines in sensitive locations (including infill activities) to allow for potential recovery of benthic invertebrates.	No	It is noted that the orthogonal grid line plan that is characteristic of 2D seismic surveys requires survey lines to overlap in numerous locations. In addition, "infill" activities may be required if the survey vessel has to return to complete a section of line that was missed during a period of shut down, and will result in some overlap. Repeat exposures may result in an incremental increase in impacts to benthic organisms. For example, Day et al. (2017) reports 9.4-11.3% mortality in scallops exposed to a single pass of the seismic source, 11.3-16.1% mortality in scallops exposed to two passes of the seismic source, and 14.8-17.5% mortality in scallops exposed to four passes of the seismic source compared with 3.6-3.8% mortality in

			control scallops (no seismic exposure). Sub-lethal impacts may also be more prevalent in areas exposed to the seismic source more than once. It is important to note that benthic communities are expected to recover from such impacts, even if slight increases in the proportion of affected organisms does occur as a result of multiple exposures. Should lethal and chronic sub-lethal impacts occur in the weeks and months following exposure, the continuous natural cycle of death, recovery and recruitment of invertebrates from adjacent sediments will occur over these same timescales, and therefore it is questionable whether any impacts from seismic exposure would be detectable from natural fluctuations in relative abundance, benthic community composition and structure. Overall, the inherent risk to benthic communities is already low. Given that both impacts to benthic organisms and recovery are expected to occur over timescales of weeks or months, the option of delaying repeat survey of overlapping sail lines in any location is not practicable.
	Reduce seismic source volume and acoustic output in water depths less than 50 m	No	The proposed ~3,000 cubic inch seismic source volume has been determined based on a detailed feasibility study as the volume necessary to achieve the objectives of the 2D seismic survey throughout the Acquisition Area, taking into account the depth of the seismic targets and the characteristics of the underlying geology. Further review of the source volume required to acquire data in areas shallower than 50 m (i.e. Lynher Bank) determined that the shallow seabed sediments and depth to target may permit a smaller source volume and acoustic output to be used. A source volume of approximately 2,000

			cubic inch was determined to be the minimum source volume suitable for these areas. INPEX engaged JASCO to model the sound levels resulting from a 2,060 cubic inch seismic source, based upon details provided by potential seismic contractors, to evaluate the potential reduction in footprint that may be possible in water depths less than 50 m, in relation to effects criteria for benthic invertebrates. The results are presented in the acoustic modelling report in Appendix D for comparison with the results for the modelled 3,080 cubic inch source. The potential reduction in the footprint of effects is summarised as follows: • Corals and sponges: No impacts are predicted to occur to corals or sponges from the full source. • Sub-lethal effects and chronic mortality (bivalves or other immobile invertebrates) based upon the 213 dB re 1µPa PK-PK level in Day et al. (2016b, 2017): A maximum reduction in impact radius of 21% was predicted. • Sub-lethal effects (crustaceans) based on the 209 and 202 dB re 1µPa PK-PK levels in Day et al. (2016a, 2016b) and (Payne et al. 2007): Reductions in impact radii of between 6% and 39% (average of 13 – 26%) depending upon location and water depth) were predicted. Based on the modelling results, there may be a minor reduction in the area of benthic invertebrate communities affected by seismic pulses during the 2D seismic survey, if a smaller source is used in areas shallower than 50 m. However, the benefit to benthic invertebrate communities achieved by doing this may not be significant based on the

			following factors described in the above consequence assessment: • The benthic habitats and communities in the Acquisition Area are highly dynamic and turbid due to strong tidal currents. Even shallow areas such as Lynher Bank comprise approximately 94-97% abiotic substrate (Heyward et al. 2018a; Nicholas et al. 2016). Areas of more diverse filter feeder communities are relatively sparse. • Use of the larger 3,080 cubic inch source would result in between 2% and 7% of benthic communities in the Acquisition Area being exposed to potential chronic mortality effects, and between 8% and 22% of benthic communities being affected by sublethal effects. The potential reduction in footprint achieved from using the smaller 2,060 cubic inch source may reduce these areas by just a few percent. • Sublethal effects and chronic mortality do not occur in all organisms exposed. For example, Day et al. (2016b, 2017) report 9.4-11.3% mortality in scallops exposed to a single pass of the seismic source, and 11.3-16.1% mortality in scallops exposed to two passes, which is comparable with natural mortality rates. • Should lethal and chronic sub-lethal impacts occur in the weeks and months following exposure, the continuous natural cycle of death, recovery and recruitment of invertebrates from adjacent sediments will occur in parallel over these same timescales, and therefore it is questionable whether any impacts from seismic exposure would be detectable from natural fluctuations in relative

			abundance, benthic community composition and structure. Therefore, impacts to benthic communities using the 3,080 cubic inch source are predicted to be temporary and recoverable and the inherent risk to benthic communities is already low. INPEX has also made enquiries with seismic contractors into the feasibility of using a smaller source. This would either require changing over the seismic source during the survey, which would involve significant time delay and costs as well as line infill and overlap (including repeat exposures to some areas) when returning to acquire the shallow areas; or another alternative would be to turn individual source elements in the source array off while the seismic vessel is in motion. Seismic contractors suggested that this is possible in theory, but individual elements would need to be powered down manually one at a time. This would result in some shot points being missed during the transition in and out of shallow areas. Although this may not correspond with large areas of lost data it is an added complexity and technical risk. Given the potential technical complexity and/or additional time associated with implementing a reduced source volume control in shallow water areas, the already low risk to benthic communities, and the limited environmental benefit gained, this option is, therefore, impracticable.
	Increased source point interval	No	The proposed source point interval is 18.75 m. Increasing the shot point interval to 25 m, for example, would result a noticeable loss in data quality and complexities during post-processing. Increasing the interval by this amount (by less than 10 m) is also unlikely to achieve much additional environmental benefit in terms of the footprint of seismic impacts to benthic invertebrate communities, as sub-lethal

			impacts may occur to some species up to tens or hundreds of metres from each pulse. Increasing the interval to more than 25 m would result in the quality of the seismic data being too poor to use. Therefore, this option is considered disproportionate to the already low level of risk to invertebrate communities and is not practicable.
	Undershooting / placement of nodes in sensitive areas	No	Undershooting involves a seismic source vessel sailing parallel a second seismic vessel towing the streamer. The seismic source would be discharged at a distance offset from any areas of sensitive habit or benthic communities, with the reflected signal collected by the streamer towed behind the second vessel. The use of nodes requires the placement of hydrophone recorders (nodes) on the seabed to record the signal from the seismic source, which would again pass at an offset distance in order to avoid operation of the seismic source over any areas of sensitive habit or benthic communities. An additional vessel would need to be engaged to deploy and retrieve the nodes. Both options are not relevant to 2D seismic acquisition: they are sometimes used for 3D seismic surveys. Both would result in a significant increase in the duration of the survey and are cost prohibitive (potentially AU$ millions). The options are also impracticable given the challenges of identifying the locations of more sensitive benthic communities, as outlined above. Given the already Insignificant consequence and low level of risk to benthic invertebrate communities, these options are not practicable.

Identify the likelihood		
Research into the effects of seismic on benthic invertebrates indicates different results, with a range of impacts occurring at distances of a few metres or potentially up to hundreds of metres. Impacts may be limited to just a few metres from the survey acquisition lines in some cases, but the assessment of consequence assumes the more conservative ranges to impact over hundreds of metres. With the above described controls in place, the likelihood of temporary and localised (hundreds of metres) impacts benthic invertebrate communities at close range from the seismic source, with Insignificant consequence is considered Possible (3).		
Residual risk summary		
Based on a consequence of Insignificant (F) and a worst-case likelihood of Possible (3) the residual risk is Low (8).		
Consequence	Likelihood	Residual risk
Insignificant (F)	Possible (3)	Low (8)
Assess residual risk acceptability		
Legislative requirements N/A – There are no legislative requirements applicable to managing the effects of seismic surveys in relation to benthic invertebrate communities. **Stakeholder consultation** Feedback was received by the WA DPIRD, WAFIC and fisheries licence holders (Table 5-4) highlighting the concerns of the fishing industry about the potential impacts of seismic to invertebrates and impacts to the food chain for commercially targeted fishes and invertebrate species. These concerns have been considered in this EP through the implementation of a series of controls and demonstration that impacts will be managed to ALARP and acceptable levels. **Australian marine park values, objectives and zone rules** Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018: • The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone. • No significant or long-term impacts are expected to occur to the benthic communities that form part of the ecosystem and KEF values of the Kimberley AMP.		

- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. No survey activities will occur in the Habitat Protection Zone, and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. No survey activities will occur in the National Park Zone, and the ecosystems, habitats and native species within the National Park Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. However, none of the recovery plans or conservation advice documents are specifically relevant to the effects of seismic or other anthropogenic noise on benthic invertebrate communities. Instead, INPEX has considered Department of Fisheries (2013) guidance and WA DPIRD’s recently published ecological risk assessment of seismic impacts to marine finfish and invertebrates (Webster et al. 2018) during this assessment.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;

- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	**Environmental performance standards**	**Measurement criteria**	**Responsibility**
N/A no controls identified			

7.1.6 Underwater noise and vibration – Fishes

Receptor sensitivity to sound and sound exposure thresholds

Fishes may use sound to communicate, locate prey, detect predators, and as a cue for orientation (McCauley & Cato 2000). Fishes vary in their vocalisations and hearing abilities even within families, but generally hear best at low frequencies below 1 kHz (Ladich 2000). The structure and function of the auditory system in fishes has been extensively reviewed, and different fishes may detect the pressure and particle acceleration components of sound to varying degrees (Fay & Popper 2000; Popper et al. 2003; Nedwell et al. 2004; Popper & Fay 2011; Popper et al. 2014; Nedelec et al. 2016; Salgado Kent et al. 2016; Carroll et al. 2017; Popper & Hawkins 2018).

The hearing sensitivity of bony fishes varies between families and species. Hearing sensitivity is a function of specialised auditory structures in the inner ear (otoliths surrounded by an epithelium of hair cells) and, if present, the swim bladder (Finneran & Hastings 2000; Nedwell et al. 2004). Otoliths are sensitive only to particle motion, while the swim bladder may provide an indirect route for sound pressure to reach the inner ear. The other main mechano-reception system in fish is the lateral line system, which runs along the side of the body of fishes and is more pronounced in some groups of fishes than others. The lateral line system responds to water displacements (particle motion) produced in the near-field of a sound source, as well as to tiny water currents set up by the fish's own motions (Nedwell et al. 2004). Therefore, all fish are sensitive to the particle motion component of sound at close range from a seismic source or other sound source, while some more specialised fishes with a swim bladder involved in their hearing are sensitive to sound pressure and are capable of detecting less intense noise and a wider range of frequencies compared to less-specialised groups of fish (Popper et al. 2014; Hawkins & Popper 2016; Carroll et al. 2017).

Three categories of fishes have been defined by Popper et al. (2014) based on their hearing sensitivity:

1. Fishes with no swim bladder or other gas chamber – These fishes are less susceptible to barotrauma than fishes with a gas-filled space as they can only detect particle motion at close range, not sound pressure changes. However, some tissue barotrauma is possible from exposure to extreme sound pressure changes.
2. Fishes with swim bladders, but without a direct connection between the swim bladder and the inner ear – These fishes' hearing does not involve the swim bladder or other gas volume. Hearing primarily involves particle motion at close range, not sound pressure. However, the presence of a gas-filled swim bladder means that some limited indirect detection of sound pressure may be possible, and the swim bladder is susceptible to barotrauma if exposed to rapid and intense pressure changes.
3. Fishes with a swim bladder or other gas volume connected directly to the inner ear – These fishes are able to detect both sound pressure as well as particle motion, and are susceptible to barotrauma.

The third, most sensitive group of fishes relates predominantly to freshwater Otophysi fishes such as carp, minnows, catfish and piranhas, as well as freshwater Cichlids (Popper & Fay 1993; Nedwell et al. 2004; Schulz-Mirbach et al. 2012; Popper et al. 2014; Popper et al. 2019). In marine fishes, the connection with the swim bladder and ability to detect sound pressure is understood to be present to some varying degree in the families Clupeidae (e.g. herrings, sardines, pilchards and shads), Gadidae (e.g. true cods such as Atlantic cod and whiting), and some nearshore / reef species relevant to tropical Australia such as Pomacentridae (e.g. damsel fishes and clown fishes), Holocentridae (soldierfishes and squirrelfishes) and Haemulidae (e.g. grunters and sweetlips) (Nedwell et al. 2004; Braun & Grande 2008; Popper et al. 2014; Popper & Hawkins 2019). However, the vast majority of marine fish species do not have this hearing specialisation.

A great many fish species possess a swim bladder or other gas-filled cavity but do not have a connection with their hearing. This is true of the demersal snapper, emperor, cod and grouper species that occur in the Operational Area, as well as some tuna and billfish species.

Fish species that lack a gas-filled cavity altogether, include elasmobranchs (e.g. sharks and rays), some flat fishes, some gobies, some tunas, mackerels and other pelagic and deep-sea species (Casper et al. 2012; Popper et al. 2014). This is true of the sharks, mackerel species and some tuna species that occur in the Operational Area.

Popper et al. (2014), a working group of leading experts in underwater acoustics, developed sound exposure guidelines for fishes and sea turtles that are approved by the Accredited Standards Committee S3/SC 1 Animal Bioacoustics and registered with the American National Standards Institute (ANSI). The technical report proposes sound exposure guidelines for potential noise impacts on fish, including impacts resulting from seismic surveys and other comparable high-amplitude, low frequency impulsive sound signals such as pile driving. Popper et al. (2014) proposed sound exposure criteria for the following effects:

- mortality, including injury leading to death;
- recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma;
- temporary threshold shift (TTS) in hearing ability; and
- behavioural and masking effects.

The sound exposure criteria proposed by Popper et al. (2014) for fishes are presented in Table 7-7. Many of the criteria are dual metrics, requiring consideration of both the peak pressure (PK), and the accumulated sound exposure level (SEL_{cum}) resulting from exposure to multiple pulses of sound from the seismic source.

Table 7-7 Sound exposure criteria for fishes (Popper et al. 2014)

Fish Hearing Category	Mortality and Potential Mortal Injury	Impairment			Behaviour *
		Recoverable Injury	TTS	Masking *	
Fish: no swim bladder	>219 dB SELcum or >213 dB PK	>216 dB SELcum or >213 dB PK	>>186 dB SELcum	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	210 dB SELcum or >207 dB PK	203 dB SELcum or >207 dB PK	>>186 dB SELcum	N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder	207 dB SELcum or	203 dB SELcum or	186 dB SELcum	(N) Low (I) Low	(N) High (I) High

Fish Hearing Category	Mortality and Potential Mortal Injury	Impairment			Behaviour *
		Recoverable Injury	TTS	Masking *	
involved in hearing	>207 dB PK	>207 dB PK		(F) Moderate	(F) Moderate
* Relative risk (high, moderate, low) is given for masking and behavioural impacts to fish at three general distances from a seismic source, defined in relative terms as near (N; tens of metres), intermediate (I; hundreds of meters), and far (F; thousands of metres). >> indicates levels 'much greater than'.					

Potential injury and mortality

At the time of developing the ANSI sound exposure guidelines, no quantified data on injury and mortality from seismic sources on fishes had been reviewed by the Working Group. Therefore, the Popper et al. (2014) exposure guidelines for mortality/potential mortal injury and recoverable injury for fishes exposed to seismic source emissions are based solely on data from pile driving conducted on predominantly temperate, freshwater fish species. Although seismic surveys and pile driving both produce impulsive sound, their sound characteristics are markedly different; pile driving impulses result in a more rapid rise time in sound pressure than seismic pulses and it is this rapid rise time that has the greatest potential for trauma (Caltrans 2001, 2004; Hastings & Popper 2005; Popper et al. 2006).

Environmental Resources Management Australia (ERM) undertook a detailed literature review of potential fish mortality and physical injury as a result of exposure to seismic sources (ERM 2017). A total of twenty-eight papers or reports relating to the findings of experimental and opportunistic laboratory and *in situ* studies on mortality, potential mortal injury and physical damage effects of seismic source exposure on fishes, conducted worldwide between 1972 and 2014, were reviewed. Of the studies covered in the literature review only three observed direct mortality of exposed fish (Weinhold & Weaver 1972; Matishov 1992; Booman et al. 1996). In each case, mortalities occurred to caged fish at very close proximity to the seismic source (<2 m), which is not representative of real-life exposures from seismic surveys because fish are free-swimming and are not typically exposed at such close range. Nine studies covered in the literature review found some evidence of damage to one or more organs in exposed fish, including damage to swim bladders, ablated ear cells, internal bleeding, or blindness. Most damage occurred upon exposure at distances up to 3 – 4 m from the source. The literature review found a further sixteen studies that reported no mortality or physical damage in any fishes exposed to seismic pulses, including to fishes exposed in cages.

Of the studies reviewed by ERM (2017) that resulted in mortality, received sound levels ranged from 220 to 241 dB re 1 µPa PK. It is also important to note that other studies reported no mortality, and in some cases no physical injury at levels as high as 246 dB re 1 µPa PK. For example, Fanta (2004) found no mortality or physical damage in 15 different coral reef fish species exposed in cages to 215-235 dB re 1 µPa PK from a 3,090 cubic inch commercial seismic array at a minimum distance of 45 m. Given that the reviewed literature reported that mortality and physical injury has only ever occurred within a few metres of the seismic source, the sound exposure criteria proposed by Popper et al. (2014) for mortality and injury are considered to be highly conservative and provide a precautionary approach in the assessment of potential injury and mortality effects to fishes from exposure to underwater noise from marine seismic surveys.

In many cases, the potential for physical injury and impairment impacts to occur may be dependent on fishes' abilities to move and avoid very high sound levels, and so the potential for physical trauma to occur is typically limited to situations where fish do not or cannot avoid such exposures (e.g. experiments involving captive fish that may not be representative of free-swimming fish). For example, Wardle et al. (2001) exposed free-swimming marine fish (juvenile saithe [*Pollachius virens*] and Atlantic cod [*Gadus morhua*], adult pollock [*Pollachius pollachius*] and adult mackerel [*Scomber scombrus*]) inhabiting a small reef system, to seismic airguns with a sound peak pressure of 195 – 218 dB PK. No mortality was observed at these levels, even though some of these species are members of the Gadidae family and have a connection between the swim bladder and inner ear.

Of particular relevance to commercially targeted demersal snapper species in the Operational Area, McCauley and Salgado Kent (2007, cited in Santos Ltd 2018) undertook a study in collaboration with the Northern Territory Department of Fisheries to observe the potential impacts of seismic sound exposure to goldband snapper. The study used a series of commercial fish traps set at increasing ranges adjacent to three seismic survey line in 90 – 110 m water depth in the Timor Sea. The seismic vessel towed two 3,090 cubic inch seismic sources. Maximum signals reached at the closest trap to each seismic pass-by were 200, 202 and 212 dB re 1 µPa PK-PK (equivalent to approximately 194, 196 and 206 dB re 1 µPa PK). No mortality or mortal injury was identified at these levels.

Despite mortality being a theoretical possibility for fish exposed to seismic sound, Popper et al. (2014) and Carroll et al. (2017) note that physical injury leading to death from seismic sound exposure is likely to be limited to extreme cases and has not been observed in any free-swimming fishes exposed during an actual seismic survey.

Juveniles and small fry may have similar hearing sensitivity as adults but are potentially more at risk of tissue damage than adult fishes as their smaller size means they have less inertial resistance to the particle motion effects of a passing sound wave in the water column (Popper & Hastings 2009; Popper et al. 2016). However, to date, research into the effects of sound on fishes has been conducted on both juvenile and adult fish and, overall, the exposure thresholds and available research is considered broadly representative of both juvenile and adult stages.

Temporary hearing impairment

Temporary hearing impairment (TTS) can occur due to fatigue and temporary changes to the epithelium (hair cells) of the inner ear and/or damage to auditory nerves innervating the ear, which has the potential to occur in some fishes exposed to intense sound pressures for prolonged periods of time (Smith et al. 2006; Popper et al. 2014; Liberman 2015).

The nature and magnitude of TTS in fishes is described in Popper et al. (2014), as follows:

"TTS has been demonstrated in some fishes, and its extent is of variable duration and magnitude. However, sensory hair cells are constantly added in fishes (e.g., Corwin 1981; 1983; Popper and Hoxter 1984; Lombarte and Popper 1994) and also replaced when damaged (Lombarte et al. 1993; Smith et al. 2006; Schuck and Smith 2009), unlike in the auditory receptors of mammals. When sound-induced hair cell damage occurs in fishes, its effects may be mitigated over time by the addition of new hair cells (Smith et al. 2006; 2011; Smith 2012; 2015).

After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of sound exposure (e.g., Popper and Clarke 1976; Scholik and Yan 2001; 2002a; 2002b; Amoser and Ladich 2003; Smith et al. 2004a; 2004b; 2006; 2011; Popper et al. 2005; 2007). While experiencing TTS, fishes may have a decrease in fitness in terms of communication, detecting predators or prey, and/or assessing their environment."

The impact threshold of 186 dB re 1 µPa^2·s proposed by Popper et al. (2014) is based on data from Popper et al. (2005) where exposure of a freshwater fish species with a connection between the swim bladder and inner ear to an SELcum of 186 dB re 1 µPa^2·s resulted in approximately 20 dB difference in hearing threshold. Fish that showed TTS recovered to normal hearing levels within 18–24 hours.

McCauley et al. (2003) demonstrated that exposure to repeated emissions with a maximum received level of 212 dB re 1µPa PK-PK during trials with a closest point of approach of 5 to 15 m caused extensive damage to the sensory hair cells in the inner ear of caged pink snapper with no evidence of repair or replacement of damaged hair cells up to 58 days post-exposure. The SELcum level is not given in the study. The study did not examine if the hair cell damage had any effects on fishes' hearing. The study acknowledged that the fish were caged and therefore not able to swim away from sound source, and that the monitoring video suggested the fish would have fled the sound source if possible.

Hair cell damage and hearing impairment in a number of reef species, including the bluestripe snapper, were examined following exposure from a 2,055 cubic inch seismic source during Woodside's Maxima 3D MSS in Scott Reef lagoon. There was statistically more ear damage in exposed fishes compared to control fishes, but the damage was marginal, and it was suggested that <1% of the exposed fishes' hearing capability was impaired (McCauley 2008). A study of auditory brainstem response (ABR) in four species of tropical reef fishes, including the pinecone soldierfish (a species which has a swim bladder connection with the inner ear), showed that none of the four species experienced any TTS following exposure to 190 dB re 1 µPa2·s SELcum (Hastings et al. 2008; Hastings & Miksis-Olds 2012).

McCauley & Salgado Kent (2007, cited in Santos Ltd 2018) found an apparent increasing trend in hair cell damage in goldband snapper from received sound exposure levels greater than ~190 dB re 1 µPa^2·s, although the authors state that the results of this study should be treated with caution due to the limited number of samples. Other studies (e.g. Popper & Hastings 2009; Song et al. 2008) indicate that TTS may occur at single pulse levels as high as 205-210 dB re 1µPa (PK).

Therefore, the 186 dB re 1 µPa2·s threshold for TTS proposed by Popper et al. (2014) is considered appropriate and is potentially conservative for many types of fishes. It is also noted that many of the available studies on TTS are based on captive fish, whereas free-swimming fishes in the wild are likely to make some effort to avoid intense sound pressures at ranges where TTS may occur. If TTS does occur, the effects are temporary and will recover.

Behavioural effects

Behavioural effects of noise on fish will vary depending on the circumstances of the fish, hearing sensitivity, the activities in which it is engaged, its motivation, and the context in which it is exposed to sounds (Hawkins & Popper 2016). Responses may include avoidance behaviours, startle reactions, increased swimming speed, change in orientation, change in position in the water column, changes to schooling behaviour (e.g. tightening of school structure), seeking refuge in reefs, and temporary avoidance of an area (Simmonds & MacLennan 2005; McCauley et al. 2000; Fewtrell & McCauley 2012; Popper et al. 2014; Carroll et al. 2017). Changes in movement patterns may also temporarily divert efforts away from feeding, egg production and spawning success (Hawkins & Popper 2016). The potential extent and duration of behavioural effects based on studies of seismic exposure are summarised below.

Pearson et al. (1992) exposed captive rockfish to multiple 10-minute periods of seismic sound from a seismic source towed at distances of less than 215 m, which is not representative of real-life exposures. Schools of rockfish were observed to exhibit a 'startle' response (shudders, flexions of the body followed by rapid swimming) at sound levels above 200 – 205 dB re 1µPa SPL. An 'alarm' response (change in vertical position in the water column to be closer to the seabed, short-term post-exposure behavioural changes) was found to occur above approximately 180 dB re 1µPa SPL, although it was suggested that some individuals may begin to exhibit subtle changes in behaviour and position in the water column at sound levels above 161 dB re 1µPa SPL. Changes in behaviour were found to return to normal before the end of the sound exposure or within just minutes of the sound ceasing, indicating only very short-term, transient effects and potential habituation to the disturbance.

Santulli et al. (1999) exposed caged European sea bass (a demersal species) to a 2,500 cubic inch seismic source. Limited response was observed at 2.5 km distance, a startle response was observed when the array was at a distance of approximately 800 m, but after passing within 180 m, fish behaviour appeared to return to normal within one hour. Increased biochemical stress levels were measured in some fish following exposure, returning to normal levels within 72 hours of exposure. It is noted that exposures of fish in the wild would likely result in avoidance of high sound levels prior to the seismic source approaching to as close a range and to as high sound levels as the captive fish in the experiment were exposed to.

The studies associated with Woodside's Maxima 3D survey at Scott Reef included a component that examined how the behaviour of fish exposed to seismic signals changed. A summary of results relevant to how the behaviour of fish exposed to seismic signals changed is as follows (Woodside 2011; Miller & Cripps 2013):

- Behavioural observations of free-swimming fish:
  - At close range, airgun noise emissions appeared to have caused prominent, short term, effects on fish behaviour. As the vessel approached, fish ceased normal behaviours and moved downward from the water column towards the seabed.
  - Fish began to feed and behave normally again within 20 minutes after the passage of the survey vessel. Once the vessel had travelled beyond a distance of ~1.5 km fish numbers and behaviour had returned to normal, baseline levels.
- Behavioural observations of caged fish:
  - Alarm responses were too infrequent to analyse.
  - Agitation levels increased with increasing received sound exposure level for squirrelfish and soldierfish species but were not detectable for the bluestripe sea perch.
- Sonar observations of free-swimming fish:
  - Individual fish tended to move lower in the water column towards the seabed on approach of the operating airgun array, consistently out to 400 m either side of the survey test line.
  - Within 200 m of the survey test line, fish schools moved to the seabed after passage of the operating seismic source and stayed significantly closer to the seabed out to 63 minutes post-exposure.
- Fish choruses:
  - For the period overlapping the survey, fish choruses followed normal predictable and relatively smooth trends with regards to timing and chorus level (at daily, lunar and seasonal scales), suggesting that in the long term the survey had little effect on the fish which produced the choruses.
- Fish diversity and abundance:
  - Shallow reef-slope fish surveys using underwater visual census:
    - No significant decreases were detected in the diversity and abundance of both sound pressure-sensitive Pomacentridae (damsel fishes and clown

fishes) and non-Pomacentridae fish species after the seismic survey compared to the long-term temporal trend before the survey.

- Analysis of baited remote underwater video stations:
  - There were no detectable effects of the seismic survey on the diversity and abundance of deeper water fish communities at the spatial and temporal scales examined.
  - There were no signs of loss of individuals or of systematic re-distribution of individuals and species at any of the time scales examined.

Wardle et al. (2001) exposed tagged, free-swimming marine fish (i.e. juvenile cod and saithe, and adult pollock from the sound pressure-sensitive family Gadidae, and adult mackerel from the relatively insensitive family Scombridae) inhabiting an inshore reef to sounds from a seismic source (195-218 dB re 1 µPa PK). The study used underwater video techniques and found:

- Fish exhibited a startle response (momentarily performed "C-turns") to all received levels, but no avoidance behaviour or any other longer lasting effects were observed.
- Fish showed no signs of moving away from the reef.
- Slight changes were recorded to the long-term day-to-night movements of two tagged pollack, particularly when located within 10 m of their normal living positions.
- Exposure to the seismic noise did not interrupt a diurnal rhythm of fish gathering at dusk and had little effect on the day-to-day behaviour of the resident fish.

Sivle et al. (2016) undertook a pilot study to explore different sound source characteristics and experimental design options for evaluating behavioural reactions in mackerel. The authors exposed caged mackerel to a range of playback sounds at close range (2-7 m), including filtered playback of seismic pulses recorded at a distance of 8 km with an SEL of 144 dB re 1 µPa2·s. In the majority of tests undertaken, mackerels did not react to the seismic sound stimulus. Minor startle responses were observed from a small number of individuals in schools in 20% of the tests conducted; a weak or moderate increase in swimming speed was observed in some individuals in schools in 45% of tests conducted; and a weak change in schooling behaviour was observed in a small number of individuals in schools in 10% of tests conducted. In all cases, reactions only lasted for the duration of the exposure and returned to normal as soon as the exposure ceased. The experiment, therefore, indicates that some mackerels may show an awareness of seismic sound at these levels. However, Sivle et al. (2016) note that mackerel are not sensitive to sound pressure, but to particle acceleration, which is likely a key stimulus in their close-range experiments. Sivle et al. (2016) also note that the sound playback technique that they used had limitations and was not representative of a real seismic signal, suggesting that future experiments should instead use a real seismic source in order to obtain more conclusive results. Therefore, the observations made by Sivle et al. (2016) should be interpreted with caution and may not be representative of mackerels' ability to detect propagating sound pressure signals at long distances (i.e. kilometres) from a real seismic survey.

McCauley et al. (2000, 2003) reported that trials involving captive fishes (of various species, including snappers, emperors, groupers, trevally, bream, herring and others) exposed to seismic sound showed a common 'startle' response (C-turns), 'alarm' responses (e.g. swimming faster, darting movements and sudden changes in school structure), or less obvious changes such as moving closer to the seabed or huddling closer together. Subtle responses such as moving closer to the seabed were suggested to commence when sound levels exceeded approximately 151 dB re 1 µPa^2.s SEL (approximately 160 dB re 1 µPa SPL). Similar behaviours in pink snapper and trevally were noted by Fewtrell & McCauley (2012) in response to comparable sound levels. These are minimal reactions that are likely to be an indication of awareness and perception of the sound rather than a response that could result in potential impacts. More obvious startle and alarm responses were apparent in trials when received sound levels were in the order of 159 – 172 dB re 1 μPa^2.s SEL (approximately 168 – 181 dB re 1 μPa SPL). In situations where a behavioural response was observed, fishes were considered to have resumed normal behaviour within 4 – 31 minutes after cessation of the seismic activity (McCauley et al. 2000, 2003). Startle and alarm responses reduced with time, indicating some habituation to the sound. No statistically clear trends in physiological stress response were observed following exposure (McCauley et al. 2000, 2003).

Behavioural observations of two tropical snapper species and another coral reef fish species, spadefish, in field enclosures before, during and after exposure to seismic sound showed that repeated exposure resulted in increasingly less obvious startle responses (Boeger et al. 2006). This is consistent with the potential habituation suggested by McCauley et al. (2000) and by Fewtrell & McCauley (2012).

McCauley and Salgado Kent (2007, cited in Santos Ltd 2018) observed the behaviour of goldband snapper in fish traps in the Timor Sea using cameras placed inside the fish traps. A seismic vessel towed two 3,090 cubic inch seismic sources. Maximum signals reached at the closest trap to each seismic pass-by were 200, 202 and 212 dB re 1 μPa PK-PK (equivalent to approximately 194, 196 and 206 dB re 1 μPa PK). No dramatic behavioural responses of fish to the passing seismic source were observed. Fish generally displayed increased activity immediately after entering a trap presumably as they searched for a way out, with this activity reducing with time. Fish which had been in a trap for some time showed increased activity levels as the operating seismic source approached but were 'quiet' when the array passed at the point of closest approach.

At the time of writing, the Australian Institute of Marine Science (AIMS), as part of the North West Shoals to Shore Research Program, had undertaken a study of the potential behavioural effects of seismic sound exposure on red emperor, another key demersal species that occurs in the Operational Area and in the wider region. However, the results of this research were not available at the time of preparing this EP.

Bruce et al. (2018) tagged tiger flathead and two shark species, which were monitored during a seismic survey undertaken in Australian waters. Sharks moved freely in and out of the study area and exposed sharks did not show any indication of differences in behaviour or distribution compared with control areas. Minor behavioural effects were observed in exposed tiger flathead, which increased their swimming speed during the seismic survey and changed daily movement patterns after the survey, but showed no significant displacement. Overall, there was little evidence for consistent behavioural responses (Bruce et al. 2018).

Paxton et al. (2017) observed temperate reef fish, including snapper and grouper species, in 33 m water depths located 7.9 km from a seismic survey line using video recordings. The authors observed fish abundance and habitat use during the evening hours for three days prior to a seismic survey and then during the evening of the day when seismic activity occurred. The authors attempted to measure sound at two other reefs in closer proximity to the survey but the hydrophones malfunctioned. No video recordings were made at the other reefs where hydrophone measurements were attempted. No hydrophone measurements were made at the reef were video recordings took place but maximum sound levels were estimated to be in excess of 170 dB re 1 μPa. Despite no clear visual evidence of behavioural responses in fishes during the seismic survey, the authors noted a 78% decline in abundance in the evening following the survey. No further recordings were made to assess when fish abundance returned to pre-exposure levels or how far they may have moved. Therefore, with limited data, it is not clear from this study if reduced abundance is attributed to the seismic sound or other natural factors such as tidal influence or food availability. However, the study may indicate a possible avoidance response and change in local abundance and distribution.

Some other studies looking at the behavioural response of sound pressure-sensitive Gadidae and Clupeidae species, such as whiting, Atlantic cod and herring, have reported changes in vertical position in the water column, potential avoidance responses and short-term changes in distribution. Chapman and Hawkins (1969) observed that the depth distribution of free-ranging whiting changed in response to an intermittently discharging stationary seismic source, which resulted in fish being exposed to an estimated SPL of 178 dB re 1 µPa. The fish school responded to the sound by shifting downward, forming a more compact layer at greater depth although temporary habituation was observed after one hour of continual sound exposure (Chapman & Hawkins 1969).

Slotte et al. (2004) monitored the effects of a 3,090 cubic inch seismic array on migrating herring (Clupeidae) and whiting (Gadidae), mapping their distribution and abundance in relation to the seismic survey lines. There was no significant evidence of immediate, near-field scaring reactions on the horizontal scale in response to acquiring survey lines, but there was some evidence that fish changed position in the water column, moving closer to the seabed. Some short-term changes in distribution were observed but weren't statistically significant; fish consistently remained within the immediate vicinity of the survey area, but in a limited number of measurements there was an indication that fish abundance was lower near to the survey area and increased with distance out to a maximum range of 37 km. However, results were inconsistent and clear trends were not observed in all cases. Slotte et al. (2004) concluded that it was not possible to determine how much abundance and distribution were attributed to the seismic survey or to the fishes' natural migration patterns, food availability or other natural factors. Herring and whiting were found to be abundant in the survey area again after a pause in seismic acquisition and monitoring of fishes for three to four days, indicating that if any displacement did occur as a result of seismic sound exposure, the displacement was temporary (i.e. less than 3-4 days) (Slotte et al. 2004). In similar studies, Engås et al. (1996) and Engås & Løkkeborg (2002) reported on the effects of seismic surveys on Atlantic cod and haddock (Gadidae) and found that the abundance of fish were lower in the survey area compared with areas outside of the survey area, which the authors hypothesize may be the result of an avoidance response. Some differences in abundance were still detectable within the survey area 5 days after the survey was completed (Engås et al. 1996; Engås & Løkkeborg 2002).

Conversely, Peña et al. (2013) described the real-time behaviour of herring schools exposed to a full-scale 3D seismic survey, observed using sonar. No changes were observed in swimming speed, swimming direction, or school size that could be attributed to a transmitting seismic vessel as it approached from a distance of 27 km to 2 km, over a 6-hour period. The unexpected lack of a response to the seismic survey was interpreted as a combination of a strong motivation for feeding by the fish, a lack of suddenness of the onset of sound, and an increased level of tolerance to seismic pulses.

The following conclusions are made regarding behavioural effects to fishes, based on the literature above:

- Different fish may exhibit different behavioural responses when exposed to seismic survey noise, depending on their activities, motivation and the context in which they receive sound.
- Fishes may change position in the water column (i.e. move closer to the seabed) as a response to becoming aware of approaching seismic sound (generally observed in response to sound levels greater than 160 dB re 1 µPa SPL, but this varies depending on hearing sensitivity and context) (e.g. Pearson et al. 1992; McCauley et al. 2000; Slotte et al. 2004; Fewtrell & McCauley 2012; Miller & Cripps 2013).
- Exposure to higher sound levels at close range to a seismic source may begin to result in more noticeable startle or alarm responses, such as changes in school structure, increased swimming speed and avoidance of the sound source (typically

observed within hundreds of metres of the seismic source or in response to sound levels of approximately 168 – 190 dB re 1 µPa SPL and varying depending on hearing sensitivity and context) (e.g. Simmonds & MacLennan 2005; McCauley et al. 2000, 2003; Fewtrell & McCauley 2012; Popper et al. 2014; Carroll et al. 2017).

- Many studies indicate that fishes resume normal behaviour shortly after cessation of the acoustic disturbance (within minutes / less than an hour), with no evidence of long-term changes (e.g. Wardle et al. 2001; Pearson et al. 1992; Santulli et al. 1999; McCauley et al. 2000, 2003; Fewtrell & McCauley 2012; Miller & Cripps 2013; Sivle et al. 2016).
- There is some evidence that fish may also tolerate gradual increases in sound levels and habituate to repeated sound exposures (Chapman and Hawkins 1969; McCauley et al. 2000; Boeger et al. 2006; Fewtrell & McCauley 2012; Peña et al. 2013).
- In other studies, there is some evidence that avoidance behaviours may temporarily alter the local abundance and distribution of fishes for up to approximately 5 days following sound exposure, although such changes are limited to studies that focused primarily on migrating sound pressure-sensitive types of fish with a swim bladder-ear connection (Clupeidae, Gadidae) where it is difficult to attribute these changes in distribution directly to the seismic survey or to natural migration patterns, food availability or other natural factors (Slotte et al. 2004; Engås et al. 1996; Engås & Løkkeborg 2002).

Masking of an animal's ability to hear normal and relevant biological sounds only occurs while the interfering sound is present, and, therefore, masking resulting from widely separated pulses of sound from a seismic source would be infrequent. The short, intermittent pulse duration (tens of milliseconds) relative to the 8-second source point interval proposed for the 2D seismic survey means that the potential for masking is limited. Popper et al. (2014) highlights that masking as a result of sound from a seismic survey is unlikely, although there may be some potential for masking to occur in fish with good hearing (swim bladder-ear connection) when they are sufficiently far from the source for the impulsive sounds to merge and become more continuous (Nieukirk et al. 2004). However, at such distances, the sound levels will have significantly reduced, and masking effects would be limited and unlikely affect an individual's overall fitness and survival.

Given the limited convergence in results from the available studies, the subjective nature of many assessments and the context under which fish receive sound, Popper et al. (2014) do not define exact sound level thresholds or ranges at which masking and behavioural responses may occur. Instead, Popper et al. (2014) uses relative risk criteria (Table 7-7) that range from high to low. For these criteria the ranges, relative to the source, were quantified as near (within tens of metres), intermediate (within hundreds of metres) and far (within thousands of metres). These criteria do not use specific acoustic thresholds, but instead gauge impacts based on general distances from the noise source. It is difficult to predict the population impacts due to behavioural response because behaviour is context dependent. Behavioural responses of wild animals to sound are likely to vary by species, size, and age class, with animal motivation, and in different contexts. Behaviour may be more strongly related to the particular circumstances of the animal, the activities in which it is engaged, and the context in which it is exposed to sounds (Ellison et al. 2012; Peña et al. 2013).

Therefore, no specific impact thresholds have been selected for the assessment in this EP for masking and behavioural effects; instead these are assessed more qualitatively, by assessing relative risk rather than by specific sound level thresholds, as proposed by Popper et al. (2014; Table 7-7), but also taking into account the results of the various studies above for context where relevant.

Table 7-8: Impact and risk evaluation – underwater noise and vibration – fishes

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">Impulsive sound emitted from the seismic source may have the potential to impact fishes in the following ways:
• mortal injury or recoverable injury to fish at very close range to the seismic source
• temporary hearing impairment (temporary threshold shift; TTS) experienced by fish exposed to high sound levels for prolonged periods
• behavioural impacts resulting from disturbance, or masking or interfering with biologically important sounds.
The following assessment considers the potential impacts to fish behaviour and spawning fishes; however, the potential impacts to fish eggs and larvae are addressed separately in Section 7.1.4 Planktonic communities.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>Summary of receptors
A large range of demersal and pelagic fish species are likely to be present within and adjacent to the Operational Area. The main fish assemblages and key sensitive receptors are:
• demersal fish species on the continental shelf, including snappers, emperors, rock cods and groupers, which are particularly common over hard substrate where ridges, rises, reefs and large epibenthos occur, including the Ancient coastline at the 125 m depth contour KEF
• deep-water benthic and demersal fishes, sharks and rays associated with the Continental slope demersal fish communities KEF
• large pelagic fish species, including mackerels, tunas and billfish, which occur widely throughout the region
• small pelagic fishes, which form a significant proportion of the total fish biomass in the region; including pilchard, sardine and herring species that are targeted as baitfish by larger predatory fish in nearshore waters located outside of the Operational Area
• shark and ray species, including foraging whale sharks on the continental shelf (and sawfish and river sharks in coastal and estuarine waters located outside of the Operational Area)
• reef-associated and site-attached fish assemblages at coral reefs such as Scott Reef, Beagle Reef and fringing coastal reefs at Browse Island, Adele Island and the Lacepede Islands (all located outside of the Operational Area).</td><td>Minor (E)</td></tr>
</table>

Spawning and recruitment of fishes

The demersal and pelagic fish assemblages that are typical on the continental shelf in the Operational Area spawn throughout their ranges. Many are broadcast spawners that release millions of eggs over multiple spawning events and over many months. Recruitment (the process of juvenile fish moving into adult populations) and population connectivity varies; some demersal and pelagic fishes within the Kimberley region show genetic connectivity within hundreds of kilometres (Underwood et al. 2012; DiBattista et al. 2017; Depczynski et al. 2017), while other species are known to comprise populations with genetic connectivity throughout waters of northern Australia and the Indian Ocean. The larvae of many continental shelf species (e.g. snappers, emperors, mackerels) settle in shallow coastal nursery habitats such as mangroves, estuaries, seagrasses, intertidal pools and coral reefs (inshore of the Acquisition Area), and juvenile fishes gradually move offshore again as they mature (Jenkins et al. 1984; Leis & Carson-Ewart 2000; Begg et al. 2006; Newman et al. 2008). The larvae of some other species that occur in more intermediate and deeper waters (e.g. goldband snapper) may spend their entire life, from larval settlement, through juvenile stages to adulthood, in the same depth ranges, although some adult and juvenile habitat separation may still occur (Lloyd et al. 2000; Lloyd 2006). The spawning periods of many key indicator fish species for the commercial fisheries in the region varies significantly between species. Spawning and recruitment can occur nearly year-round for some species peaking over specific months, as considered in the assessment below.

Evaluation of potential consequence

The maximum horizontal distances (R_{max}) at which sound levels predicted by modelling (McPherson et al*.* 2019; Appendix D) to exceed the Popper et al. (2014) thresholds for mortality, injury and TTS are presented in Table 7-9. The table presents the maximum horizontal distance over all modelled depths above the sea floor ('maximum-over-depth') and the maximum horizontal distance at the seabed. Maximum-over-depth values are relevant to pelagic fish species in the water column, while the seabed values are relevant to benthic and demersal species. Figure 7-4 presents the maximum-over-depth SEL_{24hr} contours associated with TTS in fish.

The SEL_{cum} threshold criteria, modelled for a 24-hour period, was also examined in relation to the potential for mortality and injury, but either the thresholds were not exceeded, or the horizontal ranges associated with these thresholds were less than those produced by the peak sound pressure produced by a single seismic pulse. Therefore, the peak sound pressures from a single pulse are the most relevant metric to assessing the potential for mortality and injury.

Table 7-9 Maximum (R_{max}) horizontal distances predicted by acoustic modelling to exceed the Popper et al. (2014) thresholds for mortality, injury and hearing impairment

Fish Hearing Category	Threshold Criteria	Distance R_{max}	
		Continental shelf modelling sites	Continental slope modelling sites
Mortality, potential mortal injury and recoverable injury			
Fish: no swim bladder	>213 dB re 1 µPa PK	54 – 114 m (maximum-over-depth) 71 – 114 m (at seabed)	60 m (maximum-over-depth) Not exceeded at seabed at water depths greater than ~250 m
Fish: swim bladder not involved in hearing; Fish: swim bladder involved in hearing	>207 dB re 1 µPa PK	120 – 230 m (maximum-over-depth) 154 – 205 m (at seabed)	120 m (maximum-over-depth) Not exceeded at seabed at water depths greater than ~250 m
TTS			
All hearing categories	186 dB re 1 $\mu Pa^2.s$ SEL_{24hr}	1.6 – 3.5 km (maximum-over-depth) 1.6 – 2.9 km (at seabed)	4.94 km (maximum-over-depth) Distance will be less at seabed

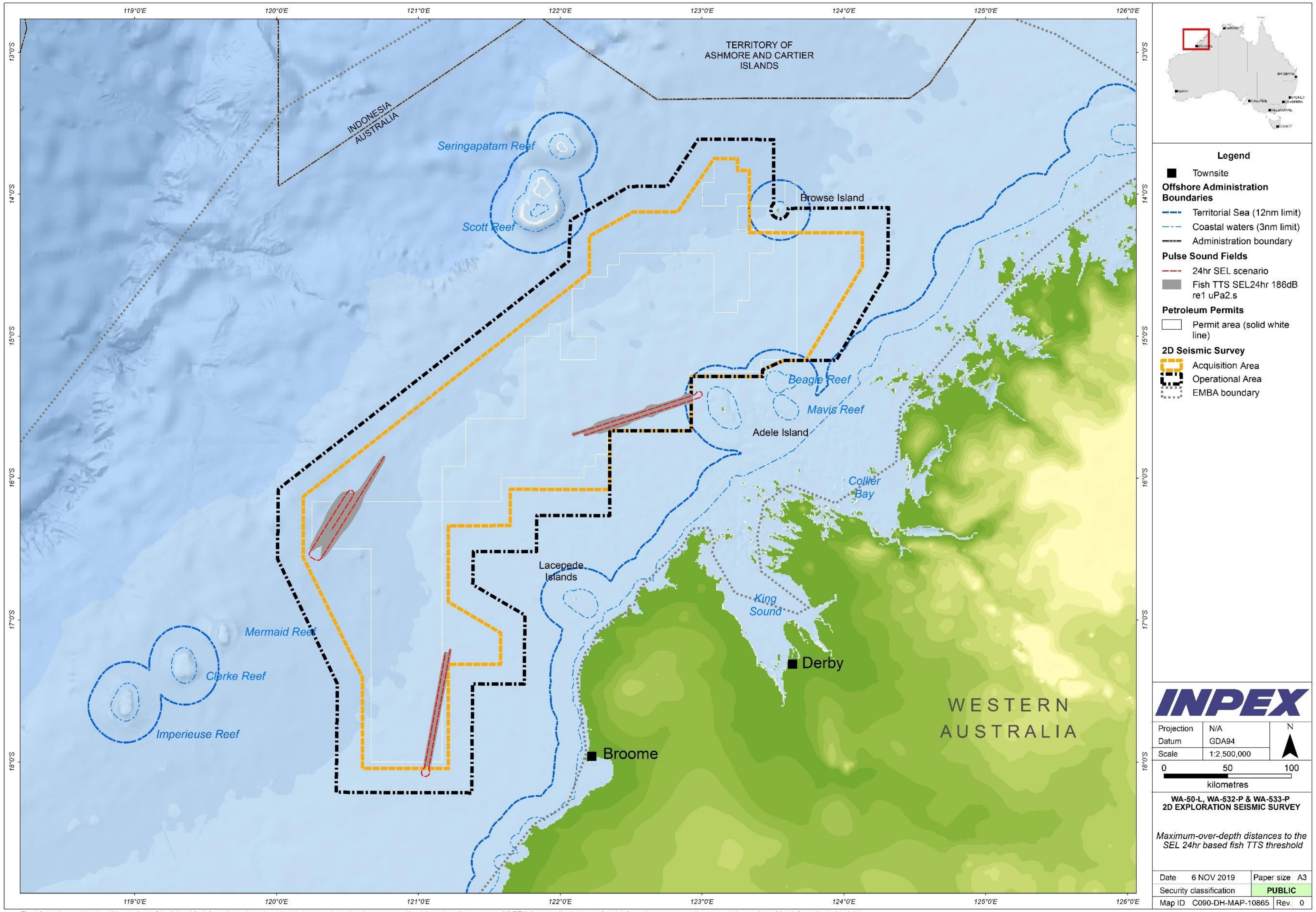


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Figure 7-4 Maximum-over-depth SEL_{24hr} contours associated with TTS in fish

Potential injury and mortality The acoustic modelling results for the 2D seismic survey (McPherson et al. 2019; Appendix D) indicate that the potential for recoverable injury or mortality in fishes on the continental shelf is limited to within 54 – 230 m of the seismic source, depending on the hearing sensitivity of different types of fish and accounting for some variability between modelling sites as a result of bathymetry and the geoacoustic properties of the seabed.Acoustic modelling at deeper water sites on the continental slope indicates that mortality and injury is limited to 60 – 120 m within the water column, but due to the vertical attenuation of sound the threshold is not expected to be exceeded at the seabed, where sound levels will be most relevant to benthic and demersal fishes, in water depths greater than approximately 250 m. Therefore, fishes associated with the Continental slope demersal fish communities KEF are not expected to be injured. It is again highlighted that the Popper et al. (2014) thresholds for injury and mortality are likely to be highly conservative, and studies have indicated that much higher received sound levels up to 246 dB re 1 µPa PK have not resulted in injury or mortality. The potential for mortality and injury is therefore likely to be limited to within very close proximity of the seismic source (ERM 2017). Based on the maximum predicted effects radii for injury and mortality of 54–230 m, the maximum area where there is potential for mortality or injury to occur from a single seismic impulse is limited to just 0.009 – 0.166 km^2 at any one time. To provide further context, over the duration of the entire survey, based on the proposed 3-6 km acquisition line spacing, the maximum extent of the seabed on the continental shelf that may support benthic and demersal fishes, and be exposed to sound levels above the mortality/injury effects thresholds, is equivalent to approximately 2–14% of the Acquisition Area. By applying the same analysis method to the most likely survey acquisition line orientation (example 2 in Figure 3-2), the extent of the seabed that may be exposed to potentially injurious effects is approximately 1.9–7.9% of the Acquisition Area [2]. This represents 0.17–2.17% of the seabed habitat within the depth ranges of the wider Kimberley stocks of any of the key commercial fish species (identified in Section 4.7.5) that may be exposed at some point throughout the entire survey duration [3].	

[2] The analyses are indicative, based on the smallest and largest effects radii predicted by the acoustic modelling for impulses on the continental shelf in water depths of between 37 m and 103 m water depth. The effects radii may be smaller in deeper waters of the continental shelf down to 250 m depth where the effects thresholds are no longer exceeded at the seabed. The results therefore provide a conservative estimate of the area of habitat that may be exposed.

[3] Further conservatism is included in this analysis, as the stock areas are assessed based upon the Kimberley fisheries management unit (similar in extent to the Northern Demersal Scalefish Managed Fishery) and within the principal depth ranges advised by DPIRD for each species. Genetic connectivity and recruitment, via the exchange of eggs and larvae within the fish stocks, is known to occur over a larger geographic area than the fisheries management unit. Therefore, the proportion of habitat for these stocks that may be exposed to injurious levels is likely to be even less.

Importantly, however, the potential for mortality and injury to occur is dependent on fishes' abilities to move and avoid very high sound levels. The demersal and pelagic fish assemblages that are expected to be present in the Acquisition Area are generally wide-ranging, free-swimming species. The demersal fish assemblages that are typical of the habitats in the Operational Area (predominantly snappers, emperors, cods and groupers), despite exhibiting particular habitat preferences and some fidelity to an area, can be found across a variety of habitats and are typically mobile with home ranges in the order of kilometres (Ovenden et al. 2004; Moran et al. 2004; Newman et al. 2008; Parsons et al. 2011; Harasti et al. 2015). Similarly, pelagic fishes such as mackerel travel distances up to 100 km or more, while tunas and billfish may travel in the order of thousands of kilometres (Section 4.7.4). Shark and rays are also highly vagrant. The available studies on the behaviour of both captive and free-swimming fishes exposed at close range to seismic surveys (as described previously in this section) generally indicate an increased level of startle response and increased swimming activity with increased sound levels or in response to exposure at close range. It is highly unlikely that commercially targeted demersal and pelagic fishes will remain within range of the seismic source where mortality/injury can occur. Injury or mortality may only occur in the immediate vicinity of the seismic source in the unlikely event that the seismic source commences operation suddenly at full power without the opportunity for fishes to avoid increasing sound levels (i.e. no soft-start management measures). However, soft-start measures will be implemented, as detailed below.Therefore, commercially targeted demersal and pelagic fishes in the Acquisition Area can reasonably be expected to exhibit an avoidance response and swim away from the approaching seismic source before sound levels approach levels that may result in injury or mortality. The potential for mortality or injury to occur within close proximity to the seismic source is therefore limited to site-attached fish species, which are species that are either unlikely or unable to flee the approaching seismic sound source and are instead likely to remain and/or seek refuge within habitat structures. There is no significant site attached fish(es) habitiat within the acquisition area. Significant site-attached fishes are limited to reef-associated fish assemblages at coral reefs such as Scott Reef, Beagle Reef and fringing coastal reefs at Browse Island, Adele Island and the Lacepede Islands, all of which are located outside of the Operational Area. In contrast, despite the presence of some hard, rocky substrate, filter feeder communities and other patchy epibenthos that provide habitat structures for fish, the turbid waters and predominantly abiotic substrates present in even the shallowest parts of the Operational Area do not provide significant areas of suitable habitat for site-attached fish assemblages. As summarised in Section 4.7.2 (Benthic communities) and Section 4.7.4 (Fishes), the shallow areas of the Acquisition Area located at Lynher Bank and on the Leveque Rise are reported to comprise approximately 94–97% abiotic substrates, with only occasional hard substrate and epibenthos (Heyward et al.	

2018a). The limited areas where some low profile, hard substrate supporting significant levels of benthos occur are in water depths of 33-57 m (Heyward et al. 2018a). The most common families of fishes observed in the shallow waters of Lynher Bank are typical of soft-bottom fishes that are widely occurring across northern Australia (Heyward et al. 2018a). Such soft-bottom habitats do not support the same diverse site-attached fish assemblages as they are typically associated with the coral reefs and oceanic banks and shoals found elsewhere in the NWMR. Therefore, the shallow parts of the survey Acquisition Area are unlikely to provide any significant areas of suitable habitat for site-attached fish assemblages, although it is possible that small areas of habitat within water depths less than 60 m (and predominantly less than 50 m given the turbid conditions) may provide habitat to support a small number of individuals of site-attached fishes. The maximum predicted effects radii for injury and mortality to fishes near the seabed for sites modelled in water depths less than 60 m is 154–220 m. To provide context on the area of habitat that may potentially support site-attached fishes, and that could be exposed to sound levels potentially resulting in injury or mortality, INPEX calculated that over the duration of the entire acquisition, the area that may be exposed to sound levels above the mortality/injury effects thresholds accounts for approximately 2.6% to 14% of the acquisition area. Noting that approximately 94-97% of this exposed area is abiotic substrate, the proportion of seabed habitat (in water depths less than 60 m that may support site-attached fishes), which could be exposed to injurious sound levels, is less than 1%. By applying the same analysis method to the indicative acquisition line plan (example 2 in Figure 3-2), the potential extent of suitable site-attached fish habitat in water depths less than 60 m, that may be exposed to potentially injurious sound levels is also less than 1% . As a proportion of the available seabed habitat in comparable water depths within the wider Kimberley AMP, the proportion of exposed seabed that may support site-attached fishes is negligible in the context of natural variability. Tropical reef fish populations and other site-attached fish populations routinely fluctuate by 10% or more due to the normal vagaries in reproduction, recruitment and natural mortality from predation and other factors (Eckert 1987; Connell 1996; Woodside 2007; Goatley & Bellwood 2016). Based on the above assessments, injury and mortality has the potential to affect a very small number of individual fishes, but this is highly unlikely. Should such effects occur, the impact will be low and not be of any ecological significance in the context of natural variability, resilience and recoverability.	

Temporary hearing impairment The potential for TTS effects to occur as a result of cumulative sound exposures from the 2D seismic survey has been evaluated based on the accumulated sound energy over a 24-hour period for different locations within the Acquisition Area and using the 186 dB re 1 μPa^2·s threshold proposed by Popper et al*.* (2014). The acoustic modelling (McPherson et al*.* 2019; Appendix D) predicts that TTS in the most sound-sensitive fishes may occur up to 3.5 km from acquisition lines on the continental shelf, and up to nearly 5 km from acquisition lines in deeper continental slope waters. The distance to impact will be less for the majority of fishes without specialized hearing. The maximum modelled distance is measured broadside of the acquisition lines, and the distance to impact for fishes located fore and aft of the approaching seismic vessel will be limited to shorter distances. The SEL_{24hr} cumulative metric reflects the dosimetric impact of noise levels based on the assumption that an animal is consistently exposed to such noise levels at a fixed position during that 24-hour period. The radii that correspond to SEL_{24hr} typically represent an unlikely worst-case scenario for SEL-based exposure since, more realistically, fishes would not stay in the same location or at the same range for 24 hours. Therefore, this method is highly conservative and a reported radius of SEL_{24hr} criteria does not mean that any animal travelling within this radius of the source will suffer hearing impairment. An expert peer review undertaken by Popper (2018) in relation to the potential for TTS impacts to demersal fishes from a 3D seismic survey in north-western Australia highlighted the reasons why the 24-hour period is conservative. Considering that most (if not all) fish species in the region have relatively poor hearing (compared to fishes with hearing specialisations), each individual fish is exposed to relatively "loud" sounds for only a short period of time and the exposure is only at levels that might lead to potential effects if the fish is relatively close to the sound source for an extended period of time. Instead, the modelled SEL_{24hr} scenarios are not weighted to the auditory thresholds of fishes and so account for a great many seismic pulses over the 24-hour period that are likely too low and distant for fishes to be able to hear (Popper 2018). Popper (2018) concludes: "…TTS is not likely to occur since the signal will not be very much above threshold for the bulk of fishes since they have no hearing specialisations. And, even if there is TTS, the amount of TTS is likely to be limited… …If TTS does take place, the duration of exposure to the most intense sounds that could result in TTS will be over just a few hours… …If TTS takes place, its level is likely to be sufficiently low that it will not be possible to easily differentiate it from normal variations in hearing sensitivity...	

…Even if fishes do show some TTS, recovery will start as soon as the most intense sounds end, and recovery is likely to even occur, to a limited degree, between seismic pulses. Based on very limited data, recovery within 24 hours (or less) is very likely." Therefore, similar to the mortality and injury impact predictions, the modelled extent over which TTS has the potential to occur in fishes is likely to be highly conservative and the mobile demersal and pelagic fishes that are typical in the Operational Area are likely to move away from the approaching seismic source before sound levels reach those that may result in TTS. It is possible that some fishes may not avoid the approaching seismic source completely and some level of TTS is possible, but as Popper (2018) summarises, recovery is likely to occur within 24 hours and the potential for such effects to have significant implications on the fishes' fitness and survival is low. The diverse site-attached, reef-associated fish assemblages at the various coral reefs located outside of the Operational Area are located beyond the range at which TTS impacts have the potential to occur (i.e. greater than 5 km from where the seismic source may be operated). **Behavioural impacts** The potential impacts of the 2D seismic survey to fishes are expected to be primarily behavioural impacts. The following paragraphs describe the expected magnitude and extent of behavioural impacts in the context of the main fish assemblages and key indicator species present in the Operational Area, including potential impacts to key life stages such as spawning and recruitment. **Demersal fish assemblages** The various species of demersal snappers (Lutjanidae), emperors (Lethrinidae), rock cods and groupers (Serranidae) that are characteristic of the Operational Area do not possess a mechanical connection between the swim bladder and the ears, and can be said to have mid to poor hearing ability (Tavolga & Wodinsky 1963; Higgs et al. 2006; Braun & Grande 2008; Engineering-Environmental Management, Inc. 2008; United States Department of the Navy 2008; Popper 2012; Caiger et al. 2012). Note that commercially targeted Rankin cod and other demersal rock cods are not true cods (Gadidae) and so are not considered to have same specialised hearing sensitivity. Therefore, these species of fish are considered to belong to the group of fishes that are primarily sensitive to particle motion with limited sensitivity to sound pressure. The majority of studies relevant to behavioural responses in demersal fish species (e.g. Pearson et al. 1992; Santulli et al. 1999; McCauley et al. 2000; 2003; McCauley & Salgado Kent 2007, cited in Santos Ltd 2018; Woodside 2011; Fewtrell and McCauley 2012; Miller and Cripps 2013; Bruce et al. 2018), indicate that exposure to a mobile seismic source and resultant changes in behaviour are likely to be limited to durations of minutes or	

hours and occur within hundreds of metres to a few kilometres of the seismic source as it passes. A study specifically looking at behavioural responses in captive goldband snapper, one of the key indicator species in the NWMR, found that goldband snapper increased swimming speed as the seismic source approached and then became relatively subdued as the source passed at the closest point (within hundreds of metres) (McCauley & Salgado Kent 2007, cited in Santos Ltd 2018). Received sound levels in this study were estimated to be approximately 194, 196 and 206 dB re 1 µPa PK. These observations are consistent with anecdotal information provided by a NDSMF stakeholder during consultation, who reported that goldband snapper "turn off" after a seismic survey passes in the vicinity of where they are fishing. Popper et al. (2014) indicate that the potential for behavioural impacts in this category of fishes is high in the near-field (tens of metres), moderate at intermediate distances (hundreds of metres) and low in the far field (thousands of metres). Based on the results of various studies that have investigated behavioural responses in fishes exposed to seismic surveys, some fishes may potentially be able to detect sound levels greater than 160 dB re 1 µPa SPL when fish may begin to exhibit subtle responses such as moving closer to the seabed. The acoustic modelling (McPherson et al. 2019; Appendix D) indicates that received SPLs of 160 dB re 1 µPa may occur up to 5 – 11 km from the seismic source depending on the bathymetry and seabed characteristics. This distance is measured in the broadside direction from the seismic source, whereas the distance measured in the endfire direction of any seismic source (as would be more representative of levels received by fishes as the seismic vessel approached), would likely be less for any seismic source. Therefore, it is reasonable to expect that some demersal fishes may be able to detect sound from the seismic source over several kilometres to vary degrees. Given that the majority of demersal species will be more sensitive to the particle motion component of sound at close range than sound pressure waves, these distances may be conservative. More apparent behavioural responses, such as startle reactions, increased swimming speed, changes to school structures and avoidance behaviours have been noted in studies to occur at SPLs of approximately 170-190 dB re 1 µPa depending on fish sensitivity, which the modelling of sound propagation at various different locations in the Acquisition Area indicates may occur between 150 m and 4 km from the seismic source. Therefore, fishes' awareness of the sound and any resultant behavioural responses may be limited to a few hours as the seismic source approaches from several kilometres away and passes, while significant startle or avoidance responses are more likely to be limited to a shorter period (less than an hour) when the seismic source passes close by. Consistent with the studies reviewed earlier in this section, behaviours may return to normal within less than an hour (sometimes just minutes) of the survey vessel passing. Limited data on biochemical stress indicators in fishes exposed to seismic sound indicates there may not be any discernible change (e.g. McCauley et al. 2000, 2003) and free-swimming fishes with the ability to avoid the approaching seismic source are less likely to experience stress than the captive fishes used in experiments. However, if	

fishes were to experience stress as a result of sound exposure, levels may return to normal within 72 hours (Santulli et al. 1999). As the seismic source will be transient (i.e. continuously moving) during seismic data acquisition, demersal fishes will only be exposed to significant sound levels for a relatively short period of time as the survey vessel passes nearby before sailing away again. The survey vessel may return along a parallel acquisition line within a few kilometres of the same location or along a perpendicular line that crosses nearby after many hours or days, so some areas and individual groups of fishes may be exposed again at a later point in time, but generally the seismic source will move across the Acquisition Area with limited potential for repeated sound exposures. Given the transient nature of the 2D seismic survey and the fact that behavioural impacts are likely to be localised and short-term, the implications of these short-term disturbances on an individual's overall fitness and survival are expected to be limited. Further, the implications for demersal fishes exposed to the transient sound of the 2D seismic survey at a population level are expected to be limited. McCauley (1994) suggests that behavioural changes in fishes may only be localised and temporary, without significant repercussions at a population level. Hawkins & Popper (2016) highlight that some responses to man-made sound may have minimal or no consequences for populations. For example, short-term startle responses to sounds that rapidly diminish with repeated presentation, or that do not change the overall behaviour of fishes are unlikely to affect key life functions. In addition, anthropogenic sound events that are transient in nature, such as a seismic survey, and result in short-term impacts do not necessarily translate into long-term consequences to populations (Hawkins & Popper 2016). During the relatively short periods of behavioural disturbance, fishes may be temporarily diverted away from activities such as egg production and spawning (Hawkins & Popper 2016; Carroll et al. 2017). As outlined in Section 4.7.4, some demersal fishes move into nearshore coastal waters to spawn, which will be outside of the Operational Area and away from any potential source of disturbance. However, a number of large demersal species spawn in offshore waters, including some lutjanids, lethrinids and serranids. Many species in these families of fishes spawn throughout their range at locations where water depths, habitat and a range of other environmental conditions are suitable (Domeier & Colin 1997; Claro & Lindeman 2003; Claydon 2004). These types of demersal fishes are highly fecund, multiple broadcast spawners, releasing large numbers of eggs on multiple occasions over an extended spawning season (typically millions of eggs per year) (Claydon 2004; Newman et al. 2008). For example, the key demersal species that are representative of demersal fishes in the region have the following spawning characteristics: • Goldband snapper - spawn consistently throughout their range (typically residing in 50 – 200 m water depths, and often concentrated in depths from 80 – 150 m) between October/November and May.	

• Red emperor – spawn in pairs throughout their range (residing in 10 – 180 m water depths, and often concentrated in depths from 60 – 120 m) between September and June, with bimodal peaks in spawning from September – November and January – March. • Blue spotted emperor – spawn throughout their range (typically residing in 5 – 110 m water depths) between July and March. • Rankin cod – spawn throughout their range (typically residing in 10 – 150 m water depths) from June to December and again in March, with peak spawning from August to October. • Ruby snapper – spawn throughout their range (typically residing in 150 – 480 m water depths) from December to April, with peak spawning from January to March. • Other demersal species – most likely to exhibit a peak spawning period from October – May. Some of these species show genetic connectivity across northern Australia (e.g. red emperor) indicating that spawning throughout this range contributes to species recruitment and so the regional stocks are not vulnerable to local disturbances. Other species such as goldband snapper and rankin cod show some evidence that there is potential genetic differentiation of populations between areas in the NWMR due to limited movement of adults and settlement of larvae in the same region as spawning (Lloyd et al. 2000; Newman et al. 2008). For example, the Kimberley stock of goldband snapper has been identified as potentially being a distinct genetic stock extending from the Northern Territory and Timor Sea to at least 122^{0}E (Lynher Bank) (Lloyd et al. 2000; Newman et al. 2000; Ovenden et al. 2002). However, the spawning of such species still occurs over thousands of square kilometres and along several hundred kilometres of continental shelf, with stock connectivity and recruitment occurring within these areas. Therefore, localized disturbances have limited influence on the overall stocks. The beginning and end of the spawning seasons are largely determined by seasonal water temperatures with triggers for spawning events including the lunar cycle, which affects tidal currents, particularly around new moons and full moons, as well as availability of food, rainfall, time of day, presence of predators, etc. (Claydon 2004; Lloyd 2006). For example, coral trout, another serranid species in the NWMR, is known to spawn when the water temperature is suitable, with spawning fishes releasing eggs over periods of approximately 5 days around the time of new moons in the lunar cycle (Samoilys 1997). However, the triggers and frequency of spawning differs between, and within, species (Claydon 2004). Spawning can vary, both spatially and temporally, during the spawning season and also inter-annually (Claydon 2004; Lloyd 2006). For example, an assessment undertaken by the former WA Department of Fisheries (2015b) of the status of red emperor and goldband snapper in the region indicated that the red emperor spawning population decreased to approximately 35% of unfished levels between 1980 and 2013 while annual recruitment success fluctuated between approximately 150 million fish and 400 million fish per year over the same period	

with no apparent trend or reduction in recruitment associated with the reduced spawning biomass. Similarly, goldband snapper spawning biomass also declined steadily to less than 40% of unfished levels while annual recruitment success fluctuated between a minimum of approximately 250,000 and 900,000 fish. This provides an indication of the normal inter-annual variability in spawning and recruitment of demersal fish species in the Kimberley region. Therefore, localised and short-term disturbances resulting from a transient seismic source are unlikely to result in a discernible impact to demersal fish populations given that spawning and stock connectivity occurs over significantly larger geographic areas, over several months, involves the production of millions of eggs over multiple spawning events, and shows high natural variation. During stakeholder consultation, both WA DPIRD and WAFIC highlighted to INPEX that while demersal fish stocks in the region are assessed as being sustainable, the stocks are fully allocated from a sustainability perspective and any additional risk could potentially impact their long-term sustainability. Noting this advice, no adult fishes will be removed from the spawning biomass / allocated stock (no fish are predicted to be killed as a result of the 2D seismic survey, as noted above). The effects of the seismic survey on the spawning biomass of the various stocks are expected to comprise occasional localised behavioural disturbances to spawning groups of fish, but the level of impact to the populations (spawning biomass and recruitment) is predicted to negligible, particularly in the context of natural variability. During the 2D seismic survey, localised and temporary disturbances from the transient seismic source are likely to affect groups of fishes as the seismic vessel moves across areas of suitable habitat and water depths where groups of demersal fishes are present. On some occasions, these disturbances may also coincide with suitable timing and conditions when the group would normally spawn. It is recognised that the disturbance may temporarily divert effort away from egg production and spawning at that particular location and point in time. Spawning at that particular site may simply be delayed for a short period (minutes or hours) with fishes' motivation to spawn resuming once normal behaviours resume, although this may result in spawning during less favourable conditions (e.g. stage of tide). Alternatively, fishes may delay spawning further until conditions are favourable again. This strategy of reallocating energy and adapting is common in demersal fishes where there may be a predation risk or environmental conditions naturally fluctuate (e.g. Sancho et al. 2000; Claydon 2004; Pavlov et al. 2009), so this is not necessarily unusual or indicative of a reduction in reproductive success, simply an adjustment in spawning behaviour. However, for the purpose of this assessment, if it is conservatively assumed that an entire spawning event is compromised for those effected groups of fishes by disturbance from the passing seismic source. During a 2D seismic survey, the seismic source does not remain encircling the same areas of seabed as might occur for a tighter focussed 3D seismic survey. Therefore, while a tightly focussed 3D seismic survey may result	

in exposure to the same groups of spawning fishes in a relatively smaller area for a relatively long period of time (weeks or months), the large area and broad line spacing over which the INPEX 2D seismic survey will be acquired will generally disturb different groups of fishes in different locations at different times. On days/nights when spawning occurs, only those groups of fishes exposed along the sail line during the hours of spawning may be affected. Therefore, it is not appropriate to assess the proportion of a fish stock that may be disrupted during spawning based on the size of the survey area. Instead, the proportion of a stock disturbed during any spawning event is assumed to be limited to the area overlapped by the survey line. i.e. at any one time during the survey, the spatial overlap with the stock is limited only to the groups of fish that may be affected within tens or hundreds of metres of the seismic source along a few tens of kilometres of sail line. Such localised disruptions may affect different groups of fishes at different locations within the Acquisition Area at different times during the survey. During each spawning event, a similar area will be affected. Given that the range and genetic connectivity of the key demersal fish stocks in this region occur over many tens or hundreds of thousands of square kilometres, disturbances to individual groups of spawning fishes represent only a very small proportion (i.e. less than 1%) of the spawning biomass available in each stock during each spawning event. Impacts are unlikely to be discernible from natural variation given that it is only those particular groups of fishes at particular sites would be affected at that point in time; spawning will continue undisturbed elsewhere throughout the stocks' ranges and the majority of spawning groups in the region at any point in time will be undisturbed. The affected groups of fishes will also spawn again at multiple other times during the spawning season and so discernible impacts to recruitment and populations are not expected. Given the transient nature of the survey and broad acquisition line spacing (3 – 6 km apart) there is limited potential for significant exposure and disturbance to be repeated at the same site. While there may be multiple occasions during the 2D seismic survey when the activity coincides with and disturbs individual groups of spawning fishes somewhere within the Acquisition Area, the acute nature of these disturbances is not expected to have a detrimental population level impact. The multiple broadcast spawning behaviours of demersal fishes on the continental shelf, by their very nature, offsets potential high natural embryo and larval mortality as a result of predation or other environmental factors and thereby spreads the risk or potential opportunity for larval settlement over large areas and long timeframes. Subsequent recruitment of fishes to the adult stock also occurs over extended timeframes and is ongoing. For example, with reference to goldband snapper stocks, the Australian Government's Fisheries Research & Development Corporation has previously noted that long-lived species such as goldband snapper are unlikely to be affected by 'short-duration' environmental/climatic changes (of one or a few years), because adult stocks comprise fish that are recruited over many years (Martin et al. 2014). Therefore, in comparison, the occasional, short-term, transient and localised disturbances to groups of fish as a result of the seismic survey would have	

impacts many orders of magnitude smaller than regional scale environmental/climatic events that would affect entire stocks, and the survey is unlikely to result in a discernible impact on the stocks. No significant or long-term changes to the spatial distribution or numbers of demersal fishes are expected and so the potential long-term implications to populations are expected to be negligible. For the reasons detailed above, overlap between the 2D seismic survey and the Ancient coastline at the 125 m depth contour KEF and the Continental slope demersal fish communities KEF are not expected to compromise the ecological function or value of these KEFs. **Pelagic fish assemblages** Pelagic fishes that occur in the Operational Area include large predatory species such as tuna and mackerel and billfish species (Section 4.7.4). Key species that may occur in the NWMR and are of value to commercial and recreational fisheries include Spanish mackerel and various other mackerels (e.g. grey mackerel), bigeye tuna, yellowfin tuna, skipjack tuna, southern bluefin tuna, broadbill swordfish, striped marlin, black marlin and Indo-Pacific sailfish, which are all fishes of the suborder Scombroidei (that includes all of the large, pelagic, fast-swimming fish species). Many of these species (e.g. mackerels and some tuna species such as skipjack tuna) do not possess a swim bladder or it is poorly developed (Popper et al. 2014; Bray & Schultz 2019a, 2019b), indicating they are sensitive only to the particle motion component of sound at close range to a sound source. Southern bluefin tuna, yellowfin tuna, bigeye tuna and billfish have swim bladders but have no apparent specialist connection with the inner ear (Bertrand & Josse 2000; Song et al. 2006). The lateral line system appears to feature in Scombroidei fishes, again indicating fishes are mainly sensitive to particle motion, but some pressure detection is possible. Song et al. (2006) discovered that the inner ears of bluefin tuna appear to be held rigidly in place by an extensive network of connective tissue and the otoliths are enclosed in a thick cartilaginous wall. These structural features of the ears are believed to be evolutionary adaptations to the heavy body mass of bluefin tuna in order to protect its ear during rapid acceleration, high-speed changes in direction and during dives to great depths (Song et al. 2006). It is possible that this adaptation may also be present in other large pelagic species for the same reasons. The relatively poor hearing abilities of tunas are also reflected in their relatively narrow bandwidth of hearing, which detects only low frequencies (< 1 kHz) with greatest sensitivity at approximately 400 – 500 Hz and a sharp drop off in sensitivity below approximately 200 – 400 Hz (depending upon the species), which are the frequencies that most energy is produced by a seismic source (Iversen 1967; Finneran et al. 2000; Moein Bartol & Ketten 2006; Song et al. 2006; Popper 1981; Popper et al. 2013; Dale et al. 2015).	

Significantly, in relation to bluefin tuna, Song et al. (2006) concluded that: "It is impossible to predict the effects of such sounds on tuna without direct experimentation. Based on the likelihood that bluefin tuna do not have particularly good hearing, however, it is reasonable to suggest that for any sound to be detected by tuna, it would have to be very loud. Thus, fish would have to be close to even the loudest anthropogenic sources (e.g. seismic air guns and sonar) in order for detection to take place." There is no definition given as to what range the authors consider to be "close". However, the authors conclude: "Overall, it is reasonable to suggest that unless bluefin tuna are exposed to very high intensity sounds from which they cannot swim away, short- and long-term effects may be minimal or non-existent. And, considering that bluefin tuna are powerful swimmers and divers, it is possible that if they encounter a sound that is very loud to them, they will move away from the sound rapidly enough to result in minimal exposure." Several papers provide details of the otoliths of swordfish (Beckett 1974), sailfish (Radtke 1981) and the blue marlin (Radtke et al. 1982; Prince et al. 1991). These papers make the point that billfish otoliths are extremely small and difficult to locate. A possible conclusion that can be drawn from this is that billfish, like bluefin tuna, do not have particularly good hearing. Popper et al. (2014) indicate that the potential for behavioural impacts in fishes that do not possess a swim bladder or where the swim bladder is not directly linked to hearing is high in the near-field (tens of metres), moderate at intermediate distances (hundreds of metres) and low in the far field (thousands of metres). Based on the available evidence, yellowfin tuna may have one of the most sensitive hearing capabilities of the scombroid fish species, in that they can possibly detect pulsed sound with source levels of around 165 dB re 1 µPa at a maximum range of approximately 1 km (Finneran et al. 2000). On this basis, this species and other species of tuna and billfish with swim bladders may be able to detect sound emissions from the seismic source during the 2D seismic survey (source level of approximately 250 dB re 1 µPa) at distances greater than 1 km (e.g. a few kilometres). However, other tuna species and mackerels are likely to have poorer hearing capabilities, hence they would potentially have to be closer than 1 km range to detect the particle motions of seismic sound pulses and for a significant behavioural response to occur. Therefore, the extent and duration of behavioural impacts to large pelagic fishes in the Operational Area is likely to be similar or less than those predicted for demersal fishes. In addition, large pelagic mackerels, tuna and billfish are highly transitory with mackerel undertaking longshore movements of tens to hundreds of kilometres (Mackie et al. 2010; Bray & Schultz 2019a, 2019b), while tuna and billfish travel distances of hundreds and sometimes thousands of kilometres on the continental shelf and in open ocean waters beyond the continental shelf (AFMA 2018; Williams et al. 2018). Therefore, the transient nature of the seismic source and the equally	

transient nature of scombroid fish species means that behavioural avoidance responses and effects on distribution will be incidental, localised and of short duration by comparison. Evans et al. (2018) examined the distribution of seismic surveys and the distribution of juvenile southern bluefin tuna in the Great Australian Bight based on an extensive multi-year dataset. Varying degrees of overlap were noted, but it was not possible to distinguish if any changes in tuna behaviour or distribution occurred that were attributable to the seismic survey, given the broad scale of the data and the complexity and degree of natural variability in fishes' behaviour. The study did note, however, that the broadscale annual migration and aggregation of tuna into the Great Australian Bight continued despite the occurrence of seismic surveys. In terms of spawning, the key pelagic species have the following spawning characteristics: • Spanish mackerel – Spanish mackerel congregate in coastal waters around reefs, shoals and headlands to feed and spawn. Congregation in shallow waters may occur from approximately June onwards. The peak spawning period is from September to December/January, with females producing a batch of eggs every 1-3 days throughout the spawning season. Batch fecundity is approximately 750,000 eggs per batch for a 10 kg female. • Grey mackerel – spawn in nearshore waters from approximately August to February, with a peak between August and December. Females produce approximately 250,000 eggs per spawning event and will spawn multiple times during the season. • Southern bluefin tuna – a single spawning ground is known for this species, located mainly in waters south of Java, and hundreds of kilometres west of the Operational Area. Spawning mainly occurs from September to April, with females spawning daily and producing 14-15 million eggs per spawning season. • Bigeye tuna – spawning occurs throughout the year in tropical waters and throughout their range, with females producing 1.2-2.5 million eggs per spawning event every 2-3 days. • Yellowfin tuna – spawning occurs throughout the year in tropical waters, with peak spawning in summer. Females spawn almost daily producing 0.2-8 million eggs per spawning event. • Skipjack tuna – spawning occurs throughout the year in tropical waters, with females spawning almost daily to produce 0.8-2 million eggs per spawning season. • Broadbill swordfish – spawning occurs throughout the year in tropical waters, with females produce 1.2-2.5 million eggs every 2-3 days. • Striped marlin – spawning occurs in summer with females releasing eggs every few days, producing up to 120 million eggs per spawning season. • Black marlin – spawns from August to November, with females capable of producing 40 million eggs.	

• Indo-Pacific sailfish – spawning occurs throughout the year, peaking in summer. Given the high fecundity of these species, the high frequency of spawning events and the large areas over which they occur, no discernible impacts are expected to occur to these stocks as a result of short-term, localised and transient disturbances from the seismic source. Brief exposures of Spanish mackerel to the seismic sound are not expected to hinder the movement of mackerels from mid continental shelf waters into coastal waters in winter and spring, prior to spawning. As described in Section 7.1.7, the 2D seismic survey will not occur during the months of June to October to avoid impacts to humpback whale calving aggregations. Therefore, the 2D seismic survey will avoid the key months when mackerel begin to congregate in coastal waters as well as the early months of the peak spawning period. It is possible that groups of spawning mackerel could occur in the shallower parts of the Acquisition Area (e.g. Lynher Bank and parts of the Leveque Rise) at the same time that the 2D seismic survey is undertaken (from November onwards), but occasional, short-term and transient disturbances to groups of spawning fishes in these areas are not expected to have a discernible impact, given the high frequency of spawning, the biological connectivity of the stocks across the region and other natural variables. It is acknowledged that scombroid and billfish species (and other predatory fishes) target smaller pelagic fishes as prey and these small pelagic fishes form a significant portion of the fish biomass in the Kimberley region. Some of these small pelagic fishes may be more sensitive to sound from the 2D seismic survey than the scombroid fish species themselves and may exhibit a behavioural response and some level of avoidance over several kilometres from the seismic source. Again, given the highly transient nature of the survey and pelagic fishes, the impacts will be short-term and relatively insignificant. However, the behaviour of prey fish species may be affected over greater distances than the larger predatory scombroid and billfish species, which may indirectly result in the abundance and distribution of the larger species being affected over greater distances than from direct disturbance alone. Of the small pelagic fish species that are abundant in the Kimberley region, a number of baitfish are common in shallow nearshore waters, including members of the family Clupeidae, such as pilchards, sardines and herrings. Movements of these baitfish along the coast near Eighty Mile Beach, Roebuck Bay, Broome and the Dampier Peninsula are thought to attract large predatory pelagic fish, such as mackerel, marlin and sailfish, which are present throughout the year, but peak from June to September when productivity and baitfish activity in the region are highest (Wright & Pyke 2010; Pepperell et al. 2011). Wright & Pyke (2010) indicate that the key movements of these baitfish occurs within approximately 25 km of the coast, which is approximately 35 – 40 km from the Acquisition Area at the closest point of approach. The key baitfish species belong to the Clupeidae family, which has specialised hearing sensitivity. Given clupeid fishes' high sensitivity to sound pressure, they may be capable of detecting seismic pulses over long distances. For example, Slotte et al. (2004) observed changes in the vertical position in the water column and potential changes in the migration and	

abundance of herring up to a maximum of 37 km from seismic survey lines. Conversely, Peña et al. (2013) did not observe any changes in the behaviour of herring schools even at 2 km from a seismic survey. However, sound levels received in these coastal waters from the closest point of approach are predicted by the acoustic modelling (McPherson et al. 2019; Appendix D) to be in the order of 120 – 130 dB re 1 μPa SPL and therefore approaching ambient levels in coastal waters. Based on this, no significant behavioural response is expected. As a worst-case, some baitfish schools may be aware of some distant seismic pulses for a brief period (i.e. minutes) when the source is operating at the closest point of approach to their location and may momentarily adjust their position in the water column, but the impact will be negligible. In addition, these baitfish and the billfish that prey on them are most abundant in these waters between June and September, which is within the June to October period that the 2D seismic survey is proposed to avoid, to prevent impacts to humpback whale calving aggregations (Section 7.1.7). Therefore, exposure of key baitfish schools to seismic sound will be largely avoided. **Sharks and rays** Shark and ray species are widely occurring in the NWMR. Species of conservation significance include whale sharks, manta rays and mako sharks. Whale sharks migrate and forage along the continental shelf in this region from July to November. A BIA is designated for these reasons, although whale sharks are transient and there are no aggregation sites. The northern river shark and species of sawfish also occur in the region, these are generally estuarine, with foraging nursing and pupping areas located nearshore, so sawfish are unlikely to be present in the Operational Area. Other key indicator shark species for fisheries in the region include sandbar shark, common blacktip shark, Australian blacktip shark, and spot-tail shark. Other species, including but not limited tiger sharks and hammerhead sharks, will also be present. Sharks and rays (elasmobranchs) are considered to be less sensitive to sound pressure than bony finfish (McCauley 1994). Studies show that elasmobranchs may detect low frequency sound from 50 Hz to 500 Hz (Myberg 2001; Hawkins & Popper 2012). The inner ears of sharks and rays possess some similar but more primitive auditory structures to finfish, with the addition of the macula neglecta, which is a non-otolithic detector composed of two large patches of sensory epithelium and covered in a gelatinous cupula that is similar to the cupula found in the lateral line hearing organs in bony fish (Myrberg 2001; Casper 2011; Carroll et al. 2017). Such structures provide the ability to sense acoustic particle motion via direct inertial stimulation (Carroll et al. 2017). As elasmobranchs lack a swim bladder it is thought that they have a relatively poor sensitivity to sound pressure and are mainly capable of detecting the particle motion component of sound (Myrberg 2001; Casper et al. 2012).	

As such, sharks and rays fall within the category of fishes that Popper et al. (2014) indicate have a high likelihood of behavioural disturbance in the near-field (tens of metres), moderate at intermediate distances (hundreds of metres) and low in the far field (thousands of metres). Shark species are highly vagrant and naturally cover large distances. As such, short-term exposures from the transient seismic source is expected to result in only localised behavioural responses and movements of sharks. The research by Bruce et al. (2018), which tagged two shark species and monitored their movements in response to a seismic survey in Australian waters noted that both control sharks and exposed sharks moved freely in and out of the study area which did not indicate any changes in behaviour or distribution as a result of seismic sound exposure. Whale sharks are known to migrate north from Ningaloo Reef from July to November. Individuals have been tagged moving away from Ningaloo using both inshore and offshore habitats (Sleeman et al. 2010; Wilson et al. 2006; Reynolds et al. 2017) although some of the population have been tracked migrating north-east along the 200 m isobath and the continental shelf towards the Timor Sea. These individuals may pass through the Operational Area. However, given that the 2D seismic survey will not take place during the months June to October, inclusive, the period when whales sharks may be present in these waters in greater abundance is limited only to November. The other months of the whale shark migration and foraging period will not be exposed to sound from the 2D seismic survey. Continental shelf waters out to the 200 m isobath are designated as a BIA for whale shark foraging. Whale sharks may be momentarily disturbed during foraging but their sensitivity to sound particle motion makes them susceptible only within a short range (i.e. within tens or hundreds of metres, consistent with qualitative criteria for sharks and other fish without swim bladders presented in Popper et al. 2014). Behavioural disturbances will therefore involve small deviations in the order of hundreds of metres, but this is negligible given their naturally vagrant behaviour and the large extent of the whale shark foraging BIA across the continental shelf in this region. On this basis, the seismic survey is not expected to displace whale sharks from their foraging habitat. Potential for disturbance to reproduction and pupping is also expected to be limited given the localised and short-term disturbances. The pupping and nursery grounds for many species, including blacktip sharks and spot-tail sharks, are located in shallow nearshore waters (Compagno 2001; Knip et al. 2010; Harry et al. 2013; Welch et al. 2014) where they will not be disturbed by the 2D seismic survey. Sandbar shark pupping and juveniles primarily occur in cooler temperate waters on the west coast of WA, rather than in the tropical waters of the Kimberley. Therefore, impacts to shark species are expected to be insignificant.	

Coral reef fish assemblages As described previously, the high diversity of fish species (many of them site-attached) that inhabit coral reefs in the region are located at coral reefs outside of the Operational Area at distances where fish will not experience any injury or hearing impairment impacts. The acoustic modelling of the sound source in locations relevant to the various coral reefs (McPherson et al. 2019; Appendix D) indicates that the following sound pressure levels may be received at the coral reefs for a short period during the closest point of approach of the operating seismic source, including during run-ins and run-outs when the source may be operated beyond the Acquisition Area boundary: • Scott Reef – 150-160 dB re 1 μPa SPL at a distance of approximately 15 km • Browse Island fringing reef – 150-160 dB re 1 μPa SPL at a distance of approximately 10 km • Beagle Reef – 150-160 dB re 1 μPa SPL at a distance of approximately 10 km (the seismic source will not be operated closer to Beagle Reef than the boundary of the Acquisition Area, due to the presence of the Kimberley Marine Park National Park Zone) • Adele Island fringing reef – 140-150 dB re 1 μPa SPL at a distance of approximately 17 km (the seismic source will not be operated closer to Adele Island than the boundary of the Acquisition Area, due to the presence of the Kimberley Marine Park Habitat Protection Zone) • Lacepede Islands fringing reef – 110-120 dB re 1 μPa SPL at a distance of approximately 60 km. Even if the source were to be operated at full volume at the boundary of the Operational Area, these coral reefs are located over 5 km from this boundary as a minimum and so the received sound levels would be below approximately 166 dB re 1 μPa SPL in any case. At these distances and sound levels, it is likely that many fishes will not be able to detect the seismic pulses. Some more sensitive species of fishes, particularly pomacentrid and holocentrid fishes (such as damsel fishes, clown fishes, soldierfishes and squirrelfishes), which have a specialised connection between their swim bladders and their inner ears, may be able to detect the sound pressures for a short period (i.e. less than an hour) while the vessel passes at the closest point of approach and moves away again, but worst-case behavioural responses will be minor at these sound levels, potentially resulting in a short-term change in vertical position in the water column or retreating into the structure of the reef. In comparison, the Woodside Maxima 3D MSS, which was undertaken within Scott Reef lagoon, resulted in such behaviours when operating at distances as little as a few hundred metres from reef fishes and no significant decreases were detected in the diversity and abundance of both the sound pressure-sensitive pomacentrids and non-pomacentrid fishes following the survey (Woodside 2011; Miller & Cripps 2013). Therefore, even given the conservatism applied in the above assessment of the 2D seismic survey, the impacts of such minor levels of behavioural response in reef fishes over the distances	

identified will be insignificant and the abundance and diversity of these coral reef-associated fish assemblages will be protected. **Summary** Overall, the predicted worst-case impacts to fishes resulting from the 2D seismic survey are: • potential mortality or injury as a result of short-term exposure to the seismic source is highly unlikely. Should such effects occur, only a very small number of individual fishes (e.g. site-attached fish) may be impacted and this will not be of any ecological significance in the context of natural variability, resilience and recoverability; • a low level of TTS in some fishes if they do not actively avoid the approaching seismic source, although recovery is likely to occur quickly (within 24 hours or less) and the potential for such effects to have significant implications on the fishes' fitness and survival is low; • temporary changes in behaviour ranging from changes in vertical position in the water column to startle responses and avoidance, although behaviours may return to normal within minutes or hours in most cases; and • localised disruption to individual groups of spawning fishes within a few kilometres of the operating seismic source, but this is not expected to have a detrimental population level impact given that spawning and stock connectivity occurs over large geographic areas, over several months, involves the production of millions of eggs over multiple spawning events, and shows extremely high natural variation. The consequence of these local scale and short-term impacts, which will affect a small proportion of fish populations at a time, is considered to be Minor (E).	

Identify existing design and safeguards/controls measures			
The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3). INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification

Elimination	None identified	No	The 2D seismic survey cannot be achieved without using a seismic source. Elimination of the seismic source is not possible.
Substitution	None identified	N/A	No additional substitution controls were identified that would practicably reduce the risk to fish and sharks.
	Use alternative seismic technologies to reduce potential impacts to fishes	No	Alternative technologies such as 'eSource' and 'e-seismic' have been considered. These technologies are relatively new technologies which are designed to limit the component of sound levels at frequencies higher than the frequencies essential for seismic exploration. The higher frequency components of the sound can be harmful to fishes at very high intensities (i.e. close to the source). Presently, however, there is only one vessel globally with the eSource capability and it is currently impossible to commit to a single seismic operator at this stage. To replace or update the seismic array on another vessel would cost in the order of US$2 million for the new hardware. Marine vibroseis is another emerging technology that may reduce sound output but currently, this technology is not widely or commercially available. Given the free-swimming nature of fishes typical of the Operational Area (i.e. no significant site-attached assemblages are expected), the potential for injury or impairment to fishes is already very low. Therefore, the identified alternative technologies may have limited environmental benefit and would attract a commercial and financial cost that is not justified.
Engineering	Design the acquisition line plan to exclude the Ancient coastline at the 125 m depth contour and the Continental slope demersal fish	No	INPEX has given consideration to the exclusion or reduction of acquisition lines in order to minimise impacts to demersal fish assemblages. This included considering if existing legacy data can be used instead of undertaking new seismic

	communities KEFs where relatively diverse fish assemblages are expected to occur and may spawn at certain times of year.		data acquisition. Unfortunately, any legacy data that is available that INPEX has not already accounted for, is old and of too poor a quality to be able to evaluate the subsurface geology at the required depths. Excluding survey lines or increasing line spacing would also result in significant loss of data quality in areas that are important for evaluating the potential of hydrocarbon targets. It is impracticable to identify the exact locations of rock outcrops or other habitat where demersal fish may spawn (e.g. using multibeam echosounder and side-scan sonar equipment). This would involve extensive and costly survey or scouting work over many months. Even then, the locations of spawning events are impossible to predict. This option is impracticable and, given the already low level of risk to populations as a result of short-term disturbances, this achieves a very limited environmental benefit. The costs are grossly disproportionate to the relatively limited risk posed to fishes.
	Reduce seismic source volume and acoustic output in water depths less than 50 m	No	The proposed ~3,000 cubic inch seismic source volume has been determined based on a detailed feasibility study as the volume necessary to achieve the objectives of the 2D seismic survey throughout the Acquisition Area, taking into account the depth of the seismic targets and the characteristics of the underlying geology. Further review of the source volume required to acquire data in areas shallower than 50 m (i.e. Lynher Bank) determined that the shallow seabed sediments and depth to target may permit a smaller source volume and acoustic output to be used. A source volume of approximately 2,000 in^3 was determined to be the minimum source volume suitable for these areas.

			INPEX engaged JASCO to model the sound levels resulting from a 2,060 cubic inch seismic source, based upon details provided by potential seismic contractors, to evaluate the potential reduction in footprint that may be possible in water depths less than 50 m, in relation to effects criteria for fishes. The results are presented in the acoustic modelling report in Appendix D for comparison with the results for the modelled 3,080 cubic inch source. The potential reduction in the footprint of effects is summarised as follows: • The range to potential injury to fish without a swim bladder is reduced by approximately 23-42%, noting that for either source, the range to impact is already limited to tens of metres from the centre of the seismic source. • The range to potential injury to fish with a swim bladder is reduced by approximately 8-28%. Based on the modelling results, there may be a minor reduction in the footprint of potential injurious effects to fish, if a smaller source is used in areas shallower than 50 m. However, the actual benefit to fishes achieved by doing this may not be significant based on the following factors described in the above consequence assessment: • As described in ERM (2017), the Popper et al. (2014) thresholds for injury in fish are likely to be conservative, and the potential for such affects is likely to be limited to within a few metres of either seismic source. • The demersal and pelagic fish that are characteristic of the seabed habitats in the Acquisition Area are mobile, free-swimming species that are able to

			move to avoid any injurious effects, therefore, limited impacts are expected. • The Acquisition Area does not provide habitat that would support significant site-attached fish assemblages that may otherwise be susceptible to injury. Coral reefs in this area are located outside of the Operational Area. Therefore, the impacts and risk to fishes using the 3,080 cubic inch source are already predicted to be low and there is limited reduction in risk from using a smaller source. INPEX made enquiries with seismic contractors into the feasibility of using a smaller source. This would either require changing over the seismic source during the survey, which would involve significant time delay and costs as well as line infill and overlap (including repeat exposures to some areas) when returning to acquire the shallow areas; or another alternative would be to turn individual source elements in the source array off while the seismic vessel is in underway. Seismic contractors suggested that this is possible in theory, but individual elements would need to be powered down manually one at a time. This would result in some shot points being missed during the transition in and out of shallow areas. Although this may not correspond with large areas of lost data it is an added complexity and technical risk. Given the potential technical complexity and/or additional time associated with implementing a reduced source volume control in shallow water areas, the already low risk to fish, and the limited environmental benefit gained, this option is, therefore, impracticable.

	Include a time interval prior to repeat survey of overlapping sail lines in sensitive locations (including infill activities) to allow for potential recovery of fish to cumulative sound exposures.	No	It is noted that the orthogonal grid line plan that is characteristic of 2D seismic surveys requires survey lines to overlap in numerous locations. In addition, "infill" activities may be required if the survey vessel has to return to complete a section of line that was missed during a period of shut down, which will result in some overlap. Repeat exposures of fish to the seismic source may result in an increase in the accumulated sound energy that fish receive and therefore increased potential for hearing impairment (TTS). In many parts of the survey, repeat exposures may not occur for several days depending upon the line sequence that is acquired. In this scenario, it is reasonable to expect that fish will have recovered from previous sound exposures based on some limited research by Popper et al. (2005) that suggests recovery from TTS may occur within 18-24 hours, and information provided in in the independent expert peer review undertaken by Popper (2018) with regards to demersal snapper exposed to a seismic survey in northern Australia, which states: • If TTS occurs, it is likely to be limited and its level is likely to be sufficiently low that it will not be possible to easily differentiate it from normal variations in hearing sensitivity. • Even if fishes do show some TTS, recovery will start as soon as the most intense sounds end, and recovery is likely to even occur, to a limited degree, between seismic pulses. The demersal and pelagic fish that are characteristic of the seabed habitats in the Acquisition Area are mobile, free-swimming species that are able to move to avoid significant exposures that may result in TTS. The Acquisition Area does

			not any significant areas of habitat that would support true-site-attached fish assemblages that would be more susceptible to TTS. The potential consequence and risk is therefore already assessed as low. The survey line acquisition sequence will be determined by specialist planning software such as SurvOpt which optimises the acquisition so that lines are completed in an efficient order. Implementing a time delay prior to acquiring overlapping sail lines in sensitive locations would introduce complexities and potentially cause delays. Acquiring all lines in one orientation before commencing lines orientated in the other direction may achieve this objective, but due to the additional sail time, this could extend the duration of the survey by several days or weeks, costing hundreds of thousands of dollars. It would be less detrimental to delay only some lines where overlap could occur within 24 hours of the first line being acquired, but determining a line plan of this sort, even with specialist software is challenging. Given that the risk of TTS in fish is already low and the complexity (and potential cost and delay) involved in implementing this control, it is not considered practicable.
Procedures & administration	Soft-start procedures to provide receptors with advanced opportunity to move away from the seismic source.	Yes	Soft-start procedures, involving the gradual ramp up of the seismic source to full power over a period of 30 minutes, will provide fish with the opportunity to move away from the seismic source and avoid injury, which could otherwise occur if the seismic source was started at full volume. Soft-start procedures will already be implemented in accordance with EPBC Policy Statement 2.1 for cetaceans.

	Apply a precautionary shut down zone around the seismic source to prevent injury and hearing impairment impacts to whale sharks	Yes	Based on the conservative Popper et al. (2014) threshold for mortal or recoverable injury, injury to sharks is predicted to occur between 54 m and 114 m from the geometric centre of the seismic source. As previously noted, the threshold is highly conservative and based on pile driving sound, rather than seismic survey sound exposures; ERM (2017) noted, it is likely that injury will not occur until much higher peak pressures are experienced. Such levels may only occur in the immediate vicinity of the seismic source array. This is further demonstrated given that dolphins, which are understood to be more susceptible to the effects of sound than sharks, are not predicted to experience sound levels that may result in injury or hearing impairment beyond 20 m from the centre of the seismic source, based on NMFS (2018) impact threshold criteria. Also, given the naturally mobile behaviours of whale sharks and ability to move freely away from the approaching seismic source, a situation where a whale shark is exposed to potentially injurious levels of sound in the immediate vicinity of the seismic source is highly unlikely to ever occur and there have been no known reported incidents involving whale sharks in other seismic surveys. In addition, the proposed timing of the survey means that the period when whales sharks are understood to be present in the Operational Area in relatively high abundance and at the same time as 2D seismic survey activities is limited to the month of November. Therefore, the potential for injury to whale sharks is already minimal and the risk is very low. However, given that whale sharks are a listed vulnerable species, a precautionary shut-down zone is considered to be a practicable measure. Whale sharks may forage near the surface and occasionally be visible at the surface. However, as they are not an air

			breathing animal like cetaceans or turtles, they can be very difficult to spot, except when in close proximity. Accounting for potential injury to occur between 54 m and 114 m from the geometric centre of the seismic source and acknowledging that these predicted ranges may already be conservative, a shut-down zone of 100 m is likely to be protective for whale sharks in most circumstances. However, INPEX propose applying a larger, 250 m shut-down zone, consistent with the shut-down zone that will be applied for marine turtles (Section 7.1.8), as the most practicable to support the operation.
	Schedule seismic acquisition to avoid key fish spawning periods	No	The proposed schedule and temporal window for the 2D seismic survey has been determined taking into account: • the timing of key environmental and socio-economic receptors • the hearing ability and sensitivity of those receptors to sound from the seismic survey • the proximity of sensitive habitat areas to seismic survey areas • the species distribution and range • the level of overlap (in space and time) by the 2D seismic survey with important habitats and life stages of sensitive species • species vulnerability / conservation status • the potential for impacts to species at both an individual level and at a population level The optimum window of opportunity was determined to be from November to May (inclusive) in any year covered under this EP, to avoid the period when humpback whales are present in the Kimberley region for calving, nursing and resting. This was based on the species' high sensitivity to

			low frequency sound and the potential for significant risks if this key life stage were to be disturbed over weeks or months. Seasonal avoidance of key turtle internesting habitats will also be implemented at other times of the year. Fish spawning periods were also considered in detail, noting the importance of spawning and recruitment of fish stocks, but also noting fishes' sensitivity to seismic sound is significantly less than that of cetaceans. Groups of spawning fishes may be disturbed for short periods when the seismic source is passing within hundreds of metres or several kilometres of their location, depending on the species (compared with resting adult and calf humpback whales, which may be aware of the sound for more extended periods or recurringly from seismic survey operations up to many tens of kilometres away). The spawning periods of the many different key indicator fish species for the commercial fisheries in the region extend throughout the entire year but can vary significantly between species. Some species spawn for most of the year. Some fish species reproductive behaviours are less likely to be disturbed by the 2D seismic survey than others. For example, Spanish mackerel congregate to spawn in nearshore waters and the Acquisition Area largely avoids these areas. Shark pupping and nursery habitat in nearshore waters is also avoided. Many tuna and billfish species spawn throughout the year, over thousands of kilometres, and these species have limited sensitivity to sound so these stocks are not expected to be impacted. The peak spawning periods of some demersal fish species will be partly or fully avoided, including blue spotted emperor (peaking July to March), Rankin cod (peaking August to October), and one of two peak spawning periods

			of red emperor (September to November). However, it is not possible to avoid the peak spawning periods of all demersal fish species, many of which spawn from September/October through to May, including goldband snapper. Goldband snapper, a key species targeted by the NDSMF, spawn consistently between September/October and May. The early peak spawning months of September and October will be avoided. However, the peak spawning period is approximately the opposite time of year as the period to be avoided for humpback whales. As noted in the above consequence assessment, occasional localised disturbances of groups of spawning demersal and pelagic fishes may occur, but this is not expected to have a significant impact on the stocks, due to their high fecundity (each female producing millions of eggs per season or per spawning event); the occurrence of multiple spawning events over extended spawning seasons (many months); and the stocks' biological connectivity through recruitment from across the region. Multiple and broadcast spawning strategies, by their very nature, are carried out by fishes to spread the naturally high risk of mortality and maximise the potential opportunity for egg and larval survival over large areas and long timeframes. The predicted minor consequence and low risk of the 2D seismic survey to fish stocks means that avoidance of fish spawning periods would provide negligible environmental benefit at a disproportionate cost. Therefore, this option is not considered practicable.

Identify the likelihood		
With the above described soft-start control in place, the potential for injury and hearing impairment in fishes is substantially reduced. Injury and mortality in particular are expected to be prevented. Behavioural impacts are still expected to occur. The likelihood of localised and short-term impacts to fish behaviours and spawning, with Minor consequences, is considered Likely (2).		
Residual risk summary		
Based on a consequence of Minor (E) and a worst-case likelihood of Likely (2) the residual risk is Moderate (6).		
Consequence	Likelihood	Residual risk
Minor (E)	Likely (2)	Moderate (6)
Assess residual risk acceptability		
Legislative requirements N/A – There are no legislative requirements applicable to managing the effects of seismic surveys in relation to fishes. **Stakeholder consultation** Feedback was received by the WA DPIRD, WAFIC and commercial fisheries licence holders (Table 5-4) highlighting the concerns the fishing industry has about the potential impacts of seismic to commercial fish stocks, including impacts to spawning, recruitment and to the food chain. These concerns have been considered in this EP through the implementation of a series of controls and demonstration that impacts will be managed to ALARP and acceptable levels. DPIRD has provided formal advice regarding the spawning periods, depth ranges and spawning behaviours of key indicator fish species which have been included in this EP and have informed the assessment of risk to the fish stocks. INPEX has also responded, in detail, to each issue raised by WAFIC. WAFIC requested that where there is limited knowledge or science, then the extensive knowledge of fishermen should be taken into consideration. INPEX reviewed the feedback of each individual fishery licence holder and responded in detail to each of them separately. In relation to spawning and recruitment, a licence holder in the Northern Demersal Scalefish Managed Fishery raised concerns about impacts to juvenile fishes which recruit to the stocks. This has been considered in the risk assessment and a response provided to the stakeholder. A licence holder in the Mackerel Managed Fishery raised concerns about the flow on effects of disturbance to spawning in the Kimberley to the stock in the Gascoyne region. INPEX was able to provide referenced information to confirm that spawning in the Kimberley region is a source of stock recruitment in the Pilbara region, but that DPIRD notes that spawning fish in the Pilbara		

sector are likely to be the source of recruitment for the Gascoyne sector, and recruitment to the Gascoyne sector from spawning in the Kimberley region is likely to be limited. The same licence holder suggested that mackerel spawning took place earlier in the year than the period suggested by DPIRD. INPEX clarified this with DPIRD who advised that the DPIRD information was the correct information to use. This has been considered in the risk assessment and a response provided to the stakeholder.

A copy of the draft risk assessments were provided in full to each stakeholder for their review prior to submission of the EP to NOPSEMA. This was accompanied by a summary explanation of the key conclusions and proposed control measures. Stakeholders were given the opportunity to provide feedback on the proposed control measures and communication protocols.

INPEX therefore considers that stakeholder concerns have been adequately addressed. The level of impact to commercial fish stocks is acceptable because impacts to spawning and recruitment are within the realms of natural variability.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts are expected to occur to the demersal and pelagic fish communities that form part of the ecosystem and KEF values of the Kimberley AMP.
- No significant or long-term impacts are expected to occur to key habitats of EPBC Act listed species included as values of the Kimberley AMP, including foraging habitat for whale sharks.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. No survey activities will occur in the Habitat Protection Zone, and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. No survey activities will occur in the National Park Zone, and the ecosystems, habitats and native species within the National Park Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. However, none of the recovery plans or conservation advice documents are relevant to the effects of seismic or other anthropogenic noise on fish assemblages. In recognition of the Conservation Advice for Whale Sharks, the proposed soft-start control minimises the potential for impacts to whale sharks and this species is not expected to be prevented from foraging within the BIA or displaced along their migration route.

INPEX has also considered Department of Fisheries (2013) guidance and WA DPIRD's recently published ecological risk assessment of seismic impacts to marine finfish and invertebrates (Webster et al. 2018) during this assessment.

ALARP summary

Given the level of environmental risk is assessed as Moderate, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD – i.e. there are no long-term impacts to spawning biomass or changes in recruitment of the stocks that are not within the realms of natural variation; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Moderate", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
Undertake seismic acquisition in a manner that prevents injury and population/stock level impacts to fishes resulting from seismic sound emissions.	Soft start procedures will be conducted in accordance with Part A of EPBC Policy Statement 2.1, specifically, the seismic source will commence operating at low power and will increase to full power over a period of 30 minutes.	Marine Fauna Observer (MFO) report confirms that soft start procedures were conducted.	MFO
Undertake seismic acquisition in a manner that prevents injury to whale sharks.	A shut down zone of 250 m radius will be applied to whale sharks.	MFO report confirms that 250 m shut down zone applied for whale sharks.	MFO

7.1.7 Underwater noise and vibration – Marine mammals

Receptor sensitivity to sound and sound exposure thresholds

Cetaceans are considered to include some of the most sensitive species to underwater sound. Cetaceans utilise their highly sensitive acoustic senses to monitor their environment and for communication, socialising, breeding and foraging. Dugongs are also able to hear low frequency sound but are generally considered to be less sensitive to sound than cetaceans.

Potential hearing impairment

The hearing sensitivity and acoustic thresholds for potential hearing impairment in marine mammals have been the subject of various comprehensive reviews of the available scientific literature by groups of internationally-recognised experts in the subject (e.g. Southall et al. 2007, 2019; Finneran 2015, 2016; U.S. NMFS 2016, 2018).

Southall et al. (2007) was the first of these studies to categorise three functional hearing groups based on the frequency hearing ranges of cetaceans (low, mid and high-frequency). Low-frequency cetaceans (LFC), generally comprising mysticetes (baleen whales), such as humpback whales and blue whales, are able to hear sound within a frequency range of a few Hz to a few tens of kHz, which coincides with the frequency range of impulsive seismic signals. Mid-frequency cetaceans (MFC), including odontocetes (toothed whales) such as dolphins and sperm whales, and high-frequency cetaceans (HFC) such as porpoises and some specialised dolphin and whale species, are considered to have their peak hearing sensitivity at frequencies greater than several kHz. Therefore, MFC and HFC are less sensitive to low frequency seismic signals, although some sound is still audible to them.

Southall et al. (2007) developed sound exposure thresholds for permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals exposed to seismic sources. PTS and TTS are shifts in an animal’s hearing threshold as a result of prolonged and/or intense sound. It should be noted that PTS effects in marine mammals are theoretical and have never been known to occur in either captive or wild animals. The thresholds proposed by Southall et al. (2007) comprised dual metric criteria, requiring consideration of both the instantaneous peak pressure (PK) and the sound exposure level accumulated over a 24-hour period (SEL24hr). The SEL_{24hr} thresholds proposed by Southall et al. (2007) were frequency weighted according to the three functional hearing groups (LFC, MFC and HFC) (m-weighting).

The TTS sound exposure threshold developed by Southall et al. (2007) (183 dB re 1 μPa2.s) was subsequently used by the Australian government to derive a single-pulse SEL exposure threshold of 160 dB re 1 μPa2.s for 95% of seismic pulses at a 1 km range, as specified in EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales (EPBC Policy Statement 2.1) (DEWHA 2008a). The Commonwealth (DEWHA 2008a) threshold is used by industry and regulators in Australia for the assessment of impacts from seismic activities and to determine appropriate mitigation zones to minimise the likelihood of TTS in mysticetes and large odontocetes.

More recently, U.S. Navy technical reports by Finneran (2015, 2016) proposed new auditory weighting functions and the U.S. NMFS (2016, 2018) undertook a comprehensive review of PTS and TTS dual metric criteria for marine mammals and revised the threshold criteria for each frequency-weighted functional hearing category of cetacean. M-weighting curves, as per Southall et al. (2007), are no longer used but replaced by more accurate auditory weighting functions reflecting the increased knowledge about hearing-related parameters for various species of the different functional hearing groups. The revised criteria for cetaceans and sirenians (dugongs and manatees) now recommended by U.S NMFS (2018) are presented in Table 7-12. The criteria represent the levels at which a 6 dB threshold shift in hearing will begin to occur either permanently (PTS) or temporarily (TTS).

Southall et al. (2019) also revised the Southall et al. (2007) marine mammal sound exposure criteria. The PTS and TTS exposure criteria in U.S. NMFS (2018) and Southall (2019) are identical. The auditory weighting functions for the different functional hearing categories are also identical4 supporting the most recent (U.S. NMFS 2018) criteria.

Although outside of the scope and jurisdiction of the U.S. NMFS (2018) report, auditory weightings and PTS/TTS threshold criteria are also defined by U.S. NMFS (2018) and Southall et al. (2019) for sirenians (dugongs and manatees). The auditory hearing range of sirenians is sensitive to a slightly lower and narrower range of frequencies than mid-frequency cetaceans (U.S. NMFS 2018; Southall et al. 2019).

The EPBC Policy Statement 2.1 (DEWHA 2008a) criteria has been evaluated in this EP when considering potential control measures to mitigate TTS, with consideration also given to the more recently proposed U.S. NMFS (2018) threshold criteria for PTS and TTS in cetaceans and dugongs (Table 7-12).

Table 7-10 TTS and PTS dual metric criteria for cetaceans and dugongs exposed to impulsive sound (U.S. NMFS 2018; Southall et al. 2019)

Functional hearing category	PTS	TTS
Low-frequency cetaceans (Generalized hearing range from 7 Hz to 35 kHz, but mainly sensitive between 200 Hz and 19 kHz)	PK: 219 dB re 1 μPa Frequency-weighted SEL_{24hr}: 183 dB re 1 μPa^2.s	PK: 213 dB re 1 μPa Frequency-weighted SEL_{24hr}: 168 dB re 1 μPa^2.s
Mid-frequency cetaceans (Generalized hearing range from 150 Hz to 160 kHz, but mainly sensitive between 8.8 kHz and 110 kHz)	PK: 230 dB re 1 μPa Frequency-weighted SEL_{24hr}: 185 dB re 1 μPa^2.s	PK: 224 dB re 1 μPa Frequency-weighted SEL_{24hr}: 170 dB re 1 μPa^2.s
High-frequency cetaceans (Generalized hearing range from 275 Hz to 160 kHz, but mainly sensitive between 12 kHz and 140 kHz)	PK: 202 dB re 1 μPa Frequency-weighted SEL_{24hr}: 155 dB re 1 μPa^2.s	PK: 196 dB re 1 μPa Frequency-weighted SEL_{24hr}: 140 dB re 1 μPa^2.s
Sirenians (dugongs) (Hearing range potentially from ~250 Hz to >60 kHz, but mainly sensitive between 4.3 kHz and 25 kHz, with peak sensitivity around 8 kHz)	PK: 226 dB re 1 μPa Frequency-weighted SEL_{24hr}: 190 dB re 1 μPa^2.s	PK: 220 dB re 1 μPa Frequency-weighted SEL_{24hr}: 175 dB re 1 μPa^2.s

[4] The auditory weighting functions and the different functional hearing categories of cetaceans are identical in both U.S. NMFS (2018) and Southall et al. (2019). However, each uses slightly different terminology. The LFC, MFC and HFC categories described in U.S. NMFS (2018) are termed LFC, HFC and very high frequency cetaceans (VHFC), respectively in Southall et al. (2019). Southall et al. (2019) explain that, pending further knowledge and future studies, it may be possible to reassign some species to new functional hearing groups, MFC and very low frequency cetaceans (VLFC). However, based on the current latest knowledge, the three existing hearing categories reflect the most up to date knowledge. To avoid confusion, the U.S. NMFS (2018) hearing categories (LFC, MFC and HFC) continue to be used throughout the assessment in this EP.

Behavioural response

The context of sound exposure plays a critical and complex role in behavioural responses in marine mammals (Gomez et al. 2016). For example, different species (and different individuals or groups within a species) may respond differently to varying levels of sound depending on their behaviours and motivation at the time (e.g. foraging, socialising, resting and reproduction) and other factors such as the type of sound, duration of exposure, and the suddenness of the onset of the received sound (Gomez et al. 2016). Currently, there are no specific received level thresholds for reliably assessing or regulating stress responses. Impact assessment is primarily focussed on responses that may impact survival, lead to significant life stage impacts or displacement from biologically important areas, so a threshold for behavioural disturbance based on cetacean avoidance reactions to seismic is more commonly adopted as a proxy for such effects (Gomez et al. 2016).

Cetaceans have been observed to exhibit varying behavioural responses (ranging from, for example, momentary pauses in vocalisations and changes in body orientation, to changes in travel direction and behavioural avoidance) to received SPLs of 140 and 180 dB re 1 µPa and as low as 110 dB re 1 µPa in some instances (Southall et al. 2007; Gomez et al. 2016). Higher received levels are not always associated with stronger behavioural responses and vice versa, and a clear dose-response relationship has not been identified (Southall et al. 2007; Gomez et al. 2016). In addition, a behavioural response does not necessarily equate to a significant avoidance or deviation in cetacean movements that would actually displace individuals or the population from the wider area.

Humpback whales have been demonstrated to have variable responses to seismic noise. Malme et al. (1985) reported feeding humpback whales responded to levels of 150–169 dB re. 1 µPa. McCauley et al. (1998) observed that migrating and feeding humpback whales showed behavioural responses at received SPLs of 150 – 170 dB re 1µPa. McCauley et al. (2000, 2003) note that some resting female humpback whales with calves display avoidance reactions at approximately 140 dB re 1 µPa SPL, though other cohorts reacted at higher levels (157–164 dB re 1 µPa SPL) and some males were even attracted towards the seismic source at received levels up to 179 dB re 1 µPa SPL.

Malme et al. (1984, cited in Southall et al. 2007) observed behavioural responses in groups of migrating gray whales in response to 140 – 180 dB re 1 µPa SPL during three decades of seismic survey activity off the coast of California. Gisiner (2017) notes that during the same period of the Malme et al. (1984) study, the same gray whale population increased dramatically in number from 2,000 to 26,000 animals, and whatever response there was by the gray whales to that seismic survey activity, it apparently had little to no discernible impact on gray whale survival or reproduction.

Malme et al. (1988) found that feeding gray whales in the Bering Sea exhibited onset of feeding interruption around received levels of 163 dB re 1 µPa SPL and that about half of the whales stopped feeding and moved away at received levels averaging 173 dB re 1 µPa SPL.

Richardson et al. (1999) observed migrating bowhead whales show a strong avoidance reaction to lower SPLs of 120 – 130 dB re 1 µPa. However, bowhead whales were found to be more tolerant of seismic noise while they were feeding and remained in the area until levels exceeded 160 dB re 1µPa (Richardson et al. 1986; Miller et al. 2005).

Dunlop et al. (2017) reported that migrating humpback whales were likely to deviate from their course within 3 km of a small volume seismic source, in response to a received SEL of 140 dB re 1 µPa2.s (approximately 156 dB re 1 µPa SPL). However, the relationship observed between dose and response was not a simple one. The reported deviations were typically short term and localised. The average deviation from the operating sound source was approximately 500 m, only 100 m (±75 m) further from the sound source than when whales were observed avoiding the vessel without the seismic source operating (Dunlop et al. 2017; Gisiner 2017). Maximum deviations were 1,500 m to 1,800 m; however, this larger deviation involved the group of whales approaching the source (potentially out of curiosity), not avoiding it, and therefore, a reported change in movement behaviour did not necessarily result in avoidance of the source (Dunlop et al. 2017; Gisiner 2017). Such small and inconsistent deviations are generally insignificant within the larger context of a migration that occurs over months and thousands of kilometres (Gisiner 2017).

U.S. NMFS and NOAA have recommended behavioural response criteria of 160 dB re 1 µPa (unweighted) SPL for a likely significant behavioural response from cetaceans (U.S NMFS & NOAA 1995; U.S. NMFS 2014).

Wood et al. (2012) proposed alternative SPL behavioural response thresholds, based partly on the U.S. NMFS and NOAA 160 dB re 1 µPa (unweighted) SPL, but with a key difference being that a frequency weighting was applied to the proposed threshold estimates. The thresholds proposed for most cetaceans were based on a graded probability of response for most cetaceans, as follows:

- low response potential (10% of individuals in a group) at an SPL of 140 dB re 1 µPa
- medium response potential (50% of individuals in a group) at an SPL of 160 dB re 1 µPa
- high response potential (90% of individuals in a group) at an SPL of 180 dB re 1 µPa.

For more sensitive life stages/behaviour modes, Wood et al. (2012) adopted a protective and precautionary approach, whereby SPLs of 120, 140 and 160 dB re 1 µPa represented the 10%, 50% and 90% response levels in a group. The adopted levels were based on studies were cetaceans were observed to change behaviour in response to a number of different sound sources, including continuous vessel noise and naval sonar, rather than impulsive seismic sound. Therefore, the graded thresholds proposed by Wood et al. (2012) may be conservative and the lower referenced sound levels may not actually elicit any notable or discernible response to impulsive seismic sound.

The behavioural response thresholds applied in the assessment of sound effects to marine mammals are presented in Table 7-11. The U.S. NMFS (2014) 160 dB re 1 µPa SPL threshold is selected as the level at which some significant behavioural responses may occur, such as avoidance by migrating and transient animals. This is broadly representative of the majority of observations reported in the literature cited above. In the risk assessment, the threshold has been applied to unweighted sound levels, as per U.S. NMFS (2014), but the acoustic modelling commissioned by INPEX has also looked at response levels weighted according to the functional hearing of LFCs, which is more biologically relevant to these species. It is stressed that while these levels are considered in the assessments to provide an indication of behavioural response, such behaviours do not necessarily equate to a material impact in the context of broader distributions, migration routes, feeding areas or other life stage behaviours.

Recognising the potential for humpback whale calving, resting and nursing to occur seasonally in the Kimberley region, INPEX has also identified more precautionary impact thresholds for these key life stages. Noting that pods with cows and calves in north-western Australia were observed by McCauley et al. (2000, 2003) to swim strongly and avoid seismic noise at received SPLs of 140 dB re 1 µPa, this is considered representative of potential avoidance response by these animals. However, it is acknowledged that lower sound levels may also result in some level of disturbance. Therefore, as a precaution, the potential for behavioural impacts during resting, calving and nursing in response to lower levels of 120 – 140 dB re 1 µPa are also discussed in the assessments, noting that 120 dB re 1 µPa SPL may be at or approaching ambient background noise levels in coastal environments (see below).

Sirenians are generally considered to be less sensitive to sound than cetaceans, including lower frequency sound (Gerstein et al. 1999), although behavioural response thresholds for cetaceans and other marine mammals have previously been applied to assess the potential behavioural effects to sirenians (e.g. Finneran & Jenkins 2012). Therefore, for the purposes of his assessment, the same 160 dB re 1 µPa SPL behavioural response criteria proposed by U.S. NMFS (2014) for cetaceans is also applied for dugongs.

Table 7-11 Marine mammal behavioural response thresholds

Marine mammal category	Behavioural response thresholds
Migrating and feeding cetaceans	Potentially significant behavioural response / avoidance: 160 dB re 1 µPa SPL
Resting, calving and nursing cetaceans	Potential avoidance: 140 dB re 1 µPa SPL Low-level disturbance: 120 – 140 dB re 1 µPa SPL
Dugongs	160 dB re 1 µPa SPL

Masking

Acoustic masking may occur when a noise impedes the ability of an animal to perceive a signal (Wood et al. 2012; Erbe et al. 2016). For this to occur the noise must be loud enough, have similar frequency content to the signal, and must happen at the same time (Wood et al. 2012). The sound generated by seismic surveys comprises brief, low frequency pulses (in the order of tens of milliseconds), occurring several seconds apart. At great distances from the seismic source, sound levels will be quieter, but transmission of the sound via multiple pathways (water, seabed) and reverberation mean that the pulse duration increases and can be greater than 1 second in length. However, given the short pulse duration relative to the duration of marine mammal vocalisations (several seconds to several minutes or longer), marine mammals are likely to be able to detect calls in between seismic pulses, despite some acoustic features of these vocalisations potentially being obscured (Wood et al. 2012). The short, intermittent pulse duration relative to the 8-second source point interval proposed for the 2D seismic survey means that the potential for masking is limited.

In addition, Wood et al. (2012) and Erbe et al. (2016) highlight studies that have documented masking compensation strategies (responses the animals use to overcome the masking effects of anthropogenic or natural noise disturbances). For example, in response to anthropogenic noise, humpback whales have increased the duration of their calls (Miller et al. 2000), right whales have altered the pitch of their calls (Parks et al. 2007), and blue whales have called more or less often (Di lorio & Clark 2009).

Currently, there are no specific received level thresholds for reliably assessing or regulating masking responses to seismic noise (Gomez et al. 2016). However, the potential impacts of masking and changes in vocalisations in relation to key life stages are considered in the risk assessment.

Table 7-12: Impact and risk evaluation – underwater noise and vibration – marine mammals

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">Without adequate control measures in place, high intensity impulsive sound emitted from the seismic source has the potential to impact marine mammals in the following ways:
hearing impairment, including permanent threshold shift (PTS) or temporary threshold shift (TTS)
behavioural disturbance and masking impacts.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>Summary of receptors
As described in Section 4.8, a number of different marine mammal species may occur in the region, including:
• humpback whales, which migrate to the Kimberley region for resting, calving and nursing between June and October;
• pygmy blue whales, which migrate north along the continental slope between approximately April and June, with the return southern migration between September and November;
• inshore dolphin species, which breed and forage in the coastal waters of the Kimberley year-round; and
• dugongs, which forage in the coastal waters of the Kimberley year-round.
A number of other cetacean species, such as sei, fin, Bryde's and sperm whales and orcas may also occur in the region from time to time, but the Operational Area and surrounding waters are not identified as significant habitat for these species.
Evaluation of potential consequence
The maximum horizontal distances (R_{max}) at which sound levels predicted by modelling (McPherson et al. 2019; Appendix D) may exceed the U.S. NMFS (2018) thresholds for PTS and TTS are presented in Table 7-13. No HFC species are known to occur in the region, hence results are shown only for LFC and MFC. The predicted distances to impact vary depending upon location due to variation in the bathymetry and seabed sediments. Figure 7-5 presents the maximum-over-depth SEL_{24hr} contours associated with PTS and TTS for LFC.
Ranges to PTS and TTS, as well as potential behavioural impacts, are discussed in more detail in the context of specific receptors and life stages below.</td><td>Significant (C)</td></tr>
</table>

Table 7-13 Maximum (R_{max}) horizontal distances predicted by acoustic modelling to exceed the U.S. NMFS (2018) effects thresholds for PTS and TTS

Functional Hearing Category	Threshold Criteria	Distance R_{max}	
		Continental shelf modelling sites	**Continental slope modelling sites**
PTS			
LFC (baleen whales)	PK: 219 dB re 1 µPa	30 m	30 m
	Frequency-weighted SEL_{24hr}: 183 dB re 1 µPa^2.s	0.7 – 2.1 km	1.35 km
MFC (toothed whales and dolphins)	PK: 230 dB re 1 µPa	<20 m	<20 m
	Frequency-weighted SEL_{24hr}: 185 dB re 1 µPa^2.s	Not exceeded	Not exceeded
Sirenians (dugongs)	PK: 226 dB re 1 µPa	20 m	N/A
	Frequency-weighted SEL_{24hr}: 190 dB re 1 µPa^2.s	Not exceeded	N/A
TTS			
LFC (baleen whales)	PK: 213 dB re 1 µPa	60 m	60 m
	Frequency-weighted SEL_{24hr}: 168 dB re 1 µPa^2.s	17.9 – 37.2 km	60.2 km
MFC (toothed whales and dolphins)	PK: 224 dB re 1 µPa	20 m	20 m
	Frequency-weighted SEL_{24hr}: 170 dB re 1 µPa^2.s	Not exceeded	Not exceeded
Sirenians (dugongs)	PK: 220 dB re 1 µPa	30 m	N/A
	Frequency-weighted SEL_{24hr}: 175 dB re 1 µPa^2.s	Not exceeded	N/A

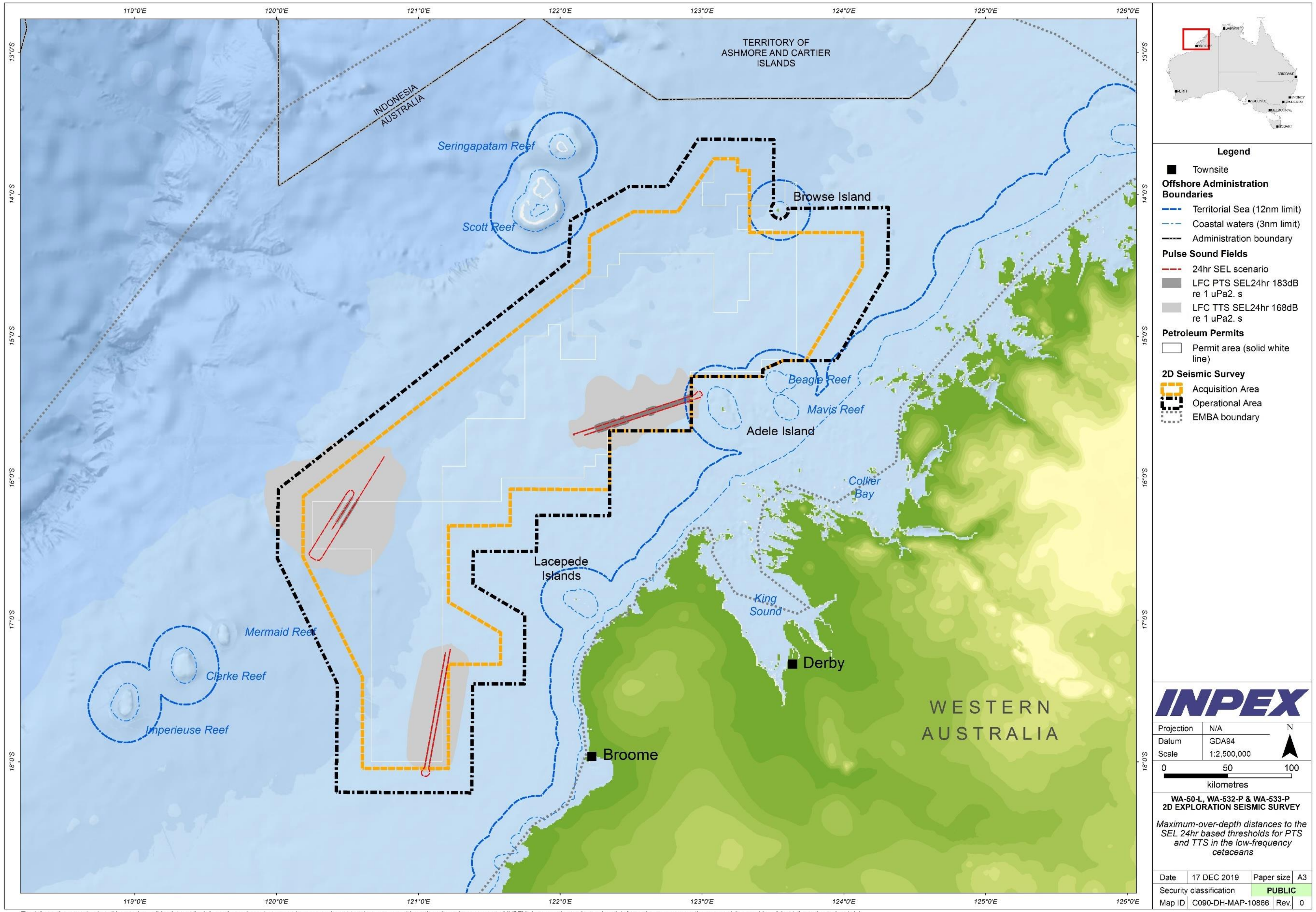

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Figure 7-5 Maximum-over-depth SEL_{24hr} contours associated with PTS and TTS in LFC

Humpback whales Humpback whales occur in the Kimberley region between June and October, with peak ingress during July and peak egress in September. BIAs have been designated for humpback whales within 100 km of the coastline, including a migration BIA and BIAs for resting, calving and nursing which extend from the Dampier Peninsula to Camden Sound. Key aggregation sites in the BIAs are Camden Sound, Tasmanian Shoal and Pender Bay. The resting, calving and nursing BIAs overlap the Acquisition Area by up to 25 km in some southern parts of WA-532-P. The migration BIA overlaps with the Acquisition Area by approximately 30 km near the eastern part of WA-533-P. A recent study as part of the Kimberley Marine Research Project (Thums et al. 2018) analysed three decades of satellite, aerial, boat-based sightings and determined that the greatest densities of whales occur at Pender Bay. Abundance was greatest in nearshore waters in water depths of approximately 35 m. Gourdon Bay to the south of Broome and to the south of the designated for resting, calving and nursing BIAs has now also been identified as an important area where whales occur in high density (Thums et al. 2018). However, whales (including cows and calves) may also occur in lower abundance elsewhere within and further offshore from the BIAs, with whales having been recorded in offshore locations such as Browse Island and Scott Reef (e.g. McCauley 2009). Humpback whales are LFCs. The acoustic modelling results (McPherson et al. 2019; Appendix D) indicate that, based on the U.S. NMFS (2018) criteria, PTS and TTS resulting from a single seismic pulse would only occur if a whale was within approximately 30 m and 60 m from the source respectively. This is highly unlikely and would only occur without control measures in place and if the seismic source was discharged suddenly at full volume next to a whale. Based on the 24-hour SEL results relevant to continental shelf waters, PTS has the potential to occur within approximately 700 m – 2.1 km from the source and TTS has the potential to occur if a whale remains within approximately 17 – 37 km of the seismic source. The SEL_{24hr} modelling results are calculated assuming that the receiver is stationary, therefore, PTS and TTS would only occur within the distances stated for accumulated SEL effects, if the exposed individual remains within this range for several hours, if not the full 24-hour duration. Analysis of the accumulated SEL during the 2D seismic survey in McPherson et al. (2019) indicates that even if a whale remained stationary less than 5 km from a survey line while the seismic source approached, it would still take 2 – 3 hours before the onset of TTS could occur and even longer for PTS to occur. Given that both the seismic survey vessel and whales will be mobile, such a scenario is highly unrealistic. Whales are likely to swim away and avoid the approaching source before PTS or significant TTS impacts could occur. However, given that whales may remain relatively stationary during activities such as resting, calving and nursing, TTS impacts are possible if the 2D seismic survey operates in waters close to	

where whales have congregated i.e. within or near the resting, calving or nursing BIA. No PTS or TTS impacts are predicted to occur at the key humpback aggregation sites at Camden Sound, Tasmanian Shoal, Pender Bay or Gourdon Bay. Behavioural disturbance impacts have been considered in detail given the significance of the Kimberley for calving and nursing. Acoustic modelling predicts that the U.S. NMFS (2014) 160 dB re 1 µPa threshold for behavioural responses may be exceeded between approximately 6 km and 11 km from the seismic source when operating on the continental shelf. This may include responses such as increased swimming and avoidance. Taking into account the more precautionary 140 dB re 1 µPa response threshold applied for resting, calving and nursing, some avoidance and other responses in cows and calves may occur up to 30 – 90 km from the seismic source, depending on location, bathymetry, etc. Some lesser responses may also occur in response to lower levels at greater distances. Figure 7-6 presents the SPL contours that are produced at different modelling sites in relation to the humpback whale resting, calving and nursing BIA. INPEX has analysed the potential received levels at the key aggregation sites at Camden Sound, Tasmanian Shoal, Pender Bay and Gourdon Bay from seismic pulses at locations on the nearshore boundary of the Acquisition Area. Maximum SPLs received from pulses 75 – 143 km away are predicted at most of these locations to be between approximately 107 dB and 123 dB re 1 µPa, which is at or approaching ambient background noise levels in these nearshore waters where SPLs are consistently between 85 – 110 dB re 1 µPa, increasing at times to in excess of 130 dB re 1 µPa as a result of biological noise tidal currents and movement of sediment, and occasionally other anthropogenic noise sources (URS 2009b; McCauley 2011, 2012; McPherson *et al*. 2016b). Received SPLs at Tasmanian Shoal are higher than at the other aggregation sites, predicted to reach approximately 135 dB re 1 µPa and potentially higher when the seismic survey vessel operates in water close to the west side of Adele Island. Therefore, some disturbance to whales is possible at this location during an important and sensitive life stage. Such sound levels will only occur at these aggregation sites for a brief period (e.g. hours) when the seismic survey vessel and operating seismic source approach at the closest point before moving away again. Although there will be limited sound exposure or impacts at the key aggregation sites, other locations where humpback whales are present further offshore may be exposed to seismic sound more regularly and for more prolonged durations. Acquisition within or up to 11 km from the BIA boundary or other waters where humpback whales are present is likely to cause a significant disturbance. There may also be times when whales in deeper waters than the main nearshore aggregation sites are regularly exposed to sound in the range of 120 – 140 dB re 1 µPa for a number of hours when seismic pulses are many tens of kilometres away. For example, sound emitted near Browse Island, approximately 90 km offshore from the humpback whale BIA, is predicted	

by the modelling to propagate reasonably efficiently across the continental shelf with SPLs of approximately 120 dB re 1 µPa at the boundary of the BIA. Therefore, with the exception of seismic acquisition in the most offshore parts of the Acquisition Area, such as in WA-50-L and over the continental slope in WA-533-P, seismic acquisition on the continental shelf (the majority of the Acquisition Area) may result in some low-level audible sound in the humpback whale BIAs. Although the sound levels received by humpback whales in the BIA may be relatively low (<140 dB re 1 µPa) much of the time while the survey vessel is operating on the middle and outer continental shelf, the potential significance of prolonged disturbances is difficult to predict with any certainty. The WA humpback whale population is understood to be very healthy, comprising more than 30,000 individuals (Salgado Kent et al. 2012; Thums et al. 2018). It may be that behavioural impacts to some groups of whales do not have any wider significant or long-term impacts at the population level. Conversely, however, regular and prolonged disturbances, even at relatively low sound levels could result in cows and calves at various locations becoming stressed, disturb social interactions or cause increased energy expenditure. A recent study of the fine-scale behaviours and energy expenditures of humpback whale mothers and calves in Exmouth Gulf has highlighted that lactating females keep their energy expenditure low by devoting a significant amount of time to rest while nursing. The study also suggested that increased and prolonged noise disturbance could compromise the whales' energy reserves, which are needed to ensure a successful migration and survival of calves (Bejder et al. 2019). Given that the 2D seismic survey overlaps the resting, calving and nursing BIA, and could overlap with a significant proportion of the humpback whale season, the extent and duration of disturbance could be significant to both individuals and the population during this important life stage. In terms of potential masking, the intermittent nature and relatively short duration of individual seismic pulses is unlikely to result in any significant masking of whale calls, although may cause whales to cease or alter their vocalisations at times, as outlined in Wood et al. (2012) and Erbe at al. (2016). Given the scientific uncertainty associated with how behavioural changes may impact calving and nursing whales, INPEX has adopted a precautionary approach and assumed that the implications could be significant and at a population level. Without management measures in place, there is the potential for PTS or TTS to occur in some individual humpback whales exposed to the seismic source at close range, and the potential for a range of behavioural impacts from lower sound levels received over greater distances. The potential consequence to the humpback whale population during a period of resting, calving and nursing has been conservatively assessed as Significant.	

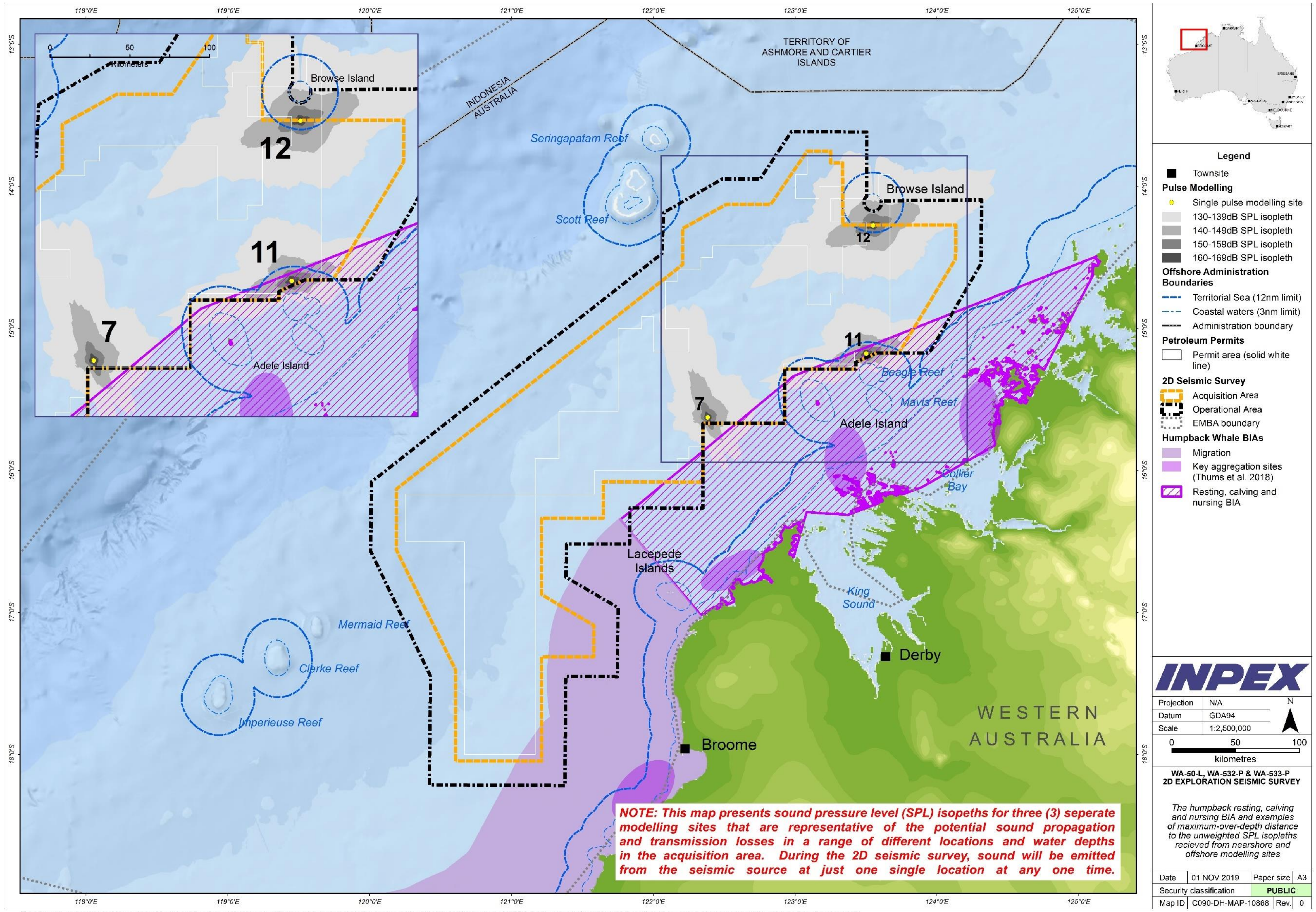

Figure 7-6 Single pulse SPL contours at representative modelling sites near the humpback whale resting, calving and nursing BIA

Pygmy blue whales

Pygmy blue whales migrate as solitary animals or in small groups along the continental slope, typically at depths between 500 m and 1,000 m on the way to the Banda and Molucca seas near Indonesia, where calving is understood to occur (Double et al. 2014). The northern migration typically passes north-western Australia between approximately April to August with the return southern migration between October and December. There is a BIA designated for the migration route. A small part of the migration BIA is overlapped by the western part of the Acquisition Area and WA-533-P. Waters surrounding and west of Scott Reef and Seringapatam Reef have been identified as a BIA for pygmy blue whale foraging.

Pygmy blue whales are LFCs. The acoustic modelling results (McPherson et al. 2019; Appendix D) indicate that PTS and TTS impacts have the potential to occur as a result of a single pulse within a maximum range of approximately 30 m and 60 m from the seismic source respectively. Based on the modelled SEL_{24hr} results relevant to the continental slope, PTS and TTS have the potential to occur if whales remain within approximately 1.35 km and 60 km from the seismic source respectively. PTS is unlikely to occur as whales are not expected to remain within close range of the seismic source for long periods of time. They would most likely swim away from the source before received sound levels became high enough to potentially cause PTS effects. Given that pygmy blue whales are expected to be transitory during their migration through these waters, the potential for TTS is also reduced.

The Blue Whale Conservation Management Plan (Action Area 2) states that anthropogenic noise in biologically important areas should be managed such that any blue whale continues to utilise the area without injury. Although TTS has previously been regarded as hearing impairment, not injury, advice from the Department of Environment and Energy is that TTS should be considered a form of injury to pygmy blue whales and this should be prevented within the BIAs.

The modelled range to TTS effects in LFCs of 60 km, resulting from modelling scenario 2 on the continental slope, may be overly conservative for the following reasons:

- The 60 km range to TTS is based on the modelled maximum-over-depth range. Therefore, this range may be driven be the influence of downslope sound propagation, whereby sound produced near the surface over the continental slope becomes refracted towards the Deep Sound Channel (Salgado Kent et al. 2016). Therefore, the 60 km maximum-over-depth range may correspond with water depths that are greater than the depths at which pygmy blue whales may typically swim and dive to.
- As explained in the assessment of impacts to humpback whales above, the SEL_{24hr} criterion is a cumulative metric that reflects the dosimetric impact of sound energy accumulated over a 24-hour period and assumes that an animal is consistently exposed to such noise levels at a fixed location. The

radii that correspond to SEL_{24hr} typically represent an unlikely worst-case scenario for SEL-based exposure since, more realistically, marine fauna would not stay in the same location or at the same range for 24 hours (McPherson et al. 2019). It is noted that the accumulation of sound energy is not linear and rapid growth in accumulated exposures may occur over a matter of hours as the seismic source approaches an animal's location, but the criterion and modelling are still limited by the assumption that animals remain in a fixed location for this period. Therefore, the potential for TTS effects (and therefore injury) to pygmy blue whales and management of this risk requires more detailed examination. The variation in sound propagation with depth has been considered. Figure 7-7, provided by JASCO (Pers. Comm. C McPherson, JASCO Applied Sciences, 12th December 2019) demonstrates how single pulse SEL propagates down the continental slope and is greater at depth. The propagation downslope is gradual, but the image demonstrates that at ranges of approximately 25 km, a shift in sound contours to depths greater than approximately 20 m begins to occur, though most downslope refraction does not begin to become apparent until distances of approximately 50 km when the sound drops off more rapidly towards greater depths. Therefore, at these distances from the seismic source, maximum-over-depth ranges may begin to overestimate the sound levels received by animals swimming near the sea surface.	

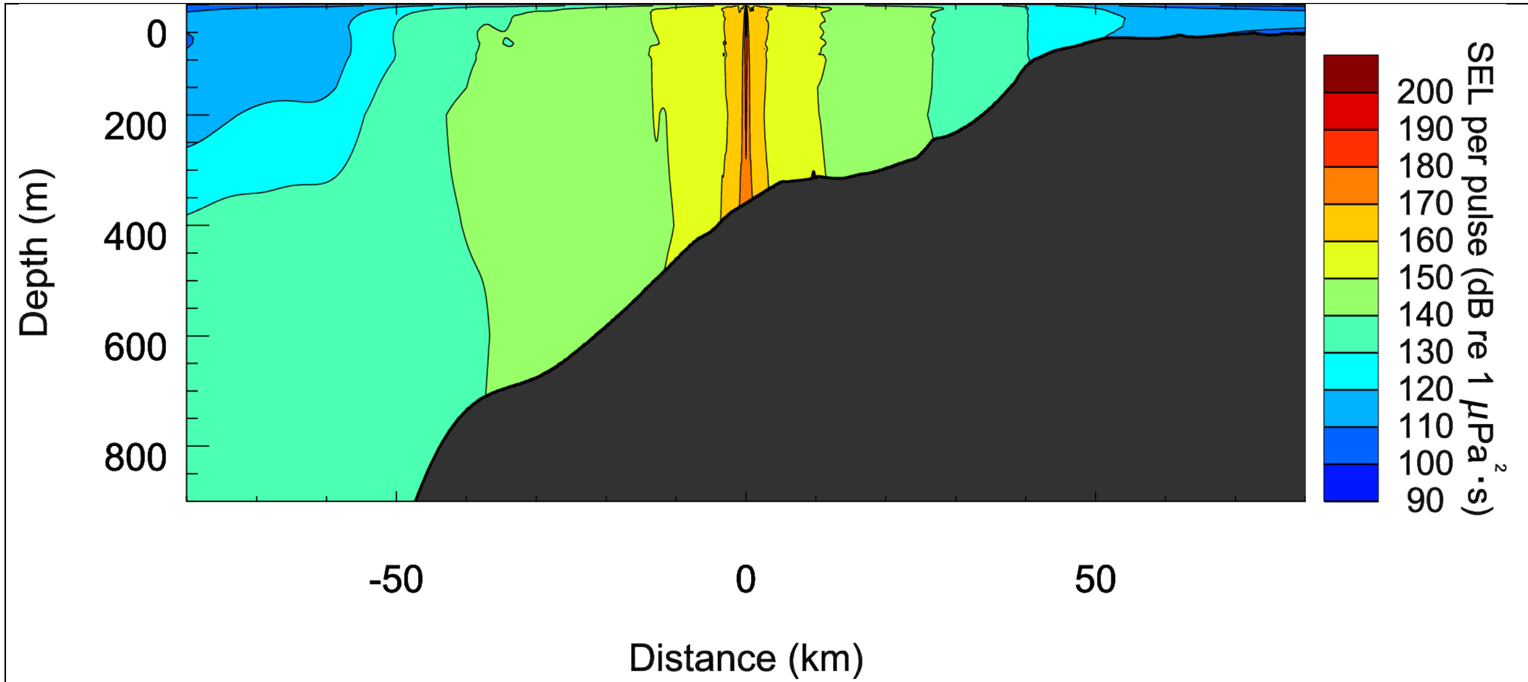

Figure 7-7: Slice plot showing the propagation of single pulse SEL down the continental slope and variation with depth from modelling site 5 (451 m water depth).

The greatest factor, however, is the movement of animals relative to the moving sound field. To account for the movement of whales, JASCO undertook animal movement (animat) modelling to predict a more realistic range at which animals experience the effects of PTS and TTS from accumulated sound exposures (Weirathmueller et al. 2019; Appendix E). Sound exposure distribution estimates were determined by moving large numbers of simulated animals through modelled time-evolving cumulative sound fields. The exposure modelling scenario considered a total of 5.2 days of parallel acquisition lines in the north-west corner of WA-533-P, where the Acquisition Area overlaps with the pygmy blue whale foraging BIA (Figure 7-8). The JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was used to model the movement of pygmy blue whales through the predicted sound field.

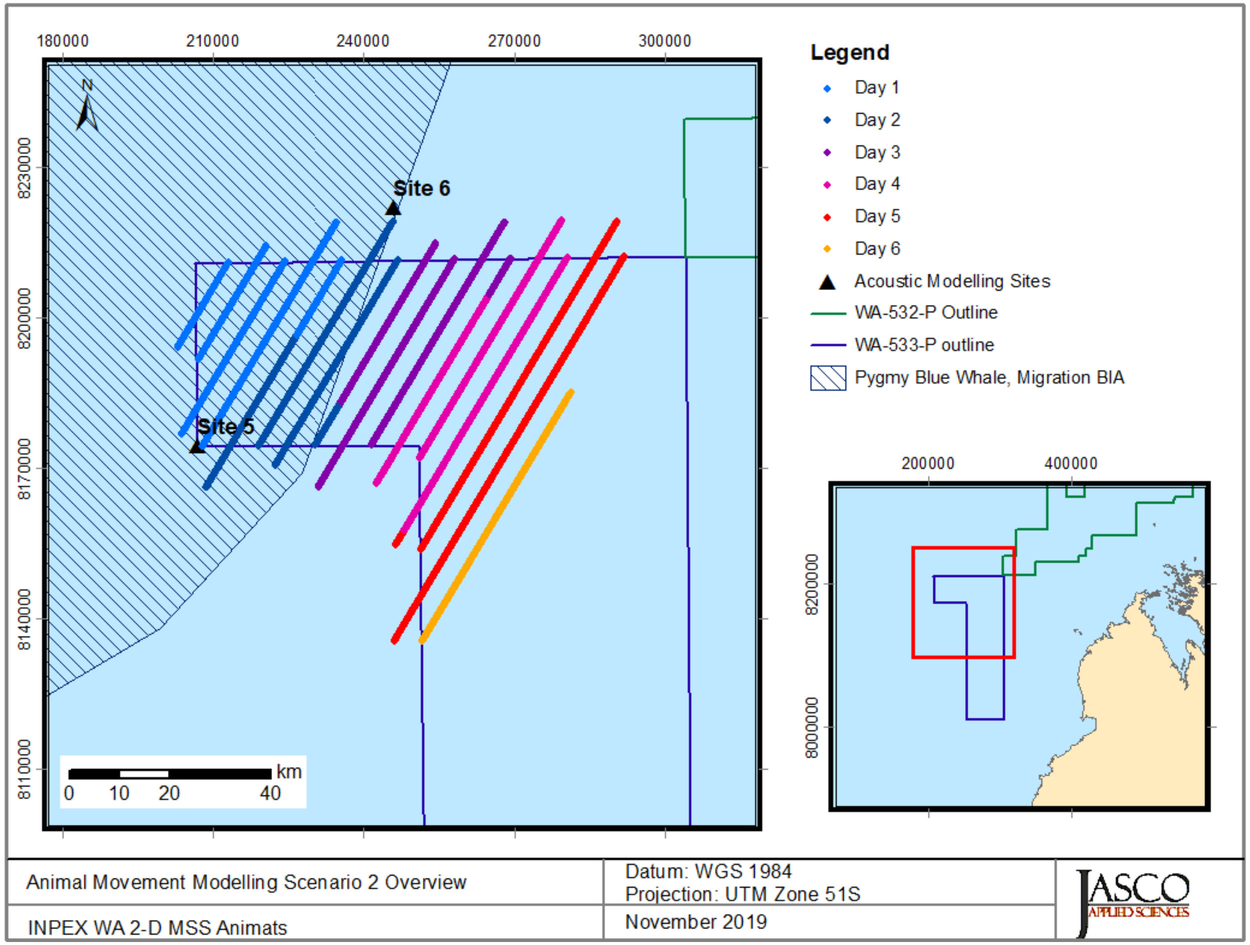

Figure 7-8: Seismic source tracks used in animal movement modelling, coloured by day of survey (Weirathmueller et al. 2019; Appendix E).

Biologically meaningful movement rules were applied to each animal in the model to represent pygmy blue whale behaviours. This included swim speeds, direction, diving and ascent rates, dive depths (for both

migratory dives near the surface and deeper exploratory or feeding dives), and time spent at or near the surface before diving again. Further detail on the movement and behaviour parameters and how the animat modelling was set up are provided in Appendix E. The behavioural profile applied for pygmy blue whales was based on the available research for migrating pygmy blue whales and blue whales. Owen et al. (2016) monitored the fine-scale movement and diving behaviours of a migrating sub-adult pygmy blue whale off the west coast of WA. To reduce energy expenditure during migration, the whale dives to a depth that is likely to allow it to avoid surface wave drag and maximize horizontal movement. The mean depth of migratory dives (82% of all dives) was 14 m ± 4 m, and the whale spent 94% of observed time and completed 99% of observed migratory dives at water depths of less than 24 m. Feeding dives were undertaken to a mean maximum depth of 129 ± 183 m (range 13–505 m). The mean maximum depth of exploratory dives (107 ± 81 m, range 23–320 m) was similar to the mean maximum depth of feeding dives (129 m) and did not appear to be related to seafloor depth. The diving behaviour of another pygmy blue whale, recently tagged off north-west Australia, is reported to have completed most dives between just 0 – 10 m with deeper dives occurring to between 50 m and 100 m, and a maximum of 250 m (AIMS 2019). This is preliminary data which may require further review and validation, but the data suggests that the movements and diving behaviours may be consistent with the findings of Owen et al. (2016). Croll et al. (2001) reports that the migratory dives of larger blue whales have a mean depth of 26.9 m ± 1.2 m. Given the blue whale’s slightly deeper migration depth, this has been used instead of the sub-adult dive depth presented in Owen et al. (2016). However, the exploratory dive depth data was based on Owen et al. (2016). The speed at which the whales swim can vary. For example, satellite tagging studies of pygmy blue whales during their northbound migration off WA by Double et al. (2012, 2014) reported that whales had a low occupancy rate in the region, with corresponding average travel rates at these latitudes between approximately 70 and 120 km/day (approximately 3 – 5 km/hr). This would indicate that pygmy blue whales passing along the continental slope in this area are likely to transit through the area within less than a day. Owen et al. (2016) report a slightly slower mean swim speed of 2.8 ± 2.2 km/hr. Sears and Perrin (2009) also report similar speeds for blue whale. Therefore, the lower travel rate of Owen et al. (2016) was selected for the model so that animals were more likely to be exposed to sound in the same location for a greater amount of time. Given the limited data available on pygmy blue whale movements and dive behaviours, conservative assumptions were applied to ensure that the analysis adopted a precautionary approach:	

- The sound exposure modelling scenario considered a total of 5.2 days of parallel survey lines acquired consecutively and oriented so that the maximum broadside sound propagation radiated towards the pygmy blue whale migration BIA. In reality, adjacent parallel lines may not be acquired in this order; instead a dip line may be followed by a perpendicular strike line, which would result in the seismic source moving away from the BIA to a different part of the Acquisition Area where limited sound energy would accumulate near the BIA. Therefore, the modelled scenario produces conservative sound exposure results.
- The animat component of the model did not include any migration bias, i.e. all whales in the model were resident in the modelling area over the entire modelling period. In reality, if whales were migrating through the area at the rates reported in Owen et al. (2016) and Double et al. (2014, 2016), they would pass through the area and would likely be out of range in less than a day.
- Migratory dives and exploratory dives were modelled at an even (50%) probability of occurrence. When compared with the 94% of time that the tagged pygmy blue whale in Owen et al. (2016) spent in shallow migratory dives, this forces the animat whales to spend a far greater proportion of time at depth and potentially exposed to greater sound levels. Such a dive profile is highly unlikely as it would be highly demanding for the whale energetically and in terms of oxygen consumption.
- The model did not include any aversion behaviour, i.e. whales exhibited no behavioural response or attempt at avoidance of the sound source. In reality, some avoidance by some animals is likely, particularly when the seismic source is at close range to a whale.

Based on the above, the results of the animat modelling exercise are expected to be very conservative.

A summary of the animat simulation results for migratory pygmy blue whales is presented for the 95th percentile exposure ranges (km) in Table 7-14. Exposure ranges to SEL thresholds on the day of greatest exposure were 0.21 km and 23.34 km for PTS and TTS respectively. The results demonstrate how exposure ranges decrease to zero during the later days in the simulation as the seismic source moved further away from the migration BIA. Based on these results, the conservative range for potential TTS effects in pygmy blue whales within the migration BIA is approximately 23 km, compared with the 60 km range previously predicted in McPherson et al. (2019) where animal movement was not factored into the model.

Table 7-14 Exposure ranges for both PTS and TTS SEL_{24hr} thresholds for each day of the simulated survey.

Simulated survey day	Range, $ER_{95\%}$ (km)

	PTS, SEL_{24hr}	TTS, SEL_{24hr}
1	0.09	18.75
2	0.21	19.24
3	0	21.06
4	0	23.37
5	0	0
6	0	0

Pygmy blue whales may potential experience the effects of TTS when within approximately 23 km of the seismic source during survey operations over the continental slope in the north west corner of WA-533-P. No other parts of the Acquisition Area or proposed acquisition line plans occur on the continental slope or within this distance from the pygmy blue whale migration BIA. The foraging BIA on the west side of Scott Reef would also be sheltered from sound produced in the Acquisition Area by the reef and bathymetry, and so pygmy blue whales foraging in these waters are unlikely to experience TTS effects.

Acoustic modelling (McPherson et al. 2019; Appendix D) also indicates that the U.S. NMFS (2014) 160 dB re 1 µPa threshold for behavioural responses may be exceeded between approximately 6.5 km and 8 km from the seismic source when it is operating in continental slope waters near the pygmy blue whale BIA (Figure 7-9). The animat modelling (Weirathmueller et al. 2019; Appendix E), taking into account animal movements, predicted exceedance of the behavioural response threshold within 5.58 km. Therefore, potential impacts to the migration are not expected as the area of avoidance is limited compared to the broad extent of the BIA and the large distances covered during the migration. If individual or small groups of pygmy blue whales are passing this area at the same time the 2D seismic survey is undertaken, they may deviate from their normal course by several kilometres to avoid the seismic sound source, but this distance is relatively small in the context of the average distance travelled in a day (approximately 60 – 120 km/day based on Owen et al. (2016) and Double et al. (2014, 2016)) and negligible in the context of the overall migration, which occurs over thousands of kilometres. Therefore, impacts to pygmy blue whales are predicted to comprise localised behavioural avoidance impacts with no long-term ecological implications for migration or the population.

Whales will not be displaced from the BIA, which includes waters extending well over 200 km west of the Acquisition Area. The potential for masking impacts is also limited; migrating whales would be exposed to the seismic pulses for less than a day and therefore would not cause long-term masking for these individuals. Foraging in waters near Scott Reef is not expected to be disrupted. Received levels from acquisition to the south of Scott Reef would be approximately 140 dB re 1 µPa or less. Sound produced from seismic acquisition in the closest part of the Acquisition Area to Scott Reef (approximately 25 km away) would be largely shielded by the reef so that levels received by whales foraging around the reef or in deeper waters to the west would be negligible. Based on the studies referenced previously, the motivation to feed would be greater than any disturbance resulting from distant and low-level pulses of sound. Pygmy blue whales will not be displaced from foraging in the BIA. Overall, without controls in place, the consequence of acquiring near the pygmy blue whale migration route, resulting in short-term behavioural impacts and potential for TTS effects (defined as injury by the Department of Environment and Energy), with no broader implications for survival or viability of the pygmy blue whale population is conservatively assessed as Moderate.	

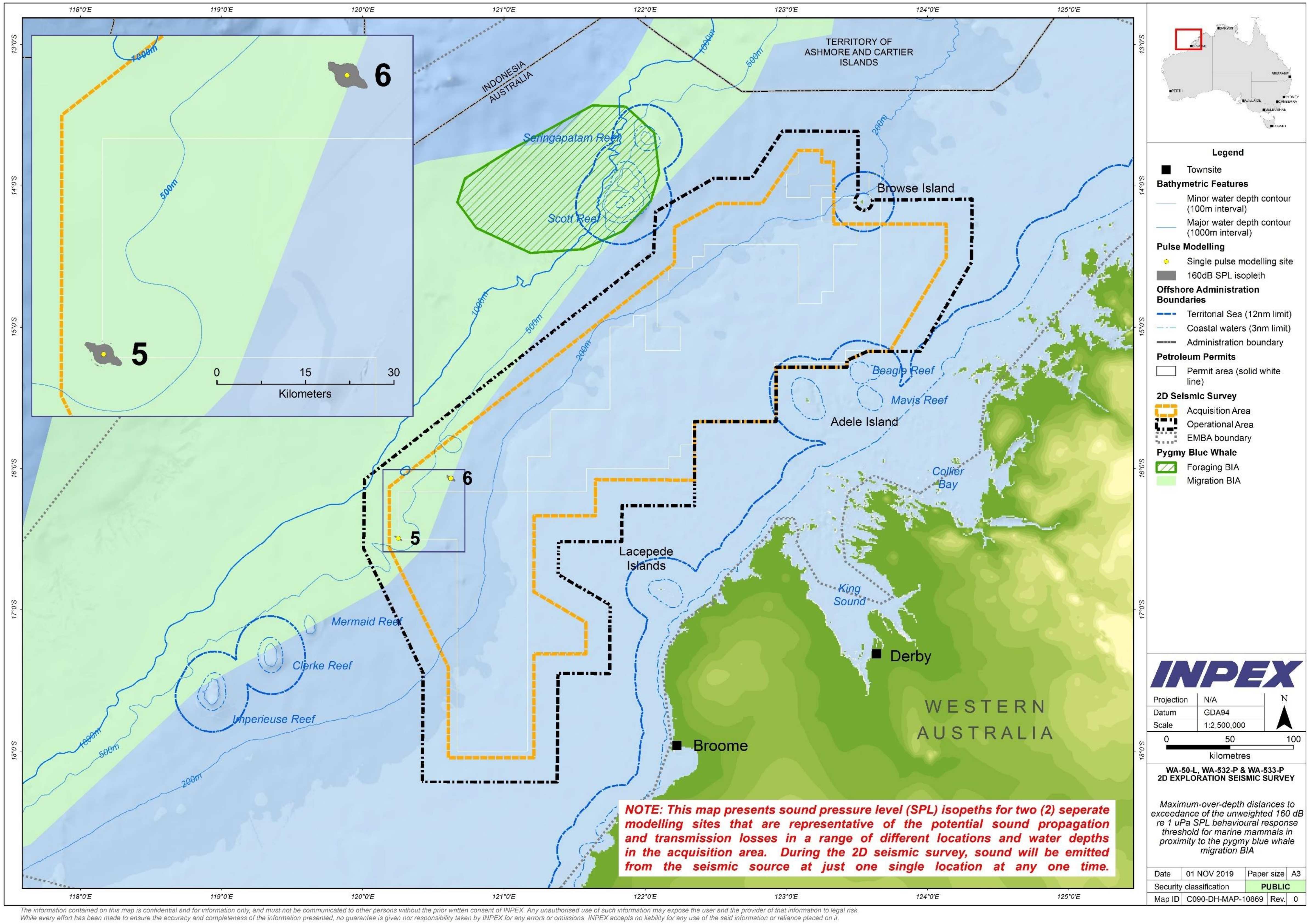

Figure 7-9: 160 dB re 1 µPa SPL contours for behavioural response in cetaceans at modelling sites relevant to the pygmy blue whale migration BIA

Inshore dolphins The coastal waters of the Kimberley provide habitat for Indo-Pacific bottlenose dolphins, Indo-Pacific humpback dolphins and Australian snubfin dolphins. These species are mainly found in nearshore areas such as shallow bays and estuaries, and coastal waters around oceanic islands. Indo-Pacific humpback dolphins, and Australian snubfin dolphins in particular, have been recorded almost exclusively in coastal and estuarine waters (Parra et al. 2002), preferring water depths less than 20 m (Parra 2006) and within approximately 10 km from the coast (Corkeron et al. 1997; Parra et al. 2002; Parra 2005). A number of coastal areas from Roebuck Bay to the north Kimberley have been designated as BIAs for foraging, breeding and calving, which occur year-round. The BIAs are all located 45 km or more from the Acquisition Area. Indo-Pacific humpback dolphins and Australian snubfin dolphins are unlikely to occur in the Acquisition Area, although Indo-Pacific bottlenose dolphins may occur from time-to-time. These inshore dolphin species are considered to be MFCs, utilising frequencies from 1 kHz to over 22 kHz (Berg Soto 2014; Marley et al. 2017). As such, they may be less sensitive to low frequency seismic impulses than LFCs, particularly at distance from the seismic source where the higher frequency components of seismic sound will have been attenuated leaving predominantly low frequency sound. When the seismic source is operating in parts of the Acquisition Area closest to the coast, the predicted received SPLs in coastal waters and the various dolphin BIAs are predicted to be between approximately 100 and 125 dB re 1 µPa. These levels are at or approaching ambient background noise levels in these nearshore waters where SPLs are consistently between 85 – 110 dB re 1 µPa, increasing at times to in excess of 130 dB re 1 µPa as a result of biological noise, tidal currents and movement of sediment, and occasionally other anthropogenic noise sources (URS 2009b; McCauley 2011, 2012; McPherson et al. 2016b). The received levels are well below the U.S. NMFS (2014) 160 dB re 1 µPa threshold for behavioural responses. These received levels would also occur for a relatively brief period of time (e.g. less than an hour) while the seismic survey vessel is operating nearby, before turning at the Acquisition Area boundary and moving away again. In the event that dolphins swim further offshore, they may avoid the seismic source by several kilometres. The consequence of such short-term disturbances to individuals is not expected to result in any impacts at the population level and has been assessed as Insignificant. **Other cetaceans** Other cetaceans that may potentially be encountered in the Operational Area during the 2D seismic survey include a number of EPBC Act listed whales and dolphins, which are categorised as LFCs (e.g. sei, fin and	

Bryde's whales) or MFCs (e.g. orcas and sperm whales). These species are expected to be transient and now significant habitats or BIAs have been identified for these species within or near the Acquisition Area. Similar to the impacts and risks assessed for humpback whales and pygmy blue whales above, there is some limited potential for LFC species to experience PTS or TTS impacts from a single seismic pulse if they are present within tens of metres of the seismic source. As animals will be transient in the area and likely to swim away from the approaching seismic source, PTS and TTS as a result of cumulative exposures are unlikely to occur. Should some level of TTS occur, it would be temporary and recoverable. MFCs are slightly less sensitive to seismic sound than LFCs. PTS and TTS as a result of cumulative exposures is not expected to occur as the frequency-weighted SEL_{24hr} criteria are not exceeded. The potential for PTS and TTS impacts from a single seismic pulse is limited to within 20 m of the seismic source for MFCs. Based on the U.S. NMFS (2014) 160 dB re 1 µPa threshold for behavioural responses, cetaceans may avoid the seismic source by up to 6 – 11 km, depending upon the location. Short-term disturbances and temporary effects to transient individuals is not expected to result in any impacts at the population level but given some limited potential for PTS and TTS impacts to occur in a small number of individuals, the consequence is conservatively assessed as Minor. **Dugongs** Dugongs generally inhabit shallow, sheltered coastal waters of the Kimberley (<20 m depth) and are commonly found in mangrove channels and shallow seagrass habitats. They are not expected to occur offshore in the Acquisition Area. Coastal waters near Roebuck Bay, Broome and the Dampier Peninsula are designated as a BIA for year-round foraging, although foraging dugongs may also occur elsewhere along the Kimberley coast. A recent study (Bayliss and Hutton 2017; Waples et al. 2019) also noted relatively high densities of dugongs at Montgomery Reef (near Camden Sound) and in coastal waters between the Maret Islands and Kalumburu. Dugongs are considered to be less sensitive to sound than cetaceans and their hearing is limited to a narrower range of frequencies. Received SPLs in the dugong BIAs and coastal waters will be less than 120 dB re 1 µPa and well below the 160 dB re 1 µPa threshold for behavioural impacts. Therefore, no impacts to the dugongs are expected at the individual or population level. The consequence is assessed to be Insignificant. The overall consequence to marine mammals has been based on the potential for impacts to humpback whales during the period of June to October when they are present in the Kimberley region for resting, calving and nursing. The overall consequence has therefore been assessed as Significant (C).	

Identify existing design and safeguards/controls measures			
The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3). INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	Eliminate the potential risk to the humpback whale population by avoiding the resting, calving and nursing period between June and October.	Yes	The proposed schedule and temporal window for the 2D seismic survey has been determined taking into account: • the timing of key environmental and socio-economic receptors; • the hearing ability and sensitivity of those receptors to sound from the seismic survey; • the proximity of sensitive habitat areas to seismic survey areas; • the species distribution and range; • the level of overlap (in space and time) by the 2D seismic survey with important habitats and life stages of sensitive species; • species vulnerability / conservation status; and • the potential for impacts to species at both an individual level and at a population level. Given humpback whale's high sensitivity to low frequency sound and the potential for significant risks during a key life stage if the humpback population were to be repeatedly disturbed over weeks or months, the humpback whale

			population is considered to be the most susceptible of all biological receptors to the effects of the 2D seismic survey. The peak period for humpback whales in the Kimberley region is from July to September, but timing can vary each year and humpbacks will generally be present in the region between June and October. Therefore, no operation of the seismic source will occur in the period from 1st June to 31st October in any year covered by this EP.
	Eliminate the potential risk to migrating pygmy blue whales by avoiding any seismic acquisition during their migration periods (April to August and October to December).	No	Consideration has been given to avoiding acquisition during the pygmy blue whale migration periods. Avoiding the pygmy blue whale migration periods as well as the humpback season leaves only the period January to March to complete the 2D seismic survey, which is insufficient time. Given that behavioural disturbances or the potential for TTS effects to a small number of migrating pygmy blue whales is predicted to be temporary and without wider population level impacts, the complexity of scheduling and the additional time required is considered grossly disproportionate to the environmental benefit that would be gained. Scheduling the entire survey outside of the pygmy blue whale migration period is therefore not practicable. An alternative temporal exclusion control for pygmy blue whales is instead adopted below.
Substitution	None identified	N/A	No additional substitution controls were identified that would practicably reduce the risk to marine mammals.
Engineering	None identified	N/A	No additional engineering solutions were identified that would practicably reduce the risk to marine mammals.
Procedures & administration	Consistent with Part A of EPBC Policy Statement 2.1, the following precaution zones will be applied:	Yes	Part A of EPBC Policy Statement 2.1 provides standard management procedures and will be implemented during the 2D seismic survey.

	• Observation zone: 3+ km horizontal radius from the seismic source. • Low power zone: 2 km horizontal radius from the seismic source. • Shut-down zone: 500 m horizontal radius from the seismic source.		Precaution zones will be implemented around the seismic source to allow whale observations to be undertaken and the seismic source to be powered down or shut down to reduce the potential for PTS and TTS in the event a whale is observed within the precaution zones. In accordance with criteria outlined in EPBC Policy Statement 2.1, acoustic modelling confirmed that the received sound exposure level from a single seismic pulse will likely exceed 160 dB re 1µPa^2.s for 95% of pulses at 1 km range. Therefore, instead of a 1 km low power zone, a larger 2 km low power zone will be implemented.
	Consistent with Part A of EPBC Policy Statement 2.1, the following procedures will be applied: • Pre-Start-up Visual Observations (30 minutes) • Start-up Delay Procedures (if sighting) • Soft-start Procedures (30 minutes) • Operational Shut-down and Low-power Procedures • Night-time and Low Visibility Procedures • Seismic survey vessel crew will be briefed in marine fauna observations, distance estimation and procedures • Cetacean sighting and compliance reports to be submitted to DEE within 2 months of survey completion	Yes	Part A of EPBC Policy Statement 2.1 provides standard management procedures and will be implemented during the 2D seismic survey. As demonstrated in the flow diagram in Figure 7-10, the following Part A procedures will be implemented to reduce the potential for PTS and TTS: • 30-minute pre-start observations to check for whales within the precaution zones before the seismic source is operated. • Start-up delay, if a whale is observed within the precaution zones. • Soft-start procedures, where the seismic source is gradually increased from the lowest volume over a period of 30 minutes to allow marine fauna an opportunity to move away before the source is operated at full volume. • Operational shut-down and low-power procedures, so that the seismic source is powered down if a whale is observed within 2 km of the seismic source and shut-down completely if it is observed within 500 m of the source.

			• Night-time and low visibility procedures, whereby the seismic source may only be started if the survey vessel has been within 10 km of the proposed start up location in good visibility conditions for at least 2 hours without a whale being sighted, and there have not been three or more shut-downs for whales in the preceding 24-hour period.
	Trained and dedicated marine fauna observers (MFOs) on board the seismic survey vessel.	Yes	Consistent with Part B of EPBC Policy Statement 2.1 (additional management measures that may be considered where the likelihood of encountering whales is moderate to high), trained MFOs will undertake marine fauna observations during the 2D seismic survey. Two MFOs will be on board the survey vessel (in addition to briefed crew members) to alternate shifts during daylight hours to manage fatigue and provide some redundancy in the event one MFO is unavailable. The MFOs will have adequate training (JNCC/UKCS standard or equivalent) and will have previous experience observing for marine fauna during seismic surveys.
	Increased precaution zones – Apply a 1 km shut-down zone if any mother-calf pairs are spotted.	Yes	Increased precaution zones are an additional optional management measure outlined in Part B of EPBC Policy Statement 2.1 (additional management measures that may be considered where the likelihood of encountering whales is moderate to high). Given that PTS and TTS resulting from a single seismic pulse may only occur within approximately 60 m of the seismic source, the standard 500 m shut-down zone provides adequate protection from multiple pulses. However, to afford additional protection to mother-calf pairs, increasing the radius of the shutdown zone to 1 km was considered an appropriate measure to provide further protection. This may apply in the event that a humpback

			whale mother-calf pair, should they be present outside of the June to October exclusion period, or to other species of whale if there is a sighting of a mother-calf pair. An increased observation zone was also considered, but observations beyond 3 km are unreliable and not practicable. The MFOs' attentions will be focussed and effective within 3 km of the survey vessel.
	Use dedicated marine fauna observer vessels or spotter aircraft	No	Given the proposed scheduling of the 2D seismic survey, other proposed control measures and the already acceptable level of risk to marine mammals, the cost of this option was considered grossly disproportionate to the limited additional benefit that would be gained. MFOs on board the survey vessel will already provide coverage of the area surrounding the seismic source to an effective and proven industry standard. Aerial observations at great distances offshore, such as the pygmy blue whale migration BIA, are not practicable as flight time and fuel is limited. The cost of an additional dedicated vessel or an aircraft to undertake additional marine fauna observations for the duration of the 2D seismic survey would likely cost hundreds of thousands of dollars and introduce additional health and safety risks. Implementing an additional dedicated vessel or an aircraft would make the survey commercially unviable.
	Passive Acoustic Monitoring (PAM)	No	PAM was considered as an additional measure to detect marine mammals during night-time and low visibility conditions and/or during sensitive periods, consistent with Part B of EPBC Policy Statement 2.1 (additional management measures that may be considered where the likelihood of encountering whales is moderate to high).

			Potential impacts to cetaceans are already reduced to an acceptable level given that the humpback whale season is avoided and behavioural impacts to other cetacean species are expected to be short term. As the humpback whale season is avoided, the potential for the likelihood of encountering a significant number of whales is relatively low. PAM has some ability to detect whale calls and estimate distance. However, its capabilities are limited and only effective if whales vocalise, thereby making it ineffective if whales cease vocalising temporarily in response to the seismic sound. While it may be possible to detect some pygmy blue whales, it would provide only a small increase in the probability of detection and therefore limited additional benefit to already low behavioural impacts and risks. Pygmy blue whales are likely to be present in low numbers and will only be exposed to sound for less than a day as they pass through the region. It is noted that the risk to whales is already reduced to an acceptable level with the other proposed control measures in place. PAM may require two PAM operators to cover redundancy and fatigue on board the vessel. There is an associated cost associated with this and a potential limit on the number of persons on board (POB) the vessel that can be accommodated (2D seismic survey vessels are typically smaller than 3D vessels with limited POB capacity). Therefore, taking into account this cost and uncertainty, the use of PAM was not considered commensurate with the limited additional benefit that may be gained.
	Adaptive management measures applied throughout the survey	No	Adaptive management measures were considered, consistent with Part B of EPBC Policy Statement 2.1 (additional management measures that may be considered

			where the likelihood of encountering whales is moderate to high). Adaptive management may include changes to the way in which a seismic survey is conducted if whales are encountered in greater abundance than expected e.g. increasing precaution zones or relocating to a different part of the survey area if more than three shut downs for whales occurs within a single 24-hour period. However, such measures do not provide a significant benefit. Relocating in particular is hugely disruptive and time consuming for the survey with no certainty that the new location will be any better, with respect to the presence and abundance of whales. Potential impacts to cetaceans are already reduced to an acceptable level given that the humpback whale season is avoided, a temporal exclusion zone will also be applied for pygmy blue whales (see below), and behavioural impacts to other cetacean species are expected to be short term. As the humpback whale season is avoided, the potential for the likelihood of encountering a significant number of whales is relatively low. Therefore, with the exception of the increased 1 km shut down zone proposed above for mother-calf pairs, no additional practicable adaptive management measures have been identified that would provide a material reduction in the already low and acceptable risk to marine mammals.
	Apply adaptive management measures when acquiring seismic data within or near the pygmy blue whale migration BIA during the pygmy blue whale migration period to prevent TTS effects.	No	A number of adaptive management options were considered to prevent TTS effects to migrating pygmy blue whales, and therefore meet the requirement for no 'injury' stipulated in the Blue Whale Conservation Management Plan. Options included relocation and/or no night-time operations if a pygmy blue whale is sighted. However, given that TTS

			effects are predicted to occur up to a maximum of 23 km from the seismic source, and the MFO observation zone extends to only 3 km, observing the pygmy blue whales is not practicable. The option of having MFOs on board a support vessel to support marine fauna observations was considered, but was not deemed practicable for the following reasons: • The deck and bridge of support vessels is often not well elevated in comparison to the survey vessel, making marine fauna observations more challenging; • MFOs would need to be brought on board for the portion of the survey that overlaps the pygmy blue whale migration, which would incur a personnel transfer cost or costly return to port; • The support vessel would only cover a separate 3 km observation zone. Combined with the observation zone from the survey vessel, there is still a significant area within the 23 km range to effect that cannot be monitored. Therefore, no practicable solution was identified, and a temporal exclusion zone has instead been selected (see below).
	Apply temporal exclusion zone to acquisition adjacent to the pygmy blue whale migration BIA to prevent TTS effects to pygmy blue whales.	Yes	Avoiding acquisition only in the part of the Acquisition Area located within and adjacent to the pygmy blue whale migration BIA during the migration period is considered a practicable control to prevent behavioural and TTS effects to pygmy blue whales. TTS effects, based on a conservative animat modelling scenario, are predicted to occur up to 23.37 km from acquisition lines on the continental slope near the

			Figure 7-11 presents a proposed 'Pygmy blue whale protection zone' which incorporates all acquisition that may occur within 24 km of the pygmy blue whale migration BIA. No operation of the seismic source will occur in this zone during the pygmy blue whale migration periods (April – August, October - December). This control was considered a potentially costly and complex concession for the 2D seismic survey given that: • The survey will avoid the humpback whale resting and calving period from 1st June to 31st October; • Parts of the Acquisition Area, including the eastern part of WA-533-P, cannot be surveyed during turtle internesting periods (October to March, or May to July in other locations; see Section 7.1.8); • The Acquisition Area is already being subdivided into two phases /areas to provide more clearly defined spatial boundaries to commercial fisheries stakeholders (see Section 7.2.1); • Seismic contractor and vessel availability is not yet confirmed, which could further limit the available window when the survey may be acquired. Accounting for the above factors, this part of the survey will only be acquired in the months of January to March, but will need to be managed around the internesting turtles and commercial fisheries control measures. In the event that this part of the survey cannot be acquired, a significant part of the acquisition plan and commitment under title will be missed. This control measure therefore places the ability of INPEX to carry out other spatial or temporal control measures effectively. In the event that acquisition outside of the pygmy blue whale migration isn't achievable, INPEX will, via ongoing consultation, contact fisheries stakeholders

			to discuss alternative arrangements to the phased approach to managing interactions with fisheries (Area A and Area B; Section 7.2.1) in order to meet the survey objectives and Title commitment. Despite the potentially significant scheduling challenges and costs, this measure was determined to be the most effective solution for preventing TTS effects (and therefore injury) to pygmy blue whales migrating through the BIA.
	Apply a precautionary shut down zone around the seismic source to prevent injury and hearing impairment impacts to dolphins	Yes	EPBC Policy Statement 2.1 was developed specifically to apply to baleen whales and large odontocete whales. Therefore, it was considered whether it would be practicable to apply similar procedures to dolphins. Smaller dolphin species have peak hearing sensitivities in the mid to high frequency ranges and are likely to be less disturbed by low frequency seismic pulses and less vulnerable to acoustic trauma. Accordingly, EPBC Policy Statement 2.1 does not normally apply to encounters with small dolphins. The potential for PTS/TTS impacts to occur to dolphins from a single seismic pulse is limited to within 20 m of the seismic source while the SEL_{24hr} thresholds for PTS and TTS impacts to dolphins are not predicted to be exceeded at any distance. The 20 m range to effect is taken from the centre of the seismic source, meaning that PTS and TTS effects are predicted to be possible only within the immediate area of the seismic source array. In addition, the offshore location of the 2D seismic survey is not sensitive habitat for dolphins. Dolphin species have been known to approach seismic survey vessels and ride the bow wake for short periods before moving away again without apparent trauma. Depending on the size of the survey vessel, the bow may

			be within less than 100 m of the towed seismic source, making it difficult to practically implement a shut-down zone. Dolphins are highly mobile creatures and are expected to avoid the seismic source at distances where received sound levels are high enough to result in significant hearing impairment. Soft-start procedures will be implemented and provide opportunity for dolphins to move away before the source is operated at full volume. Even so, as a precautionary measure to account for potential uncertainty and as a means of meeting the legislative requirement to not injure any cetacean within the Australian Whale Sanctuary, a shut down zone of 100 m radius will be applied around the seismic source.

Identify the likelihood

No operation of the seismic source will occur between 1st June to 31st October, thereby completely avoiding the period when humpback whales are present in the region. The likelihood of significant consequences to humpback whales is therefore reduced substantially. A temporal exclusion will also be applied to protect migrating pygmy blue whales. With the above control measures in place, the potential for hearing impairment or significant behavioural impacts to all marine mammals is also reduced, although some short-term behavioural impacts are still expected to occur.

The likelihood of Significant consequences to humpback whales is considered Highly unlikely (5). The likelihood of Moderate consequences to pygmy blue whales is considered Unlikely (4). However, the likelihood of Minor consequences to other marine mammal species, such as dolphins, is considered Possible (3).

Residual risk summary

Based on a consequence of Significant (C) and a likelihood of Highly Unlikely (5) the residual risk to humpback whales is Moderate (7). Based on a consequence of Moderate (D) and a likelihood of Unlikely (4) the residual risk to humpback whales is Moderate (7). In addition, based on the potential consequence to other species having a consequence of Minor (E) and a likelihood of Possible (3), the residual risk is also Moderate (7).

Consequence	Likelihood	Residual risk
Minor (E)	Possible (3)	Moderate (7)

Assess residual risk acceptability

Legislative requirements

The proposed control measures exceed the required standards and control measures set out in Part A of EPBC Policy Statement 2.1.

The proposed control measures meet the requirement to not injure any cetacean within the Australian Whale Sanctuary.

Stakeholder consultation

During consultation with relevant stakeholders, no specific concerns, objections or claims were raised regarding the potential impacts to marine mammals.

The Director of National Parks has an interest in the conservation of values protected within an Australian Marine Park, which includes humpback whales, inshore dolphins and dugongs protected as natural values in the Kimberley AMP. With the proposed control measures, no significant impacts to these marine park values are expected.

Some Aboriginal stakeholders were interested in potential impacts to dugong populations but were not concerned following the consultation due to the distance of the survey offshore. No objections, claims or concerns were raised.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts are expected to occur to key habitats of EPBC Act listed species included as values of the Kimberley AMP, including humpback whales, pygmy blue whales, inshore dolphins and dugongs.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. No survey activities will occur in the Habitat Protection Zone, and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state.

- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. No survey activities will occur in the National Park Zone, and the ecosystems, habitats and native species within the National Park Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

Consistent with the Conservation advice for humpback whales, acoustic modelling has been undertaken to assess the potential impacts on humpback whale calving and resting areas, including cumulative impacts. The 2D seismic survey will also be undertaken consistent with the EPBC Act Policy Statement 2.1.

Consistent with the Conservation Management Plan for the Blue Whale, control measures have been identified to meet the requirement, '*Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area*'.

ALARP summary

Given the level of environmental risk is assessed as Moderate, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and

• the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Moderate", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.			
Environmental performance outcomes	**Environmental performance standards**	**Measurement criteria**	**Responsibility**
Undertake seismic acquisition in a manner that is consistent with EPBC Policy Statement 2.1 and prevents PTS impacts, or displacement from BIAs resulting from exposure of marine mammals to seismic sound emissions.	Consistent with Part A of EPBC Policy Statement 2.1, the following precaution zones will be applied: • Observation zone: 3+ km horizontal radius from the seismic source. • Low power zone: 2 km horizontal radius from the seismic source. • Shut-down zone: 500 m horizontal radius from the seismic source.	MFO report confirms that the precaution zones are implemented in accordance with Part A of EPBC Policy Statement 2.1.	MFO
	Consistent with Part A of EPBC Policy Statement 2.1, the following procedures will be applied (refer to Figure 7-10 below): • Pre-Start-up Visual Observations (30 mins)	MFO report confirms that procedures implemented in accordance with Part A of EPBC Policy Statement 2.1.	MFO

	• Soft-start Procedures (30 mins) • Start-up Delay Procedures (if sighting) • Operational Shut-down and Low-power Procedures • Night-time and Low Visibility Procedures • Cetacean sighting reports within 2 months of completion of the survey.	Communication record confirms cetacean sighting reports provided to Department of Environment and Energy within 2 months of completion.	INPEX Environmental Advisor
	An extended shut down zone of 1 km will be applied in the event that mother and calf pairs are observed.	MFO report confirms that 1 km shut down zone implemented in the event that mother and calf pairs are observed.	MFO
	A minimum of two trained and dedicated MFOs will be available on board the seismic survey vessel to manage shift duties during daylight hours during the survey.	MFO report confirms two MFOs were on board the seismic vessel for daylight visual observations during the survey.	MFOs
	The required standard for MFOs is: • UK Joint Nature Conservation Committee (JNCC/UKCS) standard training (or equivalent); and • previous MFO experience on at least 2 seismic surveys.	Curriculum Vitae of the MFOs engaged for the survey confirms: • UK Joint Nature Conservation Committee (JNCC/UKCS) standard training (or equivalent); and • previous MFO experience on at least 2 seismic surveys.	CONTRACTOR Survey Manager

	Crew, survey personnel and MFOs will be briefed in the marine fauna observation, separation distance estimation, controls and reporting requirements relevant to this EP.	Induction includes briefing on Part A of EPBC Policy Statement 2.1 and additional, control measures proposed in this EP to manage the effects of underwater noise on marine fauna. Induction records confirm that the crew, survey personnel and MFO's receive the survey induction.	INPEX Environmental Advisor
Undertake seismic acquisition in a manner that avoids exposure of calving and nursing humpback whales during the period June to October to prevent displacement from the defined calving/nursing BIA and key aggregation sites.	Operation of the seismic source will not occur during the period from 1st June to 31st October in any year.	Survey records confirm the seismic source was ceased operating during the period 1st June to 31st October in any year inclusive.	INPEX Offshore Representative
Undertake seismic acquisition in a manner that prevents injury to pygmy blue whales.	No operation of the seismic source will occur within the defined 'Pygmy blue whale protection zone' (Figure 7-11) during the periods 1st April to 31st August and 1st October to 31st December in any year inclusive.	Survey records confirm the seismic source was not operated within the defined 'Pygmy blue whale protection zone' during the periods 1st April to 31st August and 1st October to 31st December in any year inclusive.	INPEX Offshore Representative
	The 'Pygmy blue whale protection zone' (Figure 7-11) will be provided as a GIS shapefile to the selected seismic contractor for inclusion in their survey planning and vessel navigation systems.	Transmittal records confirm that the 1 km 'Pygmy blue whale protection zone' was provided to the seismic contractor prior to commencement of the 2D seismic survey.	INPEX Offshore Representative

	Crew, survey personnel will be briefed regarding the requirement not to operate the seismic source within the 'Pygmy blue whale protection zone' during the periods 1st April to 31st August and 1st October to 31st December in any year inclusive.	Induction includes briefing on the 'Pygmy blue whale protection zone'. Induction records confirm that the crew, survey personnel receive the survey induction.	INPEX Environmental Advisor
Undertake seismic acquisition in a manner that prevents injury to dolphins.	A shut down zone of 100 m radius will be applied to dolphins.	MFO report confirms that 100 m shut down zone implemented for dolphins.	MFO

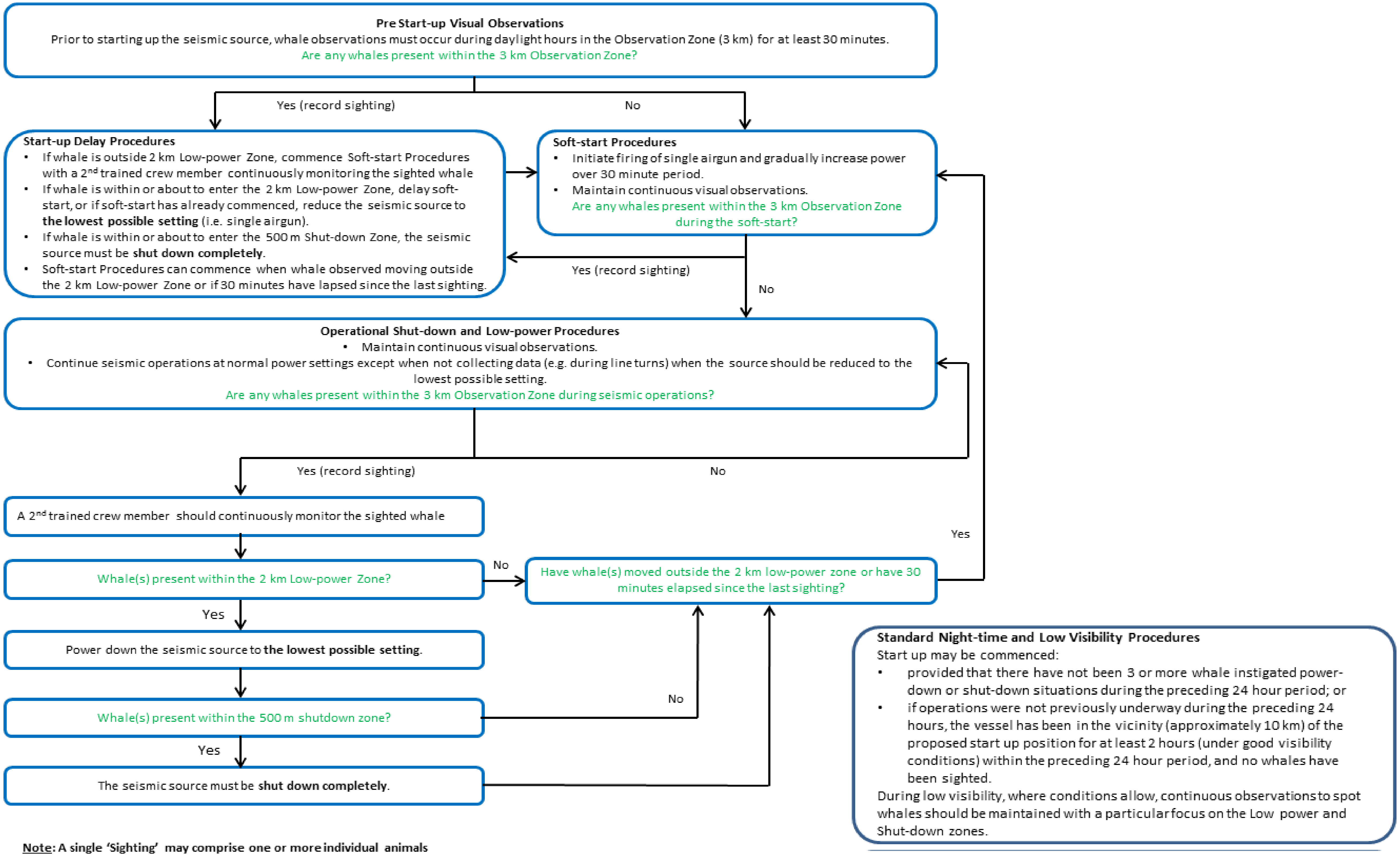

Figure 7-10 Flowchart for the implementation of standard management measures from Part A of EPBC Policy Statement 2.1 (DEWHA 2008a)

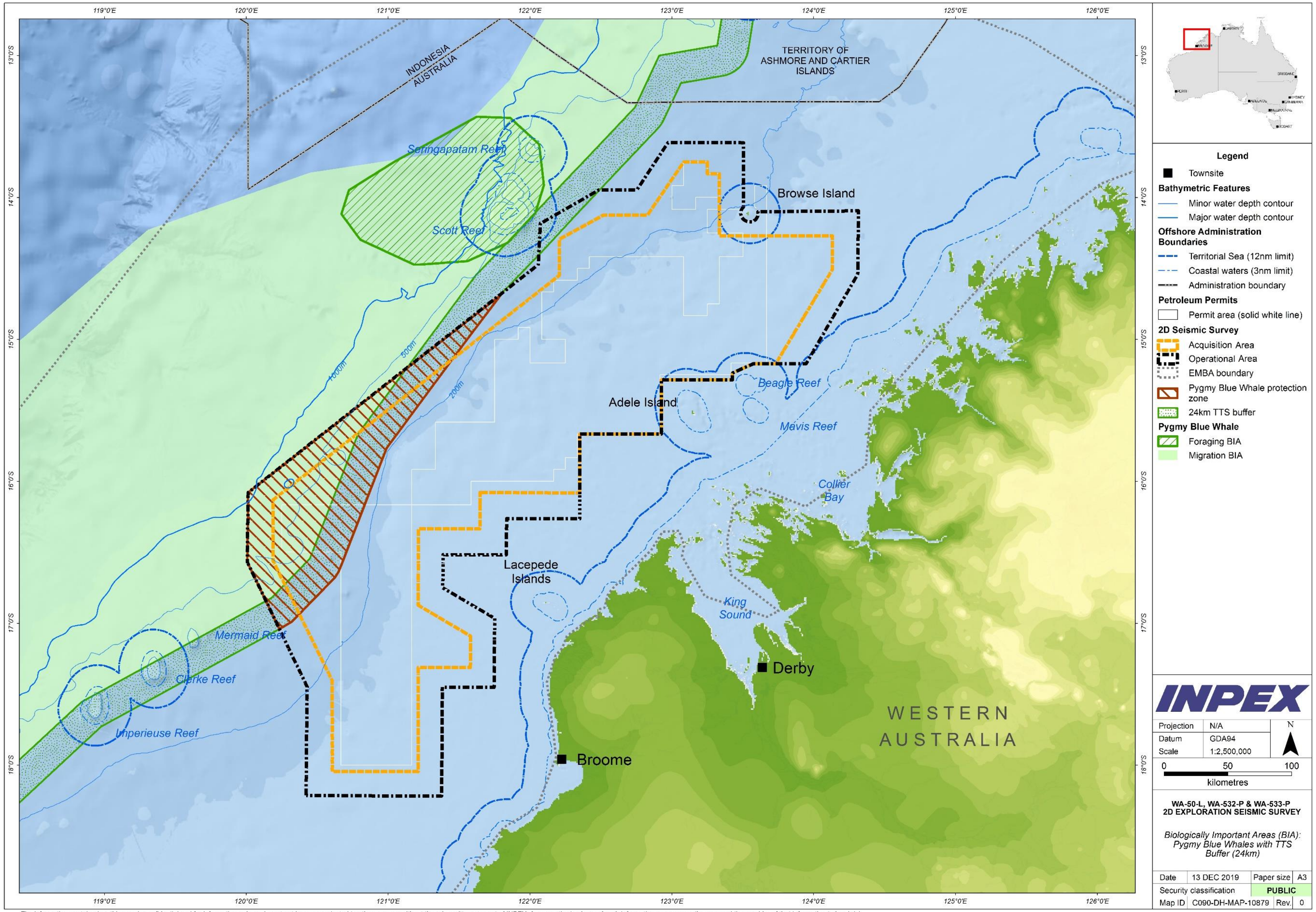

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Figure 7-11 Proposed pygmy blue whale protection zone to be applied for the temporal exclusion of seismic source operations within 24 km of the pygmy blue whale migration BIA

7.1.8 Underwater noise and vibration – Marine reptiles

Receptor sensitivity to sound and sound exposure thresholds

Marine turtles are not considered to be as sensitive to sound as cetaceans. Turtles do not have an external ear but detect sound through bone-conducted vibration in the skull and by using their shell as a receiving surface (Lenhardt et al. 1985). The ear of marine turtles appears to be adapted to detect sound in water, with the retention of air in the middle ear suggesting that they are able to detect sound pressure (Popper et al. 2014). Turtles have been shown to respond to low frequency sound, with indications that they have the highest hearing sensitivity within a narrow frequency range 100 to 700 Hz (Bartol & Musick 2003), which coincides with the frequency range of seismic signals (<250 Hz).

There is a paucity of data on the sound levels produced by seismic surveys that may result in mortality, injury or hearing impairment in turtles. As a conservative approach and in the absence of data specific to the effects of seismic impulses on turtles, Popper et al. (2014) recommend applying the thresholds developed for mortality and mortal injury to fishes to turtles as well (see Section 7.1.6). Therefore, Popper et al. (2014) suggest that injury to turtles resulting from seismic impulses may occur for sound exposures above 207 dB re 1 µPa (PK) or above 210 dB re 1 $\mu Pa^2 \cdot s$ (SEL_{24hr}). However, Popper et al. (2014) suggest that recoverable injury and TTS is likely within tens of metres of a seismic source, which is generally less than the distance associated with their proposed mortal injury threshold, hence there is some discrepancy. Popper et al. (2014) also note that turtles are highly resistant to high-intensity explosives, making it likely that they would also be resistant to damage from seismic airguns. Explosives typically produce pressure waves with a more rapid rise time and over pressure signal (and, therefore, likely greater potential for harm) than seismic impulses. Popper et al. (2014) proposed a threshold for injury from explosives of 229–234 dB re 1 µPa (PK). However, seismic impulses have lower peak pressures (and rise time) than explosives, and as such are less likely to cause injury, therefore the potential for injury at 207 dB re 1 µPa (PK) is highly unlikely. This threshold is conservative and is unlikely to represent the levels where mortality and injury may occur.

Finneran et al. (2017) presented revised thresholds for turtle injury, considering both PK and frequency weighted SEL. This work considered Popper et al. (2014), and that the working group assumed turtles to be similar to fish and defines both a weighting function and TTS exposure function parameters for turtles. Finneran et al. (2017) presents the US Navy Phase III thresholds for PTS and TTS which recognise turtles sensitivity to sound and frequency weighted hearing capabilities. The PTS and TTS onset thresholds proposed by Finneran et al. (2017) are presented in Table 7-15 and have been used in this assessment.

For comparaison, Popper et al. (2014) recommend that potential for hearing impairment and behavioural disturbance to turtles be assessed qualitatively rather than based strictly on a specific threshold. For hearing impairment, including PTS and TTS, Popper et al. (2014) rated the likelihood as high in the near-field (tens of metres from the seismic the source) and low in the intermediate to far-field (hundreds to thousands of metres from the seismic source). Similarly, the likelihood of behavioural disturbance was rated as high in the near-field (tens of metres), moderate in the intermediate-field (hundreds of metres) and low in the far-field (thousands of metres).

McCauley et al. (2000) found that turtles showed behavioural responses (i.e. increased swimming behaviour) to an approaching seismic source at received sound levels of approximately 166 dB re 1 µPa SPL, and a stronger avoidance response at around 175 dB re 1 µPa SPL. Similarly, Moein et al. (1995) monitored the behaviour of penned loggerhead turtles to seismic sources operating at 175–179 dB re 1 µPa SPL at 1 m. Avoidance of the seismic source was observed at first exposure, but the turtles habituated to the sound over time. The 166 dB re 1 µPa SPL has been used by the U.S. NMFS as the threshold level for a behavioural disturbance response (NSF 2011). Finneran et al. (2017) identified 175 dB re 1 µPa SPL as the level at which marine turtles are expected to actively avoid seismic exposures. However, the Recovery Plan for Marine Turtles in Australia (DEE 2017a) acknowledges the 166 dB re1 µPa SPL reported by McCauley et al. (2000) as the level that may result in a behavioural response to marine turtles. Therefore, the following impact assessment adopts the lower and more conservative threshold (Table 7-15).

Table 7-15 Impact threshold criteria for marine turtles

Finneran et al. (2017)				**NSF (2011)**
PTS onset thresholds (received level)		**TTS onset thresholds (received level)**		**Behaviour**
Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	**PK** (L_{pk}; dB re 1 µPa)	**Weighted SEL_{24h}** ($L_{E,24h}$; dB re 1 µPa^2·s)	**PK** (L_{pk}; dB re 1 µPa)	**SPL** (Lp; dB re 1 µPa)
204	232	189	226	160

Table 7-16: Impact and risk evaluation – underwater noise and vibration – marine reptiles

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">High intensity impulsive sound emitted from seismic sources has the potential to impact marine reptiles in the following ways:
• mortal injury or recoverable injury to marine turtles at very close range to the seismic source
• hearing impairment (TTS) at close range to the seismic source
• behavioural disturbance impacts.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>Summary of receptors
Marine turtle species that may be present in the Operational Area include flatback, green, hawksbill, loggerhead and olive ridley turtles. Key sensitivities include:
• internesting flatback turtles in waters seaward of key nesting beaches at the Lacepede Islands, Eighty Mile Beach and bays and islands of the north Kimberley coastline;
• internesting green turtles in waters seaward of the Lacepede Islands, Adele Island, Browse Island and Scott Reef; and
• foraging turtles, including a foraging BIA in nearshore waters west of James Price Point, adjacent to the Operational Area.
In addition to these key habitat areas, transient turtles may occur throughout the Operational Area during migrations and foraging.
Species of sea snakes, including short-nosed sea snakes, may also be present in the Operational Area. However, they typically prefer the reef habitats in water depths less than 10 m so their presence in the Operational Area is unlikely to be common.
Evaluation of potential consequence
The acoustic modelling (McPherson et al. 2019; Appendix D) predicts that the turtle injury criteria of 232 dB re 1 µPa PK for PTS and 226 dB re 1 µPa for TTS PK from Finneran et al. (2017) will not be exceeded at a distance greater than 20 m from the geometric centre of the seismic source. Because the arrays are not a point source (approximately 14 m x 10 m) the actual ranges from the edge of the source array are smaller than the distance from the centre. Therefore, PTS and TTS may only occur if a turtle is exposed directly next to the source array. It is noted, however, that the more conservative Popper et al. (2014) threshold for potential</td><td>Minor (E)</td></tr>
</table>

injury to turtles was also modelled by McPherson et al. (2019; Appendix D) and this threshold was predicted to be exceeded within 120 m and 230 m from the centre of the seismic source, depending upon the location and water depth. The maximum distance to the Finneran et al. (2017) SEL_{24hr} metric for PTS and TTS onset was 40 m and 1.63 km from the seismic source respectively. As is the case with marine mammals, a reported radius for SEL_{24hr} criteria does not mean that turtles travelling within this radius of the source will be injured or impaired, but rather that an animal could be exposed to the sound level associated with PTS or TTS if it remained in that location for 24 hours. The potential for injury or significant hearing impairment is limited as turtles would likely attempt to swim away and avoid the approaching seismic source before being in such close range. Based on the qualitative Popper et al. (2014) criteria for recoverable injury, PTS and TTS, such likelihood of such effects is high in the near-field (tens of metres from the seismic the source) and low in the intermediate to far-field (hundreds to thousands of metres from the seismic source). Therefore, the potential for such effects is unlikely beyond the immediate vicinity or a few tens of metres from the seismic source. There is the potential for injury to occur to turtle hatchlings that disperse in offshore waters if exposed within the immediate proximity of the source array, as hatchlings have limited ability to avoid the vessel or the seismic source. Should this occur, it is possible that those individual hatchlings may not survive. Hatchlings are largely pelagic and carried by currents during their first stage of life and they are widely dispersed throughout the region from their natal beaches (DEE 2017a). There is limited tidal exchange between mainland beaches and offshore waters in this region (Condie et al. 2006; Ivey et al. 2016) and juveniles are typically found nearshore (RPS 2010), but hatchlings may disperse from nesting beaches at offshore islands in the region. Flatback turtles, one of the key nesting species found in the Kimberley, is an exception to this. Flatback hatchlings tend to remain close to their natal beaches and do not have an offshore pelagic phase (DSEWPaC 2012). Therefore, relatively few pelagic-stage hatchlings are likely to occur in the offshore waters of the Operational Area compared with nearshore waters. Given the localised range from the seismic source within which mortal injury may occur, the potential for hatchling mortalities is not significantly greater than that of hatchlings being killed by a passing vessel. Hatchlings normally have a low chance of survival, with less than 1% of turtles reaching maturity as a result of mortality from natural causes (Limpus 2008; Queensland Department of Environment and Science 2018). Mortality rates can be even greater as a result of human factors including fishing bycatch and vessel strike. The potential for hatchling mortality from exposure to the seismic source is limited and relatively small compared with mortalities from other causes. The maximum range at which the NSF (2011) 166 dB re 1 µPa SPL threshold for behavioural response ranges from between 3 km and 6 km, varying depending on differences in the bathymetry and seabed sediments on the continental shelf. These ranges represent sound propagation in the broadside direction, with ranges in the	

endfire direction of the seismic source (which would be received as the seismic survey vessel approached) being less. Based on these results, it is reasonable to expect that some turtles will begin to show some increased swimming behaviour as the seismic source approaches a location from a few kilometres away. Resting and basking turtles may be slower to respond to the approaching noise (Ketos Ecology 2009). As the seismic source gets closer, more obvious fast swimming and stronger avoidance reactions, as observed by McCauley et al. (2000) at levels of approximately 175 dB re 1 µPa SPL, may occur when the seismic source is a kilometre or so from a turtle's location. At the proposed survey vessel speed of 4.5 knots, such an exposure scenario that would occur over a period of approximately 1 hour with sufficient time for turtles to avoid the approaching seismic source. Given the transient nature of the seismic survey and broad line spacing, a limited number of survey lines would occur in the same general area, and the survey vessel may not return to another acquisition line in this area for several hours or possibly even days. Therefore, behavioural disturbances in habitats that support marine turtles would be short-term and temporary. These exposure scenarios are consisted with observations reported in Ketos Ecology (2009), where resting or basking turtles were noted as swimming in the vicinity of dilt floats at the head of the towed seismic streamers (tens or hundreds of metres from the seismic source) or buoys at the tail end of the seismic streamers, and even foraging along the seismic cables. This may indicate that turtles may be relatively unperturbed by seismic disturbances, even within a few kilometres or few hundred metres from a seismic source. **Potential impacts to internesting marine turtles** As described in Section 4.8.4, a number of internesting habitats have been identified in the Kimberley region and around offshore reefs and islands that have been designated as BIAs and/or 'habitat critical to the survival of a species' (Habitat Critical). Some of these designated habitats extend offshore and overlap the Acquisition Area or Operational Area in some locations (see Figure 4-10 and Figure 4-11). The internesting habitats that have the potential to be exposed to sound from the 2D seismic survey are summarised in Table 7-17. The internesting buffers ascribed to the various BIAs and Habitat Critical are based on studies that have quantified the distances that female turtles will travel from nesting beaches between nesting events. They include a level of conservatism to provide protection to the species, noting that internesting turtles are typically more abundant closer to the nesting beaches. For example, the 60 km buffer associated with flatback turtle Habitat Critical and 90 km BIA buffer are based on several studies in Australia. Tagged turtles in these studies were observed to swim up to a maximum of approximately 60 km from the internesting beaches, however, the majority of individuals in these studies remained nearer to the beaches during the internesting period. Studies of flatback turtle nesting in the Pilbara region observed some individuals travelling up to 62 km alongshore from nesting beaches or towards the mainland from island nesting beaches. However, the average distance travelled at each of the beaches ranged between approximately 10 km and 27 km, and typically in	

water depths of less than 25 m (RPS 2010; Whittock et al. 2014; Whittock et al. 2016a; Waayers & Stubbs 2016). Similarly, Harmann et al. (2015) reports that internesting flatback turtles in the Torres Strait typically remain within 25 km of the nesting beach. A tagging study by Waayers et al. (2011) at the Lacepede Islands reported that the average internesting habitat utilisation was within 26 km of the beach, and within a maximum distance of 48 km. Recently, Thums et al. (2017) found that during the internesting period, flatback turtles remained at an average distance of 15.75 ± 12.25 km from West Lacepede Island, in water depths of 16 ± 3 m. None of the tagged turtles travelled offshore to the waters of the proposed Operational Area (Figure 7-12). RPS (2010) reported a low density of flatback turtles that travelled up to 50 km from the Lacepede Islands, although medium and high densities of turtles remained within 25 km. Again, none of the tagged turtles travelled offshore to the waters of the proposed Operational Area and the greater travel distances reported were towards shallower waters near the mainland. Similarly, studies at Scott Reef and the Lacepede Islands have found that green turtles typically remained within 5 – 10 km of nesting beaches (Pendoley 2005; Guinea 2009; RPS 2010). Therefore, the BIA and Habitat Critical buffers likely reflect the upper limits of the distances that turtles travel during internesting. It is likely that the areas of the BIAs and Habitat Critical that overlap the 2D seismic survey Operational Area and Acquisition Area support relatively few internesting individuals and the majority of the internesting population is located nearer to shore in waters where they are unlikely to be disturbed. In the event that the 2D seismic activity is acquired during internesting periods, there is the potential for disturbance to adult females during a sensitive life stage. However, key turtle internesting habitat is largely avoided. Where the Acquisition Area overlaps, or is located in close proximity to, an internesting BIA or Habitat Critical, the overlap tends to be at the outermost extent of this areas where the number of internesting individuals will be relatively low. The overlap is also limited that disturbances in these areas, as the seismic survey vessel transits along acquisition lines, will be of short duration (i.e. hours) and infrequent. A small proportion of the key nesting populations of flatback turtles at the Eighty Mile Beach, the Lacepede Islands and the northern Kimberley, and green turtles at Adele Island, Browse Island and Scott Reef may be subject to short-term disturbances from time-to-time, but no impacts to the overall populations are expected. Turtles will not be displaced from internesting habitats. The potential impact to internesting turtles is, therefore, assessed as Minor.	

Table 7-17 Turtle stocks that have the potential to be exposed to seismic sound during the internesting periods

Species and stock	Nesting location	Habitat designation	Inter-nesting buffer	Time of year [1]	Proximity to the survey
Flatback turtle (south-west Kimberley stock)	Eighty Mile Beach, Eco Beach	BIA	90 km	October to March (peak December to January)	Approximately 6 km south-west from the Acquisition Area, overlaps with the south-east corner of the Operational Area near WA-533-P.
		Habitat Critical	60 km		Approximately 30 km south-west from the Acquisition Area and 12 km from the Operational Area (no disturbance expected).
	Lacepede Islands	BIA	90 km		Extends within the boundary of the Acquisition Area near WA-532-P and WA-533-P.
		Habitat Critical	60 km		Abuts but does not overlap the Acquisition Area, overlaps with the Operational Area near WA-532-P and WA-533-P.
Flatback turtle (undefined north Kimberley stock)	Camden Sound, Napier-Broome Bay and islands	None	60 km	May to July	Overlaps with the Acquisition Area by approximately 5 km in WA-532-P, near Beagle Reef.
Green turtle (North West Shelf stock)	Lacepede Islands	BIA	20 km	November to March	Approximately 40 km from the Acquisition Area (no disturbance expected).
		Habitat Critical			
	Adele Island	Habitat Critical	20 km		Overlaps the Operational Area, approximately 4 km from the Acquisition Area).
Green turtle (Scott Reef		BIA	20 km		

Species and stock	Nesting location	Habitat designation	Inter-nesting buffer	Time of year [1]	Proximity to the survey
and Browse Island stock)	Sandy Islet, Scott Reef	Habitat Critical			Overlaps the Operational Area, approximately 11 km from the Acquisition Area (no disturbance expected).
	Browse Island	Habitat Critical	20 km		Overlaps the Operational Area and extends approximately 3 km into the Acquisition Area.

1. Nesting periods defined in the Recovery Plan for Marine Turtles in Australia (DEE 2017a).

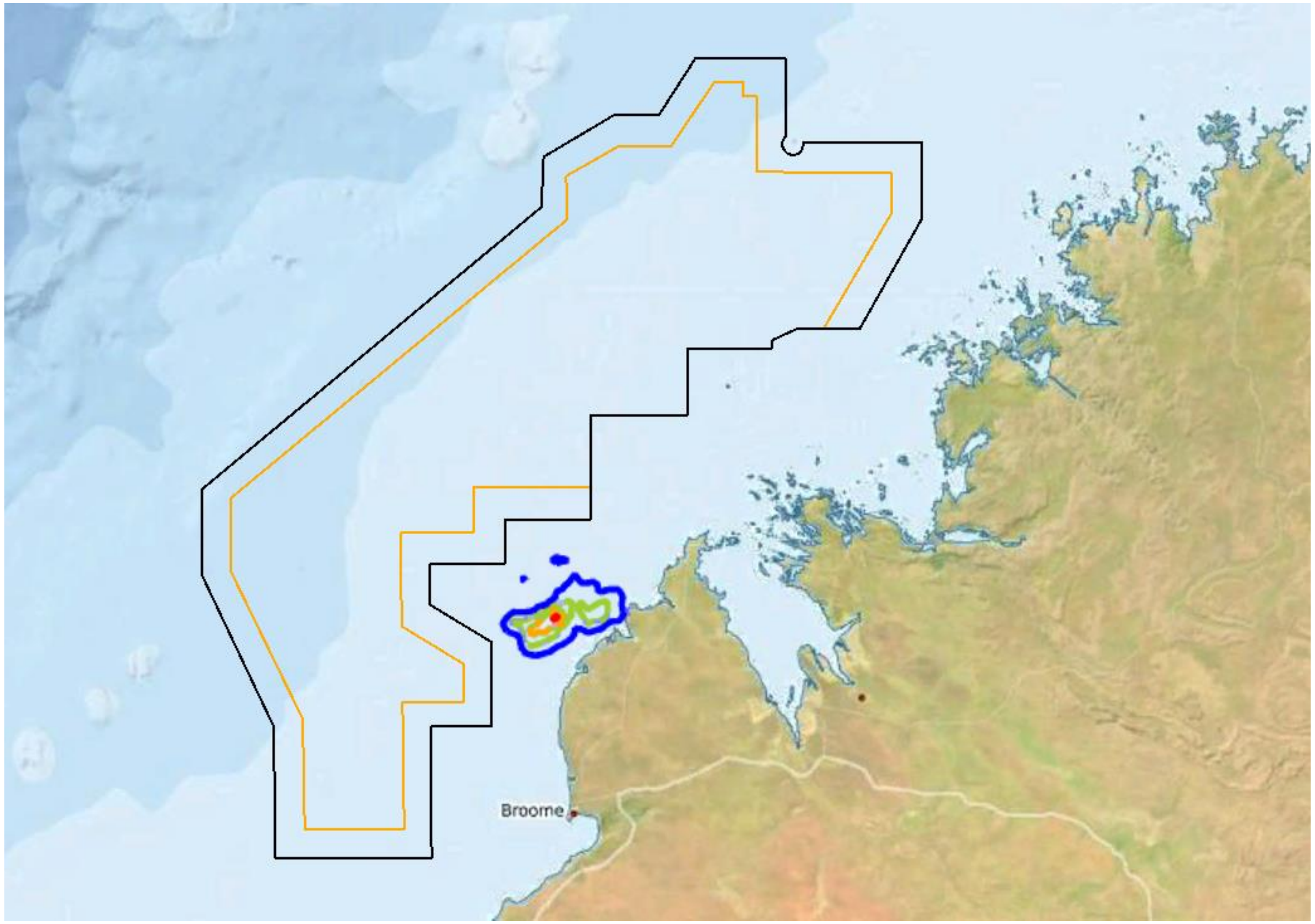


Figure 7-12 Habitat utilisation by flatback turtles during internesting at the Lacepede Islands (Thums et al. 2017). Red, orange, green and blue contours represent the 25%, 50%, 75% and 95% utilisation distribution respectively. Black lines indicate the Acquisition Area and Operational Area boundaries.

Potential impacts to foraging and migrating marine turtles Turtles will migrate and forage across large areas of the continental shelf. Favourable foraging habitat for most species is in shallow coastal habitats, but some species venture deeper to feed (RPS 2010; DEE 2017a). No migration of foraging BIAs are present within the Operational Area. A single foraging BIA has been defined for green, flatback and loggerhead turtles in waters to the west of Broome and James Price Point (see Figure 4-10 and Figure 4-11). It is likely that olive ridley and hawksbill turtle foraging also occurs here. The BIA is located immediately adjacent to the Operational Area and is approximately 15 km from the Acquisition Area. Therefore, there is limited potential for disturbance to foraging turtles in this area as sound levels received from the seismic source while it is completing acquisition lines and line run-outs (approximately 10 km away) will be below levels that would result in a behavioural response in turtles and may not be audible to them at all. A tagging study by Whittock et al. (2016b) tracked flatback turtles from the Pilbara region of WA during their post-nesting migrations along the coast of northern Australia to foraging grounds near the Sahul Shelf in the Timor Sea and beyond to the Gulf of Carpentaria in some cases. The study confirmed that waters west of Broome and James Price Point were used for foraging, as well as waters adjacent to Quondong Point, the Lacepede Islands, Lynher Bank, and the Holothuria Banks in the Timor Sea to the north-east of the Operational Area. Foraging areas were typically located in 50 m water depth (36.5 m mean depth) and 66 km from shore, but could occur in water depths up to 130 m. The foraging areas are all located outside of the Operational Area, with the exception of Lynher Bank. Thums et al. (2017) studied flatback turtles during their post-nesting migration from the Lacepede Islands and during foraging. The study found that flatback turtles migrated along the coast in water depths of 63 ± 5 m, passing near Adele Island on the way to foraging grounds on the Sahul Shelf in the Timor Sea. Therefore, flatback turtles migrating from the Lacepede Islands and other nesting beaches may occur in the Operational Area, including along the southern boundary of WA-532-P in water depths of approximately 60 m. Habitat utilisation during migration and foraging is presented in Figure 7-13. A study by WAMSI (Heyward et al. 2018a) compiled over a decade of tagging data for flatback turtles and found similar foraging areas to Whittock et al. (2016b). Turtles spent most of their time in the inshore near Cape Leveque and the most individual turtles were recorded around the Lacepede Islands, outside of the Operational Area. The less utilised area of Lynher Bank was surveyed for the purpose of mapping the benthic habitats and potential food source for turtles at this offshore location. Overall, abiotic substrate was recorded over 94% of the survey area. Areas of hard substrate supporting soft corals and filter feeder invertebrates	

were identified were present in some areas at low to moderate levels (Heyward et al. 2018a). The habitat was broadly spread but may provide suitable foraging habitat for flatback turtles.

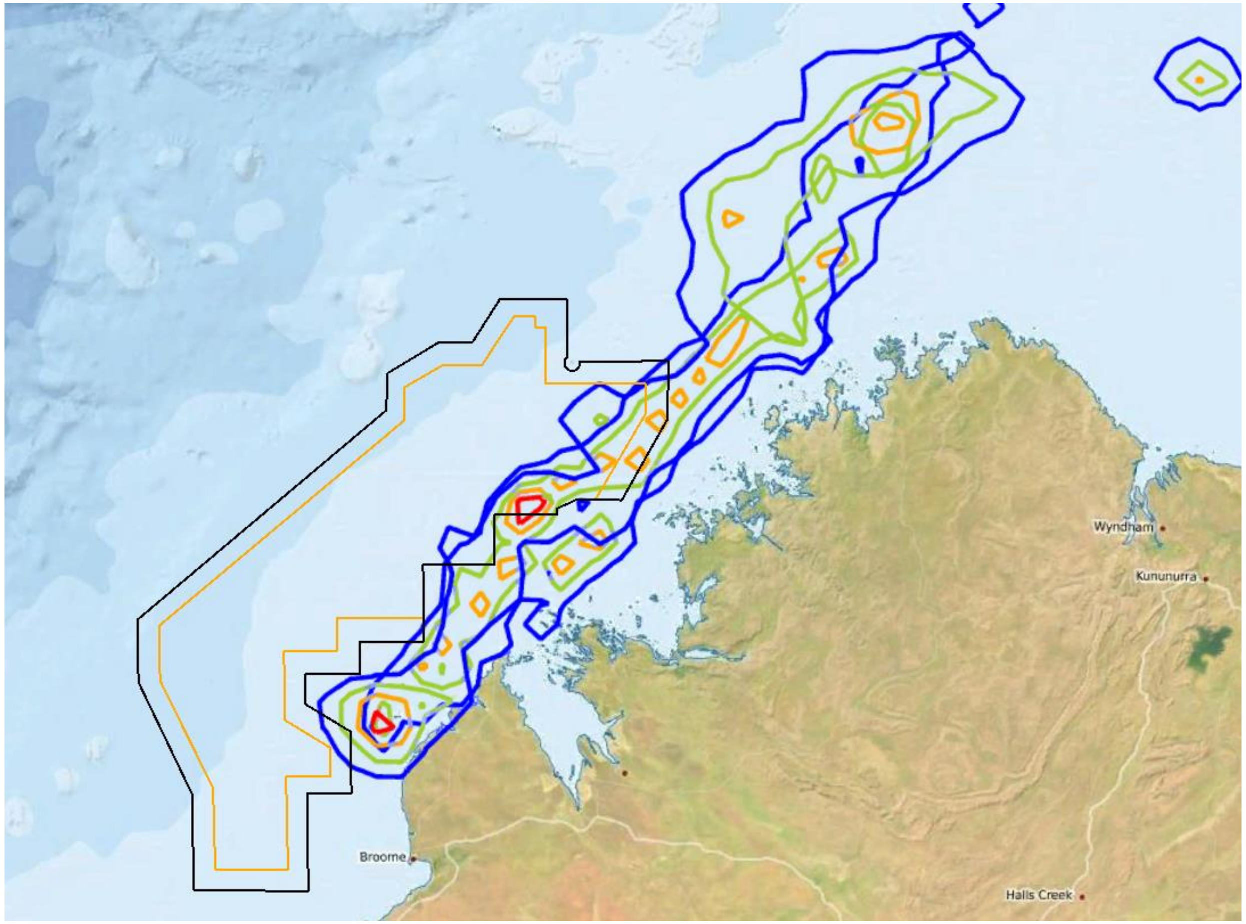


Figure 7-13 Habitat utilisation by flatback turtles during post-nesting migration and foraging from the Lacepede Islands (Thums et al. 2017). Red, orange, green and blue contours represent the 25%, 50%, 75%

and 95% utilisation distribution respectively. Black lines indicate the Acquisition Area and Operational Area boundaries.

The studies indicate that flatback turtle migration and foraging primarily occurs in waters inshore from the Operational Area, but there is the possibility of interactions with higher numbers of turtles along the southern boundary of the Acquisition Area and WA-532-P and in the vicinity of Lynher Bank and Adele Island. There is the potential for turtles to be disturbed during migration and foraging, particularly at time when the survey vessel passes the areas where higher densities of turtles may be present, but given the transient nature and wide line spacing of the 2D seismic survey such disturbances will be infrequent. There is limited potential for repeat exposure to same individuals during their migrations. Short-term disturbances may briefly interrupt foraging but is not expected to displace turtles from foraging areas or known migration routes. Any deviation made by the turtles will be negligible in the context of the large migration distances that they travel. No impacts will occur to turtles in the adjacent foraging BIA and no areas have been designated as BIAs for migration. There will be no long-term impacts to individual turtles or populations. The potential impact to migrating and foraging turtles is, therefore, assessed as insignificant.

Potential impacts to sea snakes

Sea snake responses to seismic survey sound emissions are not well studied and thus conservatively assumed to be similar to that of turtles, as described above. Sea snakes tend to occur in shallow coastal and inland waters associated with coral reefs and are not expected to be common in the Operational Area. Therefore, impacts are likely to be limited to occasional disturbances to transient individuals. The potential consequence to sea snake populations is considered to be Insignificant.

Overall, based on the worst-case impacts, the consequence to marine reptiles is considered to be Minor.

Identify existing design and safeguards/controls measures

The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3).

INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.

Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	Eliminate the risk of potential disturbance to key internesting turtle populations by excluding operation of the seismic source in internesting BIAs and Habitat Critical during their respective internesting periods.	Yes	Consistent with the requirements of the Recovery Plan for Marine Turtles in Australia (DEE 2017a), a precautionary approach will be applied, such that no operation of the seismic source will take place inside important internesting habitat during the nesting season. The Recovery Plan does not define whether important internesting habitat includes both BIAs and Habitat Critical, but INPEX will avoid acquisition in both designations during the internesting periods. The distances applied to some BIAs and Habitat Critical are likely to be precautionary, but this is considered to be a practicable measure to avoid impacts to internesting turtles and prevent population impacts. The BIAs and Habitat Critical that will be avoided and their respective nesting seasons are: • Flatback turtle (south-west Kimberley stock) at Eighty Mile-Beach and the Lacepede Islands: October to March • Green turtle (North West Shelf stock) at Adele Island: November to March • Green turtle (Scott Reef and Browse Island stock) at Browse Island and Scott Reef: November to March These areas are presented in Figure 4-10 and Figure 4-11.
	Eliminate the risk of potential disturbance to the north Kimberley flatback turtle stock by excluding operation of the seismic source in the indicative internesting habitat identified for the stock during the internesting period.	Yes	Despite the spatial boundaries of Habitat Critical not being formally defined for the north Kimberley stock of flatback turtles, INPEX has applied the 60 km internesting buffer defined in the Recovery Plan for Marine Turtles in Australia (DEE 2017a) to the known nesting beaches (Figure 4-10 and Figure 4-11).

			The north Kimberley flatback turtle stock is a natural value protected by the Kimberley AMP. Consistent with the need to avoid important internesting habitat and protect marine park values, no operation of the seismic source will occur within the internesting habitat area in Figure 4-10 between May and July. The internesting period of this stock is different from other stocks in the Kimberley, which may make scheduling of the 2D seismic survey complex, but given the limited spatial overlap is considered to be practicable.
	Avoid or reduce seismic acquisition in the area of Lynher Bank and Adele Island where low to moderate levels of flatback turtle migration and foraging are known to occur.	No	Disturbance to foraging individuals will be short-term and infrequent with no long-term ecological consequence. Survey lines in vicinity of Lynher Bank and the southern part of WA-532-P are important for evaluating the potential for key hydrocarbon targets in the area. Given that operation of the seismic source is excluded from all BIAs and Habitat Critical, the potential for disturbance is already limited. Given the already low risk to turtle populations, exclusion of significant areas of the survey was not considered practicable.
Substitution	None identified	N/A	No additional substitution controls were identified that would practicably reduce the risk to marine mammals.
Engineering	None identified	N/A	No additional engineering solutions were identified that would practicably reduce the risk to marine reptiles.
Procedures & administration	Provide the seismic contractor with the turtle internesting BIA and Habitat Critical boundaries and brief personnel on the requirement to not operate the seismic source during the internesting periods.	Yes	To ensure that the requirements are clearly communicated and implemented effectively, INPEX will confirm that the turtle internesting BIA and Habitat Critical boundaries are provided to the seismic contractor and the requirements are highlighted during personnel inductions.

	Apply soft-start procedures	Yes	Consistent with the controls applied for whales, soft-start procedures consistent with EPBC Policy Statement 2.1 will be implemented, which will allow turtles with an opportunity to avoid the seismic source before it is operated at full volume, thus reducing the risk of injury and hearing impairment.

	Apply a precautionary shut down zone around the seismic source to prevent injury and hearing impairment impacts to marine turtles	Yes	The potential for PTS/TTS impacts to occur to marine turtles from a single seismic pulse is limited to less than 20 m of the seismic source, based on an evaluation against Finneran et al. (2017) threshold criteria. The potential for PTS as a result of 24 hours of sound exposure is also limited to within 40 m of the seismic source. Because seismic source arrays are not a point source, the actual ranges from the edge of airgun arrays are smaller than the distance from the centre. Therefore, PTS and TTS may only occur if a turtle is exposed directly next to the source array. However, it is noted that the more conservative Popper et al. (2014) threshold for potential injury to turtles was predicted to be exceeded within 120 m and 230 m from the centre of the seismic source. Therefore, as a precautionary measure to account for uncertainty in the levels that will result in injury or hearing impairment to turtles, a shut-down zone of 250 m radius will be applied around the seismic source. A larger shutdown zone is not considered practicable as field observations documented in Ketos Ecology (2009), report turtles swimming in the vicinity of dilt floats at the head of the towed seismic streamers (tens or hundreds of metres from the seismic source) without apparent injury. A larger shutdown zone could lead to multiple unnecessary shutdowns and lost time. It is also challenging for MFOs to spot turtles at increasingly larger distances except in very calm conditions.
Identify the likelihood			
No operation of the seismic source will occur within turtle internesting habitat during the internesting seasons, thereby reducing the potential for disturbance to turtle populations during a key life stage. With the above control measures in place, the potential			

for minor impacts to marine turtle individuals and populations is further reduced, although some short-term behavioural impacts are still expected to occur. The likelihood of Minor consequences to internesting marine turtles is considered Highly unlikely (5). However, the likelihood of Insignificant consequences, such as occasional behavioural disturbances to transient, migrating or foraging turtles, is considered Likely (2).		
Residual risk summary		
Based on a consequence of Minor (C) and a likelihood of Highly unlikely (5) the residual risk to internesting turtles is Low (9). However, based on a worst-case residual risk, the potential for Insignificant (F) consequences to marine reptiles is assessed as being Likely (2) and the residual risk is Moderate (7).		
Consequence	Likelihood	Residual risk
Insignificant (F)	Likely (2)	Moderate (7)
Assess residual risk acceptability		
Legislative requirements The proposed control measures are consistent with requirements of the Recovery Plan for Marine Turtles in Australia (DEE 2017a). Nesting and internesting marine turtle habitats are identified as a natural value of the Kimberley AMP. No significant impacts to internesting marine turtles are predicted and the activity will be undertaken consistent with marine park objectives. Further detail is provided in Section 7.2.5. **Stakeholder consultation** During consultation with relevant stakeholders, no specific concerns, objections or claims were raised regarding the potential impacts to marine turtles. The Director of National Parks has an interest in the conservation of values protected within an Australian Marine Park, which includes marine turtles protected as natural value of the Kimberley AMP. With the proposed control measures, no significant impacts to these marine park values are expected. Some Aboriginal stakeholders were interested in potential impacts to marine turtle populations but were not concerned following the consultation due to the distance of the survey offshore. The Kimberley Land Council requested information regarding potential impacts to marine turtles and INPEX provided the relevant draft impact assessment section to them for review. No objections, claims or concerns were raised.		

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts are expected to occur to key habitats of EPBC Act listed species included as values of the Kimberley AMP, including the nesting and internesting habitats of marine turtles.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. No survey activities will occur in the Habitat Protection Zone, and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. No survey activities will occur in the National Park Zone, and the ecosystems, habitats and native species within the National Park Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

Consistent with the Recovery Plan for Marine Turtles in Australia (DEE 2017a) and protect the internesting turtle value of the Kimberley AMP, consistent with marine park objectives.

ALARP summary

Given the level of environmental risk is assessed as Moderate, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Moderate", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
Undertake seismic acquisition in a manner that prevents injury and TTS impacts to marine turtles resulting from seismic sound emissions.	Soft start procedures will be conducted in accordance with Part A of EPBC Policy Statement 2.1	MFO report confirms that soft start procedures were conducted in accordance with Part A of EPBC Policy Statement 2.1.	MFO
	A shut down zone of 250 m radius will be applied to turtles.	MFO report confirms that 250 m shut down zone applied for turtles.	MFO
Undertake seismic acquisition in a manner that avoids exposure of internesting marine turtles in internesting BIAs and 'Habitat critical to the survival of the species' during internesting periods.	Consistent with the requirements of the Recovery Plan for Marine Turtles in Australia (DEE 2017a), the seismic source will not be operated within internesting BIAs and 'Habitat critical to the survival of the species' during internesting periods, as follows: • Flatback turtle (south-west Kimberley stock) at Eighty	Survey records confirm that no operation of the seismic source occurs within internesting BIAs and 'Habitat critical to the survival of the species' during internesting periods.	INPEX Offshore Representative

	Mile-Beach and the Lacepede Islands: October to March • Flatback turtle (north Kimberley stock): May to July • Green turtle (North West Shelf stock) at Adele Island: November to March • Green turtle (Scott Reef and Browse Island stock) at Browse Island and Scott Reef: November to March		
	The marine turtle internesting BIA and Habitat Critical boundaries will be provided as a GIS shapefile to the selected seismic contractor for inclusion in their survey planning and vessel navigation systems.	Transmittal records confirm that the marine turtle internesting BIA and Habitat Critical boundaries were provided to the seismic contractor prior to commencement of the 2D seismic survey.	INPEX Exploration Project Manager
	Crew, survey personnel will be briefed regarding the requirement not to operate the seismic source in turtle internesting BIAs during the internesting periods.	Induction includes briefing on the requirement not to operate the seismic source in turtle internesting BIAs during the internesting periods. Induction records confirm that the crew, survey personnel and SEA receive the survey induction.	INPEX Environmental Advisor

7.1.9 Underwater noise and vibration – Marine avifauna

Table 7-18: Impact and risk evaluation – underwater noise and vibration – marine avifauna

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">Seabirds and migratory shore birds may potentially be affected by the 2D seismic survey in the following way:
• Direct disturbance to avifauna foraging near the operating seismic source, which may momentarily expose birds to seismic sound and result in a startle response.
• Indirect effects to foraging avifauna associated with behavioural responses in fishes that avifauna target as prey.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>Summary of receptors
The waters surrounding northern Australia are located within East Asian–Australasian Flyway and, therefore, migratory shorebird species rest and forage in the region on their way between their Northern Hemisphere breeding grounds and Northern Australian feeding grounds.
Seabird species that spend the majority of their lives within the region breed at locations along the coast of Australia and at offshore islands, including at the Lacepede Islands, Adele Island and Scott Reef. BIAs for resting and foraging bird species extend offshore from these islands. The BIAs that overlap with the Acquisition Area and/or Operational Area include:
• greater frigatebird foraging BIA, which extends approximately 115 km from Adele Island and up to 80 km into the Acquisition Area;
• lesser frigatebird foraging BIAs, which extend approximately 115 km from Adele Island and the Lacepede Islands, and approximately 80 km into the Acquisition Area;
• lesser crested tern foraging BIAs, which extend approximately 30 km from Adele Island and the Lacepede Islands, and up to 5 km into the Acquisition Area;
• little tern resting BIA at Adele Island, Beagle Reef and Mavis Reef, which is located on the edge of the Acquisition Area and overlaps the Operational Area; and
• roseate tern foraging BIA, which extends approximately 30 km from the Lacepede Islands in waters adjacent to the Operational Area.</td><td>Insignificant (F)</td></tr>
</table>

<table>
<tr><td>Other birds may forage elsewhere in the Operational Area but are likely to be present in fewer numbers than the waters surrounding these islands.

Evaluation of potential consequence

Impacts to foraging seabirds have not been observed previously during seismic surveys. Only birds diving and foraging within the Operational Area have the potential to be exposed to increased sound levels generated by the operating seismic source while diving for small pelagic fishes near the sea surface. Such behaviours may result in a startle response during diving. Birds resting on the surface of the water in proximity to the seismic vessel have limited potential to be affected by sound emissions underwater due to the limited transmission of sound energy between the water/air interface but may also be startled by seismic pulses in close proximity to the seismic source. However, given the likely avoidance response from fish and other prey species in waters immediately surrounding the seismic source, birds are unlikely to forage near the operating seismic source. In the unlikely event that birds dive and forage near the seismic source, this is likely to only affect individual birds, resulting in a startle response with the affected birds expected to move away from the area as a result. The consequence of this is expected to be negligible and impacts at a population level are extremely unlikely to occur. Avifauna will not be displaced from the wider area of the resting and foraging BIAs.

It is noted that the behaviour and distribution of some fishes may be affected for short periods during and after exposure to the seismic source (Section 7.1.6). This may result in short-term and localised changes in the distribution of target prey species. However, these effects are unlikely to be discernible to foraging birds in the context of the normal movements and variation in the distribution of fishes. The behaviours and distribution of prey at any one time will remain largely unaffected throughout the wider BIAs and the Operational Area.

Therefore, impacts to avifauna populations are not anticipated and the potential consequence is assessed to be Insignificant.</td><td></td></tr>
<tr><td colspan="2">Identify existing design and safeguards/controls measures</td></tr>
<tr><td colspan="2">The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3).

INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.</td></tr>
</table>

Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	None identified	N/A	No elimination controls were identified that would practicably reduce the risk to marine avifauna.
Substitution	None identified	N/A	No additional substitution controls were identified that would practicably reduce the risk to marine mammals.
Engineering	None identified	N/A	No additional engineering solutions were identified that would practicably reduce the risk to marine avifauna.
Procedures & administration	None identified	N/A	No procedural controls were identified that would practicably reduce the risk to marine avifauna.
Identify the likelihood			
The likelihood short-term and localised direct and indirect effects to marine avifauna, with Insignificant (F) consequence, is considered to be Possible (3).			
Residual risk summary			
Based on a consequence of Insignificant (F) and a likelihood of Possible (3), the residual risk to marine avifauna is Low (8)			

Consequence	Likelihood	Residual risk
Insignificant (F)	Possible (3)	Low (8)

Assess residual risk acceptability
Legislative requirements Foraging habitat for seabirds is identified as a natural value of the Kimberley AMP. No significant impacts to foraging avifauna are predicted and the activity will be undertaken consistent with marine park objectives. Further detail is provided in Section Further detail is provided in Section 7.2.5.

Stakeholder consultation

During consultation with relevant stakeholders, no specific concerns, objections or claims were raised regarding the potential impacts to marine avifauna.

The Director of National Parks has an interest in the conservation of values protected within an Australian Marine Park, which includes breeding and foraging habitat for seabirds protected as natural value of the Kimberley AMP. No significant impacts to these marine park values are expected.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts are expected to occur to key habitats of EPBC Act listed species included as values of the Kimberley AMP, including seabird breeding and foraging habitats.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. No survey activities will occur in the Habitat Protection Zone, and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. No survey activities will occur in the National Park Zone, and the ecosystems, habitats and native species within the National Park Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

No specific conservation advice is available in relation to underwater acoustic disturbance to avifauna. However, no significant impacts to avifauna are predicted.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond the existing design can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
N/A no controls identified			

7.2 Social and cultural heritage protection

7.2.1 Commercial fisheries

The 2D seismic survey has the potential to interact with commercial fishing activities. The potential effects to commercial fisheries and the concerns expressed by fisheries stakeholders relate to two aspects of the activity, physical presence and underwater sound exposure.

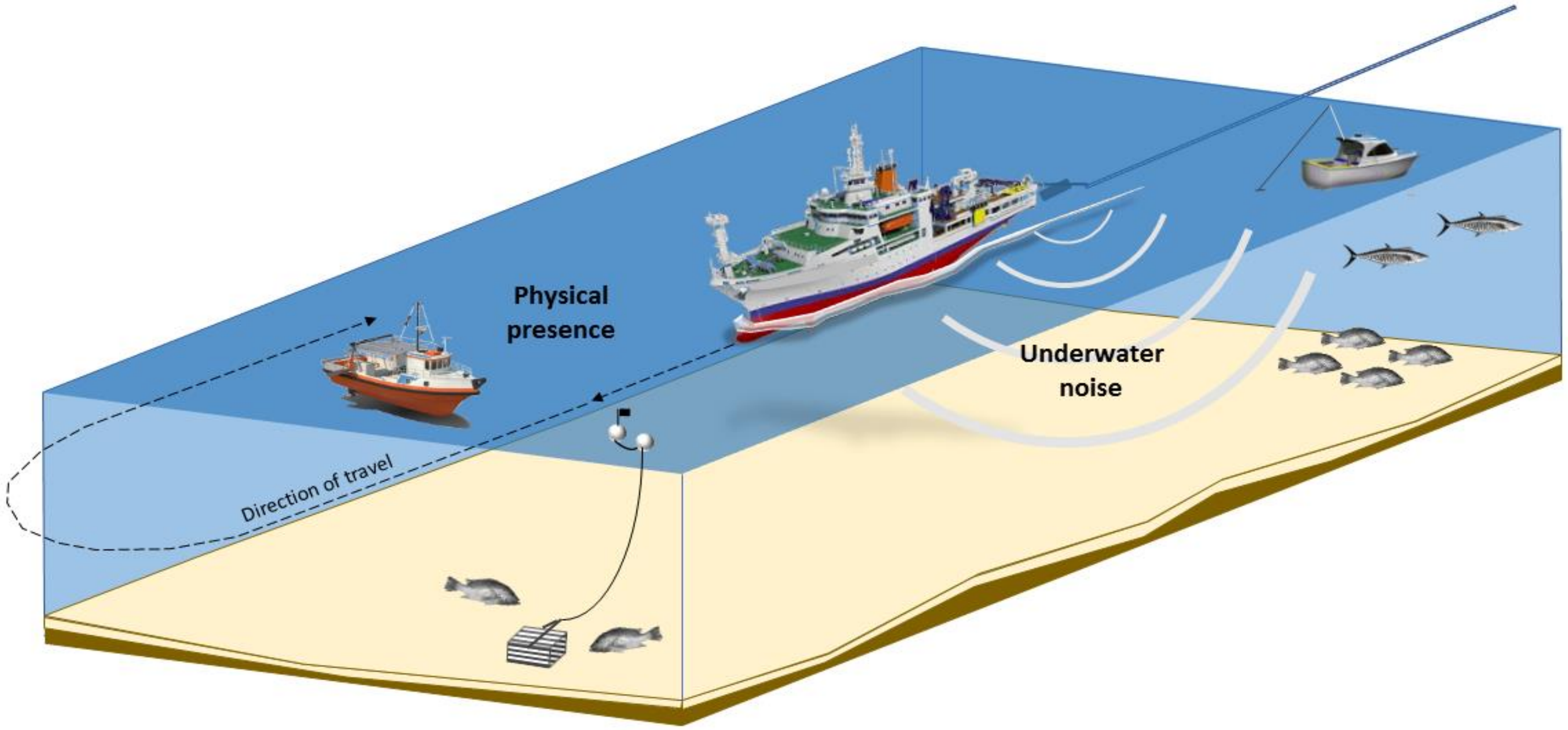
As illustrated in Figure 7-14, these two aspects are intrinsically linked but have the potential to impact fisheries in different ways. Physical presence has the potential to directly impact the physical activities of commercial fishing operators, potentially limiting access to specific fishing grounds, resulting in the displacement / relocation of fishing vessels, disturbing fishing gear, and associated operating costs. Underwater sound from the seismic source has the potential to indirectly affect target fish species and may result in temporary effects to fisheries catch rates.

During stakeholder consultation for this EP, licence holders in the Northern Demersal Scalefish Managed Fishery and the Mackerel Managed Fishery stated that they have experienced the effects of past seismic surveys in the region, both in terms of having to relocate fishing activities to avoid the seismic vessel and suppressed fish behaviours following exposure from the seismic source. Fisheries stakeholders have also expressed concern about the potential for underwater noise from seismic surveys to impact on fish stocks at a population level as a result of impacts to spawning fishes.

This risk assessment section specifically assesses the potential direct impacts to commercial fishing operations and indirect impacts to fisheries catch rates.

The potential impacts of underwater sound to fishes, including spawning behaviours and fish stocks, is assessed separately in Section 7.1.6 *Underwater noise and vibration - Fishes*. The potential impacts of underwater sound to fish eggs and larvae, as well as the effects on other planktonic organisms that provide for the base of the food chain, are assessed in Section 7.1.4 *Underwater noise and vibration – Planktonic communities*. The potential impacts to benthic communities and invertebrate organisms, which also provide a food source for demersal fishes, are assessed in Section 7.1.5 *Underwater noise and vibration – Benthic communities*. Overall, no direct injury or mortality, or other significant population level impacts to commercial fish stocks are expected to occur.

The potential risk to the activities and resource of the Pearl Oyster Fishery (WA) and coastal aquaculture operations is assessed separately in Section 7.2.3 *Pearling and aquaculture*.



Hazards and threats		Environmental receptors			Socio-economic receptors - Fisheries		
		Planktonic communities	**Benthic communities**	**Fishes**	**Fisheries access to resource**	**Fisheries operating costs**	**Fisheries catch rates**
Physical presence	Reduced access to fishing grounds and resources in areas where the seismic survey vessel is operating				✓ Direct impacts (this risk assessment section)		
	Temporary displacement / relocation of fishing vessels to avoid approaching seismic survey vessel				✓ Direct impacts (this risk assessment section)	✓ Direct impacts (this risk assessment section)	
	Disturbance, damage or loss of deployed in situ fishing gear (e.g. traps)					✓ Direct impacts (this risk assessment section)	
Noise and vibration	Behavioural disturbances to fishes (including local distribution, feeding and spawning behaviours)			✓ Direct impacts to adult and juvenile fishes (Section 7.1.6)			✓ Indirect impacts to catch rates (this risk assessment section)
	Mortality to zooplankton, eggs and larvae	✓ Direct impacts to planktonic communities (Section 7.1.4)		✓ Indirect impacts to fishes' food source, larval recruitment (Section 7.1.4)			
	Mortality / impairment to benthic invertebrates		✓ Direct impacts to benthic invertebrates (Section 7.1.5)	✓ Indirect impacts to fishes' food source (Section 7.1.5)			

Figure 7-14 Conceptual diagram illustrating the aspects, hazards, threats and potential impact pathways resulting from interactions between seismic surveys and commercial fisheries.

Table 7-19: Impact and risk evaluation – commercial fisheries

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">The physical presence and movement of the seismic survey vessel and towed streamer along pre-determined acquisition lines has the potential to encounter fishing vessels during the survey. As a result, the 2D seismic survey has the potential to interact with fishing vessels in the Operational Area, which may result in direct disruption to fishing activities in the following ways:
• Reduced access to some fishing grounds and resources in the area where the seismic survey vessel is operating.
• Temporary displacement of fishing vessels to other areas, which has the potential to result in increased costs of operation.
• Disturbance, damage or loss of deployed in situ fishing gear (e.g. traps).
Increased sound levels associated with operation of the seismic source may modify the behaviour, local abundance and distribution of fish species during and for a period following the passing of the seismic survey vessel. The effects to fishes may, therefore, indirectly affect fisheries catch rates if fishing occurs in these locations at the same time.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>Summary of receptors
As described in Section 4.9.5, a number of Commonwealth and State-managed commercial fisheries operate in the same waters as the proposed 2D seismic survey Operational Area. These fisheries include:
• Northern Demersal Scalefish Managed Fishery (WA)
• Mackerel Managed Fishery (WA)
• North West Slope Trawl Fishery (Cwlth).
The WA North Coast Shark Fishery (WANCSF) and Joint Authority Northern Shark Fishery (JANSF) have historically operated in this area, but no fishing effort has occurred in the WANCSF since the 2008/09 fishing season. AFMA and the WA DPIRD have reported that fishing effort in the JANSF has also been inactive in recent years, due to the fishery requiring a Wildlife Trade Operation (WTO) Export Approval to allow the export of products from the fishery. Stakeholder consultation with WAFIC and a stakeholder in the JANSF has indicated that an application for a WTO Export Approval is pending and there is potential for one or both of the shark fisheries to become active again in the foreseeable future and within the timeframes provided for the 2D seismic survey in this EP.
No other commercial fisheries are expected to be active within the Operational Area during the 2D seismic survey. The licence areas of a number of other Commonwealth and State-managed commercial fisheries overlap the Operational Area, but fishing effort does not normally occur in the same waters. Although fishing</td><td>Minor (E)</td></tr>
</table>

activities do not occur, the target species of these fisheries may be present and so the effects of underwater sound from the 2D seismic survey on these fish and crustacean stocks, as well as on catch rates, are considered in this assessment. These fisheries include: • Broome Prawn and Kimberley Prawn Managed Fisheries (WA) • Western Tuna and Billfish Fishery (Cwlth) • Western Skipjack Tuna Fishery (Cwlth) • Southern Bluefin Tuna Fishery (Cwlth). Other commercial fisheries that operate in the Kimberley region include the Kimberley Gillnet and Barramundi Fishery, Marine Aquarium Managed Fishery, Beche-de-Mer Managed Fishery, Specimen Shell Managed Fishery and Trochus Fishery. However, fishing effort and the target species of these fisheries are located outside of the Operational Area, in shallow coastal waters, embayments, intertidal reefs or estuaries where they are not expected to be exposed to the effects of sound from the seismic source. Therefore, no further assessment of potential impacts to these fisheries has been undertaken. **Evaluation of potential consequence** The potential for impacts to commercial fisheries due to seismic surveys in Australia is a contentious issue. Both industries have rights to access resources in the Australian EEZ, and neither industry has exclusive rights over the other. However, due to the pre-determined nature of seismic survey lines and in accordance with international maritime collision prevention regulations (the International Regulations for Preventing Collisions at Sea 1972 [COLREGs]) the seismic survey vessel's classification as a vessel limited in its ability to manoeuvre when towing equipment (which by definition is unable to keep out of the way of another vessel), fishing vessels (and other vessels) that may be operating nearby are requested to give way to the passage of the survey vessel. This matter is one that is received with contention and frustration by fisheries stakeholders, with the view that seismic surveys disadvantage fishers and hinder their ability to access fish resources. During the 2D seismic survey, the seismic survey vessel will typically move along planned seismic lines at a constant speed of approximately 4.5 knots, and will proactively and collaboratively manage situations where there is the potential for interactions between vessels active in the Operational Area. No legislated exclusion zone is enforced around the seismic survey vessel. However, when towing equipment, the survey vessel is classed as a vessel limited in its ability to manoeuvre and so commercial vessels and fishers may be asked to take measures to avoid the seismic vessel and towed equipment or remove fishing gear to avoid interaction. Depending on the length of the streamer that is selected for the 2D seismic survey, the survey vessel and streamer may take approximately 1.5 to 2.0 hours to pass a location.	

As outlined in Section 7.1.6, it is highly unlikely that any commercially targeted pelagic or demersal fishes will be injured or killed by the seismic source. There is the potential for fish in close proximity to the seismic array to temporarily modify their behaviour in areas of increased sound levels resulting from seismic operations, which may include avoidance, modified schooling behaviours, or changes in local abundance and distribution. Fish behaviours may be altered within tens or hundreds of metres from the operating seismic source, or over a few kilometres for some more sensitive species. During the period that fishes' behaviours are altered, it is possible that they may be less motivated to feed on baited gear or enter fish traps and, therefore, fisheries catch rates may be temporarily altered in areas recently exposed to sound from the passing seismic source. The potential effects to the behaviours, local distribution and catchability of fishes may last for minutes or hours (or at worst days) after the active seismic source passes a particular site. The combined effects of physical interactions and the short-term effects following exposure to seismic sound may result in disruption to fisheries. **Spatial and temporal analysis of fishing effort data** INPEX undertook a comprehensive spatial and temporal analysis of monthly and annual catch and effort data provided by the WA DPIRD. Data was assessed for 60 nm x 60 nm and for 10 nm x 10 nm Catch and Effort System (CAES) blocks the four most recent available years, 2014 – 2017. INPEX undertook the analysis to assess and quantify the potential magnitude and extent of overlap between the 2D seismic survey and State-managed commercial fisheries, recognising that the relative distribution and intensity of fishing effort provides a more meaningful understanding of the fisheries and potential for interaction than presence and absence of fishing activities or the number of CAES blocks fished. The analysis also identified the areas that is consistently greater fishing effort and may therefore be of greater importance to the fisheries. Data provided by WA DPIRD included: • Weight (kg) – a measure of fish catches per CAES block during the period of interest (i.e. month or year) • Vessel Count – a measure of the number of vessels that fished in a CAES block during the period of interest • Fishing Day Count – a measure of fishing effort, represented by the number of days when one or more vessels fished in a CAES block during the period of interest. Due to confidentiality reasons, WA DPIRD do not release catch and effort data for CAES blocks where less than three vessels fished during the period of interest (i.e. less than three vessels per month, or less than three vessels per year). Where this applies, the Vessel Count is marked 'Less than 3', while Weight and Fishing Day Count are marked as 'N/A'. CAES blocks where the results are provided in this way confirm that fishing effort did occur within the block during that period, but the associated catch and effort values are not available. CAES blocks where no fishing is recorded do not return any data and are excluded from the analyses. In some	

instances, the low number of vessels and low density of fishing effort that occurs across the region meant a significant number of blocks were fished by less than three vessels, particularly at the finer spatial and temporal scale of 10 nm x 10 nm blocks by month. This limited some of the analyses that were possible.

Cumulative fishing effort (i.e. total day count over the four-year period 2014 – 2017) was mapped for 10 nm x 10 nm blocks for the Northern Demersal Scalefish Managed Fishery (NDSMF) and the Mackerel Managed Fishery (MMF). For the purpose of mapping, where a block reported 'Less than 3' vessels, it was necessary to assume a nominal value for the level of effort in the block. A level of effort was selected that was less than the level of fishing effort reported for blocks where catch and effort data were available. The value assigned was approximately half of the minimum value for blocks where data is available.

Therefore, the results of the mapping exercise should be interpreted with caution. Some blocks shown as having low fishing effort in the analyses may have data that is underestimated or overestimated. The results of the analyses and maps are presented below with the assessment of potential impacts to each of the fisheries that overlap the Operational Area. During stakeholder consultation, DPIRD and WAFIC both highlighted the limitations in interpreting the data in this way and INPEX has acknowledged this. Where the proportion of fishing effort is referenced in the following assessment, it is important to note the limitations of the data and understand that the results are indicative and an estimate only. However, given the confidentiality restrictions, there is no alternative method of accurately quantifying fishing effort. The locations of increased fishing effort mapped by INPEX also correspond with the areas that fishery stakeholders have communicated to INPEX are of significance to them. Therefore, for the purposes of presenting relative fishing effort and identifying the areas in the fisheries where high levels of effort consistently occur, the analyses and maps are considered to be representative.

Fishing effort data for Commonwealth-managed fisheries were ascertained from annual fishery status reports published by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) within the Department of Agriculture and Water Resources.

Effects on catch rates

As noted by Salgado Kent et al. (2016) "The issue of changes in commercial fisheries catch rates due to seismic surveys is almost always contentious in Australia". The authors acknowledge that there has been some effort to relate fisheries catch data to seismic survey effort and identify if impacts have occurred, but to date none of the Australian efforts to relate fin-fish catch rates with seismic surveys have yielded meaningful results.

Short-term effects on fishes may translate into short-term effects on commercial and recreational catches within and around a seismic survey area. However, sound effects on fishing catches are not often clearly evident because of the lack of determination between the effects of a seismic survey and natural movements and changes in fish.

A critical review of the potential impacts of marine seismic surveys (Carroll et al. 2017) noted that the potential effects of seismic surveys on fish distribution, local abundance or fisheries catch rates has been examined for some fish species with varying results, possibly due to gear- and species-specific effects. Of all the studies reviewed, some have found either positive, inconsistent, or no effects of seismic surveys on catch rates or abundance (Carroll et al. 2017).

Each of the key fisheries with activities or target fish species occurring within or adjacent to the Operational Area are assessed in more detail below with reference to relevant studies. The broad line spacing and distances over which the 2D seismic survey will be undertaken means that the sound exposures in a given area will be less than from a more closely spaced 3D seismic survey line plan, as the survey vessel and seismic source do not remain in the same area for long. Therefore, changes to fish behaviour, abundance and catchability as a result of the 2D seismic survey are likely to be more transitory than for a 3D seismic survey.

Northern Demersal Scalefish Managed Fishery – Physical interaction and disruption to fishing activities

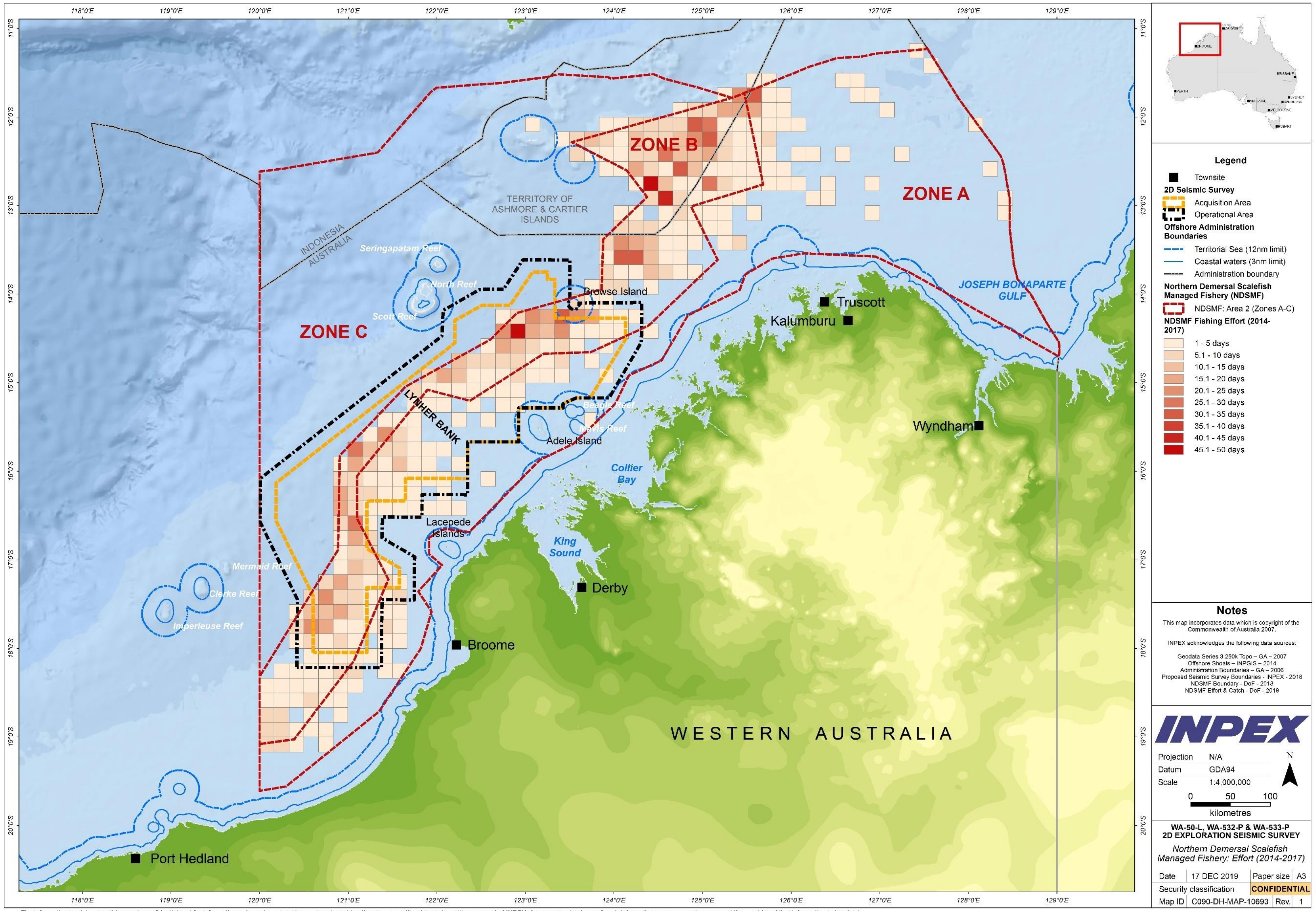
The NDSMF operates across the continental shelf from 120° E longitude, which coincides with the eastern most extent of the Operational Area, to the WA-NT border (Figure 7-15). Vessels in the fishery operate out of both Broome and Darwin. The fishery targets demersal snappers, emperors, rock cods and groupers in water depths of approximately 50 – 200 m, and principally in depths of 60 – 150 m. Eight vessels operated in the fishery between 2013 and 2015, reducing to seven vessels 2015 and 2017.

The fishery uses fish traps, which are deployed from vessels and left *in situ* on the seabed for soak times of 2-5 hours or overnight. Traps are set and retrieved two to three times daily (Newman 2006; Newman et al. 2008; Stark 2008). The fishery operates year-round (Newman et al. 2008). No seasonal trends in fishing effort in different areas were apparent from monthly effort data and no seasonality has been reported by fishery stakeholders. Fishing vessels regularly cover long distances to reach their nominated fishing ground. For example, if the nominated fishing ground is in the vicinity of Browse Island, then the travel distance is approximately 450 km from Broome; once the nominated fishing grounds have been reached, fishers may fish at multiple sites over a period of 4-10 days (Newman 2006; Newman et al. 2008). Fishers are, therefore, quite mobile and move traps over an extended area with between 60 and 120 trap pulls recorded per day (Newman et al. 2008).

Figure 7-15 shows the distribution of NDSMF fishing effort along the continental shelf for the years 2014–2017. The distribution of effort is broadly consistent with fishing effort mapped by Newman (2006) and 2011–2014

NDSMF fishing effort data mapped by Babcock et al. (2017) for the Shell INPEX Applied Research Program, suggesting that the key areas fished have remained reasonably consistent for the last 10 – 15 years. The Operational Area overlaps with approximately 50% of the blocks fished and 50% of the fishing effort[5] reported each year during the period 2014 – 2017. It is important to note that this is the overlap of the entire Operational Area, where the survey vessel will be operational at different times over the duration of the 2D seismic survey. Therefore, the overlap does not represent the overlap or proportion of the fishery that will be overlapped where the seismic vessel may be operating at any one point in time. Over the course of a single day or a week for example, the area covered by the survey vessel will be significantly smaller. However, the overlap is indicative of the total area of fishing grounds that may be overlapped at some point during the course of the survey. Given the low number of vessels that operate in the fishery (up to seven or eight vessels per year) over an area of more than 200,000 km^2, fishing effort density is generally low across the Operational Area. Some 10 nm x 10 nm blocks may have been fished just one or two days in total over the four-year period covered by the dataset. More regularly fished blocks in the Operational Area have been fished in the order of 10 to 25 days per year. However, the level and location of effort can vary considerably each year. For example, blocks that reported effort of between 10 and 25 fishing days of effort in one year, showed levels of effort in other years that was below the WA DPIRD reporting threshold. Overall, the NDSMF fishing effort occurs over long distances and is highly mobile and variable. Generally, a greater level of effort is noted to occur along the outer continental shelf in areas close to the 100 m depth contour and corresponding with Zone B of the fishery (Figure 7-15).	

[5] As described previously in this section, analysis of fishing effort data has required assumptions to be made regarding the level of fishing effort in instances where data is confidential as a result of less than three vessels fishing in a particular CAES block. Therefore, where a percentage overlap with fishing effort is given, this value is an estimate and should be treated as indicative only.



The information contained on this map is confidential and for information only, and must not be communicated to other persons without the prior written consent of INPEX. Any unauthorised use of such information may expose the user and the provider of that information to legal risk. While every effort has been made to ensure the accuracy and completeness of the information presented, no guarantee is given nor responsibility taken by INPEX for any errors or omissions. INPEX accepts no liability for any use of the said information or reliance placed on it.

Figure 7-15 Cumulative NDSMF fishing effort (2014-2017) presented as number of fishing days per 10 nm x 10 nm block (the State of Western Australia is the owner of the copyright of this information)

During the course of any 24-hour period of the survey, the seismic survey vessel will cover a total line distance of approximately 200 km, during which multiple CAES blocks may be intersected. There is, therefore, a reasonable possibility of interactions with fishing vessels or deployed traps and the potential for the 2D seismic survey to disrupt normal fishing activities from time-to-time during the survey. Fish traps are marked at the surface but may be difficult to spot during hours of darkness. The 2D seismic survey will use a single streamer towed directly behind the vessel and so the potential for fouling fishing gear is significantly less than for 3D seismic surveys which tow multiple streamers with a potential spread of hundreds of metres either side of the survey vessel. Even so, without any management measures in place, interaction between the survey vessel and the fishery may result in disturbance, damage or loss of fish traps, or result in displacement of fishing vessels and fishing effort. This could result in lost time and revenue for fishers while recovering and redeploying traps and moving to a different fishing ground. While this would clearly be inconvenient to fishers, given the normally mobile nature and variable distribution of catch and effort in the fishery, it is unclear if this would make a material difference to overall catch rates or revenue, relative to normal annual variability in fish catches. Despite the relatively low and variable fishing effort in the NDSMF, the large size of the Operational Area and the fixed gear methods used by the fishery mean it may be challenging for fishers to plan and coordinate their fishing activities in areas away from where the survey vessel is active. Therefore, without appropriate management measures in place, fishers operating in the NDSMF could be encountered and disrupted from time to time during the survey. Accounting for the total overlap of the Operational Area with the areas fished, individual fishers may be temporarily disrupted multiple times during the 2D seismic survey. Interactions with vessels in the NDSMF will be localised and short-term. However, the proportion of the NDSMF overlapped by the Operational Area and the potential for multiple interactions to occur over a number of months is recognised as an issue that may receive heightened concern from stakeholders in this fishery. In accordance with the INPEX risk matrix and consequence definitions, the consequence of physical interactions with the NDSMF is Minor (E). **Northern Demersal Scalefish Managed Fishery – Sound exposure effects on catch rates** As described in Section 7.1.6, it is highly unlikely that any commercially targeted demersal fishes will be injured or killed by the seismic source. It is acknowledged that sound levels close to the source (<230 m) may exceed sound levels that could theoretically injure fish. The area of seabed that could potentially be exposed over the total duration of the 2D seismic survey represents 0.17 – 2.17% of the habitat where the key demersal fish species targeted by the NDSMF occur. The area that could potentially be exposed over the total duration of the 2D seismic survey also represents between approximately 1% and 4.5% of the area fished by the NDSMF, based on the overlap of potential injurious effects with the blocks shown by the FishCube data to	

have been fished in recent years. However, commercially targeted demersal fishes in the Acquisition Area can reasonably be expected to exhibit an avoidance response and swim away from the approaching seismic source before sound levels approach levels that may result in injury or mortality. Therefore, fishery catch levels will not be affected by direct mortality of fishes. Instead, demersal fish catch levels may be affected by localised and temporary behavioural changes in fish behaviour and distribution, as discussed further below. The demersal snappers, emperors, rock cods and groupers targeted by the NDSMF do not have a specialised connection between their swim bladder and inner ear and are, therefore, primarily sensitive to the particle motion component of sound at close range to the seismic source, but potentially have some limited ability to detect sound pressure. As such, significant behavioural impacts such as startle and avoidance responses, are expected to be limited to within hundreds of metres to a few kilometres of the seismic source as it passes, with the effects limited to minutes or hours in most cases. Such behavioural responses were observed in a study by McCauley & Salgado Kent (2007, cited in Santos Ltd 2018) which looked at the effects of seismic exposure on goldband snapper, one of the key target species of the NDSMF. Goldband snapper were observed to become subdued when the seismic survey vessel passed close by, which is consistent with anecdotal information provided by a NDSMF stakeholder who reported during consultation that goldband snapper "turn off" after a seismic pass in the vicinity of where they are fishing. Some awareness of the sound and less significant behavioural responses may occur in demersal species when the survey vessel is several kilometres away. No long-term abandonment of fishing grounds or significant change is distribution are expected. Should such behavioural changes affect catchability, this is also likely to be localised, with recovery shortly after the seismic source has passed. Other studies have been undertaken to identify if there is an impact of seismic surveys on demersal fish catches. A study in the Bass Strait and Gippsland Basin region of Australia, examined fisheries catch-per-unit-effort (CPUE) data obtained from commercial logbooks for a number of benthic and demersal fish species, including school whiting, tiger flathead, eastern gemfish, silver warehou, jackass morwong, blue eye trevalla, school shark and gummy shark (Thomson et al. 2014). Comparison of mean catch rates for fishing operations that occurred close to and shortly after the seismic survey, with catch rates for fishing operations that occurred further away in both space and time, resulted in a range of different results, both positive and negative. However, the majority of these differed by less than 10%, which is a relatively small difference when compared with normal inter-annual variation. The authors concluded that there were no clear or consistent relationships between seismic surveys and subsequent fisheries catch rates; however, they highlight that the coarse detail of the CPUE data and the variety of results meant it wasn't possible to identify if localised and short to medium-term impacts (days or weeks) to catch rates had occurred.	

A subsequent Australian study in the same region examined catch rates for two fishing gear types (Danish Seine and Demersal Gillnet) and fifteen demersal fish species (Przeslawki et al. 2016; Bruce et al. 2018). Catch rates in the six months following the seismic survey were different than predicted in nine out of the 15 fish species. For both fishing gear types, six species (tiger flathead, goatfish, elephantfish, boarfish, broadnose shark and school shark) indicated increases in catch following the seismic survey, and three species (gummy shark, red gurnard, saw shark) indicated decreases in catch. No meaningful difference could be determined for the other six species. Bruce et al. (2018) noted that, with the exception of minor changes in the daily movement patterns of flathead, there was little evidence for consistent behavioural or catch rate changes induced by the seismic survey in the targeted species. Przeslawski et al. (2016) concluded that "*These results support previous work in which the effects of seismic surveys on catch seem transitory and vary among studies, species, and gear types*". Studies undertaken on demersal catch rates elsewhere in the world include a study by Løkkeborg et al. (2012), which found that gillnet catches increased substantially for Norwegian redfish (86% increase) and Greenland halibut (132% increase) during a seismic survey. However, during the same study, longline catch rates fell (16% for Greenland halibut, 25% for haddock). These contrary results were explained by greater swimming activity versus a reduced desire to feed in fishes exposed to seismic sound emissions. Although catch rates changed, acoustic mapping of fish abundance did not suggest displacement of fish from fishing grounds. Interestingly, no change in catch rates was observed for saithe, despite it being part of the sound pressure-sensitive fish family of fishes, Gadidae. A study by Engås et al. (1996) observed cod and haddock (also of the sound-pressure sensitive family, Gadidae) moved away from an area during a seismic survey and moved back to the area 3-5 days after a seismic survey ceased. Slotte et al. (2004) also observed the abundance of blue whiting and herring (also sound pressure-sensitive fishes) return to normal within a seismic survey area within 3-4 days after a seismic survey ceased. Skalski et al. (1992) reported a 52.4% reduction in CPUE of rockfish for a hook-and-line fishery during seismic exposure off the coast of California. However, the exposure conditions used in the study involved repeat exposures from a seismic source circling the fishing vessel, which is not representative of the transitory nature of a real seismic survey. The authors suggested that the mechanism underlying the pronounced CPUE decline was not dispersal of fishes, but rather decreased responsiveness to the baited hooks. Based on a companion study, which looked at the fishes' behavioural response, fish behaviour returned to normal within minutes following the removal of the sound source (Pearson et al. 1992). Skalski et al. (1992) suggested that the effects on demersal fish catches may be localised and transitory, primarily occurring during the sound exposure itself. Dalen and Knutsen (1987) also reported that effects to a demersal species in Norway resulted in fish moving towards the seabed, away from the seismic source, as opposed to fleeing the area. Therefore,	

disruptions may be short-term and occur during the course of the survey, with conditions returning to 'normal' levels soon after. While none of the above studies specifically looked at catch rates for a fishery that uses fish traps, it may be assumed that the decreased responsiveness to bait and reduced motivation to feed observed by Skalski et al. (1992) and Løkkeborg et al. (2012), for example, may result in demersal fishes being less motivated to enter a fish trap. However, generally, the change in behaviour of fishes and catch rates is likely to be limited to within a few kilometres of where the seismic source has passed and would return to normal levels at that location after a few hours. The potential for the effects of the seismic survey to potentially last for days, such as was reported by Engås et al. (1996) and Slotte et al. (2004), is likely to be limited given that the demersal species targeted in the NDSMF have less sensitive hearing than the sensitive Gadidae species studied in Norwegian waters. During the development of this EP, INPEX reviewed monthly and annual catch and effort data for CAES blocks within the NDSMF. The data, acquired from the WA DPIRD, was reviewed for the four most recent available years, 2014 – 2017. A preliminary review was undertaken of blocks where previous seismic surveys were confirmed to have occurred during these years. These surveys were the Polarcus Cygnus 3D seismic survey and the Searcher Seismic Quoll 3D seismic survey, both undertaken between 2015 and 2018 in an area consistently fished by the NDSMF (near the Vulcan Shoal and Sahul Shoals, located over 120 km north-east of the INPEX 2D seismic survey Acquisition Area). However, due to confidentiality reasons, WA DPIRD do not release catch and effort data for CAES blocks where less than three vessels fished during the time period of interest (i.e. less than three vessels per month, or less than three vessels per year). Given that only seven to eight vessels have operated in the NDSMF since 2013 and fishing effort is typically spread over an area greater than 200,000 km^2, the available data are limited and no significant trends could be detected. Overall, the relatively low density of fishing effort in this fishery meant that the data were too coarse to provide any meaningful results with regards to catch rates. Overall annual CPUE data across the entire fishery remains relatively consistent, indicating approximately 950 – 1,300 kg per day of fishing effort, regardless of whether seismic surveys were undertaken. Based on the assessment of behavioural effects to fishes in Section 7.1.6, behavioural effects in fishes are expected to have only a short-term and highly localised effect on potential catch rates in the NDSMF. Impacts to catch rates may only be detectable if fishing occurs in close proximity to the seismic source, during or shortly after it passes. Given the survey vessel and streamer may take between 1.5 and two hours to pass over a particular area, the behaviour and distribution of many fishes may already be returning to normal by the time the vessel and streamer have passed a fishers are able to access the site again, though some behavioural changes may continue for longer. It may not be possible to differentiate these effects from natural	

movements and changes in fish distribution and catch rates. Therefore, the effects will be highly transitory. Given the low number of vessels (seven to eight vessels) operating in this fishery and the large area fished (over 200,000 km^2), it is expected that overall catch rates can be sustained from the various other areas away from the operating seismic source. Therefore, the impact of reduced catch as a result of underwater noise from the 2D seismic survey is likely to be secondary to the effects of displacement of avoidance by fishing vessels in the event of physical interaction. Therefore, disruption to the NDSMF expected to be associated primarily with the physical presence and interaction of the seismic survey vessel with fishing vessels, although duration of effects to the catchability of fishes may last for a few hours after the survey vessel has passed. Effects on demersal fish catches may be localised and transitory, primarily occurring during the sound exposure itself or if fishing occurs close to or shortly after the survey vessel has passed. With alternative fishing grounds likely to be available and unaffected a short distance away, overall catch rates during a single voyage are unlikely to be discernible from normal catches. In accordance with the INPEX risk matrix and consequence definitions, the consequence of these limited effects to overall NDSMF catch rates is Insignificant (F). **Mackerel Managed Fishery – Physical interaction and disruption to fishing activities** The MMF primarily targets Spanish mackerel, as well as other mackerels and occasionally other pelagic species in water depths less than 100 m and principally in nearshore waters less than 70 m depth. The Operational Area overlaps with Area 1 (Kimberley sector) of the fishery, which extends east from 121° E longitude to the WA-NT border, and overlaps a small part of Area 2 (Pilbara sector), which extends west from 121° E longitude to the North West Cape of WA (Figure 7-16). A restricted number of vessels is permitted to fish in each sector and in 2013 and 2014, three vessels operated in the Kimberly sector and four vessels operated in the Pilbara sector (Mackie et al. 2010; Molony et al. 2015). Data for the period 2014 – 2017 indicates 3 – 4 vessels in operation in the Kimberley sector at any one time. The MMF is a mobile gear fishery, trolling baited lines and lures behind vessels. Vessels may be at sea for 1 – 3 weeks at a time (Mackie et al. 2010). Figure 7-16 shows the distribution of MMF fishing effort for the years 2014 – 2017. Fishing effort is focused in coastal and shallow waters where the target mackerel species tend to congregate to feed or to spawn. Many of the CAES blocks fished are shoreward of the Operational Area, but some blocks are fished within the Operational Area, including areas of relatively high fishing effort located in the vicinity of Lynher Bank and west of Broome. Effort ranges from as little as two days, up to 97 days over the four-year period covered by the dataset. More regularly fished blocks in the Operational Area have been fished in the order of 20 to 40 days per year. However, the level and location of effort can vary considerably each year.	

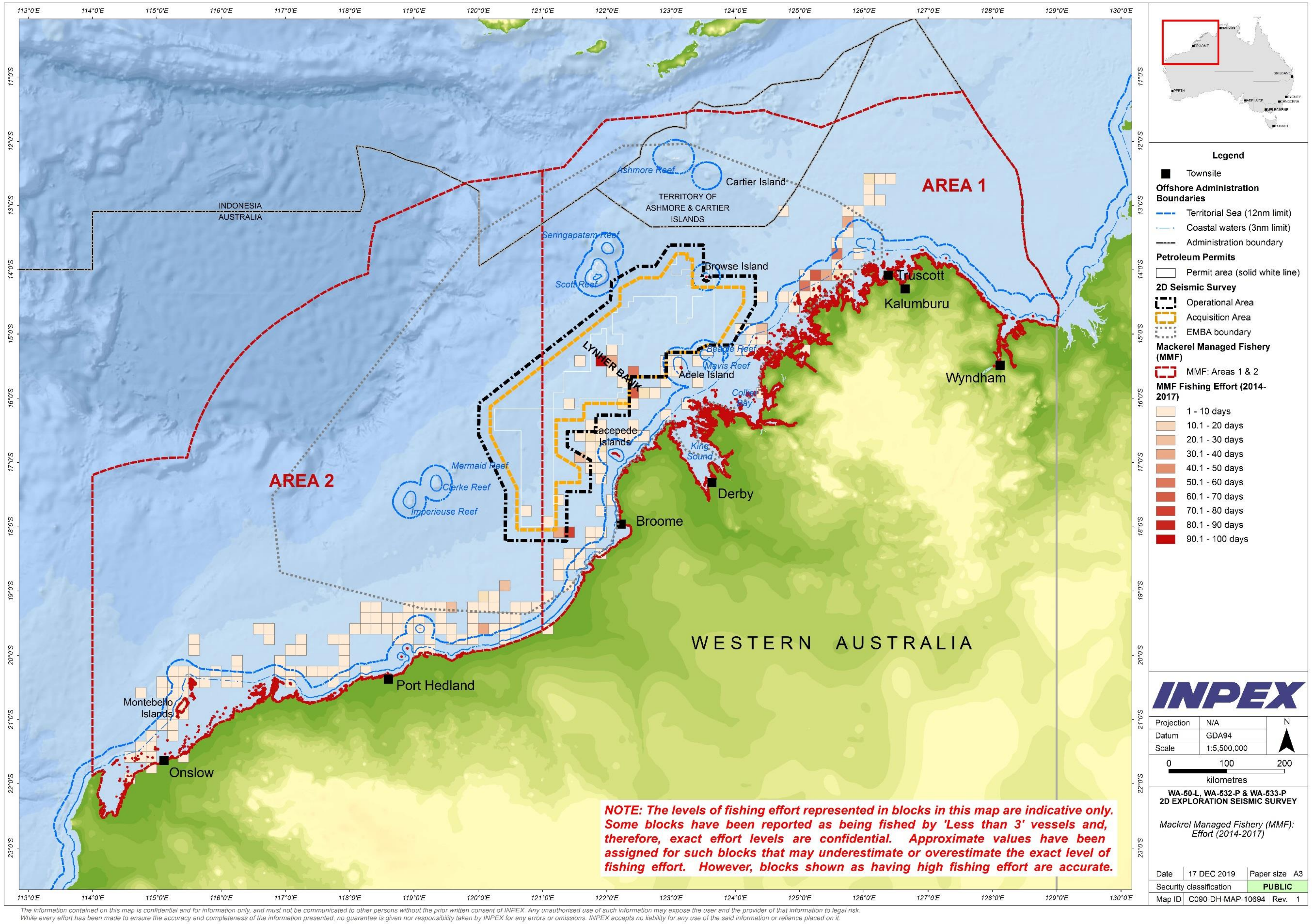


Figure 7-16 Cumulative MMF fishing effort (2014-2017) presented as number of fishing days per 10 nm x 10 nm block (the State of Western Australia is the owner of the copyright of this information)

For example, blocks that reported effort of between 20 and 40 fishing days of effort in one year, reported effort in other years that was below the WA DPIRD reporting threshold. The Operational Area overlaps approximately 28% of the blocks fished and approximately 45% of the fishing effort[6] recorded in the Kimberley sector of the fishery between 2014 and 2017. In the Pilbara sector, the Operational Area overlaps just 1% of the blocks fished and 2% of the fishing effort[3]. Therefore, the potential for the 2D seismic survey to interact with fishing vessels in the MMF is limited mainly to fishers in Area 1 (Kimberley sector) as confirmed by MMF licence holders during stakeholder consultation. Again, it is highlighted that the percent overlap is indicative of the area of fishing grounds that may be overlapped at some point during the course of the entire 2D seismic survey, while the area of the fishery that may be overlapped during any given day or week of the survey will be smaller. It is noted that some fishing effort has previously occurred in waters around King Sound, Adele Island, Beagle Reef and Mavis Reef, however, since the Australian Marine Park (AMP) network management plans came into force in 2018, these areas are no longer permitted to be fished. Therefore, from 2018/19, the displaced effort may result in a slight increase in effort in other areas, such as waters near Broome, Lynher Bank, or the north Kimberley. Strong seasonal differences are clearly notable in the MMF fishing effort. Mackie et al. (2010) note that, for the period 1990-2001, 83% of the total annual fishing effort within the Kimberley sector was expended between June and October, with a peak in August. Review of data for 2014 – 2017 shows a very similar picture, with 94% of the number of blocks with monthly effort data above the WA DPIRD reporting threshold occurring in the months from June to October. Similarly, of all the blocks that are overlapped by the Operational Area (including at Lynher Bank), 78% of effort[3] occurred between June and October, with reportable levels also occurring during the shoulder months of April, May and November. A lower level of fishing effort (below the WA DPIRD reporting threshold) is recorded in these blocks and other locations throughout the other months of the year. Incidentally, the 2D seismic survey is proposed to avoid the period June to October, when calving and resting humpback whales may be present in the region, and so the peak fishing period of the MMF will also be avoided. As a result of the main MMF fishing period (June to October) being avoided by the 2D seismic survey and the low number of vessels that operate throughout the Kimberley sector of the fishery (3 – 4 vessels), interactions between the survey vessel and fishing vessels will be infrequent, even in areas such as Lynher Bank where	

[6] As described previously in this section, analysis of fishing effort data has required assumptions to be made regarding the level of fishing effort in instances where data is confidential as a result of less than three vessels fishing in a particular CAES block. Therefore, where a percentage overlap with fishing effort is given, this value is an estimate and should be treated as indicative only.

fishing may comprise one or two vessels for just a few days per month during shoulder periods outside of the peak fishing period. The gear type and fishing method used by the MMF (trolling) is also mobile, meaning that it is relatively easy for vessels to move away from the path of the approaching survey vessel and towed array, without significant disruption. Therefore, given the avoidance e of the peak fishing period, and in accordance with the INPEX risk matrix and consequence definitions, the consequence of physical interactions between the 2D seismic survey and the MMF is expected to be Insignificant (F). **Mackerel Managed Fishery – Sound exposure effects on catch rates** As outlined in Section 7.1.6, commercially targeted pelagic fishes such as mackerel are highly mobile and can reasonably be expected to exhibit an avoidance response and swim away from the approaching seismic source before sound levels approach levels that may result in injury or mortality. Therefore, fishery catch levels will not be affected by direct mortality of fishes. Instead, catch levels may be affected by localised and temporary behavioural changes in fish behaviour and distribution, as discussed further below. Mackerels do not have a swim bladder and, therefore, their hearing is not sensitive to sound pressure. They primarily detect the particle motion component of sound at close range to the seismic source. In examining the effects of a seismic survey (received levels of 195-218 dB re 1 µPa PK) on free swimming mackerel at a reef, Wardle et al. (2001) noted that fish exhibited a startle response, but no avoidance or any other longer lasting effects were observed and fish did not move away from the reef. The reported sound levels are equivalent to levels predicted by McPherson et al (2019; Appendix D) to occur between approximately 400 m and 1.35 km from the seismic source. As a result, mackerels and other scombroid fish species would have to be very close to the seismic source for any significant behavioural responses in mackerel to take place, likely to be limited to within a kilometre or so of the seismic source (Finneran et al. 2000; Song et al. 2006; Popper et al. 2014). It is acknowledged that small pelagic fish species (e.g. herring and other clupeid species), which are targeted as prey by mackerels, may be more sensitive to sound. The abundance and distribution of these baitfish could be affected over a larger distance and for longer durations than the mackerel, which could indirectly lead mackerels to follow the food source further distances away from the operating seismic source than they would be affected themselves. Should this occur, the potential for such effects to potentially last for days, such as was reported by Engås et al. (1996) and Slotte et al. (2004), is likely to be limited and representative of a worst-case. For example, other studies into the effects of seismic sound to herring have found no change in behaviour at a distance of 2 km (Peña et al. 2013) so impacts will be variable and potentially difficult to differentiate from natural movements and variations in the movements of these fishes. Therefore, localised and short-term disturbances are expected to translate into only very minor impacts to catch rates in the event that fishing occurs in close proximity to a seismic acquisition line during or within	

hours of the seismic survey vessel and seismic source passes. Given the survey vessel and towed streamer may take between 1.5 and two hours to pass an area, the behaviour and distribution of fishes may already be returning to normal by the time the vessel and streamer have passed, though some behavioural changes may continue for longer. Given the avoidance of the peak MMF fishing period, the low number of fishing vessels, and the limited number of survey lines that will cross MMF fishing grounds, the potential for impacts overall MMF catch rates is limited. Therefore, reduced catch as a result of underwater noise from the 2D seismic survey is likely to be insignificant, with disruption to the MMF expected to be associated primarily with the physical presence and interaction of the seismic survey vessel with fishing vessels. In accordance with the INPEX risk matrix and consequence definitions, the consequence of the limited effects to MMF catch rates is Insignificant (F). **North West Slope Trawl Fishery – Physical interaction and disruption to fishing activities** The North West Slope Trawl Fishery (NWSTF) involves one or two vessels. Vessels trawl for scampi on the continental slope in water depths greater than 200 m, and principally in water depths of 420-500 m where scampi are found in association with *Globigerina* ooze sediments. Fishing occurs year-round. As the NWSTF is a Commonwealth-managed fishery, the analysis of WA fishery catch and effort data did not include this fishery. However, data published by the Commonwealth government department, ABARES, shows that fishing effort in previous years has been recorded along the continental slope in blocks overlapped by the Acquisition Area (Section 4.9.5), although these areas are limited to the north-western part of WA-533-P and the northern edge of the Acquisition Area around WA-532-P and WA-50-L, in the region of Scott Reef. Overall, the areas targeted by the fishery extend along more than 1,200 km of continental slope, from approximately 114° E longitude (north of Exmouth) to approximately 122° E longitude (near Scott Reef). The extent of the continental slope overlapped by the Operational Area represents approximately 10% of this area and the potential for interactions is mainly limited to a short period when the survey vessel is operating in the north-western part of WA-533-P. During stakeholder consultation, two NWSTF licence holders indicated that they do not currently trawl in this area. However, a third NWSTF licence holder may operate in the area but no response was received from them during stakeholder consultation. Noting that the fishery operates deep water bottom trawl gear, which limits the fishing vessel's ability to manoeuvre, should an encounter occur, both the course of the fishing vessel and the course of the 2D seismic survey may be disrupted while early avoidance measures are taken. However, given that only one or two vessels operate in the NWSTF and the spatial overlap is limited, interactions between the seismic survey vessel and NWSTF vessels are expected to be highly infrequent and may not occur at all. The potential impact of such a vessel interaction on NWSTF revenue is considered insignificant in the context of normal operational	

variability. Therefore, in accordance with the INPEX risk matrix and consequence definitions, the consequence of physical interactions between the 2D seismic survey and the NWSTF is expected to be Insignificant (F). **North West Slope Trawl Fishery – Sound exposure effects on catch rates** As described in Section 7.1.5, decapod crustacean species, like other invertebrate species, are not sensitive to sound pressure. They are only able to detect the particle motion component of sound in very close range to the seismic source. In some cases, sub-lethal physiological effects have been reported in crustaceans within tens or hundreds of metres of the seismic source (Day et al. 2016a, 2016b), but were comparable to a population within the reserve which was thriving and at carrying capacity (Green & Gardner 2009; Kordjazi et al. 2015). Goodall et al. (1990) studied the response threshold of Norwegian scampi *Nephrops norvegicus* to acoustic stimuli and found that the source had to be within 1 m to initiate a response. Notably, the study by Day et al. (2016a, 2016b) observed no mortality in adult lobsters and no injury or impairment to eggs carried by adult females, even following exposure to multiple passes of a seismic source in shallow water and at close range. Therefore, no mortality impacts or threat to the stock viability of scampi are expected, and highly localised behavioural effects are not expected to be discernible in catches. Potential effects of seismic pulses on catch rates and abundance have also been tested on decapods with no significant differences detected in any of these studies between sites exposed to seismic operations and those not exposed (Carroll et al. 2017). For example, Parry and Gason (2006) detected no change in catch-per-unit-effort in a Victorian southern rock lobster (*Jasus edwardsii*) fishery before, during and after intensive seismic exploration projects. Steffe and Murphy (1992) observed a declining trend in catch rate in a king prawn (*Penaeus plebejus*) fishery in the period after a seismic survey; however, the authors did not attribute this trend directly to the seismic survey. Andriguetto-Filho et al. (2005) examined bottom trawl yields of a Brazilian shrimp fishery before and after exposure to seismic sources (received level of 196 dB re 1 μPa) and did not identify any statistically significant changes to the catch yield after exposure to seismic survey activity. It was stated that the limited dispersal capacities of shrimp suggested any attempted movement out of the survey area was not detectable. Christian et al. (2003) identified that post-seismic snow crab catches were higher than pre-seismic catches, but this was likely due to physical, biological or behavioural factors unrelated to the seismic source. They concluded that there was no significant relationship between catch levels and distance from the seismic source. Therefore, given the limited sensitivity of scampi to sound, no impacts to catch rates of scampi are expected. The impact to the NWSTF is expected to be limited to the physical presence and interaction of the seismic survey vessel with fishing vessels. In accordance with the INPEX risk matrix and consequence definitions, the consequence of the limited effects to NWSTF catch rates is Insignificant (F).	

North Coast shark fisheries – Physical interaction and disruption to fishing activities The North Coast shark fisheries have been inactive in recent years, therefore, catch and effort data has not been analysed. Should the fisheries become active again, fishing effort may occur across the continental shelf, although given the distribution and habitat of key target species such as sandbar shark, spot-tail sharks and blacktip sharks, fishing effort is likely to be focussed on shallow, nearshore, inner continental shelf waters. Proximity to port, sailing times and demersal gear types are also likely to be factors that result in fishing effort being greater in shallower nearshore areas compared with areas a long distance offshore in deeper water. Even so, it is possible that fishing effort could occur in the Operational Area. The fisheries primarily use demersal and pelagic longlining and gillnetting, gear types that are deployed and left in situ. Therefore, in the event that the shark fisheries recommence fishing, there is the possibility that the survey vessel may encounter fishing vessels, but also fixed gear left in situ. Given the highly mobile nature of the target shark species and availability of alternative and favourable fishing areas nearer the coast than in the Operational Area, any encounters and disruption is expected to be minimal. In accordance with the INPEX risk matrix and consequence definitions, the consequence of physical interactions between the 2D seismic survey and potential future shark fishing operations would be Minor (E). **North Coast shark fisheries – Sound exposure effects on catch rates** Sharks have a low sensitivity to sound except at very close range to sound sources (Section 7.1.6) and are naturally vagrant. Tagging studies by Thomson et al. (2014), Przeslawki et al. (2016) and Bruce et al. (2018) did not detect any meaningful change in the behaviours, distribution or catch rates of sharks exposed to a seismic survey versus control sharks that weren't exposed. Therefore, given the highly transient nature of the 2D seismic survey and the transient nature of shark species, no detectable changes in catch rates is expected to occur. The impact to the north coast shark fisheries is expected to be limited to the physical presence and interaction of the seismic survey vessel with fishing vessels and in-situ fishing gear. In accordance with the INPEX risk matrix and consequence definitions, the consequence of the limited effects to catch rates is Insignificant (F). **Prawn fisheries** The Broome Prawn Managed Fishery (BPMF) and the Kimberley Prawn Managed Fishery (KPMF) operate in nearshore waters, tens of kilometres outside of the Operational Area. Trawl depths are generally between 15 and 45 m. The BPMF is limited to a small designated trawl zone off Broome where a small amount of trial fishing takes place during some years. Fishing effort in the KPMF is focussed in coastal waters and the various	

embayments, gulfs and sounds along the Kimberley coast. No disturbance to schools of prawns from the 2D seismic survey is expected in these locations given decapod crustacean's limited sensitivity to sound. While some prawns may occur in deeper waters in the Operational Area, the seismic source will not result in any mortality and is not expected to have any impact on the survival and population viability of stocks of these species (Section 7.1.5). In addition, the nursery areas that support these stocks are located in and around Roebuck Bay, Collier Bay, York Sound and Admiralty Gulf and these will not be affected by the 2D seismic survey. Therefore, the resource targeted by the prawn fisheries, and fishing catch rates, will not be impacted. **Tuna and billfish fisheries** The Western Tuna and Billfish Fishery, Western Skipjack Tuna Fishery, and the Southern Bluefin Tuna Fishery do not operate within the Operational Area. The Western Tuna and Billfish Fishery operates in waters off the west coast of WA, typically south of Carnarvon, over 1,000 km from the Operational Area. The Southern Bluefin Tuna Fishery operates mainly off South Australia, with some effort off the coast of Victoria and New South Wales, but no current effort in waters anywhere off WA. During stakeholder consultation, the Australian Southern Bluefin Tuna Industry Association confirmed the Western Skipjack Tuna Fishery has not been active since 2009, with previous fishing effort taking place in the Great Australian Bight. Therefore, the 2D seismic survey will not directly impact fishing catch rates in these fisheries. As outlined in Section 7.1.6, these fish stocks and their reproductive success will also not be detrimentally impacted. Therefore, no impacts are expected to the resource targeted by these fisheries, or fishing catch rates. **Overall consequence assessment** Overall, given the low number of fishing vessels that may be active in the NDSMF, MMF and NWSTF (10 to 14 vessels) throughout the wider Kimberley and Timor Sea region, the extent of available fishing grounds within and outside of the Operational Area, and the temporal avoidance of the peak MMF fishing period, potential interactions between the seismic survey vessel and fishing vessels are generally expected to be infrequent. The main fishery that may be an exception to is the NDSMF. Approximately 50% of the area fished by the NDSMF is overlapped by the Acquisition Area and therefore may be exposed to seismic sound or physical vessel interactions over the total duration of the 2D seismic survey. However, the area that may be affected, at any one time during the survey, is negligible and limited to waters in the immediate proximity of the seismic vessel and towed streamer. The NDSMF comprises relatively low density and variable fishing effort as a result of a low number of vessels (7 – 8 vessels) operating over an area of over 200,000 km^2, an area larger than the Operational Area. Alternative fishing areas are available to be fished away from areas where the seismic survey vessel may be operating on a particular day or week. However, there is the potential for fishers in the Operational Area to be	

temporarily disrupted and displaced multiple times during the 2D seismic survey. Given that fishers normally travel long distances and are generally mobile across multiple sites during a single trip, the impact of these disruptions to the overall catch and revenue for the whole fishery is likely to be negligible in the context of normal variability, but the disruption and inconvenience to individual fishers will be more notable. The body of peer-reviewed literature on seismic effects to fisheries catch rates does not indicate any long-term abandonment of fishing grounds by commercial species, with a number of studies indicating that catch levels returned to pre-survey levels soon after seismic activity had ceased (Carroll et al. 2017). As noted by Przeslawski et al. (2016), it is possible that fish may be temporarily displaced from a survey footprint to adjacent areas, however the total number of fishes within the fishery stock and overall catch rates remain unchanged. As fishing areas are large and commercial fish species are free-swimming, if fish are 'scared' temporarily from an area, based on evidence presented, it is likely they will be displaced temporarily. Given the evidence of fish behaviour and distribution returning to normal within minutes, hours or as a worst case, days after cessation of the acoustic disturbance indicates that the effects on catch rates are localised and short term. It is noted that such effects may make the catchability of some fishes unpredictable for fishers in locations that have recently been exposed to sound from the 2D seismic survey (i.e. hours or days following the survey). However, given the relatively low number of fishing vessels that operate over large areas, including within the Operational Area, the potential for fishing to occur in the same areas at the same time is limited. The fisheries that overlap the Operational Area operate over far wider areas than the localised areas that may be exposed to disturbance at any one time during the 2D seismic survey. Given the spatial extents of the fisheries, only a portion of the area and fishes targeted by fisheries may be affected by a survey and fish catches are expected to be available in other areas. Both the long-term and short-term effects on target fish and the economic components of the fisheries (fishing effort and catch) have been considered. During the 2D seismic survey, the extent of potential impacts to fishing effort and to catch will generally be limited to within a few kilometres of where the seismic vessel has passed within the preceding hours or days. Not all of the Operational Area will be exposed or impacted at the same time and large areas of the Operational Area will remain available to fishing throughout the survey. As described in Section 7.1.6, no lethal impacts to key demersal and pelagic fishes is expected to occur. The potential for TTS effects to occur in the target fish species is also limited with no long-term effects on fish survival or population viability. Fish behaviours and distribution are expected to have returned to normal within days of the seismic survey vessel passing a location. Therefore, localised but short-term impacts to fishers may occur somewhere within the Operational Area at any time throughout the duration of the survey (up to 210 days including contingency downtime). It is predicted that the effects of the 2D seismic survey on fishing	

activities and fish catch rates will no longer be apparent anywhere within Operational Area within days of completion of the survey. As also described in Section 7.1.6, impacts from the 2D seismic survey to spawning and recruitment of commercially targeted pelagic and demersal fish stocks are expected to be small in the context of natural variation in spawning and recruitment. The area of disturbance is in the order of 1% of each fish stock. Given the high fecundity of key species and the genetic connectivity over large areas, the localised and transient effects of sound from the seismic source are not expected to have any long-term impacts on the populations of these stocks, therefore secondary long-term impacts to catch rates are not expected. The potential magnitude and extent of impacts to each of the fisheries operating in the same waters as the Operational Area may be summarised as follows: • NDSMF: Up to 50% of the fished area may be affected over the total duration of the survey, however, at any one time the area impacted will be significantly smaller. During the course of any 24-hour period of the survey, the seismic survey vessel will cover a total line distance of approximately 200 km, during which multiple CAES blocks may be intersected. There is, therefore, a reasonable possibility of interactions with fishing vessels or deployed traps and the potential for the 2D seismic survey to disrupt normal fishing activities from time-to-time during the survey. Impacts on fish catch may be affected across this area for hours or at worst days following the passing of the survey vessel. • MMF: Up to 28% of the fished area may be affected over the total duration of the survey, however, at any one time the area impacted will be significantly smaller. The Operational Area overlaps just 1% of the blocks fished. Impacts on fish catch may be affected across this area for hours or at worst days following the passing of the survey vessel. The main MMF fishing period (June to October) will not be affected by the 2D seismic survey. • NWSTF: Approximately 10% of the fished area may be affected over the total duration of the survey; however, at any one time the area impacted will be significantly smaller. No impacts to the catch rates of scampi are expected given their limited sensitivity to the predicted received sound levels on the sea floor (refer to Section 7.1.5). • North Coast Shark fisheries: The fisheries are currently inactive and no impact to fishing activities is therefore predicted. Consistent with scientific studies in to studies on the movement and catch of shark species in Australian waters, no detectable changes in catch rates of sharks is expected to occur given their limited sensitivity to sound and the fact that they are naturally vagrant. Therefore, there will be no impact to fishing activities or catch rates.	

- Prawn fisheries: The fisheries are not active in the Operational Area and target species are not expected to be affected. Therefore, there will be no impact to fishing activities or catch rates.
- Tuna and Billfish fisheries: The fisheries do not operate in the same waters as the Operational Area, and no discernible impacts to target fish are expected. Therefore, there will be no impact to fishing activities or catch rates.

Overall, based on the assessments of all individual fisheries above, potential interactions with the NDSMF presents the worst-case consequence of all the fisheries active in the area. On the basis that the 2D seismic survey may potentially result in some localised and temporary disruption to fishing effort and acknowledging fisheries stakeholder concerns regarding the relatively large spatial overlap of the Operational Area with areas targeted by the NDSMF, the overall consequence of the 2D seismic survey to fisheries is considered to be Minor (E).

Identify existing design and safeguards/controls measures

The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3).

INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.

Propose additional safeguards/control measures (ALARP Evaluation)

Hierarchy of control	Control measure	Used?	Justification
Elimination	None identified	No	The seismic survey cannot be achieved without using a seismic source. Elimination of the seismic source is not possible.
Substitution	None identified	N/A	No additional substitution controls were identified that would practicably reduce the risk to marine mammals.
Engineering	Divide the 2D seismic survey Acquisition Area into smaller, phased areas to minimise the spatial overlap	Yes	The number of fishing vessels operating in the NDSMF, MMF and NWSTF, with the potential to occur in the Operational Area is relatively low. The area over which these fishing

	with commercial fisheries and increase the availability of alternative fishing grounds.		vessels may operate is also large, providing access to different fishing grounds. However, it is noted that the 2D seismic survey Operational Area overlaps a significant area that would normally be fished by the NDSMF, as well as some areas fished by the MMF and NWSTF (and potentially the North Coast shark fisheries if fishing recommences in the foreseeable future). Although incidents of disruption to fisheries are expected to be localised and short-term, INPEX recognises that the large Acquisition Area and potential 2D seismic data acquisition sequence, whereby orthogonal dip and strike lines may be acquired consecutively, could result in interactions with fishing gear and potential impacts to fishers at those sites, particularly in the NDSMF. To attempt to mitigate this risk, INPEX has considered options to divide the Acquisition Area into smaller, more discrete areas so that the operating survey vessel will overlap a smaller proportion of available fishing grounds at any one time. The division of the Acquisition Area involved careful consideration of the costs relative to the benefit that may be achieved. In particular, dividing the Acquisition Area into smaller areas needed to consider the potential impact this could have on shortening acquisition lines and the subsequent influence this may have on cumulative sound exposures. Small areas may result in an increased impact on receptors (including fishes and fisheries) as cumulative sound exposures and the frequency of on-the-water interactions in the area may increase. In addition, with each division of the Acquisition Area and Acquisition lines, more line turns are required, which will increase the duration of the survey (by weeks potentially)

			and therefore the cost of the survey (many hundreds of thousands to millions of dollars depending on the number of areas the acquisition is separated into). Increasing the overall duration of the survey is likely to be a concern for fishers. Therefore, to balance the costs and benefits, INPEX has separated the Acquisition Area into two parts, Area A that includes WA-532-P and WA-50-L, and Area B that includes WA-533-P (Figure 7-17). The areas were selected so that seismic acquisition can be undertaken in two stages along the continental shelf, so that key areas of the NDSMF, MMF and NWSTF will be free from seismic acquisition. An approach whereby the survey acquisition is staged across the continental shelf (e.g. acquiring areas along the outer shelf and slope, separate from the middle and inner shelf) would not be effective as it would expose all NDSMF fishing grounds in the Operational Area for duration of the survey. The proposed areas reduce the total area of the NDSMF that may be overlapped at any one time from approximately 50% (total Operational Area) to approximately 30% (Area A) and 20% (Area B). The areas, A and B, are not intended to be areas where fishing activities are excluded; instead, they are intended to provide better definition of the general areas where the 2D seismic survey will be undertaken to assist in the spatial planning and coordination of concurrent survey and fishing activities so that it is clear what alternative areas are available to be fished without potential disruption. This approach is considered practicable as it effectively reduces the area where the survey will operate by approximately half, ensuring a reasonable area of alternative fishing grounds are available to the NDSMF to undertake fishing and maintain catches undisturbed.

			Dividing the Acquisition Area into two areas is also achievable within the timeframes allowed in this EP, and does not increase the potential cumulative sound exposure or risk to receptors as already assessed in this EP. It is expected that this phased approach, in combination with the communications and other procedures outlined below, will allow for the 2D seismic survey and commercial fishing activities to be coordinated to share adequate access to resources.
Procedures & administration	Schedule seismic acquisition to avoid peak fishing periods	No	Avoidance of peak fishing periods was considered. The NDSMF and NWSTF operate year-round with no apparent seasonal patterns in where and when fishing occurs. Therefore, no period of avoidance can be practicably implemented that would result in reduced risk to these fisheries. The MMF also operates throughout the year, though fishing mainly occurs between April and November, with peak effort (approximately 80% of the total annual fishing effort) between June and October in the Kimberley sector of the fishery. Incidentally, the 2D seismic survey is proposed to avoid the period June to October, inclusive, and so the peak fishing period of the MMF will be avoided.
	Notification of the commencement and completion of the seismic survey provided to commercial fishers.	Yes	Engagement with fishers will be ongoing to provide stakeholders with information the commencement, progress and completion of the 2D seismic survey. This will also provide the necessary channels by which fisheries stakeholders may seek further information or clarification on issues of concern or provide feedback to INPEX. Notification will be sent to fisheries stakeholders 3 weeks prior to commencement of the 2D seismic survey, communicating the general location (i.e. Area A or Area B)

			where acquisition will commence, the expected start date and survey duration, IMO vessel numbers, and vessel radio and satellite phone communication details. Another notification will be sent to fisheries stakeholders one week before it is anticipated the survey vessel will relocate to commence seismic acquisition in the second Area. Notification will also be provided to fisheries stakeholders within 2 weeks of completion of the 2D seismic survey. These measures are considered practicable and an effective way of communicating and coordinating the survey activities with other industries.
	Provide daily lookahead reports	Yes	INPEX recognises that the phased approach to acquisition and notifications upon commencement and completion of the 2D seismic survey do not provide detail on the specific timing and locations where the survey vessel will be operating during the survey. More detail can be provided to fishers to assist them in understanding the specific locations where the survey vessel has finished operating and where it expects to be operating within the next 48-hour period. This may assist fishers in targeting specific fishing grounds away from the proposed acquisition lines during these periods. The option of daily look-ahead reports will be offered to fisheries stakeholders as an option, and sent to stakeholders who request/register to receive them. The look-ahead reports include: • a summary of the acquisition lines completed in the previous 24 hours; • the locations of acquisition lines proposed to be acquired in the 48 hours ahead; and

			• a summary of any changes or delays experienced or foreseen (e.g. weather, downtime). This information is likely to be helpful for not only the fishery licence holders, but also the fishing vessel crews and shore base personnel in Broome.
	Vessels to maintain 24-hour visual, radio/satellite phone and radar watch and provide on-the-water communications with fishing vessels.	Yes	In addition to the above-mentioned planning and communication controls, on-the-water vigilance and communication with fishers and other users will be important for the seismic survey vessel and support vessels to manage interactions.
	Vessels to maintain appropriate lighting, day shapes, and signals to indicate that the seismic survey vessel is towing and is therefore restricted in its ability to manoeuvre.	Yes	Consistent with COLREGS, the *Navigation Act 2012* and associated Marine Orders, vessels will maintain lighting, day shapes, and signals to indicate to other vessels that the seismic survey vessel is towing and is therefore restricted in its ability to manoeuvre.
	The towed streamer will be clearly marked with a tail buoy with light and radar reflector.	Yes	Tail buoys on the streamer will be marked so that the position of the streamer is known to other marine users.
	Procedures to notify and communicate with traditional Indonesian fishers.	Yes	Prior to commencement of the 2D seismic survey, the Indonesian Minister for Fisheries will be notified of the proposed location and start of the survey. The survey vessels will also carry translation cards (translated into Bahasa Indonesian) for communicating warning messages to Indonesian fishermen, in the event they are encountered in the Australia-Indonesia MoU Box.
	Develop a claim process for assessing claims by stakeholders of directly attributable impacts, to reduce the consequence.	No	A claim assessment process will not reduce the consequence, or the likelihood, of potential environmental impact. It is therefore an inappropriate control measure to prevent or reduce environmental risk.

			However, as part of the implementation strategy (See Section 9.6) INPEX is in consultation with commercial fishing stakeholders to develop a claim process prior to the activity commencing.

Identify the likelihood

With the above described controls in place, the likelihood of the 2D seismic survey causing occasional disruption to fisheries, with Minor consequence, is reduced, but is considered Likely (2).

Residual risk summary

Based on a consequence of Minor (E) and a worst-case likelihood of Likely (2) the residual risk is Moderate (6).

Consequence	Likelihood	Residual risk
Minor (E)	Likely (2)	Moderate (6)

Assess residual risk acceptability

Legislative requirements

N/A – There are no legislative requirements applicable to managing the effects of seismic surveys in relation to commercial fisheries.

Stakeholder consultation

Feedback was received by the WA DPIRD, WAFIC and commercial fisheries licence holders (Table 5-4) highlighting the concerns the fishing industry has about the potential impacts of seismic to commercial fish stocks and catches. These concerns have been considered in this EP through the implementation of a series of controls and demonstration that impacts will be managed to ALARP and acceptable levels.

DPIRD provided FishCube data which has been used for the assessment of fisheries effort in the above risk assessments. DPIRD provided formal advice regarding the use of the data and limitations to its interpretation. INPEX has clarified the purpose of the data analyses in this risk assessment with DPIRD and, as agreed with them, has included statements throughout the risk assessment highlighting what assumptions may have been made and the limitations associated with doing this. All information provided by DPIRD has been reflected in the risk assessment.

INPEX has responded in detail to queries and concerns received from WAFIC and each individual fishery licence holder. Fisheries stakeholders expressed concerns about resource sharing between the fishing and seismic industry, as well as the potential for underwater noise from seismic surveys to impact on fish stocks at a population level as a result of impacts to spawning fishes. All concerns raised by these stakeholders have been addressed.

A copy of the draft risk assessments were provided in full to each stakeholder for their review prior to submission of the EP to NOPSEMA. This was accompanied by a summary explanation of the key conclusions and proposed control measures. Stakeholders were given the opportunity to provide feedback on the proposed control measures and communication protocols. INPEX has confirmed with these stakeholders that a compensation claims process will be in place prior to commencement of the survey.

INPEX therefore considers that relevant matters and stakeholder objections/claims and concerns have been adequately addressed and that the level of impact to commercial fisheries is acceptable.

In addition to the proposed control measures, INPEX is consulting with stakeholders to develop a claim process.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts are expected to occur to commercial fisheries, included as social and economic values of the Kimberley AMP.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. However, none of the recovery plans or conservation advice documents are relevant to the effects of seismic surveys on fisheries. INPEX has instead considered Department of Fisheries (2013) guidance and WA DPIRD's recently published ecological risk assessment of seismic impacts to marine finfish and invertebrates (Webster et al. 2018) during this assessment.

ALARP summary

Given the level of environmental risk is assessed as Moderate, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

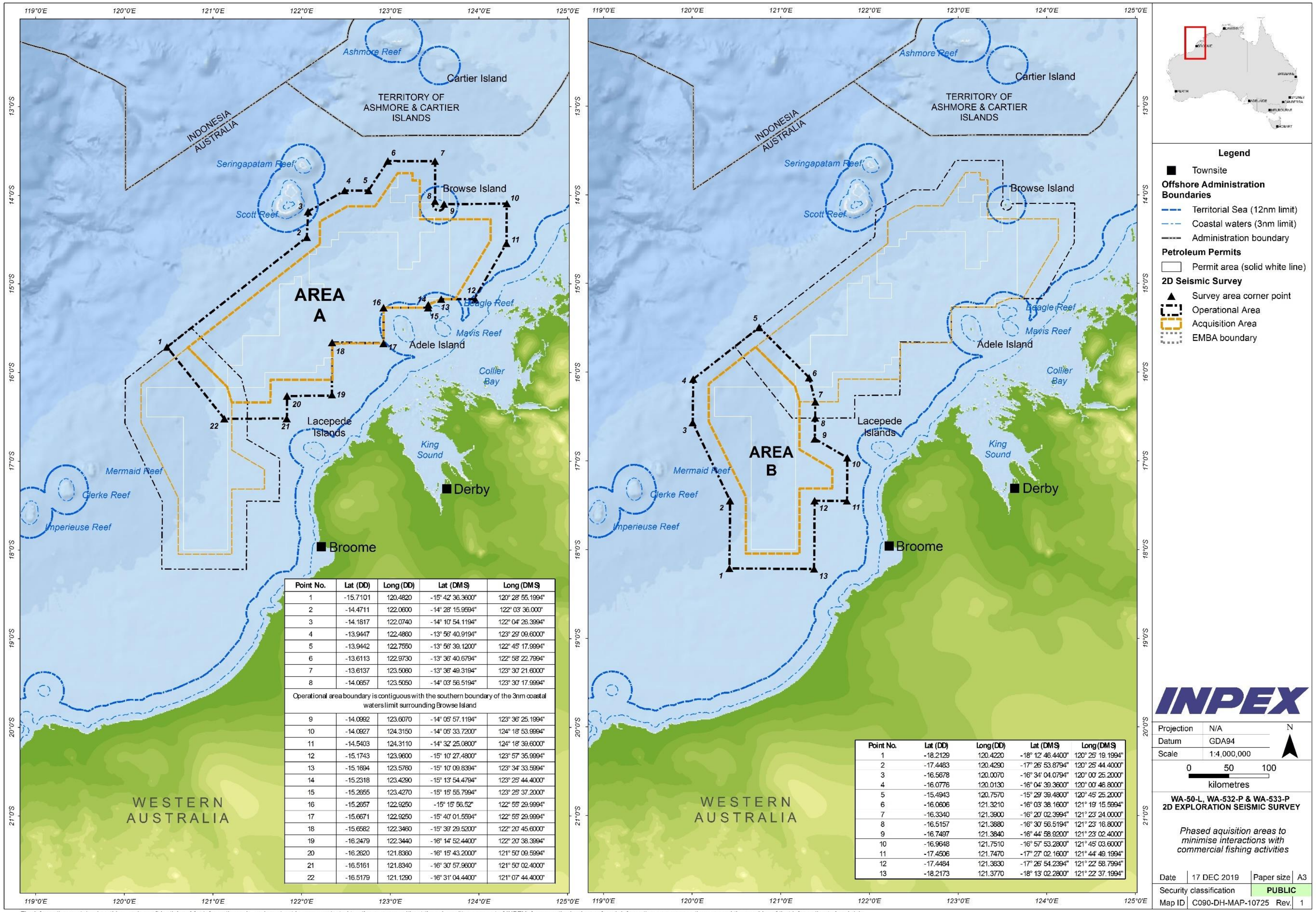
- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback – all stakeholder objections, claims or concerns and relevant matters have been addressed and stakeholders have been provided with a response;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD –i.e. no long-term impacts to fishing activities, fishing catch rates or the target stocks are expected that are not in the realm of normal variation; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Moderate", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	**Environmental performance standards**	**Measurement criteria**	**Responsibility**
Zero unresolved objections or claims from identified stakeholders.	The 2D seismic survey acquisition will be divided and acquired in two spatially separate areas (A and B), as presented in Figure 7-17.	Transmittal record confirms that the boundaries of Areas A and B were provided as a shapefile to the selected seismic contractor for inclusion in their survey planning and vessel navigation system.	INPEX Exploration Project Manager
		Vessel records confirm the boundaries of areas A and B are entered into the vessel navigation system.	Vessel Masters
		Survey log confirm that seismic data is acquired in the two spatially separate sectors.	CONTRACTOR Survey Manager
	Notification will be sent to fisheries stakeholders 3 weeks prior to	Consultation records demonstrate that relevant fisheries stakeholders were sent notification 3 weeks prior to	INPEX Environmental Advisor

	commencement of the 2D seismic survey, communicating: • the location (i.e. Area A or Area B) where acquisition will commence • expected start date and survey duration • IMO vessel numbers • Vessel radio and satellite phone communication details • how stakeholders can register to receive daily look-ahead reports during the survey.	commencement of the 2D seismic survey.	
	Notification will be sent to fisheries stakeholders 1 week before it is anticipated the survey vessel will relocate to commence seismic acquisition in the second Area, communicating: • the expected start date in the Area and anticipated survey duration • IMO vessel numbers • Vessel radio and satellite phone communication details • how stakeholders can register to receive daily look-ahead reports during the survey.	Consultation records demonstrate that relevant fisheries stakeholders were sent notification 1 week prior to commencement of seismic data acquisition in the second Area.	INPEX Environmental Advisor
	Notification of survey completion will be provided to fisheries stakeholders within 2 weeks of	Consultation records demonstrate that relevant fisheries stakeholders were sent a notification of survey	INPEX Environmental Advisor

	completion of the 2D seismic survey.	completion within 2 weeks of completion of the 2D seismic survey.	
	Daily lookahead reports will be provided to stakeholders who register to receive them. The reports will include: • a summary of the acquisition lines completed in the previous 24-hour period • the locations of acquisition lines proposed to be acquired in the 48 hours ahead • a summary of any changes or delays experienced or foreseen (e.g. weather, downtime).	Copies of daily lookahead reports and communication records confirm daily reports are provided to stakeholders who register to receive them.	INPEX Environmental Advisor
	Vessels will maintain appropriate lighting, day shapes, and signals to indicate that the seismic survey vessel is towing and is therefore restricted in its ability to manoeuvre, in compliance with COLREGS, the *Navigation Act 2012* and associated Marine Orders.	Vessel premobilisation inspection confirms the survey vessel and support vessels have functional lighting, day shapes and signals, compliant with COLREGS, the *Navigation Act 2012* and associated Marine Orders.	Vessel Master
	A 24-hour visual, radio/satellite and radar watch will be maintained by survey vessels operating in the Operational Area.	Vessel premobilisation inspection confirms the survey vessel and support vessels have functional radar, radio and satellite phone systems, and that the seismic survey vessel marine crew are competent to	Vessel Master

		STCW95 / Elements of Shipboard Safety Standards. Vessel communication logs or email documentation of on-the-water communications with fishers will be provided to NOPSEMA in the case of an audit or inspection.	
	The towed streamer will be clearly marked with a tail buoy with light and radar reflector.	Vessel premobilisation inspection confirms that the streamer is mobilised with a tail buoy with a light and radar reflector.	CONTRACTOR Survey Manager



Point No.	Lat (DD)	Long (DD)	Lat (DMS)	Long (DMS)
1	-15.7101	120.4820	-15° 42' 36.3600"	120° 28' 55.1994"
2	-14.4711	122.0600	-14° 28' 15.9594"	122° 03' 36.000"
3	-14.1817	122.0740	-14° 10' 54.1194"	122° 04' 26.3994"
4	-13.9447	122.4860	-13° 56' 40.9194"	123° 29' 09.6000"
5	-13.9442	122.7550	-13° 56' 39.1200"	122° 45' 17.9994"
6	-13.6113	122.9730	-13° 36' 40.6794"	122° 58' 22.7994"
7	-13.6137	123.5060	-13° 36' 49.3194"	123° 30' 21.6000"
8	-14.0657	123.5050	-14° 03' 56.5194"	123° 30' 17.9994"
Operational area boundary is contiguous with the southern boundary of the 3nm coastal waters limit surrounding Browse Island				
9	-14.0992	123.6070	-14° 05' 57.1194"	123° 36' 25.1994"
10	-14.0927	124.3150	-14° 05' 33.7200"	124° 18' 53.9994"
11	-14.5403	124.3110	-14° 32' 25.0800"	124° 18' 39.6000"
12	-15.1743	123.9600	-15° 10' 27.4800"	123° 57' 35.9994"
13	-15.1694	123.5760	-15° 10' 09.8394"	123° 34' 33.5994"
14	-15.2318	123.4290	-15° 13' 54.4794"	123° 25' 44.4000"
15	-15.2655	123.4270	-15° 15' 55.7994"	123° 25' 37.2000"
16	-15.2657	122.9250	-15° 15' 56.52"	122° 55' 29.9994"
17	-15.6671	122.9250	-15° 40' 01.5594"	122° 55' 29.9994"
18	-15.6582	122.3460	-15° 39' 29.5200"	122° 20' 45.6000"
19	-16.2479	122.3440	-16° 14' 52.4400"	122° 20' 38.3994"
20	-16.2620	121.8360	-16° 15' 43.2000"	121° 50' 09.5994"
21	-16.5161	121.8340	-16° 30' 57.9600"	121° 50' 02.4000"
22	-16.5179	121.1290	-16° 31' 04.4400"	121° 07' 44.4000"

Point No.	Lat (DD)	Long (DD)	Lat (DMS)	Long (DMS)
1	-18.2129	120.4220	-18° 12' 46.4400"	120° 25' 19.1994"
2	-17.4483	120.4290	-17° 26' 53.8794"	120° 25' 44.4000"
3	-16.5678	120.0070	-16° 34' 04.0794"	120° 00' 25.2000"
4	-16.0776	120.0130	-16° 04' 39.3600"	120° 00' 46.8000"
5	-15.4943	120.7570	-15° 29' 39.4800"	120° 45' 25.2000"
6	-16.0606	121.3210	-16° 03' 38.1600"	121° 19' 15.5994"
7	-16.3340	121.3900	-16° 20' 02.3994"	121° 23' 24.0000"
8	-16.5157	121.3880	-16° 30' 56.5194"	121° 23' 16.8000"
9	-16.7497	121.3840	-16° 44' 58.9200"	121° 23' 02.4000"
10	-16.9648	121.7510	-16° 57' 53.2800"	121° 45' 03.6000"
11	-17.4506	121.7470	-17° 27' 02.1600"	121° 44' 49.1994"
12	-17.4484	121.3830	-17° 26' 54.2394"	121° 22' 58.7994"
13	-18.2173	121.3770	-18° 13' 02.2800"	121° 22' 37.1994"

The information contained on this map is confidential and for information only, and must not be communicated to other persons without the prior written consent of INPEX. Any unauthorised use of such information may expose the user and the provider of that information to legal risk. While every effort has been made to ensure the accuracy and completeness of the information presented, no guarantee is given nor responsibility taken by INPEX for any errors or omissions. INPEX accepts no liability for any use of the said information or reliance placed on it.

Figure 7-17 Phased areas of acquisition, Area A and Area B

7.2.2 Recreational and traditional fisheries

Table 7-20: Impact and risk evaluation – recreational and traditional fisheries

Identify hazards and threats	
This risk assessment considers the potential for the 2D seismic survey to encounter and displace recreational and traditional fishing vessels, and to temporarily affect their catch rates.	
Potential consequence	**Severity**
Summary of receptors Recreational fishing activities are expected to be limited in the Operational Area. Occasional charter vessels may fish in the Operational Area opportunistically on the way from Broome to destinations such as the Rowley Shoals, Scott Reef and Ashmore Reef. Recreational fishing is more concentrated in nearshore waters, including billfish and sailfish fishing off the coast of the Dampier Peninsula. Traditional Indonesian vessels may fish within the Australia-Indonesia MOU Box, which includes Scott Reef and Browse Island, although fishing activities generally target reef fish, sharks, beche-de-mer and trochus at the reefs, which are located outside of the Operational Area. **Evaluation of potential consequence** The physical presence and movement of the seismic survey vessel and towed streamer along pre-determined acquisition lines has some limited potential to encounter recreational and traditional fishing vessels during the survey. As a result, the 2D seismic survey has the potential to physically disrupt fishing activities and to affect catch rates as a result of temporary changes in fish behaviour in close proximity to the seismic source. **Recreational fishing** As confirmed with recreational fishing stakeholders, no significant recreational fishing is expected to occur in the Operational Area. Occasional charter vessels may fish in the Operational Area opportunistically on the way from Broome to destinations such as the Rowley Shoals, Scott Reef and Ashmore Reef. The likelihood of a charter vessel fishing in waters recently exposed to sound from the seismic source is low and, should such a scenario occur, the effects would be incidental, localised and short term. Recreational fishing is more common in nearshore waters, including billfish and sailfish fishing off the coast of the Dampier Peninsula. The annual Broome Billfish Classic tournament occurs in waters of Quondong Point, usually in July each year. As assessed in Section 7.1.6, the 2D seismic survey is not expected to impact the distribution or behaviour of billfish or the	Insignificant (F)

baitfish that they target in these waters. In addition, the 2D seismic survey is expected to avoid the humpback whale calving and nursing period, between June and October (Section 7.1.7), so the timing of the survey avoids the period when the billfish tournament takes place, as well as the peak dry season when most recreational and charter boat fishing occurs in the region. Therefore, negligible impacts are expected from interactions with recreational fishers. **Indonesian traditional fishing** Traditional Indonesian vessels may fish within the Australia-Indonesia MOU Box at Scott Reef and Browse Island, which are located outside of the Operational Area. As outlined in Section 7.1.6, impacts to fishes at these coral reefs are expected to be negligible. Invertebrate species such as trochus and beche-de-mer are not expected to be impacted. Traditional Indonesian vessels may be encountered by the survey vessel as they transit waters between Scott Reef and Browse Island. Therefore, some minor disruption may occur, but given the limited overlap with these waters, potential encounters would be infrequent and transitory. Therefore, the impacts to traditional Indonesian fishing practices are not expected to be significantly impacted. On the basis that the 2D seismic survey may potentially result in some infrequent, localised and temporary interactions with recreational and traditional fisheries, the consequence is considered to be Insignificant (F).	

Identify existing design and safeguards/controls measures

The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3).

INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.

Propose additional safeguards/control measures (ALARP Evaluation)

Hierarchy of control	Control measure	Used?	Justification
Elimination	None identified	No	The Seismic survey cannot be achieved without using a seismic source. Elimination of the seismic source is not possible.
Substitution	None identified	No	No substitutes to the use of the seismic source or undertaking the 2D seismic survey were identified that would

			practicably reduce the already low risk to recreational and traditional fisheries.
Engineering	None identified	No	No engineering solutions were identified that would practicably reduce the already low risk to recreational and traditional fisheries.
Procedures & administration	Vessels to maintain 24-hour visual, radio/satellite phone and radar watch and provide on-the-water communications with fishing vessel.	Yes	In addition to the above-mentioned planning and communication controls, on-the-water vigilance and communication with fishers and other users will be important for the seismic survey vessel and support vessels to manage interactions.
	Vessels to maintain appropriate lighting, day shapes, and signals to indicate that the seismic survey vessel is towing and is therefore restricted in its ability to manoeuvre.	Yes	Consistent with COLREGS, the *Navigation Act 2012* and associated Marine Orders, vessels will maintain lighting, day shapes, and signals to indicate to other vessels that the seismic survey vessel is towing and is therefore restricted in its ability to manoeuvre.
	The towed streamer will be clearly marked with a tail buoy with light and radar reflector.	Yes	Tail buoys on the streamer will be marked so that the position of the streamer is known to other marine users.
	Procedures to notify and communicate with traditional Indonesian fishers.	Yes	Prior to commencement of the 2D seismic survey, the Indonesian Minister for Fisheries will be notified of the proposed location and start of the survey. The survey vessels will also carry translation cards (translated into Bahasa Indonesian) for communicating warning messages to Indonesian fishermen, in the event they are encountered in the Australia-Indonesia MoU Box.
Identify the likelihood			
With the above described controls in place, the likelihood of the 2D seismic survey encountering recreational and traditional fishing vessels, resulting in Insignificant consequences, is considered Possible (3).			

Residual risk summary		
Based on a consequence of Insignificant (F) and a worst-case likelihood of Possible (3) the residual risk is Low (8).		
Consequence	Likelihood	Residual risk
Insignificant (F)	Possible (3)	Low (8)

Assess residual risk acceptability

Legislative requirements

N/A – There are no legislative requirements applicable to managing the effects of seismic surveys in relation to recreational or traditional fisheries.

Stakeholder consultation

Feedback was received during face-to-face meetings with Recfishwest and fishing clubs in Broome (Table 5-4), and their feedback regarding the recreational fishing activities that occur in the region has been incorporated into the risk assessment. Details of the Indonesian Minister for Fisheries were provided to INPEX by AFMA.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts are expected to occur to recreational fisheries, included as social and economic values of the Kimberley AMP.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. However, none of the recovery plans or conservation advice documents are relevant to the effects of seismic surveys on fisheries. INPEX has instead considered Department of Fisheries (2013) guidance and WA DPIRD's recently published ecological risk assessment of seismic impacts to marine finfish and invertebrates (Webster et al. 2018) during this assessment.

ALARP summary

Given the level of environmental risk is assessed as Moderate, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
No material complaints from recreational or traditional fishing stakeholders during the 2D seismic survey.	Vessels will maintain appropriate lighting, day shapes, and signals to indicate that the seismic survey vessel is towing and is therefore restricted in its ability to manoeuvre, in compliance with COLREGS, the Navigation Act 2012 and associated Marine Orders.	Vessel premobilisation inspection confirms the survey vessel and support vessels have functional lighting, day shapes and signals, compliant with COLREGS, the Navigation Act 2012 and associated Marine Orders.	Vessel Master
	A 24-hour visual, radio/satellite and radar watch will be maintained by survey vessels operating in the Operational Area.	Vessel premobilisation inspection confirms the survey vessel and support vessels have functional radar, radio and satellite phone systems, and that the seismic survey vessel marine crew are competent to STCW95 / Elements of Shipboard Safety Standards.	CONTRACTOR Survey Manager
		Vessel communication logs or email documentation of on-the-water communications with fishers will be provided to NOPSEMA in the case of an audit or inspection.	Vessel Master
	The towed streamer will be clearly marked with a tail buoy with light and radar reflector.	Vessel premobilisation inspection confirms that the streamer is mobilised with a tail buoy with a light and radar reflector.	CONTRACTOR Survey Manager
Provide notification to Indonesian authorities of survey activities that have	Prior to commencement of the 2D seismic survey, the Indonesian Minister for Fisheries will be	Record of transmittal to Indonesian Minister for Fisheries.	INPEX Environmental Advisor

the potential to occur within the Australia-Indonesia MoU Box.	notified of the proposed location and start date of the survey.		
	The survey vessels will carry translation cards (translated into Bahasa Indonesian) for communicating warning messages to Indonesian fishermen in the Australia-Indonesia MoU Box.	Vessel premobilisation inspection confirms that survey vessels will carry translation cards (translated into Bahasa Indonesian) for communicating warning messages to Indonesian fishermen in the Australia-Indonesia MoU Box.	CONTRACTOR Survey Manager

7.2.3 Pearling and aquaculture

Table 7-21: Impact and risk evaluation – Pearling and aquaculture

Identify hazards and threats	
Impulsive sound emitted from the seismic source has the potential to result in physical injury or physiological changes to fish and marine invertebrates in close proximity to the seismic source. This risk assessment considers concerns and perceived threats raised by the pearling industry in relation to seismic surveys, including: • potential for sound from the 2D seismic survey to impact the physiology of pearl oysters and ability to produce market quality pearls; • potential for sound from the 2D seismic survey to impact recruitment of larvae from spawning deep water pearl oyster brood stocks to settle as spat in nearshore stocks and fishing areas through the tidal exchange of offshore and nearshore waters; • potential for sound from the 2D seismic survey to impact plankton and nutrients, resulting in impacts to the food source of pearl oysters through the tidal exchange of offshore and nearshore waters; and • potential for sound from the 2D seismic survey to impact on pearl divers' hearing and safety and thereby impact on pearl oyster fishing activities.	
Potential consequence	Severity
Impacts to pearl oyster physiology and pearl quality Section 7.1.5 provides a summary of marine invertebrate sensitivity to sound from seismic surveys and other impulsive sound sources. Specifically, invertebrates such as oysters are sensitive to the particle motion component of sound rather than sound pressure, but due to the complexity of measuring and predicting particle motion the majority of available research describes sound levels in terms of sound pressure, not particle motion (Carroll et al. 2017; Popper & Hawkins 2018). Particle motion is most relevant close to the source, and invertebrate organisms that are sensitive only to particle motion have typically been found to be sensitive only at very close range (Morley et al. 2014; Popper et al. 2014; Edmonds et al. 2016; Nedelec et al. 2016; Popper & Hawkins 2018). In studies where effects to invertebrates have been observed, these are generally limited to sub-lethal impacts and chronic mortality in some individuals weeks to months following exposure, but limited to within metres to hundreds of metres from the seismic source (Section 7.1.5). To date, studies have not specifically looked at the effects of seismic sound sources on the silverlip pearl oyster (*Pinctada maxima*), targeted by the pearl oyster fishery in the Kimberley region. The North West Shoals to Shore Research Program led by the Australian Institute of Marine Science (AIMS) is a three-year program that	Insignificant (F)

commenced in 2017, which includes studies that are specifically examining the impacts of seismic surveys on pearl oyster growth and physiology and to pearl quality. However, the results of this research were not available at the time of preparing this EP. Similarities in the physiology and sensory organs of pearl oysters and other bivalve molluscs (e.g. scallops and mussels), indicates that their sensitivity to seismic sound may be similar to other bivalves studied. Oyster species have also been found to be resilient to the shock waves created by the detonation of high explosives underwater, which produce higher magnitude sound waves and more rapid rise times than a seismic source. A study that examined the effects of underwater explosive charges on pearl oysters (LeProvost et al*.* 1986) found that no mortality occurred in the exposed animals over a 13-week period and at a minimum exposure range of 1 m from the blast centre. Seismic sources have lower potential to impact on benthic invertebrates than explosives, hence it is likely that bivalves would have to be within very close range of a seismic source to experience mortality or injury. The sound levels that may result in sub-lethal and behavioural impacts to bivalve invertebrates, as relevant to changes to pearl oyster physiology and pearl quality have not been studied as comprehensively. Studies by Payne et al. (2007, 2008) and Day et al. (2016b, 2017) observed sub-lethal effects such as potential immunodeficiency and behavioural responses in some individuals following exposures to sound levels limited to within hundreds of metres of a seismic source. The majority of the INPEX 2D seismic survey Acquisition Area and Operational Area are in water depths greater than 50 m where pearl oysters are expected to be less abundant than in shallow, nearshore waters. Parts of the Acquisition Area overlap, to a limited degree, with water depths less than 50 m, such as at Lynher Bank in WA-532-P and areas of the Leveque Rise, which is partly overlapped in the eastern part of the Acquisition Area in WA-533-P. These water depths are at the deeper end of the depth range where pearl oysters occur; however, surveys undertaken in these areas did not report any occurrences of this species (Heyward et al. 2018a; Nicholas et al*.* 2016). The majority (94-98%) of the areas surveyed in these studies were abiotic substrates supporting limited epifauna (Heyward et al. 2018a; Nicholas et al. 2016). Preliminary data from the AIMS North West Shoals to Shore research program also indicates that pearl oysters offshore from Eighty Mile Beach are more common in water depths less than 40 m, particularly at known fishing grounds such as Compass Rose (Miller 2019). Few oysters have been found in greater water depths ranging to 70 m (a single oyster) near the southern boundary of the Acquisition Area (Miller 2019). Therefore, benthic habitats this far offshore are not expected to support significant populations of *P. maxima*, and significant impacts are not expected.	

Pearl oysters occur in greater abundance in shallower waters closer to shore than the Acquisition Area, such as waters where they are fished or farmed by pearling operators offshore from Eighty Mile Beach, Broome and the Lacepede Islands. The areas where pearl oysters are typically collected and farmed are a significant distance (>50 km) from the Acquisition Area and so no impacts to oysters in these locations are expected. Even so, in recent years the pearling industry has raised concerns that seismic surveys conducted offshore may impact the physiology and behaviour of pearl oysters to a degree that may impact the growth and quality of pearls. Therefore, an assessment of the potential response of pearl oysters to distant seismic sound emissions warrants further consideration. Available research into very minor behavioural responses to sound pressure and ground-born vibration include a study by Charifi et al. (2017) into the effects of sound on Pacific oysters (*Magallana gigas*). The study noted that oysters may respond to low sound levels and vibrations with valve closures representing an appropriate end-point for behavioural response. The study estimated that the minimum low frequency (10-80 Hz) acoustic energy required to evoke a response in 30% of a group of oysters was approximately 122 dB re 1 μPa SPL and 0.02 m/s^2 ground acceleration. Higher frequency sounds required a high sound level to evoke any response. The average pressure level observed to result in a response was 146 dB re 1 μPa and an acceleration of 0.4 m/s^2 for frequencies between 10 and 600 Hz, similar to the dominant frequencies emitted by a seismic source. Similar research by Roberts et al. (2015) on blue mussels (*Mytilus edulis*) found that the minimum ground acceleration required to evoke valve closure was slightly higher than that estimated by Charifi et al. (2017), between 0.06 and 0.55 m/s^2. Ellers (1995) noted that valve closure responses in clams occurred at 146-150 dB re 1 μPa SPL (20-140 Hz) and 166 dB re 1 μPa SPL (832 Hz). Vazzana et al. (2016) observed no change in behavioural response by mussels exposed to 150 dB re 1 μPa SPL. It is fundamentally important to note that the above studies measured vibration and sound pressure levels in laboratory conditions in very close proximity to the sound source where particle motion is the dominant component of the sound wave. Particle motion (i.e. ground acceleration) would be the principle stimulus for any response from an invertebrate and sound pressure levels received at increasing distance from a sound source do not provide a reliable representation of ground acceleration at distance. Even so, to provide context and demonstrate that the INPEX 2D seismic survey is not expected to result in impacts to oysters at fishing grounds or holding and farming leases, the received SPLs that are predicted to occur at key pearl oyster fishing grounds and farm leases have been reviewed. Table 7-22 and Figure 7-18 present the locations of principle fishing grounds and pearl farm leases closest to the Acquisition Area. The maximum SPLs received from the closest modelled single pulse locations are also presented in Table 7-22. These are the maximum sound pressures that may be received for a brief period when the survey vessel passes at the closest point of approach (e.g. for less than a few minutes when the seismic source is operated at the closest point of	

approach such as at the end of an acquisition line, during a run out or a run in). At all other times during the survey, the received sound pressure levels at these locations will be less.

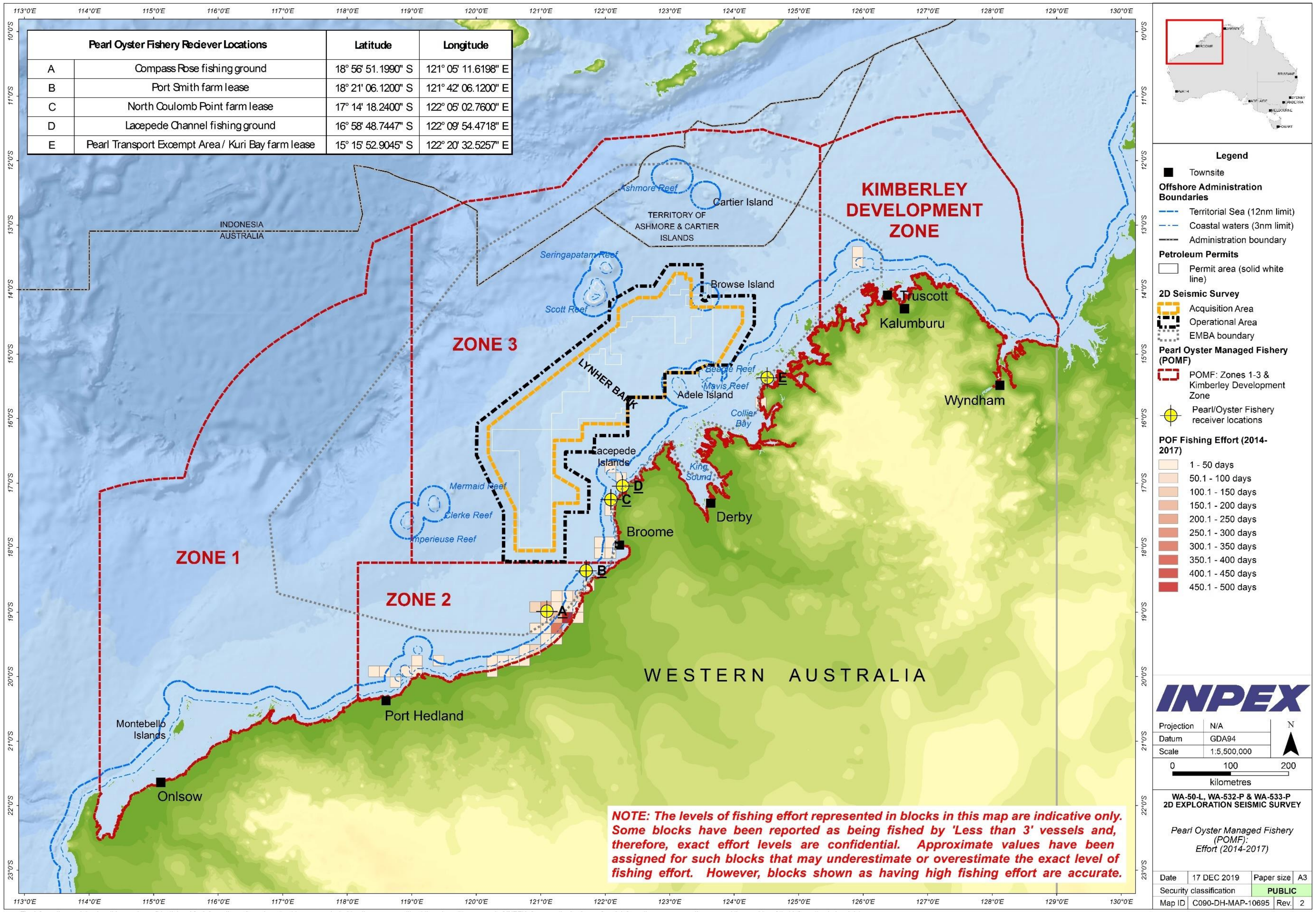
Table 7-22 Received maximum-over-depth per-pulse SPL at pearl oyster fishery receivers from the closest modelling sites (McPherson et al. 2019)

Pearl oyster fishery receiver	Distance from modelled single pulse site (km)	Received SPL (L_p; dB re 1 µPa)
Compass Rose fishing ground	100.7	119.4
Port Smith farm lease	74.5	121.1
North Coulomb Point farm lease	56.0	110.1
Lacepede Channel fishing ground	63.6	106.6
Pearl Transport Exempt Area / Kuri Bay farm leases	90.8	121.9

To verify the locations of the nearest pearl oyster fishing grounds, INPEX has engaged with pearling operators who have confirmed that they can operate out to the 40 m depth contour and up to 100 km from the coast at Eighty Mile Beach. INPEX has also analysed WA DPIRD catch and effort data for the Pearl Oyster Fishery for the years 2014-2017 (Figure 7-18), using the same method applied to fisheries (refer Section 7.2.1). Fishing effort was confirmed to be most concentrated around Eighty Mile Beach and the Compass Rose site with limited fishing effort near Broome, the Lacepede Islands and in isolated locations along the north Kimberley coast. This is consistent with the key sites reported by Hart et al. (2016). Locations that were fished between 2014 and 2017 that are not captured in Table 7-22 include the following areas:

- the north side of the Lacepede Islands, approximately 55 km from the Acquisition Area at the closest point
- waters adjacent to farm leases near Coulomb Point, approximately 50 km from the Acquisition Area at the closest point
- waters adjacent to farm leases west of Broome, approximately 65 km from the Acquisition Area at the closest point
- waters to the north-east of the Compass Rose and Eighty Mile Beach fishing grounds, approximately 70 km from the Acquisition Area at the closest point.

Of these additional areas fished, past fishing effort at these locations appears to have been minimal, with vessel activity below levels at which WA DPIRD can publish catch and effort data. In some years, no fishing effort at all was reported in these areas. The modelling by McPherson et al. (2019; Appendix D) indicates that the maximum received SPLs in these areas are predicted to be between approximately 100 and 125 dB re 1 μPa. The SPLs received at fishing grounds and leases are predicted to be comparable to or lower than the minimum SPLs (122-166 dB re 1 μPa) reported by Ellers (1995), Roberts et al. (2015), Vazzana et al. (2016) and Charifi et al. (2017) as potentially eliciting a response as minor and subjective as a valve closure. Valve closure in oysters and other bivalves is a regular and normal behavioural response in their normal ambient environment when they may close in response to a range of stimuli including tidal currents, increased turbidity or detection of nearby movements from fish or other potential predators and does not necessarily represent any ecologically significant impact. Again, it is stressed that comparison with these SPLs is likely to significantly overestimate any potential for pearl oysters to detect and respond to sound from the 2D seismic survey, given the large distances between the pearling sites and waters where the particle motion effects of seismic pulses are likely to be detectable. Pearl oysters in their natural habitat at fishing grounds live on the seabed in an environment where they are routinely exposed to tidal currents and sand gravel/movement in the order of 1 m/s or greater. Ambient background noise levels in the shallow shelf and coastal waters where fishing, holding and farming occur are consistently between 85-110 dB re 1 μPa, with sound levels increasing at times to in excess of 130 dB re 1 μPa as a result of biological noise (e.g. fish choruses), wind, tidal currents and movement of sediment, and occasionally other anthropogenic noise sources. Therefore, the maximum received sound pressure levels are broadly comparable to ambient background noise in these nearshore waters. Occasional noise from boats passing near to pearling sites will also result in higher sound levels than those predicted to be received from the INPEX 2D seismic survey. Therefore, little or no sub-lethal physiological impacts are expected to occur to pearl oysters located at known fishing grounds and leases as a result of the 2D seismic survey, and no impacts to the quality of pearls are expected to occur either.	



	Pearl Oyster Fishery Reciever Locations	Latitude	Longitude
A	Compass Rose fishing ground	18° 56' 51.1990" S	121° 05' 11.6198" E
B	Port Smith farm lease	18° 21' 06.1200" S	121° 42' 06.1200" E
C	North Coulomb Point farm lease	17° 14' 18.2400" S	122° 05' 02.7600" E
D	Lacepede Channel fishing ground	16° 58' 48.7447" S	122° 09' 54.4718" E
E	Pearl Transport Excempt Area / Kuri Bay farm lease	15° 15' 52.9045" S	122° 20' 32.5257" E

The information contained on this map is confidential and for information only, and must not be communicated to other persons without the prior written consent of INPEX. Any unauthorised use of such information may expose the user and the provider of that information to legal risk. While every effort has been made to ensure the accuracy and completeness of the information presented, no guarantee is given nor responsibility taken by INPEX for any errors or omissions. INPEX accepts no liability for any use of the said information or reliance placed on it.

Figure 7-18 Cumulative pearl oyster fishing effort (2014-2017) presented as number of fishing days per 10 nm x 10 nm block (the State of Western Australia is the owner of the copyright of this information)

Pearl oyster recruitment from deep water brood stock A concern of some pearling stakeholders is that seismic surveys may impact spawning and larvae produced by pearl oyster brood stocks in relatively deep offshore waters, which may then in turn impact upon the recruitment of pearl oyster stocks in shallower waters. Similarly, food chain impacts associated with tidal exchange between the Acquisition Area and the pearl oyster stocks has been raised as a matter of concern. As outlined above, the majority of the INPEX 2D seismic survey Acquisition Area is located in water depths greater than 50 m and limited, if any, impact to pearl oyster stocks is expected in these waters. Preliminary data from the AIMS North West Shoals to Shore research program indicates that pearl oysters offshore from Eighty Mile Beach are more common in water depths less than 40 m, particularly at known fishing grounds such as Compass Rose (Miller 2019). Few oysters have been found in greater water depths ranging to 70 m (a single oyster) near the southern boundary of the Acquisition Area (Miller 2019). Therefore, the 2D seismic survey Acquisition Area is not expected to provide significant habitat for pearl oysters. As outlined in Section 7.1.4, impacts to planktonic communities (including the eggs and larvae of various fish and invertebrates species) from the transient seismic source are likely to be limited in the context of natural variability in spawning and recruitment, as well as planktonic food sources that pearl oysters may filter out of suspension to feed on. Pearl oyster spawning typically occurs from September/October through to April or May with the primary spawning period from October to December. Settlement of larvae usually occurs after 28 to 35 days. Condie et al. (2006), Hart et al. (2011) and Hart et al. (2016) highlight that pearl oyster spawning, larval settlement and population recruitment is highly variable and primarily driven by a range of environmental factors including sea surface temperature, rainfall, wind, wave action, currents and the presence of suitable habitat (hard substrate) on which the spat settle and attach. A number of studies have been undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Marine and Atmospheric Research unit and the Western Australian Marine Science Institution (WAMSI) that have looked at the extent of the tidal exchange and biological connectivity between nearshore and offshore waters near Eighty Mile Beach and the Kimberley region (Condie et al. 2006; Condie & Andrewartha 2008; Ivey et al. 2016). The movements of pearl oyster larvae prior to settlement on the seabed are dictated by physical oceanographic processes such as wave action, prevailing winds and currents. Net transport from tide and wind driven currents is predominantly alongshore, with tidal oscillations in the Kimberley region producing cross-shore transport, back and forward, up to approximately 20 km from nearshore oyster stocks (Condie & Andrewartha 2008; Condie et al. 2006). Recent studies at Collie Bay and Camden Sound in the west Kimberley as part of the Kimberley Marine Science Research Program have also found that maximum outward movement of water from inshore locations towards	

offshore open waters as a result of the strong tidal currents in the region is approximately 18 – 23 km (Ivey et al. 2016). In a study that specifically studied the movement of larvae and settlement of pearl oyster spat in waters off Eighty Mile Beach, Condie et al. (2006) determined that *P. maxima* larvae are predominantly transported less than 30 km alongshore from the main brood stock between 8 and 15 m depth (some were transported as far as 60 km), leading to successful recruitment locally and alongshore. A limited proportion of larvae may also be carried into neighbouring shallow coastal environments via tidal oscillations and in to deeper waters (approximately 20 m depth). High local abundances of brood stock and spat observed occasionally in deeper water (approximately 30 m) in the vicinity of Compass Rose seem to be supported by intermittent larval transport from inshore populations; however, spawning in this area seems to contribute little to recruitment in the inshore populations (Condie et al. 2006). The cross-shore exchange of larvae would therefore seem to be limited between waters overlapped by the Acquisition Area and the pearl oyster stocks nearer to shore adjacent to Eighty Mile Beach and in the west Kimberley region. While it is possible there may be some biological connectivity, pearl oysters located over 50 km offshore are not expected to contribute greatly to the primary oyster populations located nearshore. Given the limited presence of suitable hard substrate in shallow waters of the Acquisition Area, mature pearl oysters are not expected to be present or be impacted in any significant numbers. This includes impacts to spawning. Even if low numbers of pearl oysters were present in the shallowest parts of the Acquisition Area, limited connectivity with the main brood stocks in shallow waters is expected. **Food chain impacts** With regard to food chain impacts to pearl oysters, no discernible impacts are predicted. Phytoplankton, algae and nutrients in the water column will not be impacted by the seismic source and the most productive time of year in nearshore waters (June to August) will be avoided by the 2D seismic survey. Any zooplankton that may be killed at close range to the seismic source will remain in the water column for several days before sinking to the seafloor where they are available to be consumed by a range of benthic organisms. In addition, as indicated in Section 7.1.4, zooplankton mortalities caused by the seismic survey will be small compared with natural mortality rates in the region. There will also be limited or no exchange of plankton and waterborne nutrients between the Acquisition Area and key pearl oyster stocks nearshore. **Pearl divers** Pearl oysters are collected by divers towed above the seabed on booms or ropes behind vessels. Collection primarily occurs during the months of March to July (Hart et al. 2016). Figure 7-18 presents the areas that	

have been fished for pearl oysters between 2014 and 2017, which is consistent with the principal fishing areas identified by Fletcher et al. (2006) and Hart et al. (2016). During stakeholder consultation for this EP, pearling operators asked if the seismic survey will affect their divers. Given the distance between the Acquisition Area and pearl oyster fishing grounds (ranging from approximately 50 km to over 100 km), the maximum received sound levels at these locations are predicted to be between approximately 100 – 125 dB re 1 μPa. As mentioned above, these levels are broadly comparable with ambient noise levels in the region, which are typically between 85 – 110 dB re 1 μPa. Under water, the human ear is about 20 dB less sensitive than it is in air at low frequencies (20 Hz), increasing to 40 dB reduced sensitivity at mid-frequencies (less than 1 kHz), and increasing to 70–80 dB reduced sensitivity at higher frequencies (Parvin 1998). Divers who wear neoprene hoods have further reduced hearing sensitivity (Sims et al. 1999). Based on photographs presented in Hart et al. (2016), hoods appear to be used by at least some pearl divers in north west WA. The auditory threshold of human hearing underwater is most sensitive at 1 kHz (70 dB re 1 μPa SPL) and less sensitive at lower and higher frequencies to around 120 dB re 1 μPa at 20 Hz and at 20 kHz (Parvin 1998). An exposure limit for both military and recreational divers has previously been proposed as a conservative measure. For frequencies between 100 and 500 Hz, the maximum SPL should be 145 dB re 1 μPa over a maximum continuous exposure of 100 seconds or with a maximum duty cycle of 20 per cent and a maximum daily cumulative total of three hours. The trading relation between the maximum SPL and duration was 4 dB per doubling of duration (e.g. 141 dB SPL for a 200 second exposure) (Fothergill et al. 2001; Pestorius et al. 2009). Based on this, Parvin (2005) suggested that 145 dB re 1 μPa is a safe criterion for divers and swimmers, although this does not imply that this level is associated with the onset of injury. Figure 7-19 presents the 145 dB re 1 μPa SPL contours for modelling sites adjacent to nearshore waters and pearl oyster fishery interests.	

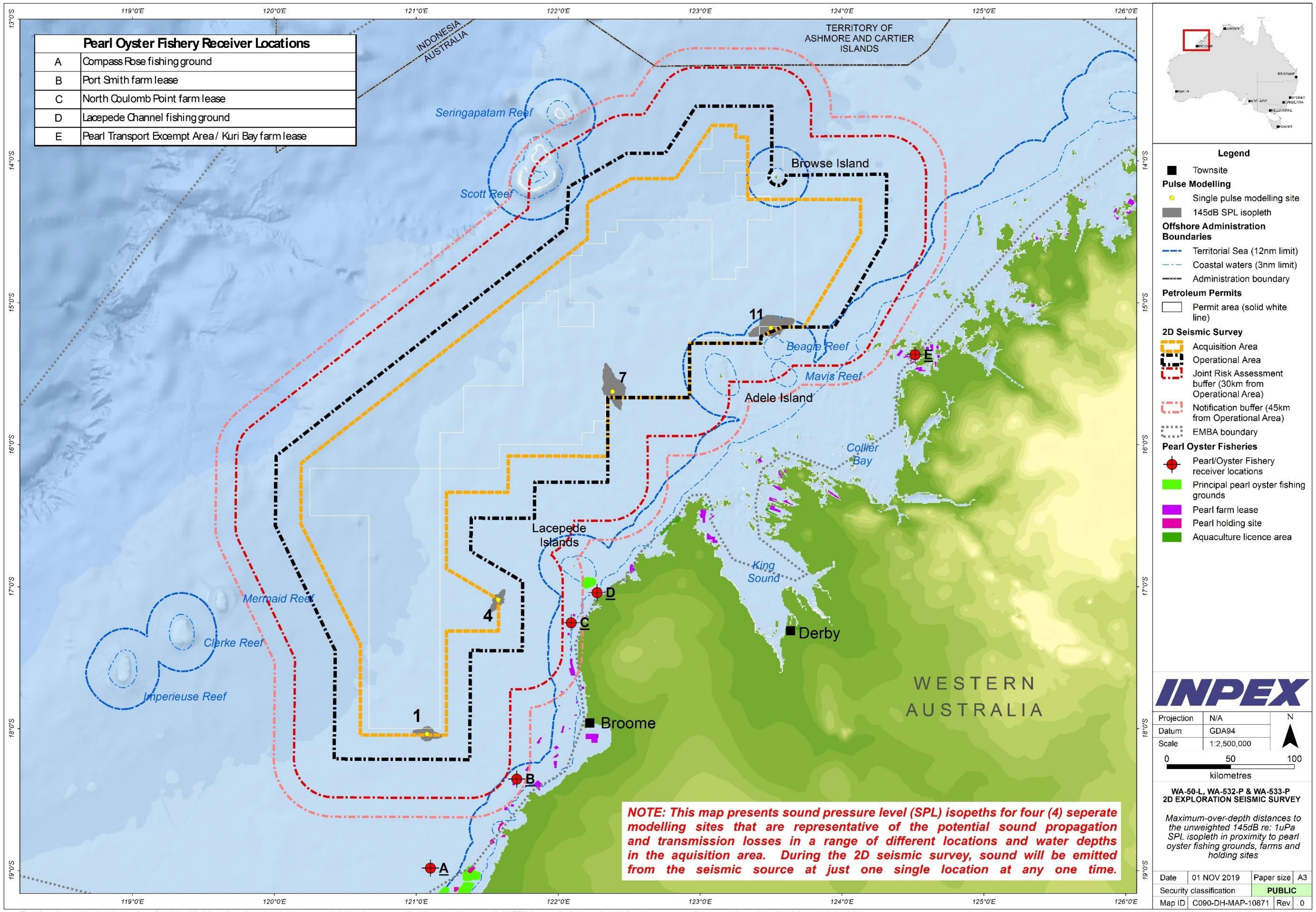


Figure 7-19 145 dB re 1 μPa SPL contours and DMAC (2019) mitigation buffers in relation to the pearl oyster fishery

Based on the predicted received sound levels at pearl oyster fishing grounds, the 2D seismic survey may be audible to pearl divers above ambient noise for short periods when the seismic survey is operating at the closest points to fishing grounds, but no adverse injury or risk to diver safety or welfare is expected. Based on the assessment above, the potential impacts and risks to pearling and aquaculture interests and activities are limited. It is possible that sound from the survey could be audible to pearl divers when the seismic source is operating at a point closest to pearl oyster fishing grounds but is not expected to pose a risk to divers. The impacts of this and the impacts to the pearling industry are predicted to be negligible. Therefore, the consequence of seismic exposures to pearling and aquaculture is considered to be Insignificant (F).	

Identify existing design and safeguards/controls measures
The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3). INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.

Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	Avoid seismic acquisition during the pearl oyster spawning period	No	The pearl oyster spawning season starts in the spring months of September or October and extends to the autumn months of April and May. The primary spawning occurs from the middle of October to December with a smaller secondary spawning in February and March. Avoiding all or part of the spawning period would significantly limit the window available to complete the survey. Avoidance is not considered practicable or proportionate to the already low level of consequence and risk to pearl oyster spawning and recruitment. INPEX has had to consider the timing of the survey in relation to the sensitive life stages of many environmental

			receptors in the region. Consequently, INPEX proposes to avoid the humpback whale aggregation and calving period from June to October so avoidance of the pearl oyster spawning period as well is not possible.
Substitution	None identified	N/A	No substitutes to the use of the seismic source or undertaking the 2D seismic survey were identified that would practicably reduce the already low risk to pearling and aquaculture.
Engineering	None identified	N/A	No engineering solutions were identified that would practicably reduce the already low risk to pearling and aquaculture.
Procedures & administration	Notification of the commencement, progress and completion of the seismic survey provided to pearling operators	Yes	Engagement with fishers and pearlers will be ongoing to provide stakeholders with information the commencement, progress and completion of the 2D seismic survey. This will also provide the necessary channels by which fisheries stakeholders may seek further information or clarification on issues of concern or provide feedback to INPEX. Notification will be sent to pearling stakeholders 3 weeks prior to commencement of the 2D seismic survey, communicating the general location where acquisition will commence, the expected start date and survey duration, IMO vessel numbers, and vessel radio and satellite phone communication details. Another notification will be sent to pearling stakeholders one week before it is anticipated the survey vessel will relocate to commence seismic acquisition in the second Area. Notification will also be provided to pearling stakeholders within 2 weeks of completion of the 2D seismic survey.

			These measures are considered practicable and an effective way of communicating and coordinating the survey activities with other industries. The notification measures are consistent with the latest Diving Medical Advisory Committee guidance note on Safe Diving Distance from Seismic Surveying Operations (DMAC 2019), which recommends that where diving and seismic activities are scheduled to occur within a distance of 45 km, all parties should be made aware of the planned survey activity where practicable. Where diving and seismic activities are scheduled to occur within a distance of 30 km, a joint risk assessment should be conducted with all relevant parties in advance of any simultaneous operations. (Figure 7-19) presents the 45 km and 30 km buffer from the Operational Area. Some pearl farm sites on the west coast of the Dampier Peninsula are situated within the 45 km buffer but not the 30 km buffer. Therefore, a notification is an appropriate measure for making pearling stakeholders aware of the seismic survey and reducing any potential risk to them.

Identify the likelihood		
With the above described controls in place, the likelihood of impacts occurring to pearling and aquaculture interests and activities is considered Unlikely (4).		
Residual risk summary		
Based on a consequence of Insignificant (F) and a worst-case likelihood of Unlikely (4) the residual risk is Low (9).		
Consequence	Likelihood	Residual risk
Insignificant (F)	Unlikely (4)	Low (9)

Assess residual risk acceptability

Legislative requirements

Consistent with the requirements of the OPGGS (Environment) Regulations 2009, INPEX has consulted with relevant pearling and aquaculture stakeholders during the development of this EP and the risk assessments relevant to these stakeholder's interests and activities. Ongoing consultation will be maintained with these stakeholders.

Stakeholder consultation

INPEX has engaged directly with pearling operators and provided information and regular updates to the PPA. Meetings with pearling operators included meetings in Broome with Paspaley and Willie Creek Pearls where the issues of impacts to recruitment, the food chain, and to divers were discussed. Consultation is summarised in (Table 5-4). Feedback has been considered in this EP with controls identified and demonstration that impacts will be managed to ALARP and acceptable levels.

INPEX therefore considers that stakeholder concerns have been adequately addressed and that the level of impact to commercial fish stocks is acceptable if disturbance to spawning fishes will not result in changes to the spawning biomass or changes in recruitment that may be discernible from normal natural variation.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts are expected to occur to pearl resources, which are listed as a cultural value of the Kimberley AMP.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. No survey activities will occur in the Habitat Protection Zone, and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. No survey activities will occur in the National Park Zone, and the ecosystems, habitats and native species within the National Park Zone will also be conserved in a natural state.

- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. However, none of the recovery plans or conservation advice documents are relevant to the effects of seismic or other anthropogenic noise on benthic invertebrate communities. Instead, INPEX has considered Department of Fisheries (2013) guidance and WA DPIRD's recently published ecological risk assessment of seismic impacts (Webster et al. 2018) during this assessment.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
Zero unresolved objections or claims from identified stakeholders.	Notification will be sent to pearling stakeholders 3 weeks prior to commencement of the 2D seismic survey, communicating: • the location where acquisition will commence • expected start date and survey duration • IMO vessel numbers • Vessel radio and satellite phone communication details.	Consultation records demonstrate that relevant stakeholders were sent notification 3 weeks prior to commencement.	INPEX Environmental Advisor
	Notification will be sent to fisheries stakeholders 1 week before it is anticipated the survey vessel will relocate to commence seismic acquisition in the second Area, communicating: • the expected start date in the Area and anticipated survey duration • IMO vessel numbers • Vessel radio and satellite phone communication details.	Consultation records demonstrate that relevant fisheries stakeholders were sent notification 1 week prior to commencement of seismic data acquisition in the second Area.	INPEX Environmental Advisor
	Notification will be provided to pearling stakeholders within 2 weeks of completion of the 2D seismic survey.	Consultation records demonstrate that relevant pearling stakeholders were sent a notification of survey completion within 2 weeks of completion of the 2D seismic survey.	INPEX Environmental Advisor

7.2.4 Other marine users

Table 7-23: Impact and risk evaluation – Physical presence of vessels resulting in disruption to marine users

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">The physical presence of the seismic survey vessel and the towed streamer (potentially 6 – 10 km in length), as well as associated support vessels, has the potential to cause disruption to other marine users in the Operational Area, including commercial shipping, other petroleum support vessels in the region and the Australian Defence Force.

Potential indirect impacts to tourism operators near the coast are also evaluated in the following risk assessment.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>Summary of receptors

Other marine users that may traverse the Operational Area or nearby waters include:
• commercial shipping operators and other vessel operators (e.g. petroleum industry vessels) in the region
• other petroleum titleholders and facility operators
• Defence – RAAF Curtin air-to-air weapons range
• tourism operators.
Impacts to commercial fisheries, the pearling and aquaculture industries, traditional fishers and recreational fishers have been assessed separately in the previous sections.

Evaluation of potential consequence

The seismic vessel will typically move along planned seismic acquisition lines at a constant speed of approximately 4.5 knots, and will proactively and collaboratively manage operational information with other marine users active in the Operational Area. There are no regulatory or enforced exclusion zones applied to the survey vessel, but due to the seismic survey vessel's classification as a vessel limited in its ability to manoeuvre while towing equipment, other marine users may be asked to take measures to avoid the seismic vessel and towed equipment to avoid interaction.</td><td>Insignificant (F)</td></tr>
</table>

Commercial shipping and other vessel operators The majority of shipping traffic in the Operational Area is of low to moderate intensity and associated with the Port of Broome and other petroleum activities in the region. However, advice received from AMSA during stakeholder consultation indicates that the far north-western corner of WA-533-P is intersected by a charted shipping fairway where vessel traffic travels to and from Port Hedland and the Port of Dampier, and vessel traffic will be greater in this area. Given that the survey vessel will be routinely crossing commercial vessel traffic, some commercial vessels may need to deviate from their intended routes to avoid the seismic vessel and towed array. The 2D seismic survey requires only a single streamer to be towed so there is not the same spread of multiple streamers, as is required for 3D surveys. Vessel encounters that occur in line with the seismic survey vessel will involve a very minor deviation of course to give way to the vessel, which would likely be similar to the deviation given to any other vessel transiting the region. Vessels that are sailing crossways to the survey sail line will need to deviate a greater distance, although as the vessel is moving, the deviation is likely to be less than the full length of the streamer. Commercial vessel masters are familiar with procedures for operating in the vicinity of a vessel restricted in its ability to manoeuvre and the seismic survey vessel and support vessel masters and crews operate in areas of the world with significantly higher vessel traffic without significant issue. No significant navigational implications or long-term changes in shipping traffic patterns are expected. **Other petroleum titleholders and operators** During the 2D seismic survey, the survey vessel will occasionally enter the permits of other petroleum titleholders, and acquisition within WA-50-L may enter the Ichthys field in proximity to the offshore production facilities. Field entry without the appropriate authorisation has the potential to disrupt field activities and vessel movements. In the event that commercial dive operations are required on offshore facilities, e.g. the INPEX Ichthys or Shell Prelude facilities, divers may be exposed to seismic pulses. **RAAF Curtin air-to-air weapons range** The Operational Area is situated in an area of air space used by Defence as an air-to-air weapons range. The seismic survey vessel is not expected to interfere with Defence activities, although air-to-air weapons training may result in closures or restrictions in some parts of the Operational Area that Defence will require INPEX and the seismic contractor to avoid. **Tourism operators**	

The Operational Area does not include any locations of interest for tourism, although Kimberley coastal waters and locations adjacent to the Operational Area may be used by tourism operators from time to time. The tourism industry in the Kimberley region includes wildlife cruises and a focus on the local pearling industry. Both typically operate in waters nearer to shore than the Operational Area, although some birdwatching tours may occasionally visit Adele Island and some cruises may pass through Operational Area to offshore locations such as such as the Rowley Shoals, Scott Reef or Ashmore Reef. However, the potential for vessel to interact at these locations at the same time is limited. Overall, no impacts are expected to the pearling industry. In nearshore waters (see Section 7.2.3). No significant impacts to marine fauna are expected outside of the Operational Area that may affect the distribution or behaviours of animals of interest to tourism operators in nearshore waters (e.g. whales, dolphins, dugongs, turtles and seabirds). Therefore, no significant impacts are expected. Overall, the potential consequence of occasional interactions with other marine users is assessed as Insignificant (F).	

Identify existing design and safeguards/controls measures

INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.

Propose additional safeguards/control measures (ALARP Evaluation)

Hierarchy of control	Control measure	Used?	Justification
Elimination	Eliminate the use of vessels and towed equipment	No	The use of vessels and towed equipment to undertake the activity cannot be eliminated. No other practicable elimination options were identified.
Substitution	None identified	N/A	No additional substitution controls were identified that would practicably reduce the risk to marine mammals.

Engineering	None identified	N/A	No additional engineering solutions were identified that would practicably reduce the risk to marine mammals.
Procedures & administration	Australian Hydrographic Office (AHO) will be informed of the proposed seismic vessel location prior to the activity commencing.	Yes	By informing AHO of the location and start date of the 2D seismic survey, information will be included in the promulgation of fortnightly Notice to Mariners. Notice to Mariners provide commercial shipping operators with information regarding activities or hazards in the region and will include details of the relevant vessels.
	The AMSA Joint Rescue Coordination Centre (JRCC) will be advised of the survey details (survey vessel, location, timing etc.) prior to mobilisation to ensure NAVAREA X and AUSCOAST warnings can be issued and kept up to date. AMSA JRCC will also be notified of survey completion.	Yes	The AMSA JRCC will be advised of the survey details for promulgation of radio-navigation warnings 24-48 hours before operations commence and upon completion of the survey.
	Vessels to maintain 24-hour visual, radio/satellite phone and radar watch and provide on-the-water communications with fishing vessels.	Yes	In addition to the above-mentioned planning and communication controls, on-the-water vigilance and communication with fishers and other users will be important for the seismic survey vessel and support vessels to manage interactions.
	Vessels to maintain appropriate lighting, day shapes, and signals to indicate that the seismic survey vessel is towing and is therefore restricted in its ability to manoeuvre.	Yes	Consistent with COLREGS, the *Navigation Act 2012* and associated Marine Orders, vessels will maintain lighting, day shapes, and signals to indicate to other vessels that the seismic survey vessel is towing and is therefore restricted in its ability to manoeuvre.
	The towed streamer will be clearly marked with a tail buoy with light and radar reflector.	Yes	Tail buoys on the streamer will be marked so that the position of the streamer is known to other marine users.

	Entry into the Ichthys field will be approved by the Ichthys Offshore Installation Manager with an associated SIMOPS plan and field entry permit.	Yes	Entry into the Ichthys field will be approved by the Offshore Installation Manager with an associated SIMOPS plan and field entry permit.
	Seismic acquisition in other titleholders' exploration permits will be undertaken in accordance with Ingress Agreements with the relevant titleholders and an Access Authority granted by NOPTA.	Yes	Seismic acquisition in other titleholders' exploration permits will be undertaken in accordance with Ingress Agreements with the relevant titleholders and an Access Authority granted by NOPTA.
	Other titleholders will be notified of the seismic survey in the event that facilities are within 45 km of survey activities. If diving operations are planned within 30 km of the survey at the same time as the survey, then other possible control measures will be considered with the titleholder.	Yes	The notification measures are consistent with the latest Diving Medical Advisory Committee guidance note on Safe Diving Distance from Seismic Surveying Operations (DMAC 2019), which recommends that where diving and seismic activities are scheduled to occur within a distance of 45 km, all parties should be made aware of the planned survey activity where practicable. Where diving and seismic activities are scheduled to occur within a distance of 30 km, a joint risk assessment should be conducted with all relevant parties in advance of any simultaneous operations.

Identify the likelihood

The likelihood of potential disruptions to other marine users with Insignificant (F) consequence is considered Possible (3).

Residual risk summary

Based on a consequence of Insignificant (F) and a likelihood of Possible (3) the residual risk is Low (8).

Consequence	Likelihood	Residual risk
Insignificant (F)	Possible (3)	Low (8)

Assess residual risk acceptability

Legislative requirements

All requirements under the *Navigation Act* and associated Marine Orders for navigation, collision, and support vessels are identified as control measures.

Stakeholder consultation

During stakeholder consultation, AMSA Nautical Advice provided advice on vessel traffic in the areas and the requirement to provide notifications to the AHO and AMSA JRCC, as well as to implement the relevant procedures for a vessel restricted in its ability to manoeuvre. The Department of Defence advised of the presence of the Curtin air-to-air weapons range, requested to be kept informed, and advised INPEX to inform the AHO prior to commencement of the activity for the promulgation of fortnightly Notice to Mariners. These procedures have been identified as control measures with associated performance standards and measurement criteria.

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. No survey activities will occur in the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts are expected to occur to tourism or petroleum activities, included as social and economic values of the Kimberley AMP.

Further detail is provided in Section 7.2.5.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP (Appendix A). None of the recovery plans or conservation advice documents are relevant to the physical presence of vessels disrupting shipping or fishing operators.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;

- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
All reasonable efforts are made to notify on-the-water stakeholders about the 2D seismic survey	The Australian Hydrographic Office (AHO) will be nor working weeks before operations commence for the promulgation of related notices to mariners (via datacentre@hydro.gov.au).	Records of document transmittal to AHO.	CONTRACTOR Survey Manager
	Notification will be provided to AMSA's Joint Rescue Coordination Centre (JRCC) for promulgation of radio-navigation warnings 24-48 hours before operations commence, including following information (via rccaus@amsa.gov.au, ph: 1800 641 792 or +61 2 6230 6811): • vessel details, including name, call sign and Maritime Mobile Service Identity (MMSI) • satellite communications details, including INMARSAT-C and satellite telephone • area of operation • requested clearance from other vessels • notification of operations start and end.	Records of document transmittal to AMSA JRCC.	CONTRACTOR Survey Manager
	Vessels will maintain appropriate lighting, day shapes, and signals to indicate that the	Vessel records confirm no records of survey or support vessels failing to	Vessel Master

	seismic survey vessel is towing and is therefore restricted in its ability to manoeuvre, in compliance with COLREGS, the *Navigation Act 2012* and associated Marine Orders.	comply with appropriate navigation, lighting, day shape and signal requirements under COLREGS, the *Navigation Act 2012* or its associated Marine Orders.	
	A 24-hour visual, radio/satellite and radar watch will be maintained by survey vessels operating in the Operational Area.	Vessel records confirm that a 24-hour visual and radar watch is maintained, and radio/satellite communications with other third-party vessels. Vessel crew training and competency records demonstrate that all relevant marine crew are competent to STCW95 / Elements of Shipboard Safety Standards.	Vessel Master
	The towed streamer will be clearly marked with a tail buoy with light and radar reflector	Pre-mobilisation audit/checklist confirms that the streamer is mobilised with a tail with a light and radar reflector.	CONTRACTOR Survey Manager
	Prior to commencement of the 2D seismic survey, ingress agreements and Access Authorities will be confirmed for petroleum permit areas / licence areas held by other petroleum titleholder that the 2D seismic survey will access.	Approved ingress agreements and Access Authorities.	INPEX Exploration Project Manager
	Titleholders of facilities within 45 km of survey activities will be notified 3 weeks prior to commencement of the seismic survey. If diving operations are planned within 30 km of the survey at the same time as the survey,	Consultation records demonstrate that relevant titleholders within 45 km of the survey were sent notification 3 weeks prior to commencement.	INPEX Environmental Advisor

	then potential controls well be included in a simultaneous operations management plan.	Simultaneous operations management plan	INPEX Exploration Project Manager

7.2.5 Australian Marine Park values

Table 7-24: Impact and risk evaluation – Australian Marine Park values

Identify hazards and threats	
The 2D seismic survey Acquisition Area and Operational Area overlaps with the Multiple use Zone (MUZ) and is located adjacent to the Habitat Protection Zone (HPZ) and National Park Zone (NPZ) of the Kimberley AMP. Impacts to the values of an AMP have the potential to impact the overall conservation of biodiversity and other natural, cultural and heritage values of the North-west Marine Parks Network and would be contrary to marine park objectives. The following assessment reviews the impacts and risks associated with the physical presence and underwater sound generated by the 2D seismic survey and considers these in the context of the management plan objectives and values. The assessment takes into account the control measures previously identified in other risk assessment sections for managing the risk to each AMP value.	
Potential consequence	**Severity**
Evaluation of impacts and risks to marine park values AMP values are broadly defined into four categories: natural, cultural, heritage and socio-economic. The risks to many of the receptors that make up these values have been assessed in detail in other risk assessment sections of the EP. Table 7-25 provides a qualitative assessment of the predicted impacts and risks to each of the AMP values as well as cross-references to relevant risk assessment sections, where further detail is provided. The Acquisition Area and Operational Area cover approximately 37% and 47% of the total Kimberley AMP area respectively. However, only a very small proportion of this area will be exposed to increased sound levels at any one time as the seismic survey vessel transits over the Acquisition Area and, due to the broad 3 – 6 km line spacing of the 2D survey, not all areas will be impacted. The evaluation in Table 7-25 considers the representativeness of the relevant AMP values and the 2D seismic survey's spatial and temporal footprint on the representative area and values of the AMP. The overall consequence severity for impacts to the values of the Kimberley AMP has been determined based on the worst-case residual consequence in Sections 7.1 and 7.2 and is considered to be Minor (E). All impacts will be temporary. **Marine park and zone objectives** The objectives of the North-west Marine Parks Network Management Plan 2018 provide for: • the protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the North-west Network; and	Minor (E)

• ecologically sustainable use and enjoyment of the natural resources within marine parks in the Northwest Network, where this is consistent with objective (a). Objectives and rules are also prescribed for each zone of the AMP: • Multiple Use Zone (MUZ) (IUCN VI) - The objective of the MUZ is to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species. • Habitat Protection Zone (HPZ) (IUCN IV) – The objective of the HPZ is to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. • National Park Zone (NPZ) (IUCN II) – The objective of the NPZ is to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. Based on these objectives, the zone rules for the Kimberley AMP allows for petroleum activities such as the 2D seismic survey to be undertaken in the MUZ. However, these activities are not permitted within the HPZ or the NPZ. No 2D seismic survey activities will occur in the HPZ or the NPZ at any time. Therefore, the 2D seismic survey will be conducted in a manner that is consistent with the zone rules of the AMP. No significant and/or long-term impacts to the ecosystems, habitats or native species of the Kimberley AMP are expected. Management of the 2D seismic survey, as per the control measures identified in the risk assessment sections of this EP, will reduce the impacts and risks, which are predicted to be of minor consequence and short-term. The 2D seismic survey will be undertaken consistent with the principals of ecologically sustainable development and, as such, will meet the zone objectives for ecologically sustainable use of the MUZ while conserving the representative ecosystems, habitats and native species. Receptors are predicted to recover from the effects of seismic sound exposure within timescales ranging from minutes and hours to weeks or months, depending on the sensitivity. Ecosystems, habitats and native species within the HPZ or the NPZ will also be conserved in a natural state and the level of impact is assessed as acceptable.	

Table 7-25 Summary of residual risk ranking to Kimberley AMP Values

Kimberley AMP values	Relevant risk assessment sections	Summary of potential consequence	Potential consequence ranking for AMP value
Natural values			
Ecosystems The Kimberley AMP includes examples of ecosystems representative of: • Northwest Shelf Province — a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and an ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales. • Northwest Shelf Transition — straddles the North-west and North Marine Regions and in the Northwest includes shelf break, continental slope, and the majority of the Argo Abyssal Plain and is subject to a high incidence of cyclones. Benthic biological communities in the deeper parts of the bioregion have not been extensively studied, although high levels of species diversity and endemism occur among demersal fish communities on the continental slope. • Timor Province — water depths (of the bioregion) ranging from about 200 m near the shelf break to 5,920 m over the Argo Abyssal Plain. The reefs and islands of the bioregion are regarded as biodiversity hotspots. Endemism in demersal fish communities of the continental slope is high; two distinct communities have been identified on the upper and mid slopes.	7.1.4 – Planktonic communities 7.1.5 – Benthic communities 7.1.6 – Fishes	The physical habitat structure and overall condition of the ecosystems within the Kimberley AMP will not be affected by the 2D seismic survey. Impacts to planktonic, benthic organisms that form the base of the food chain in these ecosystems are expected to be localised (tens of metres from the seismic source) and temporary. Impacts to planktonic communities are expected to be insignificant at a regional scale relative to the natural spatial and temporal variability in plankton abundance and the very high rates of natural mortality. The short life cycle and rapid turnover of many zooplankton also means there is potential for subsequent recruitment and rapid recovery. No long-term community level or higher trophic level impacts are expected. Impacts to benthic invertebrate communities may include some sub-lethal impacts and chronic mortality effects to some sessile organisms exposed to sound pressures directly beneath the seismic source. These chronic impacts are expected to occur within tens to hundreds of metres from the seismic source which, given the broad 3 – 6 km line spacing of the survey represents a footprint of less than 5% of the seabed in the Kimberley AMP, the majority of which (up to approximately 95%) consists of abiotic substrates rather than hard substrate and filter feeder communities. Further, any chronic mortality that may occur in benthic invertebrates will happen gradually over weeks or months following exposure to the seismic source is expected to be negligible in the context or natural mortality and processes of recruitment. Therefore, changes to these benthic communities are unlikely to be discernible from natural variation and are recoverable. Impacts are expected to include short term and localised changes in fishes' behaviour and distribution, but without any long-term or population-level impacts. Therefore, no discernible or long-term changes in the species abundance or diversity, or the broadscale condition and functioning of ecosystems represented in the Kimberley AMP are expected to occur.	Insignificant (F)
KEFs: • Ancient coastline at the 125 m depth contour — where rocky escarpments are thought to provide biologically important habitats in areas otherwise dominated by soft sediments • Continental slope demersal fish communities — characterised by high diversity of demersal fish assemblages.	7.1.5 – Benthic communities 7.1.6 – Fishes	The Ancient coastline at the 125 m depth contour KEF occurs along more than 1,500 km of the continental shelf in the NWMR. The overlap between the Kimberley AMP and the 2D seismic survey represents approximately 10% of the KEF. Similarly, the Continental slope demersal fish communities KEF occurs along over 600 km and at various different depth gradients of the continental slope and covers an area of approximately 30,000 km^2. The overlap between the Kimberley AMP and the 2D seismic survey represents approximately 6% of the KEF. The physical habitat structure and overall condition of the Ancient coastline at the 125 m depth contour KEF and the Continental slope demersal fish communities KEF will not be affected by the seismic survey activity. Impacts to benthic invertebrate communities that inhabit these areas may include some sub-lethal impacts and chronic mortality effects to some sessile organisms exposed to sound pressures directly beneath the seismic source. These chronic impacts are expected to occur within tens to hundreds of metres from the seismic source which, given the broad 3 – 6 km line spacing of the survey represents a footprint of less than 1% of each KEF. Further, any chronic mortality that may occur in benthic invertebrates will happen gradually over weeks or months following exposure to the seismic source is expected to be negligible in the context or	Insignificant (F)

Kimberley AMP values	Relevant risk assessment sections	Summary of potential consequence	Potential consequence ranking for AMP value
		natural mortality and processes of recruitment. Therefore, changes to these benthic communities are unlikely to be discernible from natural variation and are recoverable. Impacts are expected to include short term and localised changes in fishes behaviour and distribution, but without any population-level impacts. No significant or long-term changes to the spatial distribution or numbers of demersal fishes associated with the Ancient coastline at the 125 m depth contour KEF and the Continental slope demersal fish communities KEF are expected. Therefore, the ecological function and values of these KEFs will not be impacted.	
***EPBC Act* listed species** The AMP supports a range of species, including protected species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs occur for the following species:			
• Calving, migratory pathway and nursing habitat for humpback whales	7.1.7 – Marine mammals	As described in Section 7.1.7, INPEX propose to avoid the period from 1st June to 31st October, when humpback whales are present in the Kimberley region. Therefore, by avoiding the humpback whale season, no impacts to the population are expected.	Insignificant (F)
• Migratory pathway for pygmy blue whales	7.1.7 – Marine mammals	The 2D seismic survey does not overlap with the pygmy blue whale migration BIA within the area of the Kimberley AMP but does extend into a small part of the BIA at the western boundary of the Operational Area. As described in Section 7.1.7, the 2D seismic survey will not be conducted within 24 km of the pygmy blue whale migration BIA during the migration periods. Therefore, no significant impacts to pygmy blue whales are expected.	Insignificant (F)
• Breeding, calving and foraging habitat for inshore dolphins	7.1.7 – Marine mammals	Received sound levels in coastal waters will be at or approaching ambient and background levels. No significant impacts to the behaviours of inshore dolphin species in the BIAs are expected.	Insignificant (F)
• Foraging habitat for dugong	7.1.7 – Marine mammals	Received sound levels in coastal waters will be at or approaching ambient and background levels. No significant impacts to the behaviours of foraging dugongs are expected.	Insignificant (F)
• Internesting and nesting habitat for marine turtles	7.1.8 – Marine reptiles	The Acquisition Area overlaps a small proportion of the internesting BIAs at their outermost extents, though the internesting habitats are mostly avoided. In addition, no operation of the seismic source will occur in the internesting BIAs or Habitat Critical areas during the internesting periods. As a result, no significant behavioural impacts to internesting turtle populations are expected. No impacts will occur to turtles during nesting on beaches. Some localised and temporary disturbances to transient turtles in the Operational Area may occur during migration and foraging, but there will be no long-term impacts to these individual turtles or the broader populations.	Insignificant (F)
• Foraging habitat for whale sharks	7.1.6 – Fishes	Whale sharks, given their relatively poor hearing abilities, may experience very localised and short-term disturbances during foraging, but there will be no long-term impacts and individuals will not be displaced from their foraging habitat.	Insignificant (F)
• Breeding and foraging habitat for seabirds.	7.1.9 – Marine avifauna	Foraging BIAs extend into the Operational Area. There is limited potential for seabirds to be exposed to significant underwater sound levels but may be startled by the seismic source if diving for prey in close proximity to the seismic source. The behaviours and distributions of fishes targeted as prey by foraging seabirds may also be affected for short periods during and after exposure to the seismic source. However, these effects are unlikely to be discernible to foraging birds in the context of the normal movements	Insignificant (F)

Kimberley AMP values	**Relevant risk assessment sections**	**Summary of potential consequence**	**Potential consequence ranking for AMP value**
		and variation in the distribution of these fishes. The behaviours and distribution of prey will remain largely unaffected throughout the wider foraging BIAs and the Operational Area. No impacts to breeding avifauna are expected.	
Cultural values			
The Kimberley AMP has cultural significance and value in terms of the Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people's sea country and a spiritual connection with all parts of the sea, land, plants and animals put there by Wanjina Wunggurr. The national heritage listing for the West Kimberley recognises the following key cultural heritage values: • Wanjina Wunggurr Cultural Tradition which incorporates many sea country cultural sites. • log-raft maritime tradition, which involved using tides and currents to access offshore warrurru (reefs) to fish • interactions with Makassan traders around sea foods over hundreds of years • important pearl resources that were used in traditional trade through the wunan and in contemporary commercial agreements.	All of Sections 7.1 and 7.2	During development of this EP, INPEX consulted with the Kimberley Land Council (KLC) and directly with traditional owners with interests vested in the Kimberley AMP. No concerns were raised about impacts to sea country, cultural sites, traditional activities, sea foods or other resources. The 2D seismic survey is not expected to have an effect on cultural sites, pearl resources or the overall value of sea country.	Insignificant (F)
Heritage values			
The AMP contains more than 40 known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*	N/A	A search of the Australian National Shipwrecks Database (ANSDB) was undertaken. No historic shipwrecks were identified in the Operational Area and no impacts are expected.	N/A
Social and economic values			
The following social and economic activities are recognised as values of the AMP and contribute to the wellbeing of regional communities and the prosperity of the nation:			
Commercial fishing	7.2.1 – Commercial fisheries	The assessment of commercial fisheries that operate in the region identified that there was the potential to disrupt fishing activities and potentially cause some localised and temporary effects to their catch rates if fishing occurs near the operating seismic survey vessel. The Northern Demersal Scalefish Managed Fishery (NDSMF) and Mackerel Managed Fishery (MMF) were identified as the two fisheries most likely to be overlap with the 2D seismic survey and the Kimberley AMP, although the 2D seismic survey will not take place during the peak mackerel fishing season between June and October and so impacts to this fishery are reduced. INPEX will implement a number of measures to communicate and coordinate activities with commercial fisheries stakeholders.	Minor (E)

Kimberley AMP values	Relevant risk assessment sections	Summary of potential consequence	Potential consequence ranking for AMP value
Recreation, including fishing	7.2.2 – Recreational and traditional fisheries	Consultation with recreational fishing stakeholders has confirmed that the 2D seismic survey is located further offshore than where most recreational fishing occurs and the proposed timing of the survey excludes the dry season fishing period and the Broome Billfish Classic tournament.	Insignificant (F)
Tourism	7.2.4 – Other marine users 7.2.3 – Pearling and aquaculture	The tourism industry in the Kimberley region includes wildlife cruises and a focus on the local pearling industry. Both operate in waters nearer to shore than the 2D seismic survey although some cruises may pass through the Operational Area *en route* to offshore locations such as Scott Reef and Ashmore Reef. However, the potential for vessel to interact at these locations at the same time is limited. No impacts are expected to the pearling industry. No significant impacts to marine fauna that may affect the distribution or behaviours of animals of interest to tourism operators are expected outside of the Operational Area in nearshore waters (e.g. whales, dolphins, dugongs, turtles, seabirds). Therefore, no significant impacts are expected.	Insignificant (F)
Traditional use	N/A	No indigenous Australian traditional uses were identified within the Operational Area.	N/A
Mining (oil and gas)	7.2.4 – Other marine users	The 2D seismic survey activity is a petroleum activity. Survey activities that occur within the permits of other petroleum titleholders will be coordinated and will take place in accordance with the relevant Access Authorities and Ingress Agreements.	Insignificant (F)

Identify existing design and safeguards/controls measures			
The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3). INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	None identified	N/A	No elimination controls were identified that would practicably reduce the risk to marine mammals.
Substitution	Apply to NOPTA to vary the work commitment of the 2D seismic survey and reduce the number of line kilometres, thereby reducing the spatial and temporal footprint of the survey.	Yes	INPEX has identified an opportunity to substitute parts of the Acquisition Area with existing 3D seismic data. Licensing and reprocessing of existing seismic data that has previously been acquired in the area may allow INPEX to reduce the extent and duration of the survey.
Engineering	None identified	N/A	No additional engineering solutions were identified that would practicably reduce the risk to the values of the Kimberley AMP.
Procedures & administration	No survey activities in the HPZ or NPZ of the Kimberley AMP at any time.	Yes	Consistent with the zone rules, requirements and objectives of the North-west Marine Parks Network Management Plan, the petroleum activity will not take place within the Habitat Protection Zone or National Park Zone. This will include no deployment of streamers or operation of the seismic source in these zones at any time for any reason.
	Implement an acoustic source exclusions area (Figure 7-20) around	Yes	Impacts to the values of the Kimberley AMP are expected to be temporary and recoverable. Of all receptor

	the HPZ and NPZ - No operation of the seismic source within 1 km of the HPZ or NPZ at any time.		categories, some chronic lethal and sub-lethal effects may occur in a proportion of benthic organisms. Although these impacts are expected to be limited in the context of natural variability and the communities will recover within weeks to months, to provide further protection to the benthic habitats and communities within the HPZ and NPZ, a 1 km acoustic source exclusion area will be established around the HPZ and NPZ. This is to '*provide for the conservation of ecosystems, habitats and native species in as natural a state as possible*' consistent with zone objectives. The 1 km distance is a precautionary measure, as chronic mortality and sub lethal effects to benthic invertebrates are expected up to approximately 200 m and 666 m from the seismic source respectively (refer to Table 7-6 in Section 7.1.5). Therefore, no effects are expected beyond 1 km distance from the seismic source.
	Provide the seismic contractor with the AMP zone boundaries, 1 km acoustic source exclusion area, and brief personnel on the requirement to not enter the HPZ or NPZ of the Kimberley AMP at any time.	Yes	To ensure that the requirements are clearly communicated and implemented effectively, INPEX will confirm that the AMP zone boundaries and the acoustic source exclusion area are provided to the seismic contractor and the requirements are highlighted during personnel inductions.
Identify the likelihood			
The likelihood of Insignificant (F) to Minor (E) residual consequences to the values of the Kimberley AMP is considered to be Likely (2).			
Residual risk summary			
Based on a consequence of Minor (E) and a worst-case likelihood of Likely (2) the residual risk is Moderate (6).			

Consequence	Likelihood	Residual risk
Minor (E)	Likely (2)	Moderate (6)

Assess residual risk acceptability
Legislative requirements As demonstrated in the above assessment, the 2D seismic survey will be undertaken in a manner that is consistent with the objectives of the North-west Marine Parks Network Management Plan 2018 and protects the values of the Kimberley AMP. **Stakeholder consultation** The Director of National Parks has an interest in the conservation of values protected within an Australian Marine Park. With the proposed control measures, no significant impacts to these marine park values are expected. **Australian marine park values, objectives and zone rules** Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018: • The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. • No significant or long-term impacts to AMP values are expected to occur. • The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species. • The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. No survey activities will occur in the Habitat Protection Zone and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state. • The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible. No survey activities will occur in the National Park Zone and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state. • The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved. **Conservation management plans / threat abatement plans** Several conservation management plans have been consulted in the development of this EP that are applicable to the protection of the values of the Kimberley AMP.

Consistent with the requirements of the Conservation advice for humpback whales, Conservation Management Plan for the Blue Whale, and Recovery Plan for Marine Turtles in Australia, control measures have been proposed that protect important habitats and values of the Kimberley AMP.

ALARP summary

Given the level of environmental risk is assessed as Moderate, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as “Moderate”, the consequence does not exceed “C – Significant” and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
Undertake seismic acquisition in a manner that is consistent with the zone rules and management objectives of the North-west Marine Park Network Management Plan	The Kimberley AMP zone boundaries will be provided as a GIS shapefile to the selected seismic contractor for inclusion in their survey planning and vessel navigation systems.	Transmittal records confirm that the Kimberley AMP zone boundaries were provided to the seismic contractor prior to commencement of the 2D seismic survey.	INPEX Offshore Representative

2018 in order to protect the marine park values.	The 1 km acoustic source exclusion area (Figure 7-20) will be provided as a GIS shapefile to the selected seismic contractor for inclusion in their survey planning and vessel navigation systems.	Transmittal records confirm that the 1 km acoustic source exclusion area was provided to the seismic contractor prior to commencement of the 2D seismic survey.	INPEX Offshore Representative
	Crew, survey personnel will be briefed regarding the zone rules and objectives of AMP, and requirement not to operate the seismic source within the acoustic source exclusion area.	Induction includes briefing on the zone rules and objectives of AMP and the acoustic source exclusion area. Induction records confirm that the crew, survey personnel receive the survey induction.	INPEX Environmental Advisor
	No operation of the seismic source within the acoustic source exclusion area at any time.	Survey records confirm that no operation of the seismic source occurs within the acoustic source exclusion area at any time.	INPEX Offshore Representative
	No survey activities (including use of the seismic source and/or towed equipment) will occur within the Kimberley AMP HPZ or NPZ at any time.	Survey records confirm that no survey activities occur within the Kimberley AMP HPZ or NPZ at any time.	INPEX Offshore Representative

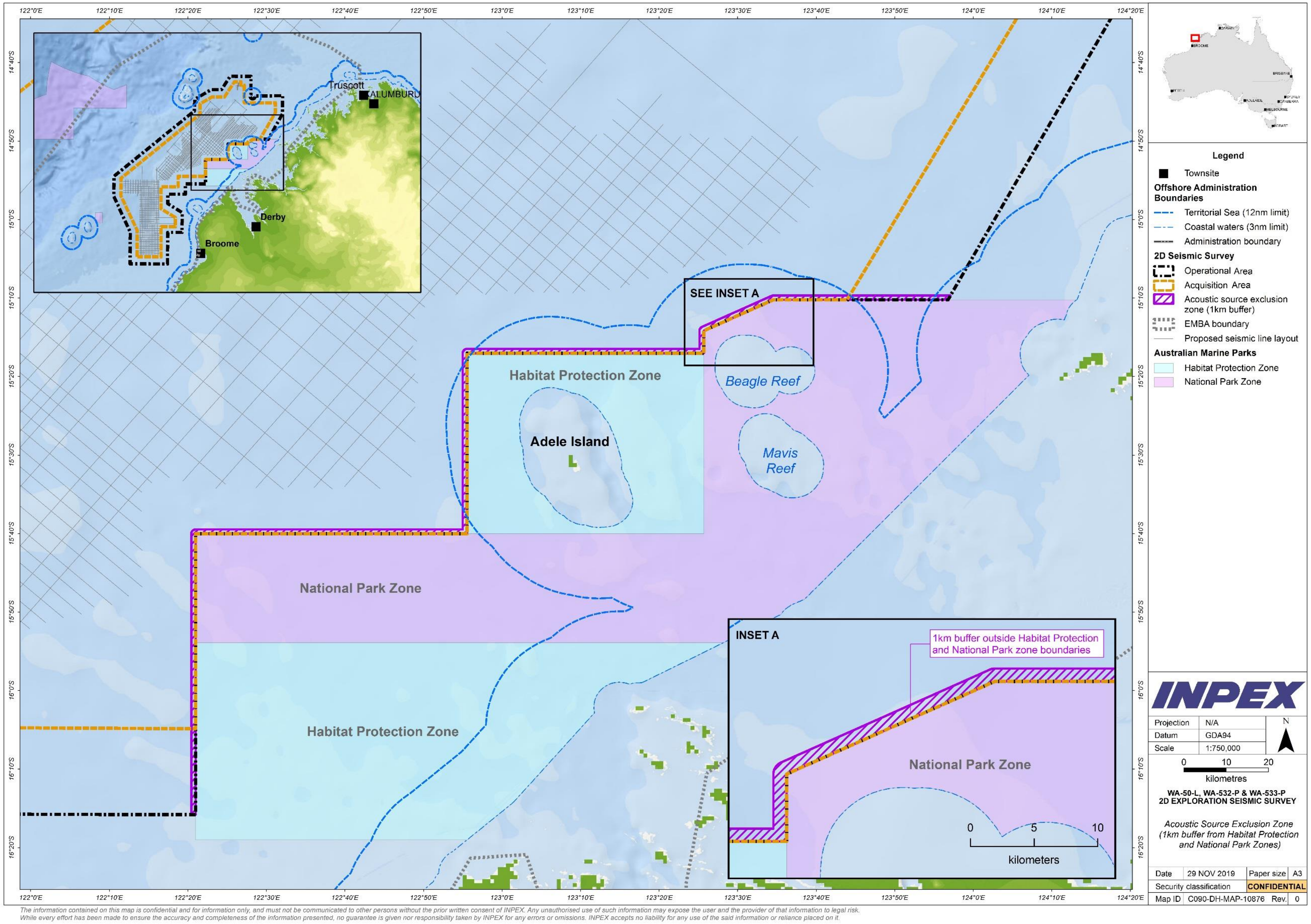


Figure 7-20: 1 km acoustic source exclusion zone surrounding the Kimberley AMP HPZ and NPZ

7.3 Cumulative seismic survey impacts

Table 7-26: Impact and risk evaluation – Cumulative impacts

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">Cumulative impacts from seismic surveys can potentially occur when:
• multiple seismic surveys occur in a region concurrently (at the same time), leading to an increase in sound exposure to the same receptors; or
• seismic surveys occur successively (one after the other) in the same area when the timeframe between surveys is less than the recovery rate of any potential impacts to receptors from the previous survey.
The hazard and threats of the cumulative effects of physical presence and seismic sound from concurrent or successive seismic surveys are the same as those assessed in Sections 7.1 and 7.2, involving potential physical and behavioural impacts to biological receptors, and disruption to stakeholders.
This section does not assess cumulative impacts from seismic surveys that may occur after the 2D seismic survey. It is not possible to anticipate what surveys will be planned after the 2D seismic survey and it is the responsibility of future seismic survey proponents to assess the potential cumulative impacts in their EPs.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>As described in Section 7.1 the duration of impact recovery following a seismic survey is in the order of minutes to hours for some receptors, or week to months for other receptors, for example:
• Localised changes in zooplankton abundance are likely to be replenished and indistinguishable from natural levels within hours of a seismic vessel passing or, based on the most conservative studies and a precautionary approach, within a few days of a seismic survey being completed.
• Sub-lethal effects and chronic lethal effects to some benthic invertebrates may occur for weeks or months after exposure in some cases, although changes in overall benthic community composition and structure are expected to be negligible in the context or natural mortality and recruitment.
• Changes in fishes' behaviour, abundance and distribution have been observed to last for minutes, hours or for up to 4-5 days, depending on the species, hearing sensitivity and situational context.
• Behavioural changes in migrating or foraging marine fauna (e.g. cetaceans, turtles) returning to normal within hours of the seismic vessel passing.</td><td>Minor (E)</td></tr>
</table>

Given the nature and magnitude of potential impacts to individual fauna, long-term impacts to populations or ecological communities are not expected to occur. Receptors are therefore expected to have recovered from the effects of the survey within days to months of completion. This has been considered with regards to temporal overlap of surveys in the following cumulative impact assessment. **Previous seismic surveys** A review of data available on the National Offshore Petroleum Information Management System (NOPIMS) website has confirmed which seismic surveys have previously been undertaken in the waters overlapping or adjacent to the proposed 2D seismic survey Operational Area. A total of 58 2D seismic surveys have been undertaken in the region between 1968 and 2010. The most recent was the Woodside Koolama 2D seismic survey, which was undertaken in 2010 in waters approximately 43 kilometres from Broome and approximately 35 kilometres west of Quondong Point (Figure 7-21). Eleven 3D seismic surveys have also been undertaken in the waters overlapping the proposed 2D seismic survey, undertaken between 1988 and 2011 (Figure 7-22). The most recent of these surveys were the PGS Aurora 3D seismic survey, undertaken to the south and west of Browse Island, and the Byron 3D seismic survey undertaken to the south of Scott Reef. Both of these surveys were completed in 2011. Receptors will have recovered from the effects of these surveys several years ago, therefore, there is no potential for cumulative effects to occur from the 2D seismic survey and previous seismic surveys in the same area. No other seismic surveys are planned in the same area as the 2D seismic survey at the time this EP was developed. **Concurrent seismic surveys** Over the scheduled period of validity of the 2D seismic survey, other seismic surveys are also in the planning stages in the region and therefore have the potential to occur at the same time. To ascertain what other seismic surveys may be undertaken during the same period and within 200 km of the INPEX 2D seismic survey, INPEX has reviewed the following: • the NOPSEMA website for seismic surveys that either have an EP accepted by NOPSEMA or have submitted an EP that is currently under assessment • the NOPTA titles database for exploration permits that include a 2D or 3D seismic survey work commitment. The 200 km distance was selected to define a conservative search area, as sound pressure levels beyond this distance will be at or approaching ambient background levels and, therefore, there is no potential for overlap of sound exposure impacts.	

Details of the identified potential seismic surveys are outlined in Table 7-27 and shown in Figure 7-23. It is important to note that, while these seismic surveys have the potential to occur during the validity period of the 2D seismic survey, they are unlikely to all occur at the same time and some (for commercial reasons) may not proceed at all. For example, each survey is subject to funding and the final scheduling of each survey can be influenced by a number of different factors, including the timing of environmental and socio-economic sensitivities, acceptance of an EP, contracting and the availability of the seismic survey vessel. Therefore, it is highly unlikely that these and other planned future surveys in the region would occur simultaneously. **Successive seismic surveys** The only known future seismic surveys that may occur within the same area as the 2D seismic survey are INPEX's 3D seismic surveys. However, the locations of these 3D seismic surveys depend upon the findings of the 2D seismic survey. Taking into account the time required to process the 2D seismic data, identify the 3D seismic survey areas, and the time required to develop and receive acceptance for an EP, biological receptors are expected to have fully recovered back to natural conditions before the 3D seismic surveys commence. Therefore, no cumulative impacts are expected as a result of successive seismic surveys in the same area.	

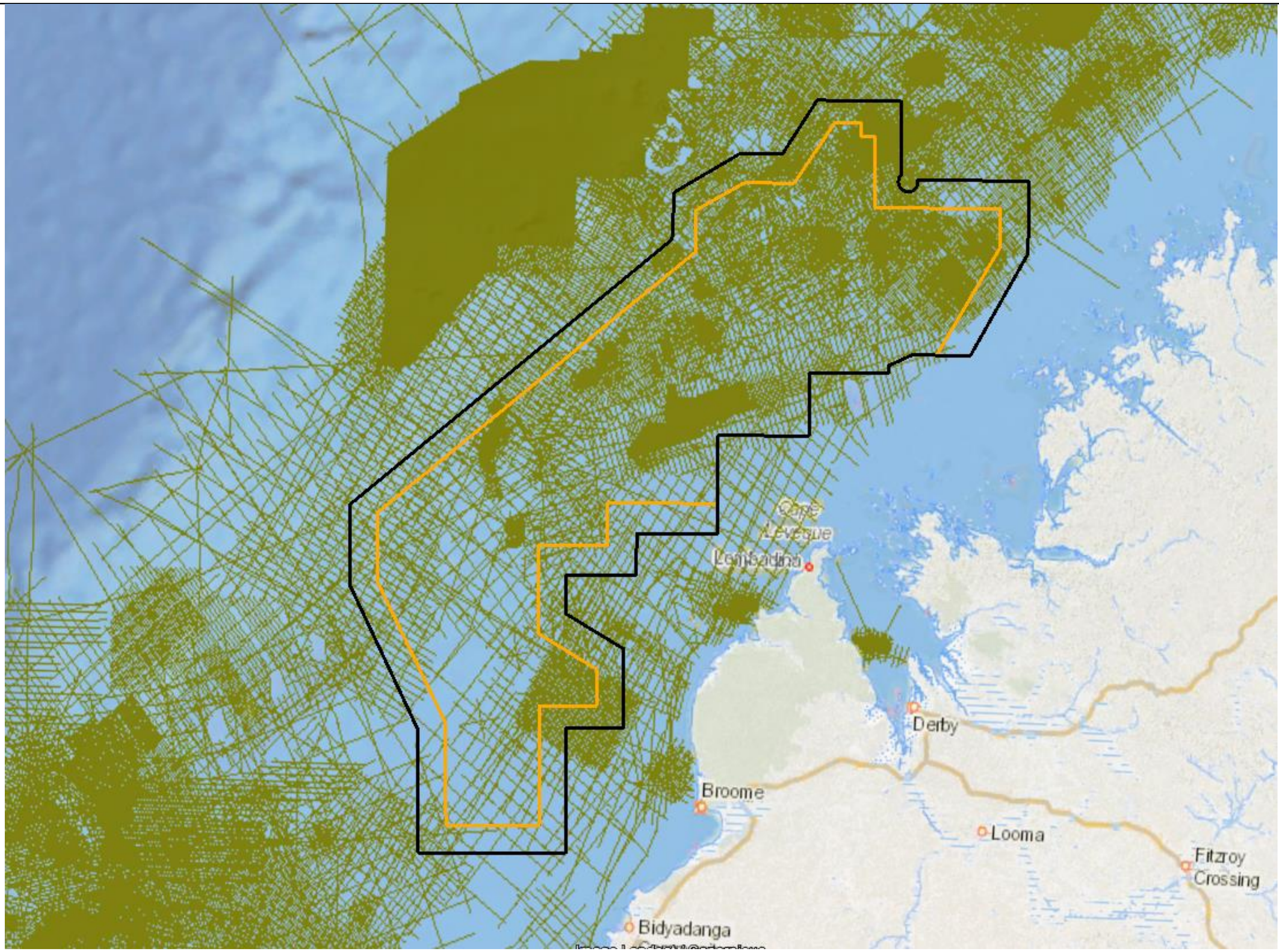


Figure 7-21: Previous 2D seismic surveys overlapping the Operational Area and Acquisition Area (source: NOPIMS)

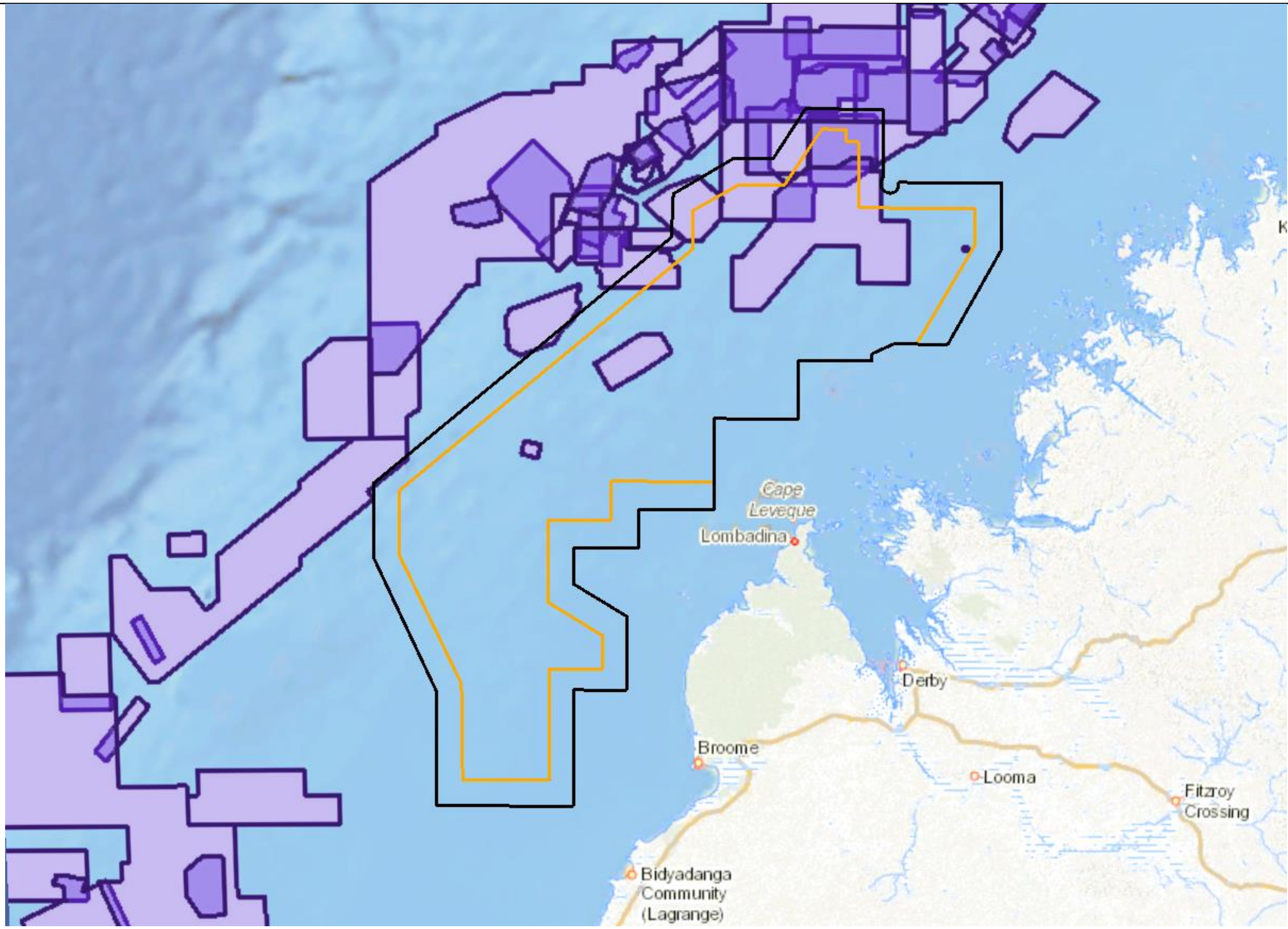
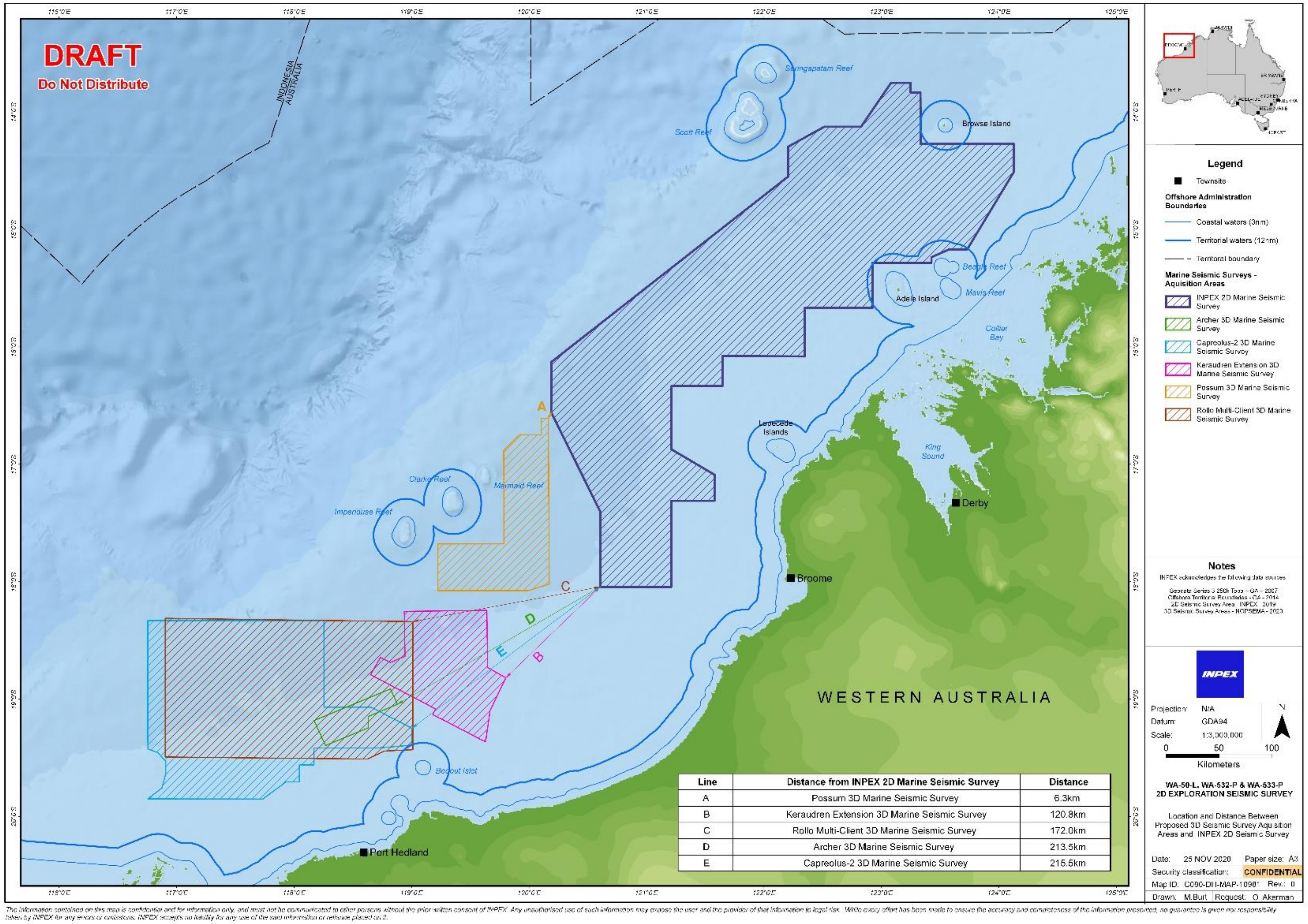


Figure 7-22: Previous 3D seismic surveys overlapping the Operational Area and Acquisition Area (source: NOPIMS)

Table 7-27 Other planned seismic surveys that may occur within 200 km of the INPEX 2D seismic survey between Q4 2021 and Q4 2023

Company	Environment Plan	Distance from Acquisition Area	Timing and duration	Survey characteristics	Status
Santos WA Northwest Pty Ltd	Keraudren Extension 3D Marine Seismic Survey Environment Plan	120.8 km from the nearest point of WA-533-P	It is Santos' intention to acquire the full survey within 2021 and/or 2022. However, acquisition of the survey will only be undertaken between 1 February to 31 July in any given year (2020-2022).	8,620 km^2 of 3D	Accepted 09 April 2020
Santos WA Northwest Pty Ltd	Archer 3D Marine Seismic Survey Environment Plan	213.5 km from the nearest point of WA-533-P	Santos intends to acquire the full survey in 2021. However, should this not be achievable, the full survey may be acquired in 2022. Acquisition only undertaken between 1 February to 31 July in either 2021 or 2022.	1,600 km^2 of 3D	Submitted for assessment on 13 November 2020
TGS-NOPEC Geophysical Company Pty Ltd (TGS)	Capreolus- 2 3D Marine Seismic Survey Environment Plan	215.5 km from the nearest point of WA-533-P	May commence as early as October 2020 and will be completed before 31 December 2024. It is estimated to take between approximately 95 and 190 days to acquire 10,000 km^2 (including contingency time for potential vessel or equipment down time and adverse weather conditions).	Up to a maximum of 10,000 km^2 may be acquired per calendar year (up to a total of 26,897 km^2).	EP accepted 10 November 2020

Company	Environment Plan	Distance from Acquisition Area	Timing and duration	Survey characteristics	Status
Searcher Seismic	Possum 3D Marine Seismic Survey Environment Plan	6.3 km from the nearest point of WA-533-P	Proposed validity 31 months between December 2020 and end of July 2023.	5,400 km^2 of 3D	Not submitted
PGS Australia Pty Ltd	Rollo Multiclient Marine Seismic Surveys (MSS) Environment Plan Note there are number of survey locations associated with the Rollo Multi-Client MSS; of relevance to this is EP is the Rollo MC MS EP Beagle survey.	172 km from the nearest point of WA-533-P	Actual timing of surveys is not defined, but could take place anytime over a five-year period from acceptance of the EP.	29,017km^2 of 3D	EP Accepted on 04 October 2018



Line	Distance from INPEX 2D Marine Seismic Survey	Distance
A	Possum 3D Marine Seismic Survey	6.3km
B	Keraudren Extension 3D Marine Seismic Survey	120.8km
C	Rollo Multi-Client 3D Marine Seismic Survey	172.0km
D	Archer 3D Marine Seismic Survey	213.5km
E	Capreolus-2 3D Marine Seismic Survey	215.5km

Figure 7-23: Location and distance of other seismic surveys in relation to the INPEX 2D seismic survey

To evaluate the potential cumulative environmental impacts that may occur as a result of another seismic survey occurring in region concurrent with the INPEX 2D seismic survey, credible scenarios were considered. The maximum credible scenario

was identified as being one other seismic survey occurring at the same time as the 2D seismic survey. Therefore, the worst credible scenarios were identified as being either one of the following two scenarios: • Possum 3D MSS, located 6.3 km from the Acquisition Area • Keraudren 3D MSS, located 120.8 km from the Acquisition Area. These two scenarios were selected due to the surveys being the closest to the 2D seismic survey, thereby allowing for potential cumulative impacts to sensitivities to be considered. The distances provided represent the closest distance that the seismic sources in the surveys may be operated at any one time. This would only occur if the INPEX 2D seismic survey vessel and the other survey vessel were operating at these closest points. This is highly unlikely to occur, but if it did, it would occur for less than an hour. For the majority of the surveys, given the size of the 2D seismic survey Acquisition Area and phases (Area A and Area B presented in Figure 7-17), the two seismic survey vessels will operate for most of the time. The cumulative sound effects of seismic may include distant seismic pulses from the two surveys occurring out of synchrony or in synchrony. Pulses that occur in exact synchrony are unlikely but have the potential to increase received sound levels due to the constructive interference of sound waves produced by the two different sources. Where sound levels from two sources combine through constructive interference, a doubling of sound pressure corresponds with an increase in SPL of 6 dB (Hass 2013). Modelling of the seismic source for the 2D seismic survey (McPherson et al. 2019; Appendix D) demonstrates that the maximum sound levels produced by the 2D seismic survey will be approximately 140 dB re 1µPa SPL at approximately 30 km from the seismic source (half-way between two seismic sources at their minimum separation distance). A combination of seismic sound from two similar seismic sources at this distance would therefore be expected to result in an SPL of no greater than 150 dB re 1µPa, which is below behavioural response thresholds for migratory marine mammals, turtles and other marine species. While overall sound levels are not expected to be significantly elevated, it is acknowledged that the result of multiple seismic vessels operating concurrently will represent a wider spatial area of potential exposure to seismic sound for receptors. Table 7-28 below provides a qualitative assessment of the potential cumulative impacts to different receptors. Overall, the additional potential consequence to receptors from cumulative sound impacts from concurrent surveys, based on the worst-case, is considered to be Minor (E).	

Table 7-28 Evaluation of potential consequence of cumulative impacts arising from two concurrent seismic surveys

Receptor category	Description of potential cumulative impacts
Planktonic communities	No cumulative effects to plankton communities are expected from different surveys given the range to impact is typically tens of metres. Even applying a highly precautionary approach accounting for impacts out to a few kilometres from the seismic source, plankton abundance is expected to return to normal levels due to recruitment from unimpacted areas before any impacted zooplankton populations move down current to another survey area (as was demonstrated by Richardson et al. 2017). There may be a small additional loss of eggs and larvae within the two separate survey areas, but with limited potential to have any discernible population level impacts to fishes and other marine organisms in the region, given their high fecundity, broadcast spawning patterns and high levels of connectivity throughout the region. The consequence of these cumulative effects at a population level is considered to be Insignificant (F).
Benthic communities	Given the potential impact footprint for sub-lethal and lethal impacts to benthic invertebrates is within tens or hundreds of metres from the seismic source, there will be no cumulative impacts to the benthic communities within each survey area or the wider region.
Demersal fishes	Taking into account the relatively limited hearing sensitivity of the key demersal fish species in the NWMR, significant behavioural impacts are not expected at the distances and predicted sound levels between survey areas, even if the seismic sources of both surveys are operating at the closest points. There may be occasional additional disturbances to groups of spawning fishes within each of the two separate survey areas, but with limited potential to have any discernible population level impacts, given their high fecundity, broadcast spawning patterns and levels of stock connectivity within the region. The consequence of these cumulative effects at a population level is considered to be Insignificant (F).

Receptor category	Description of potential cumulative impacts
Pelagic fishes	Taking into account the limited hearing sensitivity of pelagic mackerels, tunas and billfish species in the NWMR, significant behavioural impacts are not expected at the distances and predicted sound levels between survey areas, even if the seismic sources of both surveys are operating at the closest points. There may be occasional additional disturbances to groups of spawning fishes within each of the two separate survey areas, but with limited potential to have any discernible population level impacts, given pelagic fishes are highly mobile and their high fecundity, broadcast spawning patterns and high levels of stock connectivity throughout the region. Small pelagic clupeid fish species (such as herrings and sardine), which have more sensitive hearing, may have the potential to detect small sound pressure changes received from two concurrent surveys, but at a minimum distance of 30 km, detection of sound would be minimal and would most likely be represented as an awareness of the sound, rather than any significant behavioural response. The consequence of these cumulative effects at a population level is considered to be Insignificant (F).
Sharks	Given sharks have very limited hearing abilities no cumulative impacts to sharks are expected. Concurrent surveys may result in occasional disturbances to whale sharks in other parts of the foraging BIA, but each will be highly localised and short-term, with no implications on the survival of exposed individuals. The consequence of these cumulative effects at a population level is considered to be Insignificant (F).
Marine mammals – Humpback whales	Given the 2D seismic survey will avoid the humpback whale season in the Kimberley region (June to October), there is no potential for cumulative impacts to this species.
Marine mammals – Pygmy blue whales	Keraudren 3D MSS does not overlap the pygmy blue whale migration route but Possum 3D MSS may. Regardless, any sound that propagates from the survey areas towards deeper waters is expected to have limited potential to cause behavioural responses in these animals as they migrate through the region. Further, INPEX has committed to not operating the seisimic source within a defined pygmy whale protection zone (Figure 7-11), from 1 April-31 August and 1 October-31 December. Therefore, the consequence of these cumulative effects at a population level is considered to be Insignificant (F).

Receptor category	Description of potential cumulative impacts
Marine mammals – Inshore dolphins	Sound levels received in inshore dolphin BIAs in the Kimberley region from the 2D seismic survey are not expected to cause behavioural impacts. Audible sound levels from the Possum 3D MSS or the Keraudren 3D MSS are not expected to reach these inshore waters, therefore, no cumulative impacts are expected.
Marine mammals – Other cetaceans	Occasional disturbances and behavioural responses may occur in cetaceans exposed mid-way between two survey areas. At distances of 30 km and received sound levels of 150 dB re 1µPa SPL or less, behavioural responses from these transient individuals is not expected to be significant. The consequence of these cumulative effects at a population level is considered to be Insignificant (F).
Marine mammals – Dugongs	Neither the Possum 3D MSS or the Keraudren 3D MSS are expected to result in audible sound levels in the coastal waters of the Kimberley region where dugongs forage. Therefore, no cumulative impacts are expected.
Marine reptiles	The Possum 3D MSS is located far offshore and is not expected to result in audible sound levels in the turtle internesting habitats of the Kimberley region or internesting individuals from the same stocks as the 2D seismic survey. The Keraudren 3D MSS is located offshore from the south-eastern end of Eighty Mile Beach which supports nesting populations of the same flatback turtle stock as the internesting areas adjacent to the 2D seismic survey. However, as both surveys are located outside of defined internesting BIAs, there is limited potential for disturbance to internesting females. Each survey may result in localised and short-term behavioural disturbances to individual turtles belonging to the same stocks during their long distance migrations and foraging activities, but these are not expected to have any implications on the survival of exposed individuals. The consequence of these cumulative effects at a population level is considered to be Insignificant (F).
Marine avifauna	No cumulative effects to marine avifauna are expected.

Receptor category	Description of potential cumulative impacts
Commercial fisheries – Northern Demersal Scalefish Managed Fishery	The Keraudren 3D MSS does not overlap with the Northern Demersal Scalefish Managed Fishery, though it is noted that licence holders in this fishery also have licences in the Pilbara demersal fisheries. The Possum 3D MSS overlaps a small area of the Northern Demersal Scalefish Managed Fishery. It is acknowledged that multiple surveys in a region may result in disruption to fishing activities in multiple locations and an incremental reduction in access to fishing grounds. However, the cumulative area that will be subject to seismic acquisition at any one time, remains relatively small compared to the wider areas available for fishing. Measures proposed in Section 7.2.1 to reduce disruption to fisheries and INPEX's proposal to consider genuine claims from fishers, on a case by case basis, are suitable measures to manage potential impacts. The additional area of disruption is small, but the consequence to fishers has been assessed as Minor (E).
Commercial fisheries – Mackerel Managed Fishery	The Keraudren 3D MSS and Possum 3D MSS overlap with Mackerel Area 2 (Pilbara sector) and will not impact Mackerel Area 1 (Kimberley sector) where the 2D seismic survey is located. Therefore, no cumulative impacts to the Mackerel Managed Fishery are expected.
Commercial fisheries – North West Slope Trawl Fishery	Keraudren 3D MSS does not overlap with waters fished by the North West Slope Trawl Fishery. Possum 3D overlaps a small proportion of waters fished by the North West Slope Trawl Fishery; however, given the temporal controls in place to limit survey activities in this area of WA-533-P and the commitment to maintain at least 40 km separation distance between the 2D Seismic vessel and other operating seismic vessels, no cumulative impacts are expected. The additional area of disruption is small, but the consequence to fishers has been assessed as Minor (E).
Commercial fisheries – Shark fisheries	The Keraudren 3D MSS does not overlap with the licenced areas of the northern shark fisheries. The Possum 3D MSS overlaps a very small portion with the North Coast Shark Fishery (southern zone) in a minor portion of the Operational Area. However, given the temporal controls in place to limit survey activities in this area of WA-533-P and the commitment to maintain at least 40 km separation distance between the 2D Seismic vessel and other operating seismic vessels, no cumulative impacts are expected. The additional area of disruption is small, but the consequence to fishers has been assessed as Minor (E).

Receptor category	Description of potential cumulative impacts
Recreational and traditional fisheries	No overlap or cumulative effects to recreational fishing or traditional fishing activities nearshore are expected from the surveys.
Pearling	No cumulative effects to pearling and aquaculture activities or resources in the Kimberley region are expected.
Other marine users	Vessel traffic between Port Hedland and other parts of northern Australia and Asia my transit through both the 3D Possum MSS and the 2D seismic survey Operational Area. Vessel may need to make small alterations to their course to avoid the survey vessels and towed seismic arrays, but these deviations are relatively small. The consequence of potential cumulative impacts to shipping have been assessed as Insignificant.
North-west Marine Parks Network values	The North-west network of AMPs protects natural, cultural, heritage and socio-economic values of the NWMR. Given the limited potential for cumulative impacts to the natural, cultural, heritage and socio-economic values, the various values of the North-west Marine Parks Network will be protected. No significant and/or long-term cumulative effects to values of the North-west Marine Parks Network are expected.

Identify existing design and safeguards/controls measures			
The seismic source levels will be limited to the minimum required to achieve the objectives of the survey. The seismic source specification will be verified prior to commencement of the 2D seismic survey (Section 7.1.3). INPEX has successfully applied to NOPTA to vary the work commitment for WA-532-P and reduce the number of line kilometres by 2,000 km. Part of the line kilometre commitment has been substituted by the licensing and processing of existing 3D seismic data. As a result of the reduced work commitment, the number of planned acquisition lines and the associated spatial and temporal footprint of the survey is reduced.			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification

Elimination	None identified	N/A	No additional elimination controls were identified that would practicably reduce the potential for cumulative impacts.
Substitution	None identified	N/A	No additional substitution controls were identified that would practicably reduce the potential for cumulative impacts.
Engineering	None identified	N/A	No additional engineering solutions were identified that would practicably reduce the potential for cumulative impacts.
Procedures & administration	During operation of the seismic source, a minimum separation distance of 40 km shall be maintained between the 2D seismic survey seismic vessel and other operating seismic survey vessels.	Yes	This measure will reduce the risk of cumulative impacts occurring and also preserves seismic data quality.

Identify the likelihood

The likelihood of cumulative impacts with Insignificant (F) to Minor (E) consequences occurring is considered Possible (3).

Residual risk summary

Based on a consequence of Minor (E) and a likelihood of Possible (3) the residual risk is Moderate (7).

Consequence	Likelihood	Residual risk
Minor (E)	Possible (3)	Moderate (7)

Assess residual risk acceptability

Legislative requirements

Even accounting for potential cumulative impacts, the 2D seismic survey will be undertaken in a manner that is consistent with the objectives of the North-west Marine Parks Network Management Plan 2018 and protects the values of the Kimberley AMP and wider North-west Network.

Stakeholder consultation

During stakeholder consultation, WAFIC identified the issue of multiple seismic surveys and potential cumulative impacts on fisheries activities and resources. This assessment has considered the potential for such cumulative impacts.

INPEX acknowledges that there is the potential for disruption to fishing activities in multiple locations and an incremental reduction in access to fishing grounds. Measures proposed in Section 7.2.1 are considered to be suitable measures to manage the potential impacts.

In addition to the proposed control measures, INPEX is consulting with stakeholders to develop a claim process.

Australian marine park values, objectives and zone rules

No other planned seismic survey is planned to occur in the Kimberley AMP. Given the limited potential for cumulative impacts to the natural, cultural, heritage and socio-economic values, the various values of the North-west Marine Parks Network will be protected. No significant and/or long-term cumulative effects to values of the North-west Marine Parks Network are expected.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. However, none of these plans provide any specific guidance or requirements in relation to cumulative impacts from seismic surveys.

ALARP summary

Given the level of environmental risk is assessed as Moderate, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;

- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as “Moderate”, the consequence does not exceed “C – Significant” and the risk has been reduced to ALARP.

Environmental performance outcomes	**Environmental performance standards**	**Measurement criteria**	**Responsibility**
Prevent cumulative impacts from concurrent seismic surveys	During operation of the seismic source, a minimum separation distance of 40 km shall be maintained between the 2D seismic survey seismic vessel and other operating seismic survey vessels.	Survey records show no operation of the seismic source has occurred within 40 km of other operating seismic vessels.	Contractor Survey Manager

7.4 Biodiversity and conservation protection

7.4.1 Introduction of invasive marine species

Table 7-29: Impact and evaluation – Introduction of invasive marine species

Identify hazards and threats	
Invasive marine species (IMS) are non-indigenous marine plants or animals that have been introduced into a region beyond their natural range and have the ability to survive, reproduce and establish founder populations. IMS are widely recognised as one of the most significant threats to marine ecosystems worldwide. Shallow coastal marine environments in particular, are thought to be amongst the ecosystems most susceptible to the establishment of IMS, which largely reflects the accidental transport of IMS by international shipping to marinas and ports where vessels remain for prolonged periods of time and the preferred artificial structures are commonly found. Support vessels used during the 2D seismic survey will not be mobilised from overseas; however, the seismic survey vessel may arrive in Australian waters from international waters prior to mobilising to the Operational Area. This has the potential to act as a pathway for IMS to be translocated from overseas into offshore Commonwealth waters, if unmanaged, via the discharge of high-risk ballast water containing IMS (DAWR 2017) and/or via the presence of IMS within biofouling communities on the vessel hull and/or towed seismic equipment. Vessels on domestic journeys (e.g. transiting between the Operational Area and WA mainland) may, if unmanaged, act as a pathway through the uptake and subsequent discharge of high-risk ballast water containing IMS and/or IMS recruitment on submerged vessel hulls while in the vicinity of confirmed IMS sources. Such sources could include other offshore infrastructure i.e. other vessels or platforms that may have support vessel sharing arrangements; and artificial substrates such as jetties and wharves already colonised by mature IMS, such as in Broome Port. The introduction and establishment of IMS into the marine environment may result in impacts to benthic communities and associated receptors dependent on these including fishing.	
Potential consequence	**Severity**
The introduction and subsequent establishment of IMS could result in changes to the structure of benthic communities leading to a change in ecological function due to predation of native marine organisms and/or competition for resources. Once IMS establish, they can spread and become abundant in coastal waters. Some species can have major ecological, economic, human health and social/cultural consequences (Carlton 1996, 2001; Pimental et al. 2000; Hewitt et al. 2011).	Moderate (D)

Benthic communities and shallow water coastal environments in the Kimberley AMP, WA marine parks and reserves (including reefs and benthic communities near Browse Island, Adele Island and Beagle Reef), fisheries (commercial, traditional and recreational), pearling and aquaculture all have the potential to be impacted by IMS. Shallow water, coastal marine environments are susceptible to the establishment of invasive populations, with most IMS associated with artificial substrates in disturbed shallow water environments such as ports and harbours (e.g. Glasby et al. 2007; Dafforn et al. 2009a, 2009b). In order for an IMS to pose a biosecurity risk once present at a recipient location, viable IMS propagules and/or individuals must be able to transfer from the colonised area (e.g. a vessel hull), survive in the surrounding environment, find a suitable habitat, and establish a self-sustaining population. Vessel operations are a mechanism for such transfer of IMS propagules either through the uptake and discharge of high-risk ballast water containing IMS and/or via the presence of IMS within biofouling communities on hulls or submerged equipment. IMS propagules may also be transferred via natural dispersion. Natural dispersal mechanisms could involve a mobile life-history stage (such as actively swimming adults or larval stages) with sufficient swimming capacity and/or larval durations to directly reach suitable habitats in coastal waters. Natural dispersal from offshore locations for IMS with shorter pelagic dispersal capabilities to coastal areas is also theoretically possible via intermediate steps (stepping stone dispersal), where intermediate populations establish in suitable habitats closer inshore, and subsequent generations then spread towards coastal regions. With consideration of the habitat preferences of IMS (shallow water environments), the Operational Area overlaps with the Kimberley AMP where shallow water habitats (i.e. less than 50 m water depth) occur within the Multiple Use Zone at Lynher Bank and shallow areas of the Leveque Rise. These areas include low coverage of areas of hard substrate and filter-feeder communities that may be suitable for the settlement of IMS. Habitat Protection Zones and a National Park Zone are also located in the southern part of the Operational Area, where vessels are permitted to transit. Shallow habitat areas (approximately 15-20 m water depth) near Adele Island and Beagle Reef occur in these zones. Other shallow water habitat in close proximity to the Operational Area includes the fringing reefs at Browse Island (approximately 5 km from the Operational Area) and Scott Reef (approximately 12 km from the Operational Area). During the 2D seismic survey, the vessel will be continually moving and will not remain in one place for a prolonged period of time. The movement of vessels reduces the potential for IMS to settle in a location. The survey vessel and support vessels are also not expected to exchange ballast water during the survey, except in an emergency. However, the potential for IMS to become established in sensitive shallow benthic habitats in	

the Operational Area local to medium scale impacts to benthic communities within the Kimberley AMP, with a consequence rating of Moderate (D). The introduction and establishment of IMS into fishing grounds/areas of aquaculture may result in changes to benthic habitats with the potential to alter faunal assemblages, resulting in decreased ecological diversity or ecosystem health. The introduction of a potential disease may also result in the mortality of benthic organisms. In turn this may result in an economic loss of revenue. Other fishing activities that may be impacted include traditional fishing known to occur on the Kimberley coastline at the Uunguu, Dambimangari, Bardi Jawi, Yawuru, Karajarri and Mayala IPAs, and recreational fishing that is known to occur in nearshore waters in this region. This may result in regional community disruption with a moderate impact on economic or recreational values with a consequence rating of Moderate (D).			
Identify existing design and safeguards/controls measures			
Vessels have an antifouling coating applied that is in accordance with the prescriptions of the International Convention on the Control of Harmful Anti-fouling systems on ships, 2001, and the *Protection of the Sea (Harmful Antifouling Systems) Act 2006* (Cwlth) (as appropriate to vessel class).			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	Eliminate vessel use to avoid the spread of IMS	No	The 2D seismic survey cannot be achieved without using vessels. No practicable elimination controls were identified.
Substitution	None identified	N/A	No substitution controls were identified that would practicably reduce the risk of IMS.
Engineering	Vessels will be required to have an approved ballast water management system installed.	No	All vessels will comply with the Australian Ballast Water Requirements, Version 7 (DAWR 2017) – see procedural control below for all vessels. It is possible to comply with the requirements of the Australian Ballast Water Requirements (Version 7) and to meet the environmental outcome by alternative means, therefore, an approved ballast water management system may not be available on board all vessels. Compliance with

			the Australian Ballast Water Requirements (Version 7) will be maintained using one of the approved methods.
Procedures & administration	Complete a biofouling risk assessment (including immersible equipment) for vessels mobilised from international waters, and implement mitigation measures commensurate to the risk, as appropriate to ensure the mobilisation of the vessel poses a low risk of introducing IMS.	Yes	The completion of a biofouling risk assessment and the implementation of associated biofouling reduction and management measures reduce the likelihood of IMS translocation and subsequent potential for transfer and establishment. This approach is in accordance with the National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry (MPSC 2018).
	Complete a biofouling risk assessment for vessels (including immersible equipment) mobilised domestically from other regions in Australia, and implement mitigation measures commensurate to the risk, as appropriate to ensure the mobilisation of a vessel poses a low risk of introducing IMS.	Yes	If a domestically sourced vessel is used, a biofouling risk assessment will be completed by INPEX with the process to be followed presented in Figure 7-24*. The assessment will include aspects of the vessels history with respect to IMS risk e.g. vessels origin from within Australian waters and previous locations of operation (including whether these Australian locations have reported IMS occurrences), periods out-of-water and inspections/cleaning undertaken, age of anti-fouling coatings, presence and condition of internal treatment systems, etc. While undertaking the INPEX biofouling risk assessment for domestic movements, in any instances where potential risks are identified e.g. no anti-fouling coating or extended stays in Port, the process requires INPEX to engage an independent IMS expert and if required a further risk assessment (as described above for international vessels) may be undertaken. This control and implementation of any associated management measures will reduce the likelihood of IMS translocation and subsequent potential for transfer and establishment.

			* This process was developed in conjunction with WA DPIRD.
	Vessels operating within Australian seas will manage ballast water discharge using one of the following approved methods of management including (DAWR 2017): • an approved ballast water management system • ballast water exchange conducted in an acceptable area * • use of low risk ballast water (e.g. fresh potable water, water taken up on the high seas, water taken up and discharged within the same place) • retention of high-risk ballast water on board the vessel • discharge to an approved ballast water reception facility *Acceptable area is as defined in the Biosecurity (Ballast Water and Sediment) Determination 2017.	Yes	The discharge of high-risk ballast water has the potential to translocate IMS from a donor region to a recipient region. Vessels operating within Australian seas will comply with the Australian Ballast Water Requirements, Version 7 (DAWR 2017). Specifically, discharge of high-risk* ballast water into Australian seas is prohibited, unless it has been managed for discharge using one of the approved management methods as specified by DAWR (2017). Note ballast water exchange is being phased out, in favour of methods that are required to meet the Regulation D-2 standard. * DAWR (2017) defines high-risk ballast water as any ballast water that has not been managed in accordance with an approved method, and has been taken up: • within 12 nautical miles of any land mass or in water less than 50 metres deep • within 500 metres of an offshore installation, or • in an Australian port and then intended to be discharged in the Australian territorial seas.

	Vessels will have an approved ballast water management plan and valid ballast water management certificate, unless an exemption applies or is obtained.	Yes	Vessels operating in Australian seas that are designed or constructed to carry ballast water are required to carry and implement an approved vessel specific ballast water management plan. The format of the plan must be in accordance with Ballast Water Management Convention and Resolution MEPC.127 (53). The ballast water management plan outlines the duties of personnel on board for carrying out ballast operation and operational procedures for the vessel. A ballast water management certificate certifies that the vessel has an approved ballast water management plan.
	Vessels will have a biofouling management plan and maintain a biofouling record book.	Yes	A biofouling management plan provides operational guidance for the planning and actions required to manage vessel biofouling, in addition to outlining measures for the control and management of vessel biofouling in accordance with the IMO Guidelines for the Control and Management of Ship' Biofouling to Minimize the Transfer of Invasive Aquatic Species (2012 Edition). The biofouling management plan will be written by an independent IMS expert.
Identify the likelihood			
Given the proposed controls and procedures to manage ballast water exchange and biofouling risks, there is a low potential for biofouling to occur and act as a potential inoculum for the spread of IMS to the Operational Area. During the 2D seismic survey, vessels will use Broome Port as the main supply base. The presence of jetties and wharves in the port, providing substrate for IMS, mean that the port could act as a source of IMS inoculum which could then be further spread to pristine shallow water habitats in the Operational Area by the vessels. However, resupply is typically undertaken within a relatively short timeframe (approximately 48 hours) therefore the potential for vessels to become colonised by biofouling communities is reduced. Guidance from WA DPIRD (Vessel Check Biofouling Risk Assessment Tool) acknowledges that the attachment of			

biofouling may occur in as short a time frame as 24 hours, however as a 'rule of thumb', 7 days is considered to provide a pragmatic balance between logistical factors versus the risk of a vessel being contaminated with an IMS. With the described controls in place, the potential introduction and establishment of IMS in shallow areas of the Operational Area via the survey vessel and support vessels during the activity is considered to be Highly Unlikely (5).		
Residual risk summary		
Based on a consequence of Moderate (D) and a worst-case likelihood of Highly Unlikely (5) the residual risk is Moderate (8).		
Consequence	Likelihood	Residual risk
Moderate (D)	Highly Unlikely (5)	Moderate (8)
Assess residual risk acceptability		
Legislative requirements Vessel ballast water will be managed in accordance with the intent of the *Australian Ballast Water Requirements Version 7* (DAWR 2017) and the *Biosecurity Act 2015.* Biofouling will be managed through vessel and equipment risk assessments and mitigation measures, in accordance with the *National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry* (MPSC 2018). **Stakeholder consultation** Feedback was received by INPEX from WA DPIRD (Table 5-4) with regards to minimising the risk of translocating marine pests into or within WA waters. These recommendations have been reflected in this EP through a series of controls and reporting requirements (Section 9.11.3). **Australian marine park values, objectives and zone rules** Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018: • The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. Vessel transit and the discharge of ballast water (compliant with Australian ballast water requirements) are permitted in all zones. • By preventing the introduction of IMS, no significant or long-term impacts are expected to occur to benthic communities included as values of the Kimberley AMP. • By preventing the introduction of IMS, the proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.		

- By preventing the introduction of IMS, the proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats. No operation of the seismic source will occur in the Habitat Protection Zone, and the ecosystems, habitats and native species within the Habitat Protection Zone will also be conserved in a natural state.
- By preventing the introduction of IMS, the proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. IMS have been identified as a threat in many conservation management plans, with actions focusing on the prevention of their introduction. The control measures described are consistent with the actions described in the conservation management documentation.

ALARP summary

The level of environmental risk is assessed as Moderate, therefore a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and

• the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Moderate", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.			
Environmental performance outcomes	**Environmental performance standards**	**Measurement criteria**	**Responsibility**
Prevent introduction and establishment of IMS as a result of the petroleum activity (including through ballast water and biofouling from vessels).	A biofouling risk assessment will be completed by an independent IMS expert for vessels, including immersible equipment, prior to mobilisation from international waters. Where required, mitigation measures commensurate to the risk will be implemented to ensure the vessel mobilisation poses a low risk of introducing IMS.	Vessel-specific biofouling risk assessment and any records of mitigation measures implemented confirming the vessel presents a low risk.	Contractor Vessel manager
	A biofouling risk assessment will be completed for all vessels, including immersible equipment, prior to mobilisation from any Australian port. Where required, mitigation measures commensurate to the risk will be implemented to ensure the vessel mobilisation poses a low risk of introducing IMS.	Vessel-specific biofouling risk assessment and any records of mitigation measures implemented confirming the vessel presents a low risk.	Contractor Vessel manager
	Vessels operating within Australian seas will manage ballast water discharge using one of the following approved methods of management including (DAWR 2017): • an approved ballast water management system; or • ballast water exchange conducted in an acceptable area; or	Vessel ballast water management plan and ballast records confirm that an approved ballast water management option is available and has been used.	Vessel master

	• use of low risk ballast water (e.g. fresh potable water, water taken up on the high seas, water taken up and discharged within the same place); or • retention of high-risk ballast water on board the vessel; or • discharge to an approved ballast water reception facility; or • use of low risk ballast water (e.g. fresh potable water, water taken up on the high seas, water taken up and discharged within the same place).	Documentation of DAWR release from biosecurity control or low risk status.	
	All vessels will have: • an approved ballast water management plan, unless an exemption applies or is obtained • a valid ballast water management certificate, unless an exemption applies or is obtained.	Ballast water management plan or record of exemption (if not automatic exemption) Valid ballast water management certificate or record of exemption (if not an automatic exemption).	Vessel master
	Vessels will have a biofouling management plan prepared by an independent IMS expert to include elements of performance described in the IMO Guidelines for the Control and Management of Ship Biofouling to Minimize the Transfer of Invasive Aquatic Species (2012 Edition).	Biofouling Management Plan and record book	Contractor Vessel manager

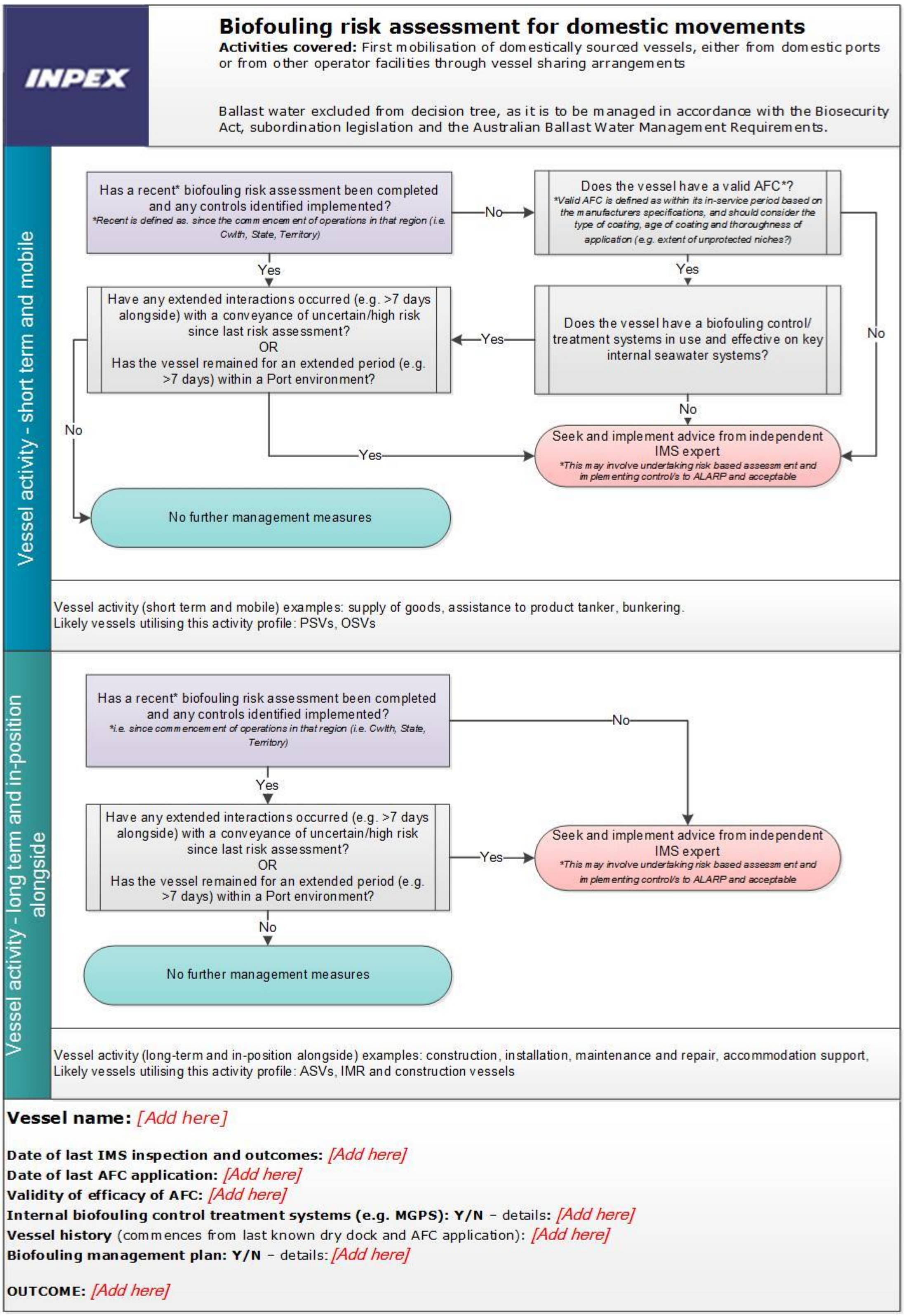


Figure 7-24 INPEX biofouling risk assessment for domestic movements

7.4.2 Interaction with marine fauna

Table 7-30: Impact and risk evaluation – Physical presence of vessels and interaction with marine fauna

Identify hazards and threats	
The physical presence and use of vessels and the towed streamer have the potential to result in collision (vessel strike) with marine fauna and/or collision or entrapment of marine turtles on the dilt float or tail buoy of the towed streamer.	
Potential consequence	**Severity**
The seismic survey and support vessels have the potential to interact with transient, EPBC-listed species; specifically, marine mammals, whale sharks and turtles. A collision (vessel strike) with marina fauna may result in the injury or death of marine fauna. The potential for vessel strike applies to all marine mammals, whale sharks and turtle species; however, humpback whales are considered to have a higher potential likelihood due to their extended surface time, particularly during resting. Vessel speed has been demonstrated as a key factor in collisions with marine fauna such as marine mammals and turtles, and it is reported that there is a higher likelihood of injury or mortality from vessel strikes on marine mammals when vessel speeds are greater than 14 knots (Laist et al. 2001; Vanderlaan & Taggart 2007). During the 2D seismic survey, the seismic vessel will be moving at low speed (4.5 knots), and the approaching seismic source and/or vessel noise will provide some level of warning to marine fauna at the surface. The reaction of whales to approaching ships is reported to be quite variable. Dolman and Williams Grey (2006) and Southall et al. (2007) indicate that cetacean species, such as humpback whales, can detect and change course to avoid a vessel. Humpback whales are subject to a DEE Conservation Advice which requires the assessment of vessel strike on humpback whales and encourages the implementation of mitigation measures and vessel strike incident reporting to the National Ship Strike Database. As such, control measures are included below, to align with the DEE Conservation Advice and address vessel strike on humpback whales. As confirmed in Section 7.1.7, the 2D seismic survey will not be acquired during the period from 1st June to 31st October, therefore, there is limited potential for encounters with humpback whales. The pygmy blue whale migration BIA also overlaps the Operational Area. The species is also subject to a DEE Conservation Management Plan. The Conservation Management Plan identifies that, since 2006, there have been two records of likely ship strikes of blue whales in Australia. In 2009 and 2010, there were blue whale strandings in Victoria, near the Bonney Upwelling with suspected ship strike injuries visible. Where blue whales	Minor (E)

are feeding at or near the surface, they are more susceptible to vessel strike. However, known blue whale foraging areas near Scott Reef are located outside of the Operational Area. The Blue Whale Conservation Management Plan highlights that minimising vessel collision is one of the top four priorities and requires assessment of vessel strike on blue whales, assures that incidents are reported in the National Ship Strike Database, and that control measures proposed will align with these priorities. Whale sharks are known to swim near to the water surface while foraging; hence, are susceptible to potential for vessel strike. The whale shark foraging BIA overlaps with the Operational Area. Whale sharks typically forage in the region between September and November. Whale sharks are also subject to a DEE Conservation Advice which notes that the threat to the recovery of the species includes strikes from vessels. As the 2D seismic survey will not be acquired during the period from 1st June to 31st October, therefore, avoiding a significant proportion of the time when whale sharks are most abundant in the Operational Area. Turtles transiting the region are also potentially at risk from vessel strike when they periodically return to the surface to breathe and rest. Only a small portion (3–6%) of their time is spent at the surface, with routine dive times lasting anywhere between 15 and 20 minutes nearly every hour. Some turtles have been shown to be visually attracted to vessels, while others show strong avoidance behaviour (Milton et al. 2003). Internesting BIAs and habitat critical to the survival of a marine turtle species have been identified in waters surrounding the following locations, which overlap the Operational Area. • Eighty Mile Beach and Eco Beach • Lacepede Islands • Adele Island • The coast and islands of the north Kimberley • Browse Island. A foraging BIA is also located in waters adjacent to the Operational Area near Broome and James Price Point. As described in Section 4.8.4, marine turtles may also forage in other areas, including flatback turtle foraging near Lynher Bank and Adele Island. There may be an increased potential for vessel strike with marine turtles in these areas. However, the slow speed of the vessels during the 2D seismic survey are unlikely to cause the death of a turtle. Turtles are also potentially at risk of being struck or entrapped in the floats and buoys attached to the towed seismic streamer. Ketos Ecology (2009) provides anecdotal reports from seismic surveys undertaken in various parts of the world where turtles have become trapped on either the dilt float on the leading end of streamers or on the tail buoys several kilometres behind the vessel. The mechanism for such incidents is believed to involve turtles basking on the sea surface or foraging near the streamer. Dilt floats may strike a turtle, but	

their hydrodynamic shape makes them unlikely to trap a turtle. Tail buoys, however, have a subsurface frame structure which is used to stabilise the surface buoy. Ketos Ecology (2009) suggest that turtles may become trapped in the subsurface structure if they startle dive in front of the approaching buoy. Once a turtle is trapped on the structure, the moving water can hold it in place and it may not be able to escape. Although a trapped turtle usually results in drag and noticeable impact on performance that survey crews sometimes detect, the entrapment can be fatal. The 2D seismic survey will tow a single streamer with the dilt float towed a short distance behind the survey vessel and a single tail buoy, unlike 3D seismic survey vessels which use a spread of multiple streamers, dilt floats and tail buoys. Therefore, during the 2D seismic survey, it is highly unlikely that fauna will be in a position behind the moving survey vessel to be struck by the dilt float and the potential for entrapment is also reduced with the use of just a single tail buoy. As confirmed in Section 7.1.8, the 2D seismic survey will not be acquired in turtle internesting BIAs or Habitat Critical during the nesting seasons. Therefore, the potential for the survey vessels to traverse areas where turtles aggregate in high numbers is reduced considerably. Given the slow speeds (4.5 knots) at which the survey vessel will acquire the 2D seismic survey, there is limited potential for a vessel strike or entrapment to result in mortality to large marine fauna, although injury may occur. While there is potential for individual marine fauna to be impacted by vessels associated with the activity, any potential vessel strike or entrapment of marine fauna is likely to be an isolated event. In the event of the death of an individual whale or turtle, it would not be expected to have a significant effect at the population level. The consequence of potential injury or mortality to individual cetaceans or turtles is assessed as Minor (E). With reference to the Recovery Plan for Marine Turtles in Australia (DEE 2017a), in considering cumulative impacts of threats on small or vulnerable stocks of marine turtles, it is likely that vessel strike, along with other threats throughout turtles' life cycle, may act as contributor to a stock level decline.	

Identify existing design and safeguards/controls measures			
None identified.			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification

Elimination	Eliminate the use of vessels	No	Vessels are the only form of transport that can undertake and support the 2D seismic survey. Therefore, no practicable elimination controls are available.
Substitution	None identified	N/A	No substitute controls were identified that would practicably reduce the risk of vessel strike or entrapment.
Engineering	Turtle guards will be fitted on tail buoys or tail buoy design will be designed to prevent turtles becoming trapped.	Yes	A tail buoy will be fitted to the end of each streamer which controls the depth at which the streamers are towed. If the tail buoys have not been designed to avoid entrapment, they will be fitted with guards to prevent accidental entrapment of turtles.
Procedures & administration	Support vessels will comply with relevant requirements of EPBC Regulations 2000 - Part 8 Division 8.1, including: • not exceeding a speed of 6 knots within the caution zone of a whale (300 m) • taking action to avoid approaching or drifting closer than 100 m of a whale.	Yes	The requirements of the EPBC regulations set out clear measures to reduce speed and avoid approaching cetaceans, which reduces the risk of vessel strike. The seismic vessel operates at 4.5 knots but is limited in its ability to manoeuvre. The application of this control only applies to the more mobile and potentially faster mover support vessels.
	Additional management considerations for support vessels outlined in the Australian National Guidelines for Whale and Dolphin Watching (2017), including: • A 300 m no approach distance behind and in front of a whale, in addition to the standard requirement to not approaching within	No	The Australian National Guidelines for Whale and Dolphin Watching were developed to be consistent with the requirements of EPBC Regulations 2000 - Part 8 Division 8.1, but provide additional distance criteria for approaching or following adult cetaceans or calves from in front or behind that are not specified in the Regulations. Additional measures are also detailed for the whale and dolphin watching industry when operating in cetacean BIAs that are not applicable to other vessels. Other vessels are not required to adopt the same measures. The guidelines were developed for use by commercial whale and dolphin watching industry. It should be noted that whale and

	100 m from the side of a whale; • A 150 m no approach distance behind and in front of a dolphin, in addition to not approaching within 50 m from the side of a dolphin; • A 300 m no approach zone for any direction surrounding whale calves; and • A 150 m no approach zone for any direction surrounding dolphin calves.		dolphin watching activities involve purposely approaching and following cetaceans, which can result in disturbance or harassment of the animals if not managed properly. Survey vessels will not be interacting with cetaceans in this way. The seismic vessel operates at 4.5 knots and is limited in its ability to manoeuvre so it is impracticable for it to attempt to implement the additional measures. Support vessels may potentially be faster moving and so the above controls, consistent with the requirements of EPBC Regulations 2000 - Part 8 Division 8.1 will be implemented. However, support vessel masters and crew will be focussed on their tasks and not searching for signs of cetaceans at the surface. Therefore, it is not possible to commit to maintaining watch over greater distances or determining animal directions of travel. In addition, the survey will already avoid operations in the humpback whale BIAs during the migration, resting and calving period, and in the pygmy blue whale migration BIA during the migration period. No other cetacean BIAs overlap the Operational Area. Therefore, it is not a sensitive area of habitat use for other species. Application of the additional controls is therefore not practicable. The control measures adopted consistent with EPBC Regulations 2000 - Part 8 Division 8.1 will already provide a level of protection that reduces the risk to cetaceans to ALARP.
	Support vessel speed restrictions or separation distances maintained for whale sharks	Yes	As whale sharks swim near the sea surface, vessel strike cannot be ruled out due to the overlap with known habitat. However, the speed of the seismic vessel (~4.5 knots) inherently reduces the likelihood of collision. In the absence of any current guidance for petroleum/commercial vessels, controls for vessels tour operators in Ningaloo (i.e. Whale Shark Wildlife Management Program No. 57) have been considered. Therefore, to be

			conservative, INPEX will adopt separation distances and vessel speed restrictions for support vessels for whale sharks.
	Implementation of environmental awareness program for vessels	Yes	Before work commences, crew will be informed of the need to avoid harm to marine fauna.

Identify the likelihood

Records from 2011 (most recently available data) showed that between six and nine vessel strikes with cetaceans, including non-fatal cases, had been reported in Australian waters in the previous three years, with only a minority occurring in WA (IWC 2011). Given the slow speeds at which the survey vessel will acquire the 2D seismic survey, a vessel strike resulting in mortality to marine fauna is unlikely. Turtle entrapment has been reported to occur during other seismic surveys but is unlikely to occur with the proposed turtle guard and tail buoy design control.

The controls described above are commensurate with the level of risk. The likelihood of a vessel strike causing injury or death to a transient, EPBC-listed species is considered to be Highly Unlikely (5).

Residual risk summary

Based on a consequence of Minor (E) and a likelihood of Highly Unlikely (5) the residual risk is Low (9).

Consequence	Likelihood	Residual risk
Minor (E)	Highly Unlikely (5)	Low (9)

Assess residual risk acceptability

Legislative requirements

EPBC Regulations 2000 – Part 8, Division 8.1 (Regulation 8.05) will be implemented with regards to vessel speeds and separation distances.

Stakeholder consultation

No stakeholder concerns have been raised regarding potential impacts and risks from the physical presence of the survey or support vessels and potential for vessel strike or turtle entrapment.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. Vessel transit is permitted in all zones.
- No significant or long-term impacts to AMP values are expected to occur.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. Actions identified in the Blue Whale Conservation Management Plan and DEE conservation advice documents for humpback whales regarding vessel strike incident reporting will be implemented.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;

<table>
<tr><td colspan="4">

- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

</td></tr>
<tr><th>Environmental performance outcomes</th><th>Environmental performance standards</th><th>Measurement criteria</th><th>Responsibility</th></tr>
<tr><td rowspan="3">Zero incidents of injury/mortality of cetaceans, whale sharks or turtles from vessel collision for the duration of the 2D seismic survey activity.</td><td>EPBC Regulations 2000 – Part 8 Division 1 Interacting with cetaceans, including:
• support vessels in the Operational Area will not travel greater than 6 knots within 300 m of a whale (caution zone)
• support vessels will not approach closer than 100 m of a whale.</td><td>Records of breaches of vessel/cetacean interaction requirements outlined in the EBPC Regulations 2000 reported.</td><td>INPEX Offshore representative</td></tr>
<tr><td>Turtle guards/deflectors will be fitted on tail buoys or tail buoys will be of another design that prevents turtles becoming trapped.</td><td>Pre-mobilisation inspection confirms that the turtle guards/deflectors are fitted on tail buoys or tail buoys are of another design that prevents turtles becoming trapped.</td><td>INPEX Environmental Adviser</td></tr>
<tr><td>Support vessels will not travel faster than 8 knots within 250 m of a whale shark and not approach closer than 30 m from ahead of a whale shark's direction of travel.</td><td>Records of any breaches</td><td>INPEX Offshore Representative</td></tr>
</table>

	Awareness materials for vessel personnel for avoiding harm to cetaceans and whale sharks.	Record of provision of awareness materials to site personnel.	INPEX Environmental Adviser

7.5 Emissions and discharges

7.5.1 Light emissions

Table 7-31: Impact and risk evaluation – Change in ambient light levels from navigational lighting on the vessels

<table>
<tr><th colspan="2">Identify hazards and threats</th></tr>
<tr><td colspan="2">Light emissions associated with vessel lighting (for navigational and safe working condition requirements) have the potential to disturb light-sensitive marine fauna, specifically turtle and bird species, through localised attraction to light that may result in behavioural changes.</td></tr>
<tr><th>Potential consequence</th><th>Severity</th></tr>
<tr><td>Behavioural changes reported in marine turtles exposed to increases in artificial lighting can include disorientation and interference during nesting (Pendoley 2005). Where artificial light sources have the potential to interfere with natural light cues and the horizon, disorientation of adult marine turtles or hatchlings has been known to result in risks to the survival of some individuals through excess energy expenditure or increased likelihood of predation (Witherington & Martin 2000; Limpus et al. 2003).

Internesting BIAs and habitat critical to the survival of a marine turtle species have been identified for key nesting beaches and waters surrounding the following locations, which overlap the Operational Area.
• Eighty Mile Beach and Eco Beach
• Lacepede Islands
• Adele Island
• The coast and islands of the north Kimberley
• Browse Island.
Once turtle hatchlings have reached the ocean, they normally maintain seaward headings by using wave propagation direction as an orientation cue. This is because waves and swells generally reliably move towards shore in shallow coastal areas, therefore swimming into waves usually results in movement towards the open sea (Lohmann & Fittinghoff-Lohmann 1992). While hatchlings and adult turtles can be attracted towards offshore sources of light, such as that generated by vessels, given the transient nature of the seismic survey vessel, the vessels will not remain stationary within the Operational Area for extended periods. As the vessels will be located offshore from nesting beaches, there is no potential for vessel lighting to interfere with natural light cues and the horizon for adult turtles or hatchlings.</td><td>Insignificant (F)</td></tr>
</table>

As confirmed in Section 7.1.8, the 2D seismic survey will not be acquired in turtle internesting BIAs or Habitat Critical during the nesting seasons. As a result, vessels will remain more than 20 km (and in some cases more than 90 km) from nesting beaches during these times. Therefore, the potential for the survey vessels to traverse areas near turtle nesting beaches is greatly reduced. Any behavioural responses due to the activity are considered to be of inconsequential ecological significance to a protected marine turtle species (Insignificant F). As described in Section 4.8.6, the Operational Area is located within the East Asian–Australasian Flyway, an internationally recognised migratory bird pathway that covers the whole of Australia and its surrounding waters. The migration of marine avifauna through the EAA Flyway generally occurs at two times of year, northward between March and May and southward between August and November (Bamford et al. 2008; DEE 2017b). BIAs for marine avifauna foraging and resting extend from Adele island and the Lacepede Islands and overlap with the Operational Area. Lighting from vessels has been found to attract seabirds, particularly those that are nocturnally active (BirdLife International 2012). Nocturnal birds are at much higher risk of impact (Weise et al. 2001); however, there are no threatened nocturnal migratory seabirds that use the EEA Flyway (DEWHA 2010). A study by Poot et al. (2008) of offshore oil platforms in the North Sea, found that large flocks of migrating seabirds can be attracted to the lights of offshore oil platforms, particularly on cloudy nights and between the hours of midnight and dawn. Poot et al. (2008) hypothesised that when such offshore platforms are located on long-distance bird migration routes, the impact of this attraction could be considered highly significant, as many birds cross the ocean with only small additional fat reserves than required for the transit (e.g. twelve hours of fat reserves for a ten-hour flight). Any delay (e.g. resting on a platform or circling around them) may decrease the bird's resilience and potential survival. Studies conducted in the North Sea indicate that migratory birds may be attracted to offshore lights when travelling within a radius of 3 to 5 km from the light source. Outside this area their migratory paths are likely to be unaffected (Marquenie et al. 2008). There is no published literature of these impacts occurring on the NWS of WA. Migratory shorebirds travelling the EAA Flyway may fly over the permit area, before moving on to the mainland (south) in the spring or Indonesia/Australian External Territories (north) in the autumn. It is possible that migratory birds may use ships and other offshore facilities in order to rest. However, the possibility of this occurring on the vessels associated with the 2D seismic survey is low due to the minor radius of potential disorientation/attraction compared to the wide extent of known migratory routes and presence of existing habitat for resting and foraging at Browse Island, Scott Reef and Ashmore Reef/Cartier Island resulting in minimal deviation from migratory pathways and limited potential for behavioural disruption. Therefore, any	

impact to seabirds or migratory birds from lighting of the vessels is considered to be of inconsequential ecological significance (Insignificant F).			
Identify existing design and safeguards/controls measures			
Vessel are not stationary during routine seismic survey activities			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	Do not use lighting at night time.	No	Lighting is required by law for navigational and safety purposes.
Substitution	Exclude offshore lighting during key periods for bird migration.	No	In general, bird migrations occur over several months of the year: between March and May (northward) and between August and November (southward) (Bamford et al. 2008). Lighting of vessels is required year-round to ensure the safety of workers and the environment and cannot be eliminated for certain periods during the year. The timing of the survey is dictated by other environmental receptors and their potential sensitivity to the effects of underwater noise, vessel availability and weather considerations.
Engineering	Reduce light intensity and/or frequencies which may attract turtles.	No	Lighting will be designed in accordance with the relevant Australian and international standards to ensure that worker vessel safety is not compromised. The deployment of low-pressure sodium vapour lamps or other technologies which reduce / eliminate frequencies which have been shown to attract turtles (Witherington 1992) would not result in any significant benefit regarding turtle hatchling attraction, given that that key internesting and nesting habitats will be avoided during the nesting periods, no potential to alter light cues on the horizon and the fact that once in the water, hatchling movements are driven by wave-front orientation cues and currents.

Procedures & administration	Premobilisation review and planning to further reduce lighting on vessels prior to the activity commencing	No	A seismic survey vessel has no additional activity specific lighting arrangements that are not required for safe operation and navigation of the vessel. The minimal light glow emitted from a moving vessel is of inconsequential environmental impact. The addition of a pre-mobilisation light review prior to activity commencement would not reduce the risk lower than 'insignificant'. It is therefore not reasonable to include as a control given the additional time and cost associated with the implementation when an environmental benefit is not obtained. This administrative control is not deemed to be ALARP.
	Instruct crews to minimise unnecessary external lighting where practicable during the activity.	No	A seismic survey vessel has no additional activity specific lighting arrangements that are not required for safe operation and navigation of the vessel. The minimal light glow emitted from a moving vessel is of inconsequential environmental impact. The addition of an instruction to the crew to minimise external lighting would not reduce the risk lower than 'insignificant'. and does provide a tangible environmental benefit. This administrative control is not deemed to be ALARP.
Sensitive receptor protection	N/A	N/A	There are no additional practicable measures that could protect sensitive receptors from light emissions due to transient vessel lighting required for navigational and safety requirements.
Identify the likelihood			
Given the distance vessels will typically operate from turtle nesting beaches, the low level of light interference that is created by vessel navigational lights, and that vessel do not remain stationary, impacts to turtles from light emissions is Remote (6). While impacts to seabirds from lighting of offshore platforms and vessels have been reported in the industry, they have only been recorded for facilities in the northern hemisphere. Given that there are several permanently moored offshore installations in the region, and a number of islands and reefs that also provide for potential resting sites, and no records published on the attraction of			

seabirds or negative impacts to migratory seabirds from lighting, the likelihood of impact to these receptors from the lighting on board the vessels is considered Remote (6).		
Residual risk summary		
Based on a consequence of Insignificant (F) and a worst-case likelihood of Remote (6) the residual risk is Low (10).		
Consequence	Likelihood	Residual risk
Insignificant (F)	Remote (6)	Low (10)
Assess residual risk acceptability		
Legislative requirements Navigational lighting is required by law for the safe operation of vessels (*Navigation Act 2012* as appropriate to vessel class and AMSA's Marine Orders Part 30: Prevention of Collisions). Although there is no environmental legislation or guideline regarding the environmental management of light emissions from vessels, the activity aligns with INPEX corporate policies through the reduction of environmental impacts and risks to ALARP levels. **Stakeholder consultation** During stakeholder consultation, AMSA Nautical Advice emphasised the importance of the vessels displaying appropriate lighting while undertaking the activity. No stakeholder concerns were received regarding potential light impacts to fauna. **Australian marine park values, objectives and zone rules** Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018: • The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. Vessels will not enter the Habitat Protection Zone surrounding Adele Island or the National Park Zone. • No significant or long-term impacts to AMP values are expected to occur. • The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species. • The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.		

- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. While several of the conservation documents list light emissions as a threatening process, none of the recovery plans or conservation advices have specific actions relating to navigation / safety lighting emissions from vessels operating offshore as this is recognised as a low risk activity.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
N/A no controls identified			

7.5.2 Atmospheric emissions

Table 7-32: Impact and risk evaluation – atmospheric emissions from vessels

Identify hazards and threats	
Atmospheric emissions produced from the vessel engines during the 2D seismic survey have the potential to result in localised changes in air quality and subsequent exposure of marine avifauna to air pollutants. Atmospheric emissions may be generated through the use of waste incinerators or from ozone depleting substances (ODS), if present on board the vessels.	
Potential consequence	**Severity**
As described in Section 4.8.6, the Operational Area is located within the East Asian–Australasian Flyway, an internationally recognised migratory bird pathway that covers the whole of Australia and its surrounding waters. The migration of marine avifauna through the EAA Flyway generally occurs at two times of year, northward between March and May and southward between August and November (Bamford et al. 2008; DEE 2017b). BIAs for marine avifauna foraging and resting extend from Adele island and the Lacepede Islands and overlap with the Operational Area. The daily consumption of marine diesel by the seismic survey vessel is approximately 15 – 25 m^3 per day and fuel consumption by the support vessels is expected to be less. Therefore, emissions are expected to be very low given the nature and duration of the survey. Given the location of survey activities offshore, any emissions are expected to disperse rapidly in the open oceanic conditions and changes to air quality are expected to be limited to the immediate vicinity of the vessels. If marine avifauna are exposed at all, they are only expected to be exposed to changes in air quality for short periods is they fly close to the engine or incinerator exhaust vents. Overall, the consequence of temporary, localised changes in air quality may result in short-term, sublethal effects to a small number of transient marine avifauna individuals and is therefore considered Insignificant (F).	Insignificant (F)
Identify existing design and safeguards/controls measures	
The vessels that will be involved in the activity will comply with the requirements of Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution, the POTS Act, the *Navigation Act 2012* and Annex VI of MARPOL 73/78 (as applicable to vessel and engine size, type and class), specifically:	

- Marine diesel engines meet NO_X emission requirements and limits as set out by MARPOL 73/78, Annex VI, Regulation 13, and have an International Air Pollution Prevention (IAPP) certificate.
- Equipment and systems that contain ODS (if present) comply with MARPOL 73/78, Annex VI, Regulation 12, are identified in the vessels' IAPP certificate and an ODS record book is maintained (where applicable).
- Vessels >400 GT have a Ship Energy Efficiency Management Plan (SEEMP).
- Vessel contractors use marine diesel with a sulfur content of 0.5% m/m sulfur content on and after 1 January 2020.

Propose additional safeguards/control measures (ALARP Evaluation)

Hierarchy of control	Control measure	Used?	Justification
Elimination	Eliminate the use of vessels	No	Vessels are the only form of transport that can undertake the 2D seismic survey. Therefore, no practicable elimination controls are available.
Substitution	None identified	N/A	No substitution controls were identified that would practicably reduce the risk.
Engineering	None identified	N/A	No engineering solutions were identified that would practicably reduce the risk.
Procedures & administration	None identified	N/A	No additional procedures were identified that would practicably reduce the risk.

Identify the likelihood

The likelihood of marine avifauna approaching and/or resting on exhaust vents on vessels during the activity and remaining in close enough proximity to be experience any symptoms of reduced air quality is Remote (6).

With the control measures described above in place, the potential changes to air quality and potential impacts to marine avifauna are reduced. Therefore, the likelihood of the described consequences to marine avifauna occurring is considered Remote (6).

Residual risk summary

Based on a consequence of Insignificant (F) and a likelihood of Remote (6) the residual risk is Low (10).

Consequence	Likelihood	Residual risk

Insignificant (F)	Remote (6)	Low (10)
Assess residual risk acceptability		

Legislative requirements

The activities and proposed management measures are compliant with industry standards, relevant international conventions and Australian legislation, specifically AMSA Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution, the POTS Act, the *Navigation Act* 2012, and MARPOL 73/78, Annex VI.

Stakeholder consultation

No specific stakeholder concerns have been raised regarding potential impacts and risks associated with atmospheric emissions.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. Vessels will not enter the Habitat Protection Zone or the National Park Zone.
- No significant or long-term impacts to AMP values are expected to occur.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. None of the recovery plans or conservation advice documents have specific threats relating to atmospheric emissions from vessels operating offshore.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	**Environmental performance standards**	**Measurement criteria**	**Responsibility**
Risks of impacts to marine avifauna from atmospheric emissions are reduced and maintained at acceptable levels through implementation of the environmental performance standards and the application of the environmental management implementation strategy.	Vessels will comply with the MARPOL 73/78 (Annex VI), *Navigation Act 2012* – Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution, Annex VI (as appropriate to class of vessel), specifically: International Air Pollution Prevention (IAPP) certificate and emission of NOx (for vessels 400 GT or above).	Record of IAPP certificate	Vessel Master
	Vessels will comply with MARPOL 73/78, Annex VI, Regulation 12 - Ozone-Depleting Substances from	ODS Record Book (where applicable)	Vessel Master

	refrigerating plants and firefighting equipment, which includes, maintenance of an ODS Record Book (where applicable).		
	Vessels >400 GT hold a valid International Energy Efficiency (IEE) certificate and a Ship Energy Efficiency Management Plan (SEEMP) compliant with the requirements of Marine Orders – Part 97, the POTS Act and MARPOL 73/78, Annex VI (as applicable to the vessel and engine size, type and class).	IEE certificate and a SEEMP	Vessel Master
	Marine diesel with 0.5% (m/m) sulfur content.	Bunker delivery note indicates sulfur content of marine diesel in line with the standard.	Vessel Master

7.5.3 Routine discharges to sea

Sewage, grey water and food waste

Table 7-33: Impact and risk evaluation – Vessel sewage, grey water and food waste discharges

Identify hazards and threats	
Discharging sewage effluent, grey water and food waste has the potential to expose planktonic communities to changes in water quality including an increase in nutrients. A decline in water quality has the potential to result in reduced ecosystem productivity or diversity.	
Potential consequence	**Severity**
The average volume of sewage and greywater expected from the vessels (including domestic waste water) generated by each person per day may vary between 60 and 230 L (based on calculations in Hänninen and Sassi 2009). Depending on the capacity of the vessel and the number of persons on board, the total volume of sewage and greywater expected from the vessels may be in the order of 10 m^3 per day. Discharges may occur daily or held in storage tanks and discharged at larger volumes less frequently. These intermittent discharges will occur in the Operational Area, which is located at least 3 Nm from the nearest land and is exposed to open ocean conditions and large tidal currents. The effects of nutrient enrichment from the discharge of sewage is typically limited to enclosed, poorly mixed water bodies, not open ocean waters (Gray et al. 1992; Weis et al. 1989). For example, McIntyre & Johnston (1975) found that the influence of nutrients in open marine areas is much less significant than that experienced in enclosed water bodies. The study also found that zooplankton composition and distribution in open ocean areas associated with discontinued raw sewage dumping practices during the 1970s were not affected. When sewage effluent, grey water and food waste is discharged there is the potential for localised and temporary, changes in water quality. The potential consequence on planktonic communities is a localised impact on plankton abundance in the immediate vicinity of the point of discharge. Given the open water location of the 2D seismic survey and strong tidal exchange, discharges will be rapidly diluted and dispersed. Therefore, the consequence is considered to be of inconsequential ecological significance (Insignificant F).	Insignificant (F)

Identify existing design and safeguards/controls measures			
Vessels will manage the discharge of sewage effluent and grey water in accordance with MARPOL 73/78 Annex IV, Marine Orders 96: Marine Pollution Prevention – Sewage (as appropriate to class), which is implemented through the POTS Act. Vessels will manage the discharge of garbage in accordance with MARPOL 73/78 Annex V, Marine Orders 95: Marine Pollution Prevention – Garbage (as appropriate to class), which is implemented through the POTS Act.			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	Eliminate discharges from vessels by storage of sewage, grey water and food waste on board and ship to the mainland for disposal.	No	The significant financial cost and health risks associated with storing sewage, grey water and food waste on vessels and transporting it to the mainland for the duration of operations is grossly disproportionate to the low level of risk associated with this discharge, permitted under legislation. Additional environmental impacts would also be generated in terms of air emissions and onshore disposal.
Substitution	None identified	N/A	No substitution controls were identified that would practicably reduce the risk.
Engineering	None identified	N/A	No engineering solutions were identified that would practicably reduce the risk.
Procedures & administration	None identified	N/A	No additional procedures were identified that could practicably reduce the risk.
Identify the likelihood			
Sewage, greywater and food waste discharges from the vessels will be in accordance with legislative requirements (MARPOL 73/78 Annex IV & V, Marine Orders 95 and 96). Maceration of sewage and food waste to a particle size <25 mm prior to disposal will increase the ability of the discharges to disperse rapidly. The volumes discharged are unlikely to cause any significant reductions in water quality, especially considering the rapid dilution provided by ocean currents. Based on the expected high dispersion due to the open-ocean environment, impacts to plankton communities are considered to be Unlikely (4).			

Residual risk summary		
Based on a consequence of Insignificant (F) and a likelihood of Unlikely (4) the residual risk is Low (9).		
Consequence	Likelihood	Residual risk
Insignificant (F)	Unlikely (4)	Low (9)

Assess residual risk acceptability

Legislative requirements

Sewage, grey water and food waste discharges are standard practice in the offshore environment and the disposal at sea is permitted under AMSA (2013) Marine Orders – Part 96: Marine Pollution Prevention – Sewage, which gives effect to MARPOL 73/78, Annex IV and Marine Orders – Part 95: Marine Pollution Prevention – Garbage, which gives effect to MARPOL 73/78, Annex V.

Stakeholder consultation

No stakeholder concerns have been raised regarding potential impacts and risks from planned discharges (sewage, grey water and food waste).

Australian marine park values, objectives and zone rules

- Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:
- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. Vessels will not enter the Habitat Protection Zone or the National Park Zone. Vessel discharges (compliant with MARPOL requirements) are permitted in the Multiple Use Zone.
- No significant or long-term impacts to AMP values are expected to occur.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.

- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP (refer Appendix A). Emissions and discharges are listed as threatening processes; however, none of the recovery plans or conservation advice documents has specific actions relating to discharges of sewage, grey water and food waste. The maceraters will assist in reducing impacts from the discharge stream, consistent with the intent of the conservation management documents.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
Zero discharges of untreated sewage and grey water or unmacerated putrescible waste	Manage and dispose of sewage in accordance with: MARPOL 73/78 Annex IV, Marine Orders – Part 96:	International Sewage Pollution Prevention Certificate (ISPPC).	Vessel Master

to the marine environment for the duration of the activity.	Marine Pollution Prevention – Sewage as enacted in the POTS Act – Part IIIB (as appropriate to vessel class), including: Current International Sewage Pollution Prevention Certificate (ISPPC).		
	Manage and dispose of garbage in accordance with: MARPOL 73/78 Annex III, Marine Orders – Part 95: Marine Pollution Prevention – Garbage, as enacted in the POTS Act – Parts IIIA and IIIC (as appropriate to vessel class), including: Garbage that has been ground or comminuted to particles <25 mm: >3 nm from the nearest land. Garbage disposal record book maintained in accordance with POTS Act – Part IIIC	Garbage disposal record book	Vessel Master

Bilge water

Table 7-34: Impact and evaluation –Bilge water discharges

Identify hazards and threats	
Bilge discharges or failure to treat oily water to suitable oil-in-water (OIW) concentrations before discharge, have the potential to expose marine fauna to changes in water quality and/or result in impacts through direct toxicity. Volumes of bilge water from engines and other mechanical sources found throughout the machinery spaces will also vary between vessels.	
Potential consequence	**Severity**
Discharges of oily water could result in a reduction in water quality, and impacts to transient, EPBC-listed species, plankton and other pelagic organisms such as fish species. Given the highly mobile and transient nature of both the vessels and marine fauna, the potential exposure is likely to be limited to individuals close to the discharge point at the time of the discharge. Worst case impacts to marine fauna exposed to oily surface water may include direct toxic effects, such as damage to lungs and airways, and eye and skin lesions from exposure to oil at the sea surface (Gubbay & Earll 2000). Considering the low concentrations of oil and the location of the discharges in the dispersive open ocean environment, a surface expression is not anticipated; therefore, impacts are considered to be of inconsequential ecological significance to transient, EPBC listed species and are therefore considered Insignificant (F). Planktonic communities in close proximity to the discharge point may be affected if exposed to oily water. Such exposure may result in lethal effects to plankton. The potential consequence on planktonic communities is a localised impact on plankton abundance in the vicinity of the point of discharge with inconsequential ecological significance (Insignificant F). There is the potential for individual fishes to be exposed to the discharge; however, this would be limited to those fish present at the sea surface rather than those associated with the ancient coastline or demersal fish community KEFs. Such exposure is not expected to result in any significant impacts to fishes based on the low toxicity, low volumes, high dilution rates and the highly mobile nature and ability of pelagic fishes to move away. The potential consequence to demersal fishes at the ancient coastline and the demersal fish community KEF or commercially targeted fish species will be short-term and highly localised with inconsequential ecological significance (Insignificant F).	Insignificant (F)

Identify existing design and safeguards/controls measures			
The vessels are equipped with oil–water separators (OWS) which remove oil prior to discharge to sea. Oily water is treated to a maximum concentration of 15 ppm (v) prior to discharge as specified in MARPOL 73/78, Annex I. Vessels may discharge oily water in accordance with MARPOL 73/78 Annex I, Marine Orders 91: Marine Pollution Prevention – Oil (as appropriate to class).			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	No discharges bilge to sea.	No	Discharge of bilge discharges cannot be eliminated from the vessels. There is not sufficient space on board for storage, and onshore disposal is not practicable given the transit times to port. Further, the associated emissions and discharges associated with such frequent transfers would have a negative impact.
Substitution	None identified	N/A	No substitution controls were identified that would practicably reduce the risk.
Engineering	None identified	N/A	No additional engineering solutions were identified that would practicably reduce the risk.
Procedures & administration	None identified	N/A	No procedures (additional to those required under MARPOL 73/78 requirements) were identified that could reduce the risk.
	Shipboard Oil Pollution Emergency Plan (SOPEP) equipment will be available on board vessels	Yes	The availability of spill kits on board vessels will enable minor spills to be responded to in a timely manner to reduce the likelihood of spillages reaching the marine environment.
	Vessels will implement specific procedures to reduce the potential for deck spills reaching the sea during bunkering activities	Yes	To reduce potential for deck spills entering the marine environment vessels will implement a process that uses of plugs/scuppers to prevent loss to the environment during bunkering.
Identify the likelihood			

Bilge discharges are treated to a maximum concentration of 15 ppm (v) OIW prior to discharge as specified in MARPOL 73/78, Annex 1. Impacts to the abundance of plankton and EPBC listed species in the vicinity of the discharge are not expected and are considered Unlikely (4).		
Residual risk summary		
Based on a consequence of Insignificant (F) and a worst-case likelihood of Unlikely (4) the residual risk is Low (9).		
Consequence	Likelihood	Residual risk
Insignificant (F)	Unlikely (4)	Low (9)
Assess residual risk acceptability		

Legislative requirements

Vessel oil–water separators (OWS) meet relevant international regulatory requirements, including MARPOL 73/78, enacted by the POTS Act in Commonwealth waters. The discharge of oil in water of <15 ppm (v) is permitted under MARPOL 73/78.

Stakeholder consultation

No stakeholder concerns have been raised regarding potential impacts and risks from bilge discharges.

Australian marine park values, objectives and zone rules

- Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:
- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. Vessels will not enter the Habitat Protection Zone or the National Park Zone. Vessel discharges (compliant with MARPOL requirements) are permitted in the Multiple Use Zone.
- No significant or long-term impacts to AMP values are expected to occur.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.

- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP. Emissions and discharges are listed as threatening processes; however, none of the recovery plans or conservation advice documents has specific actions relating to deck drainage/bilge discharges. Managing oily water discharges in accordance with legislative requirements is consistent with the intent of the conservation management documents.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
Zero discharges of oily water to the marine environment exceeding 15ppm(v).	Vessels will comply with POTS Act – Part II (Section 9), as appropriate to the vessel class, including:	Documented use of oil record book to record all oil disposal.	Vessel Master

	• Liquids from bilge will only be discharged if the oil in water content does not exceed 15 ppm(v).		
	Vessel complies with the *Navigation Act 2012* – Marine Orders - Part 91: Marine Pollution Prevention – Oil, including: • Vessels to have International Oil Pollution Prevention (IOPP) certificate to show that vessels have passed structural, equipment, systems, fittings, and arrangement and material conditions. • Oil water separators (OWS) tested and approved as per IMO resolutions MARPOL 73/78 (Annex I).	Record of current International Oil Pollution Prevention (IOPP) certificate.	Vessel master
Risks of impacts to marine fauna and planktonic communities from bilge discharges are reduced and maintained at acceptable levels through implementation of the environmental performance standards and the application of the environmental management implementation strategy.	Spill equipment is available as per the vessel SOPEP.	Inspection records confirm spill equipment is available as described in the SOPEP.	Vessel master
	Personnel are made aware of SOPEP	Vessel awareness materials include SOPEP equipment location	Vessel master

7.6 Waste management

Table 7-35: Impact and evaluation – Waste management

Identify hazards and threats	
Unsecured or incorrectly stored waste may be windblown or displaced into the ocean where it has the potential to negatively affect marine ecosystems. Wastes can cause contamination of the ocean resulting in changes to water quality (e.g. through the leaching of chemicals from hazardous wastes that are displaced). Additionally, certain types of waste can cause injury to marine fauna through entanglement or may affect the health of marine fauna if waste materials are ingested.	
Potential consequence	**Severity**
Improper management of wastes may result in pollution and contamination of the environment. There is also the potential for secondary impacts on marine fauna that may interact with wastes, such as packaging and binding, should these enter the ocean. These include physical injury or death of marine biota (as a result of ingestion, or entanglement of wastes). In the event of an accidental release of waste overboard, the particular values and sensitivities identified as having the potential to be impacted include planktonic communities and transient, EPBC listed species (marine fauna). A change to water quality has the potential to impact planktonic communities found at the sea surface. Impacts associated with the accidental loss of hazardous waste materials to the ocean as a result of leaching from waste would be localised and limited to the immediate area. These are further likely to be reduced due to the dispersive open ocean offshore environment. While plankton abundance in close proximity to the accidental loss location, or leaching waste items may be reduced, this is expected to be of insignificant ecological consequence (Insignificant F). Marine fauna can become entangled in waste plastics, which can also be ingested when mistaken as prey (Ryan et al. 1988), potentially leading to injury or death. For example, due to indiscriminate foraging behaviour, marine turtles have been known to mistake plastic for jellyfish (Mrosovsky et al. 2009). Seabirds foraging on planktonic organisms, generally at, or near, the surface of the water column may eat floating plastic (DEE 2018h). Other items (e.g. discarded rope) have also been found to entangle fauna, such as birds and marine mammals. The accidental loss of waste to the ocean may result in injury or even death to individual transient EPBC listed species, but this is not expected to result in a threat to population viability of a protected species (Insignificant F).	Insignificant (F)

Identify existing design and safeguards/controls measures			
Vessels manage waste in accordance with MARPOL 73/78 Annex V, which is implemented through the POTS Act specifically the requirement to have a garbage management plan.			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	None identified	N/A	No elimination controls were identified that would practicably reduce the risk.
Substitution	None identified	N/A	No substitution controls were identified that would practicably reduce the risk.
Engineering	None identified	N/A	No engineering solutions were identified that would practicably reduce the risk.
Procedures & administration	None identified	N/A	No additional procedures were identified that could practicably reduce the risk further.
Identify the likelihood			
Given the proposed safeguards in place, impacts to transient EPBC-listed species and planktonic communities, while not expected, are considered Possible (3) in the event of an accidental loss of waste to the ocean.			
Residual risk summary			
Based on a consequence of Insignificant (F) and a worst-case likelihood of Possible (3) the residual risk is Low (8).			

Consequence	Likelihood	Residual risk
Insignificant (F)	Possible (3)	Low (8)
Assess residual risk acceptability		
Legislative requirements		

The existing preventative and mitigation measures outlined to prevent accidental release of hazardous and non-hazardous wastes are consistent with, and typical of, good industry practice. Procedures for managing waste (i.e. handling, storage, transfer and disposal) will be outlined in the vessel garbage management plan, in accordance with MARPOL Annex V requirements.

Stakeholder consultation

No stakeholder concerns have been raised regarding potential impacts and risks from improper waste management.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP.
- No significant or long-term impacts to AMP values are expected to occur.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans have been consulted in the development of this EP (refer Appendix A). Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris was listed in August 2003 as a key threatening process under the EPBC Act as detailed in the 'Threat abatement plan for impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans' (DEE 2018h). The entanglement and ingestion of marine debris is also identified as a threat in the 'Recovery Plan for Marine Turtles in Australia" (DEE 2017a). Specific actions which contribute to the long-term prevention of marine debris (Objective 1 of the 'Threat abatement plan for marine debris on vertebrate marine life' (DEE 2018h)) have been adopted including compliance with applicable legislation in relation to the improvement of waste management practices, such as MARPOL 73/78, Annex V,

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Low", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
Zero unplanned discharge of wastes into the marine environment.	Implementation of the vessel garbage management plan.	Event report of waste lost overboard.	Vessel Masters

7.7 Loss of containment

The activity will require the handling, use and storage of chemicals and hydrocarbon materials, including wastes. These materials may include, but are not limited to:

- MGO/diesel
- hydraulic oil
- grease
- paint/solvents/detergents.

Undertaking the activity introduces the potential for loss of containment events. These events may be classified as Level 1, Level 2 or Level 3 incidents, in accordance with Table 2.2 of the OPEP (Appendix F).

INPEX defines an emergency condition as:

"an unplanned or uncontrolled situation that harms or has the potential to harm people, the environment, assets, Company reputation or Company sustainability and which cannot, through the implementation of Company standard operating procedures, be contained or controlled."

An evaluation of the environmental impacts and risks associated with emergency conditions is included in Section 8 of this EP.

A summary of the loss of containment events (and emergency conditions) associated with this EP, together with their characterisation and classification, is included in Table 7-36. Incident levels are indicative only and classifications have been assigned for the purposes of enabling the risk evaluation to be undertaken. In the event of a spill, the incident level will be classified as described in the OPEP (Appendix F).

Table 7-36: Representative loss of containment events and emergency conditions identified for the petroleum activity

Scenario		Basis of volume calculation	Fluid Type	Indicative incident level	Section addressed
Source	**Threat**				
Management of chemicals, hydrocarbons and waste products on board	Inappropriate use/handling/ spills.	Failure of an intermediate bulk container, estimated to be in the order of 1 m^3	Various	1	Accidental release overboard – Table 7-37
Hydrocarbon transfers	Split hose during bunkering	2.5 m^3 – based on 15 minutes of loss to the environment until shut-off after leak detection	Group II – marine gas oil (MGO)/ diesel	1	Accidental release overboard – Table 7-37
Emergency conditions (refer to Section 8)					

Survey vessel or support vessel	Collision	284 m^3 Volume of largest fuel tank - Spill volumes have been calculated based on AMSA (2013) guidance and the vessel types/classes expected to be used during the activity.	Group II – MGO/ diesel	2	Vessel collision – Table 8-5

7.7.1 Accidental release

Table 7-37: Impact and evaluation – loss of containment: accidental release overboard

Identify hazards and threats	
Several loss of containment events were identified (Table 7-36), including minor spills on board (<1 m^3); and loss of hydrocarbon fuels during bunkering of vessels (2.5 m^3). Specific predictive modelling was not undertaken for the potential loss of containment events due to the low volumes and that any predicted impacts are expected to be localised. Given the properties of the fluids involved (predominantly Group II hydrocarbons), which tend to be volatile and non-persistent in the environment, any spills will rapidly evaporate and disperse at the sea surface. An accidental release overboard resulting in a spill that reaches the marine environment has the potential to result in localised changes to water quality, resulting in impacts to marine fauna and planktonic communities at the sea surface, but no impact on deeper water communities or benthic habitats would be expected.	
Potential consequence	**Severity**
Potential accidental releases overboard from loss of containment events may result in the exposure of marine fauna and plankton near the sea surface, to a range of fluids and Group II hydrocarbons. Foreseeable loss of fluids and hydrocarbons to the marine environment would be of small volumes, therefore, the focus of this assessment is based on a potential release of diesel during transfers/bunkering. Given the anticipated volumes (worst case 2.5 m^3 of diesel), potential exposure is expected to be localised to the release location. Some of the spilled volume may also be contained on board the vessel, therefore reducing the potential volume released to the marine environment. Upon release, hydrocarbons will immediately begin to evaporate, disperse through natural physical oceanic processes (i.e. wind and currents), and will be subject to photochemical and biological degradation. Spill modelling undertaken by RPS (2019) reported that approximately 34% of the release volume would evaporate in the first 24 hours, including some of the most toxic and volatile fractions of the hydrocarbon which are the first to evaporate. Therefore, any surface expression is expected to weather and dissipate in a relatively short time with limited potential for exposure to surfacing marine fauna or plankton communities at or near the sea surface. Given the low volumes, limited duration of exposure due to expected weathering and dispersion in an open ocean environment, the level of consequence is expected to present a local scale event of inconsequential ecological significance (Insignificant F).	Insignificant (F)

Identify existing design and safeguards/controls measures			
Marine vessels >400 tonne (t) will carry SOPEPs approved under MARPOL 73/78 Annex 1, Regulation 37.			
Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	Eliminate the use of chemicals and hydrocarbons on board.	No	Chemicals and hydrocarbons are required for safe and efficient operations and cannot be eliminated. In the case of MGO/diesel, it is required as fuel and cannot be eliminated.
	No fuel bunkering or transfers.	No	Bunkering of fuel from supply vessels to the seismic survey vessel is required during the activity as space limitations/tank capacities mean that supplies need to be replenished. Time constraints on the survey make returning to port to refuel impracticable.
Substitution	None identified	N/A	No substitution controls were identified that would practicably reduce the risk.
Engineering	Reduce potential volumes of spilled chemicals/hydrocarbons reaching the marine environment by ensuring spill containment and recovery equipment, such as vessel SOPEP equipment, are available for responding to minor spillage of hydrocarbons and chemicals on board.	Yes	The availability of spill response equipment on board vessels will enable minor spills to be responded to in a timely manner to reduce the likelihood of spillages reaching the marine environment.
	Dry break, breakaway couplings or similar technology will be installed and used during hydrocarbon bunkering operations.	Yes	The use of dry break and breakaway couplings during transfers and bunkering, as specified by the contractors transfer procedures, will reduce the potential volume of any spills.

Procedures & administration	Implement hydrocarbon bunkering procedures that specify operational requirements (e.g. minimum lighting conditions, communications and visual monitoring.	Yes	The transfer of fuel will occur in accordance with strict conditions for preventing spills to the marine environment. Offshore transfers of fuel will be conducted in accordance with the vessel contractor's transfer procedures.

Identify the likelihood

Based on the low volumes and expected weathering of spilled hydrocarbons, the likelihood of a loss of containment event causing harm to the identified receptors with the proposed controls in place is Unlikely (4).

Residual risk summary

Based on a consequence of Insignificant (F) and a likelihood of Unlikely (4) the residual risk is Low (9).

Consequence	Likelihood	Residual risk
Insignificant (F)	Unlikely (4)	Low (9)

Assess residual risk acceptability

Legislative requirements

The activities and proposed management measures are compliant with industry standards and relevant Australian legislation, specifically concerning prevention pollution, including the POTS Act.

Stakeholder consultation

Spill response procedures and notifications to relevant stakeholders have been confirmed with AMSA and the WA DOT and included in INPEX spill response processes.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP.
- No significant or long-term impacts to AMP values are expected to occur.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.

- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans identify oil or chemical spills as key threatening processes, through both direct/acute impacts, as well as indirect impacts through habitat degradation. The prevention of loss of containment events and reducing impacts to the marine environment through the preventative controls in place and spill response preparedness, demonstrates alignment with the various conservation management plans.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and
- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as “Low”, the consequence does not exceed “C – Significant” and the risk has been reduced to ALARP.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
No incidents of spills reaching the marine environment during transfer, handling or storage of chemicals, hydrocarbons and liquid waste products.	Vessels >400 GT have SOPEPs compliant with Marine Orders – Part 91, the POTS Act, and Annex I of MARPOL 73/78 (oil) on board.	Valid SOPEP	Vessel Master
	SOPEP equipment will be on board vessels to allow clean-up of any spill to the deck.	Inspection records confirm SOPEP equipment are available and stocked.	Vessel Master
	Vessel bunkering procedures for hydrocarbon transfers will include as a minimum: • Dry break couplings/weak link breakaway couplings and flotation collars installed on hydrocarbon bulk transfer hoses to prevent entanglement and enable early leak detection. • Bunkering is undertaken during daylight hours and when weather is good (e.g. suitable sea conditions). • Night time bunkering will only occur in fully lit conditions and in favourable sea states.	Vessel bunkering procedure	Vessel master

8 Emergency conditions

An evaluation of potential spill sources identified during the environmental hazard identification (HAZID) workshops determined various potential emergency conditions related to the activity (Table 7-36).

A single emergency condition was identified, as follows:

- source – survey vessel
- threat – vessel collision
- hydrocarbon type – Group II – Marine Gas Oil (diesel)
- release type – surface spill, up to a 6-hour release
- release location – within the Operational Area (refer Table 8-2 and Figure 8-1).

8.1 EMBA based on oil spill modelling

Hydrocarbon exposure has the potential to result in both acute and chronic impacts to marine flora and fauna, depending on the sensitivity of organisms exposed and the concentration of exposure. A summary of the range of concentrations of different hydrocarbon exposure thresholds adopted to conservatively identify an area with potential environmental impacts is described in Table 8-1. These thresholds include surface, entrained, dissolved and shoreline accumulation thresholds to account for the different partitioning and fate of marine diesel released from a vessel collision scenario. Thresholds (defined in Table 8-1) have been used in stochastic modelling to define the EMBA as described in Section 4, for oil spill planning purposes.

Table 8-1: Hydrocarbon exposure threshold for impact and risk evaluation

Threshold	Description
Surface hydrocarbon exposure: 1–10 g/m^2.	Certain socioeconomic receptors, such as oil & gas industry and fishing activities may be affected by safety concerns associated with a light surface expression. Therefore, a surface exposure threshold of 1 g/m^2 is included, for information purposes. However, it is considered too low for ecological impact assessment purposes. The surface oil threshold of 10 g/m^2 to assess environmental impacts is based on research by French-McCay (2009) who has reviewed the minimum oil thickness (0.01 mm) required to impact on thermoregulation of marine species, predominantly seabirds and furred mammals. Seabirds are particularly vulnerable to oil spills because their feathers easily become coated and they feed in the upper water column. Other tropical marine megafauna species are unlikely to suffer from comparable physical oil coating because they have smooth skin. Applying the threshold for the scenario outlined for this EP therefore, represents a conservative measure to define the EMBA. This threshold has been applied to various industry oil spill impact assessments by French-McCay (2002; 2003) and is recommended in the AMSA guidelines (AMSA 2015).

Dissolved and entrained hydrocarbon exposure: 100–500 ppb.	Unplanned spill scenario in this EP include release of marine diesel at the sea surface (Table 7-36). The biological impact of entrained oil cannot be determined directly using available ecotoxicity; however, it can be derived from tests using either water-soluble fraction (WSF) of oil or oil-in-water dispersions (OWD). OWD are prepared by highly turbulent shaking of oil in water, which are allowed to separate before use, so that the test organisms are exposed to the dissolved fractions, as well as any very fine entrained oil droplets that remain in suspension. However, results are conservative because entrained droplets are less biologically available to organisms through tissue absorption than the dissolved fraction (Tsvetnenko 1998). To provide an estimate of the magnitude of toxicity effects from oil exposure to marine biota across a wide taxonomic range, a review was undertaken of global ecotoxicology data for numerous species (115 for fish, 129 for crustaceans, and 34 for other invertebrates) by French-McCay (2002). These were based on both WSF and OWD tests. Under low-turbulence conditions, the total polycyclic aromatic hydrocarbon (PAH) LC_{50} for species of average sensitivity ranges from about 300–1000 ppb. Under higher turbulence, such as a subsea release, the total PAH LC_{50} decreased to about 64 ppb (French-McCay, 2002). This is close to the 99% species protection threshold of 50 ppb for PAH in the Australian and New Zealand *Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000). For marine diesel, the surface release of the hydrocarbon tends to reduce its potential for solubility, so the toxicity decreases and a threshold up to 1000 ppb is recommended (French-McCay 2009). To be conservative a 500 ppb entrained/dissolved threshold is proposed for a surface release of marine diesel to account for any ecological impacts in the EMBA.
Shoreline accumulation: 100 g/m^2 (where threshold for surface or entrained/dissolved hydrocarbon exposure at that shoreline is also exceeded).	A shoreline accumulation threshold of 100 g/m^2 is also recommended from the review by French-McCay (2009) based on exposure to birds and smothering of invertebrates in intertidal habitats.

As described in Section 4, the spatial extent of the EMBA, used as the basis for the EPBC Protected Matters Database search (Appendix B) was determined using stochastic spill modelling. Based on the defined hydrocarbon exposure thresholds, the resulting EMBA is the sum of 100 overlaid modelling runs from six different locations (total of 600 model runs). The modelled scenario was the vessel collision scenario, involving a spill of 284 m^3 MGO, released over 6 hours.

The six locations selected are approximately on the north-west, west, south-west, north-east, east and south-east edges of the originally proposed draft Operational Area (note this area now excludes activity within the HPZ and NPZ but the spill modelling locations have been retained because they remain relevant and conservative). The exact position for each location was selected as close as possible to the nearest emergent island or sensitive coastline as shown in Table 8-2 and Figure 8-1. 100 runs per location provided variable weather conditions (during summer, winter and transitional) and under different hydrodynamic conditions (e.g. currents, winds, tides, etc.).

This technique has been used to provide a highly conservative representation of the EMBA from the potential loss of containment event, to ensure that the EPBC Protected Matters Database search includes all potential receptors. This technique also ensures that the modelling outputs regarding concentrations of floating, entrained, dissolved and shoreline accumulated oil and time to contact are conservative. As such, the actual area that may be affected from any single spill event would be considerably smaller than the area represented by the EMBA. However, these scenarios provide sufficient information to inform spill response planning commensurate with the risk of the activity.

As presented in Table 8-4, the EMBA based on the vessel collision scenario may extend up to 392 km (1 g/m^2 - visible surface sheen) or up to 206 km (above environmental impact threshold – 10 g/m^2) from the release location (RPS 2019). The maximum entrained oil concentration at or greater than the impact threshold concentrations (500 ppb) may travel up to approximately 527 km from the release location respectively. The dissolved oil threshold was not exceeded at any sensitive receptor location.

As such, the outer boundary of the EMBA (as shown in the Figures presented in Section 4) is the 1% probability contour of entrained hydrocarbon exceeding the defined exposure threshold.

The impacts and risks associated with the vessel collision scenarios are presented in Table 8-5.

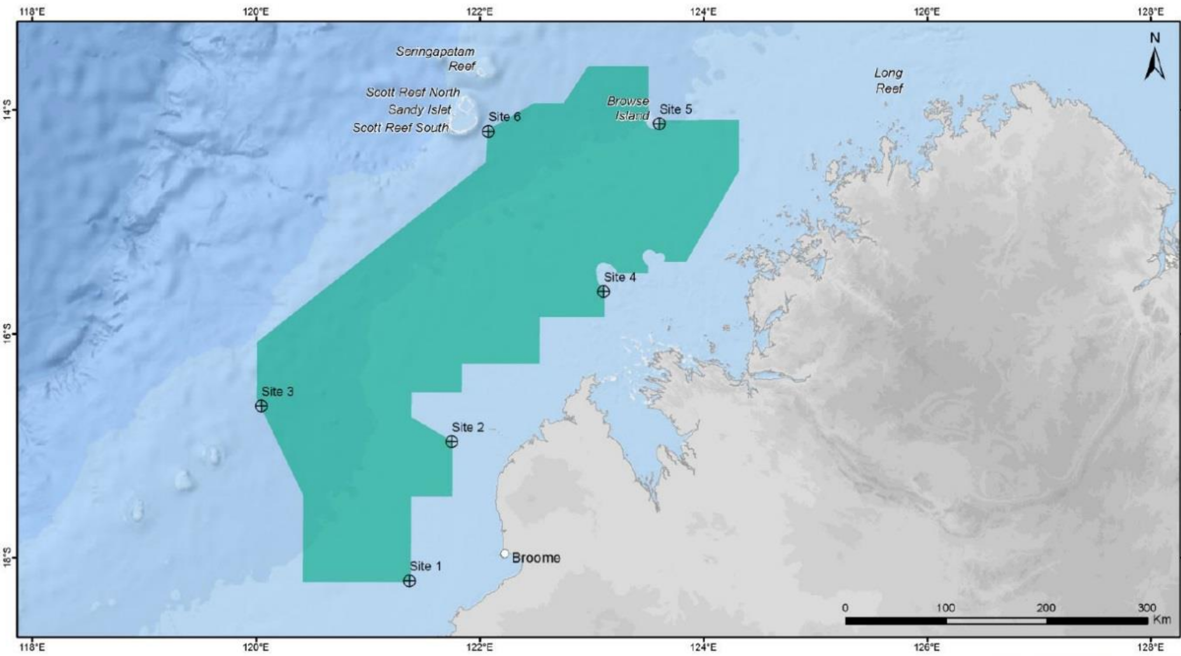


Figure 8-1: Vessel Collision Spill Modelling Locations

Table 8-2: Vessel Collision Spill Modelling Locations

Location	Coordinate	Closest receptor	Distance/direction to closest receptor

Site 1	18° 12' 40.08" S 121° 22' 27.24" E	Broome / 80 Mile Beach	95 km SW of Broome
Site 2	16° 57' 57.95" S 121° 45' 1.14" E	Lacapede Islands	42 km SW of Lacapede Islands
Site 3	16° 38' 47.63" S 120° 2' 52.78" E	Rowley Shoals	65 km NE of Rowley Shoals
Site 4 *	15° 37' 23.28" S 123° 6' 34.04" E	Adele Island	8 km SW of Adele Island
Site 5	14° 7' 18.89" S 123° 36' 37.15" E	Browse Island	7 km E of Browse Island
Site 6	14° 11' 23.14" S 122° 4' 44.63" E	Scott Reef	20 km SE of Scott Reef
* Site no longer located within the Operational Area			

8.2 Vessel Collision

8.2.1 Location

The locations of the vessel collision scenario modelling are shown in Figure 8-1.

8.2.2 Volume and duration

AMSA guidance (AMSA 2015) recommends that the maximum credible volume spill for a vessel collision scenario be based on the volume of the largest single fuel tank. A review of the expected tank sizes associated with the activity indicated the survey vessel largest tank size to be approximately 284 m^3.

For each scenario, the oil was released over a six-hour period, with the model runs continuing for 21 days post release. 21 days was determined as appropriate, as the vast majority of oil will have evaporated or undergone other forms of degradation within 21 days.

8.2.3 Hydrocarbon properties

Hydrocarbon properties associated with the Group II marine diesel used for the RPS 2019 modelling study are presented in Table 8-3.

Table 8-3: Group II marine diesel properties

Hydro-carbon type	Density at 25 °C (kg/m^3)	Dynamic viscosity (cP) – at 25 °C	Characteristic	Volatile (%)	Semi-volatile (%)	Low volatility (%)	Residual (%)
			Boiling point (°C)	**<180**	**180–265**	**265–380**	**>380**
Marine Gas Oil / Diesel	829.1	4.0	% of total	6	34.6	54.4	5

8.2.4 Modelling results

The RPS 2019 modelling study included simulations of MGO releases under light and variable wind conditions.

Under light wind conditions (<5 knots), up to 34% of an MGO spill would be expected to evaporate within 24 hours, and up to 47% evaporation after a week, with negligible levels of entrained oil or dissolved oil (0.02%). Under light wind conditions, approximately 42% of the oil would persist on the ocean surface after 1 week.

Under moderate wind conditions (4-19 knots), up to 34% of an MGO spill would be expected to evaporate within 24 hours; however, due to increased entrainment, up to 43% evaporation after a week. Due to the increased wind speed, up to 52% of oil could become entrained when wind speeds exceed 10m/s, with entrainment further increasing with increasing wind speed. Under increased wind conditions, dissolved oil was also predicted to increase to 0.2%. Under moderate wind conditions, due to significant increases in entrainment, only approximately 1% of the oil would still persist on the ocean surface after 1 week.

Biological and photochemical degradation is predicted to contribute to the decay of the floating oil at a similar rate for both weathering cases, with an approximate rate of ~1.6% per day, and an accumulated total of about 11% after 7 days.

RPS 2019 modelling results of the vessel collision scenario (100 runs x 6 locations) are presented in Table 8-4. The highlighted cells in the table indicate the highest individual value within each column. Figure 8-2 and Figure 8-3 present examples of a single deterministic run, to demonstrate the maximum geographical area that a worst-case scenario could potentially impact, over the entire duration of the spill, and in a time-sequence, respectively.

Table 8-4: Summary of oil spill modelling results

Scenario	Maximum extent - floating oil >1 g/m²	Maximum extent - floating oil >10 g/m²	Locations receiving shoreline contact >1g/m²	Minimum time for shoreline contact >1 g/m²	Worst case shoreline oil accumulation concentration (g/m²)	Worst case shoreline oil accumulation concentration (m³)	Worst case entrained oil concentration at any submerged receptor (ppb)	Maximum extent – entrained oil >500ppb	Worst case instantaneous dissolved oil concentration at any receptor (ppb)
1	194 km	97 km	North Broome coast. 80-mile beach.	84 hours (80-mile beach)	51 g/m² (North Broome coast)	2 m³ (North Broome coast)	7,038 ppb (offshore BIAs, KEFs and fisheries)	470 km	137 ppb (offshore BIAs, KEFs and fisheries)
2	167 km	69 km	Lacapede Islands. North Broome Coast. Northern Dampier Peninsula	34 hours (Lacapede Islands)	3,311 g/m² (Lacapede Islands)	48 m³ (Lacapede Islands)	10,825 ppb (offshore BIAs, KEFs and fisheries)	297 km	122 ppb (offshore BIAs, KEFs and fisheries)
3	357 km	132 km	Mermaid Reef AMP Rowley Shoals Marine Park	56 hours (Clerke Reef - Rowley Shoals Mark Park)	1,929 g/m² (Clerk Reef – Rowley Shoals)	48 m³ (Clerk Reef – Rowley Shoals)	5,258 ppb (offshore BIAs, KEFs and fisheries)	527 km	125 ppb (offshore BIAs, KEFs and fisheries)
4 *	195 km	100 km	Adele Island Lalang-garram/Camden Sound Marine Park Buccaneer Archipelago	5 hours (Adele Island)	3,313 g/m² (Adele Island)	119 m³ (Adele Island)	8,319 ppb (offshore BIAs, KEFs and fisheries)	394 km	154 ppb (offshore BIAs, KEFs and fisheries)
5	392 km	206 km	Browse Island Seringapatam Reef Scott Reef	1 hour (Browse Island)	3,312 g/m² (Browse Island)	100 m³ (Browse Island)	4,216 ppb (offshore BIAs, KEFs and fisheries)	458 km	151 ppb (offshore BIAs, KEFs and fisheries)
6	305 km	167 km	Sandy Islet- Scott Reef	35 hours (Sandy Islet – Scott Reef)	3,312 g/m² (Sandy Islet – Scott Reef)	55 m³ (Sandy Islet – Scott Reef)	6,528 ppb (offshore BIAs, KEFs and fisheries)	514 km	128 ppb (offshore BIAs, KEFs and fisheries)

* Site no longer located within the Operational Area. The Operational Area boundary is located approximately 15 km from this location, therefore, modelling results for this release location are likely to over-predict the volumes, timeframes and probability for shoreline contact. The modelling results for this site are, therefore, considered to be conservative.

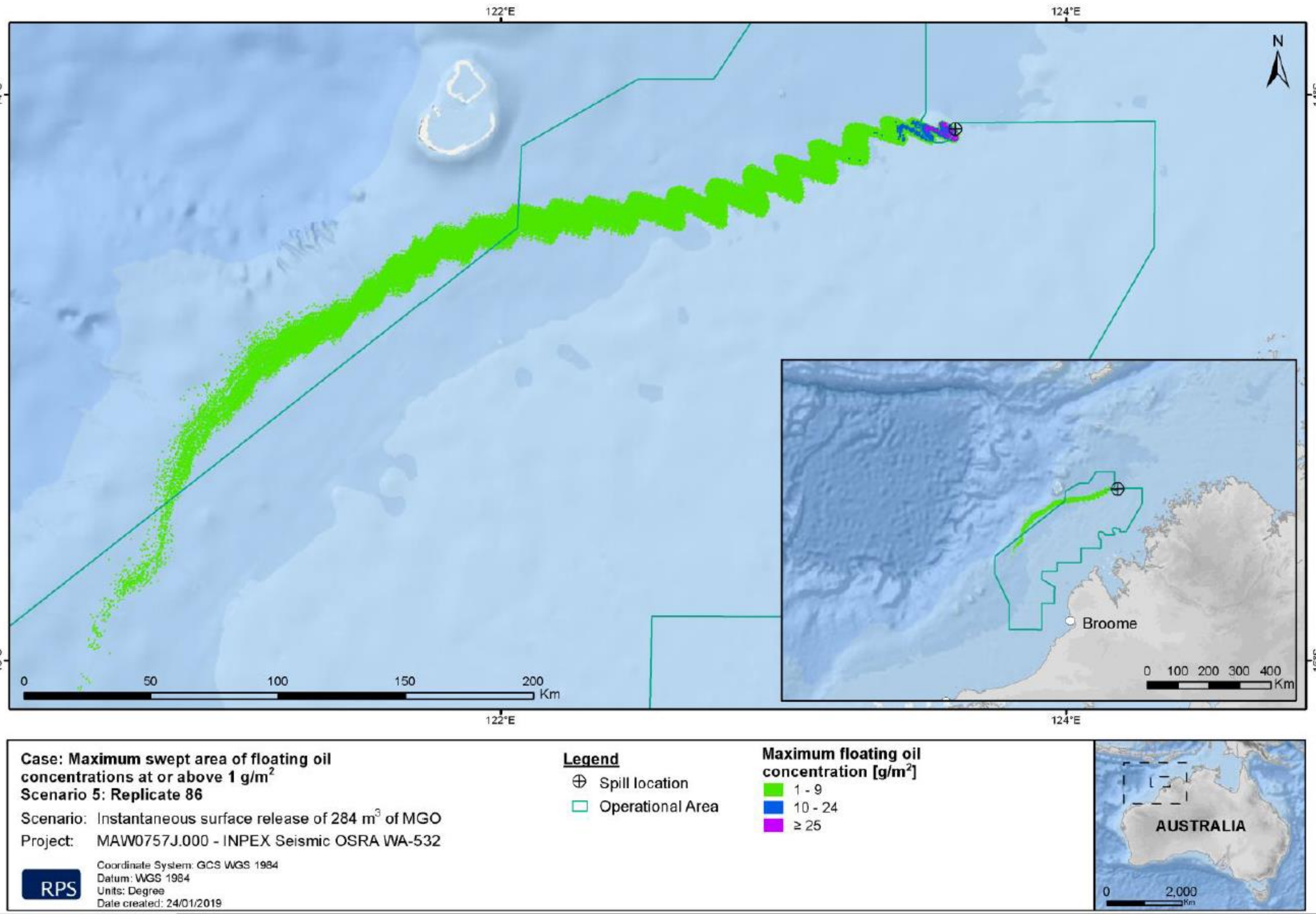


Figure 8-2: Maximum floating oil concentrations (g/m²) for the replicate simulation with the largest swept area of floating oil - 284 m³ MGO spill at Site 5

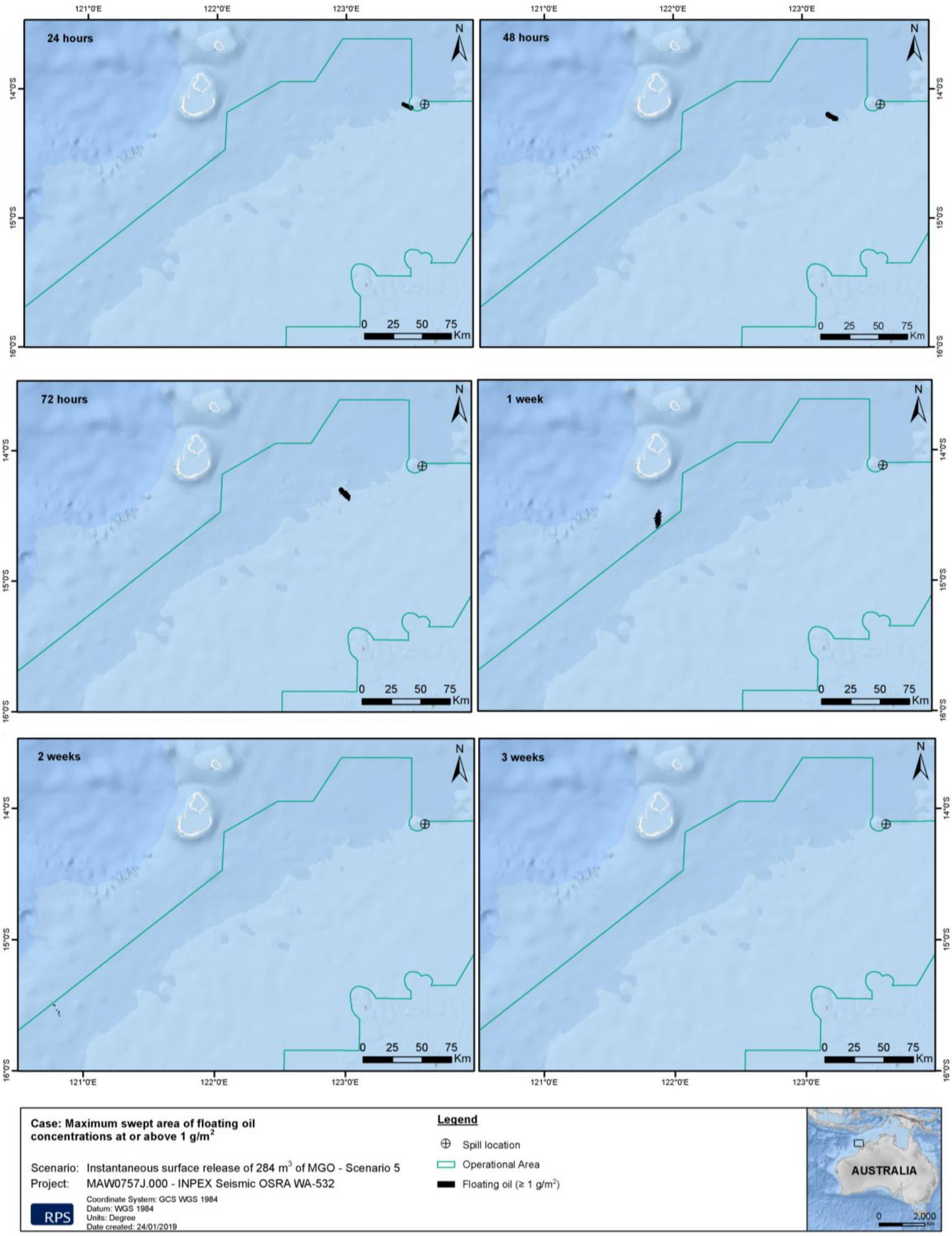


Figure 8-3: Time-varying areal extent of potential exposure at >1g/m^2 - 284 m^3 MGO spill at Site 5

8.2.5 Impact and risk evaluation

Table 8-5: Impact and evaluation – Vessel collision resulting in Surface release of a Group II (Marine Diesel)

Identify hazards and threats	
A surface release of Group II hydrocarbons has the potential to result in changes to water quality through surface and shoreline hydrocarbon exposure. The thresholds for impacts associated with surface, entrained/dissolved, and shoreline, hydrocarbon exposures are described in Table 8-1. The outcome of the predictive modelling for the vessel collision scenario is presented in Table 8-5.	
Potential consequence	**Severity**
The values and sensitivities with the potential to be affected by surface hydrocarbon exposure from a surface release due to a vessel collision include: • commercial, recreational and traditional fisheries including aquaculture (within 392 km from the release location based on 1 g/m^2 visible sheen threshold) • transient, EPBC-listed species (within 206 km from the release location based on 10 g/m^2 impact threshold) • planktonic communities (within 206 km from the release location based on 10 g/m^2 impact threshold). The values and sensitivities associated with commercial, recreational and traditional fishing (seafood quality and employment) could be impacted due to a spill from a vessel collision. Implementing an exclusion zone during a spill response may impede access to fishing areas for a short-to-medium term, and nets and lines could become oiled (ITOPF 2011). Commercial fisheries that operate within the operational area, up to 392 km from the release location could be exposed to surface hydrocarbons (1 g/m^2). The commercial fisheries comprise a relatively low number of fishing vessel and fishing effort (Section 4.9.5). Recreational fishing (Section 4.9.8) is concentrated around the population centres of Broome, Derby and Wyndham as well as other readily accessible coastal settlements along the Kimberley coastline. There is little recreational fishing that occurs within the Operational Area because of its distance from land, however recreational fishing areas may be exposed to a visible sheen of surface hydrocarbons. Traditional fishing, particularly at Browse Island, Scott Reef, Ashmore Reef and along the Kimberley coast such as at Balanggarra, Bardi Jawi, Dambimangari, Karajarri, Nyangumarta Warrarn and Uunguu IPAs could be affected by exposure to surface hydrocarbons. Based on the expected rapid weathering of MGO at the sea surface by evaporation, photo-oxidation and biodegradation and high potential for entrainment due to wave and wind action, any surface exposure is expected to be limited to a relatively short duration (less than a few days) (RPS 2019). Therefore, the socioeconomic impacts on commercial, recreational and traditional fishing are expected to be short-to-medium term, and the consequence is considered to be Minor (E).	Minor (E)

There are five marine fauna BIAs (marine mammals, dolphins and dugongs, marine reptiles, fish and sharks, and marine avifauna) located in areas predicted to be exposed to surface expressions above the 10 g/m^2 exposure threshold. As air-breathers, marine mammals, if they surface, are vulnerable to exposure to hydrocarbon spill impacts through the inhalation of evaporated volatiles. Effects include toxic effects, such as damage to lungs and airways, and eye and skin lesions from exposure to oil (AMSA 2019a; WA DoT 2018a). For the short time that the majority of volatile components of the spill are present (less than 24 hours; RPS 2019), vapours from the spill are considered the most significant risk to cetacean health, as their exposure can be significant. Vapours, if inhaled, have the potential to damage the mucous membranes of the airways and the eyes. Inhaled volatile hydrocarbons are transferred rapidly to the bloodstream and may accumulate in tissues, such as in the brain and liver, resulting in neurological disorders and liver damage (AMSA 2019a; Gubbay & Earll 2000). Blue whales and humpback whales (baleen whales), that may filter-feed near the surface, would be more likely to ingest oil than gulp-feeders, or toothed-whales and dolphins. Spilled hydrocarbons may also foul the baleen fibres of baleen whales, thereby impairing food-gathering efficiency, or resulting in the ingestion of hydrocarbons, or prey that has been contaminated with hydrocarbons (AMSA 2019a). Turtles can be exposed to hydrocarbons if they surface within the spill, resulting in direct contact with the skin, eyes, and other membranes, as well as the inhalation of vapours or ingestion (Milton et al. 2003). Floating oil is considered to have more of an effect on reptiles than entrained/dissolved oil because reptiles hold their breath underwater and are unlikely to directly ingest dissolved oil (WA DoT 2018a). Other aspects of turtle behaviour, including a lack of avoidance behaviour, indiscriminate feeding in convergence zones, and large, pre-dive inhalations, make them vulnerable (AMSA 2019a). In addition, hatchlings spend more time on the surface than older turtles, thus increasing the potential for contact with oil slicks (Milton et al. 2003). Marine avifauna have the potential to directly interact with hydrocarbons on the sea surface, in the course of normal foraging activities. Direct contact with surface hydrocarbons may result in dehydration, drowning and starvation and is likely to foul feathers, which may result in hypothermia (AMSA 2019a; Matcott et al. 2019). Birds resting at the sea surface and surface-plunging birds are considered particularly vulnerable to surface hydrocarbons. Impacts may include damage to external tissues, including skin and eyes, and internal tissue irritation in lungs and stomachs (Clark 1984; WA DoT 2018a). Toxic effects may also result where hydrocarbons are ingested, as birds attempt to preen their feathers (Jenssen 1994; Matcott et al. 2019). Based on the predicted limited geographical extent of the surface hydrocarbons at any time (refer Figure 8-2 and Figure 8-3 for worst-case examples >1 g/m^2), the rapid evaporation of volatile components, rapid entrainment of most oil under normal wind conditions, and expected weathering resulting in reduced levels of toxicity, any impacts to transient EPBC-listed species are expected to be on a local scale, with short-term impacts on a small portion of the population of a protected species (Minor E).	

Plankton may potentially be exposed to hydrocarbons on the sea surface. However, the majority of impacts would be toxicity related, associated with entrained/dissolved hydrocarbons exposure, therefore, the impact evaluation for plankton is provided in the subsection below.	
Potential consequence – entrained/dissolved hydrocarbons	**Severity**
The maximum entrained oil concentrations predicted for each scenario are presented in Table 8-4. The highest calculated entrained concentrations for each scenario ranged from 4216 ppb (Scenario 5), up to 10825 pbb (Scenario 2). The maximum extent of entrained oil plumes >500 ppb was 527 km from the release location. The maximum dissolved oil concentrations predicted for each scenario are presented in Table 8-4. The highest calculated dissolved concentrations for each scenario ranged from 122 ppb (Scenario 2), up to 154 pbb (Scenario 4). As such, no scenario exceeded the 500 ppb dissolved oil impact threshold at any distance from the release location. The values and sensitivities with the potential to be affected by entrained/dissolved hydrocarbons (up to 527 km from the release location) from a surface MGO spill include: • commercial, traditional and recreational fisheries including aquaculture • KEFs and associated biodiversity • benthic primary producer habitats / benthic habitats (corals, seagrasses and mangroves) • transient, EPBC-listed species, including all BIAs • planktonic communities. Fishing grounds that overlap or are adjacent to the permit area may potentially be exposed to entrained/dissolved hydrocarbons above impact thresholds (500 ppb). The level of effort in some fisheries is reported to be low, however for other fishing activities it is unknown. A surface release of diesel is expected to entrain predominantly within the upper water column (top 10 meters) (RPS 2019), therefore exposure is considered to be relatively limited within the water column. It is considered that socioeconomic impacts on commercial, recreational and traditional fisheries would be limited to isolated disruption with limited adverse impact (Minor E). The impact to fish communities from exposure to entrained and dissolved hydrocarbons above the 500 ppb threshold is primarily associated with toxicity. This is linked to seafood quality as described above for commercial, recreational and traditional fishing. Several KEFs (Section 4.2) overlap the Operational Area. However, in the event of a vessel collision spill, entrained/dissolved hydrocarbons will be present generally only in the very shallow/upper water column. Therefore, only the fish and sharks in the shallow water column associated with KEFs, and other site attached fish on coral reefs and other BPPH, have the potential to be exposed to entrained/dissolved hydrocarbons above the 500 ppb threshold. Chronic impacts to juvenile fish, larvae, and planktonic organisms may occur if exposed to entrained/dissolved	Minor (E)

hydrocarbon plumes potentially resulting in lethal or sub-lethal effects or impairment of cellular functions (WA DoT 2018a). Juvenile fish and larvae may experience increased toxicity upon such exposure to plumes, because of the sensitivity of these life stages, with the worst impacts predicted to occur in smaller species (WA DoT 2018a). Adult fish exposed to entrained hydrocarbons are likely to metabolise the hydrocarbons and excrete the derivatives, with studies showing that fish have the ability to metabolise petroleum hydrocarbons. These accumulated hydrocarbons are then released from tissues when fish are returned to hydrocarbon free seawater (Reiersen & Fugelli 1987). Given the highly mobile nature of pelagic fish, they are not expected to remain within entrained hydrocarbon plumes for extended periods, and limited acute impacts or risks associated with entrained hydrocarbons are expected. The Whale Shark BIA overlaps the Operational Area, and as such, Whale Sharks may be exposed above the 500 ppm threshold. Potential effects to whale sharks include damage to the liver and lining of the stomach and intestines, as well as toxic effects on embryos (Lee 2011). As whale sharks are filter-feeders they are expected to be highly vulnerable to entrained hydrocarbons (Campagna et al. 2011). Due to the short duration and limited geographical extent, only a small scale, short term impacts could occur to fish and sharks. As such, the consequence of entrained/dissolved hydrocarbons on fish and shark populations is considered to be Minor (E). Benthic communities in the EMBA including coral reefs, would be exposed to entrained/dissolved hydrocarbons above the impact threshold. Shallow-water communities are generally at greater risk of exposure than deep-water communities (NRC 1985; WA DoT 2018). Exposure of entrained and dissolved hydrocarbons to shallow subtidal corals has the potential to result in lethal or sublethal toxic effects, resulting in acute impacts or death at moderate-to-high exposure thresholds (Loya & Rinkevich 1980; Shigenaka 2001; WA DoT 2018a), including increased mucus production, decreased growth rates, changes in feeding behaviours and expulsion of zooxanthellae (Peters et al. 1981; Knap et al. 1985). Adult coral colonies, injured by oil, may also be more susceptible to colonisation and overgrowth by algae or to epidemic diseases (Jackson et al. 1989). Lethal and sublethal effects of entrained and dissolved oils have been reported for coral gametes at much lesser concentrations than predicted for adult colonies (Heyward et al. 1994; Harrison 1999; Epstein, Bak & Rinkevich 2000). Goodbody-Gringley et al. (2013) found that exposure of coral larvae to oil and dispersants negatively impacted coral settlement and survival, thereby affecting reef resilience. A spill that occurred outside of a coral-spawning period may not affect coral planktonic stages, however a range of BPPH locations may be exposed to entrained and dissolved oil concentrations greater than the threshold concentrations. However, due to the small temporal and geographical extent, and rapid weathering, potential impacts to coral reefs are considered to be Minor (E). Entrained and dissolved hydrocarbons have the potential to affect seagrasses and macroalgae through toxicity impacts. The hydrophobic nature of hydrocarbon molecules allows them to concentrate in membranes of aquatic plants. Hence the thylakoid membrane (an integral component of the photosynthetic apparatus) is susceptible to oil accumulation, potentially resulting in reduced photosynthetic activity (Runcie & Riddle 2006). However, a layer of mucilage present on	

most species of seagrass prevents the penetration of toxic aromatic fractions (AMSA 2019a). Although seagrass and macroalgae may be subject to lethal or sublethal toxic effects, including mortality, reduced growth rates, and impacts to seagrass flowering, several studies have indicated rapid recovery rates may occur even in cases of heavy oil contamination (Connell et al 1981; Burns et al. 1993; Dean et al. 1998; Runcie & Riddle 2006). For algae, this could be attributed to new growth being produced from near the base of the plant while the distal parts (which would be exposed to the oil contamination) are lost. For seagrasses this may be because 50–80% of their biomass is in their rhizomes, which are buried in sediments, thus less likely to be adversely impacted by hydrocarbons (Zieman et al. 1984). It has been reported by Taylor and Rasheed (2011) that seagrass meadows were not significantly affected by an oil spill when compared to a non-impacted reference seagrass meadow. The majority of seagrass locations within the EMBA are distant from the Operational Area; therefore, the received concentrations will generally be lower; however, still above the threshold that could cause impacts. Based on the above impact assessment and expected recovery, the consequence is considered to be Insignificant (F). Mangrove communities within the EMBA (refer to Section 4.7.3), present along WA coastlines are also susceptible to entrained oil exposure, with potential impacts, including defoliation and mortality. A study by Duke (2000), on the use of dispersant on surface spills, resulting in an increase in the entrainment of oil showed a positive benefit to mangroves. Therefore, the impacts of entrained/dissolved oil on mangroves is expected to be less than the impacts predicted from surface oiling (Burns et al. 1993; Duke et al. 2000). Mangrove communities are distant from the Operational Area, therefore the associated received concentrations will be lower; however, still above the threshold that could cause impacts. Based on the above impact assessment, the consequence is considered to be Insignificant (F). Marine mammals, marine reptiles and marine avifauna (including those present in the BIAs) could also be impacted through entrained and dissolved hydrocarbon exposure, primarily through ingestion during foraging activities (AMSA 2019a; WA DoT 2018a). Several BIAs overlap the Operational Area (Section 4.8). Several wetlands of conservational significance and Ramsar sites are also present within the EMBA (refer to Section 4.5), these sites provide important habitat for marine avifauna. However, due to the small temporal and spatial nature of the entrained plume, any impacts to transient EPBC-listed species are expected to be on a local scale, with short-term impacts on a small portion of the population of a protected species (Minor E). As a consequence of their presence close to the water surface, planktonic communities may be exposed to entrained/dissolved hydrocarbon plumes, especially in high-energy seas where the vertical mixing of oil through the water column would be enhanced. The effects of oil on plankton have been well studied in controlled laboratory and field situations. The different life stages of a species often show widely different tolerances and reactions to oil pollution. Usually, eggs, larval and juvenile stages will be more susceptible than adults (Harrison 1999). Post-spill studies on plankton populations are few, but those that have been conducted typically show either no effects, or temporary minor effects (Kunhold 1978). The lack of observed effects may be accounted for by the fact that many marine species produce	

very large numbers of eggs, and therefore larvae, to overcome natural losses (such as through predation by other animals; adverse hydrographical and climatic conditions; or failure to find a suitable habitat and adequate food). Impacts on plankton from a surface diesel spill is expected to be localised, with short-term impacts (Minor E).	
Potential consequence – shoreline hydrocarbons	**Severity**
As summarised in Table 8-4, shorelines within the EMBA were predicted to receive shoreline accumulations of hydrocarbons. Those receptors which received shoreline concentrations in excess of the 100 g/m^2 threshold are listed below. For each receptor, the worst individual shoreline concentration in any grid-square within a receptor, and probability of shoreline contact >100g/m^2 are provided. • Lacepede Islands (3313 g/m^2; 2%) • North Broome Coast (305 g/m^2; 1%) • Northern Dampier Peninsula (424 g/m2; 2%) • Clerk Reef (Rowley Shoals Marine Park (MP)) (1929 g/m^2; 2%) • Imperieuse Reef (Rowley Shoals MP) (172 g/m^2; 1%) • Adele Island (3312 g/m^2; 16%) • Bonaparte Archipelago (660 g/m^2; 1%) • Buccaneer Archipelago (3313 g/m^2; 7%) • Lalang-garram / Camden Sound Marine Park (660 g/m^2; 1%) • Browse Island (3312 g/m^2; 20%) • Sandy Islet (Scott Reef) (3312 g/m^2; 7%). The worst case volumes predicted ashore are as follows: • Lacepede Islands (48 m^3) • North Broome Coast (4 m^3) • Northern Dampier Peninsula (24 m^3) • Clerk Reef (Rowley Shoals MP) (48 m^3) • Imperieuse Reef (Rowley Shoals MP) (3 m^3) • Adele Island (119 m^3) • Bonaparte Archipelago (10 m^3)	Significant (C)

• Buccaneer Archipelago (90 m^3) • Lalang-garram / Camden Sound Marine Park (8 m^3) • Browse Island (100 m^3) • Sandy Islet (Scott Reef) (55 m^3). The minimum reported time to contact (>1 g/m^2) ranged between 1 hour (Scenario 5 – Browse Island) to 473 hours (Scenario 1 – North Broome Coast). Given this range of times at which oil could reach shorelines, the spill may or may not have undergone physical and biological weathering processes, including photo-oxidation and biodegradation (Stout et al 2016). Impacts to ecological receptors from exposure to weathered oil (waxy flakes and residues) are far less than those associated with exposure to fresh oils, which have higher levels of toxicity (Milton et al. 2003; Hoff & Michel 2014; Woodside 2014; Stout et al. 2016). Therefore, impacts from weathered oil are generally limited to smothering and coating associated with the waxy flakes and residues which generally have low levels of adhesion, compared to toxic effects, similar to those described for entrained/dissolved oils above. Intertidal habitats and marine fauna known to use shorelines are most at risk from shoreline accumulations, due to smothering of intertidal habitats (such as emergent coral reefs) and coating of marine fauna (WA DoT 2018a). It should be noted however, that completely intertidal habitats, (such as Mermaid Reef, Seringapatam Reef etc. which are only exposed on low spring tides) can't accumulate large volumes of oil in the same way as an intertidal reef/beach system can, where oil will strand upon/above the tide line. The particular values and sensitivities with the potential to be exposed to shoreline accumulated hydrocarbons are: • benthic primary producer habitats/shoreline habitats (intertidal only) • transient, EPBC-listed species (BIAs – marine reptiles and avifauna). Benthic primary producer habitats exposed at low tides are the most vulnerable to smothering. However, as spills disperse, intertidal communities are expected to recover (Dean et al. 1998). Direct contact of hydrocarbons to emergent corals can cause smothering, resulting in a decline in metabolic rate and may cause varying degrees of tissue decomposition and death. A range of impacts may also result from toxicity, including partial mortality of colonies, reduced growth rates, bleaching, and reduced photosynthesis (Negri & Heyward 2000; Shigenaka 2001). The rate of recovery of coral reefs depends on the level or intensity of the disturbance, with recovery rates ranging from 1 or 2 years, to decades (Fucik et al. 1984, French-McCay 2009). Several wetlands of conservational significance are located within the EMBA (refer Section 4.5). These coastal sites generally include intertidal mudflats and mangroves that provide important foraging, resting and breeding habitats for migratory and shoreline bird species. Mangrove communities within the EMBA could potentially be exposed to shoreline oil accumulation above impact threshold concentrations, with potential impacts including defoliation and mortality (Burns et al. 1993; Duke et al. 2000). The recovery of mangroves from shoreline oil accumulation can be a slow process, due to the long-term persistence of oil trapped in anoxic sediments and subsequent release into the water column (Burns et al. 1993). Mangrove communities are generally only present on the Kimberley coast, not close to the Operational Area. Therefore, shoreline accumulations are expected to	

be weathered residues. Lighter oils are reported to penetrate more deeply into mangrove forests than heavier and more weathered oils (Hoff & Michel 2014); therefore, it is considered that weathered hydrocarbons will generally be less toxic in nature (Stout et al. 2016). Given the range of predicted time to contact and the range of potential weathered states (fresh to very weathered) of any hydrocarbons accumulating on shorelines, impacts to benthic habitats are expected to be localised and of short to medium term with a Moderate consequence (D). Marine reptiles, including turtles and crocodiles that utilise shoreline habitats can be exposed to hydrocarbons externally, through direct contact; or internally, by ingesting oil, consuming prey containing oil, or inhaling volatile compounds (Milton et al. 2003). Shoreline hydrocarbons can impact turtles at nesting beaches when they come ashore, with exposure to skin and cavities, such as eyes, nostrils, and mouths. Eggs may also be exposed during incubation, potentially resulting in increased egg mortality and detrimental effects on hatchlings. Hatchlings may be particularly vulnerable to toxicity and smothering, as they emerge from the nests and make their way over the intertidal area to the water (AMSA 2019a; Milton et al. 2003). There are a number of foraging, nesting and internesting BIAs for turtles within the EMBA that have the potential to be exposed to shoreline accumulations above the impact threshold concentration (100 g/m^2). Potential impacts may occur on nesting populations, which may affect species recruitment at a local population level particularly in relation to the green turtles at Browse island with a small, localised range of habitat (DEE 2017a). Given the shortest predicted time for shoreline contact to occur (96 hours for Ashmore Reef) and worst-case predicted concentration (2,083 g/m^2), there is the potential for local-to-medium-scale impacts with medium-term effects on nesting populations of turtles at individual nesting beaches/locations. At locations with longer times for shoreline contact, there is a high potential for hydrocarbons to become weathered. Weathered oil has been shown to have little impact on turtle egg survival, while fresh oil may have a significant impact (Milton et al. 2003). Therefore, given the time to reach shoreline contact and potential for weathering, the potential consequence is considered to be Moderate (D). Birds coated in hydrocarbons can suffer from damage to external tissues including skin and eyes, as well as internal tissue irritation in their lungs and stomachs (AMSA 2019a). Toxic effects may also result where the product is ingested, either through birds' attempts to preen their feathers (Jenssen 1994; Matcott et al. 2019) or ingested as weathered residues present on shorelines. However, residues are generally considered to be of lower toxicity (Stout et al. 2016; Woodside 2014). Shorebirds foraging and feeding in intertidal zones are at potential risk of exposure to shoreline hydrocarbons, potentially causing acute effects to numerous marine avifauna BIAs, and species present at Ramsar/wetland sites as described above. It is also possible that birds exposed to surface hydrocarbons may be displaced (i.e. fly away) and use nearby shorelines to recover, thereby, potentially increasing their exposure to shoreline hydrocarbons. In the event of a shoreline contact following a vessel collision resulting in loss of marine diesel, there is the potential for short–to-medium-term impacts on the environment while local populations recover; however, it is not	

expected that the overall population viability for any protected species would be threatened. Therefore, the potential consequence associated with shoreline hydrocarbon exposure is considered to be Moderate (D). Turtles can be exposed to hydrocarbons externally, through contact; or internally, by ingesting oil, consuming prey containing oil, or inhaling volatile compounds (Milton et al. 2003). Shoreline hydrocarbons can impact turtles at nesting beaches when they come ashore, with exposure to skin and cavities, such as eyes, nostrils, and mouths. Eggs may also be exposed during incubation, potentially resulting in increased egg mortality and detrimental effects on hatchlings. Hatchlings may be particularly vulnerable to toxicity and smothering, as they emerge from the nests and make their way over the intertidal area to the water (AMSA 2019a; Milton et al. 2003). As there are a number of BIAs for marine turtles with the potential to be exposed to shoreline accumulation, there is the potential for impacts on nesting populations, which has the potential to affect species recruitment at a local population level particularly in relation to the green turtles at Browse Island, Sandy Islet and Lacepede Islands (DEE 2017a). Given the predicted time for shoreline contact to occur (1 hour for Browse Island, if the vessel collision occurred immediately adjacent to Browse Island with the worst possible wind conditions) and the worst credible predicted volumes ashore (100 m^3 at Browse Island, 55 m^3 at Sandy Islet – Scott Reef, and 48 m^3 at Lacapede Islands), there is the potential for local-to-medium-scale impacts with medium-term effects on nesting populations of turtles at individual nesting beaches/locations. At collision locations which result in longer times for shoreline contact, hydrocarbons will become weathered. Weathered oil has been shown to have little impact on turtle egg survival, while fresh oil may have a significant impact (Milton et al. 2003). Therefore, given high likelihood of only weathered oil reaching a shoreline, the potential consequence is considered to be Moderate (D). In summary, the potential extent of shoreline accumulation may result in exposure to marine fauna (including nesting/roosting EPBC-listed species, such as turtles and seabirds) and intertidal benthic habitats, such as coral reefs and mangroves. There would likely also be cumulative impacts as a result of interactions between surface, entrained/dissolved and shoreline hydrocarbon impacts on the food web and through bioaccumulation up the food chain. On this basis, the potential consequence associated with shoreline accumulation from the identified spill events is considered to be Significant (C).	
Identify existing design and safeguards/controls measures	
Marine vessels >400 tonne (t) will carry SOPEPs approved under MARPOL 73/78 Annex 1, Regulation 37. Vessels fitted with lights, signals, an automatic identification system (AIS) transponders and navigation equipment as required by the *Navigation Act 2012*.	

Propose additional safeguards/control measures (ALARP Evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	Eliminate vessels.	No	Vessels are the only form of transport that can undertake the seismic survey and maintain ongoing logistical support to the survey vessel.
Substitution	None identified.	N/A	N/A
Engineering	None identified	N/A	No practicable engineering solutions additional to vessels fitted with lights, signals, an automatic identification system (AIS) transponders and navigation equipment, as required by the *Navigation Act 2012*, were identified.
Procedures & administration	Australian Hydrographic Office (AHO) will be informed of the proposed survey activity location prior to the activity commencing.	Yes	By informing AHO of the location of the survey activity, it can update navigation charts, to inform third parties of the location of the survey, reducing the risk of accidental third-party interactions with areas of increased vessel activity around the survey vessel.
	Bunkering/refuelling or other vessel side-by-side activities to occur outside of the HPZ or NPZ of the Kimberley AMP and away from State waters.	Yes	By limiting where bunkering/refuelling or other vessel side-by-side activities may occur, a spill occurring as a result of refuelling or a vessel collision in these areas is prevented. No bunkering/refuelling or vessel side-by-side activities in the HPZ or NPZ of the Kimberley AMP or within 25 km of the State waters limit. 25 km was determined to be appropriate, as spill modelling (RPS 2019) indicates that in the event of a spill, there is a less than 20% probability of floating hydrocarbons >10 g/m^2 occurring beyond this range and more than 24 hours would elapse under most wind and current conditions before hydrocarbons reached State waters, by which time most of the toxic aromatic components and the volatile to semi-volatile components of the MGO will have evaporated. Therefore, the potential for a hydrocarbon spill to impact State waters, shorelines and emergent reefs is substantially reduced.

			Reducing the potential for a spill in then HPZ and NPZ protects the values of the AMP in a natural state.
	Incident management, and emergency response plans in place.	Yes	Implement INPEX Australia Incident Management Plan (0000-AH-PLN-60005), INPEX Australia Crisis Management Plan (0000-AH- PLN-60004) and Contractor Emergency Response Plan (ERP).
	Oil spill and source control response preparedness maintained	Yes	To ensure that INPEX is prepared to respond to loss of containment event, response preparedness will be maintained in accordance with Section 8.4, 8.5 and 9.10 of this EP.
	INPEX will provide all available support to AMSA and WA DoT in their performance of their control agency responsibilities for vessel-based spill events.	Yes	INPEX has signed a memorandum of understanding with AMSA for oil spill preparedness and response (AMSA/INPEX 2013). This MoU acknowledged AMSA's responsibility under the National Plan (AMSA 2019b) as the control agency for vessel-based spill scenarios, and INPEX has acknowledged that it will support AMSA to implement the NatPlan. Under the State Hazard Plan – Marine Environmental Emergencies (WA DoT 2018b), WA DoT is the control agency for all spills entering WA waters. Therefore, for vessel-based spill events, INPEX will provide support in undertake spill response activities as directed by the control agency – AMSA or WA DoT. Refer to Section 4 of the OPEP (Appendix D) for details of the INPEX oil spill response capability, which it can provide to AMSA and WA DoT in support of a vessel-based spill scenario.
Identify the likelihood			
Reported industry statistics indicate vessel failures are considered rare with 37 collisions reported out of a total of 1200 marine incidents in Australian waters between 2005 and 2012 (most recent data) (ATSB 2013). A ship collision risk assessment was undertaken to support the nearby INPEX Ichthys Project. The study determined collision frequencies and impact energies for passing (third-party) vessels, infield vessels and offloading tankers. The annual frequency of a			

collision with a passing vessel – i.e. one not within the control of INPEX – imparting at least 150 MJ (sufficient impact energy) is 3.5 × 10^{-7}, or once every 2.9 million years. The results of this study and similar level of vessel density in the Operational Area is considered comparable for this EP. The likelihood of the vessel collision occurring at the worst possible location (closes to a sensitive environmental receptor) is considered remote, given the brief period of time the seismic survey vessels would be in close proximity to a sensitive receptor. On this basis and given the controls that have been identified to minimise the potential for vessel collision and subsequent loss of containment, and the lack of time the vessel will spend in close proximity to sensitive receptors, the likelihood of the consequence occurring is considered Remote (6).		
Residual risk summary		
Based on the worst-case consequence for all applicable hydrocarbon exposure mechanisms (surface/shoreline) Significant (C) and a likelihood of Remote (6) the residual risk is ranked as Moderate (8).		
Consequence	Likelihood	Residual risk
Significant (C)	Remote (6)	Moderate (8)
Assess residual risk acceptability		
Legislative requirements The activities and proposed management measures are compliant with industry standards and with relevant Australian legislation, specifically concerning navigational safety requirements, including AMSA *Marine Orders – Part 30: Prevention of Collisions, Issue 8* (Order No. 5 of 2009). **Stakeholder consultation** Stakeholders have been engaged throughout the development of the EP. Where relevant, the controls in place have been developed in consultation with relevant stakeholders (e.g. WA DoT, AMSA, WAFIC). The controls in place are considered to manage risks associated with a vessel collision to ALARP. **Australian marine park values, objectives and zone rules** Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018: • The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. Vessels will not enter the Habitat Protection Zone or the National Park Zone. Emergency response activities are permitted in all zones.		

- No significant or long-term impacts to AMP values are expected to occur.
- The proposed activity will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- The proposed activity will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
- The proposed activity will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.
- The proposed activity will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans (refer Appendix B) identify oil spills as a key threatening process, through both direct/acute impacts of oil, as well as indirect impacts through habitat degradation (which is a potential consequence of an oil spill). The prevention of vessel collisions and reducing impacts to the marine environment through oil spill response preparedness and response (refer OPEP, Appendix F), demonstrates alignment with the various conservation management plans.

ALARP summary

Given the level of environmental risk is assessed as Significant, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the activity demonstrates compliance with legislative requirements/industry standards;
- the activity takes into account stakeholder feedback;
- the activity is managed in a manner that is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- the activity is managed in a manner that is consistent with the intent of conservation management documents;
- the activity does not compromise the relevant principles of ESD; and

- the predicted level of impact does not exceed the defined acceptable level in that the environmental risk has been assessed as "Moderate", the consequence does not exceed "C – Significant" and the risk has been reduced to ALARP.

Environmental performance outcomes	**Environmental performance standards**	**Measurement criteria**	**Responsibility**
No incidents of loss of hydrocarbons to the marine environment as a result of a vessel collision.	Vessels will be fitted with lights, signals, AIS transponders and navigation and communications equipment, as required by the *Navigation Act 2012*.	Records confirm that required navigation equipment is fitted to vessels to ensure compliance with the *Navigation Act 2012*.	Environmental Advisor
	Australian Hydrographic Office (AHO) will be informed of the proposed survey location prior to the activity commencing.	Records of document transmittal to AHO.	INPEX Offshore Representative
	No bunkering/refuelling or vessel side-by-side activities in the HPZ or NPZ of the Kimberley AMP or within 25 km of the State waters limit.	Vessel records and fuel bunkering records confirming locations of bunkering or other side-by-side resupply activities.	Vessel Master
Risks of impacts to commercial, traditional and recreational fisheries, emergent benthic primary producer habitats, BIAs, transient EPBC-listed species and planktonic communities from Group II hydrocarbon spills are reduced and maintained at acceptable levels through implementation of the environmental performance standards and the application of the environmental management implementation strategy.	Vessels >400 GT have SOPEPs compliant with Marine Orders – Part 91, the POTS Act, and Annex I of MARPOL 73/78 (oil) on board.	Valid vessel SOPEP	Vessel Master
	Emergency response preparedness will be maintained through implementing Sections 8.5 and 9.10 of this EP.	Records demonstrate response preparedness is maintained in accordance with Sections 8.5 and 9.10 of this EP.	INPEX Environmental Adviser
	INPEX Australia Incident Management Plan (0000-AH-PLN-60005) and INPEX Australia Crisis Management Plan (0000-AH- PLN-60004) and will be implemented in the event of a vessel collision.	Records demonstrate Incident and Crisis Management Plans and were implemented following a vessel collision.	IMT Leader

	In the event of a vessel collision, INPEX will provide all available support to AMSA and/or WA DoT in their performance as Control agency.	In the event of a vessel collision, records confirm INPEX provided support, as requested by AMSA and WA DoT.	IMT Leader

8.3 Spill Impact Mitigation Assessment

INPEX has developed a series of Strategic Spill Impact Mitigation Assessments (SIMA) for each maximum credible spill scenario relevant to INPEX Australia's exploration and production activities in the Browse Basin.

The strategic SIMAs are:

- condensate/gas well blowout – long duration subsea release
- condensate spill – instantaneous surface release
- MGO/diesel spill – instantaneous surface release (relevant to this EP)
- intermediate/heavy fuel oil spill – instantaneous surface release.

The SIMA process has been developed as a pre-spill planning tool for all INPEX EPs, to facilitate response option selection and support the development of the overall response strategies by identifying and comparing the potential effectiveness and impacts of oil spill response options (IPIECA 2017a). The strategic SIMA assists in the assessment of the impact mitigation potential and in making a transparent determination of response strategies that are considered most effective at minimising oil spill impacts (IPIECA 2017a). The framework includes environmental considerations as well as a range of shared values such as ecological, socio-economic and cultural aspects (IPIECA 2017a).

8.3.1 SIMA process

The SIMA process as outlined in the "Guidelines on implementing spill impact mitigation assessment (SIMA)" (IPIECA 2017a) has four stages:

1. Compile and evaluate data relevant for relevant oil spill scenarios including fate and trajectory modelling, identification of resources at risk and determination of safe and feasible response options.
2. Predict outcomes/impacts for the "No Intervention" (or "natural attenuation") option as well as the effectiveness (i.e. relative mitigation potential) of the feasible response strategy for each scenario.
3. Balance trade-offs by weighing and comparing the range of benefits and drawbacks associated with each response strategy, compared to 'No Intervention', for the spill scenario.
4. Select the best response strategies to form the response plan for the scenario, based on which best combination of response strategies will minimise the overall spill impacts and promote rapid recovery.

INPEX have generated strategic SIMAs, one of which addressed the Group II (marine diesel) surface release from a vessel collision in the Browse Basin/NW WA region. This strategic SIMA is presented in Appendix G.

Predictive oil spill modelling (E.g. outputs from various INPEX Brose Basin oil spill modelling reports) have been used to support the strategic SIMAs through defining generic oil weathering characteristics for each broad type of spill scenario.

The resource compartments presented in each SIMA reflect the values and sensitivities described in Section 4 of EPs. The resource compartments have been defined as broad habitat types which support protected species, rather than focusing on individual protected species. This approach is recommended by IPIECA (2017a).

For each generic spill scenario, a relative impact score has been assigned to each resource compartment, for the 'no intervention' option. A supporting justification for each relative impact score for each resource compartment is also presented in the SIMA.

For each SIMA, eight oil spill response strategies were considered, including operational monitor and evaluation, containment and recovery, protect and deflect, shoreline clean-up, chemical dispersant, pre-contact wildlife response, post-contact oiled wildlife response (OWR) and in-situ burn.

For each response strategy, the impact mitigation potential was assessed against each resource compartment and given a score on a scale of '-3' to '+3', where a negative score reflects additional impact and a positive score reflects mitigation of impact (balance trade-offs). A supporting justification for each impact modification score for each response strategy against each resource compartment is also presented in the SIMA.

Each impact mitigation score was evaluated with no timing or resource limitations or weather constraints on the response strategy effectiveness (these factors are further considered in the oil spill response arrangements and capability evaluation, provided in the relevant EP, as related to the EP specific spill scenario).

Those response strategies with an overall positive score, and therefore represent a mitigation of impact from the spill, are then selected for further assessment in the relevant EP. Those response options with an overall negative score have been discounted and are not further evaluated in the relevant EP.

It should be noted that it is unlikely that a single response strategy will be completely effective in a large spill scenario, hence it is expected that multiple response strategies may be utilised in the event of a Level 2/3 spill.

In order to select appropriate oil spill response strategies applicable to the oil spill scenario described in this EP (Section8.2) INPEX's strategic SIMA for a MGO/diesel surface spill has been reviewed and assessed in Section 8.4.

8.4 Oil spill response arrangements and capability evaluation

The response strategies that demonstrated a positive impact mitigation potential in the strategic SIMA for a Group II (marine diesel) spill are;

- operational monitoring and evaluation
- contain and recover
- protect and deflect
- shoreline clean-up
- pre-contact wildlife response (hazing and translocation)
- post-contact wildlife response.

The following response strategies have been excluded from this EP based on the outcome of the strategic SIMA (Appendix G):

- In-situ burn
- Chemical dispersion application (surface).

Table 8-6 presents the response strategy applicability evaluation. In this evaluation, the response strategies which were selected via the strategic SIMA have been further evaluated for their applicability and suitability, by taking into account the expected resource and logistical limitations specific to the activity described in this EP. Spill scenario specific oil spill modelling data, including stochastic and deterministic modelling (as relevant), is also evaluated. Depending on the outcome of this evaluation, some response strategies may be excluded from further evaluation, as they have been assessed as not appropriate for the EP specific spill scenario.

Following the response strategy applicability evaluation, a response strategy element identification evaluation is undertaken, to define the resources required to successfully implement the selected response strategies, under a worst-case spill scenario. This evaluation is presented in Table 8-7.

Following the response strategy element identification evaluation, the response strategy arrangements and capability evaluation is undertaken. This process examines the merits of improving the capability or timeliness of response strategy elements. The response strategy arrangements and capability evaluation are presented in Table 8-8.

The response strategy arrangements and capability evaluation provides the justification that the spill response arrangements in place are effective in reducing environmental risks to ALARP and provides the reasoning and justification of the selected controls presented in Table 8-9: *Impact and risk evaluation – implementation of spill response strategies*.

Table 8-6: Response strategy applicability evaluation

Oil spill response technique	**Likelihood of success**	**Considered for implementation**
Operational monitoring and evaluation	The strategic SIMA found that operational monitoring and evaluation should always be implemented in the event of a level 2/3 spill. To implement this response strategy, the following capabilities are available: • oil spill trajectory modelling • aerial and vessel surveillance • oil spill tracker buoys • satellite surveillance capability. A detailed assessment of the logistical resources required to implement this response strategy are described in Table 8-7.	Yes
Contain and recover	The strategic SIMA found that contain and recover was potentially appropriate for Group II / diesel spills. Generally, oil needs to be >100 g/m^2 (O'Brien 2002) to feasibly corral oil with a boom and achieve any significant level of oil recovery with the skimmers. The initial, gravity-dominated release and spreading is generally complete within minutes to hours after a release (O'Brien 2002). In the context of the Browse Basin, with high sea surface and air temperatures in all seasons, the spreading of any diesel spill would be very rapid. INPEX currently do not maintain any offshore containment and recovery equipment (booms and skimmers) offshore in the Browse Basin area. However, INPEX do have access (via AMOSC) to a Level 2 stockpile of equipment in Broome, including offshore boom and skimmers. The practical deployment of offshore booms and skimmers from Broome to the Operational Area is expected to take >24 hours using a platform supply vessel (PSV) or small vessel (based on mobilisation of vessel to port, 6 hours loading in port and then steaming time to the spill location within the Operational Area).	No

Oil spill response technique	Likelihood of success	Considered for implementation
	Even if boom was stored on large vessels within the Operational Area, it would take crews several hours to physically deploy lengths of offshore boom. A minimum of two vessels would be required in the Operational Area at the time of the slick to create a boom configuration that would attempt to recover oil. There is no requirement to support the seismic survey vessel with additional support vessels at all times, therefore there is no obvious platform on which to store or deploy booms in the Operational Area. In addition, in the early stages of a diesel spill, in locations where concentrations are expected to be >100 g/m^2, vessel access to the immediate spill area is likely to be restricted due to the presence of volatile organic compounds (VOCs) in excess of safe exposure thresholds, and potential for a flammable atmosphere. Given the very short time following a diesel spill in which the slick would have spread to <100 g/m^2, and the associated atmospheric safety risks, it would not be considered ALARP to store boom offshore, or commence the mobilisation of boom from Broome, to attempt offshore containment and recovery. Therefore, this response strategy is not considered an appropriate strategy for further evaluation.	
Protect and deflect	The SIMA evaluation found that protection and deflection was potentially appropriate for Group II / diesel spills. Generally, oil needs to be >100 g/m^2 (O'Brien 2002) to feasibly deflect oil with a boom to achieve any significant level of oil deflection away from a sensitive location, or to achieve oil deflection into a collection area on a shoreline. Some of the shoreline locations are very close to the Operational Area, and could receive oil contact within 1 – 5 hours, if the vessel collision occurred at the closest possible point to the shoreline location, and the wind/current direction was also the worst possible direction, resulting in the short time to contact. Therefore, there is a remote possibility that oil >100 g/m^2 could be received on a shoreline. However, for protect and deflect to be feasible, the response team, with vessels and booms would need to be pre-positioned at the location, to enable any feasible protect and deflect response. Given the remote likelihood of a vessel collision occurring, the transient nature of the survey activity, and large number of remote islands which the survey activity will pass, it is not	No

Oil spill response technique	Likelihood of success	Considered for implementation
	considered feasible to attempt to pre-position personnel, booms and equipment at any individual receptor. In addition, conducting protect and deflect on fresh diesel spill would likely present unacceptable health and safety risks due to evaporation of VOCs into the local atmosphere. Furthermore, if the weather conditions were such that a strong wind pushed the MGO slick rapidly towards a shoreline, the majority of the MGO would become entrained, and the sea-state would be such that protect and deflect was not a practicable option at a remote location. INPEX currently do not maintain any offshore containment and recovery equipment (booms and skimmers) offshore in the Browse Basin area. However, INPEX do have access (via AMOSC) to a Level 2 stockpile of equipment in Broome. The practical deployment of protect and deflect equipment from Broome to the Operational Area is expected to take between 12 to 30 hours using a PSV or small vessel (based on 6 hours loading in port and then steaming time to the spill location within the Operational Area). By the time the vessel arrived at the shoreline, the slick would have spread to <100 g/m^2 and not be feasible to corral with booms. Therefore, this response strategy is not considered an appropriate strategy for further evaluation.	
Shoreline clean-up	The SIMA evaluation found that shoreline clean-up was potentially appropriate for Group II / diesel spills. The outcome of the spill modelling (Table 8-4) indicates that for a vessel collision, 119 m^3 of weathered diesel could accumulate on shoreline of Adele Island for the worst-case replicate of all scenarios. As such, shoreline clean-up may be appropriate (depending on a range of factors including the volume of oil ashore, state of weathering of the oil and seasonal factors, e.g. turtle breeding). However the benefits and trade-offs of this activity would need to be compared to natural weathering, to determine the likely effectiveness. As such, in the event of a spill resulting in shoreline contact, the IMT would consider shoreline clean-up as a response strategy based on the outcome of real-time operational monitoring and evaluation data.	Yes

Oil spill response technique	Likelihood of success	Considered for implementation
	To implement this response strategy, the following capabilities are available to INPEX: • Aircraft • Vessels • Shoreline clean-up equipment • Shoreline clean-up personnel (trained and general labour) • Waste management resources. A detailed assessment of the logistical resources required to implement this response strategy are described in Table 8-10. It should also be noted that for shorelines, the WA Department of Transport would make the ultimate decision on the response strategies to be implemented, with support provided by INPEX.	
Pre-contact wildlife response (hazing and translocation)	Wildlife hazing is most suitable when used near sensitive shoreline habitats against persistent oily slicks, such as HFO or crude oil spills. It is generally not appropriate in an open water environment. In the case of a diesel spill, surface oil slicks are thin and not considered particularly adhesive, therefore reducing the likelihood and severity of impacts on wildlife. Additionally, hazing isn't considered an effective measure against volatile spills which rapidly evaporate. IPIECA (2014) advise that the difficulty of capturing wildlife safely and maintaining their health during relocation should not be underestimated, and that working with live or dead animals has health and safety issues including potential injuries (bites, scratches) or zoonotic diseases. Risks to wildlife are high during pre-emptive capture and the risks of oiling need to be weighed against the risk of injury, death etc. The translocation of turtles from beaches and islands would likely require the capture of large numbers of hatchlings at night, followed by translocation to a location far from the slick (to prevent surface oil impacts on released hatchlings). Attempting to capture large numbers of healthy seabirds would be very challenging and there is no practicable method to capture healthy seabirds at sea (DPaW 2014). Any seabirds captured and then released would likely fly back to the shoreline from which they originally were captured. Long term veterinary care (feeding etc.) would be required for any successfully captured birds, until spill weathering or remediation had	Yes

Oil spill response technique	Likelihood of success	Considered for implementation
	occurred, and it was safe to release the animals. Overall, there is a potential for harm of animals captured to occur, however, as a spill response strategy it may result in a positive impact (Appendix F). In the event of a diesel spill, the IMT would consider pre-contact wildlife response as a response strategy based on the outcome of real-time operational monitoring and evaluation data received, and whether indications were that a significant number of individuals of a protected species would be likely to benefit from the response strategy. To implement this response strategy, the following capabilities are available to INPEX: • Aircraft • Vessels • Wildlife response equipment • Wildlife response personnel (trained and general labour) • Waste management resources. A detailed assessment of the logistical resources required to implement this response strategy are described in Table 8-7. It should also be noted that for shorelines and wildlife response, the WA Department of Transport would make the ultimate decision on the response strategies to be implemented, with support provided by INPEX.	
Post-contact wildlife response	Capture, relocation, assessment, cleaning, rehabilitation of oiled wildlife does have the ability to increase the survival of individuals. The scale of oil impacts on wildlife is dependent on factors such as timing, location, oceanographic and weather patterns, and the movements of species that forage, feed, nest and inhabit that area (IPIECA 2014). Given the predicted weathering of a diesel spill, most wildlife exposure is expected to be to weathered hydrocarbons, with lower associated levels of toxicity (Stout et al. 2016). Diesel slicks are relatively non-adhesive compared to crude oils, and generally not considered an oil product that would ‘coat’ the feathers of birds, requiring a full wildlife cleaning response on a shoreline. They are also not likely to generate a thick surface barrier on a shoreline which would coat adult nesting turtles or turtle hatchlings as they transit to the ocean.	Yes

Oil spill response technique	Likelihood of success	Considered for implementation
	Any seabirds captured, cleaned and released would likely fly back to the shoreline from which they originally were captured and may be repeatedly affected. Therefore, long term veterinary care (rehabilitation, feeding, etc.) would be required for any successfully captured birds, until spill weathering or remediation had occurred, and it was safe to release the seabirds. Once oiled, it is generally agreed that birds have a very low survival rate with many studies reporting the probability of dying near to 100%. The reported high success rates of seabird cleaning are typically associated with cleaning pelicans and penguins which are not present within the Browse Basin. IPIECA (2014) advise working with live or dead animals has health and safety issues including potential injuries (bites, scratches) or zoonotic diseases. In the event of a diesel spill, the IMT would consider post-contact wildlife response as a response strategy based on the outcome of the real-time operational monitoring and evaluation data received, and whether indications were that a significant number of individuals of a protected species would be likely to benefit from the response strategy. To implement this response strategy, the following capabilities are available to INPEX: • Aircraft • Vessels • Wildlife response equipment • Wildlife response personnel (trained and general labour) • Waste management resources. A detailed assessment of the logistical resources required to implement this response strategy are described in Table 8-7. It should also be noted that for shorelines and wildlife response, the WA Department of Transport would make the ultimate decision on the response strategies to be implemented, with support provided by INPEX.	

As described in Table 8-5, the worst credible spill scenario could involve:

- Oil above impact thresholds on the open ocean and on a remote shoreline

- Maximum accumulated oil ashore of 119 m^3
- Potential for multiple shorelines to be contacted simultaneously, within a small geographic area (e.g. Lacepede Island group, or both Clerk and Imperious reef at the Rowley Shoals).

The individual elements required to successfully undertake the identified response strategies are presented in Table 8-7.

Table 8-7: Response strategy element identification

Response Strategy	Response Strategy Purpose	Response Strategy Element
Operational monitoring and evaluation	Provide up to date information to the IMT, to enable the IMT to make timely and informed decisions	Oil spill trajectory modelling (OSTM) • OSTM will provide predictions of the trajectory and fate of the oil spill • For the worst credible spill response, only a single OSTM provider is anticipated to be required.
		Aerial surveillance aircraft and trained spotters • Aerial surveillance will assist with validating the OSTM predictions, through visual confirmation of the location and type of slick. • Personnel trained in aerial observation For a worst credible spill response, up to two flights per day over the spill area is anticipated to be required.
		Vessel surveillance • Vessel surveillance will assist with validating the OSTM predictions, through visual confirmation of the location and type of slick. For a worst credible spill response, only a single vessel conducting surveillance may be required, if at all (aerial surveillance only may be appropriate – refer Table 8-8).
		Electronic surface tracker buoys (ESTBs) • ESTBs will assist with validating the OSTM predictions • ESTBs will assist with aerial surveillance flight planning

		For the worst credible spill response, deployment of multiple ESTBs is anticipated to be required, to accurately validate the OSTM and assist with aerial surveillance flight planning.
		Satellite imagery • Satellite imagery will assist with validating the OSTM predictions For a worst credible spill response, only a single satellite imagery provider is anticipated to be required.
Shoreline Clean-up	Remove oil from the shoreline to minimise impacts to biota and accelerate natural recovery of the shoreline	Shoreline clean-up personnel • Experienced personnel, such as AMOSC core-group operations team personnel, who can lead a shoreline clean-up team • Labour hire personnel, who would receive on the job training from the team lead, and carry out the shoreline clean-up activities For a worst credible spill response, up to a maximum of 20 shoreline response personnel is anticipated. Refer Table 8-8 for further details.
		Shoreline clean-up equipment • Manual tools such as rakes and shovels, used to manually recover oil and oily debris from the shoreline For a worst credible spill response, a single shoreline clean-up kit is anticipated to be required.
Pre and post contact wildlife response	Prevent or minimise harm associated with the oiling of marine fauna	Wildlife response personnel • Experienced personnel, such as AMOSC oiled wildlife response team personnel, who can lead a wildlife response team • Wildlife handlers, trained in oiled wildlife response, such as the WA Oiled Wildlife Rehabilitators Network, and Phillip Island Nature Park personnel • Labour hire personnel, who would receive on the job training from the team leads, to assist with oiled wildlife response activities For a worst credible spill response, up to a maximum of 20 wildlife response personnel is anticipated. Refer Table 8-8 for further details.

		Wildlife response equipment • Wildlife response kits – used for the safe capture and transport of oiled wildlife • Wildlife response containers – used for triage, washing and rehabilitating wildlife (wildlife response containers can be mounted on the deck of a suitable accommodation support vessel) For a worst credible spill response at a remote shoreline, only a single wildlife response kit and wildlife response container (mounted on an ASV) is anticipated to be required.
		Wildlife hazing equipment • Wildlife hazing equipment typically only includes vessel air-horns, vessel water cannons etc. • Acoustic bird scaring devices/buoy can also be deployed onshore or from a vessel. For a worst credible spill response at a remote shoreline, up to two small vessels and/or a bird-scaring device/buoy could be deployed for wildlife hazing at a remote shoreline.
Logistical Support (common to all response strategies)	Provide logistical support to enable response strategies to be undertaken	Accommodation support vessel (ASV) • To act as the Forward Operating Base, coordinating the shoreline response activity, including daily activity planning and communications back to the IMT • Provide accommodation and logistical support to the field response personnel • Provide a platform to support waste management and oiled wildlife response, if required. For a worst credible spill response at a remote shoreline, only a single ASV is anticipated to be required.
		Small support vessels (resupply vessels, tenders and landing barges) • tenders used to transport personnel and light-weight equipment to and from shorelines • landing barges used to transport heavier equipment and backload waste from shorelines • small support vessels (20-40m) used to resupply the ASV For a worst credible spill response at a remote shoreline, two tenders, a landing barge and logistic supply vessel is anticipated to be required (total of 4 small support vessels)

		Crew change helicopter • provide for routine crew change of response personnel between the mainland and the accommodation support vessel For a worst credible spill response at a remote shoreline, only a single crew change helicopter is anticipated to be required.
		Light utility helicopter • provide an alternative mechanism to land personnel and light equipment onto a shoreline, in the event that sea conditions are prohibitive to marine vessel access • using a sling, provide an alternative mechanism to move heavier equipment and backload waste between a shoreline and a support vessel, in the event that sea conditions are prohibitive to marine vessel access For a worst credible spill response at a remote shoreline, only a single light utility helicopter is anticipated to be required.
Waste management (common to all response strategies)	Prevent secondary contamination from recovered oil/oily waste	Oily waste collection containers • provision of containers to recover waste on location, such as buckets, drums, IBCs, plastic lined bulka-bags • provision of containers to transport bulk recovered oily waste, such as half-height containers and tote-tanks/ISO tanks • container types will depend on the type of oil/oily contaminated material being recovered (solid, liquid, debris etc). Oily waste transportation and receipt facilities • licenced waste contractor, required for the transportation, receipt, treatment and/or disposal of recovered oils/oily wastes an onshore locations For a worst credible spill response at a remote shoreline, based on 100 m^3 oil onshore, and 10x bulking factor, up to 1000 m^3 oily waste recovery capability is anticipated to be required

Table 8-8: Response strategy arrangements and capability evaluation

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
Oil spill trajectory modelling (OSTM) - access to OSTM services [OSTM contractor available on 24/7 call-out arrangement]. [OSTM contractor activated within 2 hours of IMT formation].	OSTM will be used to forecast the trajectory and fate of oil plumes resulting from surface or subsurface releases. OSTM is an iterative process using real-time observations to refine modelling predictions. No alternatives have been identified that could improve this oil spill response control.	The OSTM contractor will be available on-call on a 24/7 basis. OSTM requires access to information/situational awareness data provided by the Emergency Response Team. The IMT should reasonably be able to activate and transmit relevant situational awareness data the OSTM contractor within 2 hours of the formation of the IMT.	The purpose of OSTM is to provide spill trajectory forecasts, to enable the IMT to develop IAPs, and commence implementing secondary spill response activities which would be implemented in the days after the initial response. Reducing the activation timeframe of OSTM would not provide any benefit in relation to 'first strike' activities. Therefore, there is no benefit in reducing the activation timeframes.
Aerial surveillance with aircraft of opportunity using untrained observers will be available and may involve using any of the following: • crew change helicopters that can be mobilised or diverted with two pilots (second pilot can act as a spotter and record observations)	Aerial surveillance is used to provide situational awareness of the slick size, type and location back to the IMT. Aerial surveillance can only be undertaken during daylight hours and is guided using the OSTM modelling results and tracker buoy locations. There is a dedicated full-time Search and Rescue helicopter, plus a minimum of 4 crew	It may be possible to mobilise aerial surveillance in a shorter period as a crew change helicopter could be cancelled and diverted to the spill location immediately if safe to do so, and not required for higher priority safety/evacuation related tasks. To guarantee a faster response time, additional dedicated fixed wing aircraft at cost $100,000 per month could be positioned	The quality of information provided by a faster or greater response is not expected to be improved to a level that would result in substantial environmental benefits. Other techniques, such as OSTM will be implemented in parallel with aerial and/or vessel observations. This combination of data is considered sufficient to inform the IMTs situational

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
• search and rescue helicopter • Fixed-wing aircraft available on a best endeavours basis, via call-off contract, and will provide long term aerial surveillance capability, typically providing two overflights of the affected area per day. [crew-change helicopters commence surveillance activities at the spill location within 5 hours of IMT activation*]]	change helicopters available in Broome at all times. The crew change helicopters have the INPEX oil spill observation aid available, ready for use during a spill event. These resources can be mobilised to the Operational Area within 5 hours (daylight only), if not tasked with other Search and Rescue or other emergency/safety critical duties. Fixed wing aircraft on call-off contracts for rapid mobilisation are only available during the cyclone-season. During the dry-season, fixed wing aircraft are utilised by the tourism industry, and therefore these fixed wing aircraft service providers will not guarantee mobilisation within specified timeframes during the dry season, however will provide services on a best-endeavours basis. The fixed wing aircraft response could be improved by having an additional dedicated fixed wing	at Broome. The cost for this is not considered reasonable, as the current arrangements enable aerial surveillance of the Permit Area within 5 hours (daylight only), and the vessel can provide some initial information regarding slick size and trajectory.	awareness during the early stages of a spill response.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
	aircraft available for 12 months of the year at $100,000 per month. The cost for this is not considered reasonable based on the availability of alternative means of aerial surveillance (helicopter surveillance available all year).		
Aerial surveillance using 1 x trained aerial observer [Commence aerial observation task from Broome/Darwin within 48 hours]	Personnel formally trained through the AMOSC aerial observer course could be used, to increase the quality of aerial observer data received by the IMT during the spill response. However, the quality of data that would be received by the IMT, from personnel such as a helicopter co-pilot using the INPEX oil spill observation guide, and data from other operational and monitoring evaluation techniques, should still provide adequate information for the INPEX IMT to conduct its role, especially during the first 24 hours of a spill, where the slick is expected to remain close to the release location (RPS 2019).	To implement aerial surveillance sooner using trained aerial observers, the only identified method would be to have observers on a stand-by contract, located in Broome. However, this additional standby cost is not considered reasonable, given INPEX has crew-change/SAR helicopter pilots available in Broome, equipped with the INPEX oil spill observation guide, which should provide adequate initial visual observation information to the IMT for planning purposes during the initial stage of the spill response. Therefore, a faster response time for trained aerial observers is not considered ALARP	The increased quality of data that could be received by the IMT during the initial stages of a spill response using pre-positioned trained aerial observers, compared to the quality of data received using pilots as observers (using the INPEX oil spill observation aid and data from other operational and monitoring evaluation techniques) will not significantly increase the IMTs situational awareness and ability to develop and implement effective IAPs. Therefore, a greater and/or faster response time is not considered ALARP.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
	It should be noted that the crew-change helicopter pilots are familiar with observing the natural colours and shades of the ocean in the Browse Basin / Timor Sea area, and therefore less likely to mis-interpret natural phenomenon such as cloud-shadow or algal bloom for oil slicks. Also, without additional oil spill observation aircraft, additional trained personnel do not provide additional value.		
Vessel surveillance [complete mobilisation and depart from Broome/Darwin wharf within 48 hours for large PSV; within 24 hours for small support vessel]	A typical platform support vessel bridge is 10 m to 20 m above sea level. A small support vessel bridge may only be 3 m to 5 m above sea level. Due to this low visual elevation (compared to aerial surveillance platforms) and vessel speed (~14 knots), the observational data a vessel of any size can provide is significantly limited, compared to the observation data able to be obtained by aerial observers.	It should be noted that in the event of a vessel collision, the damaged vessel would not be able to conduct vessel surveillance activities, and other vessels may be prioritised to complete tasks that are not directly related to the oil spill response, such as transfer of injured personnel to nearby facilities or to shore, supporting the damages vessels involved in the collision, or search and rescue operations.	The environmental impacts and risks from a spill are not directly affected by this response technique, as the objective is to provide situational awareness to the IMT and to inform on other response techniques. The information provided by a quicker or greater response is not expected to be significant enough to result in substantial environmental benefits. Aerial surveillance and OSTM will provide the greatest level of

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
	Therefore, additional vessels could be mobilised, however a greater level and quality of information will be obtained by focusing resources on mobilising aerial observation platforms instead.	The time to mobilise a large support vessel, purely dedicated to conduct vessel surveillance, from Darwin or Broome wharf, loaded with crew and provisions and sail to location cannot be improved to less than 48 hours. There are less berth spaces available on wharfs in Broome and Darwin for these larger vessels. Therefore, immediate access to wharf space cannot be guaranteed. Additional time alongside the wharf is also required for bunkering and provisioning a large vessel. In addition, the Darwin marine supply base only has two very short windows per day to transit the access channel due to tidal restrictions, placing further restrictions on mobilisation from Darwin. Therefore, up to 48 hours is required for mobilisation activities in Broome or Darwin for large support vessels. Smaller support vessels are available in Broome and Darwin. These smaller vessels,	situational awareness to the IMT. It should be noted that in the event of a vessel collision, the damaged vessel would not be able to conduct vessel surveillance activities, and other vessels may be prioritised to complete tasks that are not directly related to the oil spill response, such as transfer of injured personnel to nearby facilities or to shore, supporting the damages vessels involved in the collision, or search and rescue operations.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
		in an emergency, could be along-side a smaller wharf to load marine crew, spill response personnel, fuel and supplies within a maximum of 24 hours, and then commence transit to the spill location. Whilst small support vessels can be mobilised to the location of the spill faster than larger support vessels, small vessel bridges are much closer to the sea surface, and therefore are of limited value as an oil spill observation platform. Aerial surveillance is considerably faster than any vessel surveillance platform. Therefore, resources will be focused on aerial surveillance, rather than vessel surveillance.	
Electronic surface tracking buoy will be available for deployment immediately from the seismic survey vessel. [immediate]	The primary purpose of the tracking buoys is to assist with situational awareness of the IMT during periods when aerial surveillance isn't available (e.g. night-time), and for the longer term validation of the OSTM.	Sufficient provision has been made for deployment of multiple tracker buoys as quickly as possible, and data will be received by the IMT via web-link. No additional environmental benefits can be achieved	Sufficient provision has been made for deployment of multiple tracker buoys as quickly as possible, and data will be received by the IMT via web-link. No additional environmental benefits can be achieved through improving the

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
	INPEX maintain a total of ten tracker buoys, which are positioned at different locations, depending on the activities underway. During the seismic survey, two tracker buoys will remain on the seismic survey vessel. Additional tracker buoys will be available on the other INPEX vessels and on the Ichthys CPF and FPSO (within the Operational Area). Additional tracker buoys could be mobilised from Broome or Darwin, if required. More tracker buoys are available via AMOSC, if required. Therefore, many tracker buoys can be mobilised to the location and deployed during the early stages of a spill occurring.	through improving the number or location of additional tracker buoys.	number or location of additional tracker buoys.
Satellite imagery analysis - obtain satellite imagery providers.	Information gained from satellite imagery would be used in combination with other data from aerial/vessel surveillance	This service cannot be provided faster as access to satellite imagery is limited due to the continuous movement and orbit of satellites around the globe.	No additional environmental benefits identified. Satellite imagery is a tool which assists with overall validation of

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
[imagery available in the IMT within 48 hours]	and OSTM, to improve the IMT's situational awareness. No greater response effort has been identified.	This results in up to 48-hour delays to obtain satellite imagery.	spill modelling and aerial surveillance, however the IMT will still maintain a high level of situation awareness, if satellite imagery isn't immediately available.
Vessel response - spill response vessel equipped with wildlife hazing, oiled wildlife response, shoreline clean–up. [available to mobilise and depart from Broome/Darwin wharf within 48 hours for large support vessels; within 24 hours for small support vessel]	Vessels will be mobilised as required under the existing call-off contracts. These contracts provide access to larger vessels (such as ASVs), and many medium to small support vessels (<~30m length). Larger vessels could be used for activities such as wildlife hazing using their water cannons and airhorns, and as ASVs to support shoreline response activities. Small support vessels can be used for supporting shallow water response activities and wildlife hazing. The very small support vessels (<10m in length) can be used for shoreline landings and intertidal access for activities	Smaller support vessels are available in Broome and Darwin. These smaller vessels can support most other spill response activities, including wildlife hazing and shoreline response activities. These smaller vessels, in an emergency, could be along-side a smaller wharf to load marine crew, spill response personnel, fuel and supplies within a maximum of 24 hours, and then commence transit to the spill location. The time to mobilise a separate large support vessel from Darwin or Broome wharf, loaded with crew and provisions ready to sail to location cannot be improved to less than 48 hours. There are less berth spaces available on wharfs in	No additional environmental benefit could be identified though a greater or faster vessel capability. If poor weather conditions are limiting vessel based responses, these same weather conditions would also be significantly increasing oil entrainment, reducing surface floating oil, reducing volumes of oil arriving on the shoreline and increasing the natural weathering of any oil on shorelines.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
	such as shallow water wildlife hazing. Each vessel can be loaded with different spill response equipment as relevant to the response activity and location. Therefore, a suitable response capacity is deemed to have been provided in this regard. It should be noted that strong winds and elevated sea-states will limit the effectiveness of most vessel-based response activities and there is no additional vessel capability that can overcome this limitation.	Broome and Darwin for these larger vessels. Therefore, immediate access to wharf space cannot be guaranteed. Additional time alongside the wharf is also required for bunkering and provisioning a large vessel. In addition, the Darwin marine supply base only has two very short windows per day to transit the access channel due to tidal restrictions, placing further restrictions on mobilisation from Darwin. Other large support vessels are also potentially available in Dampier and would require approximately 48 hours to transit to Broome and complete mobilisation there. Therefore, up to 48 hours is required for mobilisation activities in Broome or Darwin for large support vessels. The only identified method to further improve the speed of a vessel-based response would be to have additional vessels on	

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
		stand-by pre-loaded with spill response equipment. The various spill response equipment stockpiles in Darwin and Broome require regular maintenance, testing and checking and therefore can’t be permanently stored and maintained on board a vessel. In addition, there may be an operational requirement to have specific equipment from the stockpiles mobilised to different locations on different types of vessels, depending on the nature of the spill, receptors at risk and weather conditions at the time. It is not possible (space and weight limitations) to store and maintain all potentially required types of equipment offshore at all times. The cost to maintain a large vessel on stand-by in Broome or Darwin is approximately $20,000 per vessel per day. Any vessel would still need to wait for wharf space to become	

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
		available, to load the relevant response equipment and personnel, then depart for the spill location. The additional cost is not considered reasonable, given that the response time would only be reduced by perhaps 12 to 24 hours. It should be noted that the relocation of equipment stockpiles from their storage facilities in Broome/Darwin to the wharf will not result in any additional time, as the positioning of this equipment on the wharf would occur whilst the support vessel is in transit/alongside in Broome or Darwin. It is not possible (space and weight limitations) to store and maintain all potentially required types of equipment offshore at all times. Response times are dependent on the spill location and vessel mobilisation times as described above in vessel response.	

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
Vessel-based wildlife hazing equipment including vessels and vessel fog horns / water cannons Acoustic bird hazing buoy (available through AMOSC). [Within 48 hours]	Increasing the number of vessels may result in greater effectiveness of wildlife hazing, if a geographically appropriate location for hazing was identified (appropriate meaning a location where-by locally dispersing fauna from one location doesn't risk just moving the wildlife to another location of the slick). INPEX has a range of vessels it can mobilise for the purpose via vessel call-off contracts. No additional response capability is determined to be required.	Response times are dependent on the spill location, vessel mobilisation times and vessel transit times, as described above in vessel response.	Implementing a faster or greater wildlife hazing response may assist in preventing oiling of wildlife. However, given there are many limitations to the success of wildlife hazing, detailed in Strategic SIMA, more rapid or greater provision of vessel numbers or mobilisation timeframes compared to that provided is not considered ALARP.
Light utility helicopter – use of a light utility helicopter suitable for landing on remote shorelines for OWR and/or shoreline clean-up. Available under INPEX aviation call-off arrangements.	Using a BK-117, H-135 or H-145 light utility helicopter, the helicopter's maximum capacity is two pilots transporting six passengers. The use of additional utility helicopters would enable more	If a light utility helicopter was determined to be required, the minimum requirements for a helicopter to support oil spill response activities at remote shoreline locations are:	The ability to transport additional people and equipment using additional helicopters can enable quicker ramp up of the workforce and faster rate / capacity of the

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
[Commence mobilisation activities in Broome within 7 days]	responders to access the affected location. However, this will require additional helicopter landing pads/locations to accommodate the helicopter overnight. To mobilise and maintain a second light utility helicopter offshore, a very large support vessel equipped with a helicopter pad would be required. The costs associated with this large support vessel and second helicopter would be in excess of $100,000 per day. Under a worst credible scenario, only a single remote shoreline or set of adjacent shorelines requiring the use of a light utility helicopter is anticipated.	• capacity to carry at least 6 personnel and their equipment • ability to be fitted with cargo hooks for the ability to sling loads (i.e. equipment/waste) between the shoreline and nearby support vessels. • long range fuel tanks due to the potential travel distances offshore • twin engines • life raft, satellite tracking and other safety systems Under the International Civil Aviation Organization (ICAO) Annex 6 Civil Aviation Safety Regulation (CASR) 133, transport category helicopters with a seating capacity of >19 must be operated under Performance Class 1 or Category A. Therefore, INPEX's crew transfer helicopters, including the INPEX search and rescue (SAR) helicopter, are not available for shoreline oil spill response support activities.	response, if sea-state is limiting vessel response capabilities. A faster mobilisation of a utility helicopter may result in a quicker commencement of shoreline response activities. However, under circumstances where helicopter mobilisation times may be restrictive, vessel-based shoreline responses can be mounted within a few days. If poor weather conditions are limiting vessel-based responses, these same weather conditions would also be significantly increasing the entrainment of any surface oil, reducing volumes of oil ashore and increasing natural weathering of any oil on shorelines. Therefore, the additional cost of maintaining a helicopter on stand-by for faster mobilisation is not considered to be ALARP, even if the costs were shared with another near-by operator.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
		In addition, whilst the Sikorsky S-92s used for INPEX crew changes meet some of the criteria e.g. personnel capacity, twin engines and long-range fuel tanks required to access remote areas, they do not have the capability to sling equipment as they cannot be configured with cargo hooks. In addition, because of the size of the helicopter the downwash generated is in excess of 125 km/h and landing on unprepared sites can cause "brownout" conditions which can restrict the pilot's visibility due to the recirculation effect of the rotor downwash. Therefore, these helicopters are not deemed suitable for remote shoreline operations. Smaller helicopters can be operated under Performance Class 2 or 3 (Category B) and under ICAO Annex 6 CASR 133 and the Civil Aviation Safety Authority (CASA) regulations may be able to land at remote	

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
		shoreline locations with extreme caution. Under the International Association of Oil and Gas Producers *Aircraft Management Guidelines Document 390*, INPEX risk assessments, the INPEX *Refuelling Handbook* and CASA Civil Aviation Advisory Publication (CAAP) 234-1 (2) Para 5.4.2 recommends all aircraft operating under charter should have sufficient fuel to fly to an alternate aerodrome which is not a remote island. For example, for a response at Scott Reef, the closest usable airport would be Lombardina Airbase. The remoteness of other potential shoreline response locations along the WA coastline presents similar challenges. An ASV with a helicopter deck could however be considered an alternative landing location to the remote island, assisting in redundancy landing locations for remote helicopter activities.	

Response strategy element – capability and minimum implementation time	**Can a greater response effort be implemented?**	**Can the time to respond be improved?**	**Environmental benefit of increased response effort/ reduced response time**
		Based on the types of distances and the requirements for smaller helicopter types that can land at remote islands, the most suitable twin-engine helicopter types identified were the MBB Kawasaki BK-117 and the Airbus H-135 or H-145 (if fitted with a long-range fuel tank). Small helicopters such as BELL 206, AS350B and EC120 are capable of landing on remote islands with difficult access. However, they have single engines and were ruled out as they do not meet INPEX's aviation standards for safety, fuel range or have the ability to transport enough people/equipment to implement an effective response. Small helicopters, such as the BK-117 and Airbus H-135 or H-145, are generally working under contract with many configured in an air ambulance role or a surf rescue role. The market for surplus available aircraft around Australia is	

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
		therefore limited and the response time cannot be guaranteed. The response implementation time could be improved to <7 days if a BK-117, H-135 or a long-range H-145 helicopter was positioned, on standby in Broome or Darwin on a permanent basis. The high cost (calculated as AUD $1.5–2.0 million per year) of maintaining this capability, including the hire of the aircraft, pilots on standby, reoccurring training and maintenance of the aircraft, is considered to be grossly disproportionate to the environmental benefit gained and is not considered to be ALARP, even if the costs were shared with another near-by operator. This is because the spill (and resulting offshore impacts) has already occurred, and pre-contact wildlife hazing or translocation at a shoreline has low likelihood of significant impact reduction. It is not	

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
		expected that a significant improvement for the environment would be achieved if post-contact wildlife response or shoreline clean-up commenced within the first 7 days or whether it occurs from day 7 onwards. Other arrangements to position people and equipment on to remote shorelines to undertake oil spill response activities without the use of a helicopter have been considered. Vessel access to remote shorelines such as at Lacepede Islands/Adele Island can be achieved (noting some weather/met-ocean potential limitations). Vessel based response timings are discussed above. It should be noted that if heavy sea conditions were restricting vessel access, this same wave action would be increasing the natural break-up and weathering of oil at sea and on shorelines.	

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
INPEX crew-change helicopters, to provide crew rotation for remote shoreline response activities [INPEX crew-change helicopters always available]	INPEX maintain contract with a helicopter provider, to provide a fleet of crew-change helicopters for routine operations. This fleet of helicopters would be utilised to facilitate crew-change for oil spill response activities at remote locations. If additional crew-change helicopters are required above the standard fleet already maintained in Broome, additional aircraft can be arranged through the helicopter provider.	There is no requirement to increase the speed at which routine crew-change of spill responders at remote locations occurs.	The existing crew-change helicopter fleet will be suitable for managing crew-change of spill responders.
Oiled wildlife response personnel – The Oiled Wildlife Division Coordinator and Oiled Wildlife Advisor roles, within the Incident Management Team (IMT), would be provided by the WA DBCA for WA shoreline responses. If however the response was at an Australian Commonwealth island such as Ashmore or Cartier, the AMOSC core-group OWR trained	There is an appropriate limit to the number of personnel that should be put ashore during shoreline response in a sensitive location, to avoid additional impacts, e.g. trampling of turtle nests and disturbance to bird feeding/roosting/nesting behaviours. In general, to reduce wildlife disturbance on small, offshore remote locations, a longer duration response with minimum numbers is desired.	As oiled wildlife response will most likely be undertaken on a shoreline, the Control Agency will most likely be the WA DoT. The key oiled wildlife specialists (i.e. WA DBCA oiled wildlife advisers and associated field responders, acting on behalf of WA DoT) are likely to mobilise with an oiled wildlife response activity. Personnel from these government agencies are living/working in northern WA, and therefore their mobilisation	Given the limited likelihood and predicted time to shoreline contact, expected weathering of oil, limited volumes ashore, the rapid mobilisation of a larger OWR team would be unlikely to results in a significant tangible environmental benefit. Also, there are additional risks of wildlife disturbance associated with mobilising large wildlife response teams to

Response strategy element – capability and minimum implementation time	**Can a greater response effort be implemented?**	**Can the time to respond be improved?**	**Environmental benefit of increased response effort/ reduced response time**
personnel could undertake this role within the IMT. In the field, the OWR team would be led by the relevant personnel from WA DBCA/NT PaWC, supported by the AMOSC OWR Team. Trained OWR personnel are available through the Oiled Wildlife Rehabilitators Network (approximately 100 personnel), and Philip Island Nature Park (approximately 100 personnel). INPEX could provide additional personnel via INPEX Master Service Agreement with Environmental Service Providers, or other labour hire companies. A minimum of 20 personnel could be ready to mobilise from Broome/Darwin. [20 oiled wildlife personnel arrive in Broome within 24 hours]	The areas of potential shoreline impacted are remote and therefore, numbers of responders are also limited by accommodation and logistics support. For offshore islands with the ability for helicopters to safely land, it has been calculated that up to 24 personnel could work onshore on a single day, based on one utility helicopter conducting the daily transits to and from shore. Similar numbers would be expected using small boats for shoreline access. However, it should be noted that personnel numbers are not constrained, as INPEX's arrangements with contracted labour hire and other industry capability (e.g. AMOSC) provides access to additional personnel if required. Whilst multiple shorelines may be assessed (to confirm presence/absence of shoreline oiling/oiled wildlife), only a single offshore remote island/shoreline, or set of adjacent shorelines is envisaged requiring a large oiled wildlife	should not limit mobilisation timeframes. Additional trained OWR trained personnel could be positioned on stand-by in Broome/Darwin. However, as personnel can be mobilised from around Australia to Broome/Darwin in a similar timeframe as which vessels can be mobilised to these ports, this is not considered to be reasonable given the high cost and low likelihood of needing to implement an oiled wildlife response.	small, remote offshore locations.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
	response, even for a worst credible spill scenario.		
Oiled wildlife response kits, including the kit in Broome can be mobilised from the AMOSC Broome stockpile to a support vessel alongside in Broome. [OWR kit mobilised onboard a support vessel in Broome within 24 hours] Oiled wildlife response containers available for use provided by AMOSC, from Tier 3 stockpiles around Australia	INPEX could purchase additional OWR kits however as response planning indicates that OWR centres are most likely to be set up 'on-water', the number of centres is limited to the number of shorelines requiring the OWR centre. Only a single 'on water' OWR centre is envisaged, even for a worst credible spill scenario with multiple adjacent shorelines oiled. Additional OWR kits and containers are available around Australia, accessed via the Nat Plan. In addition, the types of equipment contained in the OWR kits are equipment that is easily re-supplied from Broome. Therefore resupply of stocks of OWR equipment should not present a limitation to the response capability.	AMOSC OWR kit is present in Broome and is available to be deployed. This response cannot be implemented faster, without maintaining an OWR kit and associated trained personnel onboard a support vessel, offshore at all times. This is not considered reasonable given the high cost and impracticality compared to the low likelihood of needing an oiled wildlife response. Also, the trained personnel, such as veterinarians, would not be able to maintain their training/skills, if based offshore at all times.	Response planning indicates that a single 'on water' OWR centre would be appropriate, with additional 'on water' centres and the associated people and transport logistics not required, even under worst case scenarios. Maintaining an OWR kit and associated trained personnel offshore, to increase the speed of the response is not considered practicable nor ALARP.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
Shoreline clean-up trained personnel - WA DoT may choose to provide their own trained SCAT assessment and initial shoreline clean-up personnel. Response experts would be provided by AMOSC core-group. Additional general labour would be provided by INPEX. [A minimum of 20 personnel would be ready to mobilise onto a support vessel in Broome/Darwin within 24 hours].	Increasing the number of shoreline clean-up personnel can increase the rate at which oil is removed from a shoreline. Personnel numbers can be increased as required to respond to the specific spill scenario and therefore numbers are not constrained. However, personnel numbers onshore will be limited by a range of external factors. There is an appropriate limit to the number of personnel that should be put ashore during shoreline response in a sensitive location, to avoid additional impacts, e.g. trampling of turtle nests and disturbance to bird feeding/roosting/nesting behaviours. In general, to reduce wildlife disturbance on small, offshore remote locations, a longer duration response with minimum numbers is desired. If vessels are used for access, sea-state and tides can prevent shore-landings. However, if sea-	Additional trained shoreline clean-up personnel could be positioned on stand-by in Broome/Darwin. However, as personnel can be mobilised from around Australia to Broome/Darwin in a similar timeframe as which vessels can be mobilised to these ports, this is not considered to be reasonable given the high cost and low likelihood of needing to implement a shoreline clean-up response.	Due to the labour hire arrangements INPEX has in place, personnel numbers are not limited. It is therefore, vessels and helicopters, and environmental considerations that will limit this response capacity. Given the arrangements in place, to mobilise within 24 hours, the key trained personnel (AMOSC core-group members, and WA DoT personnel) required to lead a shoreline clean-up, the benefits of a slightly faster response by maintaining these trained personnel in Broome/Darwin are not considered reasonable given the high associated financial costs. Also, there are additional risks of wildlife disturbance associated with mobilising large shoreline clean-up teams to small, remote offshore locations.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
	state and tides are forecast to be good for shore-landings, larger groups can mobilise. If a light utility helicopter is used for shoreline clean-up, sea-state and tidal access issues are eliminated and up to 24 personnel could work ashore in any single day (based on helicopter pilot duty hour limitations). Additional personnel could be transferred using small vessels (sea-state permitting). Whilst multiple shorelines may be assessed (to confirm presence/absence of shoreline oiling), only a single remote island/shoreline (or set of adjacent oiled shorelines) is envisaged requiring a large shoreline response, even for a worst credible spill scenario.		
Shoreline clean-up manual cleaning equipment can be mobilised from the Broome/ Darwin stockpiles to a support vessel alongside in	Machinery such as graders could be used to potentially assist with shoreline clean-up, however this often creates a larger volume of oily contaminated sands to be	Manual cleaning equipment can be mobilised to the wharf from the Broome/Darwin stockpiles in 6 hours. Any improvement on this is not warranted as the	There is no environmental benefit to utilising heavy machinery for shoreline clean-up. Manual clean-up equipment is readily available and will not limit response time.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
Broome/Darwin Port or to other remote mainland locations. WA DoT may choose to mobilise their own SCAT/shoreline clean-up equipment (trailers located in Karratha, Fremantle and Albany). [mobilise shoreline clean-up equipment onto support vessel within 24 hours]	removed. In addition, heavy machinery could damage sensitive turtle nesting habitat, disturb other wildlife and may not be accessible for remote offshore islands. Therefore, response equipment will almost certainly be limited to hand-held equipment, which results in less disturbance when conducting a clean-up operation. The only 'machinery' potentially used for remote shoreline clean-up would be a tracked 'bob-cat' or 'dingo', operated above the high tide line, to assist in moving collected oily waste to staging areas. Consequently, increasing response effort is limited to increasing numbers of personnel and manual cleaning equipment (shovels etc.). Sufficient equipment is considered available within existing stockpiles. Additional manual clean-up equipment can be purchased at hardware	vessels will not be ready in a shorter duration of time.	

Response strategy element – capability and minimum implementation time	**Can a greater response effort be implemented?**	**Can the time to respond be improved?**	**Environmental benefit of increased response effort/ reduced response time**
	stores, as required in Broome or Darwin.		
Waste management contract enables access to sufficient waste containers to be provided to meet the first response needs. AMOSC stockpiles also include wide range of purpose built waste containers. [Immediate]	No greater response effort can be obtained as the waste contract allows for immediate delivery of waste containers to be mobilised offshore, when requested by INPEX. Based on the estimated worst-case volume of oil accumulated on shorelines (119 m^3) and a bulking factor for waste created of 10:1 it is estimated that approximately 1200 m^3 of waste could be generated. Shoreline clean-up waste would likely be captured in plastic buckets, drums, plastic lined bulka-bags and 1 m^3 Intermediate Bulk Containers (IBCs) or transportable half-height containers. Therefore approximately 1200 m^3 of these types of oily waste containers would be required, over the full duration (weeks) of any shoreline clean-	As shoreline clean-up at a remote shoreline will be a long duration activity, and based on the anticipated worst credible waste volumes, no timing issues with provision and backload of waste containers are anticipated. The types of waste containers required are readily available via INPEX waste management contractor and AMOSC.	No additional environmental benefit could be identified though a greater or faster waste management capability.

Response strategy element – capability and minimum implementation time	Can a greater response effort be implemented?	Can the time to respond be improved?	Environmental benefit of increased response effort/ reduced response time
	up. There are no limitations to obtaining this waste storage capacity and no benefit obtained by accessing additional waste storage capacity.		

* All timings are based on the assumption that the spill occurs, and response is implemented in daylight hours where visibility is critical for successful implementation.

8.5 Oil spill response strategies

As identified in the MGO/diesel strategic SIMA (Appendix G) not all response strategies are appropriate for every hydrocarbon spill, and as discussed in Table 8-6, not all response strategies are appropriate for the specific spill scenarios associated with the activity. Different types of hydrocarbon, spill locations and spill volumes require different response strategies, or combinations of techniques, to implement an effective response.

Based on the SIMA and subsequent evaluations (Table 8-6, Table 8-7 and Table 8-8), INPEX has identified a set of primary and secondary response strategies to reduce the impacts and risks of hydrocarbon spills from the petroleum activity to ALARP. However, the deployment of response strategies has the potential to introduce further impacts and risks.

8.5.1 Primary response strategy

Operational monitoring and evaluation have been determined as the only appropriate primary (first strike) response measure for all hydrocarbon spills. This involves surveillance and reconnaissance, using an appropriate combination of OSTM, aircraft and vessel surveillance, satellite imagery and ESTBs to monitor the size, trajectory, weathering and fate of the hydrocarbon spill.

The information obtained through operational monitoring and evaluation program will inform the development of IAPs, which will include consideration of the use of secondary response strategies.

An impact and risk evaluation for the implementation of the primary response strategy is presented in Table 8-9.

8.5.2 Secondary response strategy

Shoreline clean-up, pre and post contact wildlife response have been determined as potentially applicable secondary response strategies for the vessel collision MGO/diesel spill scenario. An impact and risk evaluation for the implementation of the secondary response strategies are also presented in Table 8-9.

Table 8-9: Impact and risk evaluation – implementation of response strategies

Identify hazards and threats
Primary response strategy – monitoring and evaluation. Routine sewage effluent, grey water and food waste discharges from vessels used in oil spill response, when located close to shorelines (such as turtle and marine avifauna breeding rookeries), could result in the exposure of EPBC-listed species to untreated/non-macerated discharges. Accidental release of waste overboard as a result of inappropriate management may result in impacts to marine fauna through entanglement or ingestion of waste material, with the potential to result in injury. Inappropriate waste management also has the potential to expose marine flora and fauna to changes in water quality and may result in reduced ecosystem productivity or diversity. The physical presence of vessels used in the response strategy has the potential for vessel-to-vessel collisions. **Secondary response strategy – pre-contact wildlife response**. Routine sewage effluent, grey water and food waste discharges from vessels used in oil spill response, when located close to shorelines (such as turtle and marine avifauna breeding rookeries), could result in the exposure of EPBC-listed species to untreated/non-macerated discharges. Accidental release of waste overboard as a result of inappropriate management may result in impacts to marine fauna through entanglement or ingestion of waste material, with the potential to result in injury. Inappropriate waste management also has the potential to expose marine flora and fauna to changes in water quality and may result in reduced ecosystem productivity or diversity. The physical presence of vessels used in the response strategy has the potential for vessel-to-vessel collisions. Poorly implemented wildlife response has the potential to cause stress or suffering to wildlife impacted by a spill. **Secondary response strategies –post-contact wildlife response.** Routine sewage effluent, grey water and food waste discharges from vessels used in oil spill response, when located close to shorelines (such as turtle and marine avifauna breeding rookeries), could result in the exposure of EPBC-listed species to untreated/non-macerated discharges. Accidental release of waste overboard as a result of inappropriate management may result in impacts to marine fauna through entanglement or ingestion of waste material, with the potential to result in injury. Inappropriate waste management also has the potential to expose marine flora and fauna to changes in water quality and may result in reduced ecosystem productivity or diversity. The physical presence of vessels used in the response strategy has the potential for vessel-to-vessel collisions.

Capture, cleaning and rehabilitation of oiled wildlife has the potential to create additional stress to animals. The movement of equipment and personnel onto offshore islands has the potential to introduce terrestrial exotic pests, including rats. The movement of personnel and equipment onto offshore islands has the potential to disturb turtle nests and turtle-nesting activities. **Secondary response strategy – shoreline clean-up.** Routine sewage effluent, grey water and food waste discharges from vessels used in oil spill response, when located close to shorelines (such as turtle and marine avifauna breeding rookeries), could result in the exposure of EPBC-listed species to untreated/non-macerated discharges. Accidental release of waste overboard as a result of inappropriate management may result in impacts to marine fauna through entanglement or ingestion of waste material, with the potential to result in injury. Inappropriate waste management also has the potential to expose marine flora and fauna to changes in water quality and may result in reduced ecosystem productivity or diversity. The physical presence of vessels used in the response strategy has the potential for vessel-to-vessel collisions. The movement of equipment and personnel onto offshore islands has the potential to introduce terrestrial exotic pests, including rats. The movement of personnel and equipment onto offshore islands has the potential to disturb turtle nests and turtle-nesting activities. Incorrect management of hydrocarbon-contaminated wastes generated during shoreline clean-up has the potential to create additional contamination of the shoreline.	
Potential consequence: Primary response strategy – monitoring and evaluation	**Severity**
The values and sensitivities with the potential to be impacted are transient, EPBC-listed species (marine fauna including foraging BIAs). Monitoring and evaluation does not provide any material changes to the trajectory of the spill. Instead, it provides critical information on the fate, nature and weathering of the spill, as a result of exposure to natural biological and physical degradation processes. The strategy can be used to inform other response strategies and emergency response priorities. Since this strategy does not provide any material changes to the trajectory of the spill, the inherent impacts of the hydrocarbon on marine fauna in the trajectory of the spill will remain until natural degradation/weathering reduces the impacts of the spill. Due to the types of small vessels which may support an oil spill response, all vessels may not be fitted with sewage disinfection systems, sewage macerators and/or food macerators. Therefore, EPBC-listed species, such as marine turtles and marine avifauna may be exposed to untreated sewage, grey water and food scraps, particularly when response vessels are conducting activities near breeding rookeries, such as Browse Island, Adele Island etc. The duration of any exposure is likely to be limited to between a few days and a number of	Insignificant (F)

weeks, depending on the duration of the oil spill response activity. Due to the local currents and deep offshore waters surrounding these offshore islands, and higher currents around nearshore waters of the WA coastlines, any temporary changes to water quality that may occur are expected to be short term and localised, and are therefore considered to be Insignificant (F). Various conservation management plans (refer to Appendix B) identify inappropriate waste management as a key threatening process to the recovery of EPBC-listed species. Inappropriate storage and handling of solid and liquid wastes generated through routine operations during an oil spill response could result in impacts to individuals of transient, EPBC-listed species, resulting in isolated and localised impacts only. Therefore, the consequence is considered to be Insignificant (F). The physical presence of vessels during the implementation of this response strategy has the potential to increase the risk of a vessel-to-vessel collision. The consequences of a vessel collision are discussed in Table 8-5.	
Potential consequence: Secondary response strategy – pre-contact wildlife response (wildlife hazing)	**Severity**
The values and sensitivities with the potential to be impacted are transient, EPBC-listed species (marine fauna including BIAs associated with turtle and marine avifauna nesting). Due to the types of small vessels which may support an oil spill response, all vessels may not be fitted with sewage disinfection systems, sewage macerators and/or food macerators. Therefore, EPBC-listed species, such as marine turtles and marine avifauna may be exposed to untreated sewage, grey water and food scraps, particularly when response vessels are conducting activities near breeding rookeries, such as Browse Island, Adele Island etc. The duration of any exposure is likely to be limited to between a few days and a number of weeks, depending on the duration of the oil spill response activity. Due to the local currents and deep offshore waters surrounding these offshore islands, and higher currents around nearshore waters of the WA coastlines, any temporary changes to water quality that may occur are expected to be short term and localised, and are therefore considered to be Insignificant (F). Various conservation management plans (refer to Appendix B) identify inappropriate waste management as a key threatening process to the recovery of EPBC-listed species. Inappropriate storage and handling of solid and liquid wastes generated through routine operations during an oil spill response could result in impacts to individuals of transient, EPBC-listed species, resulting in isolated and localised impacts only. Therefore, the consequence is considered to be Insignificant (F).	Insignificant (F)

The physical presence of vessels during implementation of this response strategy has the potential to increase the risk of a vessel-to-vessel collision. The consequences of a vessel collision are discussed in Table 8-5. A wildlife response strategy can increase the survival of wildlife potentially affected by a spill (particularly seabirds, marine mammals and reptiles in transit) by encouraging wildlife to move away from the location of the spill (IPICEA 2017b). There may be potential for increased stress to wildlife individuals subjected to hazing activities, or the potential to cause wildlife to move into the area affected by the spill from poorly implemented hazing activities (IPICEA 2017b). Therefore, any potential impacts would be only to individuals of a population, and as the activity is being undertaken to reduce impacts, the impact is considered Insignificant (F).	
Potential consequence: Secondary response strategy – pre-contact (translocation) and post-contact wildlife response	**Severity**
The values and sensitivities with the potential to be impacted are transient, EPBC-listed species (turtles and marine avifauna). Due to the types of small vessels which may support an oil spill response, all vessels may not be fitted with sewage disinfection systems, sewage macerators and/or food macerators. Therefore, EPBC-listed species, such as marine turtles and marine avifauna may be exposed to untreated sewage, grey water and food scraps, particularly when response vessels are conducting activities near breeding rookeries, such as Browse Island, Adele Island etc. The duration of any exposure is likely to be limited to between a few days and a number of weeks, depending on the duration of the oil spill response activity. Due to the local currents and deep offshore waters surrounding these offshore islands, and higher currents around nearshore waters of the WA coastlines, any temporary changes to water quality that may occur are expected to be short term and localised, and are therefore considered to be Insignificant (F). Various conservation management plans (refer to Appendix B) identify inappropriate waste management as a key threatening process to the recovery of EPBC-listed species. Inappropriate storage and handling of solid and liquid wastes generated through routine operations during an oil spill response could result in impacts to individuals of transient, EPBC-listed species, resulting in isolated and localised impacts only. Therefore, the consequence is considered to be Insignificant (F). The physical presence of vessels during implementation of this response strategy has the potential to increase the risk of a vessel-to-vessel collision. The consequences of a vessel collision are discussed in Table 8-5. Pre-contact and post-contact wildlife response (capture, cleaning, relocation and rehabilitation of wildlife) can increase the survival rates of wildlife which may be, or has become, oiled at sea or onshore. There may be a potential for increased stress to some animals during capture, cleaning, relocation and/or rehabilitation (IPICEA	Moderate (D)

2017b). However, any potential impacts are considered to be of inconsequential ecological significance to protected species, as the capture, relocation cleaning, relocation and/or rehabilitation is conducted to increase survival rates of individuals (Insignificant F). The Threat abatement plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100 000 hectares (DEWHA 2009) identifies that exotic rodents (such as rats) have been a major cause of extinction and decline of island biodiversity. Introduction of rodents to any of the offshore islands in the EMBA could result in a medium-term impact on a population of protected species (Moderate D). Physical presence and movement of personnel across turtle-nesting beaches could potentially cause damage to buried turtle eggs, reducing turtle-nesting success. Artificial light is known to disorientate marine turtles, particularly hatchlings and female adults returning to the sea from nesting areas on the shore (Pendoley 2005). Incorrect management of personnel and equipment on turtle-nesting beaches could result in a minor impact on a small proportion of a turtle-nesting population (Minor E).	
Potential consequence: Secondary response strategy – shoreline clean-up	**Severity**
The values and sensitivities with the potential to be impacted are transient, EPBC-listed species (marine fauna) and marine fauna BIAs in the EMBA (turtles and marine avifauna nesting). Due to the types of small vessels which may support an oil spill response, all vessels may not be fitted with sewage disinfection systems, sewage macerators and/or food macerators. Therefore, EPBC-listed species, such as marine turtles and marine avifauna may be exposed to untreated sewage, grey water and food scraps, particularly when response vessels are conducting activities near breeding rookeries, such as Browse Island, Adele Island etc. The duration of any exposure is likely to be limited to between a few days and a number of weeks, depending on the duration of the oil spill response activity. Due to the local currents and deep offshore waters surrounding these offshore islands, and higher currents around nearshore waters of the WA coastlines, any temporary changes to water quality that may occur are expected to be short term and localised, and are therefore considered to be Insignificant (F). Various conservation management plans (refer to Appendix B) identify inappropriate waste management as a key threatening process to the recovery of EPBC-listed species. Inappropriate storage and handling of solid and liquid wastes generated through routine operations during an oil spill response could result in impacts to individuals of transient, EPBC-listed species, resulting in isolated and localised impacts only. Therefore, the consequence is considered to be Insignificant (F).	Moderate (D)

The physical presence of vessels during implementation of this response strategy has the potential to increase the risk of a vessel-to-vessel collision. The consequences of a vessel collision are discussed in Table 8-5. The Threat abatement plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100 000 hectares (DEWHA 2009) identifies that exotic rodents (such as rats) have been a major cause of extinction and decline of island biodiversity. Introduction of rodents to any of the offshore islands in the EMBA could result in a medium-term impact on a population of protected species (Moderate D). Physical presence and movement of personnel across turtle-nesting beaches could potentially cause damage to buried turtle eggs, reducing turtle-nesting success. Artificial light is known to disorientate marine turtles, particularly hatchlings and female adults returning to the sea from nesting areas on the shore (Pendoley 2005). Incorrect management of personnel and equipment on turtle-nesting beaches could result in a minor impact on a small proportion of a turtle-nesting population (Minor E). A shoreline clean-up response will generate a significant quantity of hydrocarbon-contaminated solid waste. Contaminated solids will include personal protective equipment (PPE), spill clean-up equipment (shovels, rakes, etc.) and the oil-contaminated sediments collected from shorelines (IPICEA 2015a). Inappropriate management of oil-contaminated waste could result in localised contamination of shoreline sediments and harm to individuals of protected species (Minor E).			
Identify existing design safeguards/controls			
Vessels fitted with lights, signals, an automatic identification system (AIS) transponders and navigation equipment as required by the *Navigation Act 2012*. Due to the nature of call-off vessels that may be used during an oil spill response, not all vessels can be confirmed to be equipped with onboard sewage treatment plants compliant with MARPOL 73/78 (depending on the sewage treatment plant installation date) or an approved sewage comminuting and disinfecting system. However, all vessels will comply with the requirements of MARPOL 73/78, Annex IV for sewage discharges and Annex V for food scrap discharges during oil spill response activities.			
Propose additional safeguards/control measures (ALARP evaluation)			
Hierarchy of control	Control measure	Used?	Justification
Elimination	No response strategies implemented.	No	Not responding to a spill which could result in harm to wildlife populations and leaving the spill without understanding its fate and trajectory is not considered to be ALARP. The spill could harm wildlife

			populations, contact shorelines above impact thresholds, or pose an operational risk to response personnel; therefore, INPEX will deliver monitoring and evaluation and other appropriate secondary response strategies to reduce impacts to ALARP.
	Eliminate use of vessels (collision risk and associated discharges) during a spill response.	No	Vessels are critical assets for monitoring and implementing oil spill response activities.
Substitution	None identified	N/A	N/A
Engineering	None identified	N/A	N/A
Procedures and administration	Maintain and implement an appropriate Operational Monitoring and Evaluation capability, as described, and within the timeframes specified in Table 8-8, for any Level 2/3 spill event.	Yes	Operational Monitoring and Evaluation will be implemented for any Level 2/3 oil spill response activity, to provide real-time situational awareness to the IMT. This capability involves the mobilisation/activation of: • Oil spill trajectory modelling • Aerial surveillance • Trained aerial observers • Vessel surveillance • Electronic surface tracking buoys • Satellite imagery Justification for the level of capability and mobilisation timeframes are provided in Table 8-8.
	Maintain and implement equipment, personnel and logistics capability, as described and within the timeframes specified in Table 8-8, for any shoreline clean-up and/or oiled wildlife response, if	Yes	If specified in the Operational SIMA/IAP, shoreline clean-up and/or oiled wildlife response strategies would involve the mobilisation of: • small vessel and large larger support vessels • light utility helicopter • shoreline clean-up and oiled wildlife response equipment • shoreline clean-up and oiled wildlife response personnel

	selected for activation under the IAP.		Justification for the level of capability and mobilisation timeframes are provided in Table 8-8.
	Maintain a waste management contract, to receive and treat/dispose of oily contaminated wastes.	Yes	In the event that an oiled wildlife or shoreline clean-up response is activated, oily wastes will be generated and will therefore require appropriate onshore disposal.
	Develop an Operational SIMA in accordance with Section 3 of the OPEP to confirm effectiveness of response strategies. Include the selected strategies in the IAP.	Yes	To ensure that response strategies will be effective, the INPEX IMT will use the Operational SIMA template (OPEP Section 3) and the Operational Monitoring and Evaluation data to develop an Operational SIMA, before selecting response strategies for inclusion in the IAP. The OPEP details all the response strategies, capabilities, and considerations that need to be undertaken to implement an effective response to a hydrocarbon spill. The IMT considers all relevant information at the time of the spill, and using the OPEP for guidance, develop the IAPs. The IAPs demonstrate how the OPEP was effectively implemented during a spill event.
	Emergency response preparedness will be maintained by implementing Section 9.10 this EP.	Yes	To ensure that INPEX is prepared to respond to a spill, response preparedness will be tested in accordance with Section 9.10 of this EP.
	Spill response strategy effectiveness will be monitored and terminated appropriately.	Yes	During response implementation, it is appropriate to monitor the ongoing effectiveness of the response strategy, to ensure the response continues to effectively reduce or mitigate the impacts of the spill and prevent of minimise additional harm. Ongoing monitoring of the effectiveness of the response strategy also ensures an appropriate termination point is reached.

	Visual inspections to prevent introduction of terrestrial exotic pests to offshore islands.	Yes	Visual inspections of helicopters and equipment mobilising to remote shorelines as part of any shoreline response activity will significantly reduce the risk of any introductions of terrestrial exotic pests. While the DEWHA threat abatement plan (DEWHA 2009) is focused on vessel-based vectors for introductions, this control is consistent with the intent of the actions described within that plan.
	Vessel sewage and food scrap discharges, and waste management will be conducted in accordance with MARPOL 73/78 requirements.	Yes	All vessels involved in oil spill response will have the capability to ensure sewage and food scraps discharges and waste management are compliant with MARPOL 73/78 requirements.
	Shoreline response activity HSE plan prepared and implemented which incorporates consideration of impacts to turtle nesting.	Yes	A site-specific HSE plan for any shoreline response activity will be developed to address any risks to turtle nesting associated with personnel and equipment movement on offshore islands / mainland turtle-nesting beaches. The plan will address specific issues including: personnel and equipment movement on turtle-nesting beaches light-spill (if night-time activities are required). The section of the relevant HSE plan will be prepared in consultation with AMOSC wildlife experts, DEE (Cwlth), and WA DoT/DBCA for responses on WA state lands.
	Obtain permits, in consultation with the relevant government agencies, before commencing wildlife hazing activities.	Yes	Consultation and obtaining the required permits from relevant government agencies before conducting any wildlife response activities will limit the likelihood of undue stress or harm to wildlife during the response activity.

	A waste management plan will be prepared and implemented for any shoreline response operations, in consultation with AMOSC and WA DoT.	Yes	A waste management plan to manage all hydrocarbon-contaminated solid/liquid waste is necessary to prevent accidental additional contamination of sediments and reduce the risks to wildlife.

Identify the likelihood

Likelihood	Hydrocarbon spills of a Level 2 or Level 3 nature that are likely to trigger response strategies, thereby introducing the impacts and risks from implementing response strategies, are evaluated in Table 8-5. The use of secondary response strategies may increase the likelihood of impact occurring in comparison to just employing monitoring and evaluation techniques alone. However, based on the controls described, the likelihood of response activities resulting in the consequences described is considered Highly Unlikely (5).
Residual risk	Based on a worst-case consequence of Moderate (D) and likelihood of Highly Unlikely (5) the residual risk is Moderate (8).

Residual risk summary

Consequence	Likelihood	Residual risk
Moderate (D)	Highly Unlikely (5)	Moderate (8)

Assess residual risk acceptability

Legislative requirements

The activities and proposed management measures are compliant with industry standards and relevant Australian legislation/guidance, e.g. the NatPlan (AMSA 2019b); the Western Australian State Hazard–Maritime Environmental Emergencies (WA DoT 2018b), specifically concerning implementation of oil pollution emergency plans; and MARPOL 73/78 for vessel discharges and garbage management.

Stakeholder consultation

Stakeholders have been engaged and issues/feedback have been incorporated in to the OPEP regarding potential impacts and risks associated with implementation of response strategies for Group II/MGO/Diesel spills. Stakeholder engagement is an ongoing process.

Australian marine park values, objectives and zone rules

Consistent with the requirements of the North-west Marine Parks Network Management Plan 2018:

- The proposed activity will be managed in a manner that is consistent with the zone rules applicable to the Kimberly AMP. Emergency response activities are permitted in all zones.
- No significant or long-term impacts to AMP values are expected to occur.
- Emergency response activities will be managed in a manner that is consistent with the Multiple Use Zone objective to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
- Emergency response activities will be managed in a manner that is consistent with the Habitat Protection Zone objective to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
- Emergency response activities will be managed in a manner that is consistent with the National Park Zone objective to provide for the protection and conservation of ecosystems, habitats and native species in as natural a state as possible.
- Emergency response activities will be managed in a manner that is consistent with the overarching objectives of the North-west Marine Parks Network Management Plan 2018, which provide for the ecologically sustainable use of the natural resources within marine parks in the Northwest Network, where the biodiversity and other natural, cultural and heritage values are protected and conserved.

Conservation management plans / threat abatement plans

Several conservation management plans (refer to Appendix B) identify marine debris as a key threatening process to recovery. Also, the relevant action from the *Threat abatement plan for the impacts of marine debris on vertebrate marine life* (DEWHA 2009) is to "contribute to the long-term prevention of the incidence of harmful marine debris". The prevention of garbage entering the marine environment and the appropriate management of sewage and food wastes reduces the risk of impacts to the marine environment and demonstrates alignment with the various conservation management plans and threat abatement plans.

The Threat abatement plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100 000 hectares (DEWHA 2009), describes the threat of invasion or reinvasion of rodents on bird populations. The relevant action from DEWHA (2009) is to prevent invasion or reinvasion via prevention / risk reduction for rodents gaining access to key vessels at key ports. As INPEX proposes to access islands via helicopter, controls which align with the intent of DEWHA (2009) have been developed.

The recovery plan for marine turtles in Australia (DEE 2017a) identifies that light pollution and vehicle damage (and therefore possibly excessive foot traffic) are possible threats to turtle nesting, which could result from shoreline response activities during an oil spill response. Controls which align with the intent of DEE recovery plan have been developed.

ALARP summary

Although the level of environmental risk is assessed as Low, a detailed ALARP evaluation was undertaken to determine what additional control measures could be implemented to reduce the level of impacts and risks. No additional controls, beyond those identified during the detailed ALARP assessment can reasonably be implemented to further reduce the risk of impact.

Acceptability summary

Based on the above assessment, the proposed controls are expected to effectively reduce the risk of impacts to acceptable levels because:

- the controls demonstrate compliance with legislative requirements;
- the controls meet stakeholder expectations;
- management of the activity is consistent with Australian Marine Park management objectives for ecologically sustainable use and the protection of marine park values;
- management of the activity is aligned with the relevant conservation management plans / threat abatement plans and demonstrates a contribution to the long-term prevention of the incidence of harmful marine debris; and
- the level of residual risk is 'Low' and impacts and risks are ALARP, and no further controls can reasonably be implemented to further reduce the risk of impact.

Environmental performance outcomes	Environmental performance standards	Measurement criteria	Responsibility
Oil spill response logistics, personnel and equipment capability, will be maintained at acceptable levels through implementation of the environmental performance standards.	Operational monitoring and evaluation capability which can meet the mobilisation timeframes specified in Table 8-8, will be maintained including: • Oil spill trajectory modelling • Aerial surveillance • Trained aerial observers • Vessel surveillance • Electronic surface tracking buoys • Satellite imagery	Records confirm operational monitoring and evaluation capability maintained including: • Oil spill trajectory modelling contract in place • Aircraft contacts / call-off agreements • AMOSC contract • Vessel contracts / call-off agreements	IMT Leader

		• Electronic surface tracking buoy locations (tracked via INPEX Oil Spill Preparedness and Response Register) • Satellite imagery provider contract	
	Oil spill response capability for shoreline and pre/post contact oiled wildlife response, which can meet the mobilisation timeframes specified in Table 8-8, will be maintained including: • Access to AMOSC and OSRL equipment and personnel, including shoreline clean-up and oiled wildlife response personnel and equipment. • Access to small and large support vessel capability • Access to light utility and crew change helicopters • Access to additional support personnel through Environmental Service Providers general labour hire.	Records confirm oil spill response capability is maintained including: • AMOSC contract • OSRL contract • Framework agreements	IMT Leader
IMT will evaluate operational monitoring and evaluation data for the full duration of the spill event, to determine if additional response strategies are required.	The IMT will activate and evaluate real-time operational monitoring and evaluation data for any Level 2/3 spill event. The operational monitoring and evaluation data and the OPEP's Operational SIMA template will be used for the development of the Operational SIMA and IAP.	Records confirm real-time operational monitoring and evaluation data was received and evaluated by the IMT. Records confirm operational monitoring and evaluation data and the OPEP's Operational SIMA template were used for the development of the Operational SIMA and IAP.	IMT Leader

Risks of impacts to transient, EPBC-listed species, i.e. marine turtles, marine mammals and marine avifauna (receptors) from a Level 2 or Level 3 spill (impactors) are reduced and maintained at acceptable levels through implementation of the environmental performance standards and the application of the environmental management implementation strategy.	To monitor response strategy effectiveness, daily reports from primary and secondary response activities will be provided to the IMT, in accordance with Section 4 of the OPEP. Effectiveness of the oil spill response will be monitored until: • the source of the spill has been stopped, • the objectives of the Incident Action Plans have been met or • there are no further practicable steps that can be taken to respond to a spill.	Daily field activity reports, in accordance with Section 4 of the OPEP. Daily reports or other data confirms oil spill response termination criteria have been met.	IMT Leader
	Emergency response preparedness will be maintained by implementing Section 9.10 of this EP.	Records confirm emergency response preparedness, as detailed in Section 9.10 of this EP, is maintained.	INPEX Environmental Advisor
Risks of impacts to transient, EPBC-listed species, i.e. marine turtles, marine mammals and marine avifauna, and benthic communities which support them (receptors) from vessel discharges during oil spill response activities (impactors) are reduced and maintained at	All vessels involved in oil spill response activities will conduct sewage disposal activities in accordance with MARPOL 73/78, Annex IV. All vessels involved in oil spill response activities will conduct food scrap disposal activities in accordance with MARPOL 73/78, Annex V. No de-ballasting within marine parks during oil spill response activities.	Records of sewage discharge locations are maintained in a sewage disposal record book that complies with MARPOL 73/78, Annex IV. Records of food scrap discharges are maintained in a garbage record book that complies with MARPOL 73/78, Annex V. Records of de-ballasting.	Vessel Master

acceptable levels through implementation of the environmental performance standards and the application of the environmental management implementation strategy.			
No inappropriate disposal of garbage.	All vessels involved in oil spill response activities will conduct garbage management in accordance with MARPOL 73/78, Annex V.	Records of garbage disposals are maintained in a garbage record book that complies with MARPOL 73/78, Annex V.	Vessel Master
No incidents of loss of hydrocarbons to the marine environment as a result of a vessel collision during oil spill response.	Vessels will be fitted with lights, signals, AIS transponders and navigation equipment as required by the *Navigation Act 2012*.	A premobilisation report confirms that required navigation equipment is fitted to all vessels to ensure compliance with the *Navigation Act 2012.*	INPEX Environmental Advisor
No secondary ocean or shoreline contamination due to inappropriate waste management during a shoreline response activity.	A contract will be maintained with a licenced waste management contractor, capability of receiving, treating and disposing of solid and liquid oily contaminated wastes.	Records confirm contract in place with a licenced waste management contractor.	INPEX Environmental Advisor
	In consultation with WA DoT and AMOSC, a response waste management plan, including decontamination stations and waste storage, transport and disposal arrangements, will be prepared and implemented for any shoreline response activity.	Records demonstrate that a waste management plan was prepared and implemented, in consultation with WA DoT and AMOSC, for any shoreline response activity.	IMT Leader

Risks of impacts to transient, EPBC-listed species, i.e. marine turtles, marine mammals and marine avifauna (receptors) from wildlife response activities (impactors) are reduced and maintained at acceptable levels through implementation of the environmental performance standards and the application of the environmental management implementation strategy.	Permits will be obtained in consultation with DEE (Cwlth) before any wildlife hazing, post-contact wildlife response or shoreline clean-up activities take place in Commonwealth waters or on Commonwealth lands. Permits, including launching and landing aviation assets, will be obtained in consultation with DBCA (via WA DoT) before any wildlife hazing, post-contact wildlife response or shoreline clean-up activities take place in WA/NT waters or lands.	Records demonstrate response activities with the potential to affect wildlife were conducted in consultation with, and under permits issued by, DEE (Cwlth), DBCA or NT PaWC. Records are kept of response activities demonstrating compliance with any controls defined in the permits.	INPEX Environmental Advisor
No introduction of terrestrial exotic pests to offshore islands.	Pre-flight visual inspections of helicopters conducted. Premobilisation visual inspections of vessels and equipment before mobilisation onto an offshore island and recorded on quarantine inspection checklists.	All aircraft technical logs confirm that pre-flight visual inspections have been conducted. Quarantine inspection checklists confirm vessel and equipment premobilisation inspections have been conducted.	INPEX Environmental Advisor

Risks of impacts to transient, EPBC-listed species, i.e. marine turtles, (receptors) from a shoreline response (impactors) are reduced and maintained at acceptable levels through implementation of the environmental performance standards and the application of the environmental management implementation strategy.	In the event of a shoreline response, an HSE plan will be prepared, in consultation with AMOSC and DBCA (via WA DoT) which addresses potential impacts to turtle nesting, including: • personnel and equipment movement on turtle-nesting beaches • light-spill (if night-time activities are required).	Records of correspondence with AMOSC and WA DoT/DBCA regarding turtle-nesting considerations. HSE plan documentation demonstrates controls regarding turtle nesting. Records demonstrate compliance with controls described in the HSE Plan.	INPEX Environmental Advisor

9 Environmental management implementation strategy

This section provides a description of the INPEX health, safety, environment and quality management system (HSEQ-MS) as it applies to the implementation of this EP and its associated performance outcomes and standards.

9.1 Overview

The HSEQ-MS includes standards and procedures from other business areas for its completeness. It is based on the principle of a "plan, do, check, act" (PDCA) continual improvement cycle, and has been developed in accordance with the following Australian standards:

- AS/NZS 4801:2001, *Occupational health and safety management systems—Specification with guidance for use*
- AS/NZS ISO 14001:2004, *Environmental management systems—Requirements with guidance for use*.

It provides mandatory rules and processes for the systematic and consistent management of HSEQ risks, demonstration of compliance, and facilitation of continual improvement. In the context of this EP, the HSEQ-MS enables INPEX to ensure that:

- environmental risks of activities are identified and communicated;
- organisational structures and resources are provided to ensure that control measures remain effective in reducing environmental risks to levels that are acceptable and ALARP;
- performance outcomes and standards are being met; and
- continual improvement is achieved through application of lessons learned.

The 13 external elements that influence the HSEQ-MS reflect key aspects of INPEX activities requiring process safety and HSEQ controls (Figure 9-1). These elements have to be managed and implemented properly in order to achieve the desired HSEQ performance and reflect a PDCA cycle, which is applied to every aspect of the 13 elements.

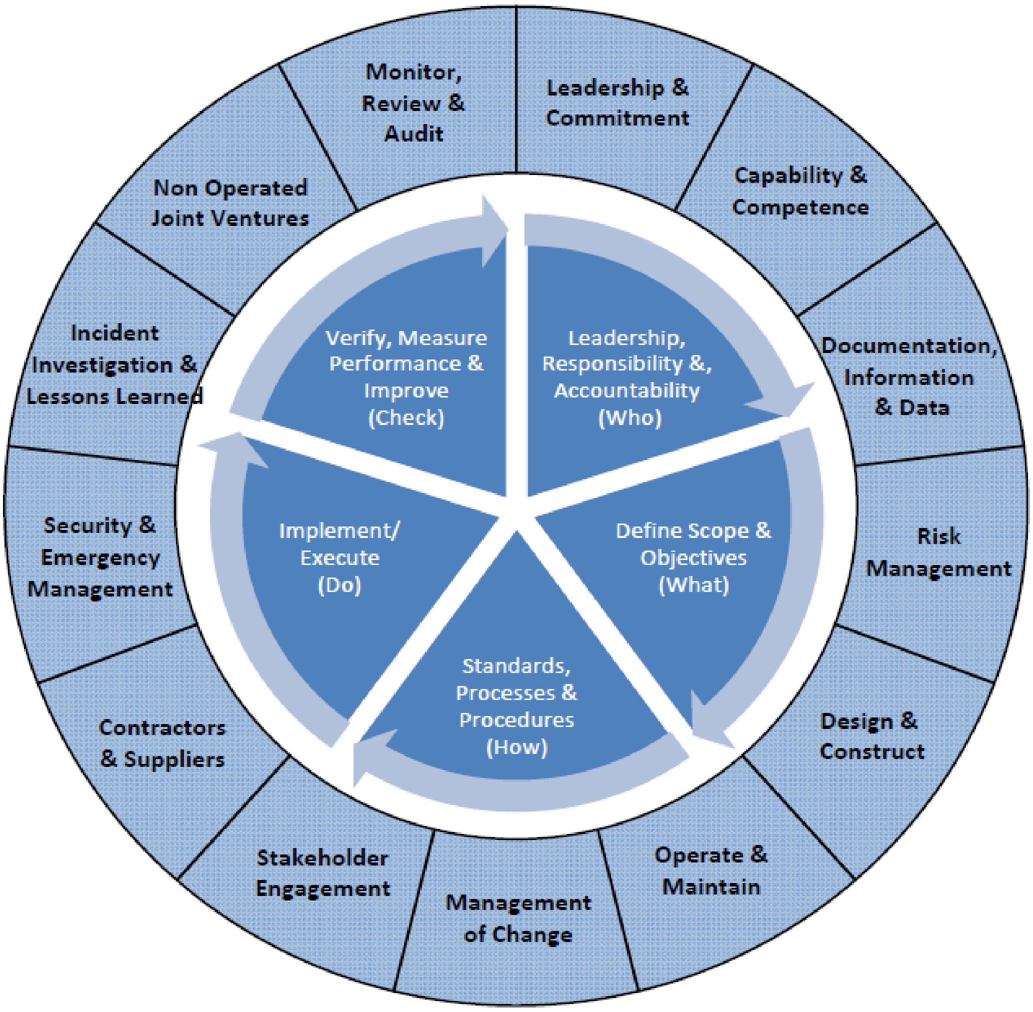


Figure 9-1: The INPEX health, safety, environment and quality management system

9.2 Leadership and commitment

INPEX environmental performance is achieved through strong visible leadership, commitment and accountability at all levels of the organisation. Leadership includes defining performance targets and providing structures and resources to meet them.

The INPEX Environmental Policy (as updated from time to time) (

INPEX

Environmental Policy

Objective

INPEX is a worldwide oil and gas exploration, development and production company committed to conducting each of its activities in a manner that is environmentally responsible.

Our objective is to develop an environment culture that is recognised as amongst "best in industry" that will exceed the performance expectations of our stakeholders.

We recognise our responsibility to adhere to the principles of sustainable development and we acknowledge that we owe a duty of care to both the natural environment and the communities in which we operate.

Strategy

To accomplish this, INPEX will:

- comply with applicable laws and regulations, environmental plans and commitments and apply appropriate INPEX standards
- maintain a culture where people are empowered to intervene to prevent environmental harm
- set, measure and review environmental performance objectives and targets and ensure appropriate management of change processes are followed
- ensure our personnel have the necessary awareness, training, knowledge, resources and support, to meet environmental objectives and targets
- identify, manage and review environmental hazards and risks associated with our current and future business activities and manage these to levels that are 'as low as reasonably practicable' (ALARP)
- implement, maintain and regularly test control measures associated with major environmental events
- maintain and regularly test emergency management processes and procedures, including with industry and government emergency response partners
- engage with and communicate openly on environmental issues with internal and external stakeholders
- provide clearly defined environmental performance expectations for our contractors and suppliers, and work collaboratively with them to attain these
- endeavour to prevent pollution and seek continual improvement with respect to emissions, discharges, wastes, energy efficiency and resource consumption
- actively promote the reduction of greenhouse gas emissions across our operations in a safe, technically and commercially viable manner
- endeavour to protect biodiversity and to contribute to increased understanding of our natural environment
- drive continual improvement in environmental performance through monitoring, auditing and reviews.

Application

This policy applies to all INPEX controlled activities in Australia and related project locations. It will be displayed at all company workplaces and on the company's intranet and it will be reviewed regularly.

Hitoshi Okawa
President Director, Australia

Rev: 3
April 2019
Document No.: 0000-AH-POL-60002

Figure 9-2) solidifies this commitment and states the minimum expectations for environmental performance. The policy applies to all INPEX-controlled activities in Australia and related project locations, including the 2D seismic survey. All personnel, including contractors, are required to comply with the policy.

The policy is available on the INPEX intranet and displayed at all INPEX workplaces, including all contractor vessels in the Operational Area. It will be communicated to personnel involved in the activities, including contractors, through inductions.

INPEX

Environmental Policy

Objective

INPEX is a worldwide oil and gas exploration, development and production company committed to conducting each of its activities in a manner that is environmentally responsible.

Our objective is to develop an environment culture that is recognised as amongst "best in industry" that will exceed the performance expectations of our stakeholders.

We recognise our responsibility to adhere to the principles of sustainable development and we acknowledge that we owe a duty of care to both the natural environment and the communities in which we operate.

Strategy

To accomplish this, INPEX will:

- comply with applicable laws and regulations, environmental plans and commitments and apply appropriate INPEX standards
- maintain a culture where people are empowered to intervene to prevent environmental harm
- set, measure and review environmental performance objectives and targets and ensure appropriate management of change processes are followed
- ensure our personnel have the necessary awareness, training, knowledge, resources and support, to meet environmental objectives and targets
- identify, manage and review environmental hazards and risks associated with our current and future business activities and manage these to levels that are 'as low as reasonably practicable' (ALARP)
- implement, maintain and regularly test control measures associated with major environmental events
- maintain and regularly test emergency management processes and procedures, including with industry and government emergency response partners
- engage with and communicate openly on environmental issues with internal and external stakeholders
- provide clearly defined environmental performance expectations for our contractors and suppliers, and work collaboratively with them to attain these
- endeavour to prevent pollution and seek continual improvement with respect to emissions, discharges, wastes, energy efficiency and resource consumption
- actively promote the reduction of greenhouse gas emissions across our operations in a safe, technically and commercially viable manner
- endeavour to protect biodiversity and to contribute to increased understanding of our natural environment
- drive continual improvement in environmental performance through monitoring, auditing and reviews.

Application

This policy applies to all INPEX controlled activities in Australia and related project locations. It will be displayed at all company workplaces and on the company's intranet and it will be reviewed regularly.

Hitoshi Okawa
President Director, Australia

Rev: 3
April 2019
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This document has been approved and the audit history is recorded on the last page

Figure 9-2: INPEX environmental policy

9.3 Capability and competence

INPEX appoints and maintains competent personnel to manage environmental risks and provide assurance that the INPEX Environmental Policy, objectives and performance expectations will be achieved. This applies to both individual competencies and the overall capability of the organisation.

9.3.1 Organisation

Figure 9-3 illustrates the organisational structure for onshore and offshore roles for the 2D seismic survey. During the survey, the Exploration Project Manager will ensure the implementation of this EP with support from the Environmental Advisor and offshore resources, namely the Marine Fauna Observers, Survey Manager, Vessel Manager and Vessel Masters.

Work activities for the 2D seismic survey will be conducted by the survey contractor, under the direction of the INPEX Offshore Representative via written work instructions and work programs.

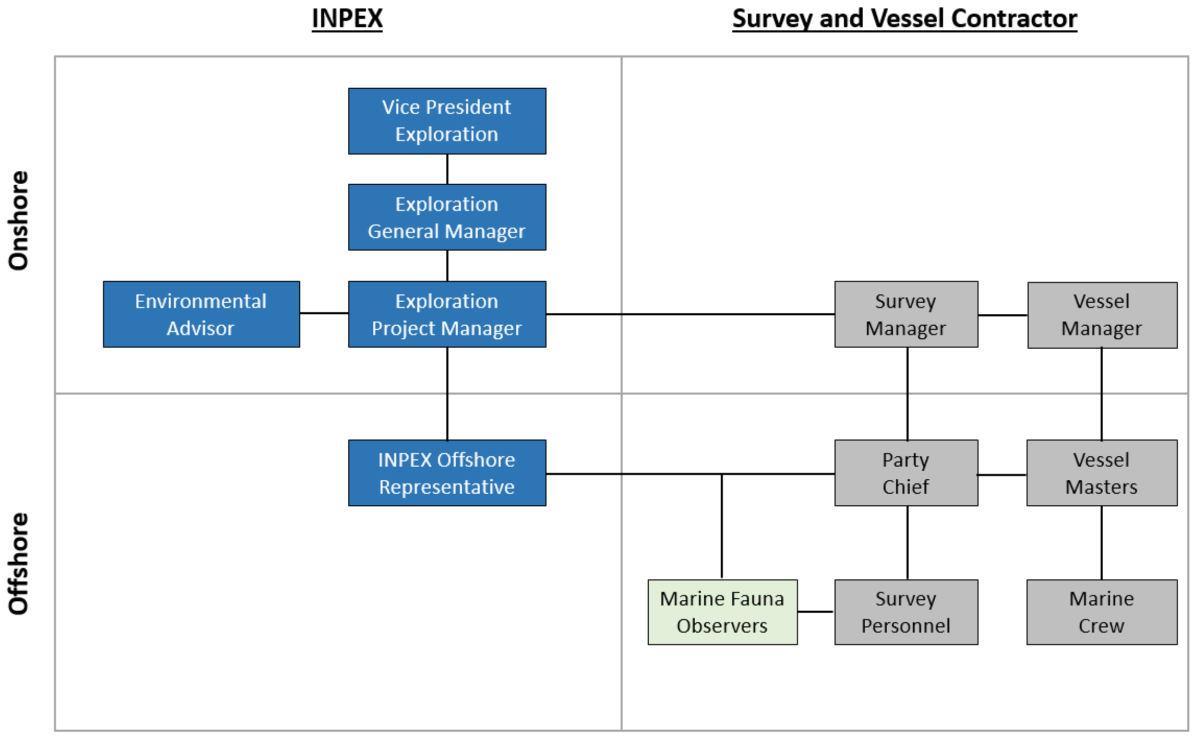


Figure 9-3: 2D seismic survey organisational structure

9.3.2 Roles and responsibilities

INPEX has established and implements standards, procedures and systems to build and maintain a trained and competent workforce capable of fulfilling its assigned roles and responsibilities, as well as meeting its legislative and regulatory requirements. The selection process for the key INPEX personnel identified in Table 9-1 includes consideration of their previous work experience and recognised qualifications when compared with the INPEX minimum competency standards.

The key roles are responsible for collecting and maintaining the required evidence and monitoring data as specified in the environmental performance standards detailed in sections 7, 8 and 9 of this EP. Supporting roles are also described in Table 9-1.

Key responsibilities in respect of environmental performance outcomes described in this EP are listed in the tables in sections 7, 8 and 9. Additional roles and responsibilities related to HSEQ-MS implementation are also listed in Table 9-1.

Table 9-1: Key personnel and support roles and responsibilities

Key role	Responsibilities
Vice President subsurface	• Provides resources to implement the 2D seismic program
Manager Geoscience subsurface (Onshore)	• Ensures overall compliance with the INPEX HSEQ-MS including environmental performance outcomes and standards.
INPEX Lead geophysicist (Onshore)	• Ensures activities are undertaken in accordance with this EP. • Ensures any changes to the activity that may affect the performance outcomes and environmental management procedures detailed in this EP are communicated to the INPEX Environmental adviser. • Ensures the Survey Manager/Vessel Master/Party Chief is provided with the resources required to ensure that the commitments in this EP are undertaken. • Ensures the INPEX Offshore Representative is provided with the resources required to ensure that the commitments in this EP are undertaken. • Ensures reporting of environmental incidents meets external reporting requirements and INPEX incident reporting requirements. • Ensures corrective actions raised from environmental audits are tracked and closed out.
INPEX Offshore Representative (Offshore)	• Ensures contractors perform operations in a manner consistent with the performance outcomes and environmental management procedures detailed in this EP. • Ensures the implementation of the INPEX Environment Policy, through application of this EP. • Ensures the Party Chief, Vessel Master and all crews adhere to the requirements of this EP. • Ensures that the INPEX Exploration Project Manager and Environmental Advisor are alerted to any changes in activities that could have a negative impact on environmental performance. • Reports incidents to the INPEX Exploration Project Manager.
INPEX Environmental Adviser (Onshore)	• Ensures that environmental audits are undertaken. • Ensures that the roles and responsibilities have been communicated. • Ensure that any changes to the survey program that may affect EP mitigation and management measures are captured via the management of change process.

Key role	Responsibilities
CONTRACTOR Survey Manager	• Ensures contractor activities are undertaken in accordance with this EP. • Ensures personnel and vessels mobilised for the survey meet the required standards specified in this EP. • Ensures vessel pre-mobilisation inspections are completed and any corrective actions are implemented • Ensures the required notifications with Government agencies and stakeholders are completed in accordance with this EP.
CONTRACTOR Vessel Manager	• Ensures contractor activities are undertaken in accordance with this EP. • Ensures vessels mobilised for the survey meet the required standards specified in this EP.
CONTRACTOR Party Chief (Offshore)	• Ensures the vessel management systems and procedures are implemented. • Ensures personnel starting work on the survey vessel and support vessels receive an induction that meets the requirements specified in this EP. • Ensures personnel are competent to undertake the work they have been assigned. • Ensures emergency drills are conducted as per the vessel schedules. • Ensures the vessels' emergency response team has been given sufficient training to implement SOPEP/SMPEP. • Ensures any environmental incidents or breaches of performance outcomes, standards or criteria, are reported immediately to the INPEX Offshore Representative.
Vessel Masters (Offshore)	• Conduct vessel operations in accordance with this EP. • Implement the vessel's SOPEP/SMPEP in an emergency. • Ensure that environmental incidents or breaches of performance outcomes, standards or criteria on vessels, are reported in line with INPEX's HSEQ performance reporting requirements for contractors.

Key role	**Responsibilities**
Marine Fauna Observers (Offshore)	• Maintain watch for cetaceans and other marine fauna during the course of the survey and advise the INPEX Offshore Representative and Party Chief, of the presence of these marine fauna. • Implement EPBC Act Policy Statement 2.1, Part A Standard Management Procedures and additional management procedures applicable to the sighting of marine fauna, as identified in this EP. • Monitor and record any interactions with cetaceans and other marine fauna. • Assist in the preparation of the marine fauna compliance and sightings report to the Department of Environment and Energy upon completion of the survey. • Support the INPEX Offshore Representative to ensure contractors perform operations in a manner consistent with the performance outcomes and environmental management procedures detailed in this EP. • Monitor and record performance against the environmental performance outcomes, performance standards and environmental management procedures detailed in this EP. Maintain records to demonstrate compliance and meet measurement criteria. • Support the INPEX Environmental Advisor and Offshore representative with inductions and environmental inspections and audits. • Provide suitable support (i.e. training and materials) to assist vessel crews understand requirements relating to the identification, distance estimation and reporting of cetaceans, consistent with EPBC Act Policy Statement 2.1, and other marine fauna. • Assist in preparation of environmental performance and incident reports. • Ensures any environmental incidents or breaches of performance outcomes, standards or criteria, are reported immediately to the INPEX Offshore Representative.
Support roles	Responsibilities
All marine crew and survey personnel (Offshore)	• Work in accordance with accepted vessel HSE systems and procedures. • Comply with EP requirements as applicable to assigned role. • Report any hazardous condition, near miss, unsafe act, accident or environmental incident immediately to supervisors. • Attend HSE meetings and training when required.

9.3.3 Inductions

Inductions are conducted for all personnel (including INPEX representatives, contractors, subcontractors and visitors) before they start work on the vessels described in this EP.

Inductions cover the health, safety and environment requirements of the vessel, including information about the commitments contained in this EP.

The environmental content of these inductions includes the following:

- HSE Policies
- a general description of the activity location
- the ecological and socioeconomic values of Operational Area and the surrounding areas
- legislative requirements, standards and procedures
- environmental management requirements, including:
  - spatial and or seasonal restrictions or exclusions applicable to the activity
  - procedures for observing and managing interactions with marine fauna
  - procedures for communicating with and managing interactions with commercial fisheries
- oil spill management, including prevention, response and clean-up, location of SOPEP equipment and reporting requirements
- waste management requirements of the Garbage Management Plan
- reporting of incidents.

9.4 Documentation, information and data

INPEX implements and maintains document and records management procedures and systems. These are in place to ensure that the information required to support safe seismic operations, is current, reliable and available to those who need it.

Documents and records are stored electronically in INPEX document management systems and databases.

Records to demonstrate implementation of the HSEQ-MS and compliance with legislative requirements and other obligations are identified and maintained for at least five years. These records will include:

- written reports – including risk assessment reports and registers, monitoring reports, audit and review reports – about environmental performance or implementation strategies
- records relating to environmental performance or the implementation strategies
- records of environmental emissions and discharges (i.e. activation of the seismic source including time and location, vessel records of diesel use and garbage disposal records).
- modification and changes authorised by INPEX and/or contractor
- incident and/or near miss investigation reports
- improvement plans (corrective actions, key performance indicators)
- records relating to training and competency in accordance with this EP.

9.5 Risk Management

The risks and impacts associated with the petroleum activity are detailed in Section 7 and Section 8. Additional risk assessments will be undertaken on an ongoing basis when triggered by any of the following circumstances:

- when there is a proposed change to the activity, as identified by an INPEX management of change (MoC) request
- when identified as necessary following the investigation of an event
- when additional information about environmental impacts or risks becomes available (e.g. through better knowledge of the receptors present within the EMBA, new scientific information/papers, results of monitoring, other industry events or studies)
- if there is a change in regulations, as necessary.

The risk assessment will be carried out in line with the assessment process described in Section 6 and is aligned to INPEX's HSE Hazard and Risk Management Standard, to ensure hazards related to the activity are systematically identified, assessed, evaluated and controlled.

9.5.1 Monthly risk review

An environmental risk register for the activity is reviewed and updated monthly. The environmental risk review process will be implemented to assess internal and external changes that may affect the performance outcomes and standards associated with the seismic survey.

9.6 Operate and maintain

Through ongoing engagement with relevant stakeholders and their representatives, INPEX will develop a process to assess genuine claims where an affected party has been directly impacted by this seismic survey.

INPEX proposes to meet the following outcomes, performance objectives and measurement criteria for the activity.

Environmental Performance Objective	Environmental Performance Standard	Measurement criteria
Petroleum activities are carried out in a manner that does not interfere with commercial fishing activities to a greater extent than is necessary for the reasonable exercise of the rights and performance of duties of the Titleholder during seismic acquisition.	Development of a process in consultation with relevant commercial fishing stakeholders whereby one, may be able to claim for losses if they have been negatively affected by an activity in this seismic survey.	Stakeholder consultation records demonstrate relevant commercial fishing stakeholders were engaged during the development of the claim process.
	Provide the claim process to relevant stakeholders at least three weeks prior to the commencement of survey activities.	Stakeholder consultation records confirm that the claim process was provided to relevant stakeholders at least three weeks prior to the commencement of the seismic survey activity (i.e. at least three weeks prior to Form 29 notification of commencement).

Environmental Performance Objective	Environmental Performance Standard	Measurement criteria
	Implementation of the claim process, in the event that a genuine claim is made by a stakeholder.	Records demonstrate that following the receipt of a claim, the process was applied.

9.7 Management of change

Changes to this EP will be managed in accordance with a business-wide standard, and related procedures and guidelines. Where a change to management of an activity is proposed, it will be logged. Internal notification will be communicated via a management of change (MoC) request. The request will identify the proposed change(s) along with the underlying reasons and highlight potential areas of risk or impact. In accordance with the INPEX business rules, it is mandatory to undertake an environmental risk assessment in every case for changes that could affect the environment. The MoC request will be managed by an environmental adviser who will then determine the necessary approval/endorsement pathway, in consultation with the environmental approvals coordinator. Minor changes (such as updating a document or process) that do not invoke a revision trigger are made in document reviews from time to time.

In accordance with Regulation 17 of the OPGGS (E) Regulations 2009, a revision of this EP will be submitted to NOPSEMA where:

- a change is considered to represent a new activity
- a change is considered to represent a significant modification to, or a new stage of, an existing activity
- a change will create a significant new environmental impact or risk that is not provided for in the current EP
- a change will result in a series of new (or increased) environmental impacts or risks that, together, will result in a significant new environmental impact or risk, or a significant increase in an existing environmental impact or risk.

The MoC request process will be periodically checked against NOPSEMA guidance to ensure ongoing compliance and will be undertaken as part of the management review process described in Section 9.13.

9.8 Stakeholder engagement

9.8.1 Legislative and other requirements

INPEX maintains an approvals and compliance tracking system which identifies future approval requirements and when they must be in place, as well as compliance with existing approvals. Through this system, responsible persons are provided with alerts for required actions and time frames to avoid non-compliance and ensure there are no gaps in approvals.

In addition, INPEX personnel participate in industry and regulator forums, as well as maintain up-to-date knowledge of industry practices and proposed regulatory changes. Changes to legislative and other requirements are reviewed for potential impacts to business operations and communicated, as required, to personnel managing potentially affected activities.

Updates to matters relating to the EPBC Act, including policy statements and conservation management documentation will be achieved through subscription to automated email notifications provided by the DEE. Where required, updates to this EP will be conducted in accordance with the MoC process described in Section 9.7.

9.8.2 Communication

The requirements of the INPEX HSEQ-MS are communicated throughout the organisation. This facilitates the cascading and implementation of business policies and standards through the business, and on to contractors who work on behalf of INPEX.

INPEX and its contractors adopt a number of methods to ensure that information relating to HSEQ risks and impacts are communicated to personnel, including:

- daily toolbox meetings
- HSE meetings
- use of noticeboards, intranet, HSE alerts and newsflashes e.g. environmental aspects and events
- internal and external reporting.

9.8.3 Ongoing stakeholder consultation

In relation to an EP Implementation Strategy, Regulation 14(9) of the OPPGS (E) Regulations 2009 specifies a requirement for consultation with relevant authorities of the Commonwealth, a state or territory, and other relevant interested persons or organisations. Any objections or claims received from stakeholders while the EP is in force will be considered and assessed as detailed in Section 5, using the same process and criteria described for the stakeholder consultation undertaken during the development of this EP. Mechanisms that provide ongoing opportunities for consultation with stakeholders, in relation to the implementation of this EP, are summarised in Table 9-2.

Table 9-2 Ongoing stakeholder consultation.

Stakeholder	Information supplied	Timing / Frequency
Department of Defence (Cwlth)	Defence to be notified 3 months prior to intended commencement to advise start date, potential survey duration and location, to deconflict activities in the REEF Curtin Air-to-Air Weapons Range.	3 months prior to commencement and upon completion
Australian Hydrographic Office (AHO; Cwlth)	The AHO will be notified of the activity commencement and cessation via datacentre@hydro.gov.au, for promulgation of fortnightly Notice to Mariners.	4 weeks prior to commencement and upon completion
Australian Maritime Safety Authority (AMSA; Cwlth) Joint Rescue Coordination Centre (JRCC)	INPEX to notify AMSA JRCC for promulgation of radio-navigation warnings 24-48 hours before operations commence and upon completion of the survey (Email: rccaus@amsa.gov.au; Phone: 1800 641 792 or +61 2 6230 6811). AMSA's JRCC require the vessel names, IMO vessel numbers and call signs, and Maritime Mobile Service Identity (MMSI) numbers	24-48 hours before operations commence and upon completion

Stakeholder	Information supplied	Timing / Frequency
NOPSEMA (Cwlth)	NOPSEMA will be notified of the activity commencement and cessation, using the Regulation 29 Notification Form available at https://www.nopsema.gov.au/environmental-management/notification-and-reporting/	At least 10 days prior to commencement and within 10 days of completion
NOPTA (Cwlth)	NOPTA will be notified of the activity commencement and cessation via reporting@nopta.gov.au	48 hours prior to commencement and upon completion
Department of Mines, Industry Regulation and Safety (WA)	DMIRS will be notified of the activity commencement and cessation.	1 week prior to commencement and within 1 week of completion.
Director of National Parks (DNP; Cwlth)	Notification via to marineparks@environment.gov.au upon acceptance of the EP by NOPSEMA	Upon acceptance of EP by NOPSEMA
	Notification via marineparks@environment.gov.au of the dates that the activity begins and ends within the Kimberley Australian Marine Park. The notification of commencement shall include: • Titleholder details and representative contact details • type of activity (2D seismic survey) • details of the location and Operational Area, including a map showing any proposed activity overlap with the Kimberley Australian Marine Park • timing and duration of the activity within the marine park (including proposed start and end dates) • names and IMO numbers of vessels entering the marine park • link to the activity summary on the NOPSEMA webpage.	At least 10 days prior to commencement and within 10 days of completion
Commercial fishers via Western Australian Fishing Industry Council (WAFIC)	INPEX will consult commercial fishers via WAFIC to develop the claim process, and other relevant matters.	Ongoing while EP is in force
	WAFIC and relevant commercial fisheries stakeholders will be notified of the activity commencement and cessation.	3 weeks prior to the commencement of activities and

Stakeholder	Information supplied	Timing / Frequency
	The notification of commencement to commercial fishers will include details of: • the location (i.e. Area A or Area B) where the survey will commence • expected start date and survey duration • IMO vessel numbers and call signs • vessel radio and satellite phone communication details • how stakeholders can register to receive daily look-ahead reports during the survey. • The notification of completion will confirm the date of completion and vessel demobilisation from the Operational Area.	following completion.
Australian Border Force, Canberra (Cwlth)	INPEX will report any unusual vessel activity within the area to the Australian Border Force.	As required
Department of Agriculture and Water Resources (Cwlth)	INPEX will keep the Department informed of any concerns raised by AFMA or other relevant Commonwealth fishing stakeholders.	As required

9.9 Contractors and suppliers

Selection and management processes are in place to ensure that contractors working for, or on behalf of, INPEX are able and willing to meet the minimum business expectations of INPEX, including those related to HSEQ and risk management.

The implementation of the INPEX contractor management requirements are achieved via the following processes:

- During the tender evaluation process, each contractor's management system is reviewed, assessed and ranked according to its robustness and ability to meet INPEX performance expectations as relevant to the tender work scope.
- All contractors and their subcontractors are required to meet INPEX HSEQ minimum requirements. These requirements are communicated to the contractors as part of the Contract HSEQ Exhibits, Specifications and Terms and Conditions documents.
- Key contractor and subcontractor personnel must be approved by INPEX under the Contract HSEQ Exhibits, Specifications and Terms and Conditions documents.
- INPEX maintains contract-specific management teams which are responsible for the day–to-day supervision and review of contractor compliance with INPEX requirements.
- Contract compliance audits, and quality control and assurance checks, are conducted throughout the life of the contract as appropriate to the scope of work and risks involved. Contractors are required to provide regular reports to communicate their HSEQ performance and compliance status.

- HSEQ performance of contractors is monitored through regular engagement between INPEX and contractor personnel, and through regular audits of compliance against the contractor HSE management plans.
- Periodic checks and reviews are conducted by INPEX representatives.
- Contractor documents, including environmental certification, procedures, emergency response and HSEQ management plans, need to be reviewed and accepted by INPEX before any work commences.

9.10 Security and emergency management

Regulation 14(8) of the OPGGS (E) Regulations 2009 requires the implementation strategy to contain an OPEP and the provision for the OPEP to be updated. The OPEP is designed to be an operational document. As such, some of the content requirements of the regulations are included in this EP. A summary of the regulatory requirements and a reference to where the obligations are met is provided below. The OPEP is presented in Appendix F.

In accordance with Regulation 14 (8AA) of the OPGGS (E) Regulations 2009, the OPEP must include arrangements to respond to and monitor oil pollution, including:

- the control measures necessary for a timely response to an oil pollution emergency (Table 2-1 of the OPEP, and the controls provided in Section 8 of this EP)
- the arrangements and response capability to implement a timely implementation of those controls, including ongoing maintenance of that capability (Sections 9.10.1, 9.10.3 and 0 of this EP)
- the arrangements and capability for monitoring the effectiveness of the controls and ensuring that performance standards for those controls are met (Section 8 of this EP)
- the arrangements and capability for monitoring oil pollution to inform response activities (refer to OPEP (Appendix F) and Section 4.6.2 Scientific Monitoring)
- the provision for the OPEP to be updated.

9.10.1 Arrangements and capability

INPEX adopts the emergency management principles of prevention, preparedness, response, recovery (PPRR). The aim of PPRR is to ensure that risks are identified and minimised; plans to respond are developed and practised; and recovery plans are in place.

Preparedness also includes ensuring that there are competent personnel available to respond to and manage emergency events and that their competence is maintained through regular training. INPEX achieves this through its adoption of competency-based training and annual 'crisis and emergency' exercise plans.

Onshore

INPEX maintains a trained and ready incident management team (IMT) and crisis management team (CMT) to execute the emergency response plans (ERPs) and crisis management plans. The IMT provides operational management support, and the CMT provides strategic direction with respect to management of reputational damage and impacts to business continuity.

The IMT and CMT will utilise the INPEX Australia Incident Management Plan (0000-AH-PLN-60005), INPEX Australia Crisis Management Plan (0000-AH- PLN-60004) respectively, to respond to the event.

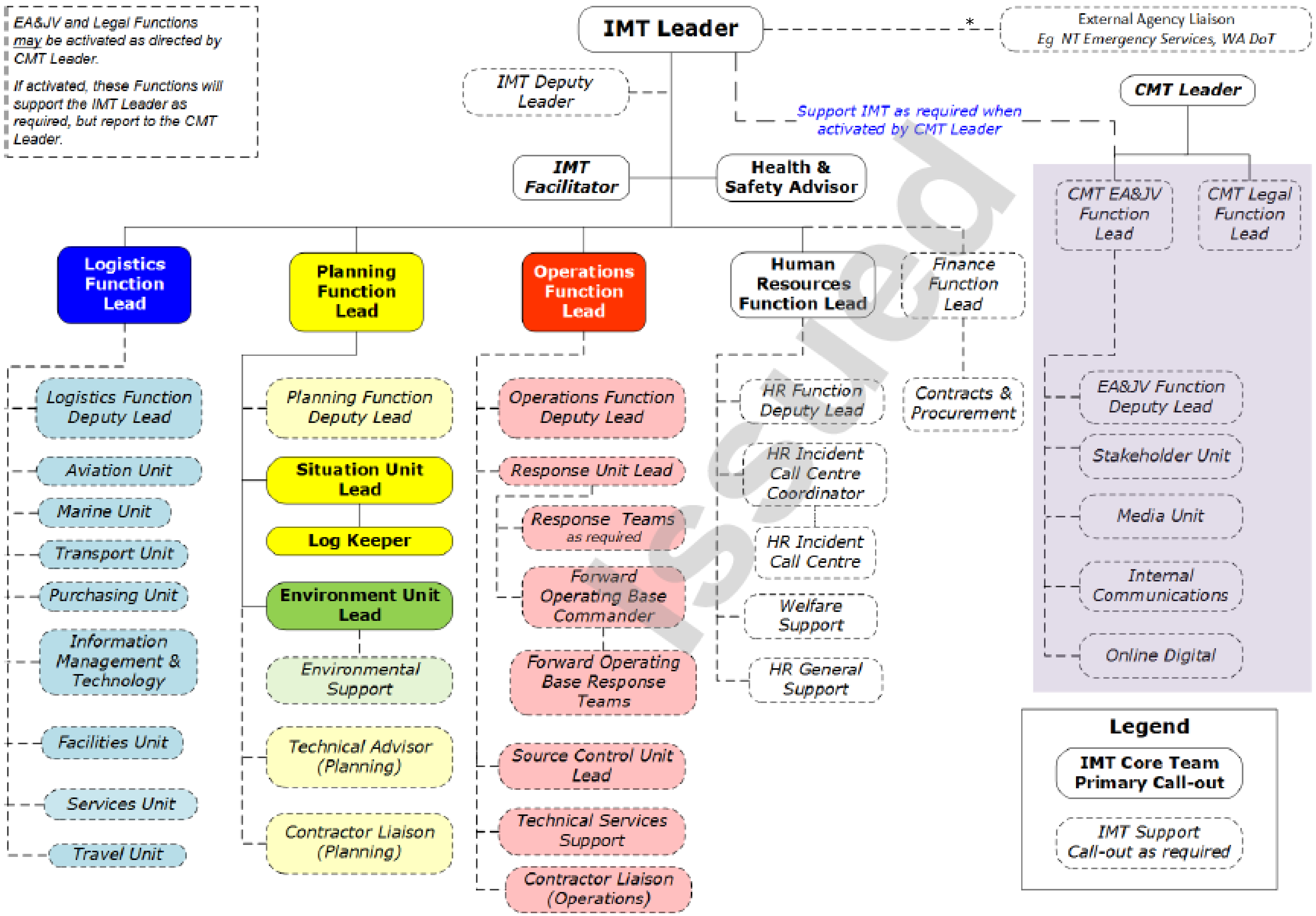
The IMT and CMT teams are large enough so that, during an emergency event, a roster can be operated to avoid fatigue and maintain staff health and well-being.

Offshore

There are ERPs for all contractor vessels that are carried out by an emergency response team (ERT). INPEX and contractors nominate and train workplace personnel to form facility and vessel-based ERTs. These will be coordinated by the relevant person in charge (Party Chief or Vessel Master) to ensure that there is adequate emergency service cover on board at all times.

The Party Chief or Vessel Master will be the point of contact between assets within the permit area and the INPEX IMT. The INPEX IMT leader is the point of contact between the INPEX IMT and the CMT. Contractors are required to notify the INPEX Offshore representative of any emergency.

The emergency response structure is presented in Figure 9-4.



* Department of Transport (WA or NT) have legal right to transfer Control Agency from Titleholder to DoT for level 2/3 oil spills impacting within State or Territory waters. WA DoT will appoint a DoT IMT Leader responsible for managing an oil spill impacting WA state waters in accordance with the State Hazard Plan Maritime Environmental Emergencies (MEE). INPEX resources will be made available to support the WA DoT 'cross jurisdictional arrangements', as specified under the MEE (WA DoT, 2018), if requested by WA DoT. NT DIPL will appoint a DoT Incident controller (in accordance with the NT OSCP cross jurisdiction 'interim arrangements') to interface with the INPEX IMT where NT waters may be impacted by a spill. NT IC will become the control agency, supported by the INPEX IMT, if a spill reaches NT shorelines.

Note that the IMT structure presented is flexible and is to be collapsed or expanded at the discretion of the IMT Leader depending on the nature and scale of an emergency.

Figure 9-4: INPEX emergency response structure

Environmental performance outcomes, standards and measurement criteria relating to the maintenance of emergency response arrangements and capability are presented in Table 9-3.

Table 9-3: Environmental performance objective, standards and measurement criteria for maintenance of emergency response arrangements and capability

Environmental performance outcome	Performance standards	Measurement criteria	Responsibility
OPEP preparedness is maintained through implementation of the environmental performance standards.	The INPEX Emergency Contacts Directory is maintained with current and relevant contact details for OPEPs on an annual basis.	Records demonstrate that electronic and hard copies of the INPEX Emergency Contacts Directory are updated at least annually.	INPEX Environmental Adviser
	The INPEX Oil Spill Forms List is reviewed annually and maintained with current and relevant forms for INPEX OPEPs.	Records demonstrate that electronic and hard copies of the relevant forms list are updated at least annually.	INPEX Environmental Adviser
	The Operational SIMA Templates (from the OPEP) and the environmental sensitivities maps from Section 4 – Existing Environment, will be maintained in hard copy in the Perth IMT room.	Records demonstrate the Operational SIMA Templates (from the OPEP) and the environmental sensitivities maps from Section 4 – Existing Environment, will be maintained in hard copy in the Perth IMT room	INPEX Environmental Adviser
	The Oil Spill Equipment Tracking Register is reviewed on an annual basis, to ensure the capabilities stated in this EP are maintained. Specifically, this includes reviewing the status of: • aviation mobilisation capability • vessel call-off contracts	Records demonstrate that the Oil Spill Equipment Tracking Register is updated at least annually.	INPEX Environmental Adviser

Environmental performance outcome	Performance standards	Measurement criteria	Responsibility
	• INPEX personnel oil spill response training • AMOSC capabilities • Oiled wildlife response kit locations • location of containment and recovery spill response equipment • spill tracker buoy locations		

9.10.2 Emergency response training

This section describes the training that will be provided to the INPEX IMT and relevant offshore personnel (seismic survey vessel and support vessels) in support of the *2D Seismic Survey (WA-532-P, WA-533P and WA-50-L) OPEP*. Environmental performance outcomes, standards and measurement criteria relating to emergency response training are presented in Table 9-4.

INPEX incident and crisis management teams

Specific functions identified within the incident management team (IMT) receive nationally accredited training in line with the Australian Quality Training Framework. In addition to this, certain identified functions, along with some key support members receive specific oil spill response training. This approach ensures that INPEX always has the capability to respond to an oil spill event.

The minimum training provision for an IMT leader is PMAOMIR418 – *Coordinate incident response,* with the course material tailored to align with the INPEX Australia Incident Management Plan (0000-AH-PLN-60005). In addition, there will be at least four IMT Leaders with IMO III – oil spill command & control aligned competency to supplement the minimum IMT leader training requirement.

The minimum training provision for the IMT Core Team positions as defined in Figure 9-4

is PMAOMIR320 - *Manage Incident Response Information*, with the course material tailored to align with the INPEX Australia Incident Management Plan (0000-AH-PLN-60005). In addition, a minimum of 15 IMT Core Team personnel will have completed an IMO II – oil spill response management aligned competency, to supplement the minimum IMT Core Team personnel training requirement.

The INPEX Crisis Management Team all receive an in-house training package, which is tailored to align with the requirements of the INPEX Australia Crisis Management Plan (0000-AH- PLN-60004).

Offshore emergency response team

Each vessel ERT will maintain its own training in oil spill response, commensurate with the risks and responses required. Vessel Masters and the Part Chief will complete mandatory minimum requirements under the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW) which includes oil spill response training.

Vessel masters will also ensure vessel ERTs complete drills as scheduled in their relevant Contractor ERP, including SOPEP drills.

Table 9-4: Environmental performance objective, standards and measurement criteria for emergency response training

Environmental performance outcome	Performance standards	Measurement criteria	Responsibility
INPEX IMT and vessel ERTs maintain oil spill response training as described in the performance standard.	INPEX IMT and vessel ERTs will maintain training in accordance with Section 9.10.2 and Party Chief / Vessel Masters will complete mandatory minimum requirements under the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW) which includes oil spill response training.	Records of training.	INPEX Environmental Adviser
	Vessel ERTs - conduct routine drills in accordance with the Vessel Contractor ERPs, including SOPEP drills.	Records of training	INPEX Environmental Adviser
	All INPEX CMT personnel will receive INPEX in-house CMT training, which is tailored to align with the requirements of the INPEX Australia Crisis Management Plan (0000-AH- PLN-60004).	Records of training	INPEX Environmental Adviser
	INPEX IMT Leaders (all) will have completed the INPEX tailored, nationally accredited course - PMAOMIR418 – *Coordinate incident response*.	Records of training	INPEX Environmental Adviser
	INPEX IMT Leader (minimum of 4) will be trained in IMO-3 aligned oil spill response training.	Records of training	INPEX Environmental Adviser

Environmental performance outcome	Performance standards	Measurement criteria	Responsibility
	INPEX IMT Core Functions (minimum of 15) will be trained in IMO-2 aligned oil spill response training.	Records of training	INPEX Environmental Adviser
	INPEX IMT Core Team personnel (all) will have completed the INPEX tailored, nationally accredited course - PMAOMIR320 - *Manage Incident Response Information*	Records of training	INPEX Environmental Adviser

9.10.3 Testing, drills and exercises

INPEX oil spill response arrangements shall be tested by the IMT:

- before the activity commences
- when the arrangements for an activity are significantly amended
- not later than 12 months following the most recent test.

Notification and call-out drills, that test communications channels and the ability to contact key individuals, shall be conducted at least annually.

Environmental performance outcomes, standards and measurement criteria relating to testing of response arrangements are presented in Table 9-5.

Table 9-5: Environmental performance objective, standards and measurement criteria for testing response arrangements

Environmental performance outcome	Performance standards	Measurement criteria	Responsibility
OPEP preparedness is maintained through the implementation of the performance standards.	The INPEX IMT will conduct a minimum of two oil spill exercises per year, using NOPSEMA-accepted OPEPs.	Exercise records demonstrate that the INPEX IMT tested a NOPSEMA-accepted OPEP at least twice yearly.	INPEX Environmental Adviser
	The Operational SIMA Templates (from the OPEP) and the environmental sensitivities maps from Section 4 - Existing Environment, will be maintained in hard copy in the Perth IMT room	Records demonstrate the Operational SIMA Templates (from the OPEP) and the environmental sensitivities maps from Section 4 - Existing Environment, will be maintained in	INPEX Environmental Adviser

Environmental performance outcome	Performance standards	Measurement criteria	Responsibility
		hard copy in the Perth IMT room	
	IMT exercises will test the IMT's ability to develop an Operational SIMA and IAP.	Exercise records will contain copies of completed Operational SIMAs and IAPs.	INPEX Environmental Adviser
	Desktop validation exercises will be conducted to test notifications processes, contracted service provider activations, and logistics assumptions, annually.	Desktop validation exercise records demonstrate that the Emergency Contacts Directory, Oil Spill Equipment Tracking Register and Forms List are tested annually.	INPEX Environmental Adviser
	Desktop validation exercises will be conducted to test notifications processes, contracted service provider activations, and logistics assumptions, annually.	Desktop validation exercise records demonstrate that the notifications processes, contracted service provider activations, and logistics assumptions were tested annually.	INPEX Environmental Adviser

9.10.4 Updating the OPEP

The OPEP will be reviewed following events requiring its activation, in order to identify any lessons learned. OPEPs will be updated accordingly, and the INPEX Emergency Contacts Directory is reviewed as part of this process.

Environmental performance outcomes, standards and measurement criteria relating to updating the OPEP are presented in Table 9-6.

Table 9-6: Environmental performance objective, standards and measurement criteria for updating the OPEP

Environmental performance outcome	Performance standards	Measurement criteria	Responsibility
The OPEP is reviewed and updated, as needed, with relevant lessons learned.	The OPEP will be reviewed and updated following any INPEX IMT exercise or incident in which the OPEP was used, or with	Records demonstrate a review and update (if necessary) of the OPEP.	INPEX Environmental Adviser

	any significant lessons learned from other INPEX OPEPs, as relevant to this OPEP (Appendix F).		

9.11 Incident investigation and lessons learned

9.11.1 HSEQ performance measurement and reporting

HSEQ performance data is monitored in accordance with the INPEX HSEQ Performance Measurement and Reporting Standard. This enables the status of conformance with HSEQ obligations and goals to be determined, and also ensures HSEQ risks are being effectively managed to support continuous improvement. HSEQ is regularly reviewed by senior management.

9.11.2 Environmental incident reporting – internal

INPEX refers to environmental incidents and hazards as "environmental events", which all personnel, including contractors, are required to report as soon as is reasonably practicable. Reporting must be in accordance with the INPEX *Event Reporting and Investigation Standard* and associated procedure.

All events will be documented and reviewed for their actual and potential consequence severity levels and investigated as appropriate. Corrective or preventative actions will be identified and documented, and their completion verified in an action register. These actions may include changes to the risk registers, standards, or procedures, or the need for training, different tools or equipment. Any actions will be recorded and tracked.

9.11.3 Environmental incident reporting – external

For the purposes of regulatory reporting to NOPSEMA, an incident is classified as either "Reportable" or "Recordable" based on the definitions contained in Regulation 4 of the OPGGS (E) Regulations 2009.

A "Reportable" incident is defined as "an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage." Environmental damage (or the potential to cause damage) includes social, economic and cultural features of the environment. For the purposes of this EP, such an incident is considered to have an environmental consequence level of Moderate (D) to Catastrophic (A) as defined in the INPEX Risk Matrix (Figure 6-1).

Based on the consequence assessments described in sections 7 and 8 of this EP, incidents identified as having the potential to be "Reportable" (i.e. Moderate (D) or above on the INPEX Risk Matrix) include:

- the introduction and establishment of an IMS attributable to the Activity
- Vessel collision resulting in a Level 2 spill.

A "Recordable" incident is defined as "a breach of an environmental performance outcome or environmental performance standard … that is not a reportable incident." In terms of the activities within the scope of this EP, it is a breach of the performance standards and outcomes listed in Section 7, Section 8 or Section 9 of this EP.

For the purposes of regulatory reporting to DEE, any significant impact to matters of national environmental significance (MNES), as classified using the INPEX Risk Matrix, will be reported to DEE and the Director of National Parks.

Reportable incidents

Initial verbal notification

In the event of a reportable incident, INPEX will give NOPSEMA an initial verbal notification of the occurrence as soon as is practicable; and in any case, not later than two hours after the first occurrence of the reportable incident; or if it is not detected at the time of the first occurrence, within two hours of the time that INPEX becomes aware of the incident.

The initial verbal notification will contain:

- all material facts and circumstances concerning the reportable incident that are known or can, by reasonable search or enquiry, be found out
- any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident
- the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.

Written notification

As soon as possible after an initial verbal notification of a reportable incident, INPEX will provide a written record of the notification to:

- NOPSEMA
- the National Offshore Petroleum Titles Authority (Cwlth)
- the Department of Mines, Industry Regulation and Safety (WA).

In the event of a significant impact to MNES, INPEX will provide an initial notification to DEE and the Director of National Parks (Cwlth) within 24 hours of becoming aware of the event.

In the event of a reportable incident, INPEX will provide a written report to NOPSEMA as soon as is practicable; and in any case, not later than three days after the first occurrence of the incident. If, within the three-day period, NOPSEMA specifies an alternative reporting period, INPEX will report accordingly. The report will contain:

- all material facts and circumstances concerning the reportable incident that are known or can, by reasonable search or enquiry, be found out
- any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident
- the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident
- the action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future.

Within seven days of giving a written report of a reportable incident to NOPSEMA, INPEX will provide a copy of the report to:

- the National Offshore Petroleum Titles Authority (Cwlth)
- the Department of Mines, Industry Regulation and Safety (WA).

Following submission of the above, NOPSEMA may, by notice in writing, request INPEX to submit an additional report(s) of the incident. Where this is the case, NOPSEMA will identify the information to be contained in the report(s) or the matters to be addressed and will specify the submission date for the report(s). INPEX will prepare and submit the report(s) in accordance with the notice given.

In the event of a significant impact to MNES, INPEX will provide a written notification to DEE (Cwlth) within three days of becoming aware of the event, and provide additional information as available, if requested by DEE.

This includes reporting any vessel strike incidents to the National Ship Strike Database at <https://data.marinemammals.gov.au/report/shipstrike>.

Suspected or confirmed presence of any marine pest or disease will be reported to WA DPIRD within 24 hours by email (biosecurity@fish.wa.gov.au) or telephone. This includes any organism listed in the WA prevention list for introduced marine pests and any other non-indigenous organism that demonstrates invasive characteristics.

Recordable incidents

Reporting

In the event of a recordable incident, INPEX will report the occurrence to NOPSEMA as soon as is practicable after the end of the calendar month in which it occurs; and in any case, not later than 15 days after the end of the calendar month. The report will contain:

- a record of all the recordable incidents that occurred during the calendar month
- all material facts and circumstances concerning the recordable incidents that are known or can, by reasonable search or enquiry, be found out
- any action taken to avoid or mitigate any adverse environmental impacts of the recordable incidents
- the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the recordable incident
- the action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future.

9.11.4 Annual performance reporting – external

In accordance with Regulation 14(2) of the OPGGS (E) Regulations 2009, INPEX will undertake a review of its compliance with the environmental performance outcomes and standards set out in this EP and will provide a written report of its findings for the reporting period to NOPSEMA on an annual basis, as agreed with NOPSEMA. The annual submission date for the environmental performance report will be 12 months after the start of the activity.

9.12 Monitor, review and audit

9.12.1 Management system audit

An audit and inspection program will be developed and implemented in accordance with the INPEX business standard for auditing. The program will include:

- self-assessment HSEQ audits against the HSEQ-MS
- regular inspections of workplace equipment and activities
- reviews to evaluate compliance with legislative and other requirements.

Unscheduled audits may be initiated by INPEX in the event of an incident, non-compliance or for other valid reasons.

Audit teams will be appropriately qualified, experienced and competent in auditing techniques. They will include relevant technical expertise, as required, and the audit team structure will be commensurate with the scope of the audit. HSEQ audit and inspection findings will be summarised in a report. Non-conformances, actions and improvement plans resulting from audits will be managed in an action tracking system.

9.12.2 Vessel inspections

Inspections will be undertaken to ensure that the environmental performance outcomes and standards documented in this EP can be achieved. The inspections will be conducted prior to mobilisation.

Findings during the inspections will be converted into actions that will be tracked within an action tracking database until closed.

9.13 Management review

Through a process of adaptive management, lessons from management outcomes will be used for continual improvement. Formal reviews of the effectiveness and appropriateness of the INPEX HSEQ-MS are performed by senior management on a periodic basis. The things learned from this process and iterative decision-making will then be used as feedback to improve future management.

10 References

Abdul Wahab, M.A., Radford, B., Cappo, M., Colquhoun, J., Stowar, M., Depczynski, M., Miller, K., and Heyward, A. 2018. Biodiversity and spatial patterns of benthic habitat and associated demersal fish communities at two tropical submerged reef ecosystems. Coral Reefs 37: 327–343.

Aerts, L., Blees, M., Blackwell, S., Greene, C., Kim, K., Hannay, D.E., and Austin, M. 2008. *Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report*. Document Number LGL Report P1011-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc. and JASCO Applied Sciences for BP Exploration Alaska.

AFMA—*see* Australia Fisheries Management Authority

Aguilar de Soto, N., Delorme, N., Atkins, J., Howard, S., Williams, J. and Johnson, M. 2013. Anthropogenic noise causes body malformations and delays development in marine larvae. *Scientific Reports* 3: 2831.

AIMS – see Australian Institute of Marine Science

Amoser, S. and Ladich, F. 2003. Diversity in noise-induced temporary hearing loss in otophysine fishes. *Journal of the Acoustical Society of America* 113: 2170–2179.

AMSA—see Australian Maritime Safety Authority

Anderson, D. J., Kobryn, H. T., Norman, B. M., Bejder, L., Tyne, J. A., and Loneragan, N. R. 2014. Spatial and temporal patterns of nature-based tourism interactions with whale sharks (*Rhincodon typus*) at Ningaloo Reef, Western Australia. Estuarine, Coastal and Shelf Science, 148, 109–119.

André, M., Kaifu, K., Solé, M., van der Schaar, M., Akamatsu, T., Balastegui, A., Sánchez, A.M. and Castell, J.V. 2016. Contribution to the understanding of particle motion perception in marine invertebrates. pp. 47–55, in Popper, N.A., Hawkins, A. (eds.), *The effects of noise on aquatic life II*. Springer, New York, USA.

Andriguetto-Filho, J.M., Ostrensky, A., Pie, M.R., Silva, U.A. and Boeger, W.A. 2005. Evaluating the impact of seismic prospecting on artisanal shrimp fisheries. *Continental Shelf Research* 25(14): 1720-1727.

ANZECC/ARMCANZ—*see* Australian and New Zealand Environment and Conservation Council and Agriculture and Resources Management Council of Australia and New Zealand.

APPEA—*see* Australian Petroleum Production and Exploration Association

Ault, T.R. and Johnson, C.R. 1998. Spatially and temporally predictable fish communities on coral reefs. *Ecological Monographs* 68(1): 25-50.

Australian and New Zealand Environment and Conservation Council and Agriculture and Resources Management Council of Australia and New Zealand. 2000. *Australian and New Zealand guidelines for fresh and marine water quality: Volume 1, the Guidelines*. Australian and New Zealand Environment and Conservation Council, Canberra and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT.

Australian Fisheries Management Authority. 2018. *Species*. Viewed online on 24 November 2018 at <https://www.afma.gov.au/species>.

Australian Institute of Marine Science. 2019. North West Shoals to Shore Research Program, December 2019 newsletter. Viewed online on 12th December 2019 at <https://www.aims.gov.au/sites/default/files/2019-11/AIMS%20NWSS%204pp%20newsletter%20December%2019_web.pdf>

Australian Maritime Safety Authority. 2015. *National Plan technical guidelines for preparing contingency plans for marine and coastal facilities*. NP-GUI-012. Australian Maritime Safety Authority, Canberra, ACT.

Australian Maritime Safety Authority. 2019a. The effects of maritime oil spills on wildlife including non-avian marine life. Viewed online on 24 June 2019 at <https://www.operations.amsa.gov.au/kids-and-teachers-resources/kids/teachers/Tech_Paper/index.html>.

Australian Maritime Safety Authority. 2019b. *National plan for maritime environmental emergencies*. Viewed online on 24 June 2019 at <https://www.amsa.gov.au/sites/default/files/amsa-496-national-plan.pdf>.

Australian Museum. 2019. *Ruby Snapper, Etelis carbunculus (Cuvier, 1828)*. Viewed online on 20 March 2019 at <https://australianmuseum.net.au/learn/animals/fishes/ruby-snapper-etelis-carbunculus-cuvier-1828/>.

Australian Petroleum Production and Exploration Association. 2008. *Code of environmental practice*. Prepared by RPS Ecos Pty Ltd, West Perth, Western Australia for the Australian Petroleum Production and Exploration Association, Canberra, ACT.

Babcock, R., van der Velde, T., Gagnon, M.M., Lawrence, E., Tonks, M., Pitcher, R., Bessey, C., Rawson, C., Dreisson, D., Harvey, E. and Cooper, L. 2017. *Monitoring the Northern Demersal Scalefish Managed Fishery: accounting for spatial variability and detecting change in key fish populations*. Unpublished Final Report to Shell/INPEX. CSIRO, Brisbane, Queensland.

Baker, C., A. Potter, M. Tran, and A.D. Heap. 2008. *Sedimentology and geomorphology of the Northwest Marine Region*. Geoscience Australia Record 2008/07, Canberra, ACT.

Baker, E.K., Puglise, K.A., and Harris, P.T. 2016. Mesophotic Coral Ecosystems - A Lifeboat for Coral Reefs? The United Nations Environment Program and GRID-Arendal, Nairobi and Arendal, 98.

Bamford, M., Watkins, D., Bancroft, W., Tischler, G. and Wahl, J. 2008. *Migratory shorebirds of the East Asian–Australasian Flyway: population estimates and internationally important sites*. Wetlands International. Oceania. Canberra, ACT.

Bartol, S.M. and Ketten, D.R. 2006. Turtle and tuna hearing. pp. 98–105 in Swimmer, Y. and Brill, R. (eds.), Sea turtle and pelagic fish sensory biology: developing techniques to reduce sea turtle bycatch in longline fisheries. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-PIFSC-7. National Oceanic and Atmospheric Administration, US Department of Commerce, Honolulu, Hawaii.

Bartol, S.M. and Musick, J.A. 2003. 'Sensory biology of sea turtles', In: Lutz, PL, Musick, JA and Wyneken, J, The biology of sea turtles. CRC Press, Boca Raton, Florida, USA, vol. 2, pp. 79–102.

Battershill, C., Cappo, M., Colquhoun, J., Cripps, E., Jorgensen, D., McCorry, D., Stowar, M. and Venables, B. 2008. *Coral damage monitoring using towed video (TVA) and photo quadrat assessments (PQA)*. Maxima 3D Marine Seismic Survey at Scott Reef. Adaptive Management Program Objective 3 – Coral Damage Monitoring. Final Report. Report for Environmental Resources Management Australia, Perth, Western Australia.

Bayliss, P. and Hutton, M. 2017. Integrating Indigenous knowledge and survey techniques to develop a baseline for dugong (*Dugong dugon*) management in the Kimberley: Final Report of project 1.2.5 of the Kimberley Marine Research Program Node of the Western Australian Marine Science Institution, WAMSI, Perth, Western Australia, 98 pp.

Beasley I., Robertson, K.M. and Arnold, P. 2005. Description of a new dolphin: The Australian snubfin dolphin *Orcaella heinsohni* sp.n. (Cetacea, Delphinidae). *Marine Mammal Science* 21(3):365–400.

Beckett, J.S. 1974. Biology of swordfish, Xiphias gladius L., in the northwest Atlantic Ocean. pp. 103-106 in Shomura, R.S. and Williams, F. (eds.) *Proceedings of the international billfish symposium: part 2*. National Oceanic and Atmospheric Administration Technical Report NFMS SSRF-675. National Oceanic and Atmospheric Administration, Honolulu, Hawaii.

Begg, G.A., Chen, C.C.-M., O'Neill, M.F. and Rose, D.B. 2006. *Stock assessment of the Torres Strait Spanish mackerel fishery*. CRC Reef Research Centre Technical Report No. 66. CRC Reef Research Centre, Townsville, Queensland.

Bejarano, I., Appeldoorn, R. S., and Nemeth, M. 2014. Fishes associated with mesophotic coral ecosystems in La Parguera, Puerto Rico. Coral Reefs 33, 313–328. doi: 10.1007/s00338-014-1125-6

Bejder, L., Videsen, S., Hermannsen, L., Simon, M., Hanf, D. and Madsen, P.T. 2019. Low energy expenditure and resting behaviour of humpback whale mother-calf pairs highlights conservation importance of sheltered breeding areas. *Scientific Reports* 9:719.

Benzie, J. and Smith, C. 2006. Microsatellite variation in Australian and Indonesian pearl oyster Pinctada maxima populations. *Marine Ecology Progress Series* 314: 197-211.

Berg Soto, A., Marsh, H., Everingham, Y., Smith, J.N., Parra, G.J. and Noad, M. 2014. Discriminating between the vocalisations of Indo-Pacific humpback and Australian snubfin dolphins in Queensland, Australia. Journal of the Acoustical Society of America, 136(2): 930-938.

Berry, O., Richards, Z., Moore, G. and Hernawan, U. 2017. *Isolation of oceanic and coastal populations of the harvested mother-of-pearl shell* Tectus niloticus *in the Kimberley*. Report of Project 1.1.3 - Project 1.1.3.3. Prepared by Curtain University, Perth, Western Australia for the Kimberley Marine Research Program, Western Australian Marine Science Institution, Perth.

Bertrand, A. and Josse, E. 2000. Tuna target-strength related to fish length and swimbladder volume. *ICES Journal of Marine Science* 57: 1143-1146.

BirdLife International. 2018. *Important bird areas factsheet: Lacepede Islands*. Birdlife International, Cambridge, United Kingdom. Accessed online on 07 November 2018 at <http://datazone.birdlife.org/site/factsheet/lacepede-islands-iba-australia>

Boeger, W.A., Pie, M.R., Ostrensky, A. and Cardoso, M.F. 2006. The effect of exposure to seismic prospecting on coral reef fishes. *Brazilian Journal of Oceanography* 54(4):235-239.

Bolten, A.B. and Witherington, B.E. (eds.). 2003. Loggerhead Sea Turtles, 1st edn. Smithsonian Books, Washington, DC.

BOM—see Bureau of Meteorology.

Booman, C., Dalen, J., Leivestad, H., Levsen, A., van der Meeren, T. og Toklum, K. 1996. Effekter av luftkanonskyting på egg, larver og yngel. Undersøkelser ved Havforskningsinstituttet og Zoologisk Laboratorium, UiB. (Engelsk sammendrag og figurtekster). Havforskningsinstituttet, Bergen. *Fisken og Havet* nr. 3 (1996). 83 s.

Braccini, M., Johnson, G., Walton, L. and Peddemors, V. 2018. *Sandbar Shark (2018)*. Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/184-Sandbar-Shark-2018>.

Braun, C.B. and Grande, T. 2008. Evolution of peripheral mechanisms for the enhancement of sound reception. pp. 99–144 in Webb, J.F., Fay, R.R. and Popper, A.N. (eds.) *Fish bioacoustics*. Springer, New York, USA.

Bray, D.J. & Gomon, M.F. 2019. *Thunnus maccoyii in Fishes of Australia*. Accessed 27 February 2019 at <http://fishesofaustralia.net.au/home/species/732>

Bray, D.J. 2019a. *Amblygaster sirm in fishes of Australia*. Accessed online on 27 February 2019 at <http://fishesofaustralia.net.au/home/species/2049>.

Bray, D.J. 2019b. *Herklotsichthys quadrimaculatus in fishes of Australia*. Accessed online on 27 February 2019 at <http://fishesofaustralia.net.au/home/species/2056>.

Bray, D.J. 2019c. *Carcharhinus plumbeus in fishes of Australia*. Accessed online on 27 February 2019 at <http://fishesofaustralia.net.au/home/species/1954>.

Bray, D.J. 2019d. *Carcharhinus melanopterus in fishes of Australia*. Accessed online on 27 February 2019 at <http://fishesofaustralia.net.au/home/species/1952>.

Bray, D.J. and Schultz, S. 2019a. *Scomberomorus semifasciatus in fishes of Australia*. Accessed online on 27 February 2019 at <http://fishesofaustralia.net.au/home/species/729>.

Bray, D.J. and Schultz, S. 2019b. *Scomberomorus commerson in Fishes of Australia*. Accessed online on 27 February 2019 at < http://fishesofaustralia.net.au/home/species/728>.

Brewer, D.T., Lyne, V., Skewes, T.D., and Rothlisberg, P. 2007. *Trophic systems of the North West Marine Region*. Report to The Department of the Environment and Water Resources, Canberra, ACT by CSIRO, Cleveland, Queensland.

Bröker, K., Gailey, G., Muir, J. and Racca, R.G. 2015. Monitoring and impact mitigation during a 4D seismic survey near a population of gray whales off Sakhalin Island, Russia. *Endangered Species Research* 28: 187-208.

Brokovich, E., Einbinder, S., Shashar, N., Kiflawi, M., and Kark, S. 2008. Descending to the twilight-zone: changes in coral reef fish assemblages along a depth gradient down to 65 m. Mar. Ecol. Prog. Ser. 371, 253–262. doi: 10.3354/meps07591

Brown, A.M., Smith, J., Salgado-Kent, C., Marley, S., Allen, S.J., Thiele, D., Bejder, L., Erbe, C. & Chabanne, D. 2017. Relative abundance, population genetic structure and acoustic monitoring of Australian snubfin and humpback dolphins in regions within the Kimberley. Report of Project 1.2.4 prepared for the Kimberley Marine Research Program, Western Australian Marine Science Institution, Perth, Western Australia, 61pp plus appendices.

Bruce, B., Bradford, R., Foster, S., Lee, K., Lansdell, M., Cooper, S. and Przeslawski, R. 2018. Quantifying fish behaviour and commercial catch rates in relation to a marine seismic survey. *Marine Environmental Research* 140: 18-30.

Brunnschweiler, J.M., and Sims, D.W. 2011. Diel oscillations in whale shark vertical movements associated with meso-and bathypelagic diving. *American Fisheries Society Symposium* 76:457–469.

Brunnschweiler, J.M., Baensch, H., Pierce, S. J., and Sims, D.W. 2009. Deep-diving behaviour of a whale shark Rhincodon typus during long-distance movement in the western Indian Ocean. *Journal of Fish Biology* 74:706-714.

Bryan, D.R., Kilfoyle, K., Gilmore Jr, R.G. and Spieler, R.E. 2013. Characterization of the mesophotic reef fish community in south Florida, USA. Journal of Applied Ichthyology, 29(1): 108-117.

Bulman, C. 2006. *Trophic webs and modelling of Australia's north west shelf*. Technical Report No. 9, North West Shelf Joint Environmental Management Study. CSIRO Marine and Atmospheric Research, Canberra, ACT and Western Australian Department of Environment, Perth, Western Australia.

Bureau of Meteorology. 2018. *Climate data online*. Accessed online on 28 August 2018 at <http://www.bom.gov.au/climate/data/>.

Burgess, H. G. and Branstetter, S. 2009. *Carcharhinus limbatus*. The IUCN Red List of Threatened Species 2009: e.T3851A10124862. Accessed online on 27 February 2019 at <http://dx.doi.org/10.2305/IUCN.UK.2009-2.RLTS.T3851A10124862.en.>.

Burns, K.A., Garrity, S.D. and Levings, S.C. 1993. How many years before mangrove ecosystems recover from catastrophic oil spills? *Marine Pollution Bulletin* 26(5):239–248.

Caiger, P.E., Montgomery, J.C. and Radford, C.A. 2012. Chronic low-intensity noise exposure affects the hearing thresholds of juvenile snapper. *Marine Ecology Progress Series* 466: 225–232.

Caltrans. 2001. *Fisheries impact assessment for the pile installation demonstration project, San Francisco: Oakland Bay bridge east span seismic safety project*. August 2001. State of California Department of Transportation, San Francisco, USA.

Caltrans. 2004. *Fisheries and hydroacoustic monitoring program compliance report – San Francisco – Oakland Bay bridge east span seismic safety project*. State of California Department of Transportation, San Francisco, USA.

Cameron, D. and Begg, G. 2002. *Fisheries biology and interaction in the northern Australian small mackerel fishery*. Final report to the Fisheries Research and Development Corporation, projects 92/144 and 92/144.02. Department of Primary Industries, Brisbane, Queensland.

Carlton, J.T. 1996. Pattern, process, and prediction in marine invasion ecology. *Biological Conservation* 78: 97-106.

Carlton, J.T. 2001. *Introduced species in U.S. coastal waters - environmental impacts and management priorities*. Prepared for the Pew Oceans Commission, United States.

Carroll, A.G., Przeslawski, R., Duncan, A., Gunning, M. and Bruce, B. 2017. A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. *Marine Pollution Bulletin* 114: 9-24.

Casper, B.M. 2011. The ear and hearing in sharks, skates, and rays. pp. 262–269 in Farrell, A.P. (ed.), *Encyclopedia of fish physiology: from genome to environment*. Academic Press, San Diego, USA.

Casper, B.M., Halvorsen, M.B. and Popper, A.N. 2012. Are sharks even bothered by a noisy environment? *Advances in Experimental Medicine and Biology* 739: 93–97.

Cato, D.H. and McCauley, R.D. 2002. Australian research into ambient sea noise. *Journal of Australian Acoustics*, 30(1), 13-20.

Celi, M., Filiciotto, F., Vazzana, M., Arizza, V. Maccarrone, V., Ceraulo, M., Mazzola, S. and Buscaino, G. 2014. Shipping noise affecting immune responses of European spiny lobster (*Palinurus elephas*). *Canadian Journal of Zoology* 93: 113–121.

Chandrapavan, A., Gardner, C. and Green, B.S. 2011. Haemolymph condition of deep-water southern rock lobsters (*Jasus edwardsii*) translocated to inshore reefs. *Marine and Freshwater Behaviour and Physiology* 44(1): 21-32.

Chapman, C. and Hawkins, A. 1969. The importance of sound in fish behaviour in relation to capture by trawls. *Fisheries and Aquaculture Report* 62 (3): 717–729.

Charifi, M., Sow, M., Ciret, P., Benomar, S., Massabuau, J-C. 2017. The sense of hearing in the Pacific oyster, *Magallana gigas*. *PLoS ONE* 12(10): e0185353.

Christian, J.R., Mathieu, A., Thompson, D.H., White, D. and Buchanan, R.A., 2003. *Effect of seismic energy on snow crab (*Chionoecetes opilio*)*. Environmental Funds Project No. 144. Fisheries and Oceans Canada, Calgary, Canada.

CITES 2001. Consideration of Proposals for Amendment of Appendices I and II. A. Proposal - Inclusion of all species of the genus Hippocampus (*Hippocampus* spp.) in Appendix II of CITES. 26 pp.

Clark, R.B. 1984. Impact of oil pollution on seabirds. *Environmental Pollution* 33:1-22.

Clarke, R. 2015. *Seabirds and shorebirds at Adele Island. Applied Research Program 6: Milestone Report #2*. A report prepared by the Australian Institute of Marine Science, Perth, Western Australia for Shell Australia, Perth and INPEX Operations Australia Pty Ltd, Perth.

Claro, R. and Lindeman, K. C. 2003. Spawning aggregation sites of snapper and grouper species (Lutjanidae and Serranidae) on the Insular Shelf of Cuba. *Gulf and Caribbean Research* 14(2): 91-106.

Claydon, J. 2004. Spawning aggregations of coral reef fishes: characteristics, hypotheses, threats and management. *Oceanography and Marine Biology* 42: 265–302.

Cogger, H.G., Cameron, E.E., Sadlier, R.A. and Eggler, P. 1993. The Action Plan for Australian Reptiles. Canberra, ACT: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/biodiversity/threatened/action/reptiles/index.html.

Colin, P.L. 1974. Observation and collection of deep-reef fishes off the coasts of Jamaica and British Honduras (Belize), Marine Biology, 24: 29–38.

Colin, P.L. 1976. Observations of deep-reef fishes in the Tongue-of-the-ocean, Bahamas. Bulletin of Marine Science, 26: 603–605.

Collins, L.B., Stevens, A., O'Leary, M, Bufarale, G., Kordi, M and Solihudden, T. 2015. Reef Growth and Maintenance. Final Report of Project 1.3.1 of the Kimberley Marine Research Program Node of the Western Australian Marine Science Institution, WAMSI, Perth, Western Australia, 246pp.

Compagno, L.J.V. 2001. *Sharks of the world*. An annotated and illustrated catalogue of the shark species known to date (Volume 3). Food and Agriculture Organisation of the United Nations, Rome, Italy.

Compagno, L.J.V. and Niem, V.H. 1998. Family Carcharhinidae - requiem sharks. pp. 312-1360 in Carpenter, K.E. and Niem, V.H. (eds), *The living marine resources of the western central Pacific. Volume 2: Cephalopods, crustaceans, holothurians and sharks*. FAO Species Identification Guide for Fishery Purposes. Food and Agriculture Organisation of the United Nations, Rome, Italy.

Compagno, L.J.V., 1984. FAO Species Catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 2 - Carcharhiniformes. FAO Fish. Synop. 125(4/2):251-655. Rome: FAO.

Condie, S.A. and Andrewartha, J.R. 2008. Circulation and connectivity on the Australian North West Shelf. *Continental Shelf Research* 28: 1724– 1739.

Condie, S.A., Mansbridge, J.V., Hart, A.M. and Andrewartha, J.R. 2006. Transport and recruitment of silver-lip pearl oyster larvae on Australia's North West Shelf. *Journal of Shellfish Research* 25(1):179-185.

Connell, D.W., Miller, G.J. and Farrington, J.W. 1981. Petroleum hydrocarbons in aquatic ecosystems—behavior and effects of sublethal concentrations: Part 2. *Critical Reviews in Environmental Science and Technology* 11(2):105–162.

Connell, S.D. 1996. Variations in mortality of a coral-reef fish: links with predator abundance. Marine Biology, 126(2): 347-352.

Cook, K., Gilmour, J., Piggott, C., Oades, D., McCarthy, P., Howard, A., Bessell-Browne, P., Arklie, S. and Foster, T. 2017. *Key ecological processes in Kimberley benthic* *communities: coral recruitment.* Final report of Project 1.1.2b Kimberley Marine Research Program. Western Australian Marine Science Institution, Perth, Western Australia.

Corkeron, P.J., Morissette, N.M., Porter, L.J., Marsh, H., 1997. Distribution and status of hump-backed dolphins, Sousa chinensis, in Australian waters. Asian Marine Biology, 14, 49–59.

Cowen, R., Gawarkiewicz, G., Pineda, J., Thorrold, S. and Werner, F. (2007). Population Connectivity in Marine Systems an Overview. Oceanography, 20(3): 14-21.

Croll, D.A., A. Acevedo-Gutiérrez, B.R. Tershy, and J. Urbán-Ramírez. 2001. The diving behavior of blue and fin whales: Is dive duration shorter than expected based on oxygen stores? Comparative Biochemistry and Physiology Part A 129(4): 797-809. https://doi.org/10.1016/S1095-6433(01)00348-8.

Dafforn, K. A., Glasby, T. M., and Johnston, E. L., 2009a. Links between estuarine condition and spatial distributions of marine invaders. *Diversity and Distributions* 15(5):807–821.

Dafforn, K. A., Johnston, E. L., Glasby, T. M., 2009b. Shallow moving structures promote marine invader dominance. *Biofouling* 25:3, 277-287.

Dale, J.J., Gray, M.D., Popper, A.N., Rogers, P.H. and Block, B.A. 2015. Hearing thresholds of swimming Pacific bluefin tuna *Thunnus orientalis*. *Journal of Comparative Physiology Part A: Physiology* 201(5): 441–454.

Dalen, J. and Knutsen, G. 1987. Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic explorations. pp. 93–102 in Merklinger, H.M (ed.), *Progress in underwater acoustics*. Plenum Publishing Corporation, New York, USA.

Davenport, S. and Stevens, J.D. 1988. Age and growth of two commercially important sharks (*Carcharhinus tilstoni* and *C. sorrah*) from Northern Australia. *Australian Journal Marine Freshwater Research* 39: 417-433.

DAWR—see Department of Agriculture and Water Resources

Day, R.D., McCauley, R.D., Fitzgibbon, Q.P. and Semmens, J.M., 2016a. Seismic air gun exposure during early-stage embryonic development does not negatively affect spiny lobster *Jasus edwardsii* larvae (Decapoda: Palinuridae). *Scientific Reports* 6:22723.

Day, R.D., McCauley, R.M., Fitzgibbon, Q.P. and Semmens, J.M. 2016b. *Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries*. FRDC Project No 2012/008. University of Tasmania, Hobart, Tasmania.

Day, R.D., McCauley, R.M., Fitzgibbon, Q.P., Hartmann, K. and Semmens, J.M. 2017. *Exposure to seismic air gun signals causes physiological harm and alters behavior in the scallop* Pecten fumatus. Proceedings of the National Academy of Science of the United States of America, October 2017, 114 (40) E8537-E8546; DOI: 10.1073/pnas.1700564114.

Dean, T.A., Stekoll, M.S., Jewett, S.C., Smith, R.O. and Hose, J.E. 1998. Eelgrass (Zostera marina L.) in Prince William Sound, Alaska: effects of the Exxon Valdez oil spill. *Marine Pollution Bulletin* 36: 201-210.

DEC—*see* Department of Environment and Conservation

DEE—*see* Department of the Environment and Energy

Delbare, D., Dhert, D. and Lavens, P. 1996. Zooplankton: production of copepods. In Lavens, P. and Sorgeloos, P. (eds.), *Manual on the production and use of live food for aquaculture*. Laboratory of Aquaculture and Artemia Reference Center, University of Ghent, Belgium.

Department of Agriculture and Water Resources. 2017. *Australian ballast water management requirements. Version 7*. Department of Agriculture and Water Resources, Canberra, ACT.

Department of Conservation (ed.). 2016. *Report of the acoustic ground-truthing technical working group.* Marine Species and Threats, Department of Conservation, Wellington, New Zealand.

Department of Environment. 2015. *Conservation Management Plan for the Blue Whale—A Recovery Plan under the* Environment Protection and Biodiversity Conservation Act 1999. Commonwealth of Australia, Canberra, ACT.

Department of Environment and Conservation. 2007. *Rowley Shoals marine park management plan*. 2007-2017. Management Plan 56. Department of Environment and Conservation, Perth, Western Australia.

Department of Environment, Water, Heritage and the Arts. 2008a. *EPBC Act policy statement 2.1 - interaction between offshore seismic exploration and whales*. Australian Government. Department of the Environment, Water, Heritage and the Arts.

Department of Environment, Water, Heritage and the Arts. 2008b. *The north marine bioregional plan: bioregional profile*. A Description of the ecosystems conservation values and uses of the North Marine Region. Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra, ACT.

Department of Environment, Water, Heritage and the Arts. 2010. *Survey guidelines for Australia's threatened birds Guidelines for detecting birds listed as threatened under the* Environment Protection and Biodiversity Conservation Act 1999. Department of Environment, Water, Heritage and the Arts, Canberra, ACT.

Department of Fisheries and Oceans. 2004. *Review of scientific information on impacts of seismic sound on fish, invertebrates, marine turtles and marine mammals*. Habitat Status Report 2004/002. Canadian Science Advisory Secretariat, Ontario, Canada.

Department of Fisheries. 2004. Final Application to Australian Government Department of the Environment and Heritage on the Kimberley Prawn Managed Fishery. June 2004. Government of Western Australia.

Department of Fisheries. 2005. *Application to the Australian Government Department of Environment and Heritage on the Western Australian Tropical Shark Fisheries (covering the Western Australia North Coast Shark Fishery and the Joint Authority Northern Shark Fishery)*. Western Australia Department of Fisheries, Perth, Western Australia.

Department of Fisheries. 2013. *Guidance statement for oil and gas industry consultation with the Department of Fisheries*. Fisheries occasional publication No. 113, 2013. Department of Fisheries, Perth, Western Australia.

Department of Fisheries. 2015a. *Pearl oyster*. Accessed online on 9 October 2018 at <http://www.fish.wa.gov.au/Species/Pearl-Oyster/Pages/default.aspx>.

Department of Fisheries. 2015b. *Assessment of the status of red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidens*) in the Northern Demersal Scalefish Fishery*. Western Australia Department of Fisheries, Perth, Western Australia.

Department of Fisheries. 2016. *Integrated fisheries management resource report Pearl oyster (Pinctada maxima) resource*. Fisheries Management Paper No. 281. Western Australia Department of Fisheries, Perth, Western Australia.

Department of Parks and Wildlife. 2013. *Lalang-garram/Camden Sounds Marine Park management plan*. Management Plan 73, 2013-2023. Department of Parks and Wildlife, Perth Western Australia.

Department of Parks and Wildlife. 2014. *Western Australian Oiled Wildlife Response Plan*. Department of Parks and Wildlife, Perth, Western Australia.

Department of Parks and Wildlife. 2016a. *North Kimberley Marine Park joint management plan 2016*. Management Plan 89. Department of Parks and Wildlife, Perth, Western Australia.

Department of Parks and Wildlife. 2016b. *Lalang-garram/Horizontal Falls and North Lalang-garram marine parks joint management plan 2016*. Management Plan 88. Department of Parks and Wildlife, Perth, Western Australia.

Department of Parks and Wildlife. 2016c. *Yawuru Nagulagun/Roebuck Bay Marine Park joint management plan 2016*. Management Plan 86. Department of Parks and Wildlife, Perth, Western Australia.

Department of Sustainability, Environment, Water, Population and Communities. 2012. Species group report card – marine reptiles, supporting the marine bioregional plan for the North-west Marine Region. Australian Government. Department of Sustainability, Environment, Water, Population and Communities.

Department of Sustainability, Environment, Water, Population and Communities. 2012. *Marine bioregional plan for the North-west Marine Region*. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.

Department of the Environment and Energy. 2017a. *Recovery plan for marine turtles in Australia*. Commonwealth of Australia, Canberra, ACT.

Department of the Environment and Energy. 2017b. *EPBC Act Policy Statement 3.21. Industry guidelines for avoiding, assessing and mitigating impacts on EPBC listed migratory shorebird species*. Commonwealth of Australia, Canberra, ACT.

Department of the Environment and Energy. 2018a. *SPRAT profile and threats database – Continental slope demersal fish communities*. Accessed online on 27 November 2018 at <https://www.environment.gov.au/sprat-public/action/kef/view/79;jsessionid=01AD87551D0DE1B0248C8722BE137004>.

Department of the Environment and Energy. 2018b. *SPRAT profile and threats database –* Tursiops aduncus *— Indian Ocean bottlenose dolphin, spotted bottlenose dolphin*. Accessed online on 27 November 2018 at <http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68418>.

Department of the Environment and Energy. 2018c. *SPRAT profile and threats database –* Dugong dugon *— Dugong*. Accessed online on 27 November 2018 at <http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28>.

Department of the Environment and Energy. 2018d. *Australian heritage database - Scott Reef and Surrounds*. Accessed online on 05 November 2018 at < https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=state%3DEXT%3Blist_code%3DCHL%3Blegal_status%3D35%3Bkeyword_PD%3D0%3Bkeyword_SS%3D0%3Bkeyword_PH%3D0;place_id=105480>.

Department of the Environment and Energy. 2018e. *Australian heritage database - Mermaid Reef - Rowley Shoals*. Accessed online on 05 November 2018 at <https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=state%3DWA%3Blist_code%3DCHL%3Blegal_status%3D35%3Bkeyword_PD%3D0%3Bkeyword_SS%3D0%3Bkeyword_PH%3D0;place_id=105255>.

Department of the Environment and Energy. 2018f. *Australian heritage database - The West Kimberley*. Accessed online on 05 November 2018 at

<http://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=106063.>

Department of the Environment and Energy. 2018g. *Indigenous Protected Areas*. Accessed online 14 November 2018 at <https://www.environment.gov.au/land/indigenous-protected-areas>.

Department of the Environment and Energy. 2018h. *Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coast and oceans*. Commonwealth of Australia 2018, Canberra, ACT.

Department of the Environment and Energy. 2018i. *Mobula alfredi* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment and Energy. 2019. *SPRAT Profile –* Orcaella heinsohni *— Australian snubfin dolphin*. Accessed online on 20 June 2019 at < http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=81322>.

Depczynski, M.M., Cure, K., Egdar, Z., George, K., Holmes, T., Howard, A., McCarthy, P., Moore, G., Oades, D., Piggott, C., Travers, M. and Wilson, S. 2017. *Key ecological processes in Kimberley benthic communities: fish recruitment*. Prepared for the Kimberley Marine Research Program, Western Australia Marine Science Institution, Perth, Western Australia.

Det Norske Veritas Energy. 2007. *Effects of seismic surveys on fish, fish catches and sea mammals*. Report by Det Norske Veritas Energy, Hovik, Norway for Cooperation group - Fishery Industry and Petroleum Industry, Stavanger.

Dethmers, KM, Broderick, D, Moritz, C, FitzSimmons, NN, Limpus, CJ, Lavery, S, Whiting, S, Guinea, M, Prince, RIT & Kennett, R 2006, 'The genetic structure of Australasian green turtles (*Chelonia mydas*): exploring the geographical scale of genetic exchange', Molecular Ecology, vol. 15, pp. 3931–3946.

DEWHA—*see* Department of Environment, Water, Heritage and the Arts

DFO—*see* Department of Fisheries and Oceans

Di Iorio, L. and Clark, C. W. 2009. Exposure to seismic survey alters blue whale acoustic communication. *Biology Letters* 6(3):334-335.

DiBattista J., Travers, M., Berry, O., Moore, G., Evans, R., Feng, M. and Newman, S. 2017. *Population connectivity of the stripey snapper* Lutjanus carponotatus *along the ecologically significant coast of north Western Australia*. Report of Project 1.1.3 - Project 1.1.3.4b, Kimberley Marine Research Program. Western Australian Marine Science Institution, Perth, Western Australia.

Director of National Parks. 2018. *North-west marine parks network management plan 2018*. Director of National Parks, Canberra, ACT.

Diving Medical Advisory Committee. 2019. Safe Diving Distance from Seismic Surveying Operations. DMAC 12 Rev. 2, London, UK. 2 pp. http://www.dmac-diving.org/guidance/DMAC12.pdf.

DMAC – see Diving Medical Advisory Committee

DNP—*see* Director of National Parks

DNV Energy—*see* Det Norske Veritas Energy

Dolman, S. and Williams-Grey, V. 2006. *Vessel collisions and cetaceans: what happens when they don't miss the boat. A WDCS Science Report*. The Whale and Dolphin Conservation Society (WDCS), Chippenham, Wiltshire, United Kingdom.

Domeier, M.L. and Colin, P.L. 1997. Tropical reef fish spawning aggregations: defined and reviewed. *Bulletin of Marine Science* 60(3): 698–726.

Done, T.J., Williams, D. McB., Speare, P.J., Davidson, J., DeVantier, L.M., Newman, S.J. and Hutchins, J.B. 1994. *Surveys of coral and fish communities at Scott Reef and Rowley Shoals*. Australian Institute of Marine Science, Townsville, Queensland.

Donovan, A., Brewer, D., van der Velde, T. and Skewes, T. 2008. *Scientific descriptions of four selected key ecological features in the North-west Bioregion: final report*. Report to the Australian Government Department of Environment, Water, Heritage and the Arts, Canberra, ACT and CSIRO Marine and Atmospheric Research, Cleveland, Queensland.

Double, M.C, Andrews-Goff, V., Jenner, K.C.S., Jenner, M-N., Laverick, S.M., Branch, T.A. and Gales, N.J. 2014. Migratory movements of pygmy blue whales (*Balaenoptera musculus brevicauda*) between Australia and Indonesia as revealed by satellite telemetry. *PLoS One* 9:9(4):e93578.

Double, M.C., Jenner, K.C.S., Jenner, M-N., Ball, I., Laverick, S. and Gales N. 2012. *Satellite tracking of pygmy blue whales (*Balaenoptera musculus brevicauda*) off Western Australia*. Australian Marine Mammal Centre, Australian Antarctic Division, Canberra, ACT.

DPaW—*see* Department of Parks and Wildlife

DSEWPaC—*see* Department of Sustainability, Environment, Water, Population and Communities.

Dubovskaya, O.P., Tang, K.W., Gladyshev, M.I., Kirillin, G., Buseva, Z., Kasprzak, P., Tolomeev, A.P. and Grossart, H-P. 2015. Estimating in situ zooplankton non-predation mortality in an oligo-mesotrophic lake from sediment trap data: caveats and reality check. *PLoS ONE* 10(7): e0131431.

Duke, N. Wood, A. Hunnam, K. Mackenzie, J. Haller, A. Christiansen, N. Zahmel, K. and Green, T. 2010. *Shoreline ecological assessment aerial and ground surveys 7-19 November 2009*. As part of the Scientific Monitoring Study of the Montara Monitoring Plan. A report commissioned by PTTEP Australasia (Ashmore Cartier) PL, Perth, Western Australia for the Department of the Environment, Water, Heritage and the Arts, Canberra, ACT.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Scott-Hayward, L., Kniest, E., Slade, R., Paton, D. and Cato, D.H. 2017. Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity. *Journal of Experimental Biology* 220:2878-2886.

Eckert, G.J. 1987. Estimates of adult and juvenile mortality for labrid fishes at One Tree Reef, Great Barrier Reef. Marine Biology 95(2): 167-171.

Edmonds, N.J., Firmin, C.J., Goldsmith, D., Faulkner, R.C. and Wood, D.T. 2016. A review of crustacean sensitivity to high amplitude underwater noise: data needs for effective risk assessment in relation to UK commercial species. *Marine Pollution Bulletin* 108: 5–11.

Ellers, O. 1995. Discrimination among wave-generated sounds by a swash-riding clam. *Biology Bulletin* 189: 128-137.

Ellison, W.T., Southall, B.L., Clark, C.W. and Frankel, A.S. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. *Conservation Biology* 26(1):21–28.

Engås, A. and Løkkeborg, S. 2002. Effects of seismic shooting and vessel-generated noise on fish behaviour and catch rates. *Bioacoustics* 12(2-3): 313–316.

Engås, A., Løkkeborg, S., Ona, E. and Soldal, A.V. 1996. Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus). *Canadian Journal of Fisheries and Aquatic Sciences* 53(10):2238-2249.

Engineering-Environmental Management, Inc. 2008. *United States Coast Guard and Maritime Administration draft environmental impact statement for Port Dolphin LLC Deepwater Port licence application*. Prepared by Engineering-Environmental Management, Inc, Kansas, USA for USCG Deepwater Ports Standards Division, Washington.

Environment Australia. 2002. *Australian IUCN reserve management principles for Commonwealth marine protected areas*. ISBN 0642548536. Environment Australia, Canberra, ACT.

Environmental Resources Management Australia. 2012. Marine Environmental Baseline Study: Field Survey Report. 0119757, Rev 1, July 2012, Final. Report prepared for PTTEP Australasia (Ashmore Cartier) Pty Ltd.

Environmental Resources Management Australia. 2017. *Bethany 3D Survey Environment Plan: Seismic Airguns & Fish Mortality Literature Review*. Environmental Resources Management Australia, Perth, Western Australia.

Epstein, N., Bak, R.P.M. and Rinkevich, B. 2000. Toxicity of 3rd generation dispersants and dispersed Egyptian crude oil on Red Sea coral larvae. *Marine Pollution Bulletin* 40: 497-503.

Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K. and Dooling, R. Communication masking in marine mammals: a review and research strategy. *Marine Pollution Bulletin* 103(2016): 15-38.

ERM—*see* Environmental Resources Management Australia

Escribano, R., Hidalgo, P., Valdés, V. and Frederick, L. 2013. Temperature effects on development and reproduction of copepods in the Humboldt Current: the advantage of rapid growth. *Journal of Plankton Research* 36 (1): 104–116.

Evans, K., McCauley, R.D., Eveson, P. and Patterson, T. 2018. A summary of oil and gas exploration in the Great Australian Bight with particular reference to southern bluefin tuna. *Deep Sea Research Part II: Topical Studies in Oceanography* 157-158: 190-202

Falkner, I., Whiteway, T., Przeslawski, R. and Heap, A.D. 2009. *Review of ten key ecological features (KEFs) in the northwest marine region*. Record 2009/13. Geoscience Australia, Canberra, ACT.

Fandry, C.B. and Steedman, R.K. 1994. Modelling the dynamics of the transient, barotropic response of continental shelf waters to tropical cyclones. *Continental Shelf Research* 14:1723–1750.

Fanta, E. 2004. *Efeitos da sísmica com Cabo Flutuante em peixes tropicais de areas recifais*. Relatório Tėcnico Universidade Federal do Paraná, Departamento de Biologia Celular, Grupo de Estudos de Impacto Ambienta. [Effects of Floating Cable Seismic on Tropical Fish in Reef Areas. Technical Report prepared by the Environmental Impact Study Group (GEIA) of Cellular Biology Department, University of Paraná, Curitiba, Brazil].

Fay, R.R. and Popper, A.N. 2000. Evolution of hearing in vertebrates: the inner ears and processing. *Hearing Research* 149: 1–10.

Fay, R.R. and Simmons, A.M. 1998. The sense of hearing in fish and amphibians. pp. 269–318 in Fay, R.R. and Popper, A.N. (eds.), *Comparative hearing: fish and amphibians*. Springer, New York, USA.

Feitoza, B.M., Rosa, R.S., Rocha, L.A. 2005. Ecology and zoogeography of deep-reef fishes in northeastern Brazil. Bulletin of Marine Science, 76: 725–742.

Fewtrell, J. and McCauley, R. 2012. Impact of air gun noise on the behaviour of marine fish and squid. *Marine Pollution Bulletin* 64 (5): 984-993.

Fields, D. M., Handegard, N. O., Dalen, J., Eichner, C., Malde, K., Karlsen, Ø., Skiftesvik, A. B., Durif, C. M. F., and Browman, H. I. Airgun blasts used in marine seismic surveys have limited effects on mortality, and no sublethal effects on behaviour or gene expression, in the copepod Calanus finmarchicus. – ICES Journal of Marine Science, doi:10.1093/icesjms/fsz126

Filiciotto, F., Vazzana, M., Celi, M., Maccarrone, V., Ceraulo, M., Buffa, G., Di Stefano, V., Mazzola, S. and Buscaino, G. 2014. Behavioural and biochemical stress response of Palinurus elephas after exposure to boat noise pollution in tank. *Marine Pollution Bulletin* 84: 104-114.

Finneran, J., Henderson, E., Houser, D., Jenkins, K., Kotecki, S. and Mulsow, J. 2017. *Criteria and thresholds for U.S. navy acoustic and explosive effects analysis (phase III)*. Department of Navy, San Diego, California, USA. 183 pp.

Finneran, J.J. 2015. Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. *Journal of the Acoustical Society of America* 138: 1702-1726.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report. Space and Naval Warfare Systems Center Pacific, San Diego, USA.

Finneran, J.J. and Hastings, M.C. 2000. A mathematical analysis of the peripheral auditory system mechanics in the goldfish (*Carassius auratus*). *Journal of the Acoustical Society of America* 108(3): 3035–3043.

Finneran, J.J. and Jenkins, A.K. 2012. *Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis*. Department of Navy, San Diego, California, USA.

Finneran, J.J., Oliver, C.W., Schaefer, K.M. and Ridgway, S.H. 2000. Source levels and estimated yellowfin tuna (Thunnus albacares) detection ranges for dolphin jaw pops, breaches and tail slaps. *Journal of the Acoustical Society of America* 107(1): 649-656.

Fletcher, W., Friedman, K., Weir, V., McCrea, J. and Clark, R. 2006. *Pearl Oyster Fishery*. ESD Report Series No. 5. Western Australia Department of Fisheries, Perth, Western Australia.

Foster, S.J. and Vincent, A.C.J. 2004. Life history and ecology of seahorses: implications for conservation and management. *Journal of Fish Biology* 65:1–61.

Fotedar, S. and Evans, L. 2011. Health management during handling and live transport of crustaceans: A review. *Journal of Invertebrate Pathology* 106: 143-152.

Fothergill, D.M., Sims, J.R. and Curley, M.D. 2001. Recreational SCUBA divers' aversion to low frequency underwater sound. *Undersea and Hyperbaric Medicine* 28(1): 9-18.

French-McCay, D.P. 2002. Development and application of an oil toxicity and exposure model, OilToxEx. *Environmental Toxicology and Chemistry* 21(10):2080–2094.

French-McCay, D.P. 2003. *Development and application of damage assessment modelling: example assessment for the North Cape oil spill*. Marine Pollution Bulletin 47(9–12):341-359.

French-McCay, D.P. 2009. State of the art and research needs for oil spill impact assessment modelling. pp. 601-653, in *Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response*. Emergencies Science Division, Environment Canada, Ottawa, Canada.

Fucik, K.W., Bight, T.J. and Goodman, K.S. 1984. Measurements of damage, recovery, and rehabilitation of coral reefs exposed to oil. pp. 115–134 in Cairns Jr., J. and Buikema Jr., A.L. (eds.), *Restoration of habitats impacted by oil spills*. Butterworth Publishers, Boston, USA.

Fuiman, L.A., Higgs, D.M. and Poling, K.R. 2004. Changing Structure and Function of the Ear and Lateral Line System of Fishes during Development. *American Fisheries Society Symposium* 40:117–144.

Fukunaga, A., Kosaki, R.K., Wagner, D., Kane, C. 2016. Structure of mesophotic reef fish assemblages in the Northwestern Hawaiian Islands. PLoS One 11:e0157861.

Funk, D., D.E. Hannay, D. Ireland, R. Rodrigues, and W. Koski (eds.). 2008. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–November 2007: 90-day report*. LGL Report P969-1. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Shell Offshore Inc., National Marine Fisheries Service (U.S.), and U.S. Fish and Wildlife Service.

Garcia-Sais, J.R. 2010. Reef habitats and associated sessile-benthic and fish assemblages across a euphotic–mesophotic depth gradient in Isla Desecheo, Puerto Rico. Coral Reefs, 29: 277–288.

Gaughan, D.J. and Santoro, K. (eds). 2018. *Status reports of the fisheries and aquatic resources of Western Australia 2016/17: the state of the fisheries*. Department of Primary Industries and Regional Development, Perth, Western Australia.

Gavrilov, A.N., McCauley, R.D., Paskos, G. and Goncharov, A. 2018. Southbound migration corridor of pygmy blue whales off the northwest coast of Australia based on data from ocean bottom seismographs. *The Journal of the Acoustical Society of America*, 144 (4): doi.org/10.1121/1.5063452.

Gerstein, E.R., Gerstein, L., Forsythe, S.E., and Blue, J.E. 1999. The underwater audiogram of the West Indian manatee (*Trichechus manatus*). *Journal of the Acoustical Society of America* 105:3575-3583.

Gibbons, M.J. and Hutchings, L. 1996. Zooplankton diversity and community structure around southern Africa, with special attention to the Benguela upwelling system. *South African Journal of Science* 92(2): 63–77.

Gilmour, J.P., Smith, L.D. and Brinkman, R.M. 2009. 'BiannualSpawning, Rapid Larval Development and Evidence of Selfseeding for Scleractinian Corals at an Isolated System of Reefs', Marine Biology, 156(6): 1297-1309.

Gilmour, J.P., Travers, M.J., Underwood, J.N., Markey, K.L., Ninio, R., Ceccarelli, D., Hoey, A.S., Case, M. and O'Leary, R. 2011. *Long term Monitoring of Shallow Water Coral and Fish Communities at Scott Reef*. AIMS Document No SRRP-RP-RT-048, SRRP Project 1: 2011. Report prepared for Woodside as operator of the Browse LNG Development, Perth, Western Australia by Australian Institute of Marine Science, Townsville, Queensland.

Gilmour, J.P., Travers, M.J., Underwood, J.N., McKinney, D.W., Gates, E.N., Fitzgerald, K.L., Case, M., Ninio, R., Meekan, M.G., O'Leary, R., Radford, B., Ceccarelli, D. and Hoey, A.S. 2010. Long-term Monitoring of Coral and Fish Communities at Scott Reef, AIMS Document No SRRP-RP-RT-045, SRRP Project 1: 2010 Annual Report for Woodside as operator of the Browse LNG Development, Australian Institute of Marine Science, Townsville, pp. 254.

Gisiner, R. 2017. 'Review notes on Dunlop et al. (2017) "Determining the behavioural dose-response relationship of marine mammals to air gun noise and source proximity" (Journal of Experimental Biology (2017) 220: 2878-2886. Doi: 10.1242/jeb.160192)'. Dr. Robert Gisiner, IAGC Director, Marine Environment Science/Biology. IAGC NewsBrief: 18 October 2017.

Glasby, T. M., Connell, S. D., Holloway, M. G. and Hewitt, C. L. 2007. Nonindigenous biota on artificial structures: could habitat creation facilitate biological invasions. *Marine Biology* 151: 887–895.

Goatley, C.H.R. and Bellwood, R.H. 2016. Body size and mortality rates in coral reef fishes: a three-phase relationship. Proceedings of the Royal Society B 283: 20161858.

Gomez, C., Lawson, J.W., Wright, A.J., Buren, A.D., Tollit, D. and Lesage, V. 2016. A systematic review on the behavioural responses of wild marine mammals to noise: the disparity between science and policy. *Canadian Journal of Zoology* 94: 801–819.

Gomez-Gutierrez, J., Palomares-García, R. and Gendron, D. 1995. Community structure of the euphausiid populations along the west coast of Baja California, Mexico, during the weak ENSO 1986-1987. *Marine Ecology Progress Series* 120: 41-51.

Goodall, C., Chapman, C., Neil, D., Tautz, J. and Reichert, H. 1990. The acoustic response threshold of the Norway lobster, Nephrops norvegicus (l.) in a free sound field. pp. 106–113 in Wiese, K., Krenz, W.D., Tautz, J., Reichert, H., and Mulloney, B. (eds.), *Frontiers in crustacean neurobiology*. Birkhauser, Basel, Switzerland.

Goodbody-Gringley, G., Wetzel, D.L., Gillon, D., Pulster, E. and Miller, A.l. 2013. Toxicity of Deepwater Horizon source oil and the chemical dispersant, Corexit® 9500, to coral larvae. *PLOS ONE* 8(1): e45574.

Gray, C.A., Otway, N.M., Laurenson, F.A., Miskiewicz, A.G. and Pethebridge, R.L. 1992. Distribution and abundance of marine fish larvae in relation to effluent plumes from sewage outfalls and depth of water. *Marine Biology* 113: 549–559.

Green, B. S., and Gardner, C. 2009. Surviving a sea-change: survival of southern rock lobster (*Jasus edwardsii*) translocated to a site of fast growth. *ICES Journal of Marine Science* 66: 656–664.

Gubbay, S. and Earll, R. 2000. *Review of literature on the effects of oil spills on cetaceans*. Scottish National Heritage Review No. 3. Report to Talisman Energy (United Kingdom) Limited and Scottish Natural Heritage, United Kingdom.

Guinea, M. 2006. *Sea turtles, sea snakes and dugongs of Scott Reef, Seringapatam Reef and Browse Island with notes on West Lacepede Island*. Unpublished report for the Department of the Environment, Water, Heritage and the Arts, Canberra, ACT.

Guinea, M.L. 2009. *Long term monitoring of the marine turtles of Scott Reef. Browse FLNG Development draft environmental impact statement*. Prepared by Sinclair Knight Merz, Perth, Western Australia for Woodside Energy Ltd, Perth.

Hallegraeff, G.M. 1995. Harmful algal blooms: a global overview. pp. 1-22 in Hallegraeff, G.M., Anderson, D.M. and Cembella, A.D. (eds.), *Manual on harmful marine microalgae*. IOC Manuals and Guides No. 33. UNESCO, Paris, France.

Hamann, M., Smith, J. and Preston S. 2015. Flatback turtles of Torres Strait. Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited, Cairns, 9 pp.

Hannay, D.E. and Racca, R.G. 2005. *Acoustic model validation*. Document Number 0000-S-90-04-T-7006-00-E, Revision 02. Technical report by JASCO Research Ltd. for Sakhalin Energy Investment Company Ltd.

Harasti, D., Lee, K.A., Gallen, C., Hughes, J.M. and Stewart, J. 2015. Movements, home range and site fidelity of snapper (*Chrysophrys auratus*) within a temperate marine protected area. *PLoS ONE* 10(11): e0142454.

Harland, E.J., Jones, S.A. and Clarke, T. 2005. SEA 6 Technical report: Underwater ambient Noise. Produced by QinetiQ as part of the UK Department of Trade and Industry's offshore energy Strategic Environmental Assessment programme. QINETIQ/S&E/MAC/CR050575, 15 March 2005.

Harrison, P.L. 1999. *Oil pollutants inhibit fertilisation and larval settlement in the scleractinian reef coral* Acropora tenuis *from the Great Barrier Reef, Australia in Sources,* *Fates and Consequences of Pollutants in the Great Barrier Reef and Torres Strait*. Conference abstracts. Great Barrier Reef Marine Park Authority, Townsville, Queensland.

Harry, A.V., Morgan, J.A.T., Ovenden, J.R., Tobin, A.J., Welch, D.J. and Simpfendorfer, C.A. 2012. Comparison of the reproductive ecology of two sympatric blacktip sharks (*Carcharhinus limbatus* and *C. tilstoni*) off north-eastern Australia with species identification inferred from vertebral counts. *Journal of Fish Biology* 81(4): 1225-1233.

Harry, A.V., Tobin, A.J. and Simpfendorfer, C.A. 2013. Age, growth, and reproductive biology of the spot tail shark, *Carcharhinus sorrah*, and the Australian blacktip shark, *C. tilstoni*, from the Great Barrier Reef World Heritage Area, north eastern Australia. *Marine and Freshwater Research* 64:277B293.

Harry, A.V., Tobin, A.J., Simpfendorfer, C.A., Welch, D.J., Mapleston, A., White, J., Williams, A.J. and Stapley, J. 2011. Evaluating catch and mitigating risk in a multi-species, tropical, inshore shark fishery within the Great Barrier Reef World Heritage Area. *Marine and Freshwater Research* 62: 710-721.

Hart, A., Murphy, D. and Jones, R. 2018. Pearl Oyster Managed Fishery Resource Status Report 2017. pp. 138-141 in Gaughan, D.J. and Santoro, K. (eds.), *Status reports of the fisheries and aquatic resources of Western Australia 2016/17: state of the fisheries*. Department of Primary Industries and Regional Development, Perth, Western Australia.

Hart, A., Travaille, K.L., Jones, R., Brand-Gardner, S., Webster, F., Irving, A. and Harry, A.V. 2016. *Western Australian Marine Stewardship Council report series No. 5: Western Australian silver-lipped pearl oyster (*Pinctada maxima*) industry*. Western Australia Department of Fisheries, Perth, Western Australia.

Hart, A.M. and Friedman, K.J. 2004. *Mother-of-pearl shell (*Pinctada maxima*): stock evaluation for management and future harvesting in Western Australia*. Final Report to the Fisheries Research and Development Corporation. FRDC project 1998/153. Fisheries Research and Development Corporation, Canberra, ACT.

Hart, A.M., Thomson, A.W. and Murphy, D. 2011. Environmental influences on stock abundance and fishing power in the silver-lipped pearl oyster fishery. *ICES Journal of Marine Science* 68(3): 444-453.

Harte, C. and Curtotti, R. 2018. North West Slope Trawl Fishery. In Department of Agriculture and Resources, *ABARES Fishery Status Reports 2018*. Commonwealth of Australia, Canberra, ACT.

Hass, Prof. J. 2013. Acoustics: What is Amplitude? Indiana University. http://www.indiana.edu/~emusic/etext/acoustics/chapter1_amplitude4.shtml Accessed: 08/08/2015.

Hastings, M.C. 2008. Coming to terms with the effects of ocean noise on marine animals. *Acoustics Today* 4(2): 22-33.

Hastings, M.C. and Miksis-Olds, J. 2012. Shipboard assessment of hearing sensitivity of tropical fishes immediately after exposure to seismic air gun emissions at Scott Reef. *Advances in Experimental Medicine and Biology* 730: 239-243.

Hastings, M.C. and Popper, A.N. 2005. *Effects of sound on fish*. Technical report by Jones & Stokes, California, USA for the California Department of Transportation, California.

Hastings, M.C., Reid, C.A., Grebe, C.C., Hearn, R.L. and Colman, J.G. 2008. *The effects of seismic airgun sound on the hearing sensitivity of tropical reef fishes at Scott Reef, Western Australia*. Underwater sound measurement, impact and mitigation. Proceedings of the Institute of Acoustics 30(5).

Hawkins, A. and Popper, A. 2012. *Effects of noise on fish, fisheries, and invertebrates in the U.S. Atlantic and Arctic from energy industry sound-generating activities workshop* *report*. Prepared by Normandeau Associates Inc., New Hampshire, USA for U.S. Department of the Interior, Bureau of Ocean Energy Management, Washington D.C.

Hawkins, A.D. 2014. Responses of Free-Living Coastal Pelagic Fish to Impulsive Sounds. Proceedings of the 2nd International Conference on Environmental Interactions of Marine Renewable Energy Technologies (EIMR2014), 28 April – 02 May 2014, Stornoway, Isle of Lewis, Outer Hebrides, Scotland.

Hawkins, A.D. and Popper, A.N. 2016. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. *ICES Journal of Marine Science* 74(3): 635-651.

Hawkins, B.L. 1962. *The Biology of the Marine Copepod* Tigriopus californicus *(Baker)*. Thesis, Humbolt State College, California, USA.

Hayes, D., Lyne, V., Condie, S., Griffiths, B., Pigot, S. and Hallegraeff, G. 2005. *Collation and analysis of oceanographic datasets for national marine bioregionalisation*. A report to the Australian Government, National Oceans Office, Canberra, ACT. CSIRO Marine Research.

Heap, A. D. and P. T. Harris. 2008. Geomorphology of the Australian margin and adjacent seafloor. *Australian Journal of Earth Sciences* 55:555-585.

Hearn, C.J. and Holloway, P.E. 1990. A three-dimensional barotropic model of the response of the Australian North West Shelf to tropical cyclones. *Journal of Physical Oceanography* 20(1):60–80.

Helmke, S., Johnson, G. and Lewis, P. 2018. *Grey Mackerel (2018)*. Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/257-Grey-Mackerel-2018>

Hewitt, C., Campbell, M., Coutts, A., Dahlstrom, A., Shields, D. and Valentine, J. 2011. *Species biofouling risk assessment*. Department of Agriculture, Fisheries and Forestry. Canberra, ACT.

Heyward, A., Jones, R., Meeuwig, J., Burns, K., Radford, B., Colquhoun, J., Cappo, M., Case, M., O'Leary, R.A., Fisher, R., Meekan, M. and Stowar, M. 2011. *Monitoring study S5 Banks and Shoals, Montara. Offshore Banks Assessment Survey*. Report for PTTEP Australasia (Ashmore Cartier) Pty Ltd, Perth, Western Australia by Australian Institute of Marine Science, Townsville, Queensland.

Heyward, A., Miller, K., Fromont, J., Keesing, J. and Parnum, I. (eds.). 2018a. *WAMSI Kimberley Marine Research Program, Subproject: Flatback turtle foraging habitats across the offshore Kimberley region*. Prepared for the Kimberley Marine Research Program, Western Australian Marine Science Institution, Perth, Western Australia.

Heyward, A., J. Colquhoun, E. Cripps, D. McCorry, M. Stowar, B. Radford, K. Miller, I. Miller, and C. Battershill. 2018b. No evidence of damage to the soft tissue or skeletal integrity of mesophotic corals exposed to a 3D marine seismic survey. *Marine Pollution Bulletin* 129(1): 8-13.

Heyward, A.J., Farrell, P.D. and Seamark, R.F. 1994. The effect of petroleum based pollutants on coral gametes and fertilisation success. p 119 in the *Sixth Pacific Congress on Marine Science and Technology*, Townsville, Queensland.

Higgs, D. M., Lu, Z. and Mann, D. A. 2006. Hearing and mechanoreception. pp. 391-429 in Evans, D. H. and Claiborne, J. B. (eds.), *The physiology of fishes*. Taylor & Francis Group, Florida, USA.

Hirst, A. G. and Kiørboe, T. 2002. Mortality of marine planktonic copepods: global rates and patterns. *Marine Ecology Progress Series* 230: 195-209.

Hoff, R., and Michel, J. 2014. *Oil spills in mangroves: planning and response considerations*. US Department of Commerce. National Oceanic and Atmospheric Administration, Washington, USA.

Holliday, D.V., Beckley, L.E., Weller, E. and Sutton, A.L. 2011. Natural variability of macro-zooplankton and larval fishes off the Kimberley, north-western Australia: Preliminary findings. *Journal of the Royal Society of Western Australia* 94: 181–195.

Holliday, D.V., Pieper, R.E., Clarke, M.E. and Greenlaw, C.F. 1987. *The effects of airgun energy releases on the eggs, larvae and adults of the northern anchovy (*Engraulis mordax*)*. API Publication 4453. Report by Tracor Applied Sciences for American Petroleum Institute, Washington D.C, USA.

Houde, E.D. and Zastrow, C.E. 1993. Ecosystem- and taxon-specific dynamic and energetics properties of larval fish assemblages. *Bulletin of Marine Science* 53(2): 290-335.

IAGC—*see* International Association of Geophysical Contractors

IEC—*see* Integrated Environmental Consultants

INPEX. 2010. *Ichthys Gas Field Development Project: draft environmental impact statement*. Report prepared by INPEX Browse, Ltd., Perth Western Australia, for the Commonwealth Government, Canberra ACT, and the Northern Territory Government, Darwin, Northern Territory.

INPEX. 2011. *Ichthys Gas Field Development Project: supplement to the draft environmental impact statement*. Report prepared by INPEX Browse, Ltd., Perth, Western Australia, for the Commonwealth Government, Canberra, ACT, and the Northern Territory Government, Darwin, Northern Territory.

Integrated Environmental Consultants. 2003. *Champion OBC Seismic Survey. Environmental Assessment Verification Trials Report, February 2003*. Report No. A688/010/03. Prepared for Brunei Shell Petroleum Company, Panaga, Brunei by Integrated Environmental Consultants Sdn. Bhd., Brunei.

International Association of Geophysical Contractors. 2017. *IAGC zooplankton paper talking points*. IAGC Position Statement. 28th June 2017.

International Maritime Organization. 2009. *Ballast Water Management Convention and the guidelines for its implementation*. International Maritime Organization, London, United Kingdom.

International Maritime Organization. 2009. *Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species*. International Maritime Organization, London, United Kingdom.

International Petroleum Industry Environmental Conservation Association. 2014. *Wildlife response preparedness. IPIECA-IOGP Good Practice Guide Series, Oil Spill Response Joint Industry Project (OSR-JIP)*. IOGP Report 516. International Petroleum Industry Environmental Conservation Association, London, United Kingdom.

International Petroleum Industry Environmental Conservation Association. 2017a. *Guidelines on implementing spill impact mitigation assessment (SIMA)*. IOGP Report 593. International Petroleum Industry Environmental Conservation Association, London, United Kingdom

International Petroleum Industry Environmental Conservation Association. 2017b. *Key principles for the protection, care and rehabilitation of oiled wildlife*. IOGP Report 583. International Petroleum Industry Environmental Conservation Association, London, United Kingdom.

International Tanker Owners Pollution Federation. 2011. *Effects if oil pollution on the marine environment*. Technical Information Paper. International Tanker Owners Pollution Federation Limited, London, United Kingdom.

IPIECA—*see* International Petroleum Industry Environmental Conservation Association.

Ireland, D.S., R. Rodrigues, D. Funk, W. Koski, and D.E. Hannay. 2009. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-Day Report*. Document Number LGL Report P1049-1.

ITOPF—*see* International Tanker Owners Pollution Federation.

Iversen, R.T.B. 1967. Response of the yellowfin tuna (Thunnus albacares) to underwater sound. pp. 105–121 in Tavolga, W.N. (ed.), *Marine bioacoustics II*. Pergamon Press, Oxford, United Kingdom.

Ivey, G., Brinkman, R., Lowe, R., Jones, N., Symonds, G. and Espinosa-Gayosso, A. 2016. *Physical oceanographic dynamics in the Kimberley*. Report of Project 2.2.1 prepared for the Kimberley Marine Research Program, Western Australian Marine Science Institution, Perth, Western Australia.

Jackson, J.B.C., Cubit, J.D., Keller, B.D., Batista, V., Burns, K., Caffey, H.M., Caldwell, R.L., Garrity, S.D., Getter, C.D., Gonzalez, C., Guzman, H.M., Kaufmann, K.W., Knap, A.H., Levings, S.C., Marshall, M.J., Steger, R., Thompson, R.C. and Weil, E. 1989. Ecological effects of a major oil spill on Panamanian coastal marine communities. *Science* 243:37–44.

Jenkins, G. P., Milward, N. E. and Hartwick, R. F. 1984. Identification and description of larvae Spanish mackerels, genus Scomberomorus (Teleostei: Scombridae), in shelf waters of the Great Barrier Reef. *Australian Journal of Marine and Freshwater Research* 35: 341-353.

Jenner, C., Jenner, M. and Pirzl, R. 2008. *A study of cetacean distribution and oceanography in the Scott Reef/Browse Basin development areas during the austral winter of 2008*. Centre for Whale Research (WA) Inc., Perth, Western Australia.

Jenner, K.C.S., Jenner, M.N., and McCabe K.A. 2001. Geographical and temporal movements of humpback whales in Western Australian waters. *The APPEA Journal* 38(1): 692-707.

Jenssen, B.M. 1994. 'Review article: Effects of Oil Pollution, Chemically Treated Oil, and Cleaning on the Thermal Balance of Birds', Environmental Pollution, vol.86, no. 2, pp. 207–215.

Johnson, G., Braccini, M., Walton, L. and Peddemors, V. 2018. Blacktip Sharks (2018). Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/156-BLACKTIP-SHARKS-2018>.

Johnson, M. and Joll, L. 1993. Genetic subdivision of the pearl oyster *Pinctata maxima* (Jameson, 1901) (Mollusca: Pteriidae) in northern Australia. *Marine and Freshwater Research* 44(4): 519-526.

Jussila, J., Jago, J., Tsvetnenko, E., Dunstan, B. and Evans, L.H. 1997. Total and differential haemocyte counts in western rock lobsters (*Panulirus Cygnus George*) under post-harvest stress. *Marine and Freshwater Research* 48: 863-867.

Kailola, P., M. Williams, P. Stewart, R. Reichelt, A. McNee and C. Greive 1993. Australian Fisheries Resources, Bureau of Resource Sciences, Canberra.

Kangas, M., Sporer, E., Wilkin, S., Shanks, M., Cavalli, P., Pickles, L. and Oliver, R. 2018. North Coast Prawn Resource Status Report 2017. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries eds. D.J.

Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 119-122.

Ketos Ecology. 2009. 'Turtle Guards': A Method to Reduce the Marine Turtle Mortality Occurring in Certain Seismic Survey Equipment. Ketos Ecology Report, 14 pp.

Ketten, D.R. and S.M. Bartol. 2005. Functional measures of sea turtle hearing. ONR project final report. Document Number ONR Award Number N00014-02-1-0510. Office of Naval Research (US).

Kahng, S.E., Copus, J.M., Wagner, D. 2014. Recent advances in the ecology of mesophotic coral ecosystems (MCEs). Curr Opin Environ Sustain 7:72–81.

Kahng, S.E., Garcia-Sais, J.R., Spalding, H.L., Brokovich, E., Wagner, D., Weil, E., Hinderstein, L. and Toonen R.J. 2010. Community ecology of mesophotic coral reef ecosystems. Coral Reefs 29:255–275.

Kirillin, G., Grossart, H-P. and Tang, K.W. 2012. Modeling sinking rate of zooplankton carcasses: Effects of stratification and mixing. *Limnology and Oceanography* 57(3): 881–894.

Knap, A.H., Sleeter, T.D., Dodge, R.E., Wyers, S.C., Frith, H.R. and Smith, S.R. 1985. The effects of chemically and physically dispersed oil on the brain coral Diploria strigose (Dana)—a summary review. pp. 547–551 in American Petroleum Institute, *Proceedings 1985 Oil Spill Conference*. API Publication Number 4385. Washington D.C., USA.

Knip, D.M., Heupel, M.R. and Simpfendorfer, C.A. 2010. Sharks in nearshore environments: models, importance, and consequences. *Marine Ecology Progress Series* 402: 1-11.

Kordjazi, Z., Frusher, S., Buxton, C. D., and Gardner, C. 2015. Estimating survival of rock lobsters from long-term tagging programmes: how survey number and interval influence estimates. *ICES Journal of Marine Science* 72: 244–251.

Koshleva, V. 1992. *The impacts of air guns used in marine seismic explorations on organisms living in the Barents Sea*. Fisheries and Offshore Petroleum Exploitation, 2nd International Conference, Bergen, Norway, 6-8 April 1992.

Kostyuchenko, L. 1973. Effects of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea. *Hydrobiological Journal* 9: 45–48.

Kunhold, W.W. 1978. Effects of the water soluble fraction of a Venezuelan heavy fuel oil (No. 6) on cod eggs and larvae. In Wilson, M.P., McQuin, J.P. and Sherman, K. (eds.), *In the wake of the argo merchant*. Centre for Ocean Management Studies, University of Rhode Island, Rhode Island, USA.

Ladich, F. 2000. Acoustic communication and the evolution of hearing in fishes. *Philosophical Transactions of the Royal Society of London B* 355(1401): 1285-1288.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. 2001. Collisions between ships and whales. *Marine Mammal Science* 17:35–75.

Lamb, J. and Peterson, W. 2005. Ecological zonation of zooplankton in the COAST study region off central Oregon in June and August 2001 with consideration of retention mechanisms. *Journal of Geophysical Research* 110: C10S15.

Langstreth, J., Williams, A., Stewart, J., Marton, N., Lewis, P. and Saunders, T. 2018. *Spanish Mackerel (2018)*. Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/253-Spanish-Mackerel-2018>

Larson, D.W. 1985. Marine seismic impact study - an annotated bibliography and literature review. pp. 114–118 in Greene, G.D., Englehardt, F.R. and Paterson, R.J. (eds.), *Effects of explosives in the marine environment*. Proceedings of the Workshop, 29-31 January 1985, Environmental Protection Branch Technical Report No. 5, Canada Oil and Gas Lands Administration, Ottawa, Ontario.

Last, P., Lyne, V., Yearsley, G., Gledhill, D., Gommon, M., Rees, T. and White, W. 2005. *Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40 m depth)*. Australian Government Department of the Environment and Heritage, Canberra, ACT and CSIRO Marine Research, Canberra.

Last, P.R. and Stevens, J.D. 2009. *Sharks and rays of Australia*. CSIRO Division of Fisheries, Hobart, Tasmania.

Lawrence, C. 1995. *Trochus:* Tectus niloticus. Western Australia Department of Fisheries, Perth, Western Australia.

Leema, J.T.M., Kirubagaran, R., Vijayakumaran, M., Remany, M. C., Kumar, T. S. and Babu, T. D. 2010. Effects of intrinsic and extrinsic factors on the haemocyte profile of the spiny lobster, *Panulirus homarus* (Linnaeus, 1758) under controlled conditions. *Journal of the Marine Biological Association of India* 52(2): 219-228.

Leis, J.M. and Carson-Ewart, B.M. (eds.). 2000. *The larvae of Indo-Pacific coastal fishes: an identification guide to marine fish larvae*. Brill, Leiden, Boston, USA.

Lenhardt, M.L., Klinger, R.C. and Musick, J.A. 1985. Marine turtle middle-ear anatomy. Journal of Auditory Research, 25: 66–72.

LeProvost, S. and C. 1986. *Harriet Field - The effect of underwater seismic explosions on pearl oysters*. Report to Apache Energy Ltd, Perth, Western Australia.

Lesser, M.P., Slattery, M., Leichter, J.J. 2009. Ecology of mesophotic coral reefs. J Exp Mar Bio Ecol 375:1–8.

Lewis, P. and Jones, R. 2017. Statewide Large Pelagic Finfish Resource Status Report 2016. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/16: The State of the Fisheries eds. W.J. Fletcher, M.D. Mumme and F.J. Webster. Department of Fisheries, Western Australia. pp. 153-157.

Lewis, P. and Jones, R. 2018. Statewide Large Pelagic Finfish Resource Status Report 2017. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 133-137.

Liberman, M.C. 2015. Noise-induced hearing loss: permanent vs. temporary threshold shifts and the effects of hair-cell versus neuronal degeneration. pp. 1-7 in Popper, A.N. and Hawkins, A.D. (eds.) *The effects of noise on aquatic life II*. Springer, New York, USA.

Limpus, C. J., Miller, J. D., Parmenter, C. J. and Limpus, D. J. 2003. The green turtle, *Chelonia mydas*, population of Raine Island and the Great Barrier Reef: 1843–2001. *Memoirs of the Queensland Museum* 49:349–440.

Limpus, C.J. 2008. A Biological Review of Australian Marine Turtle Species. 1. Loggerhead turtle, *Caretta caretta* (Linneaus), The State of Queensland, Environmental Protection Agency, Australia.

Limpus, C.J. 2009. A Biological Review of Australian Marine Turtles. Brisbane, Queensland. Queensland Government Environmental Protection Agency. pp 324.

Lindfield, S.J., Harvey, E.S., Halford, A.R., McIlwain, J.L. 2016. Mesophotic depths as refuge areas for fishery-targeted species on coral reefs. Coral Reefs 35:125–137.

Lloyd, J.A. 2006. *Demography of* Pristipomoides multidens *in northern Australia and a comparison within the Family Lutjanidae with respect to depth*. PhD thesis, James Cook University, Townsville, Queensland.

Lloyd, J.A., Ovenden, J., Newman, S. and Keenan, C. 2000. *Stock structure of* pristipomoides multidens *resources across northern Australi*a. Fisheries Research & Development Corporation, Project No. 1996/131, Fishery Report No. 49. Fisheries Research and Development Corporation, Canberra, ACT.

Lohmann, K.J. and Fittinghoff-Lohmann, C.M. 1992. Orientation to oceanic waves by green turtle hatchings. *Journal of Experimental Biology* 171:1–13.

Løkkeborg, S., Ona, E., Vold, A., Salthaug, A. 2012. Sounds from seismic air guns: gear- and species-specific effects on catch rates and fish distribution. *Canadian Journal of Fisheries and Aquatic Sciences* 69: 1278–1291.

Lourie, S.A., Foster, S.J., Cooper, E.W.T. and Vincent, A.C.J. 2004. A Guide to the Identification of Seahorses. Project Seahorse and TRAFFIC North America. Washington D.C.: University of British Columbia and World Wildlife Fund. 120 pp.

Lourie, SA, Vincent, ACJ and Hall, HJ. 1999. *Seahorses: an identification guide to the world's species and their conservation*. Project Seahorse, London, United Kingdom.

Loya, Y. and Rinkevich, B. 1980. Effects of oil pollution on coral reef communities. *Marine Ecology Progress Series* 3:167–180.

Lyle, J.M. 1987. Observations on the biology of Carcharhinus cautus (Whitley), Carcharhinus melanopterus (Quoy and Gaimard) and Carcharhinus fitzroyensis (Whitley) from northern Australia. *Australian Journal of Marine and Freshwater Research* 38: 701–710.

Macbeth, W.G., Geraghty, P.T., Peddemors, V.M. and Gray, C.A. 2009. *Observer-based study of targeted commercial fishing for large shark species in waters off northern New South Wales*. Fisheries Final Report Series No. 114. Industry & Investment NSW, Cronulla, NSW.

MacGillivray, A.O. 2018. *An airgun array source model accounting for high-frequency sound emissions during firing and solutions to the IAMW source test cases*. IEEE Journal of Oceanic Engineering DOI: 10.1109/JOE.2018.2853199.

Mackie M.C., Lewis P.D., Kennedy J., Saville K., Crowe F., Newman, S.J. and Smith, K.A. 2010. *Western Australian Mackerel Fishery*. Ecologically Sustainable Development Series No. 7. Western Australian Department of Fisheries, Perth, Western Australia.

Mackie, M., Nardi, A., Lewis, P. and Newman, S. 2007. *Small pelagic fishes of the north-west marine region*. Report for the Department of the Environment and Water Resources, Perth, Western Australia and Department of Fisheries, Perth.

Malme, C. I., Miles, P. R., Tyack, P., Clark, C. W. and Bird, J. E. 1985. *Investigations of the potential effects of underwater noise from petroleum industry activities on feeding humpback whale behavior*. Report 5851. Bolt, Beranek & Newman, Inc., Massachusetts, USA.

Malme, C.I., B. Wursig, J.E. Bird, and P. Tyack. 1988. Observations of feeding gray whale responses to controlled industrial noise exposure. pp. 55 – 73 in Sackinger, W.M. and Jeffries, M.O. (general eds.); Imm, J.L. and Treacey, S.D. (symposium eds.), *Port and Ocean Engineering Under Arctic Conditions, Volume II: Symposium on Noise and Marine Mammals*. The Geophysical Institute, University of Alaska, Fairbanks, Alaska.

Malme, C.I., Miles, P.R., Clark, C.W., Tyack, P. and Bird, J.E. 1984. *Investigations of the potential effects of underwater noise from petroleum industry activities on migration gray whale behavior, Phase II: January 1984 migration*. Report No. 5586. Prepared by Bolt, Beranek & Newman, Inc., Massachusetts, USA for the US Department of Interior, Minerals Management Service Alaska OCS Office, Alaska, Canada.

Marine Pest Sectoral Committee. 2018. *National biofouling management guidelines for the petroleum production and exploration industry*. Department of Agriculture and Water Resources, Canberra, ACT.

Marley, S.A, Salgado Kent, C.P., Erbe, C. and Thiele, D. 2017. A tale of two soundscapes: comparing the acoustic characteristics of urban versus pristine coastal dolphin habitats in Western Australia. *Acoustics Australia* 45(2): 159-178.

Marquenie, J., Donners, M., Poot, H., Steckel, W., de Wit, B. and Nam, A. 2008. *Adapting the spectral composition of artificial lighting to safeguard the environment*. Petroleum and Chemical Industry Conference Europe – Electrical and Instrumentation Applications, 5th PCIC Europe.

Marquez, R. 1990. FAO Species Catalogue; Sea Turtles of the World. An annotated and illustrated catalogue of the sea turtle species known to date. FAO Fisheries Synopsis. 125 (11): 81. Rome: Food and Agriculture Organisation of United Nations.

Marsh, H., T.J. O'Shea and J.R. Reynolds. 2011. *The ecology and conservation of sirenia; dugongs and manatees*. Cambridge University Press, London, United Kingdom.

Martin, B., K. Broker, M.-N.R. Matthews, J. MacDonnell, and L. Bailey. 2015. *Comparison of measured and modeled air-gun array sound levels in Baffin Bay, West Greenland*. OceanNoise 2015, 11-15 May, Barcelona, Spain.

Martin, B., MacDonnell, J.T. and Bröker, K. 2017a. Cumulative sound exposure levels—Insights from seismic survey measurements. *Journal of the Acoustical Society of America* 141(5): 3603-3603.

Martin, J., Keag, M., Newman, S. and Wakefield, C. 2014. Goldband Snapper *Pristipomoides multidens*. Accessed online on 27 February 2019 at <https://www.fish.gov.au/2014-Reports/Goldband_Snapper>.

Martin, S.B., Matthews, M.N.R., MacDonnell, J.T. and Bröker, K. 2017b. Characteristics of seismic survey pulses and the ambient soundscape in Baffin Bay and Melville Bay, West Greenland. *Journal of the Acoustical Society of America* 142(6): 3331-3346.

Matcott, J., Baylis, S., and Clarke, R.H. 2019. The Influence of Petroleum oil films on the feather structure of tropical and temperate seabird species. *Marine Pollution Bulletin* 138:135-144.

Matishov, G.G. 1992. *The reaction of bottom-fish larvae to airgun pulses in the context of the vulnerable Barent Sea ecosystem*. Fisheries and Offshore Petroleum Exploitation, 2nd International Conference, 6-8 April, 1992, Bergen, Norway.

Matthews, M.N.R. and MacGillivray, A.O. 2013. Comparing modelled and measured sound levels from a seismic survey in the Canadian Beaufort Sea. *Proceedings of Meetings on Acoustics* 19(1): 1-8.

McAuley, R. and Gaughan, D. 2005. *Stock assessment of the sandbar shark,* Carcharhinus plumbeus*, in Western Australia*. Shark Section Research Advice Number 16. Western Australia Department of Fisheries, Perth, Western Australia.

McAuley, R. B., Simpfendorfer, C. A., Hyndes, G. A. and Lenanton, R. C. J. 2007. Distribution and reproductive biology of the sandbar shark, *Carcharhinus plumbeus* (Nardo), in Western Australian waters. *Marine and Freshwater Research* 58, 116–126.

McAuley, R., Lenanton, R., Chidlow, J., and Allison, R. 2005. *Biology and stock assessment of the thickskin (sandbar) shark,* Carcharhinus plumbeus*, in Western Australia and further refinement of the dusky shark,* Carcharhinus obscurus, *stock assessment*. Final Report to the Fisheries Research & Development Corporation for Project 2000/134. Fisheries Research Report No. 151. Western Australia Department of Fisheries, Perth, Western Australia.

McCauley, R.D. 1994. Seismic surveys. pp. 19–122 in Swan, J. M., Neff, J. M. and Young, P. C. (eds.), *Environmental implications of offshore oil and gas development in australia—the findings of an independent scientific review*. Australian Petroleum Exploration Association, Sydney, NSW.

McCauley, R.D. 2008. *Measurement of airgun signals from Gigas Seismic Survey, Northern Lagoon of Scott Reef, Western Australia*. Report prepared for Woodside Energy Ltd., Perth, Western Australia by Centre for Marine Science and Technology, Curtin University, Perth.

McCauley, R.D. 2009. *Ambient, biological and anthropogenic sea noise sources from Browse and Maret Islands, Kimberley, 2006-2008*. A report prepared by the Centre for Marine Science and Technology, Curtin University, Perth, Western Australia for INPEX Browse Ltd, Perth.

McCauley, R.D. 2011. *Woodside Kimberley sea noise logger program, Sept-2006 to June-2009: whales, fish and man-made noise*. A report prepared by the Centre for Marine Science and Technology, Curtin University, Perth, Western Australia for Woodside Energy, Perth.

McCauley, R.D. 2012. *Fish choruses from the Kimberley, seasonal and lunar links as determined by long term sea noise monitoring*. Proceedings of Acoustics 2012, 21-23 November 2012, Fremantle, Australia.

McCauley, R.D. and Cato, D.H. 2000. Patterns of fish calling in a nearshore environment in the Great Barrier Reef. *Philosophical Transactions of the Royal Society of London B* 355(1401): 1289-1293.

McCauley, R.D. and Duncan, A.J. 2011. Sea Noise Logger Deployment, Wheatstone and Onslow, April 2009 to November 2010: Great whales, fish and man-made noise sources. CMST tech. Report R2011-23, Curtin University of Technology, Perth, Western Australia.

McCauley R.D. and Jenner, C. 2010. Migratory patterns and estimated population size of pygmy blue whales (*Balaenoptera musculus brevicauda*) traversing the Western Australian coast based on passive acoustics. Paper SC/62/SH26 presented to the IWC Scientific Committee (unpublished).

McCauley, R.D. and Salgado Kent, C. 2007. *Observations, catch and ear pathology of caged fish exposed to seismic survey passes*. CMST Report R2007-19. Prepared for Santos Ltd., Perth, Western Australia by Centre of Marine Science and Technology, Perth.

McCauley, R.D., Day, R.D., Swadling, K.M., Fitzgibbon, Q.P., Watson, R.A. and Semmens, J.M. 2017. *Widely used marine seismic survey air gun operations negatively impact zooplankton*. Nature Ecology & Evolution 1, Article 0195.

McCauley, R.D., Fewtrell, F., Duncan, A.J., Jenner, C., Jenner, M-N, Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J. and McCabe, K. 2000. Marine seismic surveys – a study of environmental implications. *The APPEA Journal* 40(1): 692-706.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.N., Penrose, J.D., Prince, R.I.T., Adihyta, A., Murdoch, J. and McCabe, K. 2003. *Marine seismic surveys: analysis and propagation of airgun signals, and effects of exposure on humpback whales, sea turtles, fishes and squid*. Prepared for the Australian Petroleum Exploration and Production Association, Perth, Western Australia from the Centre for Marine Science and Technology, Curtin University.

McCauley, R.D., Jenner, M.-N., Jenner, C., McCabe, K.A. and Murdoch, J. 1998. The response of humpback whales (*Megaptera novaeangliae*) to offshore seismic survey noise: Preliminary results of observations about a working seismic vessel and experimental exposures. *The APPEA Journal* 38:692-707.

McDougall, A. 2004. Assessing the use of sectioned otoliths and other methods to determine the age of the centropomid fish, barramundi (*Lates calcarifer*) (Bloch), using known-age fish. *Fisheries Research* 67: 129–141.

McIntyre, A.D. and Johnston, J. 1975. Effects of nutrient enrichment from sewage in the sea. In Gameson A.L.H. (ed.), *Discharge of sewage from sea outfalls*. Pergamon Press, Oxford, United Kingdom.

McKinnon, A.D., Duggan, S., Carleton, J.H. and Böttger-Schnack, R. 2008. Summer planktonic copepod communities of Australia's North West Cape (Indian Ocean) during the 1997–99 El Niño/La Niña. *Journal of Plankton Research* 30(7): 839–855.

McKinnon, A.D., Duggan, S., Holliday, D. and Brinkman, R. 2015. Plankton community structure and connectivity in the Kimberley-Browse region of NW Australia. *Estuarine, Coastal and Shelf Science* 153: 156-167.

McLoughlin, R.J., Davis, T.L.O. and Ward, T.J. 1988. Sedimentary provinces, and associated bedforms and benthos on the Scott Reef–Rowley Shoals platform off north west Australia. *Australian Journal of Marine and Freshwater Research* 39(2):133–144.

McPherson, C., Kowarski, K., Delarue, J., Whitt, C. MacDonnell, J. and Martin, B. 2016a. *Passive acoustic monitoring of ambient noise and marine mammals—Barossa Field*. JASCO Document 00997, Version 1.0. Technical report by JASCO Applied Sciences, Perth, Western Australia for Jacobs, Perth.

McPherson, C., MacGillivray, A. and Hager, E. 2018. Validation of airgun array modelled source signatures. *The Journal of the Acoustical Society of America* 144(3): 1846.

McPherson, C., Martin, B., MacDonnell, J. and Whitt, C. 2016b. *Examining the value of the acoustic variability index in the characterisation of australian marine soundscapes*. Proceedings of Acoustics 2016, 9-11 November 2016, Brisbane, Australia.

McPherson, C.R., Wladichuk, J.L., Alavizadeh, Z. and Hiltz, K. 2019. *Western Australia 2-D marine seismic survey: acoustic modelling for assessing marine fauna sound exposures*. Document 01696, Version 2.0 FINAL. Technical report prepared by JASCO Applied Sciences for INPEX Operations Australia Pty Ltd.

Miller, G., Moulton, V., Davis, R., Holst, M., Millman, P., MacGillivray, A. and Hannay, D. 2005. Monitoring seismic effects on marine mammals - southeastern Beaufort Sea. 2001-2002. pp. 511-542 in Armsworthy, S., Cranford, P. and Lee, K. (eds.), *Offshore oil and gas environmental effects monitoring/approaches and technologies*. Battelle Press, Columbus, Ohio.

Miller, I.R. and Cripps, E. 2013. Three-dimensional marine seismic survey has no measurable effect on species richness or abundance of a coral reef associated fish community. *Marine Pollution Bulletin* 7(1-2), 63-70.

Miller, K. 2017. Seabed Biodiversity of the Kimberley. 2017 WAMSI Research Conference, 27-29 November 2017, State Library of Western Australia.

Miller, K. 2019. *North West Shoals to Shore Research Program: Theme 2 - Seabed habitats and biodiversity*. North West Shoals to Shore Research Program Symposium, 19 February 2019.

Miller, P.J.O., Biassoni, N., Samuels, A. and Tyack, P. L. 2000. Whale songs lengthen in response to sonar. *Nature* 405(6789): 903.

Milton, D.A., Fry, G.C, and Quinton, D. 2009. Reducing impacts of trawling on protected sea snakes: by-catch reduction devices improve escapement and survival. *Marine and Freshwater Research* 60: 824-832.

Milton, S., Lutz, P. and Shigenaka G. 2003. Oil toxicity and impacts on sea turtles. In Shigenaka, G. (ed.), *Oil and sea turtles: biology, planning, and response*. National Oceanic and Atmospheric Administration, Washington, USA.

Moein, S.E., Musick, J.A., Keinath, J.A. 1995. Evaluation of seismic sources for repelling sea turtles from hopper dredges. In: Hales LZ (ed) Sea turtle research program: summary report. Prepared for US Army Engineer Division, South Atlantic, Atlanta, GA, and US Naval Submarine Base, Kings Bay, GA. Technical Report CERC-95, 90, pp. 75–78.

Molony, B. Lai, E. and Jones, R. 2015. Mackerel Managed Fishery Report: Statistics Only. pp. 207-210 in Fletcher, W.J. and Santoro, K. (eds.), *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014/15: The State of the Fisheries*. Western Austrlia Department of Fisheries, Perth, Western Australia.

Moran, M., Burton, C. and Jenke, J. 2004. Long-term movement patterns of continental shelf and inner gulf snapper (Pagrus auratus, Sparidae) from tagging in the Shark Bay region of Western Australia. *Marine and Freshwater Research* 54 (8): 913–922.

Morley, E.L., Jones, G., and Radford, A.N. 2014. The importance of invertebrates when considering the impacts of anthropogenic noise. *Proceedings of the Royal Society B* 281: 20132683.

MPSC—*see* Marine Pest Sectoral Committee

Mrosovsky, N., Ryan G.D. and James M.C. 2009. Leatherback turtles: The menace of plastic. *Marine Pollution Bulletin* 58(2):287–289.

Munk, P., Bjornsen, P.K., Boonruang, P., Fryd, M., Hansen, P.J., Janekarn, V., Limtrakulvong, V., Nielson, T.G., Hansen, O.S., Poomin, S., Sawangarreruks, S., Thomsen, H.A. and Ostergaard, J.B. 2004. Assemblages of fish larvae and mesozooplankton across the continental shelf and shelf slope of the Andaman Sea (NE Indian Ocean). *Marine Ecology Progress Series* 274: 87–97.

Mustoe, S. and Edmunds, M. 2008. *Coastal and Marine Natural Values of the Kimberley*. WWF Australia, Sydney, NSW, cited in Department of State Development. 2010. Browse Liquefied Natural Gas Precinct – Strategic Assessment Report (draft for public comment), Part 3 Environmental Assessment – Marine Impacts. Department of State Development, Perth, Western Australia.

Myberg, AA. 2001. The acoustical biology of elasmobranchs. *Environmental Biology of Fishes* 30(1-3):31-45.

Nair, S.R., Nair, V.R., Achuthankutty, C.T. and Madhupratap, M. 1981. Zooplankton composition and diversity in the Western Bay of Bengal. *Journal of Plankton Research* 3(4): 493–508.

National Health and Medical Research Council and the Natural Resource Management Ministerial Council. 2018. *Australian drinking water guidelines 6 2011. Version 3.5 updated August 2018*. National Health and Medical Research Council, Canberra, ACT and the Natural Resource Management Ministerial Council, Canberra.

National Oceanic and Atmospheric Administration. 2010. *Oil spills in mangroves, planning and response*. National Oceanic and Atmospheric Administration. US Department of Commerce, Office of Response and Restoration.

National Offshore Petroleum Safety and Environment Management Authority. 2014. *Information Paper IPI411: Consultation requirements under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*. National Offshore Petroleum Safety and Environment Management Authority, Perth, Western Australia.

National Offshore Petroleum Safety and Environment Management Authority. 2018. *Information Paper IPI765: Acoustic impact evaluation and management*. National Offshore Petroleum Safety and Environment Management Authority, Perth, Western Australia.

National Science Foundation, U.S. Geological Survey, and National Oceanic and Atmospheric Administration (U.S.). 2011. *Final programmatic environmental impact statement/overseas*. Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. National Science Foundation, Virginia, USA.

Nedelec, S. L., Campbell, J., Radford, A. N., Simpson, S. D. and Merchant, N. D. 2016. Particle motion: the missing link in underwater acoustic ecology. *Methods in Ecology and Evolution* 7: 836–842.

Nedwell, J.R., Edwards, B., Turnpenny, A.W.H., Gordon, J. 2004. *Fish and marine mammal audiograms: A summary of available information*. Subacoustech Report ref: 534R0214.

Negri, A.P. and Heyward, A.J. 2000 Inhibition of fertilization and larval metamorphosis of the coral *Acropora millepora* (Ehrenberg, 1834) by petroleum products. *Marine Pollution Bulletin* 41(7–12):420–427.

Nelson, J.D. and Eckert, S.A. 2007. Foraging ecology of whale sharks (Rhincondon typus) within Bahia de Los Angeles, Baja Caliofrnia Norte, Mexico. *Fisheries Research* 84:47-64.

Newman S.J., Smith K.A., Skepper C.L. and Stephenson P.C. 2008. *Northern Demersal Scalefish Managed Fishery*. ESD Report Series No. 6, June 2008. Department of Fisheries, Perth, Western Australia.

Newman S.J., Wakefield C., Skepper C., Boddington D., Jones R. and Smith, E. 2018a. North Coast Demersal Resource Status Report 2017. pp. 127-133 in Gaughan, D.J. and Santoro, K. (eds.) *Status reports of the fisheries and aquatic resources of Western Australia 2016/17: the state of the fisheries*. Department of Primary Industries and Regional Development, Western Australia.

Newman, S. J. 2006. Research and management systems for tropical deepwater demersal fish resources—a case study from northwestern Australia. pp. 221–233 in Shotton, R. (ed.), *Deep sea 2003: conference on the governance and management of deep-sea fisheries*. Part 2: Conference Poster Papers and Workshop Papers, Queenstown, New Zealand, 1–5 December 2003 and Dunedin, New Zealand, 27–29 November 2003. FAO Fisheries Proceedings, 3/2. FAO, Rome.

Newman, S.J., Steckis, R.A., Edmonds, J.S., Lloyd, J. 2000. Stock structure of the goldband snapper *Pristipomoides multidens* (Pisces: Lutjanidae) from the waters of northern and western Australia by stable isotope ratio analysis of sagittal otolith carbonate. *Marine Ecology Progress Series* 198: 239-247.

Newman, S.J., Trinnie, F. Saunders, T. and Wakefield, C. 2018e. *Rankin Cod (2018)*. Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/206-Rankin-Cod-2018>

Newman, S.J., Wakefield, C., Lunow, C., Saunders, T. and Trinnie, F. 2018b. *Red Emperor (2018)*. Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/222-Red-Emperor-2018>

Newman, S.J., Wakefield, C., Lunow, C., Saunders, T. Hughes, J. and Trinnie, F. 2018d. *Spangled Emperor (2018)*. Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/228-Spangled-Emperor-2018>

Newman, S.J., Wakefield, C., Saunders, T. and Trinnie, F. 2018c. *Bluespotted Emperor (2018)*. Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/227-Bluespotted-Emperor-2018>

Newman, S.J., Young, G. C., Travers, M. J., Pember, M. B., Skepper, C. L., Williamson, P. C., and Potter, I. C. 2003. *Characterisation of the inshore fish assemblages of the Pilbara and Kimberley coasts*. Final Report to the Fisheries Research and Development Corporation for Project 2000/132. Fisheries Research and Development Corporation, Canberra, ACT.

NHMRC & NRMMC—*see* National Health and Medical Research Council and the Natural Resource Management Ministerial Council

Nicholas, W. A., Carroll, A. G., Radke, L., Tran, M., Howard, F. J. F., Przeslawski, R., Chen, J., Siwabessy, P. J. W., and Nichol, S. L. 2016. *Seabed environments and shallow geology of the Leveque Shelf, Browse Basin, Western Australia: GA0340 – interpretive repor*t. Record 2016/18. Geoscience Australia, Canberra, ACT.

Nieukirk, S.L., Stafford, K.M., Mellinger, D.K., Dziak, R.P. and Fox, C.G. 2004. Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. *Journal of the Acoustic Society of America* 115: 1832–1843.

NOAA—*see* National Oceanic and Atmospheric Administration

NOPSEMA—*see* National Offshore Petroleum Safety and Environment Management Authority

Norman, B. M., Reynolds, S. D. and Morgan, D. L. 2016. Does the whale shark aggregate along the Western Australian coastline beyond Ningaloo Reef? Pacific Conservation Biology, 22, 72–80.

Norman, B. M. and Stevens, J. D. 2007. Size and maturity status of the whale shark (*Rhincodon typus*) at Ningaloo Reef in Western Australia. Fisheries Research, 84, 81–86.

Normandeau Associates, Inc. 2012. Effects of noise on fish, fisheries, and invertebrates in the U.S. Atlantic and Arctic from energy industry sound-generating activities workshop report. Prepared for U.S. Department of the Interior, Bureau of Ocean Energy Management, December 2012.

Nowacek, D.P. and Southall, B.L. 2016. *Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys: A resource guide for managers*. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

Nowara, G. and Newman, S. 2001. *A history of foreign fishing activities and fishery independent surveys of the demersal finfish resources in the Kimberley region of Western Australia*. Report no. 125. Western Australia Department of Fisheries, Perth, Western Australia.

NSF—*see* National Science Foundation

O'Brien, M. 2002. *At-sea recovery of heavy oils - a reasonable response strategy? 3rd Forum on High Density Oil Spill response*. The International Tanker Owners Pollution Federation Limited (ITOPF), London, United Kingdom.

O'Neill, C., D. Leary, and A. McCrodan. 2010. Sound source verification. Chapter 3, in Blees, M.K., Hartin, K.G., Ireland, D.S., and Hannay D.E. (eds.). *Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2010: 90-day report*. LGL Report P1119. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service (U.S.), and U.S. Fish and Wildlife Service.

Ovenden, J.R., Lloyd, J., Newman, S.J., Keenan, C.P. and Slater, L.S. 2002. Spatial genetic subdivision between northern Australian and southeast Asian populations of *Pristipomoides multidens*: a tropical marine reef fish species. *Fisheries Research* 59: 57–69.

Ovenden, J.R., Morgan, J.A.T., Kashiwagi, T., Broderick, D. and Salini, J. 2010. Towards better management of Australia's shark fishery: genetic analysis reveal unexpected ratios of cryptic blacktip species *Carcharhinus tilstoni* and *C. limbatus*. *Marine and Freshwater Research* 61: 253-262.

Ovenden, J.R., Salini, J., O'Connor, S. and Street, A.R. 2004. Pronounced genetic population structure in a potentially vagile fish species (*Pristipomoides multidens*, Teleostei; Perciformes; Lutjanidae) from the East Indies triangle. *Molecular Ecology* 13(7): 1991–1999.

Owen, K., C.S. Jenner, M.-N.M. Jenner, and R.D. Andrews. 2016. A week in the life of a pygmy blue whale: Migratory dive depth overlaps with large vessel drafts. Animal Biotelemetry 4: 17. https://doi.org/10.1186/s40317-016-0109-4.

Parks Australia. 2018a. *Kimberley Marine Park*. Accessed online on 05 November 2018 at <https://parksaustralia.gov.au/marine/parks/north-west/kimberley/>

Parks Australia. 2018b. *Argo-Rowley Terrace Marine Park*. Accessed online on 05 November 2018 at <https://parksaustralia.gov.au/marine/parks/north-west/argo-rowley-terrace/>

Parks Australia. 2018c. *Mermaid Reef Marine Park*. Accessed online on 05 November 2018 at <https://parksaustralia.gov.au/marine/parks/north-west/mermaid-reef/>

Parks Australia. 2018d. *Roebuck Marine Park.* Accessed online on 05 November 2018 at <https://parksaustralia.gov.au/marine/parks/north-west/roebuck/>

Parks Australia. 2018e. *Eighty Mile Beach Marine Park*. Accessed online on 05 November 2018 at <https://parksaustralia.gov.au/marine/parks/north-west/eighty-mile-beach/>

Parks Australia. 2018f. *Ashmore Reef Marine Park*. Accessed online on 05 November 2018 at <https://parksaustralia.gov.au/marine/parks/north-west/ashmore-reef/>

Parks Australia. 2018g. *Cartier Island Marine Park*. Accessed online on 05 November 2018 at <https://parksaustralia.gov.au/marine/parks/north-west/cartier-island/>

Parks Australia. 2018h. *Australian Marine Parks Science Atlas*. Accessed online on 14 December 2018 at <https://atlas.parksaustralia.gov.au/amps/>

Parks, S.E., Clark, C.W. and Tyack, P.L. 2007. Short- and long-term changes in right whale calling behavior: the potential effects of noise on acoustic communication. *The Journal of the Acoustical Society of America* 122(6):3725-3731.

Parra, G.J. 2006. Resource partitioning in sympatric delphinids: Space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins. Journal of Animal Ecology, 75(4): 862-874.

Parra, G.J. Preen, A.R. Corkeron, P.J. Azuma, C. and Marsh, H. 2002. Distribution of Irrawaddy dolphins, Orcaella brevirostris, in Australian waters. Raffles Bulletin of Zoology. 10:141-154.

Parra, G.J., 2005. Behavioural ecology of Irrawaddy, Orcaella brevirostris (Owen in Gray, 1866), and Indo-Pacific humpback dolphins, Sousa chinensis (Osbeck, 1765), in northeast Queensland, Australia: a comparative study. Ph.D. Thesis, James Cook University, Townsville.

Parry G.D., Heislers S., Werner G.F., Asplin M.D. and Gason A. 2002. *Assessment of environmental effects of seismic testing on scallop fisheries in Bass Strait*. Marine and Freshwater Resources Institute Report No. 50. Marine and Freshwater Institute, Queenscliff, Victoria.

Parry, G.D. and Gason, A. 2006. The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia. *Fisheries Research* 79:272-284.

Parsons, D.M., Morrison, M.A., McKenzie, J.R., Hartill, B.W., Bian, R. and Francis, R.C. 2011. A fisheries perspective of behavioural variability: differences in movement behaviour and extraction rate of an exploited sparid, snapper (*Pagrus auratus*). *Canadian Journal of Fisheries and Aquatic Sciences* 68(4): 632–42.

Parvin, S.J. 1998. The effects of low frequency underwater sound on divers. pp. 227-232 in *Proceedings of Undersea Defence Technology 1998*. Nexus Media Ltd., Nice, France, June 1998.

Parvin, S.J. 2005. *Limits for underwater noise exposure of human divers and swimmers*. Presented at the National Physics Laboratory Seminar on Underwater Acoustics, Teddington, United Kingdom. Subacoustech, Southampton, United Kingdom.

Pascuel, C., Sanchez, A., Zenteno, E., Cuzon, G., Gabriela, G., Brito, R., Gelabert, R., Hidalgo, E. and Rosas, C. 2006. Biochemical, physiological and immunological changes during starvation in juveniles of *Litopenaeus vannamei*. *Aquaculture* 251: 416-429.

Patterson, H. and Nicol, S. 2018. *Southern Bluefin Tuna (2018)*. Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/251-Southern-Bluefin-Tuna-2018>.

Pavlov, D.A., Emel'yanova, N.G. and Novikov, G.G. 2009. Reproductive dynamics. pp. 48–90 in Jakabsen, T., Fogarty, M.J., Megrey, B.A. and Mosksness, E. (eds.), *Fish reproductive biology, implications for assessment and management*. Wiley-Blackwell, Chichester, UK.

Paxton, A.B., Taylor, J.C., Nowacek, D.P., Dale, J., Cole, E. Voss, C.M. and Peterson, C.H. 2017. Seismic survey noise disrupted fish use of a temperate reef. *Marine Policy* 78: 68-73.

Payne, J. F., Coady, J. and White, D. 2009. *Potential effects of seismic air gun discharges on monkfish eggs (*Lophius americanus*) and larvae*. National Energy Board, Canada.

Payne, J.F. 2004. *Potential effect of seismic surveys on fish eggs, larvae and zooplankton*. CSAS Research Document 2004/125. Canadian Science Advisory Secretariat, Department of Fisheries and Oceans, Canada.

Payne, J.F., Andrews, C.A., Fancey, L.L., Cook, A.L. and Christian, J.R. 2007. *Pilot study on the effects of seismic air gun noise on lobster (*Homarus americanus*)*. Report No. 171. Environmental Studies Research Funds, St. John's, Canada.

Payne, J.F., Brickman, D. and Ouellet, P. 2004. Potential Effect of Seismic Surveys on Fish Eggs, Larvae and Zooplankton. CSAS Research Document 2004/125. Canadian Science Advisory Secretariat, Department of Fisheries and Oceans, Canada.

Payne, J.F., C. Andrews, L. Fancey, D. White, and J. Christian. 2008. *Potential effects of seismic energy on fish and shellfish: an update since 2003*. Report Number 2008/060. Canadian Science Advisory Secretariat, Canada.

Pearce, A., Helleren, S. and Marinelli, M. 2000. *Review of productivity levels of Western Australian coastal and estuarine waters for mariculture planning purposes*. Fisheries Research Report No. 123. Fisheries Western Australia, Perth, Western Australia.

Pearson, W.H., Skalski, J.R. and Malme, C.I. 1992. Effects of sounds from a geophysical survey device on behaviour of captive rockfish (*Sebastes* spp.). *Canadian Journal of Aquatic Science* 49(7): 1343–1356.

Pearson, W.H., Skalski, J.R., Sulkin, S.D., and Malme, C.I. 1994. Effects of seismic releases on the survival of development of zoeal larvae of dungeness crab (*Cancer magister*). *Marine Environmental Research* 38: 93-113.

Peña, H., Handegard, N. O., and Ona, E. 2013. Feeding herring schools do not react to seismic air gun surveys. ICES Journal of Marine Science 70(6): 1174–1180.

Pendoley, K.L. 2005. *Sea turtles and the environmental management of industrial activities in north-west Western Australia*. PhD thesis. Murdoch University, Perth, Western Australia.

Pepperell, J.G., Kopf, R.K. and Malseed, B.E. 2011. Use of historic fisheries data to determine trends in relative abundance and body size of sailfish, *Istiophorus platypterus*, off north-western Australia. *Journal of the Royal Society of Western Australia* 94: 333–344.

Pestorius, F.M., Cudahy, E. and Fothergill, D.M. 2009. *Evolution of navy diver exposure standards for deterministic underwater sound in the 100-500 Hz band*. Meetings on Acoustics Volume 8. 070002.

Peters, E.C., Meyers, P.A., Yevich, P.P. and Blake, N.J. 1981. Bioaccumulation and histopathological effects of oil on a stony coral. *Marine Pollution Bulletin* 12(10):333–339.

Petersen, D. and Jurevicius, D. 2009. *Environmental noise impact of a major transport corridor on a barramundi fish farm*. Proceedings of ACOUSTICS 2009, 23-25 November 2009, Adelaide, Australia.

Phillips, B.F (ed.). 2008. *Lobsters: biology, management, aquaculture and fisheries*. Wiley-Blackwell, New Jersey, USA.

Pietrzak, B., Bednarska, A., Markowska, M., Rojek, M., Szymanska, E. and Slusarczyk, M. 2013. Behavioural and physiological mechanisms behind extreme longevity in Daphnia. *Hydrobiologia* 715 (1): 125–134.

Pillans, R., Stevens, J.D. and White, W.T. 2009. *Carcharhinus sorrah*. The IUCN red list of threatened species 2009: e.T161376A5409506. Accessed online on 12 April 2019 at <http://dx.doi.org/10.2305/IUCN.UK.2009-2.RLTS.T161376A5409506.en.>

Pimental, D.L., Leach, R., Zuniga and Morrison, D. 2000. Environmental and economic costs of nonindigenous species in the United States. *Bioscience* 50:53-65.

Poot, H., Ens, B.J., de Vries, H., Donners, M.A.H., Wernand, M.R. and Marquenie, J.M. 2008. Green light for nocturnally migrating birds. *Ecology and Society* 13(2):47.

Popper, A., Dale, J., Gray, M.D., Keith, W., Block, B. and Rogers, P.H. 2013. Threshold of hearing for swimming bluefin tuna (Thunnus orientalis). Acoustical Society of America. *Proceedings of Meetings on Acoustics* 19: 1-5.

Popper, A.N. 1981. Comparative scanning electron microscopic investigations of the sensory epithelia in the teleost sacculus and lagena. *Journal of Comparative Neurology* 200(3):357–374.

Popper, A.N. 2012. *Fish hearing and sensitivity to acoustic impacts*. Appendix J in Atlantic OCS proposed geological and geophysical activities, mid-Atlantic and south Atlantic planning areas, draft programmatic environmental impact statement. OCS EIS/EA BOEM 2012-005. March 2012. 2 vols.

Popper, A.N. 2018. *Potential for impact of cumulative sound exposure on fishes during a seismic survey*. Environmental BioAcoustics, Maryland, USA.

Popper, A.N. and Clarke, N.L. 1976. The auditory system of the goldfish (Carassius auratus): effects of intense acoustic stimulation. *Comparative Biochemistry Physiology Part A: Physiology* 53:11–18.

Popper, A.N. and Fay, R.R. 1993. Sound detection and processing by fish: critical review and major research questions. *Brain Behavioural Evolution* 41(1):14-38.

Popper, A.N. and Fay, R.R. 2011. Rethinking sound detection by fishes. *Hearing Research* 273: 25–36.

Popper, A.N. and Hastings, M.C. 2009. The effects of human-generated sound on fish. *Integrative Zoology* 4:43-52.

Popper, A.N. and Hawkins, A.D. 2018. The importance of particle motion to fishes and invertebrates. *Journal of the Acoustical Society of America* 143 (1): 470-488.

Popper, A.N. and Hawkins, A.D. 2019. An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes. *Journal of Fish Biology* 2019: 1-22.

Popper, A.N., Hawkins, A.D., Sand, O. and Sisneros, J.A. 2019. Examining the hearing abilities of fishes. *Journal of the Acoustical Society of America*, 146(2): 948-955.

Popper, A.N., Carlson, T.J., Hawkins, A.D., Southall, B.L. and Gentry, R.L. 2006. *Interim criteria for injury of fish exposed to pile driving operations: a white paper*. Accessed online on 24 June 2019 at < https://www.researchgate.net/publication/237374178_Interim_Criteria_for_Injury_of_Fish_Exposed_to_Pile_Driving_Operations_A_White_Paper >.

Popper, A.N., Fewtrell, J., Smith, M.E. and McCauley, R.D. 2003. Anthropogenic sound: effects on the behavior and physiology of fishes. *Marine Technology Society Journal* 37(4):35–40.

Popper, A.N., Gross, J.A., Carlson, T.J., Skalski, J., Young, J.V., Hawkins, A.D. and Zeddies, D. 2016. Effects of Exposure to the Sound from seismic airguns on pallid sturgeon and paddlefish. *PLoS One* 11(8): e0159486.

Popper, A.N., Halvorsen, M.B., Kane, E., Miller, D.L., Smith, M.E., Song, J., Stein, P. and Wysocki, l.E. 2007. The effects of high-intensity, low-frequency active sonar on rainbow trout. *Journal of the Acoustical Society of America* 122:623–635.

Popper, A.N., Hawkins, A.D., Fay, R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W., Gentry, R., Halvorsen, M., Løkkeborg, S., Rogers, P., Southall, B., Zeddies, D. and Tavolga, W. 2014. *Sound exposure guidelines for fishes and sea turtles: a technical report Prepared by ANSI-Accredited Standards Committee S3/SC1 and Registered with ANSI*. 978-3-319-06658-5. Springer International Publishing, New York, USA.

Popper, A.N., Smith, M.E., Cott, P.A., Hanna, B.W., MacGillivray, A.O., Austin, M.E. and Mann, D.A. 2005. Effects of exposure to seismic airgun use on hearing of three fish species. *Journal of the Acoustical Society of America* 117:3958–3971.

Prince, E.D., Lee, D.W., Zwelfel, J.R. and Brothers, E.B. 1991. Estimating age and growth of young Atlantic blue marlin Makaira nigiricans from otolith microstructure. *Fishery Bulletin* 89(3):441-459.

Pritchard, P.C. 1997. Evolution, Phylogeny, and Current Status. In: Lutz, P.L & Musick, J. A, eds. The Biology of Sea Turtles. Boca Raton, Florida: CRC Press Inc.

Przeslawski, R., Bruce, B., Carroll, A., Anderson, J., Bradford, R., Durrant, A., Edmunds, M., Foster, S., Huang, Z., Hurt, L., Lansdell, M., Lee, K., Lees, C., Nichols, P. and Williams, S. 2016. *Marine seismic survey impacts on fish and invertebrates: final report for the Gippsland marine environmental monitoring project*. Record 2016/35. Geoscience Australia, Canberra, ACT.

Przeslawski, R., Huang, Z., Anderson J., Carroll, A.G., Edmunds, M., Hurt, L. and Williams, S. 2018. Multiple field-based methods to assess the potential impacts of seismic surveys on scallops. Marine Pollution Bulletin 129(2):750-761.

Puotinen, M. and Thums, M. 2016. *What's on the menu for flatback turtles?* Accessed online on 10 October 2018 at <https://eatlas.org.au/node/1667>.

Qiu, B., Mao, B. and Kashino, Y. 1999. Intraseasonal variability in the Indo Pacific Throughflow and the regions surrounding the Indonesian Seas. *Journal of Physical Oceanography* 29: 1599–1618.

Queensland Department of Environment and Science. 2018. Queensland Marine Turtle Conservation Strategy. Conservation & Biodiversity Operations Branch, Department of Environment and Science, Queensland Government, May 2018.

Racca, R.G., A. Rutenko, K. Bröker, and G. Gailey. 2012b. *Model based sound level estimation and in-field adjustment for real-time mitigation of behavioural impacts from a seismic survey and post-event evaluation of sound exposure for individual whales*. Acoustics 2012 Fremantle: Acoustics, Development and the Environment, Fremantle, Western Australia.

Racca, R.G., A. Rutenko, K. Bröker, and M. Austin. 2012a. *A line in the water - design and enactment of a closed loop, model based sound level boundary estimation strategy for mitigation of behavioural impacts from a seismic survey*. 11th European Conference on Underwater Acoustics 2012. Volume 34(3), Edinburgh, United Kingdom.

Racca, R.G., Austin, M., Rutenko, A., and Bröker, K. 2015. Monitoring the gray whale sound exposure mitigation zone and estimating acoustic transmission during a 4-D seismic survey, Sakhalin Island, Russia. *Endangered Species Research* 29(2): 131-146.

Radford, C.A., Montgomery, J.C., Caiger, P. and Higgs, D.M. 2012. Pressure and particle motion detection thresholds in fish: a re-examination of salient auditory cues in teleosts. *Journal of Experimental Biology* 215: 3429–3435.

Radtke, R.L. 1981. Morphological features of the otoliths of the sailfish, Istiophorus platypterus, useful in age determination. *Fishery Bulletin* 79(2):360-366.

Radtke, R.L., Collins, M. and Dean, J.M. 1982. Morphology of the otoliths of the Atlantic blue marlin (Makaira nigiricans) and their possible use in age estimation. *Bulletin of Marine Science* 32(2): 498-503.

Reynolds S.D., Norman, B.M., Beger M., Franklin, C.E. and Dwyer, R.G. 2017. Movement, distribution and marine reserve use by an endangered migratory giant. *Diversity and Distributions*, 2017; 23:1268–1279. https://doi.org/10.1111/ddi.12618

Richards Z.T., Garcia R.A., Wallace C.C., Rosser N.L. and Muir P.R. 2015. A diverse assemblage of reef corals thriving in a dynamic intertidal reef Setting (Bonaparte Archipelago, Kimberley, Australia). *PLoS One* 10(2): e0117791.

Richardson, A.J., Matear, R.J. and Lenton, A. 2017. Potential impacts on zooplankton of seismic surveys. Commonwealth Scientific Industrial Research Organisation, Canberra, Australia.

Richardson, W.J., Miller, G. and Greene Jr, C.R. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea. *Journal of the Acoustical Society of America* 106(4): 2281.

Richardson, W.J., Würsig, B. and Greene Jr, C.R. 1986. Reactions of bowhead whales, Balaena mysticetus, to seismic exploration in the Canadian Beaufort Sea. *Journal of the Acoustical Society of America* 79(4): 1117-28.

Roberts, L., Cheesman, S., Breithaupt, T. and Elliott, M. 2015. Sensitivity of the mussel Mytilus edulis to substrate borne vibration in relation to anthropogenically generated noise. *Marine Ecology Progress Series* 538: 185-195.

Roberts, L., Cheesman, S., Elliott,M. and Breithaupt, T. 2016. Sensitivity of Pagurus bernhardus (L.) to substrate-borne vibration and anthropogenic noise. *Journal of Experimental Marine Biology and Ecology* 474: 185–194.

Roelofs, A., Johnson, G. and Newman, S. 2014. *Grey mackerel* Scomberomorus semifasciatus. Accessed online on 15 April 2019 at <http://fish.gov.au/2014-Reports/Grey_Mackerel>.

Ross, A., Stalvies, C., Talukder, A., Trefry, C., Mainson, M., Cooper, L., Yuen, M. and Palmer, J. 2017. *Interpretive geochemical data report on samples obtained during ARP2 Trip 6184, May 2015*. A report prepared by CSIRO, Perth, Western Australia.

Rosser, N.L. 2013. Biannual coral spawning decreases at higher latitudes on Western Australian reefs. *Coral Reefs* 32:455-460.

RPS MetOcean Pty Ltd. 2011. *Final Metocean Design Criteria for Ichthys Development Browse Basin*. R1285v6. Report prepared by RPS MetOcean Pty Ltd for INPEX Browse, Ltd., Perth, Western Australia.

RPS. 2007. *Environmental baseline survey results*. Report prepared by RPS Environmental Pty Limited for INPEX Browse, Ltd., Perth, Western Australia.

RPS. 2010. *Marine megafauna 2009 humpback whale survey report*. Report produced for Woodside Energy Limited, Perth, Western Australia.

RPS. 2019. *WA-532-P, WA-533-P and WA-50-L oil spill risk assessment*. A report prepared by RPS, Perth, Western Australia for INPEX Operations Australia, Perth.

Runcie, J.W. and Riddle, M.J. 2006. Diel variability in photosynthesis of marine macroalgae in ice-covered and ice-free environments in East Antarctica. *European Journal of Phycology 41(2):223–233.*

Ryan, P.G., Connell, A.D., and Gardner, B.D. 1988. Plastic ingestion and PCBs in seabirds: is there a relationship? *Marine Pollution Bulletin* 19:174–176.

Sætre, R. and E. Ona. 1996. *Seismic investigations and harmful effects on fish eggs and larvae*. An assessment of the possible effects on the level of recruitment. Fisken og Havet, Havforskningsinstituttet, Bergen, Norway.

Sainsbury, K.J., Kailola, P.J. and Leyland, G.G. 1985. *Continental shelf fishes of northern and north-western Australia: an illustrated guide*. CSIRO Australia, Melbourne, Victoria.

Salgado Kent, C., Jenner, K., Jenner, M., Bouchet, P. and Rexstad, E. 2012. Southern Hemisphere Breeding Stock 'D' Humpback Whale Population Estimates from North West Cape, Western Australia. Journal of Cetacean Research and Management, 12: 29-38.

Salgado Kent, C., McCauley, R.D., Duncan, A., Erbe, C., Gavrilov, A., Lucke, K. and Parnum, I. 2016. *Underwater sound and vibration from offshore petroleum activities and their potential effects on marine fauna: an Australian perspective*. Centre for Marine Science and Technology, Curtin University, Perth, WA.

Samoilys, M.A. 1997. Periodicity of spawning aggregations of coral trout Plectropomus leopardus (Pisces: Serranidae) on the northern Great Barrier Reef. *Marine Ecology Progress Series* 160: 149-159.

Sancho, G., Solow, A.R., Lobel, P.S. 2000. Environmental influences on the diel timing of spawning in coral reef fishes. *Marine Ecology Progress Series* 206: 193–212.

Santos Ltd. 2018. *Bethany 3D Marine Seismic Survey Environment Plan Summary*. A6657652. Report prepared by Santos Ltd., Perth, Western Australia.

Santulli, A., Modica, A., Messina, C., Ceffa, L., Curatolo, A., Rivas, G., Fabi, G. and D'Amelio, V. 1999. Biochemical responses of European Sea Bass (Dicentrarchus labrax L.) to the stress induced by off shore experimental seismic prospecting. *Marine Pollution Bulletin* 38: 1105–1114.

Saunders, T., Dawson, A., Trinnie, F. and Newman, S.J. 2018. *Goldband Snapper (2018)*. Accessed online on 20 March 2019 at <https://www.fish.gov.au/report/221-Goldband-Snapper-2018>

Scales, H. 2010. Advances in the ecology, biogeography and conservation of seahorses (genus Hippocampus). *Progress in Physical Geography* 34 (443).

Scholik, A.R. and Yan, H.Y. 2001. Effects of underwater noise on auditory sensitivity of a cyprinid fish. *Hearing Research* 152:17–24.

Schulz-Mirbach, T., Metscher, B. and Ladich, F. 2012. Relationship between swim bladder morphology and hearing abilities-a case study on Asian and African cichlids. *PLoS One* 7(8):e42292.

Sears, R. and W.F. Perrin. 2009. Blue whale: Balaenoptera musculus. In Encyclopedia of marine mammals. Elsevier. pp. 120-124.

Sequeira, T., Tavares, D. and Arala-Chaves, M. 1996. Evidence of circulating haemocyte proliferation in the shrimp Penaeus japonicas. *Development and Comparative Immunology* 20: 97-104.

Shigenaka, G. 2001. *Toxicity of oil to reef building corals: a spill response perspective*. National Oceanic and Atmospheric Administration Technical Memorandum. National Ocean Service, Office of Research and Restoration 8, Seattle, USA.

Simmonds, J.E. and MacLennan, D. 2005. *Fisheries acoustics: theory and practice*. Second edition. Blackwell Science, Oxford, United Kingdom.

Sims, J.R. II, Fothergill, D.M. and Curley, M.D. 1999. Effects of a neoprene wetsuit hood on low-frequency underwater hearing thresholds. *The Journal of the Acoustical Society of America* 105(2):1298.

Sinclair Knight Merz. 2008. *Gigas 2D pilot OCB MSS, environmental monitoring programme*. Prepared for Woodside Energy Ltd, Perth, Western Australia by Sinclair Knight Merz Pty Limited, Perth.

Sinclair Knight Merz. 2010. *Nearshore benthic habitat modelling and mapping, James Price Point. Browse Liquefied Natural Gas Precinct Strategic Assessment Report (Draft for Public Review), Appendix C-5, December 2010*. Report prepared by Sinclair Knight Merz, Perth, Western Australia for Woodside, Perth.

Sivle, L.D., Hansen, R.R., Karlsen, H.E. and Handegard, N.O. 2016. *Mackerel behaviour and seismic signals – a pilot net pen study*. Report for Havforsknings instituttet, Institute of Marine Research, Bergen, Norway.

Skalski, J.R., Pearson,W.H. and Malme, C.I., 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (Sebastes spp.). *Canadian Journal of Fisheries and Aquatic Sciences* 49(7): 1357–1365.

SKM—see Sinclair Knight Merz

Sleeman, J. C., Meekan, M.G., Fitzpatrick, B.J., Steinberg, C.R., Ancel, R. and Bradshaw, C.J.A. 2010. Oceanographic and atmospheric phenomena influence the abundance of whale sharks at Ningaloo Reef, Western Australia. *Journal of Experimental Marine Biology and Ecology* 383:77–81.

Slotte, A., Hansen, K., Dalen, J. and Ona, E. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research* 67(2): 143-150.

Smith, M.E. 2012. Predicting hearing loss in fishes. pp 571–574 in Popper, A.N. and Hawkins, A.D. (eds.), *The effects of noise on aquatic life*. Springer Science + Business Media, New York, USA.

Smith, M.E. 2015. The relationship between hair cell loss and hearing in fishes. In Popper, A.N. and Hawkins, A.D. (eds.), *The effects of noise on aquatic life II*. Springer Science+Business Media, New York, USA.

Smith, M.E., Coffin, A.B., Miller, D.L., Popper, A.N. 2006. Anatomical and functional recovery of the goldfish (*Carassius auratus*) ear following noise exposure. *Journal of Experimental Biology* 209:4193–4202.

Smith, M.E., Kane, A.S., Popper, A.N. 2004a. Noise-induced stress response and hearing loss in goldfish (*Carassius auratus*). *Journal of Experimental Biology* 207:427–435.

Smith, M.E., Kane, A.S., Popper, A.N. 2004b. Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water? *Journal of Experimental Biology* 207:3591–3602.

Smith, M.E., Schuck, J.B., Gilley, R.R., Rogers, B.D. 2011. Structural and functional effects of acoustic exposure in goldfish: evidence for tonotopy in the teleost saccule. *BMC Neuroscience* 12:19.

Song, J., Mann, D.A., Cott, P.A., Hanna, B.W. and Popper, A.N. 2008. The inner ears of northern Canadian freshwater fishes following exposure to seismic air gun sounds. *Journal of the Acoustical Society of America* 124: 1360–1366.

Song, J., Mathieu, A., Soper, R.F. and Popper, A.N. 2006. Structure of the inner ear of bluefin tuna *Thunnus thynnus*. *Journal of Fish Biology* 68(6):1767–1781.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L. 2007. Marine mammal sound exposure criteria: Initial scientific recommendations. *Aquatic Mammals* 33(4): 411-509.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowle,s A.E., Ellison, W.T., Nowacek, D.P., and Tyack, P.L. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2): 125-232.

Sporer, E., M., Kangas, M., Shanks, M., and Blay, N. 2015. North Coast Prawn Managed Fisheries Status Report. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014/15: The State of the Fisheries eds. W.J. Fletcher and K. Santoro, Department of Fisheries, Western Australia, pp. 173-182.

Spring, C.S. 1982. Status of marine turtle populations in Papua New Guinea. In: Bjorndal, K.A., ed. Biology and Conservation of Sea Turtles. Washington D. C., Smithsonian Institute Press.

Stark, W. 2008. *The Northern Demersal Scalefish Fishery: a review and recommendations*. Report for Kimberley Professional Fishermen's Association, Perth, Western Australia.

Steffe, A. and Murphy, J. 1992. *The commercial fisheries and oyster cultivation industry of Botany Bay*. Report prepared for FAC. Fisheries Research Institute, NSW Fisheries, Sydney, NSW.

Stenseth, N., Llope, M., Anadon, R., Cianelli, L., Chan, K., Hjermann, D., Bagoien, E. and Ottersen, G. 2006. Seasonal plankton dynamics along a cross-shelf gradient. *Proceedings of the Royal Society* 273: 2831–2838.

Stevens, J. D. and Davenport, S. R. 1991. *Analysis of catch data from the Taiwanese gill-net fishery off northern Australia 1979–1986*. Report no. 213, CSIRO Marine Laboratories, Hobart, Tasmania.

Stevens, J.D. and Wiley, P.D. 1986. Biology of two commercially important carcharhinid sharks from northern Australia. *Australian Journal of Marine and Freshwater Research* 37: 671-688.

Stobutzki, I.C. and Bellwood, D.R. 1997. Sustained swimming abilities of the late pelagic stages of coral reef fishes. *Marine Ecology Progress Series* 149:35–41.

Stout, S. A., Payne, J. R., Emsbo-Mattingly, S. D., and Baker, G. 2016. Weathering of field-collected floating and stranded Macondo oils during and shortly after the Deepwater Horizon oil spill. *Marine Pollution Bulletin* 105(1):7-22.

Sutton, A.B. and Beckley, L.E. 2017. Euphausiid assemblages of the oceanographically complex north-west marine bioregion of Australia. *Marine and Freshwater Research* 68(11) 1988-1998.

Tang, K.W., Gladyshev, M.I., Dubovskaya, O.P., Kirillin, G. and Grossart, H-P. 2014. Zooplankton carcasses and non-predatory mortality in freshwater and inland sea environments. *Journal of Plankton Research* 36: 597–612.

Tavolga, W.N. and Wodinsky, J. 1963. Auditory capacities in fishes: pure tone thresholds in nine species of marine teleosts. *Bulletin of American Museum of Natural History* 126(2): 179-239.

Taylor, H., and Rasheed, M. 2011. Impacts of a fuel oil spill on seagrass meadows in a subtropical port, Gladstone, Australia – The value of long-term marine habitat monitoring in high risk areas. *Marine Pollution Bulletin* 63:431-437.

Terazaki, M., Takahashi, K.T. and Odate, T. 2013. Zonal variations in abundance and body length of chaetognaths in the 140°E seasonal ice zone during the austral summer of 2001/02. *Polar Science* 7(1): 39-47.

Thompson, P.A. and Bonham, P. 2011. New insights into the Kimberley phytoplankton and their ecology. *Journal of the Royal Society of Western Australia* 94: 161–169.

Thomson, R., Sporcic, M., Foster, S., Haddon, M., Potter, A., Carroll, A., Przeslawski, R., Knuckey, I., Koopman, M. and Hartog, J. 2014. *Examining fisheries catches and catch rates for potential effects of Bass Strait seismic surveys*. CSIRO, Hobart, Tasmania and Geoscience Australia, Canberra, ACT.

Thums, M., Jenner, C., Waples, K., Salgado-Kent, C. and Meekan, M. 2018. *Humpback whale use of the Kimberley: understanding and monitoring spatial distribution*. Report Project 2.1.1 prepared for the Kimberley Marine Research Program. Western Australian Marine Science Institution, Perth, Western Australia.

Thums, M., Waayers, D., Huany, Z., Pattiaratchi, C., Bernus and Meekan, M. Environmental predictors of foraging and transit behaviour in flatback turtles Natator depressus. *Endangered Species Research* 32: 333-349.

Timms, B.V. 1988. The Biogeography of Cladocera (Crustacea) in Tropical Australia. *International Review of Hydrobiology* 73: 337-356.

Turnpenny, A.W.H. and Nedwell, J.R. 1994. *The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys*. Report by Fawley Aquatic Research Laboratories Ltd, Hampshire, United Kingdom for United Kingdom Offshore Operators Association, London, United Kingdom.

U.S NMFS & NOAA—*see* United States National Marine Fisheries Service and National Oceanic and Atmospheric Administration

U.S NMFS—*see* United States National Marine Fisheries Service

Underwood, J., Richards, Z., Berry, O. and Gilmour, J. 2017. *Population connectivity and genetic diversity in brooding and broadcast spawning corals in the Kimberley*. Report of Project 1.1.3 - Project 1.1.3.1 Kimberley Marine Research Program. Western Australian Marine Science Institution, Perth, Western Australia.

Underwood, J., Travers, M. and Gilmour, J. 2012. Subtle genetic structure reveals restricted connectivity among populations of a coral reef fish inhabiting remote atolls. Ecology and Evolution, 2(3): 666–79.

Underwood, J.N., Smith, L.D., van Oppen, M.J.H. and Gilmour, J.P. 2009. Ecologically relevant dispersal of corals on isolated reefs: implications for managing resilience. *Ecological Applications* 19: 18-29.

United States Department of the Navy. 2008. *Northwest training range complex draft environmental impact statement/overseas environmental impact statement*. Volume 1. Prepared by United States Department of the Navy, Washington, USA.

United States National Marine Fisheries Service and National Oceanic and Atmospheric Administration. 1995. *Small takes of marine mammals incidental to specified activities; offshore seismic activities in southern California: Notice of issuance of an incidental harassment authorization*. Federal Register 60(200): 53,753-53,760.

United States National Marine Fisheries Service. 2014. *Marine mammals acoustic thresholds guidance*. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Viewed online on 24 February 2019 at <http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.>.

United States National Marine Fisheries Service. 2016. *Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing: underwater acoustic thresholds for onset of permanent and temporary threshold shifts*. NOAA Technical Memorandum NMFS-OPR-55. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Maryland, USA.

United States National Marine Fisheries Service. 2018. *2018 revision to technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (Version 2.0): underwater thresholds for onset of permanent and temporary threshold shifts*. NOAA Technical Memorandum NMFS-OPR-59. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Maryland, USA.

University of Rhode Island and Inner Space Center. 2017. How do you characterise sounds? Viewed online on 26 November 2018 at <https://dosits.org/science/sound/characterise-sounds/>.

URS. 2009a. Ichthys Gas Field Development Project: nearshore marine ecology and benthic communities study. Report prepared by URS Australia Pty Ltd, Perth, for INPEX Browse Ltd, Perth, Western Australia.

URS. 2009b. *Ichthys gas field development project: review of literature on sound in the ocean and effects of noise on marine fauna*. Prepared by URS Australia, Perth, Western Australia for INPEX Browse Ltd., Perth.

van Herwerden, L., Aspden, W.J., Newman, S.J., Pegg, G.G. Briskey, L. and Sinclair, W. 2009. A comparison of the population genetics of *Lethrinus miniatus* and *Lutjanus sebae* from the east and west coasts of Australia: evidence for panmixia and isolation, Fisheries Research, 100 (2): 148–155.

Vanderlaan, A.S.M. and Taggart, C.T. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. *Marine Mammal Science* 23(1):144–156.

Vazzana, M., Celi, M., Maricchiolo, G., Genovese, L., Corrias, V., Quinci, E.M. Vincenzi, G., Maccarrone, V., Cammiller, G., Mazzola, S., Buscaino, G. and Filiciotto, F. 2016. Are mussels able to distinguish underwater sounds? Assessment of the reactions of Mytilus galloprovincialis after exposure to lab-generated acoustic signals. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology* 201: 61-70.

Verghese, B., Radhakrishnan E.V. and Padhi A. 2007. Effect of environmental parameters on immune response of the Indian spiny lobster, *Panulirus homarus* (Linnaeus, 1758). *Fish Shellfish Immunology* 23(5): 928-36.

Vocus Communications. 2019. The North-West Cable System. Viewed online on 19 March 2019 at < https://www.vocus.com.au/our-network/north-west-cable-system>.

WA DoT—*see* Western Australian Department of Transport

Waayers, D. and Stubbs, J. 2016. *A decade of monitoring flatback turtles in Port Hedland, Western Australia: 2004/05 – 2013/14*. Prepared for Care for Hedland Environmental Association, Port Hedland, Western Australia.

Waayers, D.A., Smith, L.M. and Malseed, B.E. 2011. Inter-nesting distribution of green turtles (Chelonia mydas) and flatback turtles (*Natator depressus*) at the Lacepede Islands, Western Australia. *Journal of the Royal Society of Western Australia* 94: 359-364.

Wada, K.T. and Tëmkin, I. 2008. Taxonomy and phylogeny. Chapter 2 in Southgate, P.C. and Lucas, P.C. (eds.), *The pearl oyster*. Elsevier BV, Amsterdam, The Netherlands.

Waples, K., Field, S., Kendrick, A., Johnston, A., Twomey, L. 2019. Strategic Integrated Marine Science for the Kimberley Region: Kimberley Marine Research Program Synthesis Report 2012-2018. Prepared for the Western Australian Marine Science Institution, Perth Western Australia.

Ward, T. 1996. Sea snake by-catch of fish trawlers on the northern Australian continental shelf. *Marine and Freshwater Research* 47: 625-630.

Wardle, C.S., Carter, T.J., Urquhart, G.G., Johnstone, A.D.F., Ziolkowski, A.M., Hampson, G., and Mackie, D. 2001. Effects of seismic air guns on marine fish. *Continental Shelf Research* 21: 1005–1027.

Warner, G., Erbe, C. and Hannay, D.E. 2010. Underwater Sound Measurements. (Chapter 3) In Reiser, C.M., D.W. Funk, R. Rodrigues, and D. Hannay (eds.). Marine Mammal Monitoring and Mitigation during Open Water Shallow Hazards and Site Clearance Surveys by Shell Offshore Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-Day Report. LGL Report P1112-1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (U.S.), and U.S. Fish and Wildlife Service. pp 1-54.

Warner, G.A., Austin, M., and MacGillivray, A.O. 2017. Hydroacoustic measurements and modelling of pile driving operations in Ketchikan, Alaska. *Journal of the Acoustical Society of America* 141(5): 3992.

Webb, G.J.W., Whitehead, P.J. and Manolis, S.C. 1987. Crocodile management in the Northern Territory of Australia. pp. 107-124 in Webb, G.J.W., Manolis, S.C. and Whitehead, P.J. (eds.) *Wildlife management: crocodiles and alligators*. Surrey Beatty and Sons, Sydney, New South Wales.

Webster, F.J., Wise, B.S., Fletcher, W.J., and Kemps, H. 2018. *Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia*. Fisheries Research Report No. 288. Department of Primary Industries and Regional Development, Perth, Western Australia.

Weinhold, R.J. and Weaver, R.R. 1972. *Seismic air guns affect on immature coho salmon*. Contribution to the 42nd Annual. Meeting., Society of Exploration Geophysicists, Anaheim, California.

Weis, P., Weis, J.S. and Greenberg, A. 1989. Treated municipal wastewaters: effects on development and growth of fishes. *Marine Environmental Research* 28: 527–532.

Weise, F.K., Montevecchi, W.A., Davoren, G. K., Huettmann, F., Diamind, A.W. and Linke, J. 2001. Seabirds at risk around offshore oil platforms in the north-west Atlantic. *Marine Pollution Bulletin* 42(12): 1285-1290.

Welch, D., Robins, J., Saunders, T., Courtney, T., Harry, A., Lawson, E., Moore, B., Tobin, A., Turnbull, C., Vance, D. and Williams, A. 2014. *Implications of climate change impacts on fisheries resources of northern Australia, part 2: species profiles*. Final report to the Fisheries Research and Development Corporation, project 2010-565. James Cook University, Townsville, Queensland.

Wells, F.E., Hanley, J.R. and Walker, D.I. 1995. *Marine biological survey of the Southern Kimberley, Western Australia*. Western Australian Museum, Perth, Western Australia.

Western Australian Department of Transport. 2018a. *DOT307215 Provision of Western Australian marine oil pollution risk assessment – protection priorities*. Protection Priority Assessment for Zone 1: Kimberley – Draft Report May 2018, Perth, Western Australia.

Western Australian Department of Transport. 2018b. *State hazard plan: maritime environmental emergencies*. State Emergency Management Committee. Government of Western Australia, Perth, Western Australia.

White, W.T., Last, P.R., Stevens, J.D., Yearsley, G.K., Fahmi and Dharmadi. 2006. *Economically important sharks and rays of Indonesia*. Australian Centre for International Agricultural Research, Canberra, ACT.

Whiting, S. and Guinea, M. 2005. Dugongs of Ashmore Reef and the Sahul Banks: a review of current knowledge and a distribution of sightings. In Russell B., Larson H., Glasby C.J., Willan R.C., and Martin, J. (eds) *Understanding the Cultural and Natural Heritage Values and Management Challenges of the Ashmore Region*, Proceedings of a Symposium organised by the Australian Marine Sciences Association and the Museum and Art Gallery of the Northern Territory, Darwin, 4–6 April 2001. Museum and Art Galleries of the Northern Territory & Australian Marine Sciences Association, Darwin, Northern Territory.

Whiting, S., Tucker, T., Pendoley, K., Mitchell, N., Bentley, B., Berry, O., FitzSimmons, N. 2018. Marine Turtles in the Kimberley: key biological indices required to understand and manage nesting turtles along the Kimberley coast. Final Report of Project 1.2.2 prepared for the Kimberley Marine Research Program, Western Australian Marine Science Institution, Perth, Western Australia, 146 pp.

Whittock, P.A., Pendoley, K.L. and Hamann, M. 2014. Inter-nesting distribution of flatback turtles Natar depressus and industrial development in Western Australia. *Endangered Species Research* 26: 25-38.

Whittock, P.A., Pendoley, K.L. and Hamann, M. 2016a. Using habitat suitability models in an industrial setting: the case for interesting flatback turtles. *Ecosphere* 7(11): e01551.

Whittock, P.A., Pendoley, K.L. and Hamann, M. 2016b. Flexible foraging: post-nesting flatback turtles on the Australian continental shelf. *Journal of Experimental Marine Biology and Ecology* 477(2016): 112-119.

Williams, A., Patterson, H. and Mosby, D. 2018. Western Tuna and Billfish Fishery. In Department of Agriculture and Resources, *ABARES Fishery Status Reports 2018*. Commonwealth of Australia, Canberra, ACT.

Wilson, S.G., Meekan, M.G., Carleton, J.H. and Knott, B. 2003. Distribution, abundance and reproductive biology of *Pseudeuphausia latifrons* and other euphausiids on the southern North West Shelf, Western Australia. *Marine Biology* 142(2): 69–80.

Wilson, S.G., Polovina, J.J., Stewart, B. S., and Meekan, M. G. 2006. Movements of whale sharks (*Rhincodon typus*) tagged at Ningaloo Reef, Western Australia. *Marine Biology* 148:1157–1166.

Witherington, B. E. 1992. Behavioural responses of nesting sea turtles to artificial lighting. *Herpetologica* 48:31-39.

Witherington, B. E. and Martin, R. E. 2000. *Understanding, assessing and resolving light-pollution problems on sea turtle nesting beaches*. Florida Fish and Wildlife Conservation Commission FMRI Technical Report TR-2, Second Edition, Revised. Florida Marine Research Institute, Florida, USA.

Wood, J., Southall B.L., and Tollit, D.J. 2012. *PG&E offshore 3D seismic survey project EIR-marine mammal Technical Draft Report*. Prepared by SMRU Ltd, St Andrews, Scottland.

Woodside Energy Ltd. 2007. Environmental Protection Statement: Maxima 3D Marine Seismic Survey, Scott Reef. 418 pp.

Woodside Energy Ltd. 2009. *Scott Reef status report 2008*. Woodside Energy Ltd., Perth, Western Australia.

Woodside Energy Ltd. 2011. *Impacts of seismic airgun noise on fish behaviour: a coral reef case study*. Maxima 3D MSS Monitoring Program Information Sheet 1. Woodside Energy Ltd., Perth, Western Australia.

Woodside Energy Ltd. 2014. *Browse FLNG Development: draft environmental impact statement*. EPBC 2013/7079. Woodside Energy Ltd., Perth, Western Australia.

Woodside—see Woodside Energy Ltd

Wright, G. and Pyke, C. 2010. *Fishing Industry Impact Study. James Price Point Proposed Liquefied Natural Gas Precinct*. Report prepared by Big Island Research Pty Ltd, Fremantle, Western Australia for the Department of Fisheries, Perth, Western Australia.

Yamaguchi, A. and Ikeda, T. 2000. Vertical distribution, life cycle and body allometry of two oceanic calanoid copepods (*Pleuromamma scutullata* and *Heterorhabdus tanneri*) in the Oyashio region, western North Pacific Ocean. *Journal of Plankton Research* 22 (1): 29–46.

Zangerl, R., Hendrickson, L.P. and Hendrickson, J.R. 1988. A rediscription of the Australian flatback sea turtle *Natator depressus*. Bishop Museum Press, Honolulu.

Zapata, F.A. and Herrón, P.A. 2002. Pelagic larval duration and geographic distribution of tropical eastern Pacific snappers (Pisces: Lutjanidae). *Marine Ecology Progress Series* 230: 295–300.

Zieman, J.C., Orth, R., Phillips, R.C., Thayer, G. and Thorhaug, A. 1984. The effects of oil on seagrass ecosystems. pp. 37–64 in Cairn, J. and Buikema, A.L. (eds), *Restoration of Habitats Impacted by Oil Spills*. Butterworth, Boston, USA.

Appendix A-
Financial assurance

Appendix B-
EPBC Protected Matters

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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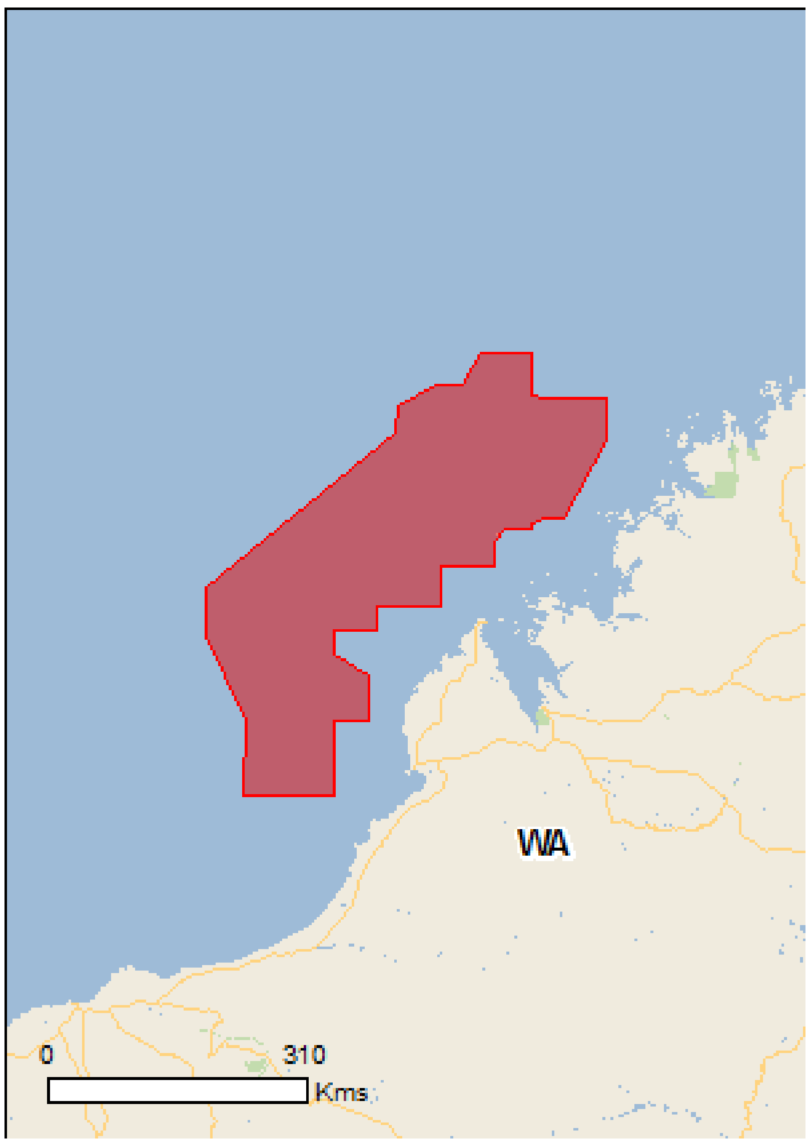

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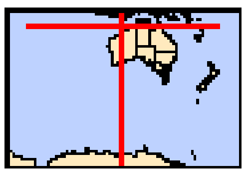

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	24
Listed Migratory Species:	53

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	1
Listed Marine Species:	90
Whales and Other Cetaceans:	27
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	3

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	5
Regional Forest Agreements:	None
Invasive Species:	2
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	3

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to

Name	Status	Type of Presence
		occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons Little Tern [82849]		Foraging, feeding or related behaviour known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat likely to occur

Name	Threatened	Type of Presence
		within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		

Name	Threatened	Type of Presence
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Sterna albifrons Little Tern [813]		Foraging, feeding or related behaviour known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area
Fish		
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat likely to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus fuscus Dusky Seasnake [1119]		Species or species habitat known to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur

Name	Threatened	Type of Presence
		within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake [1126]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis coggeri Slender-necked Seasnake [25925]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Status	Type of Presence
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Kimberley	Habitat Protection Zone (IUCN IV)
Kimberley	Multiple Use Zone (IUCN VI)
Kimberley	National Park Zone (IUCN II)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Adele Island	WA
Browse Island	WA
Unnamed WA41775	WA
Unnamed WA44673	WA
Unnamed WA44674	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Mammals		
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Rattus exulans Pacific Rat, Polynesian Rat [79]		Species or species habitat likely to occur within area

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Continental Slope Demersal Fish Communities	North-west
Seringapatam Reef and Commonwealth waters in	North-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-18.218 121.3776,-17.4469 121.3825,-17.4493 121.748,-16.9639 121.7489,-16.7487 121.384,-16.5161 121.3879,-16.5144 121.8328,-16.2624 121.8351,-16.2633 122.5266,-15.8425 122.5334,-15.8463 123.1047,-15.6082 123.1102,-15.4472 123.2337,-15.4532 123.5011,-15.3918 123.4984,-15.3498 123.6558,-15.3483 123.8414,-14.5397 124.3107,-14.093 124.315,-14.0991 123.607,-14.0657 123.5048,-13.6144 123.5051,-13.6112 122.9738,-13.9442 122.7543,-13.9446 122.4865,-14.1818 122.0749,-14.4708 122.06,-16.0779 120.0134,-16.5681 120.0073,-17.4482 120.4293,-18.2129 120.422,-18.218 121.3776

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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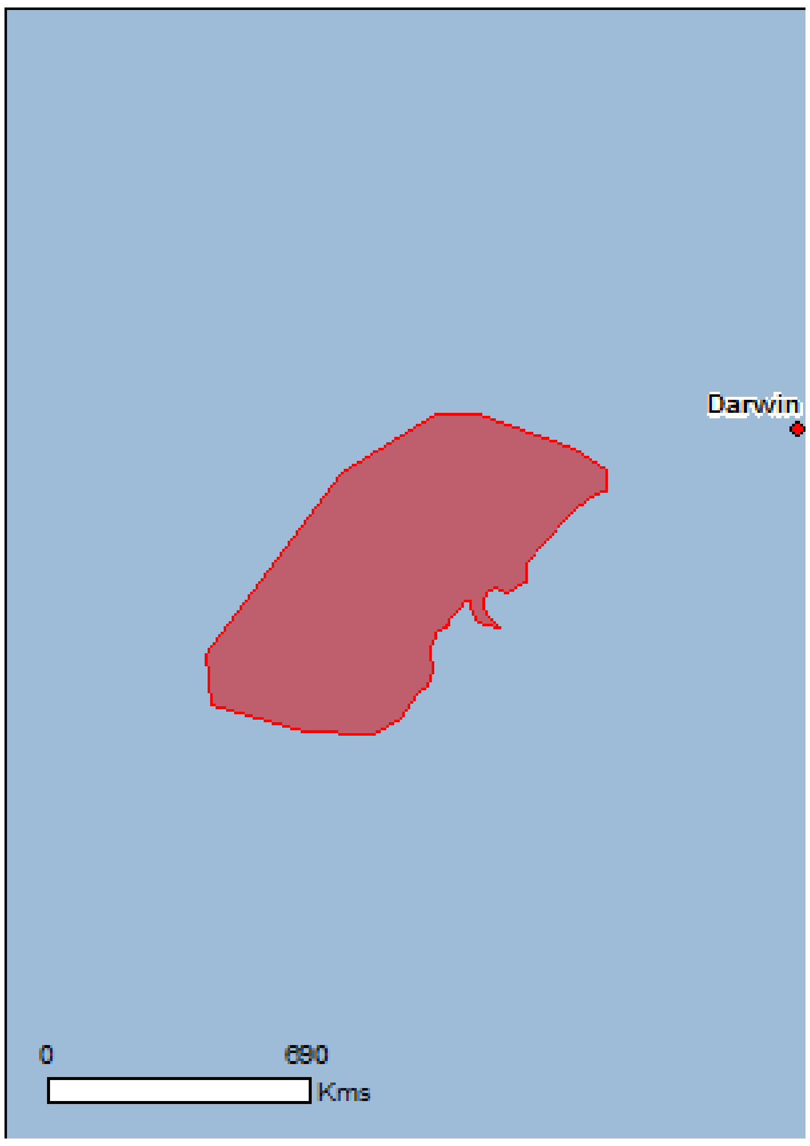
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

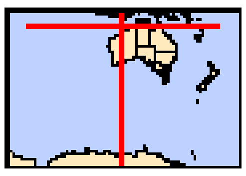
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 16/01/19 15:30:05



Coordinates
Buffer: 1.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance:	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	47
Listed Migratory Species:	74

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	3
Listed Marine Species:	132
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	12

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	16
Regional Forest Agreements:	None
Invasive Species:	19
Nationally Important Wetlands:	2
Key Ecological Features (Marine)	7

Details

Matters of National Environmental Significance

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The West Kimberley	WA	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Ashmore reef national nature reserve	Within Ramsar site
Roebuck bay	Within 10km of Ramsar

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Isoodon auratus auratus Golden Bandicoot (mainland) [66665]	Vulnerable	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesembriomys macrurus Golden-backed Tree-rat, Koorrawal [119]	Vulnerable	Species or species habitat known to occur within area
Petrogale concinna monastria Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known to occur within area
Phascogale tapoatafa kimberleyensis Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat likely to occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
Plants		
Keraudrenia exastia Fringed Keraudrenia [66301]	Critically Endangered	Species or species habitat may occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus angusticeps Northwestern Coastal Ctenotus, Airlie Island Ctenotus [25937]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Glyphis garricki		
Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding likely to occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Breeding known to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna pacifica		
Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Hydroprogne caspia		
Caspian Tern [808]		Breeding known to occur within area
Onychoprion anaethetus		
Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus		
White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon rubricauda		
Red-tailed Tropicbird [994]		Breeding known to occur within area
Sterna dougallii		
Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons		
Little Tern [82849]		Breeding known to occur within area
Sula dactylatra		
Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster		
Brown Booby [1022]		Breeding known to occur within area
Sula sula		
Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata		
Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ashmore Reef National Nature Reserve	EXT	Listed place
Mermaid Reef - Rowley Shoals	WA	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous minutus Black Noddy [824]		Breeding known to occur within area
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area

Name	Threatened	Type of Presence
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Species or species habitat known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Sterna albifrons Little Tern [813]		Breeding known to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Species or species habitat known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus fuscus Dusky Seasnake [1119]		Species or species habitat known to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake [1126]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis coggeri Slender-necked Seasnake [25925]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Tursiops aduncus (Arafura/Timor Sea populations)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str.		
Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris		
Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	National Park Zone (IUCN II)
Argo-Rowley Terrace	Special Purpose Zone (Trawl) (IUCN VI)
Ashmore Reef	Recreational Use Zone (IUCN IV)
Ashmore Reef	Sanctuary Zone (IUCN Ia)
Cartier Island	Sanctuary Zone (IUCN Ia)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Kimberley	Habitat Protection Zone (IUCN IV)
Kimberley	Multiple Use Zone (IUCN VI)
Kimberley	National Park Zone (IUCN II)
Mermaid Reef	National Park Zone (IUCN II)
Roebuck	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Adele Island	WA
Bardi Jawi	WA
Browse Island	WA
Coulomb Point	WA
Dambimangari	WA
Karajarri	WA
Lacepede Islands	WA
Swan Island	WA
Tanner Island	WA
Unnamed WA28968	WA
Unnamed WA37168	WA
Unnamed WA41775	WA
Unnamed WA44669	WA
Unnamed WA44673	WA
Unnamed WA44674	WA
Uunguu	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Sturnus vulgaris		
Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina		
Cane Toad [83218]		Species or species habitat may occur within area
Mammals		
Camelus dromedarius		
Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris		
Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus		
Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus		
Horse [5]		Species or species habitat likely to occur within area
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Rattus exulans		
Pacific Rat, Polynesian Rat [79]		Species or species habitat likely to occur within area
Rattus rattus		
Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Dolichandra unguis-cati		
Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Jatropha gossypifolia		
Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat may occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Ramphotyphlops braminus		
Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Ashmore Reef	EXT
Mermaid Reef	EXT

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Ashmore Reef and Cartier Island and surrounding	North-west
Canyons linking the Argo Abyssal Plain with the	North-west
Carbonate bank and terrace system of the Sahul	North-west
Continental Slope Demersal Fish Communities	North-west
Mermaid Reef and Commonwealth waters	North-west
Seringapatam Reef and Commonwealth waters in	North-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-18.9626 121.4046,-18.4398 121.8133,-18.2982 122.0524,-17.9369 122.1849,-17.4101 122.1207,-17.2289 122.1793,-17.1726 122.2284,-17.0906 122.26,-17.0007 122.376,-16.9475 122.4646,-16.9631 122.4825,-16.9002 122.4873,-16.891 122.5244,-16.8033 122.5459,-16.7641 122.5732,-16.4863 122.8532,-16.3555 122.9329,-16.3482 123.0509,-16.4543 123.087,-16.5267 123.0718,-16.8084 123.2318,-16.9539 123.6717,-16.913 123.7524,-16.6573 123.4176,-16.4108 123.3903,-16.1753 123.4342,-16.0474 123.6203,-16.1762 123.9427,-15.8884 124.3679,-15.5003 124.401,-14.4492 125.3283,-14.21 125.6126,-13.9024 126.0248,-13.8045 126.2824,-13.3635 126.2797,-12.872 125.4949,-12.0371 123.2778,-12.0684 122.2505,-13.3966 120.0471,-17.5234 116.7945,-18.7064 116.917,-19.2747 119.1441,-19.3551 120.7612,-18.9626 121.4046

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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This table was developed by:

1. Searching the Species Profile and Threats Database (SPRAT) (http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl) for every species identified in the EPBC search related to the 2D Seismic Survey EP
2. Through the SPRAT database, identifying the relevant conservation management documents
3. Determining the relevant aspects / threats from the conservation management documents related to the activity
4. Listing where the aspect / threat has been addressed in the EP.

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
EPBC listed cetaceans	Department of the Environment and Water Resources. 2007. EPBC Policy Statement 2.1 – Interaction between offshore seismic exploration and whales: industry guidelines. Commonwealth of Australia. Department of the Environment. 2015. Conservation Management Plan for the Blue Whales - A Recovery Plan under the *Environment Protection and Biodiversity Conservation Act 1999* (2015-2025). Commonwealth of Australia. Department of the Environment and Heritage, 2005. Australian National Guidelines for Whale and Dolphin Watching - Information Sheet. Commonwealth of Australia. Department of Environment and Energy. 2018. Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans. Commonwealth of Australia. Department of Sustainability, Environment, Water, Population and	• Underwater noise and vibration • Waste /marine debris • Introduced marine species • Vessel strike • Emissions and discharges • Oil spill.	• Ensure appropriate controls are in place to minimise the risk of acoustic injury to whales in the vicinity of a seismic survey and biological consequences from acoustic disturbance in biologically important habitat areas or during critical behaviours. • Ensure all vessel strike incidents are reported in the National Ship Strike Database. • Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented. • Protect habitat important to the survival of the species (humpback whales); assess and manage physical	• EP Section 7.1.7: Underwater noise and vibration – marine mammals • EP Section 7.2.5: Australian marine park values • EP Section 7.4.1: Introduced marine species • EP Section 7.4.1: Interaction with marine fauna • EP Section 7.5.3: Routine discharges to sea • EP Section 7.6: Waste management • EP Section 8:

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
	Communities (DSEWPaC). 2012. Marine bioregional plan for the North-west Marine Region. DSEWPaC, Canberra, ACT. Director of National Parks. 2018. North-west marine parks network management plan 2018. Director of National Parks, Canberra, ACT. Threatened Species Scientific Committee. 2015. *Balaenoptera borealis* (Sei Whale) Conservation Advice. Commonwealth of Australia. Threatened Species Scientific Committee. 2015. Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale). Commonwealth of Australia. Threatened Species Scientific Committee. 2015. Approved Conservation Advice for *Balaenoptera physalus* — Fin Whale. Commonwealth of Australia. EPBC Act Regulations 2000. Part 8 Interacting with cetaceans and whale watching. Division 8.1 Interacting with cetaceans. Commonwealth of Australia.		disturbance and development activities (such as ship-strike and pollution). • Ensure the risk of vessel strike on humpback whales is considered when assessing actions that increase vessel traffic in areas where humpback whales occur and, if required appropriate mitigation measures are implemented to reduce the risk of vessel strike. • Environmental assessment processes must ensure that existing information about coastal habitat requirements of humpback whales, environmental suitability of coastal locations, historic high use and emerging areas are taken into consideration. • Contribute to the long-term prevention of the incidence of harmful marine debris if a whale or dolphin surfaces in	Emergency conditions (oil spills).

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
			the vicinity of a vessel travelling for a purpose other than whale and dolphin watching, take all care necessary to avoid collisions. This may include stopping, slowing down and/or steering away from the animal. • Provides the rules about what activities can and cannot occur within AMP zones, ensuring for the conservation of biodiversity values.	
EPBC listed marine reptiles	Department of the Environment and Energy. 2017. Recovery Plan for Marine Turtles in Australia. Commonwealth of Australia. Threatened Species Scientific Committee. 2011. Commonwealth Conservation Advice on *Aipysurus apraefrontalis* (short-nosed seasnake). Commonwealth of Australia. Threatened Species Scientific Committee. 2011. Commonwealth	• Noise and vibration • Light emissions • Waste/marine debris • Introduced marine species • Vessel strike • Emissions and discharges • Oil spill.	• Manage artificial light from onshore and offshore sources to ensure biological important behaviours of nesting adults and dispersing hatchlings can continue. • Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these	• EP Section 7.1.8: Underwater noise and vibration – marine reptiles • EP Section 7.2.5: Australian marine park values • EP Section 7.4.1: Introduced

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
	Conservation Advice on *Aipysurus foliosquama* (leaf-scaled seasnake).Commonwealth of Australia. Threatened Species Scientific Committee. 2008. Commonwealth Approved Conservation Advice for *Dermochelys coriacea* (leatherback turtle). Canberra: Department of the Environment, Water, Heritage and the Arts. Department of Environment and Energy. 2018. Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans. Commonwealth of Australia. Department of Sustainability, Environment, Water, Population and Communities (DSEWPac). 2012. Marine bioregional plan for the North-west Marine Region. DSEWPac, Canberra, ACT. Director of National Parks. 2018. North-west marine parks network management plan 2018. Director of National Parks, Canberra, ACT.		habitats and implementation of best practice light management guidelines for developments adjacent to marine turtle nesting beaches. • Identify the cumulative impact on turtles from multiple sources of onshore and offshore light pollution. • Support retrofitting of lighting at coastal communities and industrial developments, including imposing restrictions around nesting seasons. • Manage anthropogenic activities to ensure marine turtles are not displaced from identified habitat critical for survival. • Contribute to the reduction in the source of marine debris. • Ensure that spill risk strategies and response programs include management for turtles and their habitats, particularly in	marine species • EP Section 7.4.1: Interaction with marine fauna • EP Section 7.5.1: Light emissions • EP Section 7.5.3: Routine discharges to sea • EP Section 7.6: Waste management • EP Section 8: Emergency conditions (oil spills).

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
			reference to slow to recover habitats, e.g. seagrass meadows or corals. • Implement best practices to minimise impacts to turtle health and habitats from chemical discharges. • Identify populations and areas of high conservation priority (sea snakes). • Ensure there is no anthropogenic disturbance/implement measures to reduce adverse impacts of habitat degradation and/or modification (seasnakes). • Provides the rules about what activities can and cannot occur within AMP zones, ensuring for the conservation of biodiversity values.	
EPBC listed fishes and sharks	Threatened Species Scientific Committee. 2015. Approved Conservation Advice for *Rhincodon typus* (whale shark). Commonwealth of Australia. Department of Sustainability,	• Noise and vibration • Waste/marine debris • Introduced marine species	• Identify populations and areas of high conservation priority (sawfishes) • Ensure there is no	• EP Section 7.1.6: Underwater noise and vibration –

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
	Environment, Water, Population and Communities. 2013. Recovery Plan for the White Shark (*Carcharodon carcharias*). Commonwealth of Australia. Threatened Species Scientific Committee. 2014. Approved Conservation Advice for *Isurus oxyrinchus* (shortfin mako shark). Commonwealth of Australia. Threatened Species Scientific Committee. 2014. Approved Conservation Advice for *Glyphis garricki* (northern river shark). Commonwealth of Australia. Threatened Species Scientific Committee. 2009. Commonwealth Conservation Advice on *Pristis clavata* (dwarf sawfish). Commonwealth of Australia. Threatened Species Scientific Committee. 2008. Approved Conservation Advice for *Pristis zijsron* (green sawfish). Commonwealth of Australia. Threatened Species Scientific Committee. 2014. Approved Conservation Advice for *Pristis pristis* (largetooth sawfish). Commonwealth of Australia. Department of the Environment. 2015. Sawfish and River Sharks - Multispecies Recovery Plan. Commonwealth of Australia. Department of Environment and Energy. 2018. Threat abatement plan for the impacts of marine debris on the	• Vessel strike • Emissions and discharges • Oil spill.	anthropogenic disturbance / implement measures to reduce adverse impacts of habitat degradation and/or modification (northern river shark/speartooth shark) • Ensure all future developments will not significantly impact upon sawfish and river shark habitats critical to the survival of the species, or impede upon the migration of individual sawfish or river sharks. Implement measures to reduce adverse impacts of habitat degradation and/or modification. • Review and assess the potential threat of introduced species, pathogens and pollutants. • Minimise offshore developments and transit time of large vessels in areas close to marine features likely to correlate with whale shark	Fishes • EP Section 7.2.5: Australian marine park values • EP Section 7.4.1: Introduced marine species • EP Section 7.4.1: Interaction with marine fauna • EP Section 7.5.3: Routine discharges to sea • EP Section 7.6: Waste management • EP Section 8: Emergency conditions (oil spills).

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
	vertebrate wildlife of Australia's coasts and oceans. Commonwealth of Australia. Department of Sustainability, Environment, Water, Population and Communities (DSEWPac). 2012. Marine bioregional plan for the North-west Marine Region. DSEWPaC, Canberra, ACT. Director of National Parks. 2018. North-west marine parks network management plan 2018. Director of National Parks, Canberra, ACT.		aggregations (Ningaloo Reef,) and along the northward migration route that follows the northern WA coastline along the 200 m isobath. • Contribute to the long-term prevention of the incidence of harmful marine debris. • Provides the rules about what activities can and cannot occur within AMP zones, ensuring for the conservation of biodiversity values.	
EPBC listed seabirds and shorebirds	Department of the Environment. 2015. EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC listed migratory shorebird species. Department of the Environment. 2015. Wildlife conservation plan for migratory shorebirds. Commonwealth of Australia. Department of the Environment. 2015. Referral guideline for 14 birds	• Noise and vibration • Waste / marine debris • Introduced marine species • Introduced terrestrial pests (rodents) • Emissions and discharges • Light emissions • Oil spill.	• Reduce risk of rodents gaining access to key vessels at key ports. • Contribute to the long-term prevention of the incidence of harmful marine debris. • Identify threats to important (migratory shorebird) habitat and develop conservation measures for managing them.	• EP Section 7.1.9: Underwater noise and vibration – avifauna • EP Section 7.2.5: Australian marine park values • EP Section 7.4.1: Introduced

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
	listed as migratory under the EPBC Act (Draft). Commonwealth of Australia. Department of Sustainability, Environment, Water, Population and Communities. 2012. Species group report card - seabirds and migratory shorebirds. Supporting the marine bioregional plan for the North-west Marine Region. Prepared under the *Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia. Department of the Environment, Water, Heritage and the Arts. 2009. Threat abatement plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100 000 hectares. Commonwealth of Australia. Department of Environment and Energy. 2018. Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans. Commonwealth of Australia. Department of Sustainability, Environment, Water, Population and		• Avoid degradation of migratory shorebird habitat that may occur through the introduction of exotic species, changes to hydrology or water quality (including toxic inflows), fragmentation of habitat or exposure to litter, pollutants and acid sulphate soils. Minimise human disturbance, a major threat to migratory shorebirds. • Best practice waste management should be implemented. • Provides the rules about what activities can and cannot occur within AMP zones, ensuring for the conservation of biodiversity values.	marine species • EP Section 7.4.1: Interaction with marine fauna • EP Section 7.5.1: Light emissions • EP Section 7.5.3: Routine discharges to sea • EP Section 7.6: Waste management • EP Section 8: Emergency conditions (oil spills).

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
	Communities (DSEWPac). 2012. Marine bioregional plan for the North-west Marine Region. DSEWPac, Canberra, ACT. Threatened Species Scientific Committee. 2016. *Calidris tenuirostris* (great knot) Approved Conservation Advice. Commonwealth of Australia. Threatened Species Scientific Committee. 2016. *Calidris canutus* (red knot) Approved Conservation Advice. Commonwealth of Australia. Threatened Species Scientific Committee. 2016. *Charadrius leschenaultii* (greater sand plover) Approved Conservation Advice. Commonwealth of Australia. Threatened Species Scientific Committee. 2016. *Charadrius mongolus* (lesser sand plover) Approved Conservation Advice. Commonwealth of Australia. Threatened Species Scientific Committee. 2015. *Calidris ferruginea* (curlew sandpiper) Approved Conservation Advice. Commonwealth of Australia.			

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
	Threatened Species Scientific Committee. 2016. *Limosa lapponica menzbieri* — Northern Siberian bar-tailed godwit. Approved Conservation Advice. Commonwealth of Australia. Threatened Species Scientific Committee. 2015. *Papasula abbotti* — Abbott's booby. Approved Conservation Advice. Commonwealth of Australia. Department of the Environment. 2015. Conservation advice *Numenius madagascariensis* (eastern curlew). Commonwealth of Australia. Department of the Environment. 2014. Conservation Advice *Phaethon lepturus fulvus* white-tailed tropicbird (Christmas Island) Commonwealth of Australia. Threatened Species Scientific Committee. 2015. *Erythrotriorchis radiatus* – red goshawk. Approved Conservation Advice. Commonwealth of Australia. Threatened Species Scientific Committee. 2011. *Rostratula australis* (Australian painted snipe) Approved			

Fauna type	Conservation management documents	Summary of relevant aspects/threats identified from conservation management documents	Summary of relevant actions from conservation management documents	Risk evaluation Section of EP
	Conservation Advice. Commonwealth of Australia. Threatened Species Scientific Committee. 2015. Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy). Commonwealth of Australia. Threatened Species Scientific Committee. 2002. Commonwealth Listing Advice on *Sterna albifrons sinensis* (little tern (western Pacific)). Commonwealth of Australia. Director of National Parks. 2018. North-west marine parks network management plan 2018. Director of National Parks, Canberra, ACT.			

Appendix C-
Stakeholder consultation log

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Authorities					
Australian Border Force (ABF), Broome Office (Cwth)	07/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Australian Border Force (ABF), Darwin Office (Cwth)	07/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Australian Border Force (ABF), Canberra Office (Cwth)	07/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Australian Fisheries Management Authority (AFMA) (Cwth)	30/10/2018	Email / letter to stakeholder	N/A	Initial contact advising AFMA that offshore activities are planned for late 2019/early 2020. Requested a meeting to discuss the activity.	Not applicable – correspondence sent by INPEX.
	07/11/2018	Email / letter to stakeholder	N/A	INPEX requested clarification on the following: 1. Whether email addresses are available for fishing licence holders for consultation purposes. 2. Whether it will be sufficient to contact fishing representative bodies for those fisheries that have not been active in the are for a number of years. 3. What the requirements are for activities that enter the Indonesian Memorandum of Understanding (MoU) Box.	Not applicable – correspondence sent by INPEX.
	29/11/2018	Email / letter from stakeholder	N/A	Provided information for the above questions (see 07/11/2018): 1. Advised how contact details for licence holders can be requested. 2. Confirmed these fishers still need to be consulted. 3. Provided contact details for Indonesia's Ministry for Marine Affairs and Fisheries (MMAF)	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and the functions, interests and activities of Commonwealth managed fisheries. Contact details were used by INPEX to provide information to the Indonesian MMAF.
	03/12/2018	Email / letter to stakeholder	N/A	Advised that INPEX have met with WAFIC and have agreed that to engage with the licence holders of the North West Slope Trawl Fishery using WAFIC's consultation service. Advised that in order to minimise stakeholder fatigue and unnecessary consultation, the other Commonwealth Fisheries will be consulted through representative bodies and not via individual licence holders. Advised Australian Southern Bluefin Tuna Industry Association (ASBTIA) are best placed to respond to concerns regarding bluefin tuna spawning. Advised that INPEX will contact the Indonesian MMAF.	Not applicable – correspondence sent by INPEX.
	31/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Outlines purpose of seismic survey and methodology for fisheries identification. Notified stakeholder that INPEX will use WAFICs fisheries consultation service. Advised that only fisheries that are relevant to the Operational Area will be engaged, and that Indonesia's Ministry of Marine Affairs and Fisheries will be engaged.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Australian Maritime Safety Authority (AMSA) - Marine Environment Pollution Response (Cwth)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder. INPEX will provide the final OPEP to AMSA subject to acceptance of the EP by NOPSEMA.
Australian Maritime Safety Authority (AMSA) - Nautical Advice (Cwth)	06/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.

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		13/02/2019	Email / letter from stakeholder	N/A	Provided vessel traffic plot with AIS data for January 2019. Advises that heavy vessel traffic occurs within the seismic survey area. Notes that a chartered shipping fairway crosses the north west corner of the WA-533-P permit block. Advises that the survey and support vessel will need to maintain communication with surrounding traffic due to speed differences between vessels. Notes that avoiding action by commercial shipping should not increase the navigational risk to other shipping in the region. Provides essential navigational safety requirements. Requests INPEX advise of start and end of operations for promulgation of radio-navigation warnings.	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information (i.e. vessel traffic) has been incorporated into Section 4.9.9 and Section 7.2.4 of the EP. Requested notifications have been incorporated into Section 9.8 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
		22/02/2019	Email / letter to stakeholder	N/A	Acknowledgment of information and requests outlined in email of 13/02/19. Advised that INPEX will consider the anticipated marine traffic in the area during development of the Environment Plan (EP) and the assessment of potential risk to other shipping in the vicinity. Areas of known vessel traffic and the charted shipping fairway will be identified in the EP. Confirmed understanding that heavy vessel traffic occurs within seismic survey and that NW corner of permit block WA-533-P crosses over a charted shipping fairway where vessel traffic travels to and from Port Hedland and the Port of Dampier. Confirmed EP would include requirements for the seismic contractor to implement watch keeping, navigation and communication practices, consistent with the requirements of the International Regulations for Preventing Collisions as Sea 1972 (COLREGS) and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW Convention). Outlined planned upfront/ongoing notifications to facilitate the issuing of Marine Safety Information and a Notice to Mariners by AMSA and Australian Hydrographic Office (AHO), in addition to planned notifications to AMSA's Joint Rescue Coordination Centre (JRCC). Advised that INPEX also engaged the AMSA via its Marine Environment Pollution Response unit on the development of relevant oil pollution emergency plans (OPEPs).	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
	Bardi and Jawi Niimidiman Aboriginal Corporation	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[Via legal representative, Kimberley Land Council] 'Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) - types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
		09/05/2019	Meeting with stakeholder	N/A	The stakeholder was provided with a map of the proposed survey and informed of what a seismic survey was, why they are conducted and what could be expected. The Bardi and Jawi Niimidiman Aboriginal Corporation's expressed an interest in potential impacts on turtle stocks and dugong populations. INPEX explained there would be temporary behavioural impacts due to noise, however, it would have no lasting or physical impacts. INPEX explained the role of Marine Fauna Observers (MFOs) and that the survey will avoid peak whale migration/calving times. INPEX also advised of extensive consultation conducted with fishermen. The stakeholder ultimately did not feel too concerned following the consultation due to the distance offshore. No objection or claim or other relevant matter was raised.	Not a relevant matter – General discussion only and stakeholder was satisfied with the information provided. No objection, claim or other relevant matter raised.
	Dambimangari Aboriginal Corporation	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	Department of Agriculture and Water Resources (DAWR) – Biosecurity (Marine Pests) (Cwth)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	Department of Agriculture and Water Resources (DAWR) – Biosecurity (Vessels, aircraft and personnel) (Cwth)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that the survey Operational Area extends within the 12 Nm territorial waters limit (e.g. around Browse Island and Adele Island)and the survey vessel and support vessels may transit Australian territorial waters and then depart again without entering port or State waters. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

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Department of Agriculture and Water Resources (DAWR) - Fisheries (Cwth)	30/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) - types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that to identify relevant fisheries, INPEX has reviewed Australian Fisheries Management Authority (AFMA) Fisheries summaries, ABARES Annual fishery status reports, including maps of fishing effort, and engaged the Western Australian Fishing Industry Council (WAFIC's) consultation services. Advised that INPEX has provided information about the activity and our proposed engagement of Commonwealth-managed fisheries to AFMA. With a view to minimise stakeholder fatigue, WAFIC's recommended approach to engagement is to consult only those stakeholders whose activities and interests may be affected by the planned survey activity (in this case, within or immediately adjacent to the proposed Operational Area). Confirmed that INPEX had also provided relevant information to the Indonesian Ministry for Marine Affairs and Fisheries for the awareness of traditional fishers who may be operating within the Australia–Indonesia MOU box. Requested that DAWR advise INPEX if it recommended any additional or alternative engagement activities. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Biodiversity Conservation and Attractions (DBCA) - Environmental Management Branch (WA)	24/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Communication and the Arts (Cwth)	06/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Briefly describes activity and location. Requests the Department provide details of any existing or planned subsea cables within the area. [Refer to communications with Vocus for confirmation subsea cables will not be impacted by the activity)]	Not applicable – correspondence sent by INPEX. No response received from stakeholder. Information regarding the North West Cable System sourced instead from Vocus Communications (the cable system operator).
Department of Defence, RAN Australian Hydrographic Office (AHO) (Cwth)	23/01/2019	Email / letter to stakeholder	N/A	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	25/01/2019	Email / letter from stakeholder	N/A	Confirmation of receipt. Advised they will wait to hear about details of operations and timing once they are confirmed.	Not a relevant matter – General correspondence only.
Department of Defence, Directorate of Property Acquisition, Mining and Native Title (Cwth)	06/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided fact sheet. Asked whether there were any planned Defence exercises or surface restrictions areas that INPEX should be aware of.	Not applicable – correspondence sent by INPEX.
	25/02/2019	Email / letter from stakeholder	N/A	Advised that the Defence are not able to provide an accurate estimate of operations due to the broad estimated timing of the seismic survey activity. Requests INPEX advise Defence within 90 days of the seismic activity to deconflict activities. Defence advised there may be unexploded ordinance (UXO) within the survey area. Requested INPEX notify the Australian Hydrographic Service (AHS) at least 3 weeks prior to the commencement of activities for maritime safety and planning.	Relevant matter – Stakeholder has requested information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. The stakeholder requests activity notifications which have been incorporated into Section 9.8.3 (Ongoing stakeholder consultation) of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
	04/04/2019	Email / letter to stakeholder	N/A	INPEX acknowledged that as the proposed survey is within the RAAF Curtin overwater air weapons range and restricted airspace, there may be unexploded ordnance (UXO) within the survey area. INPEX confirmed that the seismic array is not expected to interact with the seabed during the proposed 2D seismic survey activity. INPEX advised it will aim to provide sufficient notice to Defence, however providing 90 days advance notice may be challenging due to operational and logistical factors. INPEX confirmed information about the commencement of the activity will be provided to the AHO no fewer than four working weeks before operations commence for the promulgation of related Notices to Mariners.	Not applicable – correspondence sent by INPEX.

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	04/04/2019	Email / letter from stakeholder	N/A	Advised that the proposed seismic activities will be taking place almost entirely within the RAAF Curtin overwater air weapons range (restricted airspace R811) and therefore any activities (including survey vessel activities) in this area has the potential of conflict with Defence operations and training activities. As advised previously, Defence is not able to accurately predict potential conflicts at this early stage as operations in this area for the proposed survey period (Q4 2019 to Q4 2021) are not yet confirmed. Regarding INPEX enquiry if there were circumstances when Defence operations within this airspace would restrict or preclude INPEX and its contractor from undertaking the survey activities in this area, Defence advised that in certain instances it may be necessary to prohibit access to the area or parts of the area dependant on operational or safety requirements.	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information has been acknowledged in Section 4 and Section 7.2.4 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
Department of Industry, Innovation and Science (DIIS) (Cwth)	06/02/2019	Email / letter to stakeholder	N/A	Briefly describes activity and location. Advised that an INPEX representative will be in Canberra during February and offered to meet.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Mines, Industry Regulation and Safety (DMIRS) (WA)	06/02/2019	Email / letter to stakeholder	N/A	INPEX advised DMIRS that as required under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 INPEX will notify DMIRS of the start and end of the proposed activities at the appropriate time. Requested DMIRS advise whether they would like to be consulted in the lead up to the activity. Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019. Also confirmed that in accordance with OPGGS(E) Regulations, INPEX will notify DMIRS as the adjacent State of the start and end of the proposed activities at the appropriate time.	Not applicable – correspondence sent by INPEX.
	11/02/2019	Email / letter from stakeholder	N/A	Acknowledges activity and confirms receipt of information. DMIRS asks two questions as follows: - whether INPEX has information on (and can provide) the planned total volume of the source array to be used; and - whether the seismic source will be soft started in the Kimberley Marine Park Habitat Protection and National Park Zones near Adele Island.	Relevant matter – Stakeholder has requested information or provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information has been provided to the stakeholder during consultation. The stakeholder raised no concerns or objections regarding the seismic survey.
	22/02/2019	Email / letter to stakeholder	N/A	Confirmed the seismic source will have an approximate total volume of 3000 inches cubed. Confirmed no operation of the seismic source will occur within the National Park and Habitat Protection Zones of the Kimberley Australian Marine Park (including soft starts). Advised that survey and support vessels may transit these zones. Advised that INPEX is also consulting with the Director of National Parks. Also advised that the Operational Area does not extend into state waters.	Not applicable – correspondence sent by INPEX.
	22/02/2019	Email / letter from stakeholder	N/A	Confirmed receipt and acknowledged response. Advised no further information is required at this stage. Requests activity commencement and cessation of notifications are provided.	Relevant matter – Stakeholder has requested information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. The stakeholder requests activity notifications which have been incorporated into Section 9.8.3 (Ongoing stakeholder consultation) of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
Department of Primary Industries and Regional Development (DPIRD) - Aquatic Environment section (WA)	29/10/2018	Email / letter to stakeholder	N/A	INPEX provided early notification of the activity and offered to meet with the Department to discuss the planned seismic activity.	Not applicable – correspondence sent by INPEX.
	07/12/2018	Email / letter to stakeholder	N/A	INPEX offer to establish a meeting to discuss the proposed seismic activity with the Department.	Not applicable – correspondence sent by INPEX.
	11/12/2018	Phone call to stakeholder	N/A	Restated INPEX's desire to brief the Department on the proposed seismic activity. DPIRD advised they would discuss internally on the proposal and get back to INPEX with a response.	Not applicable – correspondence sent by INPEX.
	10/01/2019	Phone call to stakeholder	N/A	Follow up on request to brief the Department on the proposed seismic survey activity. Agreed that INPEX will send through relevant consultation information, including consultation activities to data and planned consultation. DPIRD will review this information and notify INPEX if they think a meeting is warranted. DPIRD noted the guidance for oil and gas companies on seismic surveys, as well as the guidance on consultation and environment plans.	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. Guidance for oil and gas companies on seismic surveys, as well as the guidance on consultation and environment plans have been considered by INPEX during stakeholder consultation and development of the EP. Specific guidance is referenced, where applicable, in Section 2 and Section 7 of the EP.
	11/01/2019	Email / letter to stakeholder	Yes: - Fact sheet	Provided stakeholder with information on: - The proposed offshore petroleum activity - How fisheries were identified - The engagement with fishers undertaken to date - Proposed engagement with other relevant stakeholders - DPIRD ecological risk assessment and guidance statement on seismic surveys Restated offer to brief the Department in person.	Not applicable – correspondence sent by INPEX.

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		04/02/2019	Email / letter from stakeholder	N/A	Officer within Department advised they will respond soon to the email sent on 11/01/2019.	Not a relevant matter – General correspondence only.
		18/02/2019	Phone call with stakeholder	N/A	Phone call from DPIRD Aquatic Environment (Fisheries) to INPEX. Re Ministerial engagement DPIRD enquired about INPEX's practice of sending offshore activity information to both the Department and its Minister. This creates a duplication of work for the Department. INPEX advised that the information provided to the Minister is high-level/generic, whereas the information provided to the Department is more operational in nature (related to fisheries identification, consultation approach, etc). Ministerial engagement is not specifically required under the regulations (Subreg 11(A)1a, b and c relate to Cwth, state and territory government departments), but INPEX has previously engaged Ministers of relevant portfolios on a relationship basis to keep them/their advisors generally informed of INPEX's offshore activities. However, to ensure the Minister is not sending potentially unnecessary requests for follow-up to the Department/to avoid duplication of the Department's work, INPEX agreed that future correspondence to Ministers would make it clear that INPEX is also engaging with the Departments. DPIRD advised that they will check back with the Minister's advisers to see if they need to provide a response through that channel, or if the Department's communications directly with INPEX will meet the Minister's requirement. Re INPEX's offer of briefing DPIRD about the 2D seismic survey activity INPEX restated the offer to provide a briefing on the activity (refer earlier engagement with DPIRD Aquatic Environment), and potential risks that may be of interest. DPIRD acknowledged that a briefing could be useful. DPIRD advised that they would be interested to see the outcomes and a summary of assumptions from the environmental risk assessments INPEX advised DPIRD that a date could be arranged once the information was available, unless there is a preference by DPIRD or INPEX to meet sooner than that.	Not a relevant matter – General correspondence only.
		22/02/2019	Email / letter from stakeholder	Yes: - Seismic Survey Guidance Statement - Draft Species Spawning Table	Advised that the Department will be providing a response on the proposed activity and not the Ministers office. DPIRD provided a revised fish spawning table with the most recent available information. Requested INPEX provide details of the proposed seismic source and minimum operating water depths. Advised a response will be provided once the Department receives the impact assessment.	Relevant matter – Stakeholder has requested information and provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. Fish spawning information has been incorporated into Section 4 and Section 7 of the EP (NB the fish spawning advice in this correspondence has since been updated by the Department - see correspondence dated 17/06/2019. This updated advice is used in the EP).
		01/03/2019	Email / letter to stakeholder	Yes: - Fact sheet	Per 18/02/19 telephone call, confirmed INPEX would advise Minister's office if separately sending information on proposed offshore activities to Department. Advised the seismic source would have an approximate total volume of 3,000 inches cubed, based on a detailed feasibility study within the Acquisition Area. Advised that the seismic contractor has not yet been selected and the exact source level could not be confirmed at this stage. Advised that water depths within the Acquisition Area mostly range from approximately 50-600 m. INPEX identified shallow points in the Acquisition Area at Lynher Bank (approximately 30 m) and the Easter part of Acquisition Area in WA-533-P (37 m). INPEX confirmed the information provided in the updated fish spawning table will be incorporated into the impact assessment. INPEX confirmed the risk assessment sections will be sent to DPIRD when available.	Not applicable – correspondence sent by INPEX.
		26/03/2019	Email / letter from stakeholder	N/A	Stakeholder contacted INPEX to follow up on impact risk assessment work, checking if it had been completed.	Not a relevant matter – General correspondence only.
		26/03/2019	Email / letter to stakeholder	N/A	INPEX confirmed work was expected to be completed in approximately two weeks and that a copy of relevant materials would be provided to the Department once completed. In addition, INPEX asked again if DPIRD would like a briefing.	Not applicable – correspondence sent by INPEX.
		07/05/2019	Email / letter to stakeholder	Yes: - EP Risk Assessment sections (containing disturbance to other marine users and noise impacts on commercial fish species).	Risk assessment sent to the Department. Requested DPIRD confirm that fisheries data assessed in the EP had been interpreted correctly and that DPIRD are satisfied with the overall assessment. INPEX requested an update on the status of DPIRD's next guidance statement and assessment of population level impacts. INPEX summarised the methodology and results of the impact assessment and advised that while it is not possible to avoid all spawning times, careful consideration has been given to what spawning periods could practically be avoided. INPEX requested clarification on the following: - Information provided by DPIRD on mackerel spawning timing conflicted with information provided by stakeholders and contained in previous 'state of the fisheries' reports. - It was previously understood that there was a peak spawning period for goldband snapper, which is not identified in DPIRD's most recent advice. INPEX requested confirmation that this is correct. INPEX provided further information of the proposed survey timing and confirmed that no seismic activity will occur in the period from 1 June to 31 October. Advised that INPEX will consider a "make good policy", that will compensate fishers that are genuinely impacted by the proposed seismic survey. Requested feedback/comments on the risk assessment information by 7 June 2019. INPEX also reiterated offer to provide a briefing to the Department.	Not applicable – correspondence sent by INPEX.

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		13/05/2019	Phone call with stakeholder	N/A	DPIRD advised they are yet to complete a review of the fish and fisheries risk assessment. DPIRD advised they had received direct comments from a fisheries stakeholder regarding the proposed survey. INPEX confirmed ability to meet with DPIRD and discuss any particular points. DPIRD advised they will prepare a response to the risk assessment within the next two weeks and consult with internal scientists.	Not a relevant matter – General correspondence only.
		30/05/2019	Phone call to stakeholder	N/A	Left a message inquiring about the status of DPIRD's review of the relevant risk assessment sections.	Not applicable – correspondence sent by INPEX.
		04/06/2019	Email / letter to stakeholder	Yes: - EP Risk Assessment sections (containing disturbance to other marine users and noise impacts on commercial fish species).	Follow up email inquiring about the status of DPIRD's review of the relevant risk assessment sections (attached again for reference).	Not applicable – correspondence sent by INPEX.
		04/06/2019	Email / letter from stakeholder	N/A	Confirmed DPIRD is still working through the information. Advised that the Department has some feedback about the assumptions made on the FishCube data.	Not a relevant matter – General correspondence only. [NB: Concern regarding FishCube data interpretation is identified as a relevant matter in consultation sent by the Department on 05/06/2019]
		04/06/2019	Phone call to stakeholder	N/A	Left a message enquiring about the concerns about assumptions made on the FishCube data.	Not applicable – correspondence sent by INPEX.
		05/06/2019	Email / letter from stakeholder	N/A	DPIRD advised on the limitations and of FishCube data and identified assumptions made in the risk assessment that may lead to the data being misinterpreted. Specifically, DPIRD stated that INPEX's figures that used nominal value blocks containing confidential fishing effort (less than three boats fishing) was incorrect. DPIRD provided the example that one larger fishing boat can sometimes be more efficient than two smaller boats. DPIRD recommended that on fishing effort figures, blocks containing confidential fishing effort use a grey/neutral colour.	Relevant matter - Feedback provided by DPIRD regarding FishCube data interpretation is relevant to the assessment of impacts to fisheries. Limitations of the data have been acknowledged by INPEX in Section 7 of the EP, including adding disclaimer statements where FishCube data is referenced, as discussed with the stakeholder (refer to further correspondence below dated 05/06/2019). In addition, the INPEX assumptions only inform the risk and would not alter proposed controls or introduce new controls.
		05/06/2019	Phone call to stakeholder	N/A	Phone call with DPIRD acknowledging the limitations of the data and why INPEX had felt it was pertinent to understand the relative distribution of fishing effort within the 2D seismic survey Operational Area and therefore apply assumptions. The limitations and assumptions were acknowledged by INPEX. Options for further acknowledging limitation in the EP and on maps of FishCube data were discussed and summarised in a follow up email (see below).	Not applicable – correspondence sent by INPEX.
		05/06/2019	Email / letter to stakeholder	N/A	INPEX recognised the limitations in the FishCube data and that making assumptions about the level of catch and effort in blocks with 'Less than 3 boats' could mis-represent the data. Advised that INPEX made this assumption in order to get a more in depth understanding of the potential overlap and interaction with the fisheries that goes beyond simply the overlap with the number of blocks fished, so as to acknowledge areas of greater effort. Advised that any assumptions and limitations are made in the EP. INPEX proposed the following amendments would be made in the EP: - Maps will be revised so that blocks with 'Less than 3 boats' are a neutral colour or hollow, as suggested. Alternatively, a caveat will be added to each map explaining the assumptions and limitations. - Include a clear explanation why INPEX has looked at overlap with fishing effort in addition to number of blocks fished. - Clearly state that DPIRD has highlighted to INPEX the limitations of making such assumptions. - References to percentage overlap with fishing effort will be followed by the limitations and that the value is for indicative purposes only. Requested that DPIRD please advise if they have any concerns regarding the proposed approach to acknowledging the data limitations.	Not applicable – correspondence sent by INPEX. No response received from stakeholder to object to the proposed acknowledgement of limitations to be included in the EP.
		07/06/2019	Email / letter from stakeholder	N/A	DPIRD advised the review of the risk assessments was still in progress and will be provided as soon as possible.	Not a relevant matter – General correspondence only.
		17/06/2019	Email / letter from stakeholder	Yes. - Advice general finfish spawning May 2019 revised.docx	[In response to INPEX's email 7 May 2019] The Department raised concerns with the data assumptions made with the FishCube data around the N/A block data, which relates to confidential information. DPIRD advised that catch (Kg) and fishing day count are not always proportional to the vessel count and the 'Less than 3 boats' doesn't always mean smaller fishing day count or smaller catch.	Relevant matter- Feedback regarding FishCube data interpretation was raised previously by the stakeholder and addressed by INPEX (refer to correspondence above dated 05/06/2019).
					The Department advised it is working on the collaborative seismic survey environment plan project with NERA and WAFIC and as such it will not progress the development of a guidance statement until that project is completed, as anything produced now may be out of date.	Not a relevant matter – General correspondence only.

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					The Department advised that due to water depths (30m to 600m) with a volume sound source of 3000 cubic inch and given the location of the survey the Department does not support any proposed seismic survey where the risk is severe or high (in reference to the Fisheries Research Report No. 288 - Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia, June 2018), in particular for immobile and mobile invertebrates and demersal finfish, unless scientific peer reviewed literature (location and species specific) demonstrates there is no impact.	Stakeholder requested the consideration of Fisheries Research Report No. 288, which relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit is addressed in Section 2.1.3 of the EP. However, it is noted that Fisheries Research Report No. 288 considers worst case impacts at the *individual* level, assuming the organism does not move from the path of the seismic source. the risk assessment outcomes in Fisheries Research Report No. 288 therefore do not account for situational context which is crucial for assessing likely real life impacts as well as potential impacts at a *population* level. No additional management measures were selected as a result of this matter being raised. The outcomes of the assessment have been shared with the stakeholder and it has been clarified to DPIRD that Fisheries Research Report No. 288 has been considered (refer to correspondence date 28/06/2019).
					DPIRD observed that stocks in the area are fully allocated from a sustainability perspective and any additional risk could potentially impact long term sustainability for fish stocks. DPIRD observed that spawning grounds are particularly sensitive and requests that no seismic survey acquisition occurs during spawning periods for key species. Advised that management controls to mitigate the risk/impact to fish stock, if spawning time are unavoidable, should be assessed and provided to relevant stakeholders for comment. The Department observed that the survey timing will extend completely over the Goldband Snapper spawning window in the Kimberley and therefore the DPIRD expects INPEX to revise the window of opportunity to consider new updated spawning information [attached]. Advised this information is based on the most current science from relevant scientists, and that the table was also sent to WAFIC and relevant fishers. The Department observed that the operational area overlaps with approximately 50% of the blocks fished for the Northern Demersal Scalefish Managed Fishery, combined with the overlap on goldband snapper spawning stocks. DPIRD Advised that this is not acceptable in its current format.	Concern raised by stakeholder regarding potential overlap with peak spawning for the key indicator species (in particular goldband snapper) relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Section 7.1.4 and 7.1.6 of the EP. The stakeholder's feedback regarding allocation of the stocks and concerns that the seismic survey could potentially impact long term sustainability for fish stocks (in particular goldband snapper) are also noted. However, the potential for long term population level impacts is not considered to have merit, based on the reasons and references presented in Section 7.1.4 and 7.1.6 of the EP, as provided to the stakeholder for review on 07/05/2019. This was communicated to DPIRD on 28/06/2019. Specifically, occasional behavioural disturbances to spawning groups of fish are acknowledged, but the level of impact is predicted to be small in the context of natural variability. No adult fish will be removed from the spawning biomass / allocated stock (no fish are predicted to be killed). In addition, with reference to goldband snapper, the Australian Government's Fisheries Research & Development Corporation has previously noted that long-lived species such as goldband snapper are less likely to be affected by short-duration environmental/climatic changes (of one or a few years), because adult stocks comprise fish that have been recruited over many years (Martin et al. 2014). Therefore, in comparison, the occasional, short-term, transient and localised disturbances to groups of fish as a result of the seismic survey would have impacts many orders of magnitude smaller than regional scale environmental/climatic events, and the survey is unlikely to result in a discernible impact on the stocks. Updated fish spawning information provided by DPIRD has been incorporated into Section 4, Section 7.1.4 and Section 7.1.6 of the EP and the risk assessments reviewed based on the new information. The predicted impacts and overall level of risk are unchanged. DPIRD advice to consider avoiding the goldband snapper spawning period (November to May) is noted, but avoidance is not practicable, given the identified need to avoid the June to October period that is important for more sensitive calving, nursing and resting humpback whales in the region.
					The Department queried whether INPEX will commit to reducing the extent of the seismic data acquisition in WA-532-P by 28% (in which case the revised impact assessment document be sent for review). DPIRD's email also included advice and requests that had already been actioned by INPEX, including: - requests that INPEX consults with WAFIC, PPA, Recfishwest and Relevant Traditional Owner groups. - requests that potentially affected commercial fishers ad charter operators are also consulted, and provides method for requesting licence holder names. - the Department advised the method for determining relevant fisheries and understanding the fish stock in the proposed area, including assessing spatial boundaries of fisheries, obtaining catch and effort data from DPIRD's FishCube database, DPIRD's published literature and scientist staff profiles. - the Department expects that INPEX in its EP has considered and incorporated the recommendations published by NOPSEMA on the Acoustic Impact evaluation and management guidance - the Department also expects that INPEX has incorporated the outcomes of the Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia, June 2018	Relevant matter - Reduction in work plan is subject to NOPTA approval and cannot be confirmed by INPEX. INPEX responded to DPIRD on 28/06/2019 to advise that if the application is successful and NOPTA approves a reduction there will be less impact. However, the revised risk assessment is unlikely to deviate significantly and the controls proposed to reduce risk to ALARP and Acceptable would be unchanged. A revised risk assessment will not be sent for review. Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information has been incorporated into the development of the EP. A reply was sent to DPIRD on 28/06/2019 (see below).
		28/06/2019	Email / letter to stakeholder	N/A	**Consultation with Representative Bodies and Individuals** INPEX confirmed that consultation had been conducted / was underway with the stakeholder identified by DPIRD. Confirmed fishery data acquisition processes had been followed as per DPIRD's advice. **FishCube data** Advised INPEX has taken this advice on board and subsequently amended interpretations as per previous discussions with DPIRD (Refer to correspondence dated 05/06/2019).	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.

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				Consideration of Recommendations INPEX confirmed that the recommendations published by NOPSEMA in the *Acoustic impact evaluation and management* information paper have been taken into consideration in the development of the risk assessments in the EP. Confirmed the outcomes of the Fisheries research report: *Risk assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia* , have also been taken into account **Risk Assessment** INPEX explained that under the OPGGS Regulations an EP is required to demonstrate that that impacts and risk are acceptable and reduced to as low as reasonably practicable (ALARP), rather than demonstrating there is 'no impact' as requested in DPIRD's feedback. Impacts and risks are assessed in general alignment to the processes outlined in ISO 31000:2009 Risk Management – Principles and guidelines (Standards Australia/ Standards New Zealand, 2009) and Handbook 203:2012 Managing environment-related risk (Standards Australia/Standards New Zealand 2012). Expressed belief that INPEX has a robust process for determining whether residual risks have been reduced to ALARP and acceptable levels. Advised the assessments evaluate the latest scientific peer reviewed research and advice, including the research referred to in the Fisheries 'Risk assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia'. **Spawning Periods** Thanked DPIRD for providing advice on spawning areas, key spawning periods and depth ranges for a range of key commercial fish species. INPEX acknowledged that the survey timing overlaps the full peak period of goldband snapper spawning, however noted that the assessment takes into account that spawning occurs over large areas and disturbance to any particular spawning event will be localised and spawning will continue undisturbed elsewhere throughout the fishes' ranges and the majority of spawning aggregations in the region will be undisturbed. INPEX expressed confidence in the risk assessment outcomes and demonstration that potential impacts and risks to spawning for commercial fish species are ALARP and acceptable. **Potential Reduction in Seismic Acquisition Area** Advised that if the application is successful and NOPTA approves a reduction there will be less impact. Advised the revised risk assessment is unlikely to deviate significantly and the controls proposed to reduce risk to ALARP and Acceptable would be unchanged. A revised risk assessment will not be sent for review.	
Department of Primary Industries and Regional Development (DPIRD) - Sustainability and Biosecurity section (WA)	24/01/2019	Email / letter to stakeholder	N/A	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder. Response on behalf of DPIRD provided by Aquatic Environment section (see above).
Department of Transport - Marine (WA DoT) (WA)	14/12/2018	Phone call to stakeholder	N/A	WA DoT advised that they view Seismic as a shipping activity, and the risk profile is similar to that of any bulk carrier / container ship carrying a large fuel load, and therefore the risk and response planning is generally similar. DoT acknowledged that AMSA / WA DoT are the Control Agencies. DoT requested that INPEX conduct normal engagement, as per the Industry Guidance Note requirement for the EP.	Relevant matter – Stakeholder has requested information or provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information has been incorporated into Section 7.7 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	29/01/2019	Email / letter from stakeholder	N/A	Confirmation of receipt. Requested that if there is a risk of a spill entering state waters, WA DoT needs to be consulted in accordance with the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018).	Relevant matter – Stakeholder has requested information or provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. The stakeholder raised no concerns or objections regarding the seismic survey.
	09/07/2019	Email / letter to stakeholder	Yes: - Draft Seismic Survey OPEP - WA DoT - Industry Guidance Note Consultation Table	INPEX forwarded DoT the following: - DRAFT - INPEX 2D seismic survey (WA-532-P, A-533-P and WA-50-L) OPEP - 2D Seismic Summary Table (provision of information requested by WA DoT in Petroleum Industry Guidance Note, Rev 4, Appendix 6) INPEX advised that due to file size, INPEX Document Control will transmit the EP (DRAFT - INPEX 2D seismic survey (WA-532-P, A-533-P and WA-50-L)) via SharePoint.	Not applicable – correspondence sent by INPEX.

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	17/07/2019	Email / letter to stakeholder	Yes: INPEX Strategic Spill Impact Mitigation Assessment (SIMA) Surface Diesel Release	INPEX provided DoT with a coy of INPEX's Strategic Spill Impact Mitigation Assessment (SIMA) a surface MGO release in the Browse Basin	Not applicable – correspondence sent by INPEX.
	17/07/2019	Email / letter to stakeholder	Yes: - Draft Seismic Survey EP	Email from INPXE Document Control to DoT, providing access to the draft 2D seismic survey EP	Not applicable – correspondence sent by INPEX.
	19/07/2019	Email / letter from stakeholder	N/A	Email from DoT acknowledging receipt of the OPEP, draft EP and provision of information in accordance with WA DoT in Petroleum Industry Guidance Note, Rev 4, Appendix 6. DoT will review and advise if they have any queries.	Not applicable - General correspondence only.
	19/07/2019	Email / letter from stakeholder	N/A	Email from DoT acknowledging receipt of the strategic SIMA.	Not applicable - General correspondence only.
	02/08/2019	Email / letter to stakeholder	N/A	[In response to the provision of the Draft Seismic Survey OPEP, Draft EP and WA DoT - Industry Guidance Note Consultation Table, 09/07/2019] Advised DoT has no comments on the proposal beyond those captured in the Industry Guidance Note September 2018. Requested INPEX forward accepted documents and provided an email address for future correspondence.	Not applicable - General correspondence only.
	11/11/2019	email/letter from stakeholder	no	After an industry exercise, Titleholder sought clarification from thestakeholder on their intentions to utlise their own resources during event response. WaDoT responded to confirm that it intends to update Industry guidance in 2020 with the following: a) WA DoT intends to mobilise its own equipment and resources b) inclusive of showeline clean-up and in house booms managed by WADoT c) Titleholder's OPEPs shoudl be updated to reference WADoT's equipment and resources	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information has been incorporated into the EP and OPEP in EP Table 5-4, EP Table 8-8 and OPEP Table 4-2.
Department of Water and Environment Regulation (DWER) (WA) Hazard Management Branch Contaminated Sites Branch	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Office of the Director of National Parks (Cwth)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet - INPEX map showing AMP intersection	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Provided specific information useful specifically to the Director of National Parks, including petroleum activity title numbers, overlap with Australian Marine Parks (AMP) and potential impact on Marine Parks in the event of a spill. Requested any information that may be useful in impact assessment be provided. Advised that INPEX commits to notifying the Director of National Parks 10 days prior to the commencement of the survey activity within the Kimberley Marine Park. INPEX confirmed it will notify the Marine Park Compliance Duty Officer in the highly unlikely event of spill. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.

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	13/03/2019	Email / letter from stakeholder	Reattached INPEX's attachments from 23.01.19 email	On 13 March 2019 the DNP responded to INPEX's factsheet. The DNP noted the proposed survey overlaps with Kimberley Marine Park, which forms part of the North-west Network of Marine Parks. The DNP also noted the activity is located within 100 kilometres of Roebuck Bay, Eighty Mile Beach, Mermaid Reef and Argo-Rowley Terrace marine parks. The DNP acknowledged that the North-west Marine Parks Network Management Plan 2018 allows for mining authorisation to be given through a class approval for the Multiple Use Zone of the Kimberley Marine Park. The DNP noted class approval requires an accepted EP. The DNP advised that INPEX need to be aware of obligations under the class approval (including conditions), and referred to the Petroleum Activities and Australian Marine Parks Guidance Note. The DNP identified the specific natural values for the Kimberley Marine Park, as defined in the North-west Marine Parks Network Management Plan 2018. The DNP identified the need for INPEX to notify the DNP of any oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park as soon as possible. The DNP requested notification if the EP is approved, when the activity commences and the date that the survey begins and ends within the Kimberley Marine Park.	Request raised by stakeholder regarding conformance to regulatory requirements and obligations associated with Marine Parks relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and is addressed in the EP. The matter has been assessed in Section 7.2.5 of the EP and controls identified to reflect the Marine Park requirements. Further, notifications requested by DNP have been captured in Section 9.8.3 of the EP.
	27/05/2019	Email / letter to stakeholder	N/A	Acknowledged feedback provided and confirmed that it had been considered in the EP.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
	05/11/2019	Email / letter to stakeholder	Attachment - Map	Request for clarification from stakeholder on the acceptability of the Activity occuring in the Kimberley Marine Park, with paritcular focus on the INPEX interpretation of the zone rules for the national park zone and the habitat protection zone.	Not applicable – correspondence sent by INPEX.
	20/11/2019	email/letter from stakeholder	N/A	Confirmation from stakeholder that provided the survey is carried out in the manner described, then INPEX's interpretation of the zoning rules and class approval are correct.	Relevant matter (Subsequently withdrawn on 26/11/19)
	26/11/2019	Email / letter from stakeholder	N/A	Stakeholder advised that their original advice provided on 20/11/19 was incorrect and that if a seismic array is fully deployed and towed behind the vessel it would not be classed as "transiting" and that the action would be not be permissable under the zoning rules.	Relevant matter – Stakeholder has requested information or provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information has been incorporated into the Activity description and resulted in amendments to the Opertional area described in the EP. Stakeholder was informed that the changes would be incorporated into the revison of the EP.
Member for Kimberley (WA)	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that INPEX will be speaking directly with pearling businesses in Broome, local fishing clubs (Broome), local Aboriginal and Torres Strait Islander traditional owners and entities and the offshore commercial fishing industry in Western Australia Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Indonesian Ministry for Marine Affairs and Fisheries (MMAF)	29/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Indigenous Land Corporation (ILC)	31/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Kimberley Land Council (KLC)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	30/01/2019	Email / letter to stakeholder	N/A	Requested best contact for receiving information in regard to the exploration activity. Asked whether KLC would be interested in receiving a briefing while INPEX are in Broome performing consultation activities.	Not applicable – correspondence sent by INPEX.

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	07/02/2019	Meeting with stakeholder	N/A	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. KLC requested information regarding potential impacts to turtles. INPEX advised that the relevant impact assessment sections would be sent to KLC once the marine fauna sections of the EP are complete.	Relevant matter – Request for turtle impact assessment actioned 20/06/2019.
	07/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided KLC with information sheet regarding the activity.	Not applicable – correspondence sent by INPEX.
	20/06/2019	Email / letter to stakeholder	Yes: - Draft marine fauna (Turtle) section of EP	INPEX observed that when stakeholder was met in February, INPEX agreed to share with the KLC the draft marine fauna (Turtle) section of the EP. Attached the relevant Risk Assessment information, and advised INPEX also included: the introduction to describe the Activity; and Section 4 - Existing environment and Section 6, which describes the risk assessment process.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Kimberley Ports Authority (KPA)	31/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Advised that INPEX proposes to engage the Kimberley Land Council and other Native Title representative bodies in locations of potential impact from the offshore activity. Also provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Minister for Regional Development; Agriculture and Food; Ports (WA)	04/02/2019	Email / letter to stakeholder	Yes: - Fact sheet	Briefly described the activity and location. Advised that INPEX will be meeting directly with pearling businesses in Broome, local fishing clubs, local Aboriginal and Torres Strait Islander entities, and the commercial fishing industry. INPEX offered to provide the Minister with a briefing on the activity.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Minister for Agriculture and Water Resources (Cwth)	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that INPEX will be speaking directly with pearling businesses in Broome, local fishing clubs (Broome), local Aboriginal and Torres Strait Islander traditional owners and entities and the offshore commercial fishing industry in Western Australia Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	07/03/2019	Email / letter from stakeholder	N/A	Confirms understanding of the proposed seismic activity. Notes and commends consultation efforts with fishing and aquaculture stakeholders. Encourages consultation with the Department of Agriculture and Water Resources, AFMA, and any other relevant parties.	Not a relevant matter – General correspondence only. [NB: at the time of consultation, consultation with the mentioned stakeholders was already underway].
	10/04/2019	Email / letter to stakeholder	N/A	Assured that INPEX has and will continue to engage the fishing stakeholders and members of the Kimberley community referenced in that communication. INPEX will keep the Minister's office informed of activities.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Minister for Environment (WA)	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that INPEX will be speaking directly with pearling businesses in Broome, local fishing clubs (Broome), local Aboriginal and Torres Strait Islander traditional owners and entities and the offshore commercial fishing industry in Western Australia Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	06/03/2019	Email / letter from stakeholder	Yes: - Response sent as a signed letter	Advises that since operations are being undertaken wholly outside State waters, the stakeholder has no jurisdiction to provide formal input on the proposed 2D survey. Notes INPEX s environmental management addresses matters such as underwater sound, waste, biosecurity, vessel interactions with marine fauna, and unplanned discharges.	Not a relevant matter – General correspondence only.

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	10/04/2019	Email / letter to stakeholder	N/A	Notes position in regard to providing input on the proposed seismic survey. Advises Minister of the government departments that have been consulted as part of the ongoing stakeholder engagement. Advised INPEX has also consulted closely with WA's pearling and fishing sectors, along with key community groups, businesses, Aboriginal groups, tourism operators in Broome and the broader Kimberley region.	Not applicable – correspondence sent by INPEX.
Minister for the Environment (also Member for Durack) (Cwth)	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Advised that INPEX proposes to engage the Kimberley Land Council and other Native Title representative bodies in locations of potential impact from the offshore activity. Also provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) - types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	04/02/2019	Email / letter from stakeholder	N/A	Ministerial staffer confirmed receipt, advised they forwarded the email to the Minister's advisors and provide a response as soon as possible.	Not a relevant matter – General correspondence only.
Minister for Fisheries (WA)	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) - types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that INPEX will be speaking directly with pearling businesses in Broome, local fishing clubs (Broome), local Aboriginal and Torres Strait Islander traditional owners and entities and the offshore commercial fishing industry in Western Australia Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder. Response provided by DPIRD (see above).
Minister for Infrastructure and Transport (Cwth)	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Advised that INPEX proposes to engage the Kimberley Land Council and other Native Title representative bodies in locations of potential impact from the offshore activity. Also provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) - types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Minister for Mines and Petroleum (WA)	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that INPEX will be speaking directly with pearling businesses in Broome, local fishing clubs (Broome), local Aboriginal and Torres Strait Islander traditional owners and entities and the offshore commercial fishing industry in Western Australia Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Minister for Resources and Northern Australia (Cwth)	04/02/2019	Email / letter to stakeholder	N/A	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that INPEX will be speaking directly with pearling businesses in Broome, local fishing clubs (Broome), local Aboriginal and Torres Strait Islander traditional owners and entities and the offshore commercial fishing industry in Western Australia Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX.

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	04/02/2019	Email / letter from stakeholder	N/A	Confirmation of receipt.	Not a relevant matter – General correspondence only.
National Native Title Tribunal (NNTT) (Cwth)	31/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Advised that INPEX proposes to engage the Kimberley Land Council and other Native Title representative bodies in locations of potential impact from the offshore activity. Also provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) - types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019. Outlined INPEX's understanding that it is not the Tribunal's position to make comment on our offshore activities, but in line with recommendations of past years, INPEX proposes to engage the Kimberley Land Council, who INPEX understands has jurisdiction over Commonwealth waters off the Kimberley coast (location of our proposed activity). Also stated that INPEX will similarly engage other Native Title representative bodies (prescribed bodies corporate) in locations of potential impact from our offshore activity.	Not applicable – correspondence sent by INPEX.
	31/01/2019	Email / letter from stakeholder	N/A	Automated response confirming receipt of email.	Not a relevant matter – General correspondence only.
National Offshore Petroleum Titles Administrator (NOPTA) (Cwth)	06/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Advised that INPEX proposes to engage the Kimberley Land Council and other Native Title representative bodies in locations of potential impact from the offshore activity. Also provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	07/02/2019	Email / letter from stakeholder	N/A	Confirmed receipt. Asked which seismic company will be used to acquire the survey.	Not a relevant matter – General correspondence only.
	07/02/2019	Email / letter to stakeholder	N/A	Advised INPEX is in the pre-qualification phase of the contract/selection process and expects to award a contract in the second half of 2019. Asks whether providing this information is a NOPTA requirement.	Not applicable – correspondence sent by INPEX.
	06/03/2019	Email / letter to stakeholder	N/A	Following up on question whether information on which seismic company will be used is a NOPTA requirement	Not applicable – correspondence sent by INPEX.
	06/03/2019	Email / letter from stakeholder	N/A	Confirmed seismic company information is not required by NOPTA.	Not a relevant matter – General correspondence only.
Nirrimbuk Aboriginal Corporation (NAC)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	07/02/2019	Meeting with stakeholder	N/A	NAC advised that broader Bardi Jawi group needs to be consulted through its Prescribed Body Corporate (PBC). NAC raised no other concerns regarding environmental impacts or consultation requirements.	Not a relevant matter - Correspondence does not relate to the stakeholder's functions, interests or activities being affected by the petroleum activity. The stakeholder raised no concerns or objections regarding the seismic survey. The request to consult with the PBC has been actioned via engagement with the Bardi Jawi PBC on 09/05/2019.

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Shire of Broome	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX.
	05/02/2019	Email / letter from stakeholder	N/A	Advised the fact sheet will be circulated among the Broome Councillors. Confirmed that a meeting could be arranged if required.	Not a relevant matter – General correspondence only.
	07/02/2019	Email / letter to stakeholder	N/A	INPEX advised that extensive consultation is underway with fishing and pearling businesses in Broome, and a briefing can be held at the Broome Visitors Centre.	Not applicable – correspondence sent by INPEX. No further correspondence received from stakeholder.
Shire of Derby / West Kimberley	06/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Shire of Wyndham / East Kimberley	06/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Wanjina Wunggurr Aboriginal Corporation RNTBC	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[via legal representative, Kimberley Land Council] 'Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Wunambal Gaambera Aboriginal Corporation	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[via legal representative, Kimberley Land Council] 'Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Yawuru Native Title Holders Aboriginal Corporation RNTBC represents traditional owners in Broome area.	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Business					

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Australian Marine Oil Spill Centre (AMOSC)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Australia's North West Tourism	01/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided fact sheet and offered to arrange a meeting, if required.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Broome Chamber of Commerce	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided fact sheet and offered to arrange a meeting, if required. Advised that INPEX is taking an open and transparent approach to consultation and discussions will be held directly with pearling businesses in Broome, local fishing clubs (Broome), local Aboriginal and Torres Strait Islander traditional owners and entities and the offshore commercial fishing industry in Western Australia.	Not applicable – correspondence sent by INPEX.
	04/02/2019	Email / letter from stakeholder	N/A	Confirmed receipt. Advised the fact sheet has been forwarded internally.	Not a relevant matter – General correspondence only.
Broome Visitors Centre	01/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	INPEX provides the Broome Visitors Centre with the consultation fact sheet.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
IPB Petroleum	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
KRED Enterprises	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	07/02/2019	Meeting with stakeholder	N/A	KRED enterprises advised that INPEX should ensure that any messaging about seismic activity to be carefully considered. Recommended that Bardi Jawi PBC needs to be consulted (this request was actioned via engagement with the Bardi Jawi PBC on 09/05/2019). KRED enterprises raised no other concerns regarding environmental impacts or consultation requirements.	Not a relevant matter - Correspondence does not relate to the stakeholder's functions, interests or activities being affected by the petroleum activity. The stakeholder raised no concerns or objections regarding the seismic survey. The request to consult with the PBC has been actioned via engagement with the Bardi Jawi PBC on 09/05/2019.
Nyamba Buru Yawuru Ltd	23/01/2019	Email / letter to stakeholder	N/A	Extends initiation to Yawuru representatives to have a personal briefing with INPEX's Environment Team representatives in early February.	Not applicable – correspondence sent by INPEX.
	23/01/2019	Email / letter from stakeholder	N/A	Accepts invitation to meet, timing to be confirmed. [NB: a meeting was not able to be scheduled during consultation efforts in Broome]	Not a relevant matter – General correspondence only.
Oil Spill Response Limited (OSRL)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

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Pathfinder Energy	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
RPS Asia-Pacific Applied Science Associates (APASA)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Santos	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	05/02/2019	Email / letter from stakeholder	Yes: - Fact Sheet	Confirming receipt. Advises information will be shared to relevant personnel within Santos.	Not a relevant matter – General correspondence only.
Shell	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	04/02/2019	Email / letter from stakeholder	N/A	Confirmation of receipt.	Not a relevant matter – General correspondence only.
Toll Group	31/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Vocus Communications	08/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Identified that the seismic acquisition will occur in the vicinity of the Ichthys CPF and FPSO where their North West Cable System connects. Requested Vocus provide advice in relation to seismic surveys in vicinity to the cable that need to be considered. Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	08/02/2019	Email / letter from stakeholder	Yes: INPEX fact sheet reattached	Email forwarded to another Vocus personnel for attention/information.	Not applicable – correspondence sent by INPEX.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
	11/02/2019	Email / letter from stakeholder	N/A	Vocus advised that the Survey line is not going over a repeater so there is no risk from this seismic activity and the Survey will not have any effect on the cable system. Stakeholder advised they have no recommendations or requirements.	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information has been incorporated into Section 4.9.12 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
Woodside	04/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	04/02/2019	Email / letter from stakeholder	N/A	Confirmation of receipt.	Not a relevant matter – General correspondence only.
Civil Society					
Australian Institute of Marine Science (AIMS)	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	24/01/2019	Email / letter to stakeholder	N/A	Additional request for the stakeholder to flag any forthcoming research on the Kimberley that INPEX should be aware of.	Not applicable – correspondence sent by INPEX.
	24/01/2019	Email / letter from stakeholder	N/A	Confirming receipt of both emails and noting of additional request.	Not a relevant matter – General correspondence only.
	01/02/2019	Email/ letter from stakeholder	N/A	Asking if INPEX has received invitation to NW Shoals to Shore Research Program forum where much of the current research relevant to the activity will be presented.	Not a relevant matter – General correspondence only.
	12/02/2019	Email / letter to stakeholder	N/A	Confirmation/acknowledgment of email dated 01/02/2019 (INPEX has received invitation and will attend).	Not applicable – correspondence sent by INPEX.
Ardyaloon Incorporated	04/04/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. INPEX noted stakeholder wishes to engage stakeholder as Chairperson of Ardyaloon Incorporated and in particular in relation to the Ardyaloon Hatchery and associated Trochus Shell industry. INPEX wanted to offer Ardyaloon Incorporated the opportunity of a face-to-face meeting with representatives from INPEX to further inform the organisation and answer any queries Ardyaloon may have.	Not applicable – correspondence sent by INPEX.
	09/05/2019	Meeting with stakeholder	N/A	The stakeholder was provided with a map of the proposed survey and informed of what a seismic survey was, why they are conducted and what could be expected. Ardyaloon asked about the impact on turtle stocks and dugong populations. INPEX explained there would be temporary impacts due to noise, such as displacement, however it would have no lasting or physical impacts. INPEX explained the role of MFOs and that the survey will avoid peak whale migration/calving times. INPEX also advised of extensive consultation conducted with fisherman and tour operators. The stakeholder ultimately did not feel too concerned following the consultation.	Not a relevant matter – General discussion only and stakeholder was satisfied with the information provided. No objection, claim or other relevant matter raised.

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CSIRO	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	The initial email was returned. The email was forwarded to another contact within the organisation.	Not a relevant matter – General correspondence only.
	24/01/2019	Email / letter to stakeholder	N/A	Requested that the stakeholder flag any forthcoming research on the Kimberley that INPEX should be aware of.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Centre of Marine Science and Technology (CMST) - Curtin University	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	24/01/2019	Email / letter to stakeholder	N/A	Requested that the stakeholder flag any forthcoming research on the Kimberley that INPEX should be aware of.	Not applicable – correspondence sent by INPEX.
	24/01/2019	Email / letter from stakeholder	N/A	Confirmation of receipt. Advised that staff within Curtin are pressed for time, but someone may review the material and provide comments.	Not a relevant matter – General correspondence only.
	24/01/2019	Email / letter to stakeholder	N/A	Thanking stakeholder for the above email.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Djarindjin Aboriginal Corporation (DAC)	13/03/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019. INPEX offered an opportunity to brief the stakeholder on the activity. Stakeholder asked to advise INPEX if they would be interested in meeting with INPEX personnel about this matter at Djarindjin community on the morning of Friday 12 April 2019 and INPEX would make arrangements.	Not applicable – correspondence sent by INPEX.
	10/04/2019	Email / letter to stakeholder	N/A	Email to advise that due to closure of Djarindjin road, briefing would have to be postponed. INPEX would contact stakeholder to reschedule briefing.	Not applicable – correspondence sent by INPEX.
	10/04/2019	Email / letter from stakeholder	N/A	Acknowledgment and also enquiry about which DAC stakeholders INPEX would like to attend the briefing.	Not a relevant matter – General correspondence only.
	10/04/2019	Email / letter to stakeholder	N/A	Confirmed the invitation was intended for the DAC Board members and CEO.	Not applicable – correspondence sent by INPEX.
	10/04/2019	Email / letter from stakeholder	N/A	Advised next Board meeting was scheduled for 16 May 2019 and enquired if this would this suit INPEX for a briefing.	Not a relevant matter – General correspondence only.
	01/05/2019	Email / letter from stakeholder	N/A	Email to inform INPEX that next Board meeting was rescheduled for 29 and 30 May 2019. We will not be able to attend on the 9 May 2019 due to other commitments that were prearranged sometime ago.	Not a relevant matter – General correspondence only.

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Lombadina Aboriginal Corporation (Dampier Peninsula)	13/03/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) - types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019. INPEX offered an opportunity to brief the stakeholder on the activity. Stakeholder asked to advise INPEX if they would be interested in meeting with INPEX personnel about this matter at Djarindjin community on the morning of Friday 12 April 2019 and INPEX would make arrangements.	Not applicable – correspondence sent by INPEX.
	10/04/2019	Telephone call to stakeholder	N/A	Telephone call to arrange briefing date - changed to 9 May following closure of Djarindjin Road (refer Djarindjin Aboriginal Corporation email of 10/04/2019	Not a relevant matter – General correspondence only.
	09/05/2019	Meeting with stakeholder	N/A	The stakeholder was provided with a map of the proposed survey and informed of what a seismic survey was, why they are conducted and what could be expected. Lombadina Aboriginal Corporation asked about the impact on turtle stocks and dugong populations, as well as risks associated with oil spills impacting the coastline and tidal creek system. INPEX explained there would be temporary impacts due to noise, such as displacement, however it would have no lasting or physical impacts. INPEX explained the role of MFOs and that the survey will avoid peak whale migration/calving times. INPEX also advised of extensive consultation conducted with fisherman and tour operators. The stakeholder ultimately did not feel too concerned following the consultation.	Not a relevant matter – General discussion only and stakeholder was satisfied with the information provided. No objection, claim or other relevant matter raised.
Western Australian Marine Science Institution (WAMSI) - Kimberley research station	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	24/01/2019	Email / letter to stakeholder	N/A	Requested that the stakeholder flag any forthcoming research on the Kimberley that INPEX should be aware of.	Not applicable – correspondence sent by INPEX.
	29/01/2019	Email / letter from stakeholder	N/A	Confirming receipt. Advises there is no scientific work in the area that WAMSI is aware of.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
University of Western Australia Oceans Institute	23/01/2019	Email / letter to stakeholder	Yes: - Fact Sheet	Provided stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach. Advised that all feedback, comments and queries were welcome and provided contact details to do so. Requested feedback be provided by 11 March 2019.	Not applicable – correspondence sent by INPEX.
	23/01/2019	Email / letter from stakeholder	N/A	Confirming receipt. Advises they will share with senior staff and the Oceans Graduate School and other research collaborators.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Recreational Fishing					
Broome Fishing Club (BFC)	22/01/2019	Email / letter to stakeholder	N/A	INPEX briefly describes activity and offers to meet in Broome to discuss further	Not applicable – correspondence sent by INPEX.
	01/02/2019	Email / letter to stakeholder	N/A	Forwards fact sheet. Extends invitation to meet at an organised Broome consultation event.	Not applicable – correspondence sent by INPEX.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
	07/02/2019	Meeting with stakeholder	Yes: Presentation slides	Briefing to stakeholder held in Broome. Minutes summary: - INPEX provided introduction and an overview of INPEX Australia. Also provided an overview of the proposed activity and Environment Plan. - BFC advised that the current recreational fishing limit is at 50 nautical miles. - BFC notes that 5 charter fishing operators travel to Scott Reef. Identifies two features where fishing takes place, particularly during the July billfish tournament (annual). - BFC advises that their main fishing competition season is July to August, however the Operational Area is a long distance from competitions. - BFC notes that fishing could take place at Rowley Shoals up to Scott Reef, and fishing also takes place out from James Price Point (no concerns raised). - BFC advised that the shallow (approximately 45 metre water depth) bank in the southern part of the 2D acquisition area is too far offshore to be targeted by recreational fishers, even in the larger boats.	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information (i.e. recreational fishing activity/patterns) has been incorporated into Section 7.2.2 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
	15/02/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes (INPEX / Broome Fishing Club)	Forwards draft minutes from the meeting held in Broome on 7 February. Requests BFC checks minutes for accuracy.	Not applicable – correspondence sent by INPEX.
	16/04/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes (INPEX / Broome Fishing Club)	Following up on meeting minutes confirmation. Advises stakeholder of the changes in regulations to enhance transparency and the new requirement to publish the full EP online. Informs stakeholder of opportunity to request specific information is not published.	Not applicable – correspondence sent by INPEX.
	19/06/2019	Email / letter to stakeholder	Yes: - Final meeting minutes (INPEX / Broome Fishing Club)	Follow up with signed copy of meeting minutes. Stakeholder advised to notify INPEX if anything is incorrect.	Not applicable – correspondence sent by INPEX.
Broome North Fishing Club (BNFC)	22/01/2019	Email / letter to stakeholder	N/A	Advised of proposal to undertake offshore exploration activities. Expresses interest in meeting and proposed a date. Advised environmental experts from the team will be present.	Not applicable – correspondence sent by INPEX.
	22/01/2019	Email / letter from stakeholder	N/A	Stakeholder confirms interest in meeting.	Not a relevant matter – General correspondence only.
	22/01/2019	Email / letter to stakeholder	N/A	Proposes meeting date for the 6th of February	Not applicable – correspondence sent by INPEX.
	25/01/2019	Email / letter from stakeholder	N/A	Confirms meeting on 6th of February	Not a relevant matter – General correspondence only.
	29/01/2019	Email / letter to stakeholder	N/A	Proposes time and place to meet.	Not applicable – correspondence sent by INPEX.
	30/01/2019	Email / letter from stakeholder	N/A	Stakeholder extends invitation to organisational committee.	Not a relevant matter – General correspondence only.
	01/02/2019	Email / letter to stakeholder	Yes: - Fact sheet.	Advises stakeholder on who from INPEX will be attending the meeting. Extends initiation to general stakeholder consultation meeting that will be held in Broome around the same time. Provides stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach.	Not applicable – correspondence sent by INPEX.

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		07/02/2019	Meeting with stakeholder	Yes: Presentation slides	Briefing to stakeholder held in Broome. Minutes summary: - INPEX provided introduction and an overview of INPEX Australia. Also provided an overview of the proposed activity and Environment Plan. - BNFC advised a fishing charter goes to Scott Reef, including one operator who does a trip to the reef in late September - Advised that Broome recreational fishers travel offshore to a maximum distance of 15 nautical miles for smaller boats, and 40 nautical miles (approximately 75-80 metre water depth) for larger boats (Members of the club tend to not travel as far as the planned seismic program.) - BNFC notes some fishing takes place near the Lacepede Islands - BNFC advises there is a planned billfish tournament (five days) in July 2019 - Stakeholder is interested in understanding how INPEX interprets seismic data (INPEX provided response - not related to the activity).	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information (i.e. recreational fishing activity/patterns) has been incorporated into Section 7.2.2 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
		15/02/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes (INPEX / Broome North Fishing Club)	Sent draft minutes from meeting in Broome on 6 February. Requests BNFC review for accuracy.	Not a relevant matter – General correspondence only.
		17/02/2019	Email / letter from stakeholder	N/A	Confirms accuracy of meeting minutes. Confirmed the fishing club does not have any competitions scheduled After August 2019.	Not a relevant matter – General correspondence only.
		16/04/2019	Email / letter to stakeholder	Yes: - Final meeting minutes (INPEX / Broome North Fishing Club)	Minutes of meeting on 07/02/2019 provided. Advised stakeholder of the changes in regulations to enhance transparency and the new requirement to publish the full EP online. Informs stakeholder of opportunity to request specific information is not published.	Not applicable – correspondence sent by INPEX.
	Recfishwest	01/11/2018	Email / letter to stakeholder	N/A	Email to Recfishwest requesting meeting to discuss upcoming proposed exploration activities, including 2D seismic survey.	Not applicable – correspondence sent by INPEX.
		01/11/2018	Email / letter from stakeholder	N/A	Confirmed receipt of email and proposed INPEX suggest a time to meet.	Not a relevant matter – General correspondence only.
		05/11/2018	Email / letter to stakeholder	N/A	Proposal to hold meeting on 09/11/2018	Not applicable – correspondence sent by INPEX.
		06/11/2018	Email / letter from stakeholder	N/A	Confirmation of meeting time on 09/11/2018.	Not a relevant matter – General correspondence only.
		06/11/2018	Email / letter to stakeholder	N/A	Advised INPEX participants to the meeting.	Not applicable – correspondence sent by INPEX.

	STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
		09/11/2018	Meeting / video conference with stakeholder	N/A	Briefing held with stakeholder at Recfishwest office. Summarised below: **Introductions** - INPEX led with an introduction of personnel present and their roles within INPEX. - Recfishwest representative described the objectives and values of Recfishwest. Provided an introduction of their role within the organisation **Overview of INPEX's proposed exploration activities** - INPEX representatives provided an brief overview of INPEX. - INPEX advised that they had previously engaged with Broome North Fishing Club during Ichthys consultation activities, and had provided the fishing club with a new barbeque trailer. - INPEX explained exploration activates planned in the region. Presented an overview map of INPEX Australia acreage. **Overview of the proposed seismic survey activity and EP** - This part of the meeting relates to a separate activity outside the scope of this EP Understanding of recreational fishing interests and activities off the Kimberly Coast - INPEX advised of desire to better understand recreation fishing interests associated with the offshore permit areas and what level of engagement would be appropriate. - Recfishwest advised that the Pilbara region (Exmouth to Port Hedland) has the greatest level of recreational fishing activity and interaction with offshore oil and gas on the NW shelf. Advised that recreational fishers generally accepted O&G activity since many are employed in the resources industry. Historically, relationships have been good. Fishers generally happy as long as activities avoid disrupting fishing, tournaments and fishing grounds during peak fishing periods. - Recfishwest advised recreational fishing off Broome and the Kimberley coast is less extensive. Provided information about specific fishing interests in this region, including sailfish and billfish fishing, key fishing spots, main fishing zones and fishing boat routes. **Stakeholder consultation with recreational fishers** - Recfishwest advised the best way to consult with recreational fishers is through Recfishwest and directly with clubs and carter operators. - Recfishwest identified the relevant clubs that should be contacted: Broome Fishing Club and North Broome Fishing Club. Advised WA Game Fishing Association should also be contacts. - INPEX advised of plans for ongoing stakeholder consultation	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information (i.e. recreational fishing activity/patterns) has been incorporated into Section 7.2.2 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
		22/11/2018	Email / letter to stakeholder	Yes: - Draft meeting minutes from: Meeting with Recfishwest re INPEX's proposed offshore exploration activities.	Sent Recfishwest a copy of the minutes from the meeting held 9/11/2018. Requested the contact details for WAGFA, relevant fishing clubs and charter operators. Requested research papers relevant to billfish in the Kimberley region.	Not applicable – correspondence sent by INPEX.
		11/12/2018	Email / letter to stakeholder	N/A	Follow up email regarding meeting minutes confirmation. Also requested abovementioned research papers.	Not applicable – correspondence sent by INPEX.
		14/12/2018	Phone call to stakeholder	N/A	Attempted call to Recfishwest. A voicemail was left requesting confirmation of receipt of meeting minutes. Also requested was the abovementioned contact details (email from the 22/11/2018) and research papers.	Not applicable – correspondence sent by INPEX.
		14/12/2018	Email / letter from stakeholder	Yes: - Draft meeting minutes attached with Recfishwest comments	Provided response to correspondence from INPEX dated 22/11/2018, 11/12/2018 and 14/12/2018. One comment provided on the meeting minutes from the meeting dated 09/11/2018. The comment provided clarification around which fishing clubs have previously been engaged in INPEX consultation. Recfishwest provided the contact details for the relevant clubs and organisations.	Not a relevant matter – General correspondence only.
		14/12/2018	Email / letter to stakeholder	N/A	Acknowledgement of the comment provided on the meeting minutes. Requested update on the sailfish research papers.	Not applicable – correspondence sent by INPEX.
		14/12/2018	Email / letter from stakeholder	N/A	Advised that the availability of the research papers is being assessed. Will be in touch soon with the outcome.	Not a relevant matter – General correspondence only.
		14/12/2018	Email / letter to stakeholder	N/A	Acknowledged and thanked stakeholder.	Not applicable – correspondence sent by INPEX.

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		07/01/2019	Email / letter to stakeholder	Yes: - Final meeting minutes from: Meeting with Recfishwest re INPEX's proposed offshore exploration activities.	Meeting minutes from meeting dated 09/11/2018 signed and forwarded to stakeholder.	Not applicable – correspondence sent by INPEX.
		4/02/2019 (and 11/02/2019)	Email / letter to stakeholder	Yes: - Fact sheet - Meeting minutes (reattached)	Supplied stakeholder with factsheet. Advised that INPEX will consult with the WA Game Fishing Association. Advised that INPEX will be speaking directly with pearling businesses in Broome, local fishing clubs (Broome), local Aboriginal and Torres Strait Islander traditional owners and entities and the offshore commercial fishing industry in Western Australia.	Not applicable – correspondence sent by INPEX.
		08/05/2019	Email / letter to stakeholder	N/A	Following up on previous correspondence and providing a general update. Advised that INPEX met in Broome with Broome Fishing Club and Broome North Fishing Club in February. Clubs had little concern regarding the survey due to distance offshore and timing of the survey which excludes the period 1st June to 31st October (most months of the dry season fishing period and Billfish Classic tournament are avoided). Reminded stakeholder that INPEX could now provide the completed risk assessment relevant to fish and fisheries, if required.	Not applicable – correspondence sent by INPEX.
		09/05/2019	Email / letter from stakeholder	N/A	Confirms that no risk assessment is needed and Recfishwest is satisfied with the level of consultation and the fact that proposed activities are going to avoid peak fishing seasons and areas.	Not a relevant matter – General correspondence only.
		13/05/2019	Email / letter to stakeholder	N/A	Confirmed receipt. Advised Recfishwest will be informed of key updates going forward.	Not applicable – correspondence sent by INPEX.
	Western Australian Game Fishing Association	04/02/2019	Email / letter to stakeholder	Yes: - Fact sheet.	Advises stakeholder who from INPEX will be attending the meeting. Extends initiation to general stakeholder consultation meeting that will be held in Broome around the same time. Provides stakeholder with general information about the activity, including the location, purpose of seismic surveys and regulatory commitment. Attached a fact sheet with more detailed information on: - the location and forecast schedule of the activity; - a description of the 2D seismic activity (methodology) -types of vessels to be used and logistical arrangements, as known; and - environmental management approach.	Not applicable – correspondence sent by INPEX.
		05/03/2019	Email / letter from stakeholder	N/A	Identified two clubs that may be affected by the survey activity (Broome Fishing Club and Broome North Fishing Club). Advised they have contacted the clubs for input - both of which advised the seismic survey is outside of their usual range of activities and will not be affected by the survey.	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information (i.e. recreational fishing activity/patterns) has been incorporated into Section 7.2.2 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
		05/03/2019	Email / letter to stakeholder	N/A	Acknowledgement	Not applicable – correspondence sent by INPEX.
Commercial Fishing and Pearling Stakeholders						
	Industry associations					
	Australian Southern Bluefin Tuna Industry Association (ASBTIA)	20/03/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
		01/04/2019	Email / letter from stakeholder	N/A	Confirmed the operating area is outside of those known activities and sensitivities for the Southern Bluefin Tuna fishery. Advised the ASBTIA does not need to receive updates on the survey. Stakeholder noted that, while it is welcome that INPEX will assess the time periods that are important for environmental sensitivities, it is also necessary to clarify how these will be prioritised when determining an appropriate window for the activity. What baseline field surveys will be undertaken before the seismic vessel starts the activity, and how often will these be re-surveyed during and post activity? And wondering why survey acquisition lines are outside of the petroleum permit boundaries.	Relevant matter – Stakeholder has requested information or provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information has been incorporated into Section 7.2.1 of the EP. INPEX responded to stakeholder's queries 07/05/2019, as below. The stakeholder raised no concerns or objections regarding the seismic survey.

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	07/05/2019	Email / letter to stakeholder	N/A	[WAFIC on behalf of INPEX] Thanked ASBTIA for taking time to comment on the proposed seismic survey activity, and for confirming that the survey Operational Area is outside of those known activities and sensitivities of the Australian Southern Bluefin Tuna Fishery. Confirmed that the process of the risk assessment undertaken during development of the EP identifies the potential level of risk to individual sensitivities and identifies the priority considerations when determining the window of opportunity for the survey. INPEX identified the factors that are considered in order to determine the appropriate survey window (e.g. the timing of key environmental and socio-economic receptors; the proximity of sensitive habitat areas; species distribution and range; species vulnerability / conservation status etc.). Confirmed that comprehensive baseline information is available for the sensitivities and proposed survey location, (e.g. studies completed in the region by government scientific bodies; research undertaken by petroleum titleholders; Australian Marine Parks Science Atlas; DoEE publications etc.). Therefore, INPEX believes that sufficient baseline information is available without needing to undertake bespoke baseline field surveys. Advised that INPEX has completed its environmental risk assessment process and identified a range of measures to reduce environmental impacts and impacts to the commercial fishing industry. The overall residual risk of the survey is low and no significant or irreversible population level impacts are expected, therefore no specific environmental monitoring is proposed. INPEX acknowledged that seismic surveys may have some temporary effects on fishes and fisheries, noting that previous studies into long term impacts of seismic surveys are largely inconclusive (examples provided e.g. Thomson et al. 2014; Przeslawki et al. 2016; Carrol et al. 2017; Bruce et al. 2018; Evans et al. 2018). INPEX addressed the ongoing research on seismic impacts and the difficulty/cost in performing these studies. Advised that due to the temporary nature of effects from seismic surveys, monitoring is not often undertaken. Explained that a limited number of acquisition lines extend beyond the boundaries of exploration permits WA-532-P and WA-533-P to tie-in with locations where existing exploration data is available, thereby enabling a more complete model of the subsurface geology to be developed.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Commonwealth Fisheries Association	21/03/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	11/06/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Contacted the new executive officer / key contact for the Commonwealth Fisheries Association. Noted since CFA predecessor left, colleagues at Atlantis Fisheries have been the short-term contacts. Advised about the consultation that had taken place with Commonwealth-managed fisheries for the INPEX 2D seismic survey: • North West Slope Trawl Fishery o WAFIC Email Template, fact sheet and supplementary fisheries information sent to the three companies this fishery. o Follow up fishery-specific risk assessment has been sent. • Western Tuna and Billfish o WAFIC Email Template and attachment above sent to the active fisher. o Follow up fishery specific risk assessment sent. • Southern Bluefin Tuna o Agreed engagement, noting no active fishing, all information sent to the Australian Southern Bluefin Tuna Industry Association (ASBTIA). o INPX has provided a response specific to queries raised. o ASBTIA noted the survey Operational Area is outside of those known activities and sensitivities of the Australian Southern Bluefin Tuna Fishery, no further updates required. • Joint Authority Shark o WAFIC Email Template and attachment above sent to Atlantis Fisheries. o Follow up fishery specific risk assessment had been sent. Requested stakeholder advise if they would like a copy of the above risk assessments, or any additional information.	Not applicable – correspondence sent by INPEX. Response received from stakeholder 13/06/2019, as below.
	13/06/2019	Email / letter from stakeholder	N/A	Stakeholder acknowledged receipt of email of 11/06/19, but did not request to receive copy of the risk assessments.	Not a relevant matter – General correspondence only.
Pearl Producers Association of WA (PPA)	02/11/2018	Email / letter to stakeholder	N/A	Email to PPA requesting meeting to discuss the exploration activities, including the proposed 2D seismic survey activity.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	26/11/2018	Email / letter to stakeholder	N/A	Follow up email to propose a meeting in the following week.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	26/11/2018	Phone call to stakeholder	N/A	[INPEX tried to leave voice message but unable to do so as voice mail full].	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

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	05/12/2018	Phone call to stakeholder	N/A	Left phone message.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	14/12/2018	Phone call to stakeholder	N/A	Left phone message.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	15/01/2019	Phone call to stakeholder	N/A	Left phone message.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	15/01/2019	Email / letter to stakeholder	N/A	[Sent by INPEX] Restating desire to meet to discuss exploration plans and potential impacts on pearl producers. Advised that INPEX understands there is a preferred process to engage pearling operators through PPA; however, INPEX plans to arrange to meet and brief relevant pearling operators in Broome on the seismic activity in early February (tentatively, between 6-8 February). Notwithstanding the formal requirement to consult relevant stakeholders as part of the offshore environmental approval process, INPEX wishes to main good relationships with pearling operators in Broome (a key area of operations for the company) and INPEX saw engagement on the proposed 2D seismic survey activity as part of its regular and ongoing engagement activities with those operators. Advised that INPEX was prepared to schedule and hold those meetings, but welcomed PPA advice on the proposal/direct engagement. Also advised that further information on the potential impacts and risks of the survey and proposed management measures could be provided to the PPA prior to submission of the environment plan to NOPSEMA, if it is of interest to the PPA.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	29/01/2019	Email / letter to stakeholder	N/A	Advised stakeholder of meeting with pearl producers in Broome on 7 February. Provided date, time and purpose of meeting, and extended and invite. [Stakeholder did not attend].	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	01/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[Group email] INPEX provided pearling stakeholders with fact sheet prior to meetings in Broome.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	15/02/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	[Group email] Minutes of 7 February briefing to pearl producers in Broome copied to PPA.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	20/03/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	25/03/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	[Group email] Requests stakeholder review minutes. Advises of changed transparency rules about publishing Environment Plans. Advises the risk assessment will be available soon on underwater noise risk assessments for planktonic communities, benthic communities, and pearling and aquaculture. Requests stakeholders confirm interest in receiving this information. Requests best contact for the PPA Research and Development Committee, who were previously flagged as interested in the impact assessment.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	02/04/2019	Email / letter to stakeholder	N/A	[WAFIC on behalf of INPEX] Requested opportunity to catch up about he proposed seismic survey activity (WAFIC and stakeholder offices in same building).	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	07/05/2019	Email / letter to stakeholder	Yes: - Impact assessment for planktonic communities, benthic	[Group email] Provides the impact assessment for planktonic communities, benthic communities, and pearling and aquaculture. Summarises key points on the proposed survey timing, management and communications. Request for any enquiries/feedback on the impact assessment information to be provided to INPEX by 7 June. Also sent final signed copy of meeting minutes [no comments/requests for amendment received on draft minutes circulated on 15/02/19 and 25/03/19].	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
				Minutes of 7 February briefing to pearl producers in Broome (copied to PPA), summarised as follows: INPEX provided an overview and explanation of the proposed 2D seismic activity. Explained that here have been 58 2D MSSs in the region over the last 50 years, the most recent of which was in 2010. Explained the proposed MSS was approximately 50 km from the nearest pearling lease. The activity will avoid the humpback whale migration. Plans to undertake begin the activity as early as December 2019, but likely commencing early 2020, and will last ~5 months. Advised changes had been made to the original MSS area to avoid coastal sensitivities (e.g. Scott Reef, Browse Island and Adele Island). - A pearl producer raised concerns regarding the risk of seismic surveys on the juvenile spat growth and the impacts to the food sources and the food chain linked to pearl oysters, as there could be impacts associated with any changes in tidal flows. - INPEX advised it would provide the impact assessment sections of the EP which include assessment on these two points (food sources and larval recruitment). - The pearl producer noted that 50 kms is not a large distance in terms of water movement. - INPEX acknowledged this, noting that pearl oysters can detect the particle motion component of a sound wave (water and sediment borne vibration). Acknowledged that impacts to larvae in the plankton can be lethal or sub-lethal at close range to a seismic source, and these impacts are being assessed. - INPEX observed that some inshore stocks of pearl oysters self-seed and do not receive significant numbers of larval recruits from offshore stocks. Advised stakeholders of ongoing studies that are measuring potential impacts. - The pearl producer advised their main concern is overlap with the pearl spawning period (October to March). The pearl producer noted that the PPA shares this concern, and asked ether INPEX had consulted with the PPA. - INPEX advised it had started consultation with fishing Operators via WAFIC, and recreational fishing clubs in Broome. Notes seismic does not have lethal affects on fish but can result in short-term behavioural changes. Notes that like pearl oysters, many demersal species cannot detect the sound pressure component of a sound wave, and are only sensitive to the particle motion component at close ranges (10s to 100s of metres). Advised the impact assessment primarily focuses on site-attached fish, which is also a focus of NOPSEMA (particularly in depths <60m). INPEX advised that Lynher Bank is a key area potential impacts to site-attached fish are being assessed. Advised INPEX will be able to provide the impact assessment sections when they are complete, but at this stage wanted to engage as early as possible to understand the stakeholder's concerns. - Pearl producer recommends INPEX consult with the PPA's Research and Development Branch. [NB: One stakeholder has redacted comments from this meeting - refer to Sensitive Matters Report]	
	11/06/2019	Email / letter to stakeholder	Yes: - Impact assessment for planktonic communities, benthic communities, and pearling and aquaculture (summary and full versions).	[WAFIC on behalf of stakeholder] WAFIC sent stakeholder impact assessment information for the pearl oyster managed fishery (as previously sent by INPEX to stakeholder and relevant pearl producers on 07/05/2019)	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	12/06/2019	Email / letter to stakeholder	N/A	[Group email] Follow-up on previous email which included the draft environmental risk assessment and management information for the Pearl Oyster Fishery. Advised that INPEX has not received any responses to date, and wanted to confirm that feedback could be considered if provided by the end of the week. Advised that INPEX's current plan is to submit its 2D seismic survey environment plan (EP) in July 2019. On submission to offshore petroleum industry regulator, NOPSEMA, the EP will be published online in full, and will be open for public comment for 30 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Western Australian Fishing Industry Council (WAFIC) * WAFIC is both a relevant stakeholder (commercial fishing industry representative) for the proposed offshore activity, and has also been contracted by INPEX to coordinate engagement with the commercial fishing industry (relevant individual licence holders	02/11/2018	Email / letter to stakeholder	N/A	Requested a meeting to discuss offshore exploration program. Requested feedback on planned seismic survey program and advice on consulting with members.	Not applicable – correspondence sent by INPEX. Response received from stakeholder 02/11/2018, as below.
	02/11/2018	Email / letter from stakeholder	N/A	Confirmed receipt of email and confirmed desire to meet to discuss the exploration activity. Requests a fact sheet that is specific to each commercial fishery, including information on activities, key indicator species and the food chain. Requests ALARP is demonstrated in initial consultation, including assessment of impacts on these three components.	Relevant matter – Stakeholder has requested information relevant to the petroleum activity and the stakeholder's functions, interests or activities. INPEX replied 05/11/2018 requesting meeting to discuss further, as below.
	05/11/2018	Email / letter to stakeholder	N/A	Email confirming receipt of correspondence. Proposed meeting time and agenda of the meeting. Confirmed understanding that Pearl Producers Association is located in the same building and, if possible, it would be useful to have a joint meeting.	Not applicable – correspondence sent by INPEX. Stakeholder agreed to meet on 08/11/2018.

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and other industry associations). Communications included here regard INPEX's engagement with WAFIC and its feedback as an industry representative.	08/11/2018	Meeting / video conference with stakeholder	N/A	Meeting held with stakeholder. [Signed meeting minutes sent to WAFIC on 02/07/2019] Meeting minutes summarised below: **Introductions - Roles at INPEX/WAFIC, and about WAFIC.** • WAFIC is looking for better ways for the oil and gas and commercial fishing industries to communicate. Specifically notes stakeholder fatigue within the commercial fishing industry. Notes that information provided on offshore petroleum activities often does not address the concerns of the fishing industry. **Overview of proposed seismic exploration activity and Environment Plan.** • INPEX explained fisheries are considered the most important stakeholder for this EP. Provided an overview of current INPEX operations in the North West Shelf. Provided an overview of the proposed seismic survey activity, including maps of proposed survey lines, timing, and shallow areas (i.e. Lynher Bank). • WAFIC noted common fisher concern with seismic occurring in shallow water. Noted that Pearl Oyster Fishers would also be interested in this activity. • INPEX advised work on the EP had begun and would include acoustic modelling to inform the assessment of impacts and risks o fish stocks / fisheries. Advised INIPEX would like to begin consultation as early as possible to incorporate fisheries feedback to the assessment (e.g. concerns on particular fishing spots). **Understanding of WA fisheries intersects and activities overlapped by the 2D seismic survey.** • INPEX and WAFIC discussed and confirmed the fisheries that are relevant to the EP, which include the Northern Demersal Scalefish Managed Fishery, Mackerel Managed Fishery, North-west Slope Trawl Fishery, Pearl Oyster Fishery and the Broome Prawn Managed Fishery. • WAFIC confirmed the Northern Shark Fisheries overlap with the proposed survey area, which are closed to fishing but have potential to become active in the future. WAFIC raised protection of the key shark species as a relevant issue. • INPEX and WAFIC confirmed a number of other fisheries overlap with the proposed survey but their interests and activities do not overlap (e.g. Nearshore and Estuarine, Beche-de-mer, Trochus, Specimen Shell, Marine Aquarium and West Coast Deep Sea Crustacean). • WAFIC advised DPIRD's FishCube catch and effort system and VMS logbook data are relevant to understanding where fishing is taking place • INPEX recognised FishCube is a useful (although limited) tool. INPEX noted VMS logbook data is not available to the oil and gas industry. INPEX noted specific feedback was therefore needed to achieve the best resolution of fishing activity. **Approach to stakeholder consultation and transparency.** • INPEX described the current approach of identifying relevant fisheries was to use overlap with the licence area boundaries with the environment that may be affected by the activity. • WAFIC confirmed that this method of identification was not necessary, as some fisheries (identified above), have licences that overlap but will not be interested. • WAFIC advised expectations for consultation include a map showing overlap for each fishery, address relevant issues for each fishery and identify controls used to reduce to ALARP, and provide assurance that contractor will be held to the same expectations/controls as in the EP. • INPEX described consultation strategy (i.e. Fact sheet sent which also requests feedback; INPEX will then undertake risk assessments, which will be sent out when complete). • WAFIC advised it does not consider this to be sufficient, identifying fact sheets as a fatigue issue, and requests controls are identified up-front so that fishers can comment on those. Issues to consider include displacement, loss of catch and cumulative noise impacts. WAFIC advised that getting no response from a licence holder does not necessarily mean they are not interested, as they might just be busy/fatigued. • WAFIC advised is was a belief among fishing operators that behavioural changes in fish as a result of seismic negatively affect fishing and impact on fishing patters as well as spawning. • WAFIC advised of it's consultation expectations, which include provision of a bespoke fact sheet for each fishery, information on activity timing, provision of information which can identify the best window (e.g. spawning periods), inclusion of how ALARP has been reached. WAFIC requested a compensation mechanism if ALARP still significantly impacted fishers. • INPEX noted compensation wasn't applicable to all situations. INPEX acknowledged WAFICs recommendations in relation to fact sheets/consultation, but noted that that fact sheet was to provide early notification. Advised that the extent of magnitude of impacts were not yet known control measures can only be committed once fishing activities are understood in more detail. • WAFIC requested INPEX publish the EP for public comment in advance of transparency changes • INPEX confirmed it is willing to be transparent and will provide risk assessments and request comments prior to submission. [NB: this EP has been submitted post transparency changes] **Scientific research and environmental risk assessment.** • WAFIC note the FRDC Oil and Gas National Coordination Project. Once complete, reference gaps will be sent to FRDC to be prioritise for research. WAFIC requested that where there are gaps in research, fisher knowledge be used in EPs. • INPEX acknowledged the project, and will consider it in the EP if it is published prior to EP submission.	Relevant matter – Stakeholder has commented on dissatisfaction with previous consultation and lack of transparency. This information has been acknowledged and INPEX has assured ongoing transparent consultation and desire to achieve a workable outcome. Relevant matters discussed – Stakeholder has provided information on commercial fishers fishing activity, including relevant licence holders, which has been incorporated into Section 4 and 7.2 of the EP. Relevant matters discussed – Stakeholder has provided information on commercial fishers fishing activity, including relevant licence holders, which has been incorporated into Section 4 and 7.2 of the EP. INPEX took heed of WAFIC's feedback regarding approach and subsequently contracted WAFIC to facilitate identification and engagement with relevant fishers during stakeholder consultation. During development of the EP, INPEX acquired relevant FishCube catch and effort data to inform understanding of fishing activities and the associated risk assessments. INPEX noted WAFIC's request to include detailed information and commitments to fishers at the outset of consultation, but explained to WAFIC that this level of detail could not be confirmed until the risk assessments had been completed, which rely on long lead-in items such as modelling and research to inform the process. Therefore, it was not possible to provide the requested level of detail at the early stages of stakeholder consultation. However, as part of the stakeholder materials provided to WAFIC and fishers (provided materials on 21/12/2018 and 07/05/2019), INPEX provided maps of relevant fisheries and summaries of INPEX's understanding of each relevant fishery to supplement the generic stakeholder factsheet. INPEX requested feedback from fishers on this information and committed to providing fishers with more detailed risk assessments and details of control measures for comment, prior to submission of the EP to NOPSEMA. INPEX acknowledged the request for a compensation mechanism and advised that the matter needed to be considered in the context of the outcomes of the environmental risk assessment which had not yet been completed. Relevant matter, but FRDC Project not complete prior to submission of the EP to NOPSEMA. INPEX has made reference in the EP to anecdotal evidence provided by fishers during consultation.
	10/12/2018	Phone call to stakeholder	N/A	Confirmed that proposed timeframe for engagement with commercial fishing stakeholders (mid-December to January) would not be appropriate due to Christmas holiday/New Year period.	Not a relevant matter – General correspondence only. In light of this discussion, INPEX postponed commencement of consultation until February 2019.
	10/12/2018	Email / letter to stakeholder	N/A	Advised INPEX would like to meet with the PPA, a priority stakeholder for the EP, and that previous attempts to contact the association had been unsuccessful. Requested that WAFIC pass on request to meet.	Not applicable – correspondence sent by INPEX. WAFIC agreed to contact PPA (see record dated 20/12/2018 below) and INPEX also continued to make efforts to contact the PPA (see PPA consultation records above).

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		11/12/2018	Email / letter to stakeholder	Yes: - Draft meeting minutes from 8 Nov meeting	Email sent with draft minutes from 8 Nov meeting attached for WAFIC review.	Not applicable – correspondence sent by INPEX.
		20/12/2018	Email / letter from stakeholder	N/A	[With reference to INPEX email of 10/12/2018]. Advised it can be difficult to contact PPA. WAFIC agreed consultation is important for the seismic activity, and advised contact will be attempted at the start of January 2019.	Not a relevant matter – General correspondence only.
		21/12/2019	Email / letter to stakeholder	Yes: (consultation materials, including print-layout version of the information sheet)	INPEX provided WAFIC with consultation materials, including a print-layout version of the information sheet, maps and fisheries identification justification.	Not applicable – correspondence sent by INPEX.
		07/02/2019	Email / letter to stakeholder	Yes: Reviewed cover email for licence holders Fisheries supplementary information	INPEX provided revised cover email for licence holders and fisheries supplementary information which included information specific to each fishery: fishery licence area, description, gear types and usage, target species habitat and biology, summary of fishing activities and potential overlap with the survey. Feedback from fishery stakeholders requested by 8th April 2019.	Not applicable – correspondence sent by INPEX.
		15/04/2019	Email / letter from stakeholder	N/A	Following assessment of the information provided by INPEX and ongoing engagement with commercial fishers, WAFIC highlighted the following: • The NOPSEMA website states that for every environment plan, a titleholder undertakes consultation with relevant persons that could be affected by the proposed petroleum activity – i.e. potentially affected parties. o Offshore over the operational area of the proposed INPEX 2D survey by far the number one potentially impacted party is the commercial fishing sector. o We are the only stakeholders who will have their business interrupted. o Mitigation costs of the survey and future prospectively risk due to potential impact on the resource are a significant concern. o This survey will cause financial loss for commercial fishers. • Irrespective of when INPEX proposes to do this survey, both the NDSMF and the MMF will have their actual fishing activities significantly impacted. o Past surveys have shown that it is the commercial fishers who have had to make all the adjustments / all mitigations / all mitigation costs regarding seismic surveys with the survey dictating where and when they can fish and where and when they can set their traps. • Notes the survey is proposed to take 15 to 20 weeks (almost 4 months up to 5 months), with the potential to extend to 25 to 30 weeks (over 6 months up to approximately 71/2 months), should the survey be delayed due to adverse weather etc.	Concerns raised by stakeholder regarding impact of actual fishing activities, financial loss for commercial fishers and duration of the survey relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Section 7.2.1 of the EP. Control measures selected as a result of this matter being raised include: - Subdivision of the Acquisition Area into broad phased areas in an attempt to provide for segregation and avoid potential on-water conflict; - Proposed notifications to fishers prior to, during and following the survey; - Daily lookahead reports that can be provided to fishers with survey lines completed in previous 24 hours and proposed lines for the 48 hour period ahead - On the water communications with fishers - application to the National Offshore Petroleum Titles Administrator (NOPTA) for approval to vary the permit work program commitment in WA-532-P. Further, INPEX has committed to developing a compensation mechanism for fishers in the event there is a genuine impact to fishing activities that could not be avoided.
					• This proposed survey – location and water depths – covers the prime areas of the Northern Demersal Scalefish Managed Fishery (NDSMF) and the Mackerel Managed Fishery Area 1 (MMF).	**Relevant matter –** Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. This information on the main fishing areas of the NDSMF and MMF has been incorporated into Section 7.2.1 of the EP.
					• Noting the duration of the survey and the potential overlay with peak spawning / juvenile development there is significant concern regarding impact on the key indicator species for each fishery.	Concerns raised by stakeholder regarding potential overlap with peak spawning / juvenile development for the key indicator species for each fishery relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Section 7.1.4 of the EP. It is acknowledged that some commercially important fish stocks are understood to be more constrained geographically, but they are not expected to be significantly impacted either. For example, goldband snapper is a key demersal species targeted in the region that is understood to have geographically distinct genetic stocks in different parts of the NWMR. The Kimberley stock of goldband snapper has been identified as potentially being a distinct genetic stock extending from the Timor Sea to at least 122°E (Lynher Bank). Goldband snapper in other locations (e.g. Timor Sea and the Pilbara) are potentially separate stocks with evidence of only limited genetic connectivity (Lloyd et al. 2000; Newman et al. 2000; Ovenden et al. 2002). However, goldband snapper spawns throughout its range along the outer continental shelf, releasing numerous batches of pelagic eggs into the water column over several months (Lloyd 2006; Newman et al. 2008). Spawning of these stocks occurs across hundreds of kilometres of continental shelf, therefore, fish stock recruitment is not expected to be significantly impacted as a result of localised mortalities associated with the transient seismic source; especially when compared with mortalities from other natural causes that will occur ubiquitously across the entire region.

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				• WAFIC noted from the seismic survey fact sheet that the "precise timing is also subject to vessel availability, weather condition and other operational factors" o An ongoing concern with all seismic survey consultations is that ultimately, no matter how much consultation takes place with potentially affected parties, it is the availability of the vessel which ultimately determines the survey timing – always at a cost to commercial fishers. o Despite intention, this can make consultation appear to be a farce, a tick-the-box process when all along, it is vessel availability which will determine when a proponent proposes to conduct a survey, not the best possible outcome from the consultation process and other impacts. o WAFIC are seeking the best possible "window of opportunity" for this INPEX 2D survey with a survey vessel to be booked around this best possible timing.	Concern raised by stakeholder regarding the availability of the vessel which ultimately determines the survey timing relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter does not have merit, because of the multiple factors (e.g. whale migration/calving) that determine the timing of the seismic vessel (refer to INPEX explanation provided 07/05/2019). Therefore, this matter has not been considered further in the EP. INPEX's strategy may differ from other operators, as it is not proposing to undertake the survey from June-October.
				• WAFIC acknowledged there is a limited amount of research, some research saying there is little or no impacts, other outcomes have determined there are impacts and other research projects resulting in an unclear outcome. It is unfortunate that in the past other seismic proponents have selectively looked at research outcomes which favour their work, papers to the contrary are also available. • Commercial fishers, over the decades of oil and gas activities in the north-west, are adamant that seismic surveys disrupt fish activity / fish behaviours, impact spawning and definitely impact actual fishing operations. Fishers know and understand their resource, where to fish, fish behaviours. In the absence of clear science we seek consideration of appropriate, knowledgeable fisher feedback.	**Relevant matter** raised. However, INPEX have used valid and recent available research to inform the impact assessments in the EP. INPEX have provided these to WAFIC openly for transparency and asked the stakeholder to flag any research that INPEX can consider and has included this in the EP, where provided. INPEX has also consulted with fishing licence holders to incorporate their knowledge and views into the EP where appropriate, and requested fishers flag any research that INPEX can consider. The outcomes of the risk assessments and proposed control measures were shared with the stakeholder for consideration (refer to correspondence date 07/05/2019) and adequate time was allowed for review.
				• WAFIC stressed the need for a precautionary principal for the timing of this survey.	Relevant matter raised regarding the use of the precautionary principle. The precautionary principle and/or levels of conservatism have been applied and identified in the risk assessments in the EP, including in the assessment of impacts on fish stocks, spawning and juvenile stages. The outcomes of the risk assessments and proposed control measures were shared with the stakeholder (refer to correspondence date 07/05/2019).
				Noting the potential impacts to commercial fishers in the NDSMF and the MMF, WAFIC advised it looked forward to working with INPEX on an agreed framework for a formal "make good" process, included in the environment plan for this survey for impacted commercial fishers. • WAFIC looked forward to potential support from INPEX, similar to the "good standing" arrangement with Quadrant/Santos which is funding the AIMS seismic research project currently well underway in WA.	Not a relevant matter – General correspondence only. [e.g. general correspondence such as acknowledgement of receipt, salutations, etc.]
				WAFIC included the following broader points for INPEX's reference: • As per previous engagement and confirmation from INPEX, it is our expectation that there will be no recreational fishing from any INPEX, contractor or subcontractor vessels / support vessels throughout this activity. • Please make sure INPEX's communication strategy with their extended staff / contractors / subcontractors ensures all agreed activities in the EP (such as the recreational fishing information above and points below) have been clearly communicated to this broad network.	Concerns raised by stakeholder regarding recreational fishing from vessels and communication of EP commitments to relevant contractors relates to the petroleum activity and the stakeholder's functions, activities or interests. These two matters have merit and are administered/managed in accordance with INPEX internal policy and good industry practice. This matter is not addressed further in the EP.
				• WAFIC requests that INPEX and its contractors and sub-contractors acknowledge the right of access for commercial fishers and give right of way to commercial fishers / commercial fishing activity and respect and protect the rights of commercial fishers in these waters and do their utmost not to disrupt any commercial fishing activity or disruption of fish schooling/aggregations etc – near the proposed survey and with support and supply vessels transiting fishing grounds.	Request raised by stakeholder regarding right of access for commercial fishers relates to the petroleum activity and the stakeholder's functions, activities or interests. However, this matter does not have merit. INPEX recognises that fishers have a right to access their resource but cannot agree to give exclusive right of way to commercial fishers because of factors including manoeuvrability of the seismic vessel, COLREGS, and fishers' access to alternative fishing grounds, as assessed in Section 7.2.4 of the EP. INPEX acknowledges that support vessels have the ability to avoid other vessels. The outcomes of the risk assessments and proposed control measures have been shared with the stakeholder (refer to correspondence date 07/05/2019).
	18/04/2019	Phone call to stakeholder	N/A	Phone call to discuss information and draft risk assessments to be provided to fishers. WAFIC also suggested that they believe some seismic EPs are selective with the research they reference in EPs. INPEX stressed that it would take a fair and balanced view of the most relevant and available research and would consider other papers if WAFIC had any they considered to be relevant. WAFIC agreed to send through references, including papers on sound effects on mackerel.	Concern regarding bias and selectivity with research does not have merit with regards to the INPEX 2D seismic survey EP. The risk assessment is based on balanced review of available scientific literature. Other available studies identified by WAFIC have been considered by INPEX in Section 7.1.6 of the EP. Inclusion of references has been confirmed to the stakeholder (refer to correspondence below dated 07/05/2019.

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		07/05/2019	Email / letter to stakeholder	Yes: - EP Risk Assessment sections (containing disturbance to other marine users and noise impacts on commercial fish species).	*[NB: INPEX's response is contained under WAFIC's points from 15/04/2019. WAFIC's points are in* ***bold*** *]* *The draft risk assessment sections for plankton, benthic communities, fishes, commercial fisheries, pearling and aquaculture were provided to WAFIC as attachments.* **Following assessment of the information provided by INPEX and ongoing engagement with commercial fishers, WAFIC highlights the following:** **• The NOPSEMA website states that for every environment plan, a titleholder undertakes consultation with relevant persons that could be affected by the proposed petroleum activity – i.e. potentially affected parties.** **o Offshore over the operational area of the proposed INPEX 2D survey by far the number one potentially impacted party is the commercial fishing sector.** **o We are the only stakeholders who will have their business interrupted.** **o Mitigation costs of the survey and future prospectively risk due to potential impact on the resource are a significant concern.** **o This survey will cause financial loss for commercial fishers.** INPEX notes and acknowledges this. The potential for impacts to commercial fisheries is considered in the EP risk assessments and we have proposed measures to reduce the potential for fishers to be impacted. As discussed with you, INPEX is developing a compensation policy so that there is a mechanism to assess, on a case-by-case basis, claims for loss of catch or costs incurred by fishers if they are genuinely impacted by the 2D seismic survey. The compensation policy is specifically referenced in the EP. **• This proposed survey – location and water depths – covers the prime areas of the Northern Demersal Scalefish Managed Fishery (NDSMF) and the Mackerel Managed Fishery Area 1 (MMF).** **• Noting the survey is proposed to take 15 to 20 weeks (almost 4 months up to 5 months), with the potential to extend to 25 to 30 weeks (over 6 months up to approximately 71/2 months), should the survey be delayed due to adverse weather etc.** **• Irrespective of when INPEX proposes to do this survey, both the NDSMF and the MMF will have their actual fishing activities significantly impacted.** INPEX acknowledges that the NDSMF and the MMF (Area 1) are the fisheries most likely to have interactions with a seismic survey vessel in the proposed survey Operational Area. INPEX has reviewed and mapped historical fishing effort (DPIRD Fish Cube) data for these fisheries, and these are included in the EP and in the attachments that we have provided to stakeholders in these fisheries. We note the significance of Lynher Bank as one of the MMF's key fishing grounds and the distribution of NDSMF fishing effort along the mid and outer continental shelf. While both the NDSMF and MMF operate year-round, the MMF (Area 1) mainly operate between approximately April/May and October/November. This information was confirmed by an MMF Area 1 licence holder. What is also apparent from the historic fishing data and assessments by WA DPIRD is that fishing peaks between June and October (approximately 80% of the annual fishing effort consistently occurs during this period). We are pleased to confirm that the proposed window of opportunity for the 2D seismic survey will avoid the period from 1 June to 31 October, therefore, most MMF fishing activities are expected to be avoided. Mackerel fishing activities in other significant coastal locations, such as the coastal waters between Beagle Reef and Cassini Island, are avoided completely. As the NDSMF operate year-round, please appreciate that it is unfortunately not possible to completely avoid their fishing activities. INPEX has proposed a number of measures that we hope will facilitate communication between INPEX, the seismic contractor and commercial fishers, in addition to developing a "make good" process.	Not applicable – correspondence sent by INPEX.

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					o Past surveys have shown that it is the commercial fishers who have had to make all the adjustments / all mitigations / all mitigation costs regarding seismic surveys with the survey dictating where and when they can fish and where and when they can set their traps. We note and appreciate that planning or relocating fishing activities in response to seismic surveys is a contentious and difficult issue for fishers. Both the petroleum industry and the fishing industry have rights to access resources in the Australian Exclusive Economic Zone. However, due to the pre-determined nature of seismic survey lines and in accordance with international maritime collision prevention regulations (the International Regulations for Preventing Collisions at Sea 1972 [COLREGs]) the seismic survey vessel's classification as a vessel limited in its ability to manoeuvre when towing equipment (which by definition is unable to keep out of the way of another vessel), fishing vessels (and other vessels) that may be operating nearby are requested to give way to the passage of the survey vessel. This is not done disrespectfully, but it is the understanding of the petroleum industry that fisheries have access to alternative fishing grounds from which viable catch rates may be sustained without disturbance from the survey. A seismic survey vessel towing several kilometres of equipment has limited ability to manoeuvre and limited, if any, alternative options than the vessel speed and line plan it must follow to achieve the geophysical objectives of the survey. Therefore, INPEX has proposed a number of proactive measures to better communicate with fishers and define where and when the survey vessel will be operating. There is an option for fishers to register to receive email updates on survey activities including a 48-hour "lookahead" each day during the survey. We encourage fishers to register for these updates, particularly vessel-based and shore-based personnel who are involved in the day-to-day fishing activities. The updates will detail where and when the survey vessel is anticipated to be operating and should, therefore, assist in determining which fishing grounds may be affected and which will be accessible over the days ahead. We do of course appreciate your feedback on this proposal. To reiterate, in situations where fishers still feel they have been disadvantaged by the 2D seismic survey activities, INPEX intends to implement a compensation process to assist with claims. INPEX has made efforts to understand the spawning, recruitment and life stages of various commercially targeted and key indicator fish species in the region, as well as their geographical extent and biological connectivity, to assess the potential risks of the 2D seismic survey to these stocks. **• Noting the duration of the survey and the potential overlay with peak spawning / juvenile development there is significant concern regarding impact on the key indicator species for each fishery.** The assessment of disturbance to fish spawning aggregations considers that fish may temporarily divert effort away from spawning at particular aggregation sites if the survey vessel passes at a time when conditions at that location are suitable for spawning. However, even if it is conservatively assumed that an entire spawning event at an affected aggregation site is prevented (rather than simply delayed for a short period), impacts may still not be discernible from "normal" conditions as the various key target fish species in the region tend to spawn thousands or millions of eggs on multiple occasions over many months. These multiple, broadcast spawning behaviours, by their very nature, are used by fishes to offset naturally high predation rates and regional-scale mortality from a range of other causes, thereby spreading the risk over large areas and long timeframes. Therefore, the ecological significance of localised and temporary effects to individual spawning aggregations from a passing seismic survey vessel are very small compared with other natural factors and variability. In the case of many fish species, the juvenile stages are spent in nearshore nursery habitats and fishes gradually move offshore as they mature to recruit to the adult stocks. Other species spend their juvenile stages in in similar depth ranges and habitats as adults. Research into the effects of sound on fishes has been conducted on both the juvenile and adult life stages of fishes and, overall, the exposure thresholds and reported effects in the EP broadly reflect both life stages.	

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					• We note from your fact sheet that the "precise timing is also subject to vessel availability, weather condition and other operational factors" **o An ongoing concern with all seismic survey consultations is that ultimately, no matter how much consultation takes place with potentially affected parties, it is the availability of the vessel which ultimately determines the survey timing – always at a cost to commercial fishers.** **o Despite intention, this can make consultation appear to be a farce, a tick-the-box process when all along, it is vessel availability which will determine when a proponent proposes to conduct a survey, not the best possible outcome from the consultation process and other impacts.** **o We are seeking the best possible "window of opportunity" for this INPEX 2D survey with a survey vessel to be booked around this best possible timing.** As you will appreciate from your own experience working previously for a petroleum titleholder, contracting for major activities such as a seismic survey is a lengthy and complex process. It is difficult to confirm the exact timing of a survey when initial stakeholder consultation commences, potentially months or years in advance of the activity, as this is influenced by: • The timing of potential acceptance of the EP by NOPSEMA, which itself is a lengthy and uncertain process given the level of scrutiny that NOPSEMA applies and now the extended timeframe that incorporates the new transparency and public comment arrangements. • The contracting and availability of a seismic vessel – at times there may not be a suitable vessel available in the region or even in Australian waters. Seismic operators may also have contractual agreements with other titleholders to complete one survey before being able to relocate to commence another survey. A range of unforeseeable delays can lead to some uncertainty which prevents specific dates being confirmed until nearer the time of survey vessel mobilisation. • The timing of key sensitivities in a region that need to be considered in detail during the EP risk assessment process before a more focussed window of opportunity is proposed. Therefore, when consultation for the 2D seismic survey commenced, the timeframe communicated to stakeholders was broad and subject to a number of factors. The EP will be submitted with the intent of being valid for more than one year (i.e. 2019 – 2021) due to this uncertainty. The window of opportunity now proposed for the survey (1 November to 31 May in any year covered under the EP) narrows the timeframe down to some degree, but due to the significant commercial risk involved in committing a survey vessel prior to contracting and other unforeseeable issues such as inclement weather, equipment issues, etc., some flexibility is required. The potential survey duration specified is also conservative for the same reasons. Therefore, vessel availability is one of several key considerations when it comes to considering the practicability of survey timing around fishing activities and environmental sensitivities. However, vessel availability is certainly not the sole driver and the window of opportunity is selected based on several factors, including but not limited to: o the timing of key environmental and socio-economic receptors (please refer to the matrix of key sensitivities included in Attachment 1) o the hearing ability and sensitivity of those receptors to sound from the seismic survey o the proximity of sensitive habitat areas to seismic survey areas o the species distribution and range o the level of overlap (in space and time) by the 2D seismic survey with important habitats and life stages of sensitive species o species vulnerability / conservation status o the potential for impacts to species at both an individual level and at a population level. If there is an opportunity to avoid key fishing periods of spawning periods, these are considered very carefully and adopted where reasonably practicable or if necessary to ensure impacts will be reduced to an acceptable level. Please appreciate though that many fishing activities occur throughout the year, and different species of fish also spawn at different times of year, therefore, proposed survey timeframes are unlikely to be favourable to all fishers' activities and interests. The proposed window of opportunity for the 2D seismic survey does, however, avoid key periods for mackerel fishing and avoids the spawning periods of some demersal and pelagic fish species, either partially or completely. **• Commercial fishers, over the decades of oil and gas activities in the north-west, are adamant that seismic surveys disrupt fish activity / fish behaviours, impact spawning and definitely impact actual fishing operations. Fishers know and understand their resource, where to fish, fish behaviours. In the absence of clear science, we seek consideration of appropriate, knowledgeable fisher feedback.** INPEX has considered the feedback from fishers. We have made clear note of their claims in the EP risk assessments where relevant. For example, the assessment of risks to commercial fisheries specifies what the common issues and grievances raised by fishery stakeholders during consultation are. Feedback such as goldband snapper "turning off", as indicated by one NDSMF licence holder, has also been included in the risk assessment, which acknowledges that fishes' motivation to feed, take bait or enter fish traps may be temporarily reduced. Please note however, that it is not always appropriate to simply accept anecdotal evidence without question in all cases. This is because sometimes perception of issues, or the cause of impacts being a seismic survey, may not always be correct and potential assumptions or misperceptions also need to be considered carefully. Therefore, INPEX considers the merit of each claim, balanced with available and relevant science.	

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					• We acknowledge there is a limited amount of research, some research saying there is little or no impacts, other outcomes have determined there are impacts and other research projects resulting in an unclear outcome. It is unfortunate that in the past other seismic proponents have selectively looked at research outcomes which favour their work, papers to the contrary are also available. INPEX's risk assessments include a comprehensive review of relevant studies into the hearing mechanisms and sensitivity of different types of fish, as well as impacts to fish behaviours and fish catches. This includes known, key research, in many instances, peer reviewed. We have not been selective of research that favours seismic. In some cases, it is necessary to provide critique so that the limitations of research are clear and not misinterpreted. INPEX accepts that there may be other research available, which it is happy to consider. For example, we have reviewed and included the study into mackerel by Doksæter et al. (2016) that you provided following our phone call with you on 18th April 2019 [correction: paper incorrectly referenced; now referenced as Silve et al. 2016 in the EP]. **• We stress the need for a precautionary principal for the timing of this survey.** The precautionary principle is a key consideration throughout the development of the EP and is applicable in situations where there is both scientific uncertainty and a threat of serious or irreversible environmental damage. While there is certainly scope for further research into the effects of seismic surveys on the behaviours of fish species in this region, a significant amount of research has occurred over a number of decades that provides understanding of the hearing sensitivity of different types of fishes to sound, as well as a number of studies into the effects of seismic surveys on fish behaviours, eggs and larvae that provide an understanding of the potential magnitude of impacts from the seismic survey. This provides reasonable insight into how fishes are likely to be affected. Based on the available science, a number of credible and conservative impact scenarios are considered in the risk assessments, but serious or irreversible population level impacts are not expected. **• Noting the potential impacts to commercial fishers in the NDSMF and the MMF, we look forward to working with INPEX on an agreed framework for a formal "make good" process, included in the environment plan for this survey for impacted commercial fishers.** Thank you. The policy and process will be in development over the next few months and INPEX will invite WAFIC to review and provide feedback. **• We look forward to potential support from INPEX, similar to the "good standing" arrangement with Quadrant/Santos which is funding the AIMS seismic research project currently well underway in WA.** INPEX is not currently undertaking any research programs which look at the effects of seismic surveys. **Broader points for INPEX's reference include:** **• As per previous engagement and confirmation from INPEX, it is our expectation that there will be no recreational fishing from any INPEX, contractor or subcontractor vessels / support vessels throughout this activity.** **• Please make sure INPEX's communication strategy with their extended staff / contractors / subcontractors ensures all agreed activities in the EP (such as the recreational fishing information above and points below) have been clearly communicated to this broad network.** Selection and management processes are in place to ensure that contractors working for, or on behalf of, INPEX are able and willing to meet the minimum business expectations of INPEX, including those related to HSEQ and risk management. With respect to commercial fishing, all contractual documentation states that no recreational fishing is to occur from vessels during the activity. Prior to the activities described in the EP commencing, inductions are conducted for all personnel (including INPEX representatives, contractors, subcontractors and visitors) before they start work on survey and support vessels. Inductions cover the health, safety and environment requirements including that recreational fishing is not allowed. **• WAFIC requests that INPEX and its contractors and sub-contractors acknowledge the right of access for commercial fishers and give right of way to commercial fishers / commercial fishing activity and respect and protect the rights of commercial fishers in these waters and do their utmost not to disrupt any commercial fishing activity or disruption of fish schooling/aggregations etc – near the proposed survey and with support and supply vessels transiting fishing grounds."** As noted above, both the petroleum industry and the fishing industry have rights to access resources in the Australian Exclusive Economic Zone, but neither industry has exclusive rights over the other. Due to the pre-determined nature of seismic survey lines and in accordance with international maritime collision prevention regulations (COLREGs) the seismic survey vessel's classification as a vessel limited in its ability to manoeuvre when towing equipment (which by definition is unable to keep out of the way of another vessel), fishing vessels (and other vessels) that may be operating nearby are requested to give way to the passage of the survey vessel.	

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					It is the understanding of the petroleum industry that fisheries will typically have access to alternative fishing grounds from which viable catch rates may be sustained without disturbance from the survey. A seismic survey vessel towing several kilometres of equipment has limited ability to manoeuvre and limited, if any, alternative options than the line plan it must follow to achieve the geophysical objectives of the survey. For these reasons, INPEX recognises that fishers have a right to access their resource but cannot agree to give exclusive right of way to commercial fishers. INPEX's selected seismic contractor must comply with the COLREGS. This matter is not specific to INPEX or the 2D seismic survey but is one that applies globally. To reiterate, INPEX has proposed a number of measures to better define and communicate with fishers where and when the survey vessel will be operating. In situations where fishers still feel they have been disadvantaged by the 2D seismic survey activities, INPEX intends to implement a compensation process to assist with claims. Draft risk assessments available for review and comment For transparency, INPEX has attached a summary of the outcomes of our risk assessment, the proposed survey timing that has been selected considering the timing of all environmental sensitivities and commercial fishing activities, and INPEX's proposed management measures (Attachment 1). A copy of the draft risk assessment sections of the Environment Plan (EP) is also attached in full (Attachment 2). We trust that this will provide you with more specific information and helps to explain the predicted impacts of the survey and how INPEX intends to manage them. Should you wish to review and provide comment, we would appreciate your feedback by Friday, 7 June 2019. Please note that INPEX has volunteered this information ahead of submission of the EP to NOPSEMA and is in addition to the 30-day period that the EP will be open to public comment following submission of the EP. To reiterate, the key points are: Proposed survey timing: • The EP will be submitted to NOPSEMA with the intent of allowing the survey to be undertaken at some point in time between the fourth quarter of 2019 and the end of 2021. • INPEX has reviewed and assessed key environmental sensitivities and socio-economic activities (including commercial fishing activities) in the region and determined that the most appropriate window of opportunity for the survey to take place is between 1 November and 31 May. • No seismic activity will occur in the period from 1 June to 31 October. • The year and the exact start and end dates of the survey within the proposed November-to-May window of opportunity are subject to the acceptance of the EP by NOPSEMA, INPEX engaging a seismic survey contractor and the availability of a seismic survey vessel, weather conditions and other operational factors. • The exact start date will be communicated once confirmed and prior to commencement of the survey. Proposed management measures and "make good" policy: • INPEX is exploring options to reduce the extent and duration of seismic data acquisition in WA-532-P, potentially by up to 28%. INPEX plans to apply to the National Offshore Petroleum Titles Administrator (NOPTA) to vary its work commitment in WA-532-P accordingly. • Communication and coordination – INPEX will notify commercial fisheries of the commencement of the 2D seismic survey and provide ongoing information regarding the location of seismic survey activities. This will include sending notification of the location and start date of the 2D seismic survey to fishers 3 weeks prior to commencement; the option for fishers to receive daily updates on progress and the more specific location of proposed survey activities for the next 48 hours ahead; on-the-water communications; and notification of survey completion. • In addition, INPEX will consider – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. The specific details of the compensation policy are being developed. Prior to commencement of the 2D seismic survey, INPEX will provide information about the process and criteria by which claims for loss of catch, loss of income, or other costs incurred can be submitted.	
		13/06/2019	Email / letter from stakeholder	N/A	**Make good process** WAFIC thanked INPEX for formally including a "make good" / compensation process into the EP. WAFIC notes that impacts to commercial fishing are not just about potential impacts to actual fishing activities but also incorporates potential impacts to the resource (and therefore future prospectively). WAFIC suggested INPEX contact a commercial fishing stakeholder [name redacted - refer Sensitive Matters Report], who is in the process of working through make good arrangements with for another seismic activity and will be able to offer some experiences / information regarding what did or did not work from a commercial fisher's perspective. Also suggested INPEX speak with NERA who are working on the Collaborative Seismic EP project, an EP which will include a formal compensation pathway / process.	Relevant matter – INPEX responded on 01/07/2019 (see below). Compensation policy and process to be developed in consultation with relevant stakeholders and the INPEX Commercial Team. A commitment to develop a compensation/make-good process has been included in Section 9 of the EP. Potential impacts to future prospectivity of the fish resource are difficult to identify and demonstrate. The burden of proof for claims for compensation in this regard needs to be discussed. INPEX is part of the Collaborative Seismic EP project and is seeking to align with the protocol to be developed. The outcome of this process will be determined separately from the 2D seismic survey EP and cannot be determined prior to submission of the EP for public comment. It is not appropriate to comment on commercial discussions with other operators or bodies.

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				NDSMF and Seismic Scheduling Acknowledges the NDSMF operates all year round and there is no defined "window of opportunity" to schedule a survey or offshore activities. Acknowledges that seismic vessels, due to their limited manoeuvrability have right of way on the water. Requested advance contact between the survey operator and the two fishing companies operating in the NDSMF to discuss crucial times so that the survey vessel can make changes to their schedule if fishing vessels are targeting particular hot spots at the time the surveys vessel looks to be coming though. Advises that the best communication method is to liaise with fishers directly to seek their direct input. It may be that 48 hour look ahead via email can / cannot be accessed offshore by our vessels, or regular radio contact at sea. Advised WAFIC is not in position to make comment confirm, and INPEX will need direct feedback from key operators in the NDSMF and MMF.	Relevant matter. Request for communication with the NDSMF is acknowledged. Control measures were provided (via WAFIC)to the NDSMF and MMF for a suitable period for consideration, and no comments were received from individual fishers. Control measures included in the draft risk assessments provided to stakeholders included: - Subdivision of the Acquisition Area into broad phased areas to reduce the area of potential interaction with fishers; - Proposed notifications to fishers prior to, during and following the survey; - Daily lookahead reports that can be provided to fishers with survey lines completed in previous 24 hours and proposed lines for the 48 hour period ahead - On the water communications with fishers. INPEX has subsequently requested (01/07/2019) that WAFIC provide the contact details of fishers so that the communication protocol can be discussed.
				Potential Impacts to Key Indicator Species (spawning) etc. Notes INPEX feedback and reference to research in regard to potential impacts to key indicator species. Advises that WAFIC still agrees with fisher concerns that there is an impact on the resource, irrespective of how big or small it can / cannot be measured by. Notes this is a global issue/concern. Raises concern in regard to ALARP levels - specifically that WAFIC/fishers never know whose ALARP level and what this level actually is. Asks whether ALARP is uniform across all proponents or open for interpretation. Notes INPEX comments that "serious or irreversible population level impacts are not expected." WAFIC comments that this is just as anecdotal as fisher feedback from their on-the-water experience. Restates the importance of including potential future prospectively impact as part of the "make good" assessment for this survey.	Concerns raised by stakeholder regarding potential overlap with peak spawning / juvenile development had been raised previously. This has been assessed in Sections 7.1.4 and 7.1.6 of the EP. The stakeholder's feedback that there is an impact on the resource is not considered to have merit, based on the reasons and references presented in Sections 7.1.4 and 7.1.6 of the EP, as provided to the stakeholder for review on 07/05/2019. Specifically, occasional behavioural disturbances to spawning groups of fish are acknowledged, but the level of impact is predicted to be small in the context of natural variability. No adult fishes will be removed from the spawning biomass / allocated stock (no fish are predicted to be killed). In addition, with reference to goldband snapper, the Australian Government's Fisheries Research & Development Corporation has previously noted that long-lived species such as goldband snapper are less likely to be affected by short-duration environmental/climatic changes (of one or a few years), because adult stocks comprise fish that have been recruited over many years (Martin et al. 2014). Therefore, in comparison, the occasional, short-term, transient and localised disturbances to groups of fish as a result of the seismic survey would have impacts many orders of magnitude smaller than regional scale environmental/climatic events that would affect entire stocks, and the survey is unlikely to result in a discernible impact on the stocks. An assessment of ALARP and justifications for adopting / not adopting particular control measures were provided in Sections 7.1.4 and 7.1.6 of the EP, as provided to the stakeholder for review on 07/05/2019. It is not appropriate for INPEX to provide guidance on the definition of ALARP for other proponents or to WAFIC. INPEX notes useful guidance is provided by NOPSEMA (See N-04750-GN1344 Revision 4 Environment Plan content requirements Section 3.5.2).
	14/06/2019	Email / letter from stakeholder	N/A	WAFIC advised that WAFIC had met with DPIRD (Fisheries) yesterday to discuss the FishCube process prior to it being released for public access. Notes that WAFIC were able to get an understanding of the limitations with the data - in particular due to confidentiality clauses with less than three vessels operating at a time, the "N/A" factor. Noted that DPIRD advised that INPEX EP writers had reviewed the FishCube data for the 2D survey and are liaising with the Department on how INPEX may interpret this, with initial interpretation information in place on how INPEX had looked at the data this far. WAFIC advises they will defer formal feedback on this topic to DPIRD, however wanted to also raise concerns that proponents are considering "interpreting" data. Advised that WAFIC do not believe current practice will deliver the best / most accurate outcome for the EP and an unacceptable / less than accurate risk assessment for our fisheries. Advised that commercial fishing is moving to a more corporate structure, the days of many small operators are being replaced by a very small number of larger operators, often fully vertically integrated international businesses. Advised that in any context in any EP, any reference to only one or only two vessels does not have merit and extrapolating data for the unknown "N/A" blocks (assuming that there is little effort or a low catch level) also does not have merit. Explained that the size, capacity and capability of vessels currently operating in the north can mean that one vessel operating in a 10x10 or a 60x60 block can actually deliver a significant /competitive level of catch. Noted that there is potentially significant environmental and commercial impact on the block and single-businesses.	Relevant matter NB: WAFIC deferred formal feedback/concern regarding FishCube interpretation to DPIRD. See correspondence with DPIRD dated 05/06/2019 for assessment of merit and actions taken. INPEX has advised WAFIC (01/07/2019) that DPIRD feedback regarding FishCube data interpretation has been clarified with DPIRD.
	27/06/2019	Email / letter from stakeholder	Yes: Signed signature page of minutes	Confirmation/sign off of minutes of meeting from 08.11.18. Enquiry about communications around past seismic surveys (inclusion in communications to commercial fishers) and assessment of cumulative impacts.	Not a relevant matter – General correspondence only. [See correspondence dated 01/07/2019 for meeting minutes assessment of merit]
	27/06/2019	Email / letter to stakeholder	N/A	Confirmation that information on past seismic surveys had been included in the initial communication sent to all commercial fishers (ref commercial fishing group email of 26/02/19). Additionally, a section will be included within the EP that provides an assessment of cumulative impacts.	Not applicable – correspondence sent by INPEX.

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	01/07/2019	Email / letter to stakeholder	N/A	Thanked stakeholder for emails dated 13 and 14 June. **Fisher communications** Confirmed stakeholders feedback has been considered in the EP. Confirmed that communication with fishers will continue as per the proposed notification process. INPEX requested WAFIC provide the contact details of fishers so that communication protocol can be discussed further. **Make good process** The development of the compensation process will be based on the outcome of the detailed risk assessments in the EP. Advised INPEX will be in contact with WAFIC to advance the conversation regarding the compensation/'make good' process. **INPEX advice from DPIRD** Advised that INPEX have responded to DPIRD to clarify aspects of the information DPIRD provided (refer to correspondence dated 14/06/2019)	Not applicable – correspondence sent by INPEX.
	02/07/2019	Email / letter to stakeholder	Yes: Signed meeting minutes from 08/11/2018 (signed by INPEX and WAFIC)	INPEX emailed signed meeting minutes from meeting held 08/11/2018.	Not applicable – correspondence sent by INPEX.
	03/07/2019	Email / letter from stakeholder	N/A	WAFIC seek further information from INPEX prior to the EP being submitted to NOPSEMA and prior to the final 30 day review period. **Fisher communications** - WAFIC thanked INPEX for facilitating open communication with active commercial fishers operating in and around the proposed INPEX 2D seismic survey. - WAFIC confirmed that once the seismic survey dates have been confirmed, they will email fishers (Mackerel Area 1 and Northern Demersal Scalefish) and ask them to contact INPEX directly with the best / most appropriate contact person and email / phone contact details. ? **Make good process** - WAFIC thanked INPEX for confirming that a representative from the INPEX Commercial team will be in contact with WAFIC to advance the conversation regarding the make good process. - WAFIC noted that INPEX intends to inform the make good process based on the detailed risk assessments that were provided but, on behalf of commercial fishers stated: - INPEX's risk assessments are based on desktop research and desktop sound modelling. WAFIC asked INPEX if they ever cross-check sound levels during a survey to ascertain if the modelling was actually correct. - WAFIC and fishers do not agree with the view that there is not an impact to the food chain (plankton etc) and to fish spawning to ALARP levels. WAFIC referred generally to third party published seismic research but not to specific research. - WAFIC noted that INPEX is avoiding peak spawning for some key indicator species but is not in position to avoid all. - WAFIC considers that not including these potential impacts to fish stocks in the compensation framework is unacceptable and not to an ALARP level, on the basis that it is not to a level which commercial fishers find to be acceptable. - WAFIC do not agree with the risk assessment to goldband snapper, noting they spawn throughout the Kimberley region. WAFIC believes the survey will impact the spawning of the species along with other seismic surveys planned in the Kimberley. - WAFIC again recommended discussing the make good process with a commercial fishing stakeholder [name redacted - refer Sensitive Matters Report] and NERA who is working on a similar protocol and asked if INPEX had contacted them. **INPEX advice from DPIRD** - WAFIC thanked INPEX for confirming that there is ongoing discussion with DPIRD on this matter.	Relevant matters discussed in relation to matters previously discussed with stakeholder. Please refer to assessments of merit below relating to correspondence received from stakeholder on 05/07/2019, which included additional detail on the same matters as well as additional items.
	04/07/2019	Email / letter from stakeholder	N/A	WAFIC reiterated that they do not consider issues to have been addressed and requested further information, especially in relation to fish spawning and ALARP interpretation.	Not a relevant matter – General correspondence only.
	05/07/2019	Email / letter from stakeholder	N/A	WAFIC do not believe that INPEX has responded in full to the queries raised by WAFIC and therefore do not believe the consultation "circle" has been adequately closed out (and therefore the risk of NOPSEMA not accepting the EP). WAFIC request that INPEX ensure the following feedback and INPEX's response is included in full in the EP to be submitted prior to the 30 day public comment period.	Objection / claim / concern raised by stakeholder regarding stakeholder engagement relates to the petroleum activity and the stakeholder's functions, activities or interests. However, this matter does not have merit, because INPEX has acted in accordance with the OPGGS (Environment) Regulations Division 2.2A, and allowed a reasonable period (3 months) for the stakeholder to consider the information provided. Therefore, this matter has not been considered further in the EP. INPEX has reviewed the feedback received from WAFIC and has replied 08/07/2019. These records are included prior to submission of the EP and the public comment period.
				"Make Good" / Compensation - WAFIC does not support or agree with INPEX's decision that impacts to the resource (spawning etc) is not part of the "make good" process (see below further information under impacts to spawning). - WAFIC advises that INPEX should consult with Austral Fisheries, NERA and Santos regarding the compensation process.	Relevant matters - INPEX has previously advised that the INPEX Commercial Team will be in touch to progress the compensation agreement. INPEX is a contributing member of the NERA project and is seeking to align its compensation/make good policy.

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					Risk Assessment – potential impacts to spawning, food chain - WAFIC notes that DPIRD have raised concerns regarding impacts to fish spawning. WAFIC suggested that INPEX does not appear to have recognised DPIRD's concerns. - WAFIC does not support INPEX's risk assessment regarding goldband snapper spawning. - Appreciate INPEX is avoiding peak spawning for some key indicator species but is not in position to avoid all. This is an issue for the commercial fishing sector – not just in Western Australia, it is a global issue. - No fish species is distributed over the entire gazetted legal boundary of the NDSF.	INPEX acknowledges the concerns raised by both WAFIC and DPIRD re spawning and food chain impacts. These matters have been raised and addressed previously. Updated fish spawning information provided by DPIRD has been incorporated into Section 4 and Section 7.1.4 of the EP and the risk assessments reviewed based on the new information. The predicted impacts and overall level of risk are unchanged, and controls remain appropriate. The claim that there is potential for long term population level impacts is not considered to have merit, based on the reasons and references presented in Section 7.1.4 of the EP, as provided to the stakeholder for review on 07/05/2019. Specifically, occasional behavioural disturbances to spawning groups of fish are acknowledged, but the level of impact is predicted to be small in the context of natural variability in the wider stocks. No adult fishes will be removed from the spawning biomass / allocated stock (no fish are predicted to be killed). In addition, with reference to goldband snapper, the Australian Government's Fisheries Research & Development Corporation has previously noted that long-lived species such as goldband snapper are less likely to be affected by short-duration environmental/climatic changes (of one or a few years), because adult stocks comprise fish that have been recruited over many years (Martin et al. 2014). Therefore, in comparison, the occasional, short-term, transient and localised disturbances to groups of fish as a result of the seismic survey would have impacts many orders of magnitude smaller than regional scale environmental/climatic events that would affect entire stocks, and the survey is unlikely to result in a discernible impact on the stocks.
					- WAFIC note that INPEX's assessment is based on desktop research and acoustic modelling and asks if INPEX measure actual sound levels to verify predicted and actual levels. - We do not agree with the view (there is also some third party published seismic research) that the impact to the food chain (plankton etc) is to ALARP levels. - All up, the seismic survey will impact the overarching balance to the marine environment which will have an impact on commercial fishers and the resource.	The risk assessment provided to WAFIC for review already notes that fish species are not distributed evenly over the licence area and considers plausible sound exposure scenarios where the transient seismic source will occasionally pass and disturb groups of fishes, potentially at the same time as a group would normally spawn. The risk assessment is based on balanced review of available scientific literature. Despite INPEX offering to consider other research that WAFIC considers relevant (refer to correspondence dated 18/04/2019 and 07/05/2019), other references that WAFIC infer show that seismic have an impact have not been provided. References that indicate effects on fish and plankton are considered and acknowledged but the impact on populations is not expected to be significant. The JASCO acoustic model has been validated previously, including off North West Australia. Model predictions have been found to show good agreement between predicted and measured levels. The model is considered to be representative. Impacts and control measures have been considered and an ALARP assessment completed. The ALARP assessment and justifications were provided to WAFIC previously with the draft risk assessments on 07/05/2019. Avoiding the goldband snapper spawning period (November to May) is not practicable, given the identified need to avoid the June to October period that is important for more sensitive calving, nursing and resting humpback whales in the region.
					NDSMF and Seismic Scheduling INPEX have stressed seismic vessel right-of-way. Fishers also need to access the resource at certain times of the year when the resource is in that area. Simply put, this is how they fish. It is not just a case of fishing elsewhere, there may not be alternate fishing grounds in that area at that time of the year. INPEX's information that "The areas, A and B, are not intended to be areas where fishing activities are excluded; instead, they are intended to provide better definition of the general areas where the 2D seismic survey will be undertaken to assist in the spatial planning and coordination of concurrent survey and fishing activities so that it is clear what alternative fishing grounds are available without potential disruption" actually is not clear. INPEX has not responded to WAFIC's query on behalf of fishers for INPEX to work around fishing activity. Especially Northern Demersal Scalefish. Based on the FishCube information you have obtained from DPIRD, we expect INPEX will be able to schedule the seismic vessel around the historical catch information. Is this what INPEX plans to do? We would greatly appreciate FishCube consideration and advance contact between the survey operator and the two fishing companies operating in the NDSMF to discuss crucial times well ahead so that the survey vessel, if required, can make well-in-advance changes to their schedule around fishing activities.	Relevant matters raised INPEX has proposed a series of control measures and communication options, which were provided to WAFIC on 07/05/2019 and subsequently disseminated to fishers for comment. INPEX has not received feedback from fishers on these options or suggested alternatives. However, INPEX notes that the query is made by WAFIC on behalf of fishers. The two areas, A and B, are the first in the series of controls that will better define the survey location to fishers. While the two areas are broad, they begin to narrow the survey area down, and can help fishers identify if fishing grounds to the west of Broome or to the north of the Kimberley coast may be disrupted. Then, broad areas of alternative fishing grounds (demonstrated by FishCube catch and effort data to yield significant catch and effort) are available to be fished. In addition, notifications, daily lookaheads and on-the-water communications can inform fishers of specific locations of proposed seismic survey activities over the near-term. FishCube data has already been considered for the NDSMF and the MMF. The MMF fishing season (April/May to November) is largely avoided by the proposed survey window. NDSMF cannot be avoided as previously explained to WAFIC and NDSMF licence holders.

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						FishCube data does not indicate any temporal (seasonal or month by month) trends in NDSMF catch and effort that would enable survey scheduling. In some instances, it may be possible for the NDSMF and the seismic survey vessel to avoid each other and their respective working locations. However, as explained to WAFIC and fishers previously (risk assessments, summary information and covering emails provided 07/05/2019), due to the fixed acquisition line locations that must be acquired by the survey vessel, it is not possible to commit to avoiding fishers. Hence, INPEX has proposed to develop a compensation policy to address claims if there are instances where fishers are genuinely impacted, as communicated by INPEX to WAFIC and fishers previously on 07/05/2019. INPEX has also requested fishers contact details so that they can further discuss communication and coordination activities (see correspondence dated 01/07/2019 above), but notes that WAFIC has responded to say that they can assist in obtaining the relevant vessel crew / shore personnel contact details once the survey dates our confirmed and notified to fishers.
					Potential Impacts to Key Indicator Species (spawning) etc - WAFIC still 100% support and agree with DPIRD and fishers' concerns that there is an impact on the resource, irrespective of how big or small it can / cannot be measured by. - DPIRD also support this view and have formally advised INPEX of their expectations. It was noted that "the stocks in the area are fully allocated from a sustainability perspective and any addition risk could potentially impact long term sustainability for fish stocks." - Note that DPIRD provided information and expressed their concerns regarding Goldband Snapper – that the survey will extend completely over the Goldband Snapper spawning window in the Kimberley and therefore the Department expects INPEX to revise the window of opportunity to consider the new updated spawning information. - INPEX's reply that "full peak period of goldband snapper spawning, the assessment takes into account that spawning occurs over large areas and disturbance to any particular spawning event will be localised. Spawning will continue undisturbed elsewhere throughout the fishes' ranges and the majority of spawning aggregations in the region will be undisturbed." As noted above, DPIRD has confirmed that Goldband snapper occupy at depth range from ~60 to 200m, but are not equally distributed within that depth range. They predominantly occur in the 80-140 m depth range, i.e. where the bulk of the catch originates. - While spawning is likely to occur across the depth range, the bulk of spawning will occur where the bulk of the biomass is present. In essence this approximates Zone B of Area 2 of the NDSF, but note some northern areas of Zone A also contain some levels of goldband spawning biomass." How much of this specific area does this survey operate over?	INPEX acknowledges the concerns raised by both WAFIC and DPIRD re spawning. These matters have been raised and addressed previously. Updated fish spawning information provided by DPIRD has been incorporated into Section 4 and Section 7.1.4 of the EP and the risk assessments reviewed based on the new information. The predicted impacts and overall level of risk are unchanged. The WAFIC and DPIRD claim that there is potential for long term population level impacts is not considered to have merit, based on the reasons and references presented in Section 7.1.4 of the EP, as provided to the stakeholder for review on 07/05/2019. WAFIC's query regarding the area of Zone B / 80 - 140 m depth range overlapped by the survey is relevant, but INPEX does not consider this to be representative of the scale of impact. The risk assessment in Section 7.1.4 of the EP (provided on 07/05/2019 to WAFIC and fishers for review) already notes that fish species are not distributed evenly over the licence area and considers plausible sound exposure scenarios where the transient seismic source will occasionally pass and disturb different groups of fish. Separate groups of fishes exposed to sound from the seismic source will be localised with limited potential for significant repeat exposures due to the broad line spacing (i.e. ~5km) of the 2D seismic survey. Stocks across the Acquisition Area will not all be exposed and disturbed at the same time.
					WAFIC highlighted a statement made by INPEX: " …because sometimes perception of issues, or the cause of impacts being a seismic survey, may not always be correct and potential assumptions or misperceptions also need to be considered carefully. Therefore, INPEX considers the merit of each claim, balanced with available and relevant science." Perceptions and assumptions come from both sides of the equation. We acknowledge there is science noting limited impacts we also acknowledge science which does recognise impacts and everything in between. I am comfortable in stating that in many instances when the science is unknown that a regular comment has been to observe the \precautionary principle". We do not believe that the science unequivocally supports ALARP level impacts from this survey on peak fish spawning. For your reference only, DPIRD also noted to me that the use of the word "aggregation" is now not being used in these contexts, there was reference to different definitions globally of this term hence a preference for other descriptors such as "groups"	The INPEX risk assessments have been based on a balanced review of available and relevant science. Specifically, occasional behavioural disturbances to spawning groups of fish are acknowledged, but the level of impact is predicted to be small in the context of natural variability. No adult fishes will be removed from the spawning biomass / allocated stock (no fish are predicted to be killed). Despite previous seismic surveys occurring since 1960s along with commercial fishing activities, the spawning biomass and recruitment levels have remained sustainable, despite natural fluctuation and the effects of fishing, as highlighted in Section 7.1 in the EP. Seismic surveys are not expected to kill or remove an of the spawning adult population. In addition, with reference to goldband snapper, the Australian Government's Fisheries Research & Development Corporation has previously noted that long-lived species such as goldband snapper are less likely to be affected by short-duration environmental/climatic changes (of one or a few years), because adult stocks comprise fish that have been recruited over many years (Martin et al. 2014). Therefore, in comparison, the occasional, short-term, transient and localised disturbances to groups of fish as a result of the seismic survey would have impacts many orders of magnitude smaller than regional scale environmental/climatic events that would affect entire stocks, and the survey is unlikely to result in a discernible impact on the stocks. Feedback from DPIRD and WAFIC re revised terminology ("groups" instead of "aggregations") is acknowledged and this has been amended in the EP where relevant.

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					Risk assessed to ALARP Where we find it difficult is that generally speaking, proponents for all EPs use the expression "ALARP " as the panacea for all issues – it's been addressed to "ALARP levels". What is ALARP? At a recent industry meeting a representative of one of the major WA proponents acknowledged there's no agreed industry descriptor/definition re what ALARP is. Is it uniform across all proponents? Is it open for interpretation etc? We note your comment that "but serious or irreversible population level impacts are not expected". Not expected? How do you measure "not expected"? Not expected can also mean "may be reality but we're unsure". This is an assumption and based on limited science we see this statement as just as anecdotal as fisher feedback from their on-the-water experience. We do not believe assumptions such as this adequately address any fisher concern to seismic survey impacts on fish spawning etc to an "ALARP" level. Hence for us, it is very important that INPEX incorporates the potential future prospectivity impact, potential impact on the resource, as part of the "make good" assessment for this survey and not limit the make good process to potential impacts to fishing activity only. Santos have set the precedence for this inclusion, I hope you can have a fruitful discussion with them about how they worked this into the Timor Sea compensation engagement. **INPEX advice from DPIRD – Misinterpretation of FishPlan [sic] Information** As noted in a previous email, thank you for confirming that you have been in ongoing discussion with DPIRD on this matter. However, the misinterpretation of FishCube information could potentially impact a significant component of your risk assessment. We are loath to see any form of assumptions incorporated when as previously noted, less than three vessels can actually still be a significant volume of catch. In the interests of openness and transparency and considering this issue is part of this EP engagement, can INPEX please provide the response provided to DPIRD so we have a better understanding that INPEX is using this information in the manner it was intended to be used.	An assessment of ALARP and justifications for adopting / not adopting particular control measures were provided in Section 7.1.4 of the EP, as provided to the stakeholder for review on 07/05/2019. It is not appropriate for INPEX to provide guidance on the definition of ALARP for other proponents or to comment on comments made by other proponents that are not relevant to this EP or the Activity described. INPEX notes useful guidance is provided by NOPSEMA (See N-04750-GN1344 Revision 4 Environment Plan content requirements Section 3.5.2). WAFIC also seem to reference 'ALARP' in the context of 'acceptable level' of impact. Acceptable levels of impact have also been demonstrated in Section 7.1.4 of the EP, as provided to the stakeholder for review on 07/05/2019. Stakeholder's query relates to specific detail regarding INPEX's ALARP process, which was not provided in full with the risk assessments. This is detailed in Section 6 of the EP which will be included in the EP submitted for public comment. This specific query is not directly relevant to the seismic survey activity. Refer to INPEX ALARP process in Section 6 of the EP. Clarify ALARP / Acceptable. It is not appropriate for INPEX to provide guidance on the definition of ALARP for other proponents or to comment on comments made by other proponents that are not relevant to this EP or the Activity described. INPEX notes useful guidance is provided by NOPSEMA (See N-04750-GN1344 Revision 4 Environment Plan content requirements Section 3.5.2). As previously discussed with WAFIC (refer to correspondence above dated 01/07/2019), a compensation policy and process is to be developed in consultation with relevant stakeholders and the INPEX Commercial Team. This is being undertaken separately from the EP. Potential impacts to future prospectivity of the fish resource are difficult to identify and demonstrate. The burden of proof for claims for compensation in this regard needs to be discussed. The outcome of this process will be determined separately from the 2D seismic survey EP and cannot be determined prior to submission of the EP for public comment. The process will be developed and communicated prior to commencement of the survey. As previously communicated to WAFIC (refer to correspondence above dated 01/07/2019, the assumptions and limitations made in relation to FishCube data has been clarified with DPIRD. In the absence of being able to access confidential data, it has been necessary to make some assumptions. Further explanation and acknowledgement of limitations and assumptions has been added to Section 7.2 of the EP, including a statement added to each map. DPIRD was informed of the amendments that INPEX has included on 05/06/2019. No objection has been received. INPEX is proceeding on this basis, acknowledging the limitations.
					Cumulative Impacts As a final comment and something which INPEX needs to be aware of. The INPEX 2D survey in the north is not the only seismic consultation WAFIC is currently working on. We are working on multiple engagements for seismic surveys in the north of WA – over the same fisheries in the same broad region. Just because a previous or future proposed survey does not overlap the INPEX operational area they are still part of the cumulative impacts – same fisheries getting hammered and the way it is looking now, potentially one survey a year or more than once a year (impact after impact and ongoing disruptions).	**Relevant matter** - INPEX has developed a cumulative impact assessment that looks at the potential cumulative impacts from previous and potentially concurrent seismic surveys. This is included in Section 7.3 of the EP and will be available for review during the public comment period.
		08/07/2019	Email / letter to stakeholder	N/A	INPEX thanked WAFIC for making their position clear and agreed that our consultation process with WAFIC has not finished. Acknowledged that INPEX and WAFIC's positions on outstanding matters currently differ. INPEX assured WAFIC that concerns are take seriously and aim to resolve concerns to mutual satisfaction. Advised that any differences at the time of EP submission to NOPSEMA will be clearly noted and efforts to resolve identified differences will continue during the public consultation period. Advised that NIPEX is developing the make good process with the goal of arriving at an agreed industry-wide approach to compensation. Advised that INPEX is actively engaged with NERA on this issue and discussions will continue with WAFIC once the approach has been further developed.	Not applicable – correspondence sent by INPEX.
		09/07/2019	Email / letter from stakeholder	N/A	WAFIC replied: Thank you for your email. As part of the EP consultation process a proponent addresses issues, concerns and claims raised by potentially affected parties to the activity prior to the EP submission. As requested and as part of the formal consultation process for INPEX's seismic survey EP, it would be greatly appreciated if INPEX responds to each point raised below (I have highlighted points and added comment in red). We are not at a point where we can continue constructive dialogue when you have not answered specific queries raised.	**Relevant matter-** INPEX has previously demonstrated how the objections and claims have been considered based on merit and has provided responses (and draft risk assessments) to WAFIC relating to key issues. However, INPEX has reviewed and considered the detail of WAFIC's requests for further clarification. The concerns raised regarding the 2D seismic survey have been addressed, however, INPEX has noted that additional clarification could be provided. Further detail was provided to WAFIC via email on 17/07/2019 (see below).
		10/07/2019	Email/ letter from stakeholder	N/A	WAFIC believe that crucial information has not been provided and indicated they were unwilling to provide the final fishery stakeholder consultation report.	Objection / claim / concern raised by stakeholder regarding crucial infomation relates to the petroleum activity and the stakeholder's functions, activities or interests. However, this matter does not have merit, because it is related to a commercial deliverable that the Stakeholder agreed to provide for afee. . Therefore, this matter has not been considered further in the EP. The stakeholder has been informed of this decision and reasons provided (refer to correspondence dated 11/07/2019).

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	11/07/2019	Email/ letter to stakeholder	N/A	INPEX provided the following responses to the specific questions you raised in your previous correspondence with INPEX [*WAFIC questions are indicated in Bold font*]: **Make good process - Have you had the chance to contact [commercial fishing stakeholder name redacted - refer Sensitive Matters Report]?** - INPEX is working through a process with the goal of arriving at an agreed industry-wide approach to compensation. This includes understanding precedent. - The INPEX commercial team is actively engaged with NERA and other operators on this issue. - The INPEX commercial team will be in touch to discuss how to advance the make good process once the approach has been further developed. This process is separate from the EP and associated stakeholder consultation. **Risk Assessment -- Is this a key area of the proposed boundaries of the INPEX 2D survey? Does it marry in with the FishCube data obtained by INPEX?** - The depth ranges and preferred habitats of different fish species, including goldband snapper are recognised and considered in the risk assessment provided to WAFIC on 7 May 2019 (Attachment 2, Section 4.1.6). - The geographical extent and genetic connectivity of the stocks are considered. - INPEX's analysis of FishCube fishing effort data shows increased fishing effort throughout these depth ranges, as recognised and considered in the risk assessment provided to WAFIC on 7 May 2019 (Attachment 2, Section 4.2.1). **Does INPEX plan to cross-check the modelling data against real-time data during a survey to ascertain if the sound modelling was actually correct or any deviations to the modelling outcome versus actual situation?** - INPEX is not proposing to undertake in-field monitoring. The acoustic model used to inform the risk assessment has been validated previously, including off North West Australia. Model predictions were found to show good agreement between predicted and measured levels. - INPEX considers the model is representative and likely conservative. - In the risk assessment provided to WAFIC on 7 May 2019, INPEX provided an ALARP evaluation relating to sound source verification. **NDSMF and seismic schedule - INPEX has not responded to WAFIC's query on behalf of fishers for INPEX to work around fishing activity. Especially Northern Demersal Scalefish. Based on the FishCube information you have obtained from DPIRD, we expect INPEX will be able to schedule the seismic vessel around the historical catch information. Is this what INPEX plans to do?** - The seismic activity will not be scheduled around historical catch data. FishCube data does not indicate any temporal (seasonal or month by month) trends in NDSMF catch and effort that would enable survey scheduling. - In some instances, it may be possible for the NDSMF and the seismic survey vessel to avoid each other and their respective working locations. However, as explained to WAFIC and fishers previously (risk assessments, summary information and covering emails provided 07/05/2019), due to the fixed acquisition line locations that must be acquired by the seismic survey vessel, it is not possible to commit to avoiding fishers entirely. - As previously requested INPEX has contracted WAFIC to facilitate direct contact with fishers in order to confirm the proposed on-water communication protocol. INPEX has not received any alternatives to the proposed timing or methods but understands this component of the consultation is ongoing at the time of submission for public comment. **Potential impacts to key indicator species - While spawning is likely to occur across the depth range, the bulk of spawning will occur where the bulk of the biomass is present. In essence this approximates Zone B of Area 2 of the NDSF, but note some northern areas of Zone A also contain some levels of goldband spawning biomass How much of this specific area does this survey operate over?** - As the seismic survey vessel sails across the Acquisition Area, it will cross the preferred depth ranges and habitats of goldband snapper (approximate to NDSMF Area 2, Zone B) and other key species from time to time. - It is not the case that fishes will be exposed to sound or disturbed in these depth ranges throughout the whole Acquisition Area over the duration of the survey. Therefore, the proportion of the area that the Acquisition Area overlaps is not representative of the magnitude or extent of the potential impact to target fish resources. - Disturbances to spawning fishes may only occur in the vicinity of the vessel at times when the vessel passes across these depth ranges and, specifically, at the same time as when conditions are also suitable for those specific groups of fish to normally spawn. - - The risk assessment in Section 4.1.6 of Attachment 2 (provided on 07/05/2019 to WAFIC and fishers for review) notes this. The extent of effects to fishes is, therefore, significantly smaller than the area of overlap with Zone A or Zone B of the NDSMF. - To provide additional context for why such transient and localised disturbances to different groups of fish are unlikely to impact the stocks, the risk assessment notes that the multiple and broadband spawning behaviours of the key fish species naturally offset larger scale, natural threats to larvae survival and settlement over larger areas and longer timeframes. - With reference to goldband snapper in particular, the Australian Government's Fisheries Research & Development Corporation assessment of this stock has previously noted that long-lived species such as goldband snapper are less likely to be affected by short-duration environmental/climatic changes (of one or a few years). This is because adult stocks comprise fish that have been recruited over many years (https://www.fish.gov.au/2014-Reports/Goldband_Snapper). - Therefore, in comparison to this example, the occasional, short-term, transient and localised disturbances to groups of fish as a result of the seismic survey would have impacts many orders of magnitude smaller than regional scale environmental/climatic events that would affect entire stocks. - The seismic survey is unlikely to result in a discernible impact on the stocks. **Risk assessment ALARP - What is ALARP?** - INPEX notes useful guidance on "as low as reasonably practicable" (ALARP) is provided by NOPSEMA (See N-04750-GN1344 Revision 4 Environment Plan content requirements Section 3.5.2). - Section 6 of the EP further describes how meets this requirement in relation to EP content requirements. INPEX notes there was an assessment of ALARP within the risk assessments provided to WAFIC on 7 May 2019, but that only an abridged description was provided within Section 6 of the Draft issued to WAFIC. Section 6 of the EP, which describes the INPEX risk assessment process will be provided in full for the public comment period. - In addition to risks being reduced to ALARP, titleholders are also required to demonstrate that impacts and risks are reduced to an acceptable level. Details of this are also included in the EP.	**Relevant matter-** INPEX has previously demonstrated how the objections and claims have been considered based on merit and has provided responses (and draft risk assessments) to WAFIC relating to key issues.

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					DPIRD Communication - Can INPEX please provide the response provided to DPIRD so we have a better understanding that INPEX is using this information in the manner it was intended to be used. - A summary of our communications with DPIRD will be available in EP when it is issued for public comment. - In the absence of being able to access confidential data, it has been necessary for us to make some assumptions. - Limitations of the data have been acknowledged by INPEX in Section 7 of the EP. - This includes adding disclaimer statements where FishCube data is referenced, as discussed with the DPIRD. - In addition, the INPEX assumptions only inform the risk and would not alter proposed controls or introduce new controls. - DPIRD was informed of the amendments that INPEX has included. No objection has been received to date. We are proceeding on this basis, while acknowledging the limitations. **Stakeholder Communication industry wide - WAFIC will be formally raising this issue with NOPSEMA. There is a clear flaw in the system when NOPSEMA does not know what EPs are in process until they receive the formal EP for review. WAFIC knows more than NOPSEMA re current EP engagement and therefore future offshore activities. We will be suggesting that the process includes a formal notification – i.e. once consultation commences a proponent needs to advise NOPSEMA and include the consultation material so they then have an understanding what is coming up and what is happening concurrently.** **Can you offer any other suggestions to improve this please?** - INPEX supports WAFIC's proposal. - INPEX noted to WAFIC that it regularly engages with NOPSEMA to inform them of upcoming activities and EP submission schedules. Stakeholder engagement is discussed in this forum.	
		23/07/2019	Email/ letter from stakeholder	N/A	WAFIC thanked INPEX for the email and advised WAFIC considers this to round out current consultation pre submission to NOPSEMA. Acknowledged the make good process is outside the scope of the EP and advised WAFIC look forward to future discussions. - Thanked INPEX for assisting with cross referencing noting Attachment 2, Section 4.2.1. Requested INPEX provide (when available) the cross-referencing with the relevant commercial fishing sections in the final published EP so WAFIC can review more easily. - Noted 4.2.1 – The summary comment "Overall, no significant population level impacts to commercial fish stocks are expected to occur". Advised WAFIC does not agree with this point as there is not enough information to ascertain what the impact will be. Commented this is a "no significance" determination from an oil/gas and seismic operator, not from the perspective of commercial fishing. Commented that from past experiences, other global locations expressing similar experiences etc what INPEX deems as "not significant" is not the view held by commercial fishers. Any impact on the resource is unwelcome and must be avoided. Commented that WAFIC look forward to NOPSEMA's assessment of this from both sides of the equation and look forward to more research into these ongoing issues.	Relevant matter – INPEX has previously demonstrated how the objections and claims have been considered based on merit and has provided responses (and draft risk assessments) to WAFIC relating to key issues. **WAFIC advised it now considers this to round out current consultation pre-submission to NOPSEMA.**
					- WAFIC acknowledged that INPEX is not planning to undertake in-field monitoring and from past correspondence regarding this EP, is also not planning on being part of or contributing to any seismic research. Advised WAFIC would like to keep the requirement for scheduled in-field monitoring on the agenda, confirmed the lack of in-field monitoring is a point where WAFIC does not agree. Advised WAFIC hopes that sometime in the future that INPEX is in position to support more research in some form. - Thanked INPEX for reconfirming position on working around fishers activities and confirmed understanding that direct communication methods to be discussed with potentially impacted fishers closer to survey commencement date. - Thanked INPEX for confirming position on potential impacts to the fishing resource. Confirmed commercial fishing stakeholders still hold concerns based on previous experiences that there is an impact on catchability and the resource. It may not be survey alone, may also be compounded potentially by other natural environmental changes. WAFIC hopes further research focusing on the impacts of seismic on fish spawning is a priority and hopes INPEX reconsiders its position on support for additional research in the future when in position to do so. - In response to INPEX's response to what is considered ALARP in the EP, WAFIC replied: "The release of the final pre-submission EP for the public comment period is just that – for public comment. As part of the EP consultation process, potentially affected parties such as commercial fishers provide feedback / queries with the proponent held responsible for a response. We do not wait for the public consultation period to have our responses addressed. We don't always have to agree. The issue WAFIC, our stakeholders and our associated commercial fishing colleagues also have in other states is that ALARP is done from the perspective of the proponent – it is to your low level risk assessment which is not necessarily what we deem to be ALARP from a commercial fishing perspective. Impacts and risks which many proponents deem to be at an acceptable level, often are not acceptable to commercial fishers." - Advised WAFIC shares DPIRD's previous concern of INPEX's use of assumptions in the absence of data in some blocks. WAFIC reconfirmed that less than three vessels does not mean a low level of fishing activity and / or a low catch rate. Reconfirmed that in many fisheries, especially northern demersal scalefish, this is how the fishery functions – larger, highly technical and efficient vessels work the same volume and area as what multiple vessels would have done in years gone by. Advised it is an ongoing frustration fishers experience with many proponents constantly referring to "only one or only two or only three vessels" operating in the area with the assumption that it is a low risk, low fishing activity, low catch rate etc region. Acknowledged that DPIRD was informed of the amendments that INPEX included and that no objection has been received to date.	
					Thanked INPEX for supporting WAFIC proposal that the consultation process includes a formal notification to NOPSEMA – i.e. once consultation commences a proponent needs to advise NOPSEMA and include the consultation material.	Not applicable – correspondence sent by INPEX.
		01/08/2019	Email / letter to stakeholder	N/A	INPEX provided notification that the EP is open for public comment, as requested by WAFIC on the 17/07/2019. INPEX identified the sections which may be of particular interest to WAFIC. INPEX provided further clarification on the timing of the survey, advising that the acceptable window of opportunity was determined to be from 1 November to 31 May in either calendar year that the EP applies. Advised INPEX is aiming to commence November 1st 2020.	Not applicable – correspondence sent by INPEX.
		01/08/2019	Email / letter from stakeholder	N/A	WAFIC forwarded the above correspondence (01/08/2019) email to commercial fishing stakeholders, noting the sections which may be of particular interest to fishers.	Not a relevant matter – General correspondence only.

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	02/09/2019	Email / letter to stakeholder	N/A	Following the public comment period, INPEX updated the stakeholder regarding progress made in relation to the claim process developments and advised that no comments were received on the published EP during the 30 day period.	Not applicable – correspondence sent by INPEX.
	19/11/2019	Email / letter to stakeholder	N/A	INPEX provided further update to email sent August 1 2019 on progress towards wishing to develop an industry wide claim process. INPEX requested stakeholder advise a suitable time to discuss development of a claims process.	Not applicable – correspondence sent by INPEX.
Joint Authority Northern Shark Fishery (Cwth/WA) and North Coast Shark Fishery (WA)					
Joint Authority Northern Shark Fishery - Licence Holder A	26/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
	03/04/2019	Email / letter to stakeholder	(reattached information sent 26/02/2019)	[WAFIC on behalf of INPEX] Follow-up on email of 26/02/2019, i.e. information regarding the proposed 2D seismic survey was sent to all licence holders with a fishery overlapping the survey site some weeks back (late February and March). Referred to the Fisheries supplementary information attachment, which has information on both the stakeholder's actual fishing activities as well as peak spawning information. INPEX has got this information from the Department and other references. Asked the stakeholder to advise if INPEX have missed anything in the information provided, or if anything is incorrect. Advised that INPEX have confirmed that they will get the risk assessment (based on the above info) to fishers in the following week. WAFIC advised stakeholder that WAFIC have requested that INPEX prepare a matrix showing months of the year, fishing activity and peak spawning, so there is a clear picture of peaks and troughs.	Not applicable – correspondence sent by INPEX.
	08/04/2019	Email / letter from stakeholder	N/A	[Via WAFIC] Stakeholder advised that their business is currently applying for a Wildlife Trade Operation (WTO) Export Approval and that once this this occurs the business intends to commence fishing operations in the JANSF. Stakeholder unable to comment on the timing of this survey regarding actual fishing activities Stakeholder raised concern regarding the protection of the main target species, being the Australian blacktip shark, common blacktip, and spot-tail shark and fish species that may also be taken being grey mackerel and narrow barred or Spanish mackerel. Stakeholder indicated they are aware of the science which notes the negative impact of seismic surveys on marine fauna, plankton and fish reproduction and spawning. Asked if INPEX has identified pupping areas of the two Blacktip shark species and Spot tail shark and mackerel spawning areas and what measures INPEX have taken to mitigate any potential impacts on the reproduction of these species.	Relevant matter – Stakeholder has requested information or provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. Information relating to the potential recommencement of activities has been incorporated into Section 7.2.1 of the EP. Concerns raised by stakeholder regarding potential overlap with key target species relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Sections 7.1.4 and 7.1.6 of the EP (advised the 2D seismic survey will avoid shark pupping and nursery habitat and will avoid most suitable mackerel spawning habitat as well). These outcomes and control measures were shared with the stakeholder (refer to correspondence dated 07/05/2019).
	07/05/2019	Email / letter to stakeholder	N/A	[WAFIC on behalf of INPEX] Thanked stakeholder for their feedback and appreciated information and clarifications in their email. INPEX provided draft risk assessment information and responded to stakeholder's enquiries. In respect to stakeholder's enquiry on potential for overlap with future shark fishing activities, advised that despite limited fishing effort in recent years, INPEX has considered both the JANSF and the WANCSF in the EP, noting that fishing could recommence during the period covered by the EP, the key target species and gear used. Advised the potential for the survey to overlap with JANSF fishing activities (should they recommence in the near future) is limited, as the proposed seismic acquisition that overlaps the JANSF is likely to comprise a single acquisition line and some vessel line turns at the western boundary of the fishery. INPEX noted the stakeholder's concern about protection of the main target species, the Australian blacktip shark, common blacktip, and spot-tail shark, as well as the secondary target fish species, grey and narrow-barred Spanish mackerel. INPEX has considered the reproductive behaviours, locations and timing of these and various other fish species in detail. Provided an overview of the scientific information used to inform the impact assessment for each species. Advised the 2D seismic survey will avoid shark pupping and nursery habitat and will avoid most suitable mackerel spawning habitat as well. Advised another key consideration given by INPEX to the potential impacts to sharks and mackerels from the seismic survey vessel is the relatively limited hearing ability of shark and mackerel species. Sharks are considered to be less sensitive to sound pressure than most other types of fish, as their hearing structures are more primitive. Sharks may move to avoid high sound levels produced by the approaching seismic source, but given sharks are naturally highly mobile, any avoidance behaviour is likely to be negligible in the context of their normal movements. INPEX advised that mackerels also have relatively poor hearing. Mackerels do not have swim bladders and, therefore, have limited ability to sense changes in sound pressure at distance from a seismic source. Therefore, any disturbances to mackerels when the survey vessel occasionally passes a location such as Lynher Bank will be very localised (i.e. within a few kilometres from the seismic source) and short-term, with behaviours returning to normal soon after the seismic survey vessel passes. In the context of broadcast spawning events, releasing of millions of eggs every few days across the region and over many months, these disturbances are not going to have a discernible impact on spawning and will not affect the stocks. The timing of the survey is proposed to take place between 1 November and 31 May, with no seismic to take place in the period 1 June to 31 October. This period avoids the first three months of the peak grey mackerel spawning season and the first two months of peak Spanish mackerel spawning, although the later spawning months in the season won't be avoided.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Mackerel Managed Fishery (WA)					

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	All licence holders in the Mackerel Managed Fishery (Area 1 and Area 2)	26/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
		03/04/2019	Email / letter to stakeholder	(reattached information sent 26/02/2019)	[WAFIC on behalf of INPEX] Follow-up on email of 26/02/2019, i.e. information regarding the proposed 2D seismic survey was sent to all licence holders with a fishery overlapping the survey site some weeks back (late February and March). Referred to the Fisheries supplementary information attachment, which has information on both the stakeholder's actual fishing activities as well as peak spawning information. INPEX has got this information from the Department and other references. Asked the stakeholder to advise if INPEX have missed anything in the information provided, or if anything is incorrect. Advised that INPEX have confirmed that they will get the risk assessment (based on the above info) to fishers in the following week. WAFIC advised stakeholder that WAFIC have requested that INPEX prepare a matrix showing months of the year, fishing activity and peak spawning, so there is a clear picture of peaks and troughs.	Not applicable – correspondence sent by INPEX.
		07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX - sent to all licence holders who did not receive an individual response (refer MMF Licence Holders A-N)] INPEX provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX.
	Mackerel Managed Fishery (Area 1) - Licence Holder A	08/04/2019	Email / letter from stakeholder	N/A	[via WAFIC - by phone, confirmed by email] Stakeholder noted the following in their response: • Concerned that from their experience seismic has negative impacts on the fishing resource. Concerned that seismic companies use research funded by the seismic and oil and gas industries, which finds there are no or very little impacts on commercial fishing and the fish resource. Concerned that science which finds negative impacts needs to be considered, as well as knowledge the commercial fishers have. Concerned that oil and gas undervalues and/or disrespects this knowledge	Concern regarding bias and selectivity with research does not have merit with regards to the INPEX 2D seismic survey EP. The risk assessment is based on balanced review of available scientific literature.
					• Concerned that from their experience seismic has negative impacts on actual commercial fishing activity.	Concerns raised by stakeholder regarding impact of actual fishing activities relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Section 7.2.1 of the EP.
					Stakeholder specifically requested: • No interactions with commercial fishing during peak fishing periods	Relevant matter - Request provided that is relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. Request raised by stakeholder regarding avoidance of peak commercial fishing activity relates to the petroleum activity and the stakeholder's functions, activities or interests. INPEX confirmed 07/05/2019 (refer below) that the period from 1st June to 31st October had been identified as a period to avoid, therefore, the 2D seismic survey would not take place at the same time as peak fishing activities in the stakeholder's fishery. INPEX therefore anticipated relatively few interactions between the survey vessel and mackerel fishing vessels.
					• No seismic activity at all during peak mackerel spawning periods	Relevant matter - Request provided that is relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. INPEX replied 07/05/2019 (refer below) with justification of why avoidance of the mackerel spawning period is not practicable, nor necessary to reduce impacts to an acceptable level
					The stakeholder noted they are currently leasing their licence and need to protect the business of the lessee, as well as protecting the value of their licence for their own future perceptivity. Noted their commercial fishing activity pattern for Mackerel in Area 1 is continuous throughout the year though mainly from April to November.	Relevant matter – Stakeholder has provided information on the dates of their fishing activities. Timing of fishing activities has been incorporated into Section 4 and Section 7.2.1 of the EP.
		07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] Thanked stakeholder for their feedback on the proposed survey and addressed enquiries, as below: **Overlap with mackerel fishing activities in Mackerel Area 1 (Kimberley sector)** INPEX thanked stakeholder for confirming details of their fishing activities, including water depths, key times of year and the significance of Lynher Bank. INPEX noted it had looked closely at catch and effort data for the Mackerel Managed Fishery and acknowledge that Lynher Bank is an area of relatively high fishing effort, and also noted that fishing occurs throughout the year, noting approximately 80% of the fishing effort occurs between June and October. INPEX confirmed that the period from 1st June to 31st October has been identified as a period to avoid, therefore, the 2D seismic survey will not take place at the same time as peak fishing activities in the Mackerel fishery. INPEX would therefore anticipate relatively few interactions between the survey vessel and mackerel fishing vessels. However, it is not practicable for the survey to completely avoid the entire April to November fishing period or the whole of the mackerel spawning period.	Not applicable – correspondence sent by INPEX.

	STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
					Stakeholders personal experience and observations INPEX noted stakeholder's comments about their on-the-water experience and being negatively impacted by seismic surveys in the past. INPEX enquired whether there are there specific details (i.e. when, how stakeholder was impacted) that they think INPEX should consider in developing its management strategies? With regards to research, INPEX noted it had reviewed the available research and other information extensively. INPEX asked that if the stakeholder believed there is specific research or other relevant information that has not been considered, to please let INPEX know and it will be taken into consideration. INPEX provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	
		07/05/2019	Email / letter to stakeholder	(Documents reattached from earlier 07.05.19 email)	[WAFIC on behalf of INPEX] As an addendum to previous email, INPEX provided information to stakeholder about the new regulatory requirement for INPEX to publish a copy of the full EP on the NOPSEMA website, and requested stakeholder to advise if any information provided to INPEX should be redacted from the published copy.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
	Mackerel Managed Fishery (Area 1) - Licence Holder B	08/04/2019	Email / letter from stakeholder	N/A	[via WAFIC - by phone, confirmed by email] Stakeholder advised INPEX of following items. • Stakeholder noted that seismic proponents "say the right words" regarding fishing activity and spawning but stakeholder has yet to see a mutually workable final outcome, final activities have always been to the detriment to commercial fishers. However, the stakeholder appreciated this engagement and was seeking an agreed outcome for this environment plan. • Stakeholder noted that INPEX and other companies will try to tick all the boxes, but until the final EP is accepted, as a commercial fisher, the stakeholder doesn't know where they stand. • Stakeholder noted that it is hard for a commercial fishers to understand what the end result of the environment plan will be.	Relevant matter – Stakeholder has commented on dissatisfaction with previous consultation and lack of transparency. This information has been acknowledged and INPEX has assured ongoing transparent consultation and desire to achieve a workable outcome, including the development of a compensation mechanism.
					• Stakeholder acknowledged that they are aware of the new legislation which will mean that this, and other seismic EPs will be published prior to final submission to NOPSEMA (ensuring a final cross-check).	Not a relevant matter – General correspondence only. Not activity specific.
					Stakeholder requested: • No interactions with commercial fishing during peak fishing periods	Relevant matter - Request provided that is relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. Request raised by stakeholder regarding avoidance of peak commercial fishing activity relates to the petroleum activity and the stakeholder's functions, activities or interests. INPEX confirmed 07/05/2019 (refer below) that the period from 1st June to 31st October had been identified as a period to avoid, therefore, the 2D seismic survey would not take place at the same time as peak fishing activities in the stakeholder's fishery. INPEX therefore anticipated relatively few interactions between the survey vessel and mackerel fishing vessels.
					Stakeholder requested: • No seismic activity at all during peak mackerel spawning periods	Relevant matter - Request provided that is relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. INPEX replied 07/05/2019 (refer below) with justification of why avoidance of the mackerel spawning period is not practicable, nor necessary to reduce impacts to an acceptable level.
					The stakeholder advised their commercial fishing activity pattern is: • May to July Broome, southern area of Area 1 off Broome. • Balance of the year the other parts of Area 1 Stakeholder noted that mackerel fishing is shallow inshore reef fishing: • Not much more than 70 metres water depth to as shallow as the boat can go • Lynher Bank is a popular commercial mackerel fishing area.	Relevant matter – Stakeholder has provided information on the dates of their fishing activities. Timing and location/depth of fishing activities, and significance of Lynher Bank has been incorporated into Section 4 and Section 7.2.1 of the EP.

	STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
		07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] Thanked stakeholder for their feedback on the proposed survey and addressed enquiries, as below: **Overlap with mackerel fishing activities in Mackerel Area 1 (Kimberley sector)** Thanked stakeholder for confirming details of their fishing activities, including water depths, key times of year and the significance of Lynher Bank. Advised INPEX has looked closely at catch and effort data for the Mackerel Managed Fishery and acknowledge that Lynher Bank is an area of relatively high fishing effort. INPEX also noted that some level of fishing occurs throughout the year, noting an increase in fishing effort from the months of April/May to October/November. In particular, INPEX noted that most fishing effort (approximately 80% of the fishing effort each year) occurs between June and October. INPEX confirmed that the period from 1st June to 31st October had been identified as a period to avoid, therefore, the 2D seismic survey would not take place at the same time as peak fishing activities in the stakeholder's fishery. INPEX therefore anticipated relatively few interactions between the survey vessel and mackerel fishing vessels. However, it is not practicable for the survey to completely avoid the entire April to November fishing period or the whole of the mackerel spawning period. Further explanation about the proposed timing and reasons for the period of avoidance was provided in the attachments. **Risk Assessments** INPEX also provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
	Mackerel Managed Fishery (Area 2) - Licence Holder C	08/04/2019	Email / letter from stakeholder	N/A	[via WAFIC - by phone, confirmed by email] Stakeholder advised INPEX of following items. • Advised that the large majority of this survey takes place in Mackerel Area 1 and of the area proposed to be surveyed in Area 2, the large majority is in water depths outside mackerel preferred fishing water depths (i.e. deeper than approximately 70 metres of water). Therefore, stakeholder confirmed that this survey would not impact their actual fishing activities. Advised that stakeholder would be at sea for some time, and may not be able to formally corroborate this information (with email response). Stakeholder noted that even though this survey shouldn't impact their fishing activities, stakeholder noted concern regarding the potential impact on the mackerel resource, i.e. on breeding / spawning. Stakeholder noted that mackerel tend to congregate to spawn between June to September and that as a migratory species spawning activities (and impacts to spawning in Area 1), could potentially impact the resource sustainability in Area 2. Accordingly, stakeholder specified that there is to be no seismic surveys taking place during peak spawning periods.	Relevant matter – Stakeholder has provided information on their fishing activities. This information has been incorporated into Section 4 and Section 7.2.1 of the EP and subsequent consultation. Concerns raised by stakeholder regarding potential overlap with peak spawning / juvenile development for the key indicator species relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Section 7.1 of the EP. Note that the spawning period for mackerel has been confirmed by DPIRD as occurring September to January, not June to September as indicated by the stakeholder. Mackerel may congregate in coastal waters between June and September prior to spawning. Relevant matter - Request provided that is relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. INPEX replied 07/05/2019 (refer below) with justification of why avoidance of the mackerel spawning period is not practicable, nor necessary to reduce impacts to an acceptable level.

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	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] Thanked stakeholder for their feedback on the proposed survey and addressed enquiries, as below. Noted that Mackerel Managed Fishery (Area 2) - Licence Holder H had been copied into this response, as Licence Holder H endorsed this stakeholder's feedback to INPEX. **Overlap with mackerel fishing activities in Mackerel Area 2 (Pilbara sector)** Thanked stakeholder for confirming details of their fishing activities in Mackerel Area 2 (Pilbara sector) and the depths they typically fish in. Advised that INPEX greatly appreciated the stakeholder confirming that they do not expect the 2D seismic survey will impact their fishing activities. Note that in recent months INPEX had looked closely at catch and effort data for the Mackerel Managed Fishery during the years 2014 - 2017 and could confirm that the proposed 2D seismic survey Acquisition Area is located outside of the areas commonly fished in Mackerel Area 2. **Potential effects to spawning aggregations and the mackerel resource** INPEX provided an overview of the information used to inform the impact assessment, including spawning behaviours. Advised the mackerel stock that extends from the Northern Territory to the west coast of WA is genetically similar due to the along-shore dispersal of eggs and larvae, which generally drift southwards with the Leeuwin current (as the stakeholder rightfully pointed out). Spawning in the Kimberley region is noted as a source of stock recruitment in the Pilbara region. DPIRD noted that spawning fish in the Pilbara sector are likely to be the source of recruitment for the Gascoyne and West Coast sectors of the fishery, but recruitment in these sectors from spawning in the Kimberley region is likely to be limited. Information from DPIRD states mackerel spawning occurs in the Kimberley region between September and January. Based on a review of the timing of all sensitivities in the region, the 2D seismic survey is proposed to avoid the period from 1st June to 31st October and would avoid the first two months of the spawning period, but not the entire spawning period. Advised the 2D seismic survey is located further offshore than most of the shallow coastal waters where spawning occurs, although aggregations in the shallowest parts of the survey (e.g. Lynher Bank) may support spawning. Mackerels have relatively poor hearing compared to other types of fishes, and any disturbance will be very localised (i.e. mainly within a few kilometres from the seismic source) and short-term, with behaviours returning to normal soon after the seismic survey vessel passes. Taking all of these things into account and given the millions of eggs that each female produces, the extensive areas where spawning occurs, and the protracted spawning season, no discernible impacts are expected to occur to the overall mackerel resource. INPEX also provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX.
Mackerel Managed Fishery (Area 2) - Licence Holder D	09/04/2019	Email / letter from stakeholder	N/A	[via WAFIC - by phone, confirmed by email] • Stakeholder confirmed their licence is currently not in use, although there may be the possibility that they will lease this licence to a third-party sometime in the future. Accordingly, at this point in time, confirmed that the seismic survey will not impact their actual fishing activities. • Stakeholder noted that even though this survey shouldn't impact their fishing activities, stakeholder noted concern regarding the potential impact on the mackerel resource, i.e. on breeding / spawning. Stakeholder noted concern that a seismic survey in Area 1 and parts of Area 2 of the Mackerel Managed Fishery would impact the resource, future sustainability and future prospectivity. Accordingly, stakeholder specified that there is to be no seismic surveys taking place during peak spawning periods	Relevant matter – Stakeholder has provided information on their fishing activities. Concern raised by stakeholder regarding potential overlap with spawning relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Section 7.1 of the EP. However, the concern regarding the potential for impacts to the future sustainability and prospectivity of the mackerel resource is not considered to have merit, based on the reasons and references presented in Sections 7.1.4 and 7.1.6 of the EP, as provided to the stakeholder for review on 07/05/2019. Relevant matter - Request provided that is relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. INPEX replied 07/05/2019 (refer below) with justification of why avoidance of the mackerel spawning period is not practicable, nor necessary to reduce impacts to an acceptable level.
	10/04/2019	Email / letter from stakeholder	N/A	[via WAFIC to INPEX] Further to phone conversation yesterday, stakeholder added that they also have a Pilbara line licence and a Mackerel licence in the Gascoyne, and they are concerned about how the spawning would affect these (*sic*).	Not a relevant matter – General correspondence only. [NB: this was addressed as a concern regarding impacts to spawning of the key indicator species, which the stakeholder had raised in their previous correspondence]

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		07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] **Overlap with mackerel fishing activities in Mackerel Area 2 (Pilbara sector)** Thanked stakeholder for confirming that their fishing activities occur in in Mackerel Area 2 (Pilbara sector) and that the large majority of the 2D seismic survey is in water depths outside your preferred fishing grounds. Noted INPEX's appreciation that the stakeholder confirmed that that the 2D seismic survey would not impact fishing activities. Noted that in recent months INPEX has looked closely at catch and effort data for the Mackerel Managed Fishery during the years 2014 - 2017 and could confirm that the proposed 2D seismic survey Acquisition Area is located outside of the areas commonly fished in Mackerel Area 2. **Potential effects to spawning aggregations and the mackerel resource** INPEX provided an overview of the information used to inform the impact assessment, including spawning behaviours. Advised the mackerel stock that extends from the Northern Territory to the west coast of WA is genetically similar due to the along-shore dispersal of eggs and larvae, which generally drift southwards with the Leeuwin current (as the stakeholder rightfully pointed out). Spawning in the Kimberley region is noted as a source of stock recruitment in the Pilbara region. DPIRD noted that spawning fish in the Pilbara sector are likely to be the source of recruitment for the Gascoyne and West Coast sectors of the fishery, but recruitment in these sectors from spawning in the Kimberley region is likely to be limited. Information from DPIRD states mackerel spawning occurs in the Kimberley region between September and January. Based on a review of the timing of all sensitivities in the region, the 2D seismic survey is proposed to avoid the period from 1st June to 31st October and would avoid the first two months of the spawning period, but not the entire spawning period. Advised the 2D seismic survey is located further offshore than most of the shallow coastal waters where spawning occurs, although aggregations in the shallowest parts of the survey (e.g. Lynher Bank) may support spawning. Mackerels have relatively poor hearing compared to other types of fishes, and any disturbance will be very localised (i.e. mainly within a few kilometres from the seismic source) and short-term, with behaviours returning to normal soon after the seismic survey vessel passes. Taking all of these things into account and given the millions of eggs that each female produces, the extensive areas where spawning occurs, and the protracted spawning season, no discernible impacts are expected to occur to the overall mackerel resource.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
					INPEX also provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	
	Mackerel Managed Fishery (Area 2) - Licence Holder E	10/04/2019	Email / letter from stakeholder	N/A	[via WAFIC - by phone, confirmed by email] Noted that the large majority of the proposed INPEX survey takes place in Mackerel Area 1 and of the area proposed to be surveyed in Area 2, the large majority is in water depths outside mackerel preferred fishing water depths (i.e. deeper than approximately 70 metres of water). Therefore, stakeholder could confirm that the survey would not impact their actual fishing activities.	Relevant matter – Stakeholder has provided information on their fishing activities. This information has been incorporated into Section 4 and Section 7.2.1 of the EP.
					Stakeholder raised concern regarding the potential impact on the mackerel resource, i.e. on breeding / spawning. Even though only part of this survey is in Area 2, the entire mackerel fishery is co-dependent on the Leeuwin Current and a lot of fish spawn will be carried into other fishing areas from the site of this proposed seismic survey in Area 1.	Concern raised by stakeholder regarding potential overlap with spawning relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Section 7.1 of the EP, as provided to the stakeholder for review on 07/05/2019.
					Stakeholder stressed that there is to be no seismic surveys taking place during any peak spawning periods.	Relevant matter - Request provided that is relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. INPEX replied 07/05/2019 (refer below) with justification of why avoidance of the mackerel spawning period is not practicable, nor necessary to reduce impacts to an acceptable level.
		10/04/2019	Email / letter from stakeholder	N/A	[via WAFIC to INPEX] As an addendum to the first email of 10/04/2019, the stakeholder advised that WAFIC's record of the telephone conversation was accurate and outlined stakeholder's concerns regarding the proposed survey. Stakeholder advised that they had read a paper which indicates that, once recruited to the Pilbara, mackerel do not make large lateral movements along the coast. However, the Kimberly fish apparently make extensive southern migrations during the summer months. This would make any disruption to the Kimberly stock of mackerel of significant interest to Area 3 fishers, and also to recreational fishers who target mackerel off Perth during the summer months.	Relevant matter – Stakeholder has provided information relevant to the petroleum activity and/or the stakeholder's functions, interests or activities. INPEX advised the stakeholder that the range, movement and connectivity of mackerel stocks has been carefully considered in the EP and further information was provided. INPEX also requested the stakeholder provide the paper for consideration if they had different information (refer to correspondence dated 07/05/2019). However, paper has not provided.

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	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] **Overlap with mackerel fishing activities in Mackerel Area 2 (Pilbara sector)** Thanked stakeholder for confirming that their fishing activities occur in in Mackerel Area 2 (Pilbara sector) and that the large majority of the 2D seismic survey is in water depths outside your preferred fishing grounds. Noted INPEX's appreciation that the stakeholder confirmed that that the 2D seismic survey would not impact fishing activities. Noted that in recent months INPEX has looked closely at catch and effort data for the Mackerel Managed Fishery during the years 2014 - 2017 and could confirm that the proposed 2D seismic survey Acquisition Area is located outside of the areas commonly fished in Mackerel Area 2. **Potential effects to spawning aggregations and the mackerel resource** INPEX provided an overview of the information used to inform the impact assessment, including spawning behaviours. Advised the mackerel stock that extends from the Northern Territory to the west coast of WA is genetically similar due to the along-shore dispersal of eggs and larvae, which generally drift southwards with the Leeuwin current (as the stakeholder rightfully pointed out). Spawning in the Kimberley region is noted as a source of stock recruitment in the Pilbara region. DPIRD noted that spawning fish in the Pilbara sector are likely to be the source of recruitment for the Gascoyne and West Coast sectors of the fishery, but recruitment in these sectors from spawning in the Kimberley region is likely to be limited. Information from DPIRD states mackerel spawning occurs in the Kimberley region between September and January. Based on a review of the timing of all sensitivities in the region, the 2D seismic survey is proposed to avoid the period from 1st June to 31st October and would avoid the first two months of the spawning period, but not the entire spawning period. Advised the 2D seismic survey is located further offshore than most of the shallow coastal waters where spawning occurs, although aggregations in the shallowest parts of the survey (e.g. Lynher Bank) may support spawning. Mackerels have relatively poor hearing compared to other types of fishes, and any disturbance will be very localised (i.e. mainly within a few kilometres from the seismic source) and short-term, with behaviours returning to normal soon after the seismic survey vessel passes. Taking all of these things into account and given the millions of eggs that each female produces, the extensive areas where spawning occurs, and the protracted spawning season, no discernible impacts are expected to occur to the overall mackerel resource. INPEX noted the stakeholder's point regarding the movements of adult mackerel and advised that from the documents that INPEX had reviewed (including DPIRD publications) indicated that adult mackerel movements are typically limited to within 100 km to 300 km, occasionally further. INPEX advised it was not aware of the paper the stakeholder mentioned that indicates that mackerel in the Kimberley migrate greater distances down the west coast in the summer months. Requested that the stakeholder please share this reference with INPEX. Either way, INPEX does not see any reason why any effects of the survey would extend this far; no fish will be killed or injured by the survey, and for the reasons outlined above and in the attached documents, short-term disturbances to fishes from occasional passes of the survey vessel are not expected to have any wider-reaching effects on fish movements or on the stock. INPEX also provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Mackerel Managed Fishery (Area 2) - Licence Holder F	10/04/2019	Email / letter from stakeholder	N/A	[via WAFIC - by phone, confirmed by email] Stakeholder confirmed that this survey would not impact their actual fishing activities. However, stakeholder noted concern regarding the potential impact of the proposed INPEX 2D seismic survey on the mackerel resource, i.e. on breeding / spawning. Stakeholder advised they have personally experienced and seen the impacts of seismic on commercial fishing activities over the past many years and noted that their extensive fishing history and anecdotal knowledge regarding these negative impacts has not been acknowledged or respected by seismic operators.	Relevant matter – Stakeholder has provided information on their fishing activities. This information has been incorporated into Section 4 and Section 7.2.1 of the EP. Concern raised by stakeholder regarding potential overlap with spawning relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Sections 7.1.4 and 7.1.6 of the EP, as provided to the stakeholder for review on 07/05/2019.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
				Stakeholder requested that if their ocean and fishing knowledge and their observations of the negative impacts of past seismic surveys is not accepted the stakeholder was therefore seeking INPEX and other oil, gas and seismic companies to invest in comprehensive and legitimate research assessing the impacts of seismic activities on the environment and on the commercial fishing resource with specific focus on WA fisheries.	Relevant matter - Stakeholder has provided information on their personal experience which has been acknowledged in the risk assessment in Section 7.2.1. INPEX replied to the stakeholder on 07/05/2019 and acknowledged the stakeholder's feedback. INPEX requested that the stakeholder please elaborate on what their experience has been. Asked if the stakeholder was referring to impacts to their fishing activities as a result of interactions on the water with seismic vessels, or what they considered to be impacts to the mackerel stock. Further clarification / evidence was not received. Request raised by stakeholder regarding investment in new research is acknowledged by INPEX as a broader industry wide issue, but is not activity specific.
	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] **Overlap with mackerel fishing activities in Mackerel Area 2 (Pilbara sector)** Thanked stakeholder for confirming that their fishing activities occur in in Mackerel Area 2 (Pilbara sector) and therefore stakeholder does not expect the 2D seismic survey would impact their fishing activities. Advised that, in recent months, INPEX had looked closely at catch and effort data for the Mackerel Managed Fishery during the years 2014 - 2017 and could confirm that the proposed 2D seismic survey Acquisition Area is indeed located outside of the areas commonly fished in Mackerel Area 2.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
				Potential effects to spawning aggregations and the mackerel resource INPEX noted stakeholder concern regarding potential impacts of the seismic survey on spawning and how this may affect the overall mackerel resource. This is a concern that had been raised by other fishery licence holders as well. It is a matter that INPEX had assessed in detail. Mackerel are known to aggregate in coastal waters around reefs, shoals and headlands to feed and spawn, releasing a batch of eggs every 1-3 days throughout the spawning season. Each batch of eggs that is released by a single female can comprise approximately 750,000 eggs, which disperse great distances alongshore throughout the region before larvae develop into juvenile fish in coastal waters, bays and estuaries. Spawning in the Kimberley region is noted as a source of stock recruitment in the Pilbara region. INPEX noted that the advice that INPEX had received from the Department of Primary Industries and Regional Development (DPIRD) is that peak mackerel spawning period in the Kimberley region occurs between September and January. Based on a review of the timing of all sensitivities in the region, the 2D seismic survey is proposed to avoid taking place during the period 1st June to 31st October. Therefore, the 2D seismic survey would avoid the first two months of the spawning period, but not the entire spawning period. The 2D seismic survey is located further offshore than most of the shallow coastal waters where spawning occurs, although aggregations in the shallowest parts of the survey (e.g. Lynher Bank) may support spawning. Any disturbances to mackerels, which have relatively poor hearing compared to other types of fishes, will be very localised (i.e. mainly within a few kilometres from the seismic source) and short-term, with behaviours returning to normal soon after the seismic survey vessel passes. Taking all of these things into account and given the millions of eggs that each female produces, the extensive areas where spawning occurs, and the protracted spawning season, no discernible impacts are expected to occur to the overall mackerel resource. **Stakeholder's personal experience and observations** INPEX noted stakeholder's feedback regarding their personnel experience and observations of seismic surveys impacting on your commercial fishing activities. INPEX requested that the stakeholder please elaborate on what their experience has been. Asked if the stakeholder was referring to impacts to their fishing activities as a result of interactions on the water with seismic vessels, or what they considered to be impacts to the mackerel stock? Requested that if the stakeholder had additional details, INPEX could acknowledge these in the Environment Plan (EP) and may consider this with the other information INPEX had available relating to mackerel and the development of our management strategies. INPEX also provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	
Mackerel Managed Fishery (Area 2) - Licence Holder G	08/04/2019	Email / letter from stakeholder	N/A	[via WAFIC - by phone, confirmed by email] Stakeholder noted that in relation to the INPEX seismic survey, the stakeholder had interest in potential issues but has no faith that any seismic operator will do anything to mitigate impacts to commercial fishing and the commercial fishing resource, therefore it would be a waste of stakeholder's time to contribute.	Not a relevant matter – General feedback regarding seismic survey EP experience. The feedback was acknowledged by INPEX in the response dated 07/05/2019 (see below).

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	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] **Stakeholder's personal experience and observations** INPEX noted it was regrettable to hear that the stakeholder considers the Environment Plan stakeholder process to be a waste of your time and that the stakeholder does not have faith in petroleum titleholders or seismic operators to mitigate impacts to commercial fisheries. Noted that while INPEX is not aware of the details of your previous experience with other titleholders or seismic operators, INPEX has made a concerted effort to assess the impacts and risks to fisheries and target fish stocks in detail, as well as to offer a range of management and mitigation measures. **Overlap with mackerel fishing activities in Mackerel Area 2 (Pilbara sector)** Noted that as stakeholder is a licence holder in Area 2 of the Mackerel Managed Fishery, INPEX could confirm that the proposed 2D seismic survey Acquisition Area is located outside of the areas commonly fished in Mackerel Area 2. Therefore, INPEX did not anticipate impacting mackerel fishing activities in Mackerel Area 2. The 2D seismic survey is also proposed to avoid the period between 1st June and 31st October 2019, which we understand avoids a period of peak mackerel fishing in the Kimberley area of the fishery (Mackerel Area 1). **Potential effects to the mackerel resource** Advised that, with regards to impacts to fishing resources, INPEX had also assessed in detail the potential for impacts to mackerel, including spawning and food chain impacts. While it is acknowledged mackerels may experience short-term disturbances from the passing seismic source, these are not expected to result in population-level impacts to the mackerel stock. Advised that further information is included in the attachments. INPEX also provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX.
	07/05/2019	Email / letter to stakeholder	(Documents reattached from earlier 07.05.19 email)	[WAFIC on behalf of INPEX] As an addendum to previous email, INPEX provided information to stakeholder about the new regulatory requirement for INPEX to publish a copy of the full EP on the NOPSEMA website, and requested stakeholder to advise if any information provided to INPEX should be redacted from the published copy.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Mackerel Managed Fishery (Area 2) - Licence Holder H	08/04/2019	Email / letter from stakeholder	N/A	[via WAFIC - by phone, confirmed by email] Stakeholder noted that they would prefer to defer to feedback provided by Mackerel Managed Fishery (Area 2) - Licence Holder C, noting that stakeholder's significant and long history in this fishery.	Relevant matter – Stakeholder has deferred their response to Mackerel Managed Fishery (Area 2) - Licence Holder C, who raised concerns regarding the impacts to key species spawning. Refer to Mackerel Managed Fishery (Area 2) - Licence Holder C for more detail.
	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	*Stakeholder copied into INPEX's 07/05/2019 email to Mackerel Managed Fishery (Area 2) - Licence Holder C. Refer above.*	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Mackerel Managed Fishery (Area unknown) - Licence Holder I	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] WAFIC noted that the stakeholder was unwell and out of the office/unable to provide feedback. Noted the stakeholder is the largest unit/quota holder in the Mackerel fishery. INPEX provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Mackerel Managed Fishery (Area 1) - Licence Holder J	20/03/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX - sent to all MMF licence holders from whom INPEX had not received a specific enquiry. INPEX provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Mackerel Managed Fishery (Area 2) - Licence Holder K	20/03/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX - sent to all MMF licence holders from whom INPEX had not received a specific enquiry. INPEX provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Mackerel Managed Fishery (Area 2) - Licence Holder L	08/04/2019	Email / letter from stakeholder	N/A	[via WAFIC - by phone, confirmed by email] Stakeholder noted that the proposed seismic survey activity would not impact their fishing business	Relevant matter – Stakeholder has provided information on their fishing activities not being impacted in Area 2. This information has been acknowledged into Section 7.2.1 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.
	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX - sent to all MMF licence holders from whom INPEX had not received a specific enquiry.. INPEX provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Mackerel Managed Fishery (Area 2) - Licence Holder M	03/04/2019	Email / letter from stakeholder	N/A	[via WAFIC to INPEX] Stakeholder confirmed that they area of the proposed seismic survey was way out of the area of their operation.	Relevant matter – Stakeholder has provided information on their fishing activities not being impacted in Area 2. This information has been acknowledged into Section 7.2.1 of the EP. The stakeholder raised no concerns or objections regarding the seismic survey.

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	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX - sent to all MMF licence holders from whom INPEX had not received a specific enquiry. INPEX provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Mackerel Managed Fishery (Area 1) - Licence Holder N	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Managed Mackerel Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX - sent to all MMF licence holders from whom INPEX had not received a specific enquiry. INPEX provided draft risk assessment information relevant to the Mackerel Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
North West Slope Trawl Fishery (Cwth)					
North West Slope Trawl Fishery - Licence Holder A	26/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
	02/04/2019	Email / letter from stakeholder	N/A	[via WAFIC to INPEX] Stakeholder advised they don't really have an opinion (on INPEX's seismic survey activity) except to say that they don't like this type of survey, and any anti survey data that can be used in defence would be good. Advised that stakeholder is not currently trawling in this area.	General objection regarding seismic is not activity specific. General objection does not have merit nor is it in relation to a specific issue, so it cannot be addressed. Relevant matter raised – Stakeholder has provided information on their fishing activities not taking place in the same area as the seismic survey. This information has been acknowledged in Section 7.2.1 of the EP.
	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (North West Slope Trawl Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] Thanked stakeholder for confirming that they are not operating in the area of the proposed INPEX 2D seismic survey. For stakeholder's interest, INPEX also provided draft risk assessment information relevant to the North West Slope Trawl Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
North West Slope Trawl Fishery - Licence Holder B	26/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
	02/04/2019	Email / letter from stakeholder	N/A	[via WAFIC to INPEX] Stakeholder advised the survey would have no impact on stakeholder's activities as currently has no operations in the area. Advised that Licence Holder C more likely to be impacted. Advised that the Kimberley region will be trap operators, plus Mackerel Managed Fishery (Areas 1 and 2) - Licence Holder I.	Relevant matter – Stakeholder has provided information on their fishing activities, as well as other commercial fishers. This information has been acknowledged in Section 7.2.1 of the EP.

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	03/04/2019	Email / letter to stakeholder	(reattached information sent 26/02/2019)	[WAFIC on behalf of INPEX] Follow-up on email of 26/02/2019, i.e. information regarding the proposed 2D seismic survey was sent to all licence holders with a fishery overlapping the survey site some weeks back (late February and March). Referred to the Fisheries supplementary information attachment, which has information on both the stakeholder's actual fishing activities as well as peak spawning information. INPEX has got this information from the Department and other references. Asked the stakeholder to advise if INPEX have missed anything in the information provided, or if anything is incorrect. Advised that INPEX have confirmed that they will get the risk assessment (based on the above info) to fishers in the following week. WAFIC advised stakeholder that WAFIC have requested that INPEX prepare a matrix showing months of the year, fishing activity and peak spawning, so there is a clear picture of peaks and troughs.	Not applicable – correspondence sent by INPEX.
	11/06/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (North West Slope Trawl Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] Thanked stakeholder for advising that they do not currently have operations in the area of the proposed seismic survey. INPEX provided draft risk assessment information relevant to the North West Slope Trawl Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
North West Slope Trawl Fishery - Licence Holder C	26/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
	03/04/2019	Email / letter to stakeholder	(Reattached information sent 26/02/2019)	[WAFIC on behalf of INPEX] Follow-up on email of 26/02/2019, i.e. information regarding the proposed 2D seismic survey was sent to all licence holders with a fishery overlapping the survey site some weeks back (late February and March). Referred to the Fisheries supplementary information attachment, which has information on both the stakeholder's actual fishing activities as well as peak spawning information. INPEX has got this information from the Department and other references. Asked the stakeholder to advise if INPEX have missed anything in the information provided, or if anything is incorrect. Advised that INPEX have confirmed that they will get the risk assessment (based on the above info) to fishers in the following week. WAFIC advised stakeholder that WAFIC have requested that INPEX prepare a matrix showing months of the year, fishing activity and peak spawning, so there is a clear picture of peaks and troughs.	Not applicable – correspondence sent by INPEX.
	11/06/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (North West Slope Trawl Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] WAFIC acknowledged had not heard from the stakeholder in regards to the proposed seismic survey. INPEX provided draft risk assessment information relevant to the North West Slope Trawl Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Northern Demersal Scalefish Managed Fishery (WA)					
All licence holders in the Northern Demersal Scalefish Managed Fishery	26/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.

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	03/04/2019	Email / letter to stakeholder	(Reattached information sent 26/02/2019)	[WAFIC on behalf of INPEX] Follow-up on email of 26/02/2019, i.e. information regarding the proposed 2D seismic survey was sent to all licence holders with a fishery overlapping the survey site some weeks back (late February and March). Referred to the Fisheries supplementary information attachment, which has information on both the stakeholder's actual fishing activities as well as peak spawning information. INPEX has got this information from the Department and other references. Asked the stakeholder to advise if INPEX have missed anything in the information provided, or if anything is incorrect. Advised that INPEX have confirmed that they will get the risk assessment (based on the above info) to fishers in the following week. WAFIC advised stakeholder that WAFIC have requested that INPEX prepare a matrix showing months of the year, fishing activity and peak spawning, so there is a clear picture of peaks and troughs.	Not applicable – correspondence sent by INPEX.
	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Northern Demersal Scalefish Managed Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX - sent to all licence holders who did not receive an individual response (refer NDSMF Licence Holders A & B)] INPEX provided draft risk assessment information relevant to the Northern Demersal Scalefish Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	Not applicable – correspondence sent by INPEX.
Northern Demersal Scalefish Fishery - Licence Holder A	26/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
	02/04/2019	Email / letter to stakeholder	N/A	[WAFIC on behalf of INPEX] Follow up with stakeholder to understand if stakeholder has any comments/feedback on the proposed seismic survey activity.	Not applicable – correspondence sent by INPEX.
	02/04/2019	Email / letter from stakeholder	N/A	[via WAFIC to INPEX] Stakeholder advised that they had not responded because they had not heard about the activity before. Stakeholder remarked that the undefined timing of the survey within a two-year timeframe (as included in the consultation materials sent on 26/02/2019) was inappropriate and objected to that proposal.	Objection / concern raised by stakeholder regarding undefined timing of the survey relates to the petroleum activity and the stakeholder's functions, activities or interests. INPEX subsequently provided further detail and justification of the proposed November to may window of opportunity (refer to correspondence below dated 07/05/2019).
	03/04/2019	Email / letter from stakeholder	N/A	[via WAFIC to INPEX] Stakeholder advised of two errors in the information INPEX had sent. • *Re INPEX statement that Red emperor spawn multiple times between August and May, with peaks in October and March* . Stakeholder advised that the Western Australia Fisheries Publication No. 112 of 2013 provides a guidance statement on seismic surveys in WA waters. That paper acknowledges the precautionary principle and the possible effects of seismic activity on all life stages of fish. It also acknowledges the potential avoidance of areas by, or dispersal of, spawning aggregations as a consequence of seismic. Appendix 2 in that paper identifies the peak spawning periods for the indicator species in the Northern Demersal Scalefish Managed Fishery as: 1. Goldband Snapper - January to April inclusive; 2. Red Emperor - January, March and October. Advised that INPEX had it wrong for Red Emperor by leaving out January as a peak spawning month. • *Re INPEX statement that fish traps are offloaded and left on the seabed in waters near port while vessels unload catch and are retrieved when the vessel leaves port again.*- Stakeholder advised that this statement was incorrect.	Relevant matter raised regarding accuracy of spawning information. However, DPIRD have updated and released spawning information since the publication Western Australia Fisheries Publication No. 112. Therefore, the information provided by the stakeholder has not been considered further in the EP. The stakeholder has been informed of this and reasons provided (refer to correspondence dated 07/05/2019 below).

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
	07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Northern Demersal Scalefish Managed Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] **Survey timeframes** INPEX advised stakeholder they appreciated stakeholder's feedback regarding the proposed timing of the 2D seismic survey, and understood that the timing of the 2D seismic survey that was communicated in the information sheet seems broad. This is the total time period that will be covered by the Environment Plan (EP) to allow the 2D seismic survey take place i.e. the earliest the survey would commence is the fourth quarter of 2019, the latest the survey might be conducted is before the end of 2020. The timeframe was included in initial stakeholder information sheet to provide stakeholders with an early indication of the proposed survey. The timeframe is intentionally broad in the early planning stages as it is difficult to anticipate when acceptance of the EP may be achieved by or when a seismic survey vessel may be in Australian waters and available to undertake the survey. More precise timing is also difficult to confirm at that stage, as the timing of various environmental sensitivities and fishing activities needed to be researched in detail first. However, since INPEX's previous communication we have reviewed the timing in context of key sensitivities in the region and are able to provide further information on the "window of opportunity" for the survey. INPEX noted it could confirm that the period from 1 November to 31 May had been identified as the most appropriate window for the survey to take place, while no survey activity would occur in the period 1 June to 31 October. This is primarily to avoid the period from June to October, when humpback whales are present in the Kimberley region for calving, nursing and resting. INPEX noted that this period also happens (to) avoid the peak spawning periods of some (but not all) demersal fish species targeted by the Northern Demersal Scalefish Managed Fishery (NDSMF). Spawning by the different species targeted by the NDSF occurs at various different times throughout the year, and INPEX noted that it is therefore impossible to avoid all of these periods.	Not applicable – correspondence sent by INPEX.
				Fish spawning periods INPEX noted stakeholder's feedback regarding spawning periods published in WA Department of Fisheries Publication No. 112 (2013). However, this information is no longer current. Since the publication of that document, DPIRD had obtained additional data that has improved the understanding of spawning periods for different species. Generally, it is evident that some species spawn over more protracted periods than was previously understood, and there is greater confidence in the peak periods. DPIRD are currently preparing a new guidance document, which will include the revised spawning time frames and will be published in the near future. The spawning periods for goldband snapper and red emperor are: • goldband snapper spawning - September to May • red emperor spawning - August to May, peaking in October and again in March. DPIRD also provide spawning information for a number of other species, which have been considered in the EP. ***[Note: DPIRD provided revised spawning information to INPEX on 17/06/2017, which differs from those stated above. The latest information provided by DPIRD has been reflected in the EP]*** **NDSMF fish trap offloading activities** INPEX thanked the stakeholder for clarifying that the statement, 'Fish traps are offloaded and left on the seabed in waters near port while vessels unload catch and are retrieved when the vessel leaves port again', is not correct. That information was sourced from a former Department of Fisheries document, published in 2008, which INPEX reviewed in an effort to better understand NDSMF activities, gear types and how the fishery operates. INPEX acknowledge that this information may not accurately reflect current practices. As this statement relates to activities outside of the defined survey Operational Area, INPEX does not anticipate it changing the outcomes of our risk assessment. However, INPEX requested that if there is other information that the stakeholder thinks is relevant, to please let INPEX know. **Draft risk assessments** INPEX also provided draft risk assessment information relevant to the Northern Demersal Scalefish Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	
Northern Demersal Scalefish Fishery - Licence Holder B	26/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet - Supplementary fisheries information	[WAFIC on behalf of INPEX] Informed stakeholder of the survey, including an activity description, proposed location, potential impacts to commercial fishing stakeholders, the consultation process, previous seismic surveys in the area, and how to provide feedback.	Not applicable – correspondence sent by INPEX.
	03/04/2019	Email / letter to stakeholder	(Reattached information sent 26/02/2019)	[WAFIC on behalf of INPEX] Follow-up on email of 26/02/2019, i.e. information regarding the proposed 2D seismic survey was sent to all licence holders with a fishery overlapping the survey site some weeks back (late February and March). Referred to the Fisheries supplementary information attachment, which has information on both the stakeholder's actual fishing activities as well as peak spawning information. INPEX has got this information from the Department and other references. Asked the stakeholder to advise if INPEX have missed anything in the information provided, or if anything is incorrect.	Not applicable – correspondence sent by INPEX.

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		10/04/2019	Email / letter from stakeholder	N/A	[via WAFIC to INPEX] Stakeholder noted the following: • The stakeholder feels that consultation by companies undertaking seismic, is patronising (with the exception of Quadrant/Santos and their contributions to furthering the available science and commitment to a genuine make good process). • Concerned that there is little concept or genuine interest amongst the seismic proponents in understanding the natural resource management of the North West shelf fish stocks or actual environmental impacts of their work. • Concerned that the brief to the environmental teams and/or hired consultants is to ensure the EP is approved. (The petroleum and commercial fishing industries) seem to have such diametrically opposed interests and the stakeholder's perception is that (petroleum production companies) have no interest in any outcome other than their own project approval. Stakeholder advised they are experiencing stakeholder fatigue.	Not a relevant matter - Concern / dissatisfaction raised regarding previous titleholder's alleged approach is not specifically relevant to the INPEX 2D seismic survey and does not have merit. The EP considers the biology of fish stocks and plausible sound exposure scenarios to determine potential impacts and suitable control measures. INPEX responded to the stakeholder on 07/05/2019 regarding this matter (see below). Stakeholder fatigue is acknowledged.
					• Concerned the process of mitigation of seismic risks seems to rely on a handful of symbolic acts which in the minds of the proponents and NOPSEMA, mitigate every other negative aspect of their noise interference into a marine ecosystem. There seems to be a focus on the spawning period as being the high risk time to our stocks during a survey which seems to be quite nonsensical given the life cycle of juveniles can span some years. In the absence of hard research and evidence the precautionary principal should apply. This would suggest that operators are not able to proceed until they have taken some steps towards contributing to the knowledge of our ecosystems and stocks and the effects of their activities thereon.	Concern raised regarding the stakeholder's perception of the EP impact assessment process in relation to fish stocks does not have merit. The impact assessment process considers a wide range of mitigation factors include Australian regulations and industry best practice. Fish spawning, as well as potential impacts to planktonic eggs and larvae and juvenile stages have been considered in Sections 7.1.4 and 7.1.6 of the EP. INPEX responded to the stakeholder on 07/05/2019 regarding this matter (see below).
					Stakeholder noted that their company (a corporate fishing entity) has extensive commercial fishing history and experience in the Northern Demersal Scalefish (relevant to this survey) and Pilbara Trap fisheries. Stakeholder noted that seismic surveys in the past have impacted their commercial fishing, - stakeholder has had to make all the adjustments / all mitigations re the survey timing and trap placement Operationally, the stakeholder advised that they are not prepared to move their activities out of the way of seismic while there is an assumption that the stakeholder, as the pre-existing activity should not be required to absorb uncompensated, the cost of any on water avoidance so the survey operators may continue with an activity that the stakeholder perceives as being harmful to their stocks.	Concerns raised by stakeholder regarding impact on fishing activities and their previous experience having to relocate is relevant to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Section 7.2.1 of the EP. This concern and anecdotal experience of fishers has been acknowledged. A number of control measures and a compensation mechanism for fishers have been proposed. INPEX provided this feedback to the stakeholder on 07/05/ 2017 (see below).
					Stakeholder noted that seismic surveys in the past have created uncertainty on whether this on water activity is having any effect on the feeding behaviour of our target species, but anecdotally the stakeholder's skippers complain that the fish, and particularly gold band snapper, will "turn off" after a seismic pass in the vicinity of where we are fishing. This then requires the stakeholder to retrieve all their traps, move to another area and locate viable quantities of fish to continue operations, which can be some distance away. The stakeholder advised of their daily fish value of their fleet, and the financial consequence of interaction with seismic operations can be high. Stakeholder noted that it is fair to assume that seismic noise has some effect on fish, their spawning activities, larval behaviour and the trophic food chain - the question is how much. Concerned that the assumption that is used by the proponents is that there is no effect but "If we see a whale, we will stop". Concerned that choosing a single top end cetacean species such as whales or dolphins to be the sole sentinels of a complex surface and benthic trophic environment is grossly negligent on the part of both the Department of the Environment and NOPSEMA. Requests that if proponents cannot afford to take steps towards producing better science to answer these questions, then the precautionary principle should apply which should mean no or reduced survey activity. Stakeholder noted that they require some hard science that demonstrates seismic has no effect on the key indicator species for the Northern Demersal Scalefish Fishery i.e. Goldband Snapper and Red Emperor, their spawning activities and their larval and juvenile life cycles.	Concerns raised by stakeholder regarding potential for behavioural impacts, spawning activities, larvae and the food chain relates to the petroleum activity and the stakeholder's functions, activities or interests. These matters have merit and reasonable basis for being addressed in the EP. These matters have been assessed in Sections 7.1.4 and 7.1.6 of the EP. The risk assessment is based on balanced review of available scientific literature. The stakeholder's anecdotal account and effects to various life stages have also been acknowledged in Sections 7.1.4 and 7.1.6 of the EP, provided in draft to the stakeholder with INPEX's response on 07/05/2019.
					The stakeholder noted they sought an agreed framework for a make good process based on either a contribution by the proponents towards funding better science specifically based around North West shelf key species and/or a make good process that compensates operators for estimated financial loss. Requests in the absence of a separate compensation process for on water avoidance, operators should restructure activities around commercial fishing operators during their survey when both are active in the same area.	Relevant matter – Compensation policy and process to be developed. INPEX informed stakeholder of this on 07/05/2019 (see below).
					Stakeholder advised they operate 12 months per year across the fishery up to and including the area of the proposed INPEX survey in primary depth range between 45 and 150 meters. The fishing grounds of this area are spread right across the 50 to 150 meter depth range and fishing can take place anywhere in this area. This can be supported by the stakeholder's historical fishing data.	Relevant matter – Stakeholder has provided information on their fishing activities. This information has been incorporated into Section 4 and Section 7.2.1 of the EP.
		07/05/2019	Email / letter to stakeholder	Yes: - Overview of draft risk assessment information (Northern Demersal Scalefish Managed Fishery) - Full copy of draft risk assessment information (Fisheries)	[WAFIC on behalf of INPEX] INPEX noted stakeholder's previous dissatisfaction with consultation. Advised this is INPEX's first time undertaking stakeholder consultation and developing an Environment Plan (EP) for a seismic survey. INPEX appreciate that the process of consultation may seem repetitive to the stakeholder; however, the oil and gas industry is required to complete this process, and INPEX genuinely wants to provide fishers with an opportunity to comment and have input on proposed activities. Advised the timing and management of the survey has considered fisheries, but also a number of other receptors. INPEX has included a number of proposed management measures relevant to commercial fisheries and is developing a "make good" process by which claims for compensation will be considered in the event that commercial fishers are genuinely impacted by the 2D seismic survey. INPEX responded to several specific points raised in the stakeholder's 10/04/2019 email:	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.

	STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
					Fish spawning, other life stages and trophic level impacts Fish spawning periods are a key focus of seismic survey EPs because spawning is a key life stage that is important for stock recruitment. The spawning periods of key fish species are also provided to titleholders by DPIRD – Fisheries as sensitive periods to be considered. They have also been highlighted to us by WAFIC as important life stages to consider. INPEX's assessment of potential impacts to fish stocks considers the potential consequences of disturbing spawning aggregations during the seismic survey, as well as potential impacts to planktonic eggs and larvae and juvenile stages of the relevant fish species. Research into the effects of sound on fishes has been conducted on both the juvenile and adult life stages of fishes and, overall, the exposure thresholds and reported effects are considered for both in the EP. INPEX has also considered impacts to the food chain in the EP, including plankton communities, benthic invertebrate communities and prey fish species. INPEX provided reasons as to why the impacts are considered temporary with limited potential for long-term impacts of ecological significance. It is a similar situation for impacts to plankton, benthic communities and food chain impacts, whereby the transient nature of the survey and the short-term and localised effects from the sound source represent a relatively small difference when compared with natural variations in these populations and communities. These effects and interactions are described in detail in the attached documents. **Available science and the precautionary principle** The precautionary principle is a key consideration throughout the development of the EP and is applicable in situations where there is both scientific uncertainty and a threat of serious or irreversible environmental damage. Based on the available science, a number of credible and conservative impact scenarios have been considered in the risk assessments. Avoidance of the peak times of year when key species spawn was considered very carefully as an additional precaution. Goldband snapper for example, which we recognise is a key target species for your fishery, spawns consistently from September to May. Avoiding this period in addition to the June-October period was not considered practicable. Serious or irreversible population level impacts are not expected to goldband snapper or other demersal fish stocks and so avoidance of the spawning period is disproportionate to the low level of risk to the stock. Further information on the proposed timing of the survey and the reasons for this are summarised in Attachment 1. **Your operational experience of seismic surveys** Thanked stakeholder for providing additional context on your fishing activities, an indicative value of the vessels' production, and your previous experience of interactions with seismic survey vessels. Advised that stakeholder's observation that goldband snapper "turn off" after a seismic pass in the vicinity of fishing activities has been noted in the risk assessment in the EP. INPEX acknowledged that there may be effects on catch rates but understand that this is likely to be limited to waters within a few kilometres of the survey vessel for a short period (e.g. hours) after the vessel passes. Advised that INPEX and its survey contractor will provide as specific detail as we can to fishers regarding the location of day-to-day survey activities. It is INPEX's understanding from reviewing historical catch and effort data and the extensive area over which the Northern Demersal Scalefish Managed Fishery operates, that it should be possible for fishing vessels to continue to sustain normal catch rates from alternative fishing grounds while the 2D seismic survey is underway. A number of measures are proposed (as summarised in Attachment 1) to facilitate adequate communication between the seismic survey vessel and commercial fishing stakeholders, and the development of a "make good" process if fishers are genuinely disadvantaged. **Mitigation and "make good" policy** Advised that to manage on-the-water interactions with commercial fishers, INPEX is proposing a number of communication measures. This includes measures to better define where and when the survey vessel will be operating. There is an option for fishers to register to receive email updates on survey activities including a 48-hour "lookahead" each day during the survey. We encourage fishers to register for these updates, particularly your vessel-based and shore-based personnel who are involved in the day-to-day fishing activities. The updates will detail where and when the survey vessel is anticipated to be operating and should, therefore, assist in determining which fishing grounds will be affected and which will be accessible over the days ahead. We do of course appreciate your feedback on this proposal. In addition, INPEX will consider – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. The specific details of the compensation policy are being developed. Prior to commencement of the 2D seismic survey, INPEX will provide information about the process and criteria by which claims for loss of catch, loss of income, or other costs incurred can be submitted. Lastly, in relation to the comment about seismic surveys ceasing activity if a whale is sighted, please note that shut-downs in the presence of whales is an Australian Government requirement of all seismic operators, in accordance with policy established under the Environmental Protection and Biodiversity Conservation Act 1999. This is because whale species have specialised hearing, and many are more sensitive to seismic sound than most other receptors. **Draft risk assessments** INPEX also provided draft risk assessment information relevant to the Northern Demersal Scalefish Managed Fishery, both in summary format and also a full copy of the draft risk assessment sections of the EP. Requested feedback by 7 June. INPEX highlighted key points identified in the risk assessment information, including planned timeframe for seismic survey, timeframe in which seismic activities would not occur, proposed timing for confirmation and communication of exact dates for seismic survey activity, communications and coordination management plans, and commitment to assess – on a case-by-case basis – claims for compensation received from fishers in the event they have experienced a genuine impact as a result of INPEX's 2D seismic survey activities. Detailed "make good" criteria and process would be informed prior to the commencement of the 2D seismic survey.	
	Northern Demersal Scalefish Fishery - Licence Holder C *(received communications sent to NDSMF from 26/02/19 to 07/05/19)*	08/05/2019	Email / letter from stakeholder	N/A	[via WAFIC to INPEX]. Stakeholder observed that two zones in Area 1 of the NDSMF map in both attachments sent on 07/05/2019 were incorrectly labelled (Zones A and C had been swapped over).	Not a relevant matter – General correspondence only.
		08/05/2019	Email / letter to stakeholder	N/A	INPEX thanked stakeholder and WAFIC for the information, noting that the map would be corrected for the environment plan, as requested.	Not applicable – correspondence sent by INPEX.

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	09/05/2019	Email / letter from stakeholder	N/A	WAFIC advised an error in previous email message. Correct message was that Zones A and C in Area 2 (not Area 1) of the NDSMF map were incorrect/had been swapped over.	Not a relevant matter – General correspondence only.
	10/05/2019	Email / letter to stakeholder	N/A	INPEX confirmed that the error was noted (incorrectly labelled zones in Area 2 of NDSMF maps) and confirmed will be corrected in the environment plan.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.
Pearl Oyster Managed Fishery (WA)					
Cygnet Bay Pearls	17/01/2019	Email / letter to stakeholder	N/A	Informed stakeholder that INPEX is consulting with the PPA but also wanted to consult directly. Advised INPEX are coming to Broome and offered to meet with Pearl producers including Maxima, Willie Creek and Paspaley.	Not applicable – correspondence sent by INPEX.
	17/01/2019	Email / letter from stakeholder	N/A	Stakeholder expressed interest in meeting and provided unavailable dates. Offered work around to make the meeting possible.	Not a relevant matter – General correspondence only.
	18/01/2019	Email / letter to stakeholder	N/A	Confirmed receipt. Advised a date could be confirmed once other details regarding the visit were locked in.	Not applicable – correspondence sent by INPEX.
	29/01/2019	Email / letter to stakeholder	N/A	Proposes date/time to meet. Advised INPEX are looking to invite the Pearl Producers Association.	Not applicable – correspondence sent by INPEX.
	01/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[Group email] INPEX provided pearling stakeholders with fact sheet prior to meetings in Broome.	Not applicable – correspondence sent by INPEX.
	06/02/2019	Email / letter from stakeholder	N/A	Stakeholder advised they would not be able to attend the briefing the following day due to other business. Advised INPEX could visit stakeholder office at future convenience.	Not a relevant matter – General correspondence only.
	15/02/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	[Group email] Draft meeting minutes of 7 February briefing to pearl producers in Broome copied to Cygnet Bay.	Not a relevant matter – General correspondence only. [Refer to final meeting minutes confirmation in the correspondence dated 07/05/2019]
	25/03/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	[Group email] Requests stakeholder review minutes. Advises of changed transparency rules about publishing Environment Plans. Advises the risk assessment will be available soon on underwater noise risk assessments for planktonic communities, benthic communities, and pearling and aquaculture. Requests stakeholders confirm interest in receiving this information. Requests best contact for the PPA Research and Development Committee, who were previously flagged as interested in the impact assessment.	Not a relevant matter – General correspondence only.
	07/05/2019	Email / letter to stakeholder	Yes: - Impact assessment for planktonic communities, benthic communities, and pearling and aquaculture (summary and full versions). - Final meeting minutes from 7 February meeting	[Group email] Provides the impact assessment for planktonic communities, benthic communities, and pearling and aquaculture. Summarises key points on the proposed survey timing, management and communications. Request for any enquiries/feedback on the impact assessment information to be provided to INPEX by 7 June. Also sent final signed copy of meeting minutes [no comments/requests for amendment received on draft minutes circulated on 15/02/19 and 25/03/19]. **Minutes of 7 February briefing to pearl producers in Broome (copied to Cygnet Bay), summarised as follows:** INPEX provided an overview and explanation of the proposed 2D seismic activity. Explained that here has been 58 2D MSSs in the region over the last 50 years, the most recent of which was in 2010. Explained the proposed MSS was approximately 50 km from the nearest pearling lease. The activity will avoid the humpback whale migration. Plans to undertake begin the activity as early as December 2019, but likely commencing early 2020, and will last ~5 months. Advised changes had been made to the original MSS area to avoid coastal sensitivities (e.g. Scott Reef, Browse Island and Adele Island). - A pearl producer raised concerns regarding the risk of seismic surveys on the juvenile spat growth and the impacts to the food sources and the food chain linked to pearl oysters, as there could be impacts associated with any changes in tidal flows. - INPEX advised it would provide the impact assessment sections of the EP which include assessment on these two points (food sources and larval recruitment). - The pearl producer noted that 50 kms is not a large distance in terms of water movement. - INPEX acknowledged this, noting that pearl oysters can detect the particle motion component of a sound wave (water and sediment borne vibration). Acknowledged that impacts to larvae in the plankton can be lethal or sub-lethal at close range to a seismic source, and these impacts are being assessed.	Not applicable – correspondence sent by INPEX.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
				- INPEX observed that some inshore stocks of pearl oysters self-seed and do not receive significant numbers of larval recruits from offshore stocks. Advised stakeholders of ongoing studies that are measuring potential impacts. - The pearl producer advised their main concern is overlap with the pearl spawning period (October to March). The pearl producer noted that the PPA shares this concern, and asked whether INPEX had consulted with the PPA. - INPEX advised it had started consultation with fishing Operators via WAFIC, and recreational fishing clubs in Broome. Notes seismic does not have lethal affects on fish but can result in short-term behavioural changes. Notes that like pearl oysters, many demersal species cannot detect the sound pressure component of a sound wave, and are only sensitive to the particle motion component at close ranges (10s to 100s of metres). Advised the impact assessment primarily focuses on site-attached fish, which is also a focus of NOPSEMA (particularly in depths <60m). INPEX advised that Lynher Bank is a key area potential impacts to site-attached fish are being assessed. Advised INPEX will be able to provide the impact assessment sections when they are complete, but at this stage just wanted to engage as early as possible to understand the stakeholder's concerns. - Pearl producer recommends INPEX consult with the PPA's Research and Development Branch. [NB: One stakeholder has redacted comments from this meeting - refer to Sensitive Matters Report].	
	12/06/2019	Email / letter to stakeholder	N/A	[Group email] Follow-up on previous email with draft environmental risk assessment and management information for the pearl oyster fishery. INPEX advised that INPEX has not received any responses to date, and wanted to confirm that feedback could be considered if provided by the end of the week. Advised that INPEX's current plan is to submit its 2D seismic survey environment plan (EP) in July 2019. On submission to offshore petroleum industry regulator, NOPSEMA, the EP will be published online in full, and will be open for public comment for 30 days.	Not applicable – correspondence sent by INPEX.
Maxima Pearls	17/01/2019	Email / letter to stakeholder	N/A	Informed stakeholder that INPEX is consulting with the PPA but also wanted to consult directly. Advised INPEX are coming to Broome and offered to meet with pearl producers including Cygnet Bay, Willie Creek and Paspaley.	Not applicable – correspondence sent by INPEX.
	01/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[Group email] INPEX provided pearling stakeholders with fact sheet prior to meetings in Broome.	Not applicable – correspondence sent by INPEX.
	15/02/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	[Group email] Draft meeting minutes of 7 February briefing to pearl producers in Broome copied to Maxima.	Not applicable – correspondence sent by INPEX.
	25/03/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	[Group email] Requests stakeholder review minutes. Advises of changed transparency rules about publishing Environment Plans. Advises the risk assessment will be available soon on underwater noise risk assessments for planktonic communities, benthic communities, and pearling and aquaculture. Requests stakeholders confirm interest in receiving this information. Requests best contact for the PPA Research and Development Committee, who were previously flagged as interested in the impact assessment.	Not applicable – correspondence sent by INPEX.
	07/05/2019	Email / letter to stakeholder	Yes: - Impact assessment for planktonic communities, benthic communities, and pearling and aquaculture (summary and full versions). - Final meeting minutes from 7 February meeting	[Group email] Provides the impact assessment for planktonic communities, benthic communities, and pearling and aquaculture. Summarises key points on the proposed survey timing, management and communications. Request for any enquiries/feedback on the impact assessment information to be provided to INPEX by 7 June. Also sent final signed copy of meeting minutes [no comments/requests for amendment received on draft minutes circulated on 15/02/19 and 25/03/19]. **Minutes of 7 February briefing to pearl producers in Broome (copied to Maxima), summarised as follows:** INPEX provided an overview and explanation of the proposed 2D seismic activity. Explained that here has been 58 2D MSSs in the region over the last 50 years, the most recent of which was in 2010. Explained the proposed MSS was approximately 50 km from the nearest pearling lease. The activity will avoid the humpback whale migration. Plans to undertake begin the activity as early as December 2019, but likely commencing early 2020, and will last ~5 months. Advised changes had been made to the original MSS area to avoid coastal sensitivities (e.g. Scott Reef, Browse Island and Adele Island). - A pearl producer raised concerns regarding the risk of seismic surveys on the juvenile spat growth and the impacts to the food sources and the food chain linked to pearl oysters, as there could be impacts associated with any changes in tidal flows. - INPEX advised it would provide the impact assessment sections of the EP which include assessment on these two points (food sources and larval recruitment). - The pearl producer noted that 50 kms is not a large distance in terms of water movement. - INPEX acknowledged this, noting that pearl oysters can detect the particle motion component of a sound wave (water and sediment borne vibration). Acknowledged that impacts to larvae in the plankton can be lethal or sub-lethal at close range to a seismic source, and these impacts are being assessed.	Not applicable – correspondence sent by INPEX.

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				- INPEX observed that some inshore stocks of pearl oysters self-seed and do not receive significant numbers of larval recruits from offshore stocks. Advised stakeholders of ongoing studies that are measuring potential impacts. - The pearl producer advised their main concern is overlap with the pearl spawning period (October to March). The pearl producer noted that the PPA shares this concern, and asked whether INPEX had consulted with the PPA. - INPEX advised it had started consultation with fishing Operators via WAFIC, and recreational fishing clubs in Broome. Notes seismic does not have lethal affects on fish but can result in short-term behavioural changes. Notes that like pearl oysters, many demersal species cannot detect the sound pressure component of a sound wave, and are only sensitive to the particle motion component at close ranges (10s to 100s of metres). Advised the impact assessment primarily focuses on site-attached fish, which is also a focus of NOPSEMA (particularly in depths <60m). INPEX advised that Lynher Bank is a key area potential impacts to site-attached fish are being assessed. Advised INPEX will be able to provide the impact assessment sections when they are complete, but at this stage just wanted to engage as early as possible to understand the stakeholder's concerns. - Pearl producer recommends INPEX consult with the PPA's Research and Development Branch. [NB: One stakeholder has redacted comments from this meeting - refer to Sensitive Matters Report].	
	12/06/2019	Email / letter to stakeholder	N/A	[Group email] Follow-up on previous email with draft environmental risk assessment and management information for the pearl oyster fishery. INPEX advised that INPEX has not received any responses to date, and wanted to confirm that feedback could be considered if provided by the end of the week. Advised that INPEX's current plan is to submit its 2D seismic survey environment plan (EP) in July 2019. On submission to offshore petroleum industry regulator, NOPSEMA, the EP will be published online in full, and will be open for public comment for 30 days.	Not applicable – correspondence sent by INPEX.
Paspaley	17/01/2019	Email / letter to stakeholder	N/A	Informed stakeholder that INPEX is consulting with the PPA but also wanted to consult directly. Advised INPEX are coming to Broome and offered to meet with Pearl producers including Maxima, Willie Creek and Cygnet Bay.	Not applicable – correspondence sent by INPEX.
	19/01/2019	Email / letter from stakeholder	N/A	Direct recipient of the above email unable to attend. Stakeholder forwards email internally to someone else who may be able to attend.	Not a relevant matter – General correspondence only.
	21/01/2019	Email / letter to stakeholder	N/A	Further information provided to stakeholder regarding proposed meeting time and attendance of a technical expert.	Not applicable – correspondence sent by INPEX.
	29/01/2019	Email / letter to stakeholder	N/A	Informed stakeholder of meeting time and requested confirmation of attendance. Advised INPEX's intention to invite PPA to attend the briefing.	Not applicable – correspondence sent by INPEX.
	01/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[Group email] INPEX provided pearling stakeholders with fact sheet prior to meetings in Broome.	Not applicable – correspondence sent by INPEX.
	07/02/2019	Meeting with stakeholder	N/A	**Minutes of 7 February briefing to pearl producers in Broome summarised as follows:** INPEX provided an overview and explanation of the proposed 2D seismic activity. Explained that here has been 58 2D MSSs in the region over the last 50 years, the most recent of which was in 2010. Explained the proposed MSS was approximately 50 km from the nearest pearling lease. The activity will avoid the humpback whale migration. Plans to undertake begin the activity as early as December 2019, but likely commencing early 2020, and will last ~5 months. Advised changes had been made to the original MSS area to avoid coastal sensitivities (e.g. Scott Reef, Browse Island and Adele Island). - A pearl producer raised concerns regarding the risk of seismic surveys on the juvenile spat growth and the impacts to the food sources and the food chain linked to pearl oysters, as there could be impacts associated with any changes in tidal flows. - INPEX advised it would provide the impact assessment sections of the EP which include assessment on these two points (food sources and larval recruitment). - The pearl producer noted that 50 kms is not a large distance in terms of water movement. - INPEX acknowledged this, noting that pearl oysters can detect the particle motion component of a sound wave (water and sediment borne vibration). Acknowledged that impacts to larvae in the plankton can be lethal or sub-lethal at close range to a seismic source, and these impacts - INPEX observed that some inshore stocks of pearl oysters self-seed and do not receive significant numbers of larval recruits from offshore stocks. Advised stakeholders of ongoing studies that are measuring potential impacts. - The pearl producer advised their main concern is overlap with the pearl spawning period (October to March). The pearl producer noted that the PPA shares this concern, and asked whether INPEX had consulted with the PPA. - INPEX advised it had started consultation with fishing Operators via WAFIC, and recreational fishing clubs in Broome. Notes seismic does not have lethal affects on fish but can result in short-term behavioural changes. Notes that like pearl oysters, many demersal species cannot detect the sound pressure component of a sound wave, and are only sensitive to the particle motion component at close ranges (10s to 100s of metres). Advised the impact assessment primarily focuses on site-attached fish, which is also a focus of NOPSEMA (particularly in depths <60m). INPEX advised that Lynher Bank is a key area potential impacts to site-attached fish are being assessed. Advised INPEX will be able to provide the impact assessment sections when they are complete, but at this stage just wanted to engage as early as possible to understand the stakeholder's concerns. - Pearl producer recommends INPEX consult with the PPA's Research and Development Branch. [NB: One stakeholder has redacted comments from this meeting - refer to Sensitive Matters Report].	Relevant matter – Pearling stakeholders have provided information on their fishing activities which has been incorporated into Section 4 and Section 7.2.3 of the EP. Concern raised by pearling stakeholders regarding impact to juvenile spat growth and food chain relates to the petroleum activity and the stakeholder's functions, activities or interests. However, this matter is assessed in Section 7.1.4 and Section 7.2.3 of the EP and is not considered to have merit. No significant impacts are expected to the pearl oyster resource, both directly and indirectly (larvae, spat or food chain) due to survey distance from shore and sound exposure levels. The seismic survey Acquisition Area is located mostly beyond the depth range of pearl oysters and where shallow areas do occur, the Acquisition Area is not known to support significant areas of suitable pearl oyster habitat. The tidal exchange and currents between the offshore Acquisition Area and nearshore pearl oyster grounds are also understood to have limited connectivity. The stakeholder has been informed of the outcomes of the assessment and provided with the draft risk assessment for review on 07/05/2019 (see below).

	STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
		15/02/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	[Group email] Minutes of 7 February briefing to pearl producers in Broome copied to Paspaley.	Not applicable – correspondence sent by INPEX.
		25/03/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	[Group email] Requests stakeholder review minutes. Advises of changed transparency rules about publishing Environment Plans. Advises the risk assessment will be available soon on underwater noise risk assessments for planktonic communities, benthic communities, and pearling and aquaculture. Requests stakeholders confirm interest in receiving this information. Requests best contact for the PPA Research and Development Committee, who were previously flagged as interested in the impact assessment.	Not applicable – correspondence sent by INPEX.
		25/03/2019	Email / letter from stakeholder	N/A	Stakeholder confirmed interest in receiving the impact assessment for planktonic communities, benthic communities, and pearling and aquaculture. Stakeholder provided contact details for the PPA Research and Development Committee.	Not applicable – correspondence sent by INPEX.
		07/05/2019	Email / letter to stakeholder	Yes: - Impact assessment for planktonic communities, benthic communities, and pearling and aquaculture (summary and full versions). - Final meeting minutes from 7 February meeting	[Group email] Provides the impact assessment for planktonic communities, benthic communities, and pearling and aquaculture. Summarises key points on the proposed survey timing, management and communications. Request for any enquiries/feedback on the impact assessment information to be provided to INPEX by 7 June. Also sent final signed copy of meeting minutes [no comments/requests for amendment received on draft minutes circulated on 15/02/19 and 25/03/19].	Not applicable – correspondence sent by INPEX.
		12/06/2019	Email / letter to stakeholder	N/A	[Group email] Follow-up on previous email with draft environmental risk assessment and management information for the pearl oyster fishery. INPEX advised that INPEX has not received any responses to date, and wanted to confirm that feedback could be considered if provided by the end of the week. Advised that INPEX's current plan is to submit its 2D seismic survey environment plan (EP) in July 2019. On submission to offshore petroleum industry regulator, NOPSEMA, the EP will be published online in full, and will be open for public comment for 30 days.	Not applicable – correspondence sent by INPEX.
		20/06/2019	Email / letter from stakeholder	N/A	Stakeholder advised they are at sea at present so will provide a response to INPEX summary early next week when back in Broome.	Not a relevant matter – General correspondence only. No further response received from stakeholder.
	Willie Creek Pearls	26/11/2018	Email / letter from stakeholder	N/A	Provided contact details to arrange a meeting with the head of pearling operations in Broome.	Not a relevant matter – General correspondence only.
		27/11/2018	Email / letter to stakeholder	N/A	Contact made with head of pearling, Broome. Expressed desire to meet within December or early 2019. No meeting date confirmed yet.	Not applicable – correspondence sent by INPEX.
		27/11/2019	Email / letter from stakeholder	N/A	Stakeholder provides available dates to meet.	Not a relevant matter – General correspondence only.
		27/11/2018	Email / letter to stakeholder	N/A	INPEX advised it would plan a briefing for those dates	Not applicable – correspondence sent by INPEX.
		17/01/2019	Email / letter to stakeholder	N/A	Advised stakeholder that INPEX will be in Broome conducting consultation in the week beginning 4 February. Discussed dates for briefing to pearl producers.	Not applicable – correspondence sent by INPEX.
		21/01/2019	Email / letter to stakeholder	N/A	Above email forwarded to another individual within Willie Creek Pearls.	Not applicable – correspondence sent by INPEX.
		21/01/2019	Email / letter from stakeholder	N/A	Confirmation of receipt. Informed INPEX that the head of pearling operations will respond soon.	Not a relevant matter – General correspondence only.
		25/01/2019	Email / letter from stakeholder	N/A	Confirms desire to meet, provides available dates. Requests that the Pearl Producers Association (PPA) are also invited.	Not a relevant matter – General correspondence only.

	STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
		29/01/2019	Email / letter to stakeholder	N/A	Meeting date/time proposed. INPEX confirms that the PAA have been consulted and can be invited.	Not applicable – correspondence sent by INPEX.
		01/02/2019	Email / letter to stakeholder	Yes: - Fact Sheet	[Group email] INPEX provided pearling stakeholders with fact sheet prior to meetings in Broome.	Not applicable – correspondence sent by INPEX.
		07/02/2019	Meeting with stakeholder	N/A	**Minutes of 7 February briefing to pearl producers in Broome summarised as follows:** INPEX provided an overview and explanation of the proposed 2D seismic activity. Explained that here has been 58 2D MSSs in the region over the last 50 years, the most recent of which was in 2010. Explained the proposed MSS was approximately 50 km from the nearest pearling lease. The activity will avoid the humpback whale migration. Plans to undertake begin the activity as early as December 2019, but likely commencing early 2020, and will last ~5 months. Advised changes had been made to the original MSS area to avoid coastal sensitivities (e.g. Scott Reef, Browse Island and Adele Island). - A pearl producer raised concerns regarding the risk of seismic surveys on the juvenile spat growth and the impacts to the food sources and the food chain linked to pearl oysters, as there could be impacts associated with any changes in tidal flows. - INPEX advised it would provide the impact assessment sections of the EP which include assessment on these two points (food sources and larval recruitment). - The pearl producer noted that 50 kms is not a large distance in terms of water movement. - INPEX acknowledged this, noting that pearl oysters can detect the particle motion component of a sound wave (water and sediment borne vibration). Acknowledged that impacts to larvae in the plankton can be lethal or sub-lethal at close range to a seismic source, and these impacts are being assessed. - INPEX observed that some inshore stocks of pearl oysters self-seed and do not receive significant numbers of larval recruits from offshore stocks. Advised stakeholders of ongoing studies that are measuring potential impacts. - The pearl producer advised their main concern is overlap with the pearl spawning period (October to March). The pearl producer noted that the PPA shares this concern, and asked whether INPEX had consulted with the PPA. - INPEX advised it had started consultation with fishing Operators via WAFIC, and recreational fishing clubs in Broome. Notes seismic does not have lethal affects on fish but can result in short-term behavioural changes. Notes that like pearl oysters, many demersal species cannot detect the sound pressure component of a sound wave, and are only sensitive to the particle motion component at close ranges (10s to 100s of metres). Advised the impact assessment primarily focuses on site-attached fish, which is also a focus of NOPSEMA (particularly in depths <60m). INPEX advised that Lynher Bank is a key area potential impacts to site-attached fish are being assessed. Advised INPEX will be able to provide the impact assessment sections when they are complete, but at this stage just wanted to engage as early as possible to understand the stakeholder's concerns. - Pearl producer recommends INPEX consult with the PPA's Research and Development Branch. [NB: One stakeholder has redacted comments from this meeting - refer to Sensitive Matters Report].	Relevant matter – Pearling stakeholders have provided information on their fishing activities which has been incorporated into Section 4 and Section 7.2.3 of the EP. Concern raised by pearling stakeholders regarding impact to juvenile spat growth and food chain relates to the petroleum activity and the stakeholder's functions, activities or interests. However, this matter is assessed in Section 7.1.4 and Section 7.2.3 of the EP and is not considered to have merit. No significant impacts are expected to the pearl oyster resource, both directly and indirectly (larvae, spat or food chain) due to survey distance from shore and sound exposure levels. The seismic survey Acquisition Area is located mostly beyond the depth range of pearl oysters and where shallow areas do occur, the Acquisition Area is not known to support significant areas of suitable pearl oyster habitat. The tidal exchange and currents between the offshore Acquisition Area and nearshore pearl oyster grounds are also understood to have limited connectivity. The stakeholder has been informed of the outcomes of the assessment and provided with the draft risk assessment for review on 07/05/2019 (see below).
		15/02/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	[Group email] Minutes of 7 February briefing to pearl producers in Broome.	Not applicable – correspondence sent by INPEX.
		25/03/2019	Email / letter to stakeholder	Yes: - Draft meeting minutes with pearl producers from 7 February 2019	Requests stakeholder review minutes. Advises of changed transparency rules about publishing Environment Plans. Advises the risk assessment will be available soon on underwater noise risk assessments for planktonic communities, benthic communities, and pearling and aquaculture. Requests stakeholders confirm interest in receiving this information. Requests best contact for the PPA Research and Development Committee, who were previously flagged as interested in the impact assessment.	Not applicable – correspondence sent by INPEX.
		07/05/2019	Email / letter to stakeholder	Yes: - Impact assessment for planktonic communities, benthic communities, and pearling and aquaculture (summary and full versions). - Final meeting minutes from 7 February meeting	[Group email] Provides the impact assessment for planktonic communities, benthic communities, and pearling and aquaculture. Summarises key points on the proposed survey timing, management and communications. Request for any enquiries/feedback on the impact assessment information to be provided to INPEX by 7 June. Also sent final signed copy of meeting minutes [no comments/requests for amendment received on draft minutes circulated on 15/02/19 and 25/03/19].	Not applicable – correspondence sent by INPEX.
		12/06/2019	Email / letter to stakeholder	N/A	[Group email] Follow-up on previous email with draft environmental risk assessment and management information for the pearl oyster fishery. INPEX advised that INPEX has not received any responses to date, and wanted to confirm that feedback could be considered if provided by the end of the week. Advised that INPEX's current plan is to submit its 2D seismic survey environment plan (EP) in July 2019. On submission to offshore petroleum industry regulator, NOPSEMA, the EP will be published online in full, and will be open for public comment for 30 days.	Not applicable – correspondence sent by INPEX. No further response received from stakeholder.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Western Tuna and Billfish Fishery (Cwth)					

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Authorities					
Australian Border Force (ABF), Broome and Darwin Office (Cwth)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX.
	07/10/2020	Email from stakeholder	N/A	Thanking INPEX for updates. Advising that they will look forward to hearing form INPEX in due course.	Not a relevant matter – General correspondence only
Australian Border Force (ABF), Canberra Office (Cwth)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	08/10/2020	Email from stakeholder	No	Internal email within department requesting contact update.	Not applicable - General correspondence only.
	12/10/2020	Email from stakeholder	No	Stakeholder advising new contact for future reference.	Not applicable - General correspondence only.
Australian Fisheries Management Authority (AFMA) (Cwth)	09/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Australian Maritime Safety Authority (AMSA) - Marine Environment Pollution Response (Cwth)	15/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Australian Maritime Safety Authority (AMSA) - Nautical Advice (Cwth)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Bardi and Jawi Niimidiman Aboriginal Corporation	23/01/2019	Internal Email	No	INPEX Aboriginal Affairs Advisor met with Chairperson who was notified of date changes keeping all other EP details the same.	Not applicable

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Dambimangari Aboriginal Corporation	11/01/2021	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Agriculture, Water and Environment (DAWE) – Biosecurity (Marine Pests) (Cwth)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Agriculture, Water and Environment (DAWE) – Biosecurity (Vessels, aircraft and personnel) (Cwth)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Agriculture, Water and Environment (DAWE) - Fisheries (Cwth)	09/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Biodiversity Conservation and Attractions (DBCA) - Environmental Management Branch (WA)	25/09/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Defence, RAN Australian Hydrographic Office (AHO) (Cwth)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX.
	08/10/2020	Email from stakeholder	N/A	Confirmation of receipt. Advised they provided information will be registered, assessed, prioritised and validated for updating their Navigational Charting products, used to adhere to International and Australian Charting Specifications and standards.	Not a relevant matter – General correspondence only

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Department of Defence, Directorate of Property Acquisition, Mining and Native Title (Cwth)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Industry, Science, Energy and Resources (DISER)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Infrastructure, Transport, Regional Development and Communications	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Mines, Industry Regulation and Safety (DMIRS) (WA)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX.
	09/10/2020	Email from stakeholder	N/A	Acknowledges activity and confirms receipt of information. DMIRS requested that INPEX sends commencement and cessation notification.	Not a relevant matter – General correspondence only
Department of Primary Industries and Regional Development (DPIRD) - Aquatic Environment section (WA)	09/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Primary Industries and Regional Development (DPIRD) - Sustainability and Biosecurity section (WA)	25/09/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Department of Transport - Marine (WA DoT) (WA)	15/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	23/10/2020	Email from stakeholder	N/A	Marine Environment Emergency Response Intelligence Office responded acknowledging receipt and requesting copy of revised EP when available.	Not a relevant matter – General correspondence only
	23/10/2020	Email from stakeholder	N/A	Officer requested a copy of revised OPEP once available.	Not a relevant matter – General correspondence only
	09/12/2020	Email to stakeholder	No	Senior Environmental Advisor acknowledged receipt and will respond accordingly.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Department of Water and Environment Regulation (DWER) (WA) Hazard Management Branch Contaminated Sites Branch	15/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Indonesian Ministry for Marine Affairs and Fisheries (MMAF)	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Indigenous Land Corporation (ILC)	01/03/2019	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Kimberley Land Council (KLC)	21/12/2020	Internal Email	No	Aboriginal Affairs Advisor sent initial email prior changes including fact sheet and no further information was required.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Kimberley Ports Authority (KPA)	21/12/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Minister of the Environment (WA)	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX.
	13/05/2019	Email/Letter from stakeholder	Yes Letter	Minister thanking INPEX for the opportunity to comment and providing feedback that activity is outside of his jurisdiction	Not a relevant matter – General correspondence only.
Minister for the Environment (also Member for Durack) (Cwth)	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments:	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Minister for Fisheries (WA)	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Minister for the Infrastructure, Transport and Regional Development (Cwth)	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Minister for Kimberley (WA)	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Minister for Mines and Petroleum (WA)	08/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

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Minister for Regional Development; Agriculture and Food; Ports (WA)	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX.
	05/10/2020	Email from stakeholder	N/A	Minister's Principal Policy Advisor acknowledge receipt.	Not a relevant matter – General correspondence only.
National Native Title Tribunal (NNTT) (Cwth)	03/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
National Offshore Petroleum Titles Administrator (NOPTA) (Cwth)	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX.
	13/10/2020	Email from stakeholder	N/A	Titles Manager Exploration acknowledge receipt and noting changes to EP and timing of the acquisition.	Not a relevant matter – General correspondence only.
Office of the Director of National Parks (Cwth)	01/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX.
	15/10/2020	Email from stakeholder	N/A	Senior Marine Parks Office acknowledging receipt and thanking INPEX for notification of EP changes.	Not a relevant matter – General correspondence only.
Shire of Broome	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Shire of Derby / West Kimberley	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

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Shire of Wyndham / East Kimberley	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Wanjina Wunggurr Aboriginal Corporation RNTBC	21/12/2020	Internal Email	No	Aboriginal Affairs Advisor sent initial email prior changes to KLC as per their representation of Wajina Wunggurr Aboriginal Corporation and Wunambak Gaanbera Aboriginal Affairs, including fact sheet and no further information was required.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Wunambal Gaambera Aboriginal Corporation	21/12/2020	Internal Email	No	Aboriginal Affairs Advisor sent initial email prior changes to KLC as per their representation of Wajina Wunggurr Aboriginal Corporation and Wunambak Gaanbera Aboriginal Affairs, including fact sheet and no further information was required.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Business					
Australian Marine Oil Spill Centre (AMOSC)	16/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Australia's North West Tourism	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Broome Chamber of Commerce and Industry	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Broome Visitors Centre	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX.
	09/10/2020	Email from stakeholder	N/A	Stakeholder thanked INPEX for update and planned future meeting.	Not a relevant matter – General correspondence only.
IPB Petroleum	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

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KRED Enterprises	08/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Nyamba Buru Yawuru Ltd	08/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Oil Spill Response Limited (OSRL)	16/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Pathfinder Energy	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
RPS Asia-Pacific Applied Science Associates (APASA)	16/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Santos	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

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Shell	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Western Australian Fishing Industry Council (WAFIC)	10/11/2020	Email to stakeholder	No	Email follow up on emails sent to fisheries stakeholders on behalf of INPEX and enquiring about any comments.	Not applicable – correspondence sent by INPEX.
	10/11/2020	Email from stakeholder	N/A	WAFIC received informal feedback from a key stakeholder noting the November to May period overlaps with key spawning periods, as per the initial environment plan. - Email expressed frustration of WAFIC and all involved parties that they reached out to on behalf of INPEX, especially when survey is backed up against potential cumulative impacts on fishing activities and the commercial fishing resource. - WAFIC thanked INPEX for acknowledging other potential parallel seismic surveys and the possibility that Western Australian commercial fisheries having to endure more than one seismic survey in one calendar year and in some cases same season. - Email re confirmed displacement costs previously agreed upon, in the case of lost / damaged gear and impacts to commercial catch (evidence based comparison). - WAFIC will work closely with INPEX to ensure there is proactive forward planning for survey vessel – commercial fishing on-the-water and via email engagement, open communication and announcements – open radio – call for contact – so the ocean can be shared without commercial impact.	Not a relevant matter – General correspondence only.
	10/11/2020	Email to stakeholder	No	INPEX Environment Operations Team Lead explained that query was about scope part 2a, for emails dispatched mid October. - He stated that INPEX did not receive any correspondence as we commence preparation of our resubmission on the basis of no feedback received upon notifying respective stakeholders. -He explained that feedback window is still open for (2b and 2c)and that any secondary information will be requested through out the approval process. Email ended stating that re submission timeline is January 2021.	Not applicable – correspondence sent by INPEX.
	10/11/2020	Email from stakeholder	N/A	WAFIC confirmed that no replies were received as same EP was consulted on before.	Not a relevant matter – General correspondence only.
	15/11/2020	Email from stakeholder	Yes Map identifying survey locations and area being covered by INPEX 2D survey	- WAFIC sent their response forwarded on an email template sent to Commercial fishing licence holders in the following fisheries: Mackerel areas 1 and 2, Northern Demersal Scalefish Area2, Northern Shark (JA) and North West Slope Trawl. • Email template: 'Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so. • Returned feedback: Re email sent to commercial fishing licence holders potentially impacted by the INPEX 2D Seismic Survey. Stakeholders acknowledged this is an approved NOPSEMA EP, and that INPEX is seeking licence holder and peak body feedback regarding the proposed change of survey date bought about by the impacts / disruptions caused by COVID19. They also acknowledged that there are no changes to the window of opportunity and survey duration. Stakeholders thanked INPEX for recognizing potential cumulative impacts resulting of other approved seismic survey EPs and or postponed approved seismic survey EPs. They also, thanked INPEX for being vigilant ensuring this survey map is monitored and updated and any potential additional cumulative impacts taken into consideration. Stakeholders reconfirmed INPEX's commitment to a claim process if this survey results in economic impacts to a commercial fishery – displacement costs, lost / damaged gear and impacts to fishers' commercial catch (evidence-based comparison). Stakeholder expressed an ongoing concern about potential cumulative impacts, not just on our commercial fishing activities but also the unknown black holes - the significant research gaps - regarding potential cumulative impacts on the commercial fishing resource, spawning, the food chain and the extended marine	Objection / claim / concern raised by stakeholder regarding cumulative impacts on the commercial fishing resource, spawning, the food chain and the extended marine environment relates to the petroleum activity and the stakeholder's functions, activities or interests. This matter has merit and reasonable basis for being addressed in the EP. The matter has been assessed in Section 7.3 of the EP. A 40 km separation distance between operating vessels was selected as a control measure (in 2019). No additional management measures were selected as a result of this matter being raised again in 2020 because the control remained appropriate.
	15/11/2020	Email from stakeholder	Yes - Map identifying survey locations and area being covered by INPEX 2D survey - Letter to Augustus Rose. - Letter to Bilyaya Holdings.	WAFIC provided snails letters sent to Augustus Rose and Bilyara Holdings on behalf of INPEX. Letters included: 'Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent on behalf of INPEX.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Toll Group	20/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Woodside	02/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Civil Society					
Ardyaloon Incorporated	8/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Australian Institute of Marine Science (AIMS)	01/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Centre of Marine Science and Technology - Curtin University	01/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Commonwealth Scientific and Industrial Research Organisation (CSRIO)	01/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Djarindjin Aboriginal Corporation (DAC)	08/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX.
	08/10/2020	Email from stakeholder	N/A	Stakeholder's CEO confirmed receipt of email and informing INPEX with change of contact for future correspondence. And inquiry was made about when in November the survey will occur.	Not a relevant matter – General correspondence only.
	08/10/2020	Email to stakeholder	No	INPEX Aboriginal Affairs Advisor thanked stakeholder for acknowledgment of email and new contact. Response to inquiring about timing of survey, stating that it was November 2020 and subject communication is to advise that it is changed to 1 November 2020 at the earliest.	Not applicable – correspondence sent by INPEX.
	08/10/2020	Email from stakeholder	N/A	Stakeholder reinstated that they want to know the earliest ETA of them being informed of exact survey date.	Not a relevant matter – General correspondence only.
Lombadina Aboriginal Corporation (Dampier Peninsula)	08/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Oceans Institute - University of Western Australia	01/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Western Australian Marine Science Institution (WAMSI) - Kimberley research station	01/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Recreational Fishing					
Broome Fishing Club	26/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Broome North Fishing Club (BNFC)	26/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Recfishwest	09/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
WA Game Fishing Association	09/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Commercial Fishing and Pearling Stakeholders					
Fishing Industry associations					
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	15/10/2020	Email to stakeholder	Yes Map identifying survey locations and area being covered by INPEX 2D survey	[WAFIC on behalf of INPEX] 'Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Commonwealth Fisheries Association (CFA)	15/10/2020	Email to stakeholder	Yes Map identifying survey locations and area being covered by INPEX 2D survey	[WAFIC on behalf of INPEX] 'Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Peal Producers Association					
Pearl Producers Australia	15/10/2020	Email to stakeholder	Yes Map identifying survey locations and area being covered by INPEX 2D survey	[WAFIC on behalf of INPEX] 'Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.

STAKEHOLDER	Date of Correspondenc	Type of Correspondence	Attachments	Summary of Correspondence	Assessment of Merit and Relevant Matters
Maxima Pealing Company	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Cygnet Bay Pearls	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
Willie Creek Pearls	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days. Advised that all feedback, comments and queries were welcome and provided contact details to do so.	Not applicable – correspondence sent by INPEX.
	16/10/2020	Email from stakeholder	N/A	Acknowledges and confirms receipt of information.	Not a relevant matter – General correspondence only.
Paspaley	07/10/2020	Email to stakeholder	No	Provided stakeholder with EP changes resulting with Survey date change due to travel restrictions caused by COVID-19 Email included: - Link to original unchanged submission on NOPSEMA's website. - Relevant amendments: Survey proposed commencement day 1 November 2021 at its earliest. No changes to window of opportunity presented and accepted in current accepted EP. Further provision to commence the activity on 1 November 2022 or 1 November 2023 if COVID-19 restrictions are to be prolonged. No change to INPEX intentions for a single campaign. No change to the duration of the survey activity which will comprise approximately 140 days of seismic data acquisition. - Explained the consequence of operational downtime and potential adverse weather, that the survey vessel may be present in the Operational Area for up to 210 days.	Not applicable – correspondence sent by INPEX. No response received from stakeholder.
	08/10/2020	Email from stakeholder	N/A	Acknowledges and confirms receipt of information.	Not a relevant matter – General correspondence only.

Appendix D-
Acoustic modelling report (JASCO)

Western Australia 2-D Marine Seismic Survey

Acoustic Modelling for Assessing Marine Fauna Sound Exposures

Submitted to:

Joe Edgell
INPEX Operations Australia Pty Ltd
PO: 4500039837 and 4500039843

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Craig McPherson
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Zahraalsadat Alavizadeh
Karen Hiltz

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Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Suggested citation:

McPherson, C.R., J.L. Wladichuk, Z. Alavizadeh and K. Hiltz. 2018. *Western Australia 2-D Marine Seismic Survey: Acoustic Modelling for Assessing Marine Fauna Sound Exposures*. Document 01696, Version 2.0. Technical report by JASCO Applied Sciences for INPEX Operations Australia Pty Ltd.

Contents

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Executive Summary

JASCO Applied Sciences performed a numerical estimation study of underwater sound levels associated with the planned INPEX Western Australia (WA) 2-D Marine Seismic Survey (MSS) to assist in understanding the potential acoustic impact on key regional receptors including fish, marine mammals, benthic invertebrates (including pearl oysters), plankton, and turtles. The planned Acquisition Area is focused on two exploration permits, WA-533-P and WA-532-P, and Production Licence, WA-50-L, in northwest WA. Three seismic sources were initially considered, with the propagation modelling considering the source with the loudest far-field representative signature, a 3080 in^3 seismic source towed at a 7 m depth behind a single vessel.

A specialised airgun array source model was used to predict the acoustic signature of the three seismic sources, and complementary underwater acoustic propagation models were used in conjunction with the modelled array signature of a 3080 in^3 to estimate sound levels over a large area around the source. Single-impulse sound fields were predicted at defined locations within the entire Acquisition Area, and accumulated sound exposure fields were predicted for three representative scenarios for likely survey operations over 24 hours. The modelling methodology considered source directivity and range-dependent environmental properties in each of the areas assessed. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), zero-to-peak pressure levels (PK, L_{pk}), peak-to-peak pressure levels (PK-PK; $L_{pk\text{-}pk}$), and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, L_E) as appropriate for different noise effect criteria. A conservative sound speed profile that would be most supportive of sound propagation conditions for the period of the survey was defined and applied to all modelling.

The analysis considered the distances away from the seismic source at which several effects criteria or relevant sound levels were reached. The results are summarised below for the representative single-impulse sites and accumulated SEL scenarios. Additionally, sound levels were predicted at five locations relevant to the pearl oyster fishery and four locations relevant to calving and resting humpback whales.

Marine mammal injury and behaviour

- The maximum distance where the NMFS (2014) marine mammal behavioural response criterion of 160 dB re 1 µPa (SPL) could be exceeded varied between 5.52 and 11.19 km (Site 8, 45 m and Site 12, 103 m, permit WA-532-P).
- The maximum received SPL, LF-weighted SPL and per-pulse SEL at any of the four locations relevant to calving and resting humpback whales were received at Tasmanian Shoal considering a modelled site 79 km away. The respective levels were 134.6 (L_p; dB re 1 µPa), 120 ($L_{p,LF}$; dB re 1 µPa) and 126.2 (L_E**;** dB re 1 µPa^2·s).
- The results for the criteria applied for marine mammal Permanent Threshold Shift (PTS), NMFS (2018), consider both metrics within the criteria (PK and SEL_{24h}). The longest distance associated with either metric is required to be applied. The table below summarise the maximum distances for PTS, along with the relevant metric and the location of the results within this report.
- The furthest distance from the array that high-frequency cetaceans could experience PTS was 440 m at Site 12 (103 m, permit WA-532-P), a site in a different location to any of the SEL_{24h} scenarios.

Table 1. Summary of maximum marine mammal PTS onset distances for SEL_{24h} modelled scenarios

Relevant hearing group	Metric associated with longest distance to PTS onset	R_{max} (km)		
		Scenario 1 (WA-533-P Shallow)	Scenario 2 (WA-533-P Deep)	Scenario 3 (WA-532-P)
Low-frequency cetaceans†	SEL_{24h}	0.7	1.35	2.13
Mid-frequency cetaceans†	PK	< 0.02	< 0.02	< 0.02
High-frequency cetaceans	PK	0.27	0.22	0.39
Sirenians	PK	NA	NA	0.02

† The model does not account for shutdowns.

- The 24-h SEL is a cumulative metric that reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The corresponding 24-h SEL radii for low-frequency cetaceans were larger than those for peak pressure criteria, but they represent an unlikely worst-case scenario. More realistically, marine mammals (and fish) would not stay in the same location or at the same range for 24 hours. Therefore, a reported radius for 24-h SEL criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with injury (either PTS or TTS) if it remained in that range for 24 hours

Turtle Behaviour

- The maximum distance where the United States NMFS criterion (NSF 2011) for behavioural effects in turtles of 166 dB re 1 µPa (SPL) could be exceeded varied between 3.09 and 6.13 km (Site 8, 45 m and Site 11, 70 m, permit WA-532-P).

Turtle Injury (Finneran et al. 2017)

- The maximum distance to the SEL_{24h} metric for PTS onset was 40 m and 0.4 km for TTS onset. As is the case with marine mammals, a reported radius for SEL_{24h} criteria does not mean that turtles travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with injury (either PTS or TTS) if it remained in that location for 24 hours.
- The PK turtle injury criteria of 232 dB re 1 µPa for PTS and 226 dB re 1 µPa for TTS from Finneran et al. (2017) was not exceeded at a distance greater than 20 m (horizontal modelling resolution for FWRAM) from the centre of the array. Because the arrays are not a point source (approximately 14 m x 10 m) the actual ranges from the edge of airgun arrays are smaller than the distance from the centre.

Fish, turtle injury, fish eggs, and fish larvae

- The modelling study assessed the seafloor and water column ranges for quantitative criteria based on Popper et al. (2014) and considering both PK and SEL_{24h} metrics associated with mortality and potential mortal injury and impairment in:
  - Fish without a swim bladder (also appropriate for sharks in the absence of other information)
  - Fish with a swim bladder that do not use it for hearing
  - Fish that use their swim bladders for hearing
  - Turtles
  - Fish eggs and fish larvae
- Water column receptors, assessed at four modelling sites:

  - The maximum distance to sound levels associated with mortality and potential mortal injury on most the sensitive fish groups are associated with the PK metric, and range from 120 m (Sites 1, 5 and 12) to 220 m (Site 7). For fish without a swim bladder, the distance is 60 m at all four sites.
- Seafloor receptors, assessed at five modelling sites, along with sites representative of different depths and geoacoustic parameters, three in WA-533-P and five in WA-532-P (depths from 30 to 103 m):
  - The maximum distance to sound levels associated with mortality and potential mortal injury in fish, turtles, fish eggs and fish larvae is associated with the PK metric in all cases.
  - The maximum distance for the most sensitive fish groups (associated with a PK threshold of 207 dB re 1 µPa) varies between 154 and 185 m for the 3080 in^3 source, and 121 and 171 m for the 2060 in^3 source.
  - The maximum distance for the less sensitive fish groups (associated with a PK threshold of 213 dB re 1 µPa) varies between 54 and 114 m for the 3080 in^3 source, and 57 and 75 m for the 2060 in^3 source.
- Considering the three 24-hour SEL scenarios, and based on Popper et al. (2014), the SEL_{24h} metric criteria for potential TTS could be exceeded within the following distances:
  - 1.58 km of the array at both the seafloor for maximum-over-depth during Scenario 1,
  - 4.94 km for maximum-over-depth during Scenario 2
  - within 2.92 km at the seafloor and 3.5 km for maximum-over-depth during Scenario 3.

Crustaceans and Bivalves, Sponges and Coral, and Plankton

To assist with assessing the potential effects on these receptors, the following have been determined:

- The maximum received SPL and per-pulse SEL at any of the five locations relevant to the pearl oyster fishery were received at the closest lease to modelling Site 1, 74.5 km away. The respective levels were 101.9 (L_p; dB re 1 µPa) and 121.1 (L_E**;** dB re 1 µPa²·s).
- Crustaceans: The sound level of 202 dB re 1 µPa PK-PK from Payne et al. (2008) was considered; it was reached at ranges between 461 and 666 m depending on the modelled site, with range generally increasing with bottom depth.
- Sponges and coral: The PK sound level at the seafloor directly underneath the seismic source was estimated at all modelling sites considered for seafloor fish receptors, and compared to the sound level of 226 dB re 1 µPa PK for sponges and corals (Heyward et al. 2018); it was found to reach or just exceed the criterion only at sites with a water depth less than 45 m, with the maximum distance being < 12 m (30 m depth).
- Plankton: The distance to the sound level of 178 dB re 1 µPa PK-PK from McCauley et al. (2017) was estimated at all modelling sites through full-waveform modelling using FWRAM; the results ranged from 7.94 km to 12.23 km.

1. Introduction

JASCO Applied Sciences (JASCO) performed a numerical estimation study of underwater sound levels associated with the planned INPEX Western Australia (WA) 2-D Marine Seismic Survey (MSS) to assist in understanding the potential acoustic impact on key regional receptors including fish, marine mammals, benthic invertebrates (including pearl oysters), plankton, and turtles. The survey plan Acquisition Area is focused on two exploration permits, WA-533-P and WA-532-P, and Production Licence, WA-50-L, in northwest WA. Three seismic sources were initially considered for the main survey, with the propagation modelling considering the source with the loudest far-field representative signature, a 3080 in^3 seismic source towed at a 7 m depth behind a single seismic source vessel. Additionally, a smaller 2060 in^3 seismic source towed at a 7 m depth was considered for water depths shallower than 50 m.

JASCO's specialised Airgun Array Source Model (AASM) was used to predict the acoustic signature of all arrays. AASM accounts for individual airgun volumes and array geometry. Complementary underwater acoustic propagation models were used in conjunction with the selected modelled array signature to estimate sound levels over a large area around the source. Single-impulse sound fields were predicted at defined locations within the entire Acquisition Area, including for seafloor peak pressure levels relevant to fish, and accumulated sound exposure fields were predicted for three representative scenarios for likely survey operations over 24 hours. A conservative sound speed profile that would be most supportive of sound propagation conditions for the period of the survey was defined and applied at each of the modelling locations.

The modelling methodology considered source directivity and range-dependent environmental properties in each of the areas assessed. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), zero-to-peak pressure levels (PK, L_{pk}), peak-to-peak pressure levels (PK-PK; $L_{pk\text{-}pk}$), and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, L_E) as appropriate for different noise effect criteria.

2. Modelling Scenarios

Six standalone single impulse sites and three likely scenarios of survey operations over 24 hours to assess accumulated SEL were initially defined, with an additional six modelling sites (a combined total of 12 sites) defined to ensure a robust assessment of accumulated SEL. The locations of all modelling sites are provided in Table 2, with all sites shown in Figure 1 along with the exploration permits and survey boundaries. Seafloor sound levels were examined at depths of 45, 55, and 65 m in WA-533-P, and 30–70 m in WA-532-P using geological profiles consistent with associated water depths for the 3080 in^3 source, with sites shallower than 50 m also considered for the 2060 in^3 source.

Single impulse sound fields were also sampled at fixed receiver locations relevant to humpback whale resting, calving and nursing grounds (Figure 1, Table 4).

Three representative scenarios (Scenarios 1–3) for acquisition within the Acquisition Area were considered for 24 hours of operation, the period relevant considering the various criteria applied in this study. Two scenarios are located in permit WA-533-P, located in the shallowest (Scenario 1) and deepest (Scenario 2) sections of the permit, and the third scenario is in WA-532-P, close to shoals and Australian Marine Parks. The track lines for each scenario are shown in Figures 2–4. The modelling assumes that the vessels sail along the survey lines at ~4.5 knots, with an impulse interval of 18.75 m. The considered survey lines take between ~3.75–11.3 h to traverse, with ~1.86–1.92 h of turn time required between the lines depending upon the scenario, this is likely a faster turn than for the actual survey. The scenarios account for 9840, 9046, and 9591 impulses, respectively. For Scenario 3, the time history of sound exposure accumulation at the seafloor was also estimated at static receivers located at eight offset distances (50, 100, 300, 500, 1000, 2000, 3000, and 5000 m) from both survey lines within the scenario.

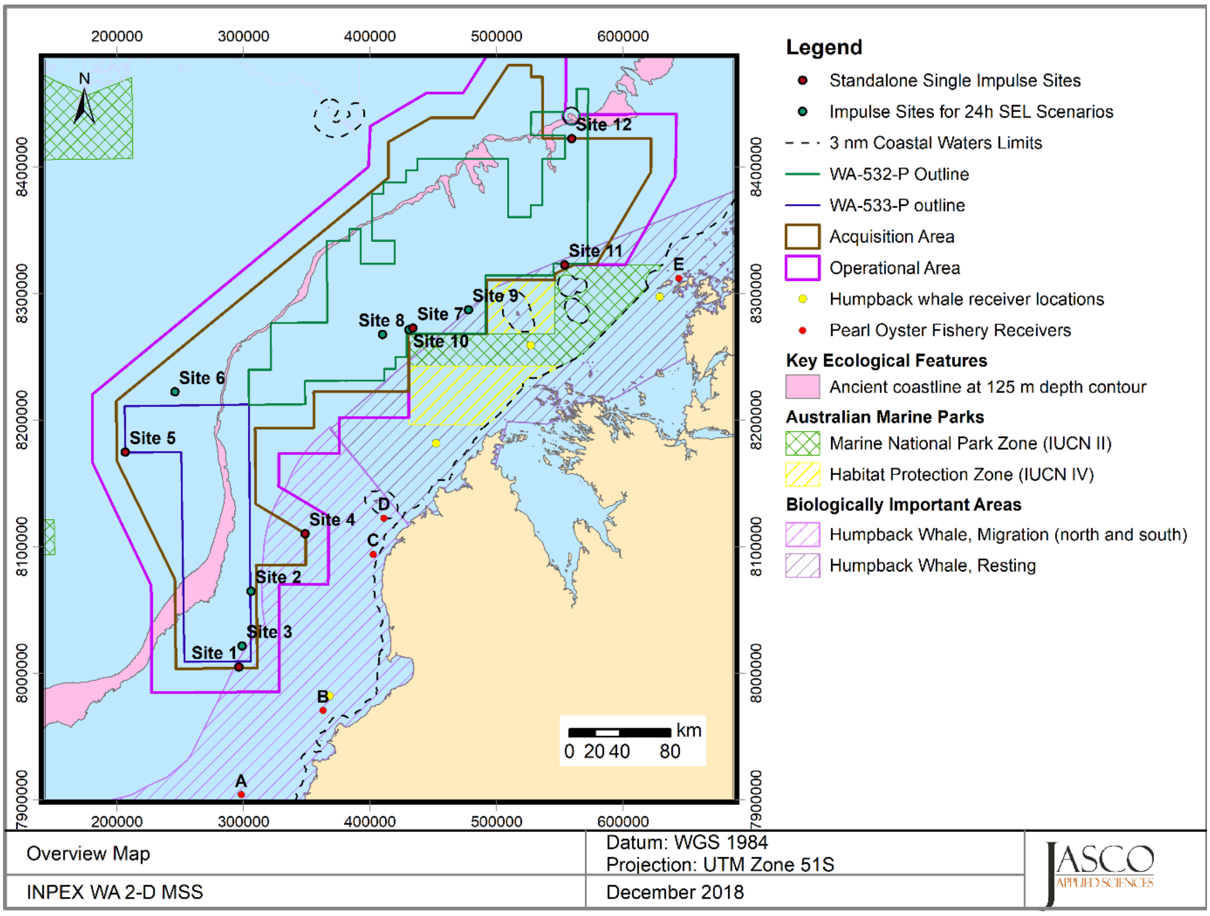


Figure 1. Overview of the modelling sites and features for the WA 2-D marine seismic survey modelling.

Table 2. Location details for the standalone single impulse sites.

Site	Latitude (S)	Longitude (E)	UTM (WGS84), Zone 51 S		Water depth (m)	Representative tow direction (°)	Associated 24-hour Scenario
			X (m)	*Y* (m)			
1	18° 02' 13.9900"	121° 04' 33.4297"	296326.9	8004637	67	189.9/9.9	Scenario 1
2	17° 29' 49.1347"	121° 10' 22.9614"	306025.7	8064535	98		
3	17° 53' 14.1409"	121° 06' 07.7760"	298932.4	8021264	89		
4	16° 29' 36.2192"	120° 15' 10.6251"	206726.2	8174490	37	121.3	NA
5	17° 05' 25.8942"	121° 34' 42.8679"	348758.8	8109879	451	210.9/30.9	Scenario 2
6	16° 04' 07.4590"	120° 37' 26.6740"	245821.2	8222002	360		
7	15° 37' 26.7291"	122° 23' 02.9719"	433987.3	8272549	59	71.5/251.5	Scenario 3
8	15° 40' 10.9159"	122° 09' 33.6274"	409907.5	8267422	45		
9	15° 29' 40.4578"	122° 47' 35.8906"	477830.4	8286960	84		
10	15° 38' 15.4254"	122° 21' 15.4894"	430791.4	8271043	34		
11	15° 10' 29.8828"	123° 30' 06.3271"	553899.2	8322260	70	160.9	NA
12	14° 16' 20.9080"	123° 33' 04.0528"	559446.5	8422069	103	339.5	NA

Table 3. Humpback whale receiver locations and relevant modelling sites.

Receiver location	Latitude (S)	Longitude (E)	UTM (WGS84), Zone 51 S		Relevant modelling site	Distance (km)
			X (m)	*Y* (m)		
Camden Sound	15° 24' 00.0000"	124° 12' 00.0000"	628774.2	8297073	11	93.8
					12	142.9
Tasmanian Shoal	15° 45' 00.0000"	123° 15' 00.0000"	526781	8258702	7	79.0
					11	69.1
Pender Bay	16° 27' 00.0000"	122° 33' 00.0000"	451962.6	8181234	4	125.4
					7	93.1
Gourdon Bay	18° 15' 00.0000"	121° 45' 00.0000"	367851	7981704	1	75.1
					4	129.5

Table 4. Pearl oyster fishery receiver locations and relevant modelling sites.

Pearl oyster fishery receiver	Latitude	Longitude	Relevant modelling site	Location description	Distance (km)
A	18° 56' 51.1990" S	121° 05' 11.6198" E	1	Compass Rose fishing ground	100.8
B	18° 21' 06.1200" S	121° 42' 06.1200" E	1	Port Smith farm lease	74.8
C	17° 14' 18.2400" S	122° 05' 02.7600" E	4	North Coulomb Pt farm lease	56.0
D	16° 58' 48.7447" S	122° 09' 54.4718" E	4	Lacepede Channel fishing ground	63.6
E	15° 15' 52.9045" S	124° 20' 32.5257" E	11	Pearl Transport Exempt Area / Kuri Bay farm leases	90.7

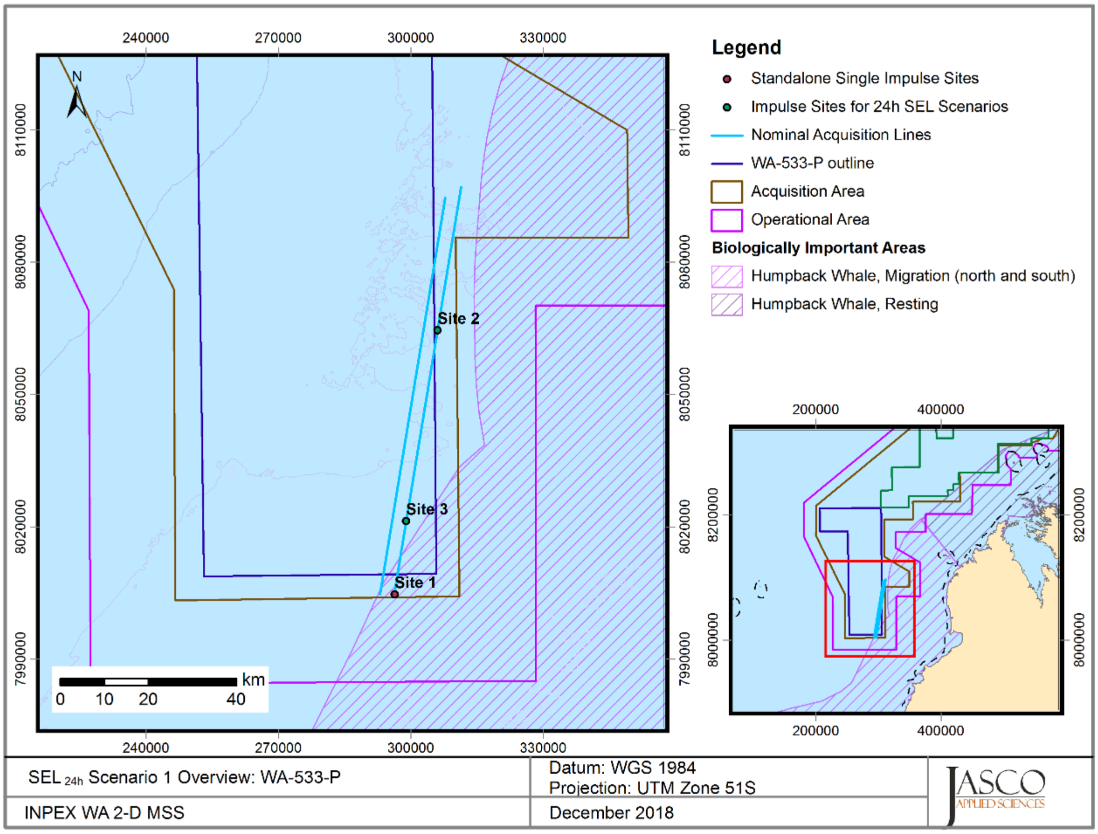


Figure 2. *Scenario 1*: Acquisition lines and static receiver locations considered for SEL_{24h} calculations, WA-533-P Shallow.

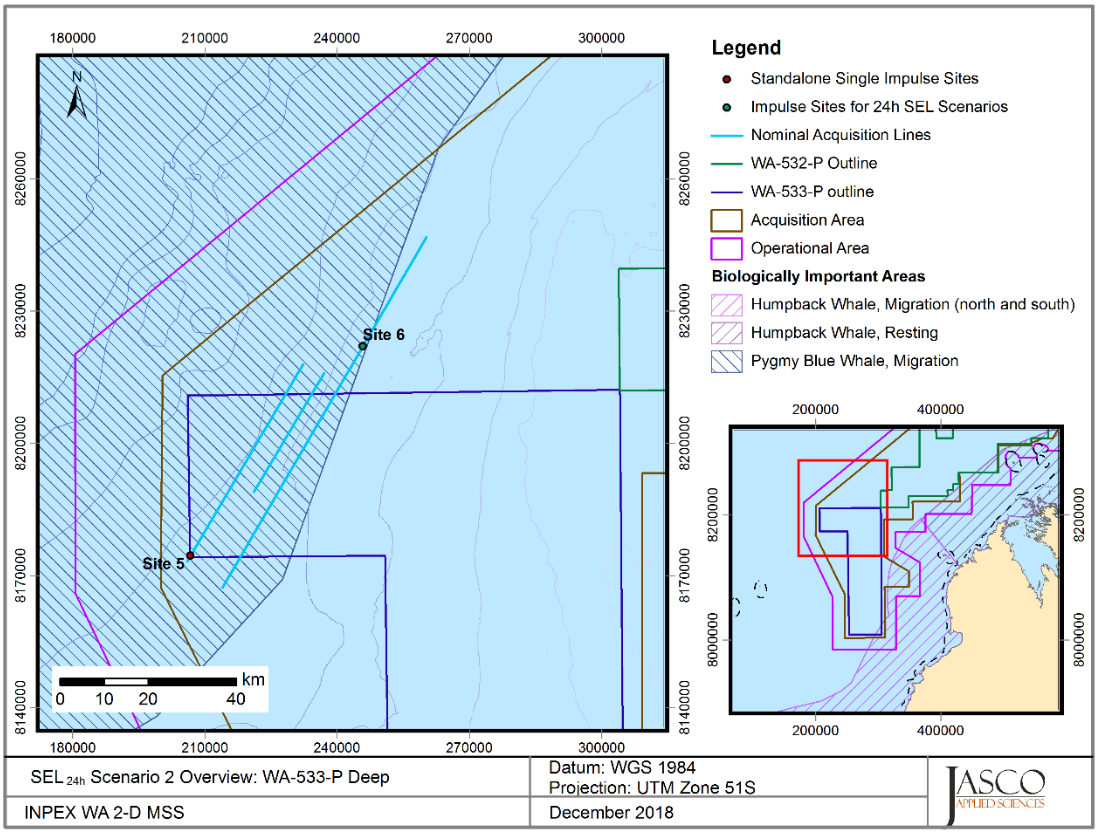


Figure 3. *Scenario 2*: Acquisition lines and static receiver locations considered for SEL_{24h} calculations, WA-533-P deep.

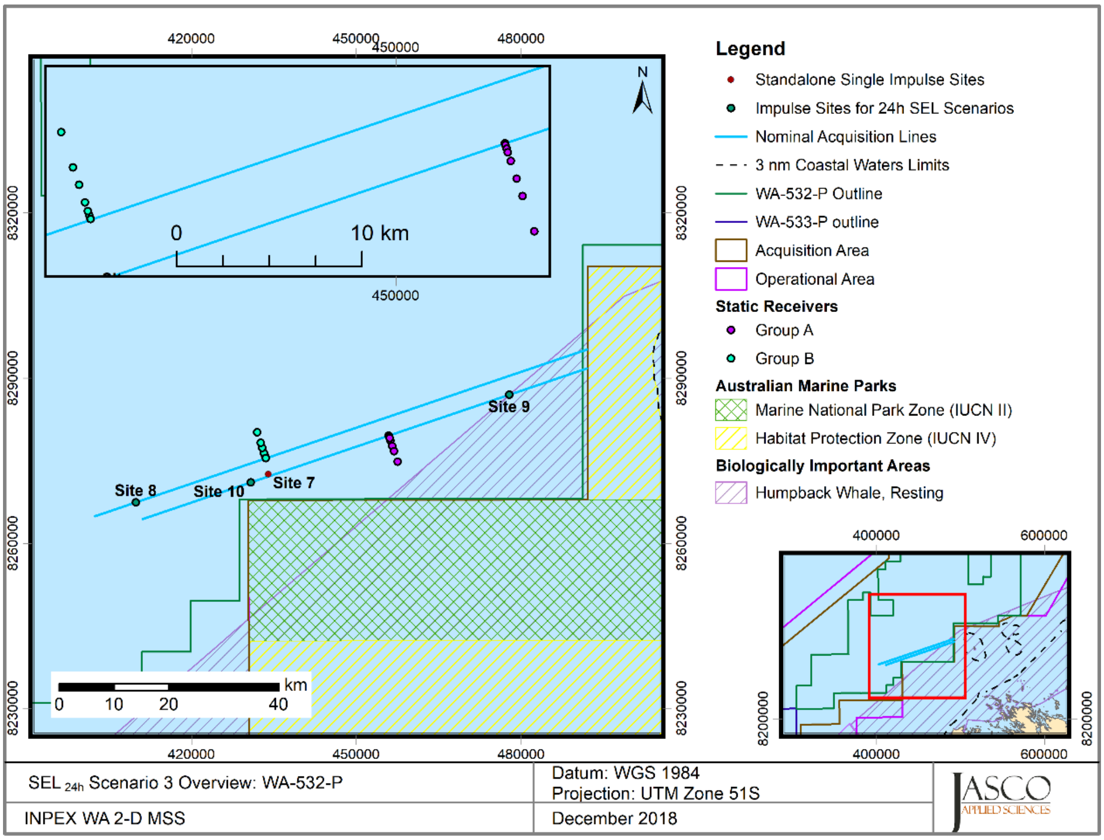


Figure 4. *Scenario 3*: Acquisition lines and static receiver locations considered for SEL_{24h} calculations, WA-532-P.

3. Noise Effect Criteria

The perceived loudness of sound, especially impulsive noise such as from seismic airguns, is not generally proportional to the instantaneous acoustic pressure. Rather, perceived loudness depends on the pulse rise-time and duration, and the frequency content. Several sound level metrics, such as PK, SPL, and SEL, are commonly used to evaluate noise and its effects on marine life (Appendix A). The period of accumulation associated with SEL is defined, with this report referencing either a "per pulse" assessment or over 24 hours. Appropriate subscripts indicate any applied frequency weighting; unweighted SEL is defined as required. The acoustic metrics in this report reflect the updated ISO standard for acoustic terminology, ISO/DIS 18405.2:2017 (2017).

Whether acoustic exposure levels might injure or disturb marine mammals is an active research topic. Since 2007, several expert groups have investigated an SEL-based assessment approach for injury, with a handful of key papers published on the topic. The number of studies that investigated the level of disturbance to marine animals by underwater noise has also increased substantially.

We chose the following noise criteria and sound levels for this study because they include standard thresholds, thresholds suggested by the best available science, and sound levels presented in literature for species with no suggested thresholds (Sections 3.1–3.2 and Appendix A):

1. Peak pressure levels (PK; L_{pk}) and frequency-weighted accumulated sound exposure levels (SEL; $L_{E,\mathrm{24h}}$) from the U.S. National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS 2018) for the onset of Permanent Threshold Shift (PTS) in marine mammals.
2. Marine mammal behavioural threshold based on the current interim U.S. National Marine Fisheries Service (NMFS) (2014) of 160 dB re 1 µPa SPL (L_{p}) for impulsive sound sources.
3. Sound exposure guidelines for fish, fish eggs and larvae, and turtles (Popper et al. 2014).
4. Threshold for turtle behavioural response (NSF 2011), 166 dB re 1 µPa SPL (L_{p}), applied by the U.S. NMFS.
5. Peak pressure levels (PK; L_{pk}) and frequency-weighted accumulated sound exposure levels (SEL; $L_{\mathrm{E,24h}}$) from Finneran et al. (2017) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in turtles.
6. A sound level 178 dB re 1 µPa PK-PK in the water column, reported for comparing to McCauley et al. (2017) for plankton.
7. Peak-peak pressure levels (PK-PK; $L_{\mathrm{pk-pk}}$) at the seafloor to help assess effects of noise on crustaceans and bivalves, through comparing to results in Payne et al. (2008), and Day et al. (2016).
8. A sound level of 226 dB re 1 µPa PK (L_{pk}) reported for comparing to Heyward et al. (2018) for sponges and corals.

Additionally, to assess the size of the low-power zone required under the Australian Environment Protection and Biodiversity Conservation (EPBC) Act Policy Statement 2.1, Department of the Environment, Water, Heritage and the Arts (DEWHA) (2008), the distance to an unweighted per-pulse SEL of 160 dB re 1 µPa^2·s is reported.

The following section expands on the thresholds and sound levels for marine mammals, fish, turtles, fish eggs, and fish larvae and benthic invertebrates.

3.1. Marine Mammals

The criteria applied in this study to assess possible effects of airgun noise on marine mammals are summarised in Table 5 and detailed in Sections 3.1.1 and 3.1.2, with frequency weighting explained in Appendix A.3.

Table 5. Unweighted SPL, SEL_{24h}, and PK thresholds for acoustic effects on marine mammals.

Hearing group	NMFS (2014)	NMFS (2018)			
	Behaviour	PTS onset thresholds* (received level)		TTS onset thresholds* (received level)	
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency cetaceans	160	183	219	168	213
Mid-frequency cetaceans		185	230	170	224
High-frequency cetaceans		155	202	140	196
Sirenians (Dugong)		190	226	175	220

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.
L_p-denotes sound pressure level period and has a reference value of 1 µPa
L_{pk}, flat–peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa
L_E - denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa²s
Subscripts indicate the designated marine mammal auditory weighting.

3.1.1. Behavioural response

Southall et al. (2007) extensively reviewed marine mammal behavioural responses to sounds. Their review found that most marine mammals exhibited varying responses between 140 and 180 dB re 1 µPa SPL, but inconsistent results between studies makes choosing a single behavioural threshold difficult. Studies varied in their lack of control groups, imprecise measurements, inconsistent metrics, and that animal responses depended on study context, which included the animal's activity state. To create meaningful quantitative data from the collected information, Southall et al. (2007) proposed a severity scale that increased with increasing sound levels.

NMFS has historically used a relatively simple sound level criterion for potentially disturbing a marine mammal. For impulsive sounds, this threshold is 160 dB re 1 µPa SPL for cetaceans NMFS (NMFS 2014). This threshold has been applied for this report.

3.1.2. Injury and hearing sensitivity changes

There are two categories of auditory threshold shifts or hearing loss: permanent threshold shift (PTS), a physical injury to an animal's hearing organs; and Temporary Threshold Shift (TTS), a temporary reduction in an animal's hearing sensitivity as the result of receptor hair cells in the cochlea becoming fatigued.

To assist in assessing the potential for injuries to marine mammals this report applies the criteria recommended by NMFS (2018), considering both PTS and TTS, to help assess the potential for injuries to marine mammals. Appendix A.2 provides more information about the NMFS (2018) criteria.

3.2. Fish, Turtles, Fish Eggs, and Fish Larvae

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to continue developing noise exposure criteria for fish and turtles, work begun by a panel convened by NOAA two years earlier. The resulting guidelines included specific thresholds for different levels of effects and for different groups of species (Popper et al. 2014). These guidelines defined quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death.
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma.
- TTS.

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. These effects are not assessed in this report. Because the presence or absence of a swim bladder has a role in hearing, fish's susceptibility to injury from noise exposure varies depending on the species and the presence and possible role of a swim bladder in hearing. Thus, different thresholds were proposed for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Turtles, fish eggs, and fish larvae are considered separately.

Table 6 lists relevant effects thresholds from Popper et al. (2014). In general, any adverse effects of seismic sound on fish behaviour depends on the species, the state of the individuals exposed, and other factors. We note that, despite mortality being a possibility for fish exposed to airgun sounds, Popper et al. (2014) do not reference an actual occurrence of this effect. Since the publication of that work, newer studies have further examined the question of possible mortality. Popper et al. (2016) adds further information to the possible levels of impulsive seismic airgun sound to which adult fish can be exposed without immediate mortality. They found that the two fish species in their study, with body masses in the range 200–400 g, exposed to a single-impulse of a maximum received level of either 231 dB re 1 µPa (PK) or 205 dB re 1 µPa^2·s (SEL), remained alive for 7 days after exposure and that the probability of mortal injury did not differ between exposed and control fish.

The SEL metric integrates noise intensity over some period of exposure. Because the period of integration for regulatory assessments is not well defined for sounds that do not have a clear start or end time, or for very long-lasting exposures, it is required to define a time. Popper et al. (2014) recommend a standard period should be applied, where this is either defined as a justified fixed period or the duration of the activity, however also include caveats about how long the fish will be exposed because they can move (or remain in location) and so can the source. Popper et al. (2014) summarises that in all TTS studies considered, fish that showed TTS recovered to normal hearing levels within 18–24 hours. Due to this, a period of accumulation of 24 hours has been applied in this study for SEL, which is similar to that applied for marine mammals in NMFS (2016, 2018).

In the discussion of the criteria, Popper et al. (2014) discuss the complications in determining a relevant period of mobile seismic surveys, as the received levels at the fish change between impulses due to the mobile source, and that in reality a revised guideline based on the closest PK or the per-pulse SEL might be more useful than one based on accumulated SEL. This is because exposures at the closest point of approach are the primary exposures contributing to a receiver's accumulated level (Gedamke et al. 2011). Additionally, several important factors determine the likelihood and duration a receiver is expected to be in close proximity to a sound source (i.e., overlap in space and time between the source and receiver). For example, accumulation time for fast moving (relative to the receiver) mobile sources is driven primarily by the characteristics of source (i.e., speed, duty cycle; NMFS 2016, 2018).

Table 6. Criteria for seismic noise exposure for fish and turtles, adapted from Popper et al. (2014).

Type of animal	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	>219 dB SEL_{24h} or >213 dB PK	>216 dB SEL_{24h} or >213 dB PK	>>186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	>>186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	186 dB SEL_{24h}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Turtles	210 dB SEL_{24h} or > 207 dB PK	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	>210 dB SEL_{24h} or >207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes: Peak sound level (PK) dB re 1 µPa; SEL_{24h} dB re 1µPa^2·s. All criteria are presented as sound pressure, even for fish without swim bladders, since no data for particle motion exist. Relative risk (high, moderate, or low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F). >> denotes levels much greater than.

3.2.1. Turtle behavioural response and injury

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. McCauley et al. (2000b) observed the behavioural response of caged turtles—green (*Chelonia mydas*) and loggerhead (*Caretta caretta*)—to an approaching seismic airgun. For received levels above 166 dB re 1 µPa (SPL), the turtles increased their swimming activity and above 175 dB re 1 µPa they began to behave erratically, which was interpreted as an agitated state. The 166 dB re 1 µPa level has been used as the threshold level for a behavioural disturbance response by NMFS and applied in the Arctic Programmatic Environment Impact Statement (PEIS) (NSF 2011). Some additional data suggest that behavioural responses occur closer to an SPL of 175 dB re 1 µPa, and TTS or PTS at even higher levels (McCauley et al. 2000b, McCauley et al. 2000a), but the received levels were unknown. Sound levels defined by Popper et al. (2014) show that animals are very likely to exhibit a behavioural response when they are near an airgun (tens of metres), a moderate response if they encounter the source at intermediate ranges (hundreds of metres), and a low response if they are far (thousands of meters) from the airgun.

As a conservative approach and in the absence of data specific to the effects of seismic impulses on turtles, Popper et al. (2014) recommend applying the thresholds developed for mortality and mortal injury to fishes to turtles as well (shown in Table 6). Therefore, Popper et al. (2014) suggest that injury to turtles resulting from seismic impulses may occur for sound exposures above 207 dB re 1 µPa (PK) or above 210 dB re 1 µPa^2·s (SEL_{24h}), these thresholds are considered in this study. However, Popper et al. (2014) suggest that recoverable injury and TTS is likely within tens of metres of a seismic source, which is generally less than the distance associated with their proposed mortal injury threshold, hence there is some discrepancy. Popper et al. (2014) also note that turtles are highly resistant to high-intensity explosives, making it likely that they would also be resistant to damage from seismic airguns. Explosives typically produce pressure waves with a more rapid rise time and over pressure signal (and, therefore, likely greater potential for harm) than seismic impulses. Popper et al. (2014) propose a threshold for injury from explosives of 229–234 dB re 1 µPa (PK). However, seismic impulses have lower peak pressures (and rise time) than explosives, and as such are less likely to cause injury, therefore the potential for injury at 207 dB re 1 µPa (PK) is highly unlikely.

Finneran et al. (2017) presented revised thresholds for turtle injury, considering both PK and frequency weighted SEL. This work considers Popper et al. (2014), and that the working group considered turtles to be more similar to fish, and defines both a weighting function and TTS exposure function parameters for turtles. As summarised in Finneran et al. (2017), there are no published data regarding TTS in sea turtles exposed to underwater explosions or other impulsive noise sources. Applying the marine mammal rule for converting SEL-based non-impulsive TTS to SEL-based impulsive TTS (11 dB), the impulse TTS threshold would be 189 dB re 1 µPa^{2}s (non-impulsive TTS threshold of 200 dB re 1 µPa^{2}s less 11 dB) — slightly higher than the fish threshold of 186 dB re 1 µPa^{2}s.

No recommendation for PK based TTS thresholds for turtles are provided in Popper et al. (2014), however Finneran et al. (2017) does, presenting the US Navy Phase III turtle PK based TTS threshold for impulse noise as 226 dB re 1 µPa (PK), equivalent to the highest marine mammal TTS value, as defined in NMFS (2018) and Finneran et al. (2017). The derivation of PTS for turtles follows the same method as for marine mammals, with 15 dB being added to the SEL-based TTS threshold and 6 dB to the peak pressure-based thresholds. The appropriate frequency weighting function for each functional hearing group is applied only when using the SEL-based thresholds to predict PTS. The result for the PK threshold is more similar to that for explosives proposed in Popper et al. (2014) then that proposed for seismic sources.

This report considers the thresholds proposed in Popper et al. (2014), the updated thresholds proposed in Finneran et al. (2017), and the NMFS criterion for behavioural disturbance (SPL of 166 dB re 1 µPa) (Table 7).

Table 7. Acoustic effects of impulsive noise on turtles: Unweighted SPL, weighted and unweighted SEL_{24h}, and PK thresholds

<table>
<tr><th>Effect type</th><th>Criterion</th><th>SPL
(L_p; dB re 1 µPa)</th><th>Weighted SEL_{24h}
($L_{E,24h}$;
dB re 1 µPa^2·s)</th><th>PK
(L_{pk};
dB re 1 µPa)</th><th>SEL_{24h}
($L_{E,24h}$;
dB re 1 µPa^2·s)</th></tr>
<tr><td rowspan="2">Behaviour</td><td>NSF (2011)</td><td>166</td><td colspan="2" rowspan="2">NA</td><td rowspan="4">NA</td></tr>
<tr><td>McCauley et al. (2000a)</td><td>175</td></tr>
<tr><td>PTS onset thresholds* (received level)</td><td rowspan="2">Finneran et al. (2017)</td><td rowspan="2">NA</td><td>204</td><td>232</td></tr>
<tr><td>TTS onset thresholds* (received level)</td><td>189</td><td>226</td></tr>
<tr><td>Mortality and Potential mortal injury</td><td>Popper et al. (2014)</td><td>NA</td><td>NA</td><td>> 207 dB PK</td><td>210</td></tr>
</table>

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.
L_p denotes sound pressure level period and has a reference value of 1 µPa.
L_{pk}, flat denotes peak sound pressure that is flat weighted or unweighted and has a reference value of 1 µPa.
L_E denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa^{2}s.

3.3. Benthic Invertebrates (Crustaceans and Bivalves)

Research is ongoing into the relationship between sound and its effects on crustaceans, including the relevant metrics for both effect and impact. Available literature suggests particle motion, rather than sound pressure, is a more important factor for crustacean and bivalve hearing. Water depth and seismic source size are related to the particle motion levels at the seafloor, with larger arrays and shallower water being related to higher particle motion levels, more likely relevant to effects on crustaceans and bivalves.

At the seafloor interface, crustaceans and bivalves are subject to particle motion stimuli from several acoustic or acoustically-induced waves. These include the particle motion associated with an impinging sound pressure wave in the water column (the incident, reflected, and transmitted portions), substrate acoustic waves, and interface waves of the Scholte type. However, it is unclear which aspect(s) of these waves is/are most relevant to the animals, either when they normally sense the environment or their physiological responses to loud sounds so there is not enough information to establish similar criteria and thresholds as done for marine mammals and fish. Including recent research, such as Day et al. (2016), current literature does not clearly define an appropriate metric or identify relevant levels (pressure or particle motion) for an assessment. This includes the consideration of what particle motion levels lead to a behavioural response, or mortality. Therefore, at this stage, we cannot propose authoritative thresholds to inform the impact assessment. However, levels can be determined for pressure metrics presented in literature to assist the assessment.

A PK-PK sound level of 202 dB re 1 µPa (Payne et al. 2008) is considered to be associated with no impact, and therefore applied in the assessment. Additionally for context, the PK-PK sound levels determined for crustaceans in Day et al. (2016), 209–212 dB re 1 µPa, are also included

4. Methods

4.1. Acoustic Source Model

The pressure signatures of the individual airguns and the composite 1/3-octave-band point-source equivalent directional levels (i.e., source levels) of three seismic sources (2970, 3000 and 3080 in^3) were modelled with JASCO's Airgun Array Source Model (AASM). Although AASM accounts for notional pressure signatures of each seismic source with respect to the effects of surface-reflected signals on bubble oscillations and inter-bubble interactions, the surface-reflected signal (known as surface ghost) is not included in the far-field source signatures. The acoustic propagation models account for those surface reflections, which are a property of the propagating medium rather than the source.

AASM considers:

- Array layout.
- Volume, tow depth, and firing pressure of each airgun.
- Interactions between different airguns in the array.

The array was modelled over AASM's full frequency range, up to 25 kHz. Appendix B details this model.

4.2. Sound Propagation Models

Three sound propagation models were used to predict the acoustic field around the seismic source for frequencies of 5 Hz to 25 kHz:

- Combined range-dependent parabolic equation and gaussian beam acoustic ray-trace model (MONM-BELLHOP).
- Full Waveform Range-dependent Acoustic Model (FWRAM).
- Wavenumber integration model (VSTACK).

4.3. Parameter Overview

The specifications of the seismic sources and the environmental parameters used in the propagation models are described in detail in Appendix D.

The following seismic sources considered were:

- 2970 in^3 seismic source array consisting of three strings towed at a depth of 7 m, (see Figures D-8 to D-6) with a nominal firing pressure of 2000 psi.
- 3000 in^3 seismic source array consisting of three strings towed at a depth of 6 m, (see Figures D-8 to D-6) with a nominal firing pressure of 2000 psi.
- 3080 in^3 seismic source array consisting of three strings towed at a depth of 7 m, (see Figures D-8 to D-6) with a nominal firing pressure of 2000 psi.

A single sound speed profile for July was considered in the modelling; this was identified as the seasonal period that would provide the greatest propagation. The following four geological regions were identified:

- Gravelly sand (SW shelf), Sites 1–4
- Muddy sand (SW slope), Sites 5 and 6
- Muddy sandy gravel (central shelf), Sites 7–11
- Gravelly muddy sand (NE shelf), Site 12

4.4. Accumulated SEL

During a seismic survey, new sound energy is introduced into the environment with each pulse from the seismic source. While some impact criteria are based on the per-pulse energy released, others, such as the marine mammal and fish SEL criteria used in this report (Sections 3.1 and 3.2) account for the total acoustic energy marine fauna is subjected to over a specified period of time, defined in this report as 24 hours. An accurate assessment of the accumulated sound energy depends not only on the parameters of each seismic pulse impulse, but also on the number of impulses delivered in a period and the relative positions of the impulses.

When there are many seismic pulses, it becomes computationally prohibitive to perform sound propagation modelling for every single event. The distance between the consecutive seismic impulses is small enough, however, that the environmental parameters that influence sound propagation are virtually the same for many impulse points. The acoustic fields can, therefore, be modelled for a subset of seismic pulses and estimated at several adjacent ones. After sound fields from representative impulse locations are calculated, they are adjusted to account for the source position for nearby impulses.

Although estimating the cumulative sound field with the described approach is not as precise as modelling sound propagation at every impulse location, small-scale, site-specific sound propagation features tend to blur and become less relevant when sound fields from adjacent impulses are summed. Larger scale sound propagation features, primarily dependent on water depth, dominate the cumulative field. The accuracy of the present method acceptably reflects those large-scale features, thus providing a meaningful estimate of a wide area SEL field in a computationally feasible framework.

To produce maps of accumulated received sound level distributions and calculate distances to specified sound level thresholds, the maximum-over-depth level and level at the seafloor were calculated at each sampling point within the modelled region. The radial grids of maximum-over-depth and seafloor sound levels for each impulse were then resampled (by linear triangulation) to produce a regular Cartesian grid. The sound field grids from all impulses were summed (Equation A-5) to produce the cumulative sound field grid with cell sizes of 40 m. The contours and threshold ranges were calculated from these flat Cartesian projections of the modelled acoustic fields. The single-impulse SEL fields were computed over model grids 200 × 200 km in range, which encompasses the full area of the cumulative grid (the entire survey area).

The unweighted (fish) and frequency-weighted SEL_{24h} results were rendered as contour maps, including contours that focus on the relevant criteria-based thresholds. Only contours at ranges larger than the nearfield of the seismic source were rendered.

4.5. Geometry and Modelled Regions

To assess sound levels with MONM-BELLHOP, the sound field modelling calculated propagation losses up to distances of 100 km from the source, with a horizontal separation of 10 m between receiver points along the modelled radials. The sound fields were modelled with a horizontal angular resolution of $\Delta\theta$ = 2.5° for a total of N = 144 radial planes. Receiver depths were chosen to span the entire water column over the modelled areas, from 2 m to a maximum of 10,000 m, with step sizes that increased with depth. To supplement the MONM results, high-frequency results for propagation loss were modelled using Bellhop for frequencies from 2.5 to 25 kHz. The MONM and Bellhop results were combined to produce results for the full frequency range of interest.

FWRAM was run to 150 km, but along only four radials (fore and aft endfire and port and starboard broadside) for computational efficiency, from 10 Hz to 2048 Hz in 1 Hz steps. This was done to compute SEL-to-SPL conversions (Appendix D.2). The horizontal range step is dependent on frequency and ranges from 50 m at lower frequencies to 10 m above 800 Hz. Additional single transects from specific modelling sites to the humpback whale receivers (Table 3) were run.

The maximum modelled range for VSTACK was 1000 m and used a step size of 10 m. Received levels were computed for receivers at seafloor.

5. Results

5.1. Acoustic Source Levels and Directivity

AASM (Section 4.1) was used to predict the horizontal and vertical overpressure signatures and corresponding power spectrum levels for four seismic sources under consideration for the survey area, including the smaller source being considered for water depths shallower than 50 m, the 2060 in^3, with results provided in Appendix B.2 along with the horizontal directivity plots.

Tables Table 8–11 show the PK and per-pulse SEL source levels for each seismic source in the horizontal-plane broadside (perpendicular to the tow direction), endfire (along the tow direction), and vertical directions. The vertical source level that accounts for the “surface ghost” (the out of phase reflected pulse from the water surface) is also presented to make it easier to compare the output of other seismic source models.

Figures B.2 through B.4 show the broadside, endfire, and vertical overpressure signature and corresponding power spectrum levels for each array. The signatures consist of a strong primary peak, related to the initial release of high-pressure air, followed by a series of pulses associated with bubble oscillations. Most energy is produced at frequencies below 500 Hz, although this is different for each array, with noticeable differences between the broadside and endfire signatures. Frequency-dependent peaks and nulls in the spectrum result from interference among airguns in the array and correspond with the volumes and relative locations of the airguns to each other.

The source with the loudest far-field source level specifications is the 3080 in^3 source, therefore, is was selected for consideration in the propagation modelling for all locations.

Table 8. Far-field source level specifications for the 2970 in^3 array, for a 7 m tow depth. Source levels are for a point-like acoustic source with equivalent far-field acoustic output in the specified direction. Sound level metrics are per-pulse and unweighted.

Direction	Peak source pressure level ($L_{S,pk}$) (dB re 1 µPa^{2}m^2)	Per-pulse source SEL ($L_{S,E}$) (dB 1 µPa^{2}m^{2}s)	
		10–2000 Hz	2000–25000 Hz
Broadside	247.1	223.3	180.0
Endfire	246.5	223.8	183.5
Vertical	255.8	228.8	189.9
Vertical (surface affected source level)	255.8	231.8	192.8

Table 9. Far-field source level specifications for the 3000 in^3 array, for a 6 m tow depth. Source levels are for a point-like acoustic source with equivalent far-field acoustic output in the specified direction. Sound level metrics are per-pulse and unweighted.

Direction	Peak source pressure level ($L_{S,pk}$) (dB re 1 µPa^{2}m^2)	Per-pulse source SEL ($L_{S,E}$) (dB 1 µPa^{2}m^{2}s)	
		10–2000 Hz	2000–25000 Hz
Broadside	249.3	224.7	180.8
Endfire	245.8	222.9	181.9
Vertical	255.2	228.2	189.2
Vertical (surface affected source level)	255.2	231.1	192.2

Table 10. Far-field source level specifications for the 3080 in^3 array, for a 7 m tow depth. Source levels are for a point-like acoustic source with equivalent far-field acoustic output in the specified direction. Sound level metrics are per-pulse and unweighted.

Direction	Peak source pressure level ($L_{S,pk}$) (dB re 1 µPa^{2}m^2)	Per-pulse source SEL ($L_{S,E}$) (dB 1 µPa^{2}m^{2}s)	
		10–2000 Hz	2000–25000 Hz
Broadside	249.6	224.8	184.6
Endfire	246.4	223.6	187.2
Vertical	255.9	228.5	194.6
Vertical (surface affected source level)	255.9	231.4	197.6

Table 11. Far-field source level specifications for the 2060 in^3 array, for a 7 m tow depth. Source levels are for a point-like acoustic source with equivalent far-field acoustic output in the specified direction. Sound level metrics are per-pulse and unweighted.

Direction	Peak source pressure level ($L_{S,pk}$) (dB re 1 µPa^{2}m^2)	Per-pulse source SEL ($L_{S,E}$) (dB 1 µPa^{2}m^{2}s)	
		10–2000 Hz	2000–25000 Hz
Broadside	246.1	221.8	181.0
Endfire	246.8	222.2	184.4
Vertical	252.0	225.1	190.6
Vertical (surface affected source level)	252.0	227.6	193.6

5.2. Per-pulse Sound Fields

5.2.1. Tabulated results

Per-pulse results for the 3080 in³ seismic source towed at 7 m are presented for SPL, SEL, PK, and PK-PK, including seafloor PK and PK-PK. Tables 12–15 list the estimated ranges for the various applicable maximum-over-depth per-pulse effects criteria and isopleths of interest, and Tables 16 and 17 list the sound levels at the pearl oyster fishery and humpback whale receivers. Tables 18–21 list the estimated ranges for seafloor per-pulse effects criteria and isopleths of interest

5.2.1.1. Entire water column

Table 12. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3080 in³ array to modelled maximum-over-depth per-pulse SEL isopleths from the twelve modelled single impulse sites.

Per-pulse SEL (L_E; dB re 1 µPa²·s)	Site 1 (67 m)		Site 2 (98 m)		Site 3 (89 m)		Site 4 (37 m)		Site 5 (451 m)		Site 6 (360 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.04	0.04	0.04	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.04
180	0.27	0.24	0.24	0.21	0.26	0.23	0.23	0.22	0.16	0.14	0.16	0.14
170	0.82	0.72	0.77	0.66	0.74	0.65	0.87	0.77	1.01	0.92	1.00	0.88
160†	2.76	2.37	2.84	2.42	2.92	2.55	2.79	2.29	3.56	3.03	3.89	3.22
150	7.34	6.06	8.10	6.58	7.29	6.25	7.23	5.89	14.57	12.25	15.59	11.90
140	19.73	16.46	19.65	16.24	19.06	15.91	21.56	17.23	43.40	33.82	44.56	36.75
130	54.14	44.02	49.09	41.07	48.41	41.44	76.16	66.42	130.58	100.43	124.36	102.82
Per-pulse SEL (L_E; dB re 1 µPa²·s)	Site 7 (59 m)		Site 8 (45 m)		Site 9 (84 m)		Site 10 (34 m)		Site 11 (70 m)		Site 12 (103 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.05	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
180	0.34	0.30	0.26	0.23	0.22	0.19	0.26	0.22	0.34	0.29	0.32	0.29
170	1.69	1.38	0.93	0.82	0.85	0.68	1.01	0.83	1.63	1.39	1.60	1.37
160†	4.71	3.82	2.55	2.14	2.94	2.54	3.19	2.42	4.94	3.96	5.88	4.83
150	12.59	10.04	6.36	5.14	7.16	5.97	8.64	6.83	12.32	9.69	14.98	12.54
140	39.97	31.71	16.25	13.08	17.55	13.22	22.54	17.58	29.96	24.70	38.99	32.91
130	92.39	80.91	32.21	25.54	45.51	35.71	62.41	47.18	85.24	63.40	105.30	83.78

† Low power zone assessment criteria DEWHA (2008).

Table 13. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3080 in^3 array to modelled maximum-over-depth SPL isopleths from the twelve modelled single impulse sites.

SPL (L_p; dB re 1 µPa)	Site 1 (67 m)		Site 2 (98 m)		Site 3 (89 m)		Site 4 (37 m)		Site 5 (451 m)		Site 6 (360 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04
190	0.23	0.20	0.18	0.15	0.21	0.18	0.22	0.20	0.15	0.13	0.15	0.13
180	0.73	0.62	0.67	0.57	0.68	0.58	0.80	0.70	0.48	0.40	0.88	0.79
170	2.60	2.13	2.36	2.08	2.79	2.19	2.59	2.10	2.82	2.31	3.06	2.59
166†	4.07	3.25	3.98	3.36	3.79	3.40	3.81	3.08	4.29	3.69	4.53	3.83
160‡	6.73	5.57	7.22	5.96	6.73	5.81	6.55	5.41	7.74	6.51	8.04	6.69
150	17.96	14.88	17.64	14.67	17.06	14.52	18.85	15.29	24.32	19.46	23.90	18.83
140	49.41	40.75	44.19	37.79	44.96	38.80	69.50	60.78	112.80	66.18	120.30	65.62
130	101.45	76.56	79.64	66.57	93.77	72.85	139.36*	112.61*	141.39*	109.96*	139.61*	112.51*

SPL (L_p; dB re 1 µPa)	Site 7 (59 m)		Site 8 (45 m)		Site 9 (84 m)		Site 10 (34 m)		Site 11 (70 m)		Site 12 (103 m)	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
190	0.31	0.27	0.24	0.21	0.19	0.15	0.23	0.21	0.30	0.26	0.31	0.28
180	1.35	1.17	0.81	0.70	0.68	0.58	0.91	0.74	1.35	1.15	1.24	1.09
170	3.77	3.15	2.19	1.91	2.35	2.06	2.50	1.99	4.01	3.29	4.09	3.56
166†	5.98	4.73	3.09	2.65	3.74	3.07	4.16	3.07	6.13	4.76	6.09	5.10
160‡	10.84	8.62	5.52	4.35	6.80	5.16	7.11	5.70	10.32	8.19	11.19	9.14
150	33.85	27.13	14.58	11.51	14.77	11.80	20.37	16.23	27.45	22.64	28.25	24.19
140	90.49	75.93	29.85	23.96	40.71	32.01	55.04	42.43	75.51	57.72	78.18	62.97
130	112.26	94.57	61.14	45.10	87.13	69.86	93.07	75.72	114.92*	96.09	131.72*	102.65*

* Radii extend beyond modelling boundary.
† Threshold for turtle behavioural response to impulsive noise (NSF 2011).
‡ Marine mammal behavioural threshold for impulsive sound sources (NMFS 2014)

Table 14. Maximum (R_{max}) horizontal distances (km) from the 3080 in^3 array to modelled maximum-over-depth peak pressure level (PK) thresholds based on the NOAA Technical Guidance (NMFS 2018) for marine mammals, Popper et al. (2014) for fish and turtles, and Finneran et al. (2017) for turtles, at four of the modelling sites (Table 2).

Hearing group	PK threshold (L_{pk}; dB re 1 µPa)	Distance R_{max} (km)			
		Site 1 (67 m)	Site 5 (451 m)	Site 7 (59 m)	Site 12 (103 m)
Low-frequency cetaceans (PTS)	219	0.03	0.03	0.03	0.03
Low-frequency cetaceans (TTS)	213	0.06	0.06	0.06	0.06
Mid-frequency cetaceans (PTS)	230	< 0.02	< 0.02	< 0.02	< 0.02
Mid-frequency cetaceans (TTS)	224	0.02	0.02	0.02	0.02
High-frequency cetaceans (PTS)	202	0.27	0.22	0.39	0.44
High-frequency cetaceans (TTS)	196	0.64	0.43	0.67	0.8
Sirenians (PTS)	226	0.02	NA	0.02	0.02
Sirenians (TTS)	220	0.03	NA	0.03	0.03
Fish: No swim bladder (also applied to sharks)	213	0.06	0.06	0.06	0.06
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Fish eggs, and larvae Turtles†	207	0.12	0.12	0.22	0.12
Turtles (PTS)‡	232	< 0.02	< 0.02	< 0.02	< 0.02
Turtles (TTS)‡	226	< 0.02	< 0.02	< 0.02	< 0.02

† Popper et al. (2014)
‡ Finneran et al. (2017)

Table 15. Maximum (R_{max}) horizontal distances (in km) from the 3080 in^3 array to modelled maximum-over-depth 178 dB re 1µPa PK-PK , assessed along the three FWRAM modelling transects (maximum presented) at four of the modelling sites (Table 2).

PK-PK (L_{pk-pk}; dB re 1 µPa)	Distance R_{max} (km)			
	Site 1 (67 m)	Site 5 (451 m)	Site 7 (59 m)	Site 12 (103 m)
178	7.94	12.23	10.71	9.56

Table 16. Received maximum-over-depth per-pulse SEL and SPL from the 3080 in^3 array at pearl oyster fishery receivers (Table 4) from the closest modelling sites.

Pearl oyster fishery receiver	Relevant modelling site	Location relevance	Distance (km)	Location	Received SEL (L_E; dB re 1 µPa²·s)	Received SPL (L_p; dB re 1 µPa)
A – Compass Rose fishing ground	1	Closest fishing ground	100.7	18° 56' 51.1990" S, 121° 05' 11.6198" E	95.6	119.4
B – Port Smith farm lease	1	Closest lease	74.5	18° 21' 06.1200" S, 121° 42' 06.1200" E	101.9	121.1
C – North Coulomb Pt farm lease	4	Closest lease	56.0	17° 14' 18.2400" S, 122° 05' 02.7600" E	101.1	110.1
D – Lacepede Channel fishing ground	4	Closest fishing ground	63.6	16° 58' 48.7447" S, 122° 09' 54.4718" E	97.6	106.6
E - Pearl Transport Exempt Area / Kuri Bay farm leases	11	Closest lease	90.8	15° 15' 52.9045" S, 124° 20' 32.5257" E	113	121.9

Table 17. Received SPL, LF-weighted SPL and per-pulse SEL from the 3080 in^3 array at humpback whale resting/calving receivers (Table 3) from the closest modelling sites.

Receiver location	Relevant modelling site	Distance (km)	Received SPL (L_p; dB re 1 µPa)	Received LF-weighted ($L_{p,LF}$; dB re 1 µPa)	Received SEL (L_E; dB re 1 µPa²·s)
Camden Sound	11	93.8	120.5	118.2	113.2
	12	142.9	120.3	120.2	111.4
Tasmanian Shoal	7	79.0	134.6	120.1	126.2
	11	69.1	120.6	120.2	111.6
Pender Bay	4	125.4	107.6	107.6	98.6
	7	93.1	123.2	122.9	114.2
Gourdon Bay	1	75.1	118.0	117.8	109.0
	4	129.5	120.5	120.3	111.5

5.2.1.2. Seafloor

Table 18. Maximum (R_{max}) horizontal distances (in m) from the 3080 in^3 and 2060 in^3 arrays to modelled seafloor PK for representative depths in WA-532-P. The 2060 in^3 array was only considered for depth shallower than 60 m.

Hearing group/animal type	PK threshold (L_{pk}; dB re 1 µPa)	Distance R_{max} (m)				
		30 m	40 m	50 m	60 m	70 m
3080 in^3 array						
Sound levels for sponges and corals†	226	12	7	—	—	—
Fish: No swim bladder (also applied to sharks)	213	89	98	105	114	88
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Turtles‡, fish eggs, and larvae	207	185	154	164	185	178
2060 in^3 array						
Sound levels for sponges and corals†	226	7	—	—	N/A	N/A
Fish: No swim bladder (also applied to sharks)	213	68	75	71		
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Turtles‡, fish eggs, and larvae	207	171	121	132		

† Heyward et al. (2018)
‡ Popper et al. (2014)
A dash indicates the level is not reached.
N/A – not modelled.

Table 19. Maximum (R_{max}) horizontal distances (in m) from the 3080 in^3 and 2060 in^3 arrays to modelled seafloor PK for representative depths in WA-533-P. The 2060 in^3 array was only considered for depth shallower than 60 m.

Hearing group/animal type	PK threshold (L_{pk}; dB re 1 µPa)	Distance R_{max} (m)		
		45 m	55 m	65 m
3080 in^3 array				
Sound levels for sponges and corals†	226	1	—	—
Fish: No swim bladder (also applied to sharks)	213	95	82	71
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Turtles‡, fish eggs, and larvae	207	168	185	205
2060 in^3 array				
Sound levels for sponges and corals†	226	—	—	N/A
Fish: No swim bladder (also applied to sharks)	213	62	57	
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Turtles‡, fish eggs, and larvae	207	131	133	

† Heyward et al. (2018)
‡ Popper et al. (2014)
A dash indicates the level is not reached.
N/A – not modelled.

Table 20. Maximum (R_{max}) horizontal distances (in m) from the 3080 in^3 and 2060 in^3 arrays to modelled seafloor PK from five single-impulse modelling sites (Table 2). The 2060 in^3 array was only considered for depths shallower than 60 m.

Hearing group/animal type	PK threshold (L_{pk}; dB re 1 µPa)	Distance R_{max} (m)				
		Site 1 (67 m)	Site 4 (37 m)	Site 7 (59 m)	Site 11 (70 m)	Site 12 (103 m)
3080 in^3 array						
Sound levels for sponges and corals†	226	—	7	—	—	—
Fish: No swim bladder (also applied to sharks)	213	71	100	114	88	54
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Turtles‡, fish eggs, and larvae	207	205	163	185	178	230
2060 in^3 array						
Sound levels for sponges and corals†	226	N/A	—	—	N/A	N/A
Fish: No swim bladder (also applied to sharks)	213		65	66		
Fish: Swim bladder not involved in hearing, Swim bladder involved in hearing Turtles‡, fish eggs, and larvae	207		131	147		

† Heyward et al. (2018)
‡ Popper et al. (2014)
A dash indicates the level is not reached.
N/A – not modelled.

Table 21. Maximum (R_{max}) horizontal distances (in m) from the 3080 in^3 and 2060 in^3 arrays to modelled seafloor PK-PK from five modelling sites (Table 2). Results included in relation to benthic invertebrates (Section 3.3). The 2060 in^3 array was only considered for depth shallower than 60 m.

PK-PK ($L_{pk\text{-}pk}$; dB re 1 µPa)	Distance R_{max} (m)				
	Site 1 (67 m)	Site 4 (37 m)	Site 7 (59 m)	Site 11 (70 m)	Site 12 (103 m)
3080 in^3 array					
213	190	161	181	177	212
212	210	169	190	189	241
211	228	178	199	203	266
210	243	186	215	215	289
209	257	195	304	231	310
202	559	461	536	536	666
2060 in^3 array					
213	N/A	127	143	N/A	N/A
212		137	153		
211		149	160		
210		160	168		
209		169	184		
202		368	502		

N/A – not modelled.

5.2.2. Sound field maps and graphs

5.2.2.1. Sound level contour maps

Maps of the estimated sound fields, threshold contours, and isopleths of interest for the per-pulse SEL and SPL sound fields for the 3080 in^3 array are presented at all modelling sites, with representative sites (the six standalone single impulse sites, Table 2), shown in Figures 5–16, and the additional six sites included in the accumulated SEL scenarios shown in Appendix E.1, Figures E-1 to E-12.

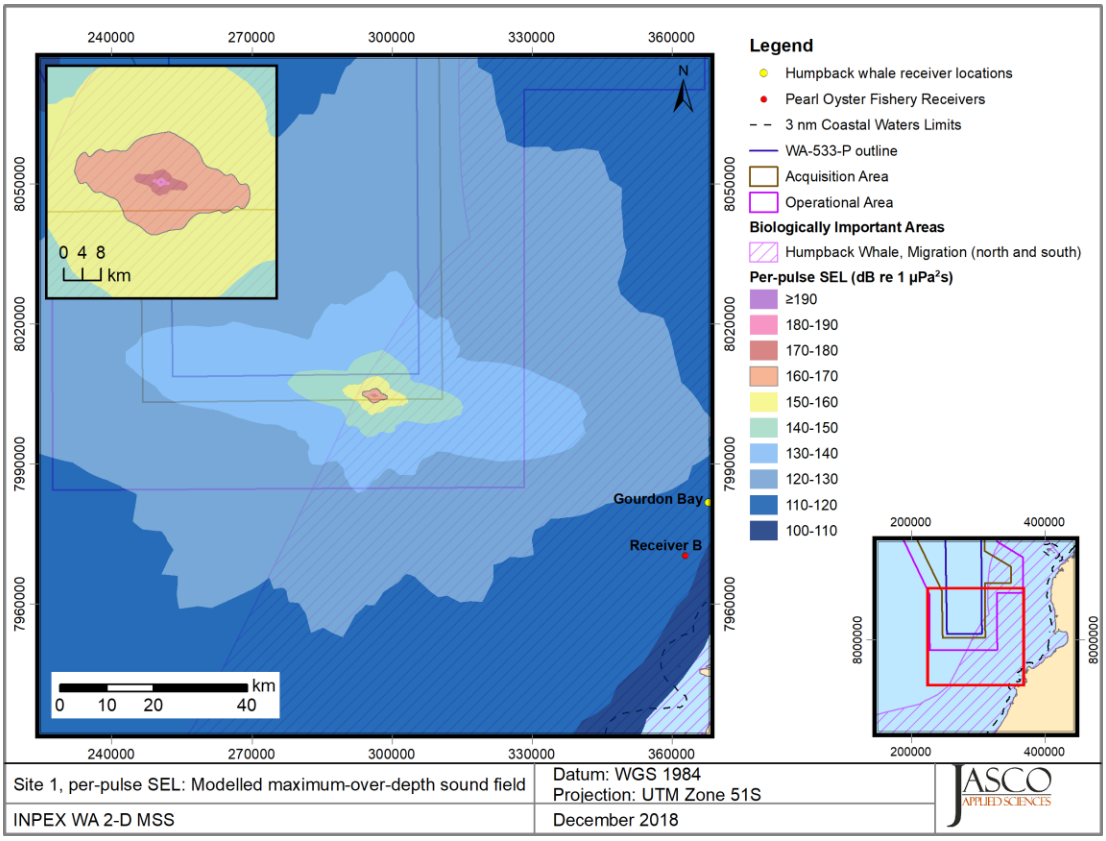


Figure 5. *Site 1 (WA-533-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

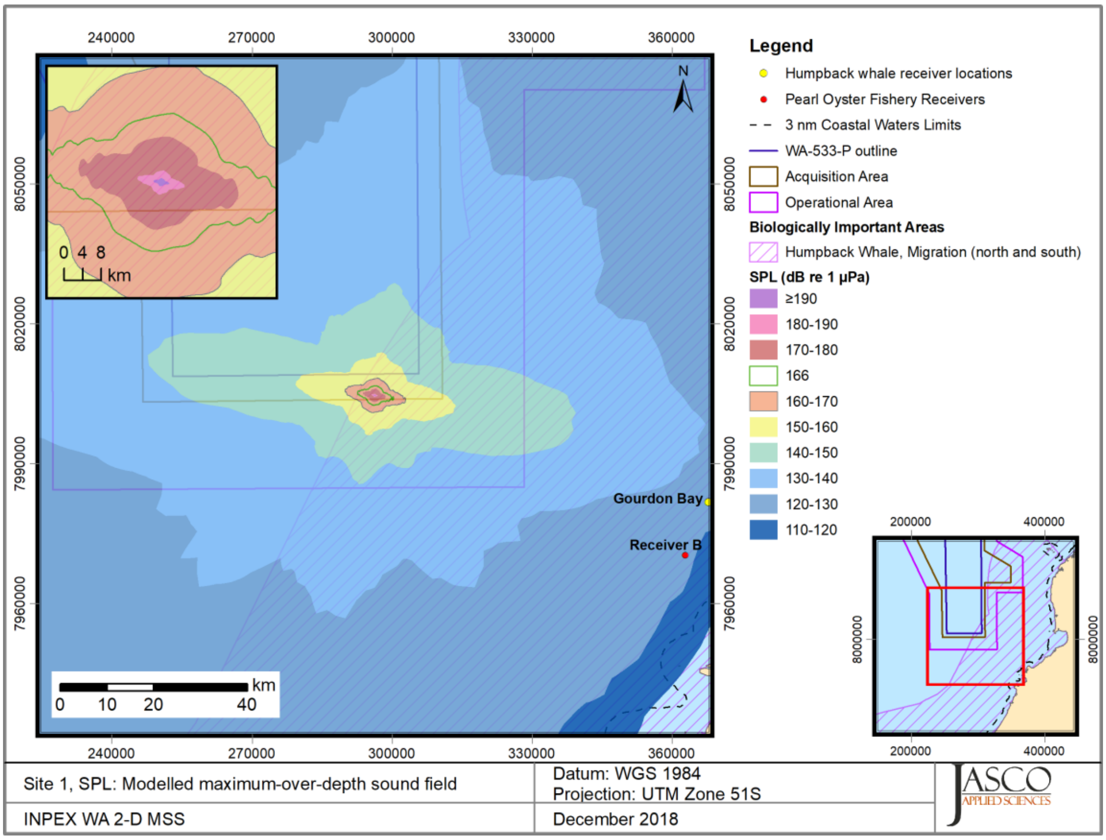


Figure 6. *Site 1 (WA-533-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

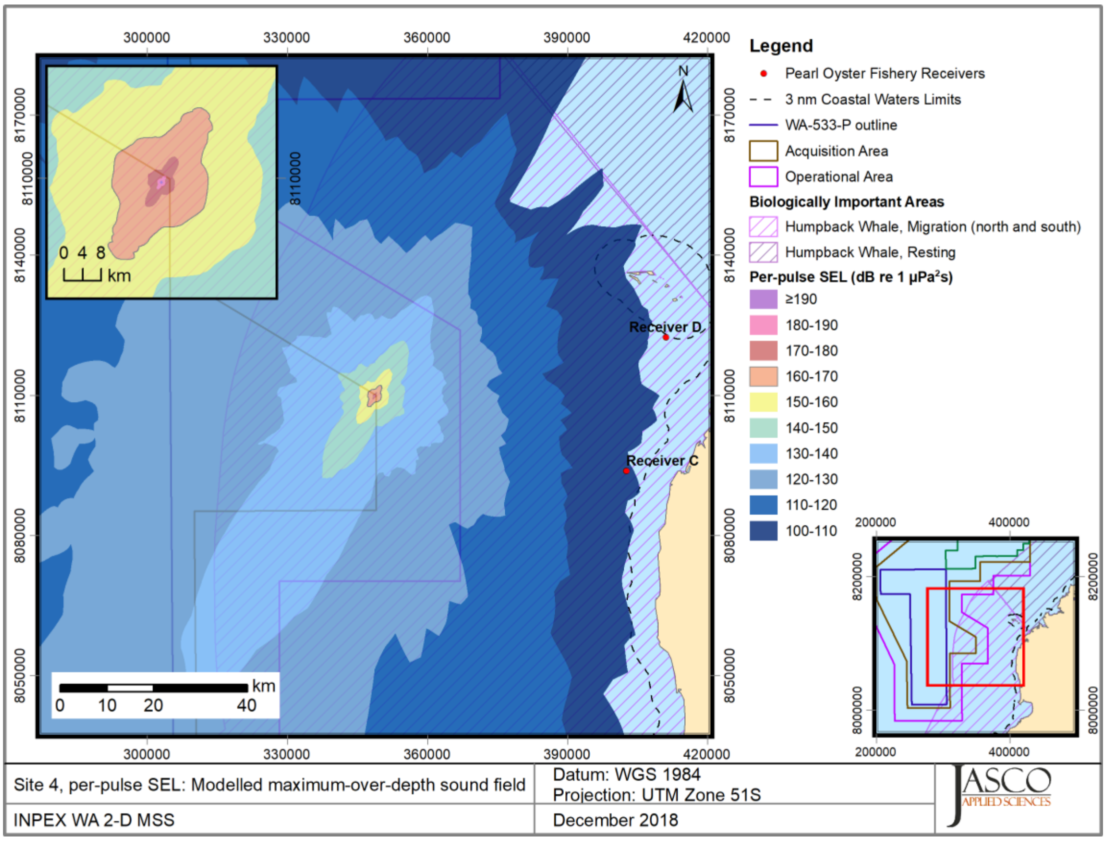
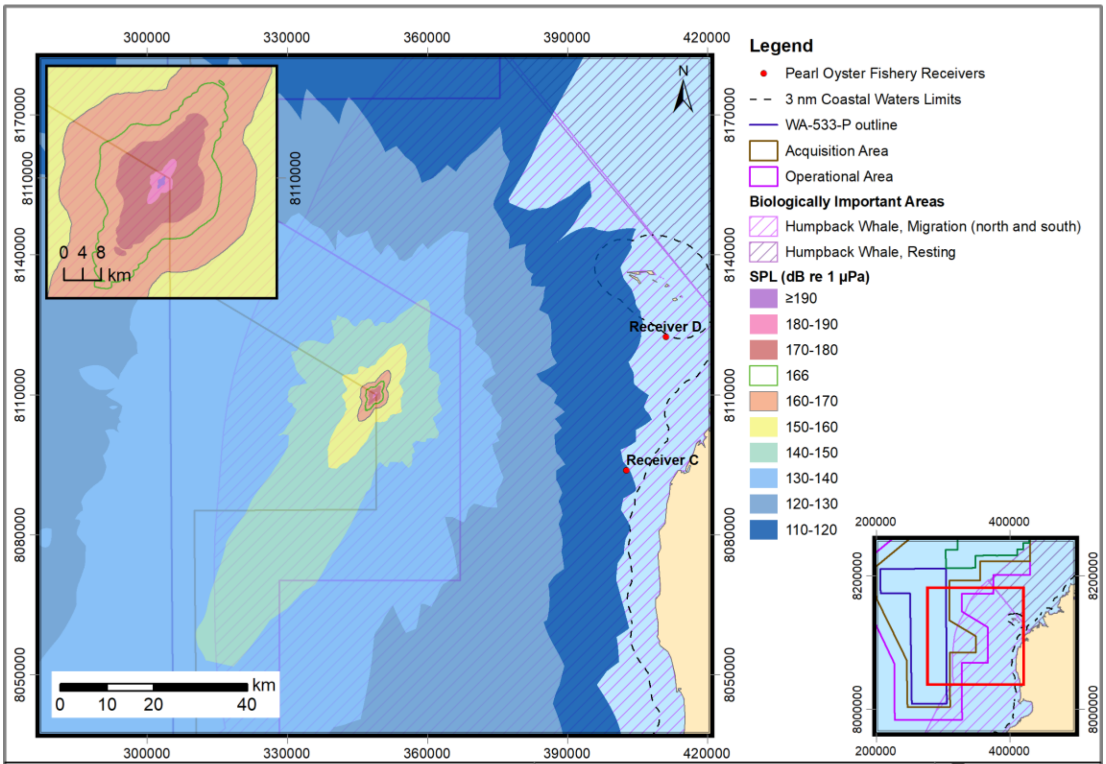
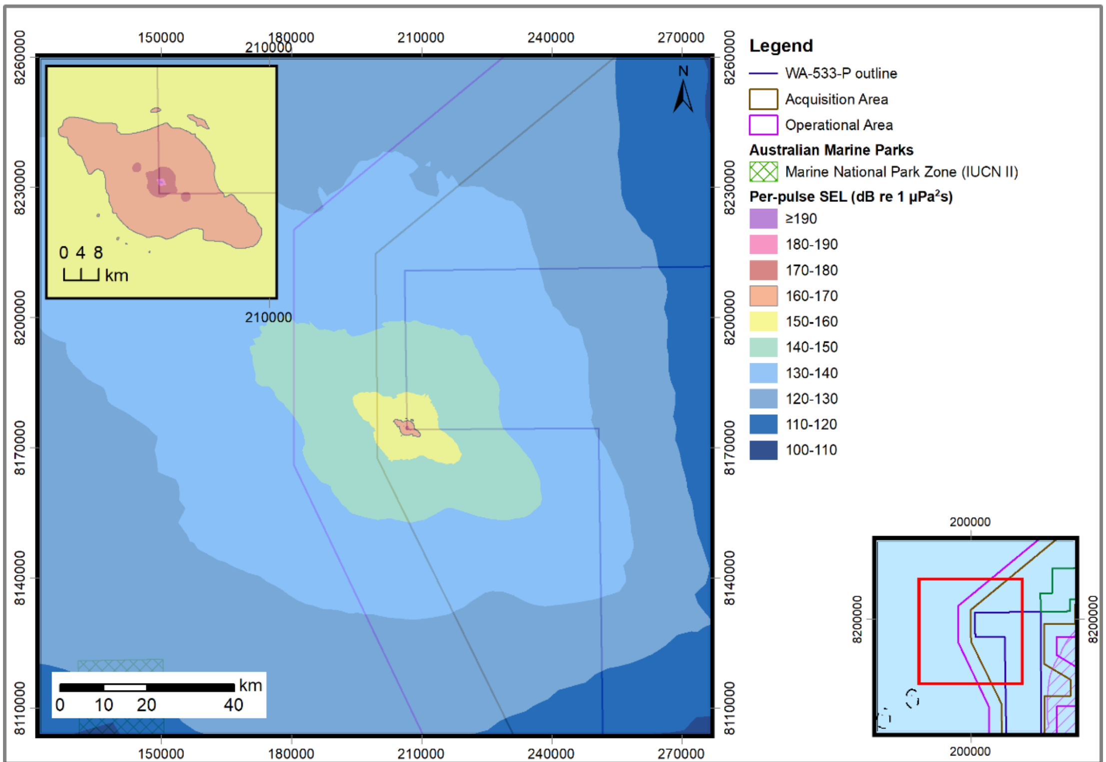


Figure 7. *Site 4 (WA-533-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.



Site 4, SPL: Modelled maximum-over-depth sound field	Datum: WGS 1984 Projection: UTM Zone 51S
INPEX WA 2-D MSS	December 2018

Figure 8. *Site 4 (WA-533-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.



Site 5, per-pulse SEL: Modelled maximum-over-depth sound field	Datum: WGS 1984 Projection: UTM Zone 51S
INPEX WA 2-D MSS	December 2018

Figure 9. *Site 5 (WA-533-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

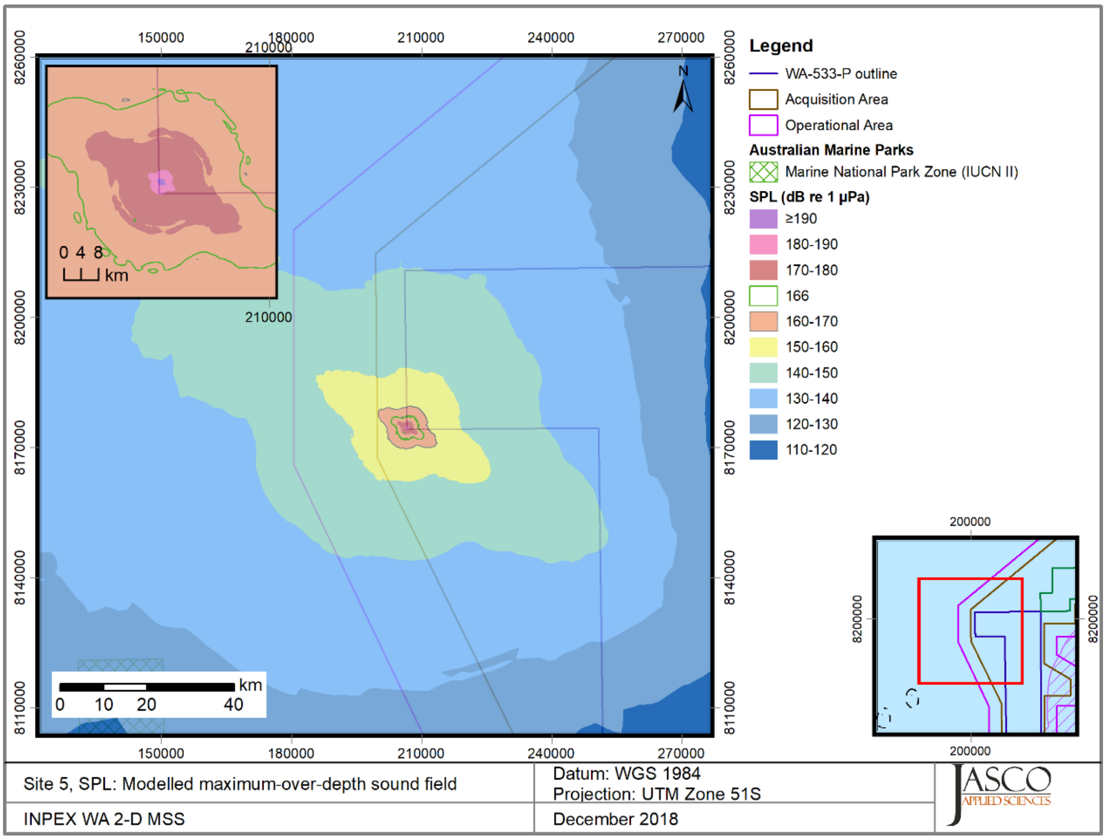


Figure 10. *Site 5 (WA-532-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

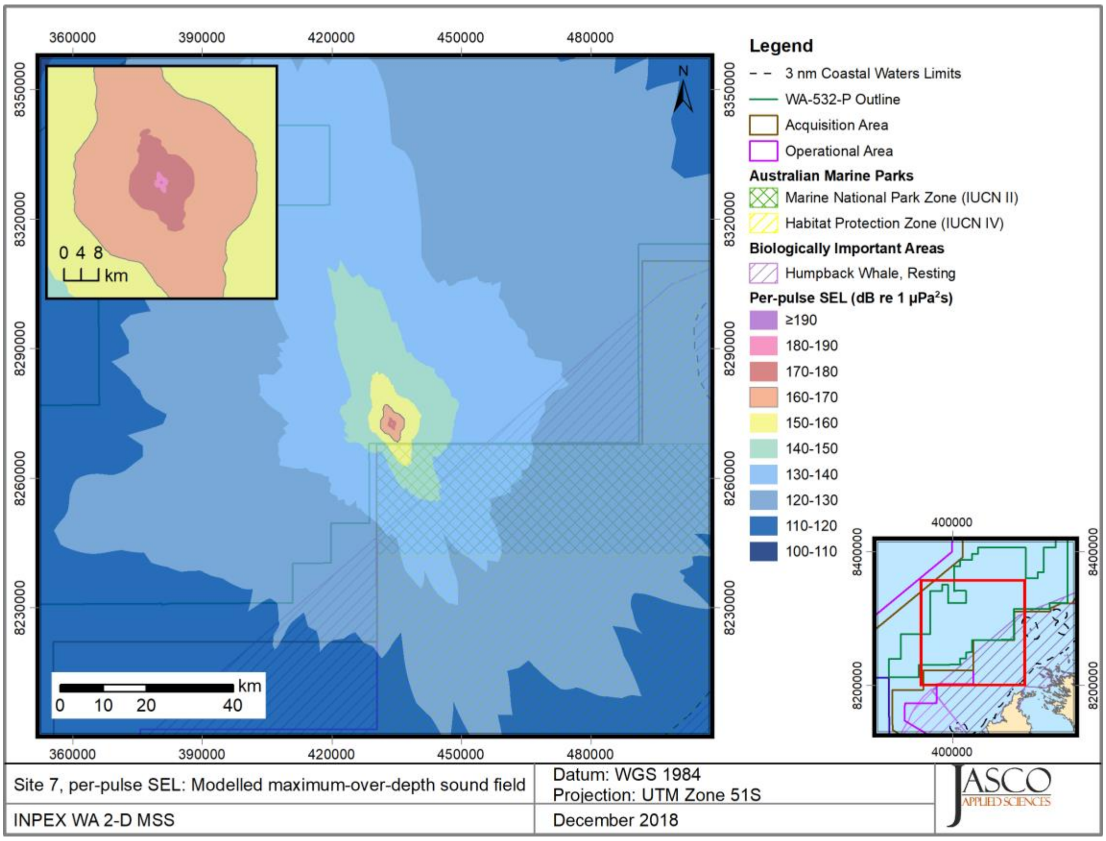


Figure 11. *Site 7 (WA-532-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

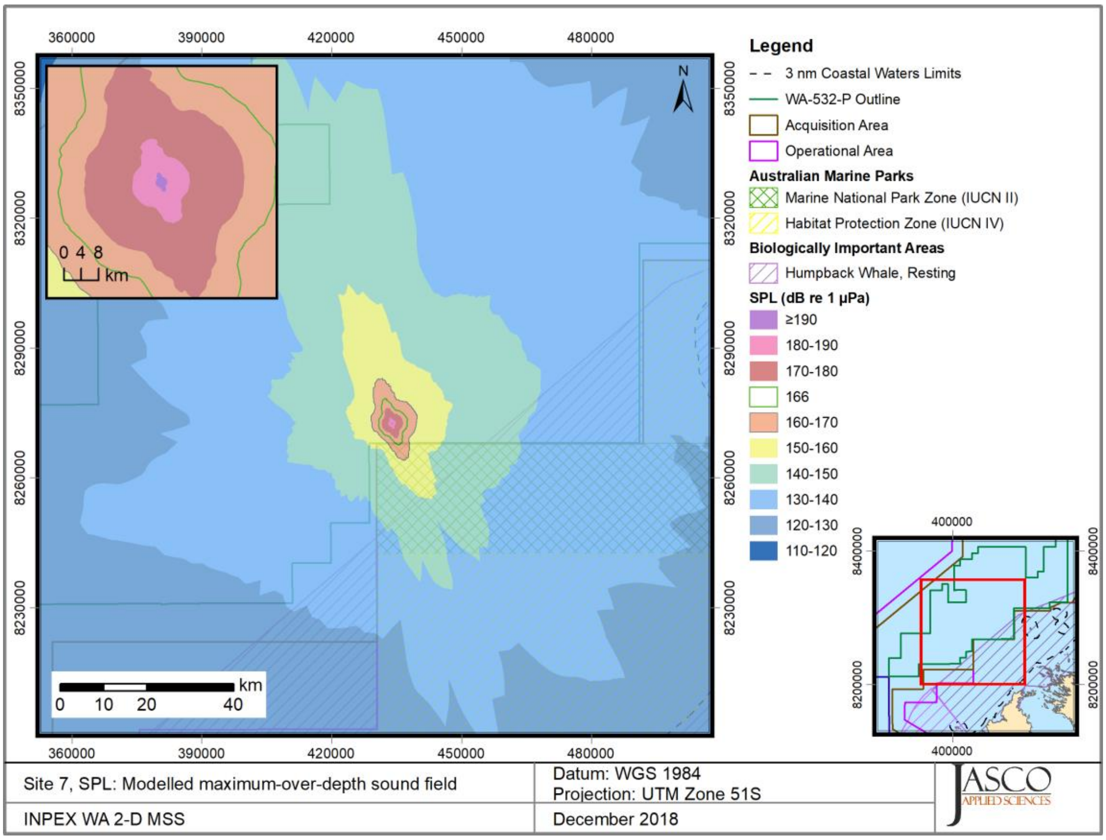


Figure 12. *Site 7 (WA-532-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

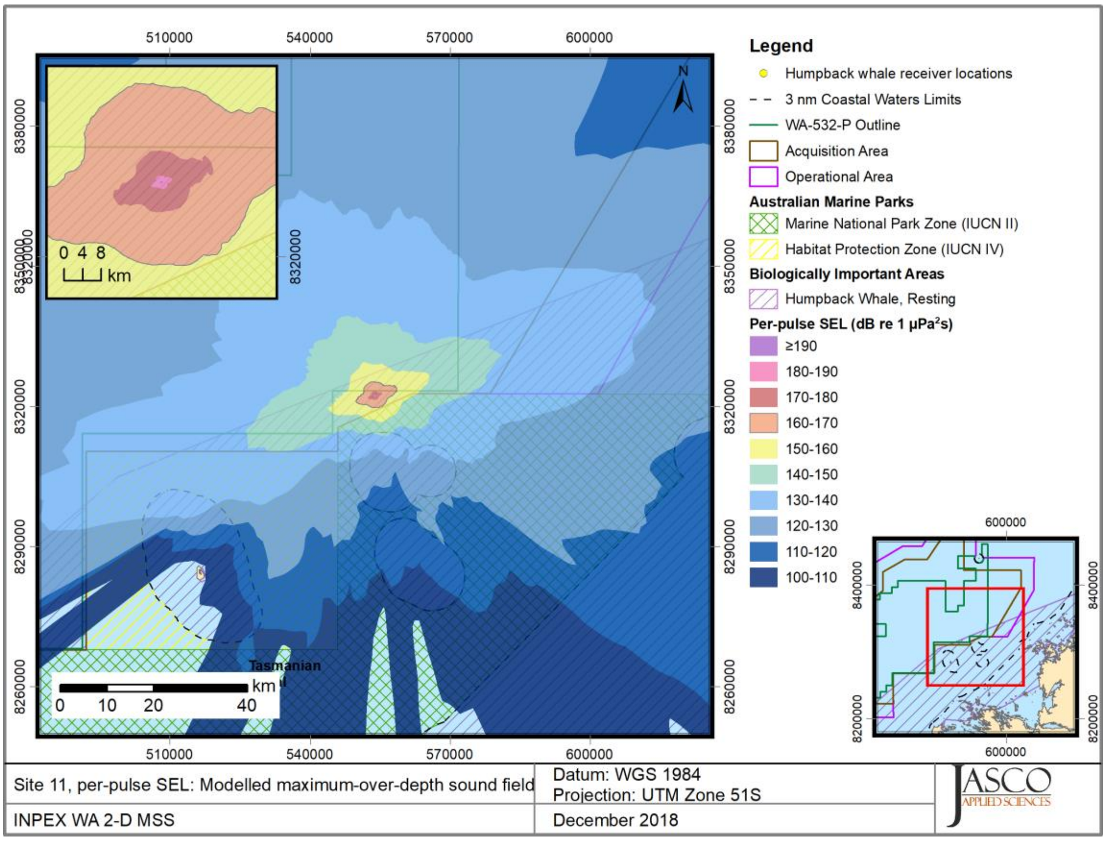


Figure 13. *Site 11 (WA-532-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

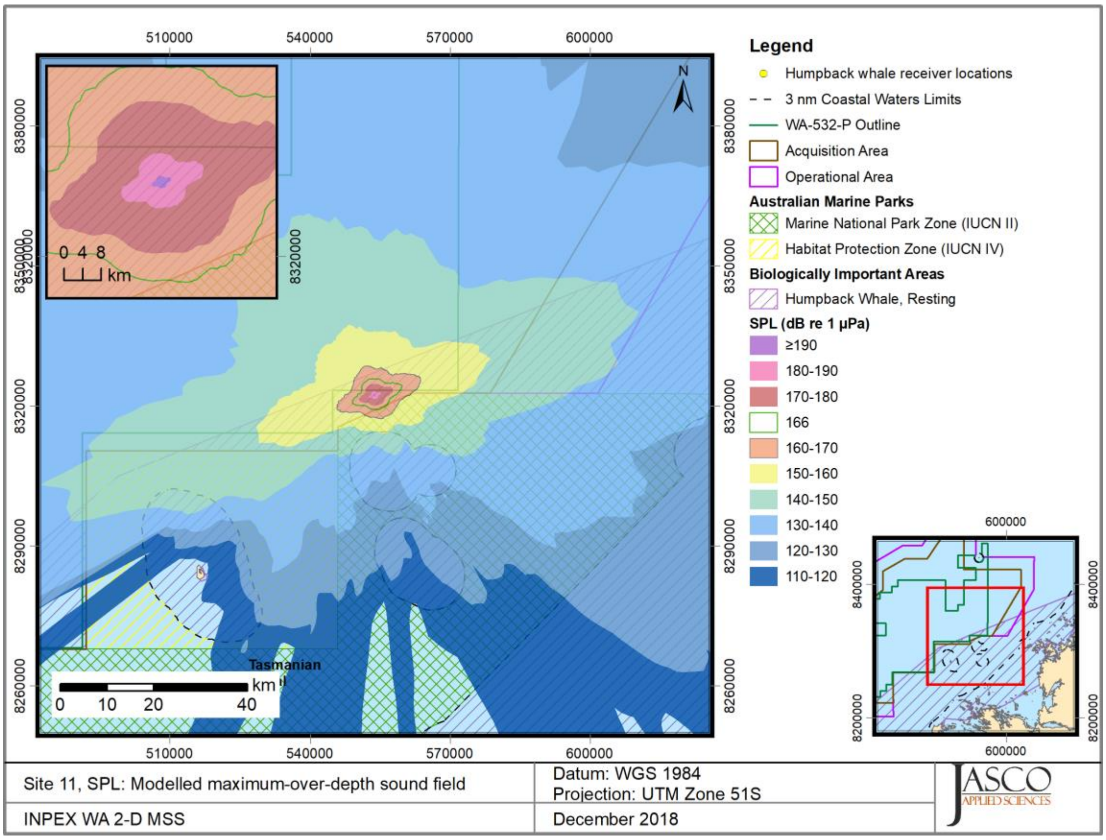


Figure 14. *Site 11 (WA-532-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in3 array.

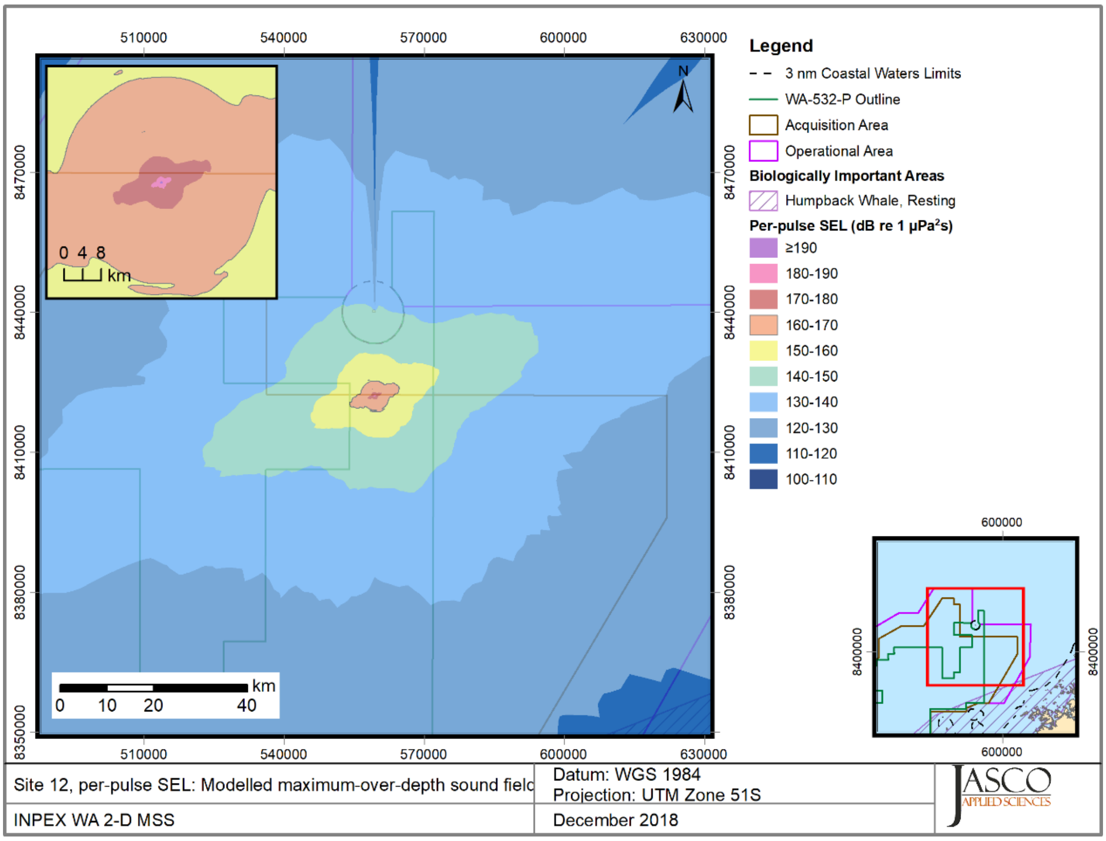


Figure 15. *Site 12 (WA-532-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in3 array.

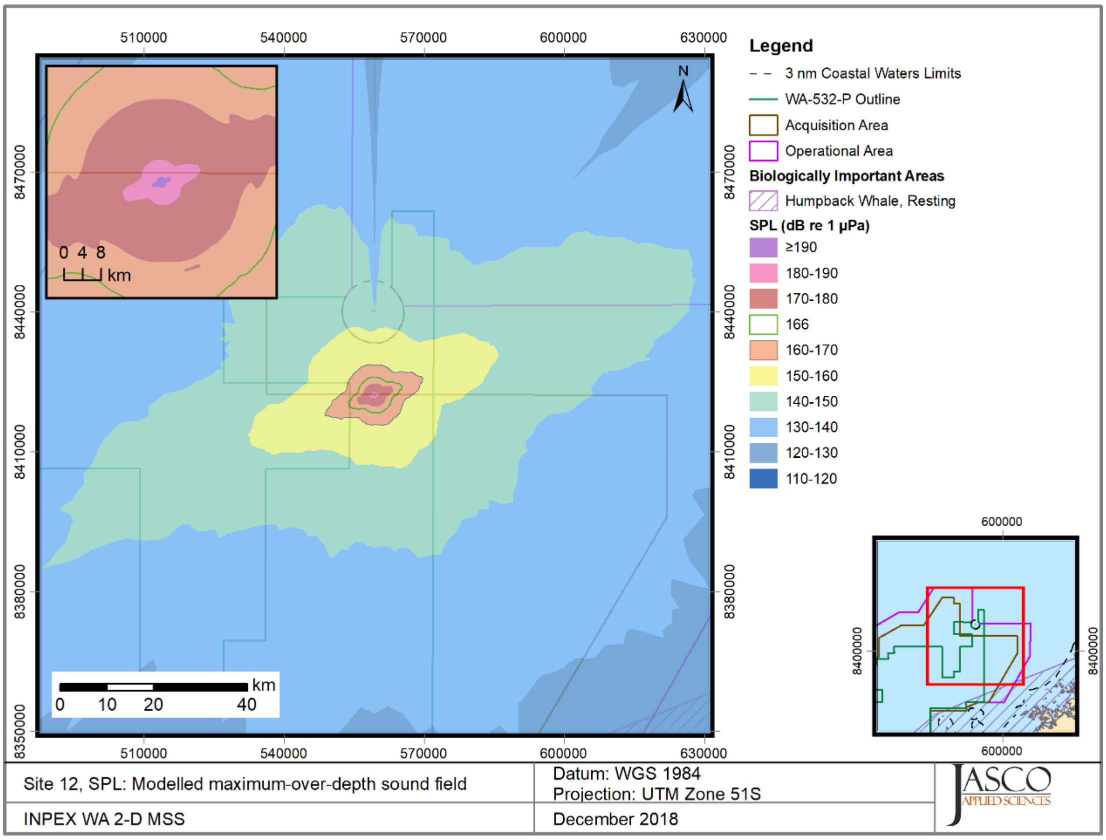


Figure 16. *Site 12 (WA-532-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

5.2.2.2. Vertical slices of modelled sound fields

Vertical slices of the per-pulse SEL sound fields for the 3080 in³ airgun array are shown in Figures 17–22, while vertical slices of the SPL sound fields are shown in Appendix E.2, Figures E-13 to E-18.

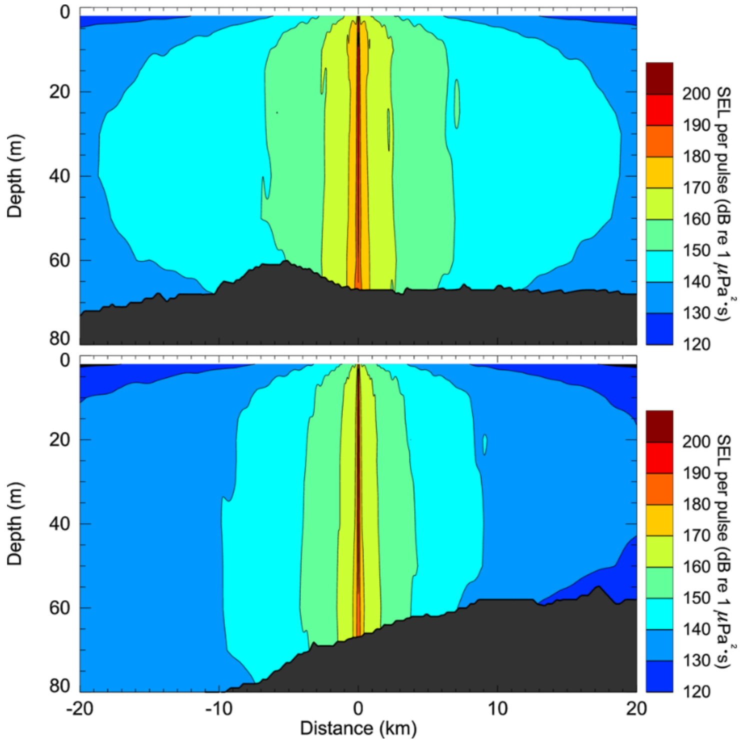


Figure 17. *Site 1 (WA-533-P), per-pulse SEL*: Vertical slice of the predicted per-pulse SEL for the 3080 in³ array. Levels are shown along the broadside (top) and endfire (bottom) directions.

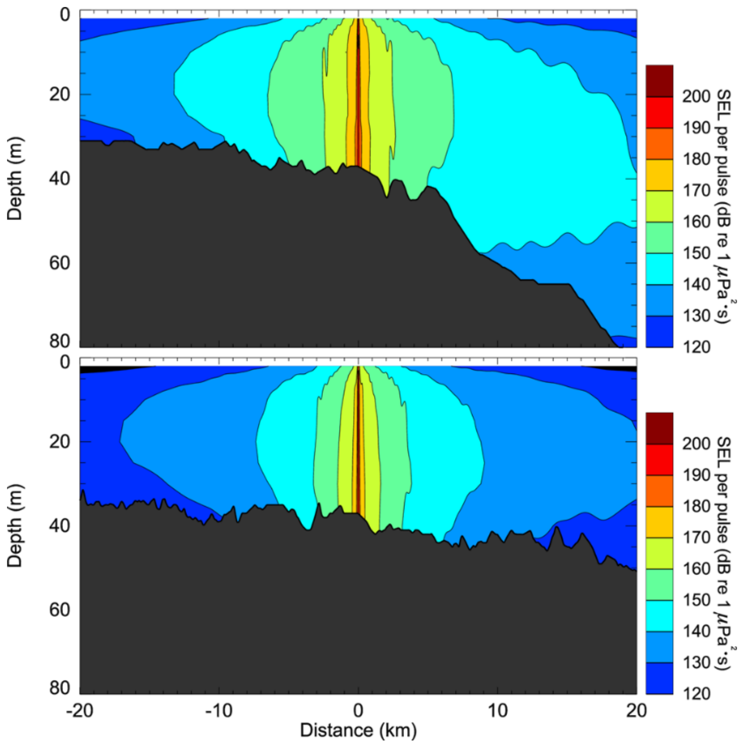


Figure 18. *Site 4 (WA-533-P), per-pulse SEL*: Vertical slice of the predicted per-pulse SEL for the 3080 in³ array. Levels are shown along the broadside (top) and endfire (bottom) directions.

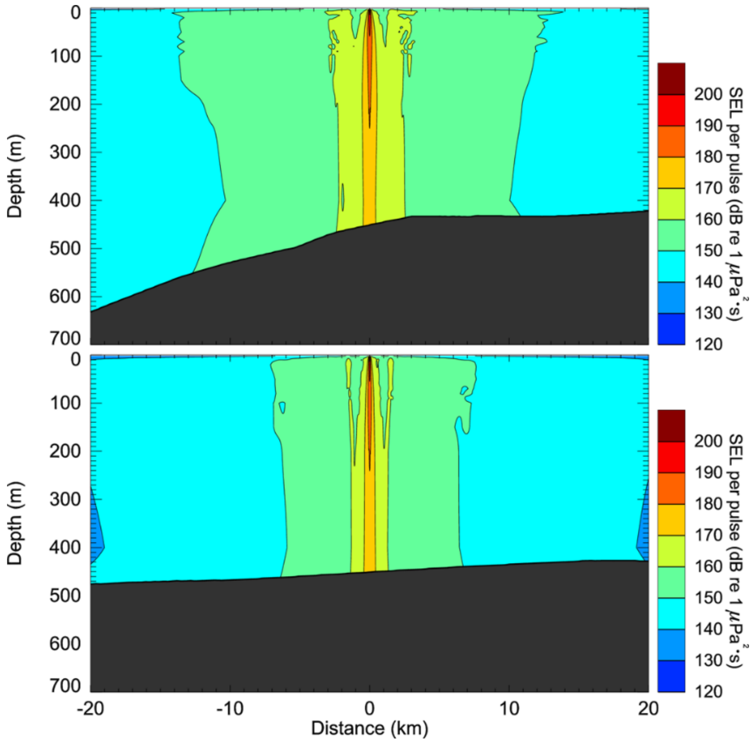


Figure 19. *Site 5 (WA-533-P), per-pulse SEL*: Vertical slice of the predicted per-pulse SEL for the 3080 in^3 array. Levels are shown along the broadside (top) and endfire (bottom) directions.

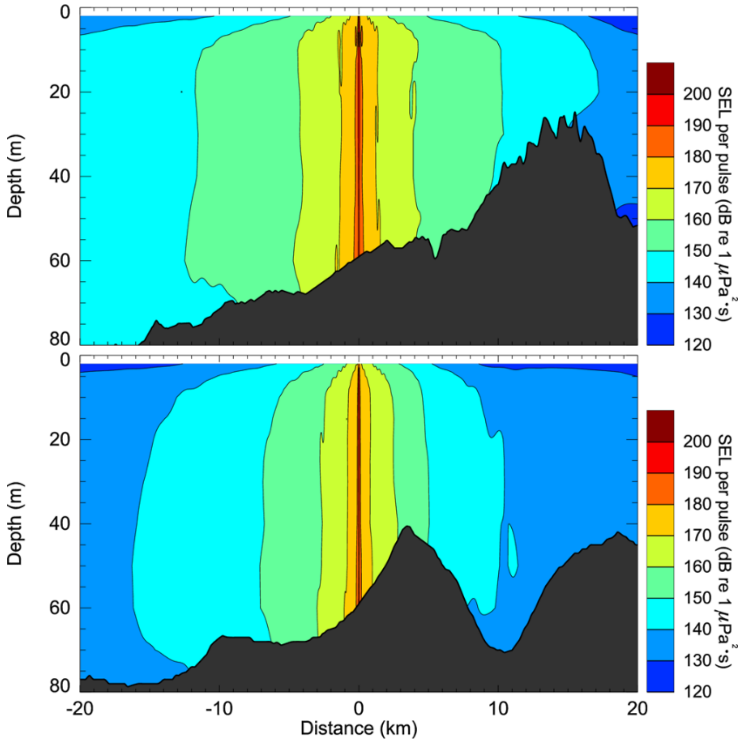


Figure 20. *Site 7 (WA-532-P), per-pulse SEL*: Vertical slice of the predicted per-pulse SEL for the 3080 in^3 array. Levels are shown along the broadside (top) and endfire (bottom) directions.

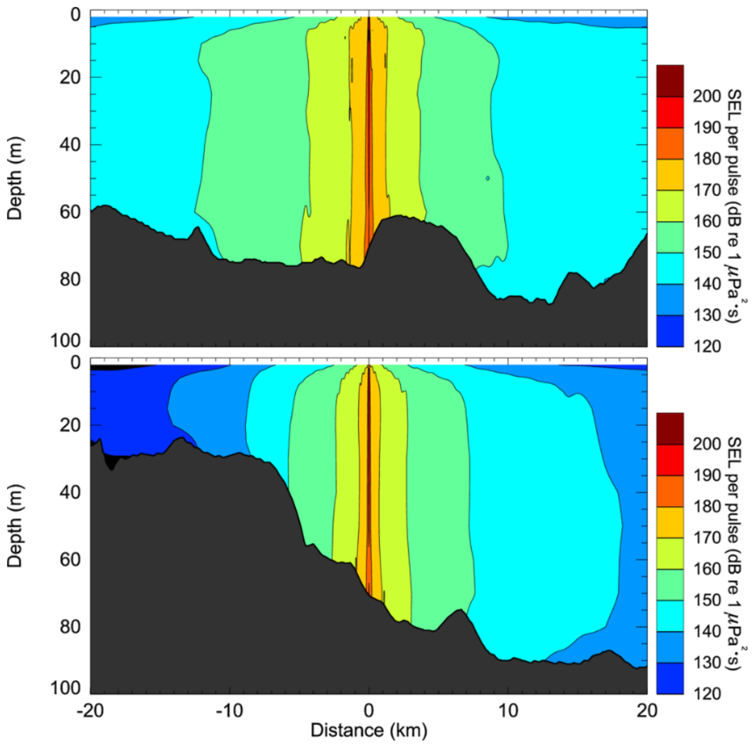


Figure 21. *Site 11 (WA-532-P), per-pulse SEL*: Vertical slice of the predicted per-pulse SEL for the 3080 in³ array. Levels are shown along the broadside (top) and endfire (bottom) directions.

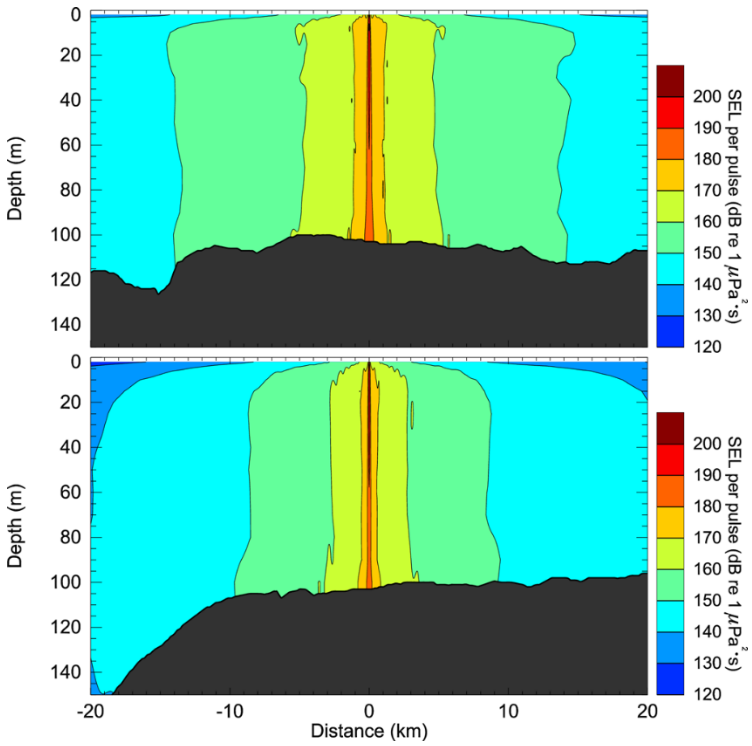


Figure 22. *Site 12 (WA-532-P), per-pulse SEL*: Vertical slice of the predicted per-pulse SEL for the 3080 in³ array. Levels are shown along the broadside (top) and endfire (bottom) directions.

5.3. Multiple Pulse Sound Fields

The SEL_{24h} results for the proposed survey are presented for three possible operational scenarios within the Acquisition Area, described in Section 2. Tables 22–27 show the estimated ranges to the appropriate cumulative exposure criterion contour for the various marine fauna groups considered, and the corresponding ensonified areas. The ranges in this section are the perpendicular distance from the survey line to the relevant isopleth.

5.3.1. Scenario 1

Table 22. *Scenario 1*: Maximum-over-depth distances (in km) to frequency-weighted SEL_{24h} based marine mammal PTS and TTS thresholds (NMFS 2018) and turtles (Finneran et al. 2017).

Hearing group	**PTS**		
	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)
Low-frequency cetaceans	183	0.70	213.05
Mid-frequency cetaceans	185	—	—
High-frequency cetaceans	155	—	—
Turtles	204	0.03	1.06
Hearing group	**TTS**		
	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)
Low-frequency cetaceans	168	17.92	3470.09
Mid-frequency cetaceans	170	—	—
High-frequency cetaceans	140	0.34	100.50
Turtles	189	0.40	138.22

A dash indicates the threshold is not reached.

Table 23. *Scenario 1*: Distances to SEL_{24h} based criteria from Popper et al. (2014).

Marine fauna group	**Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)**	**Maximum-over-depth**		**At seafloor**	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
Mortality and potential mortal injury					
I	219	0	0	—	—
II, Turtles, fish eggs and fish larvae	210	0	0	—	—
III	207	0.03	3.59	—	—
Fish recoverable injury					
I	216	0	0	—	—
II, III	203	0.03	3.62	—	—
Fish TTS					
I, II, III	186	1.58	540.0	1.58	496.6

A dash denotes a value below the minimum resolution of the modelling.
Fish I–No swim bladder; Fish II–Swim bladder not involved with hearing; Fish III–Swim bladder involved with hearing.

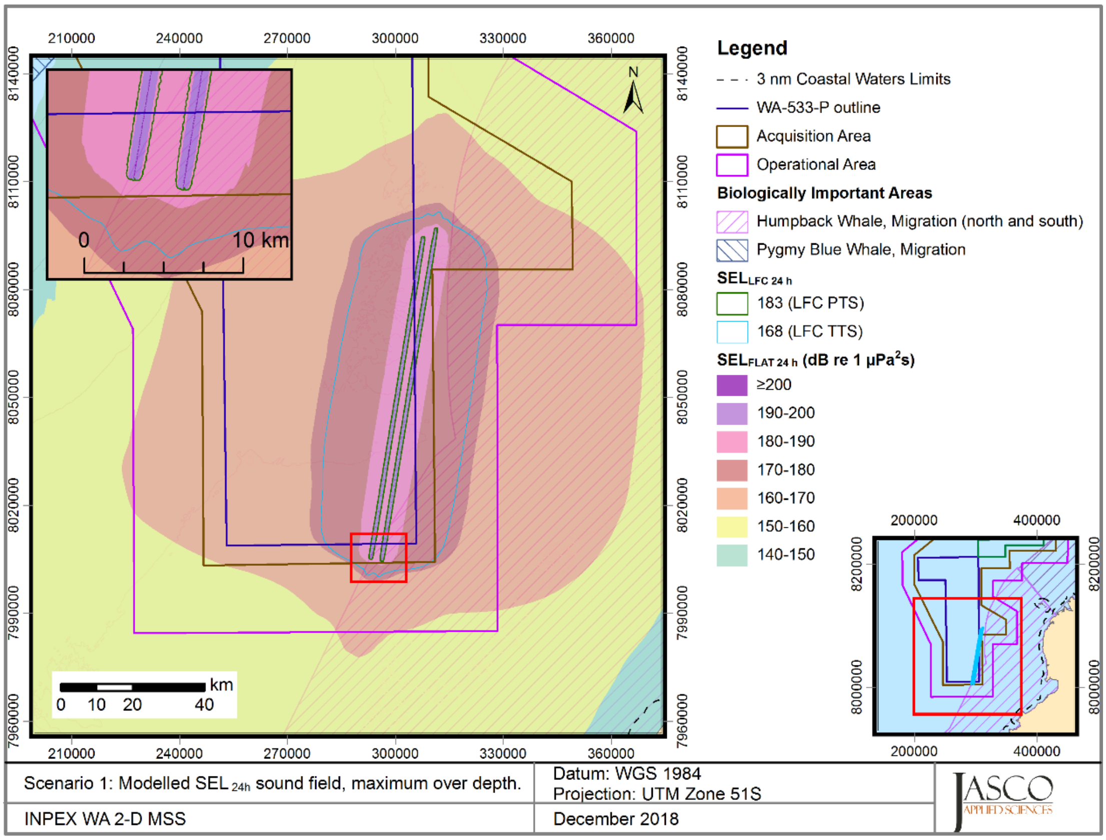


Figure 23. *Scenario 1*: Sound level contour map showing maximum-over-depth SEL_{24h} results.

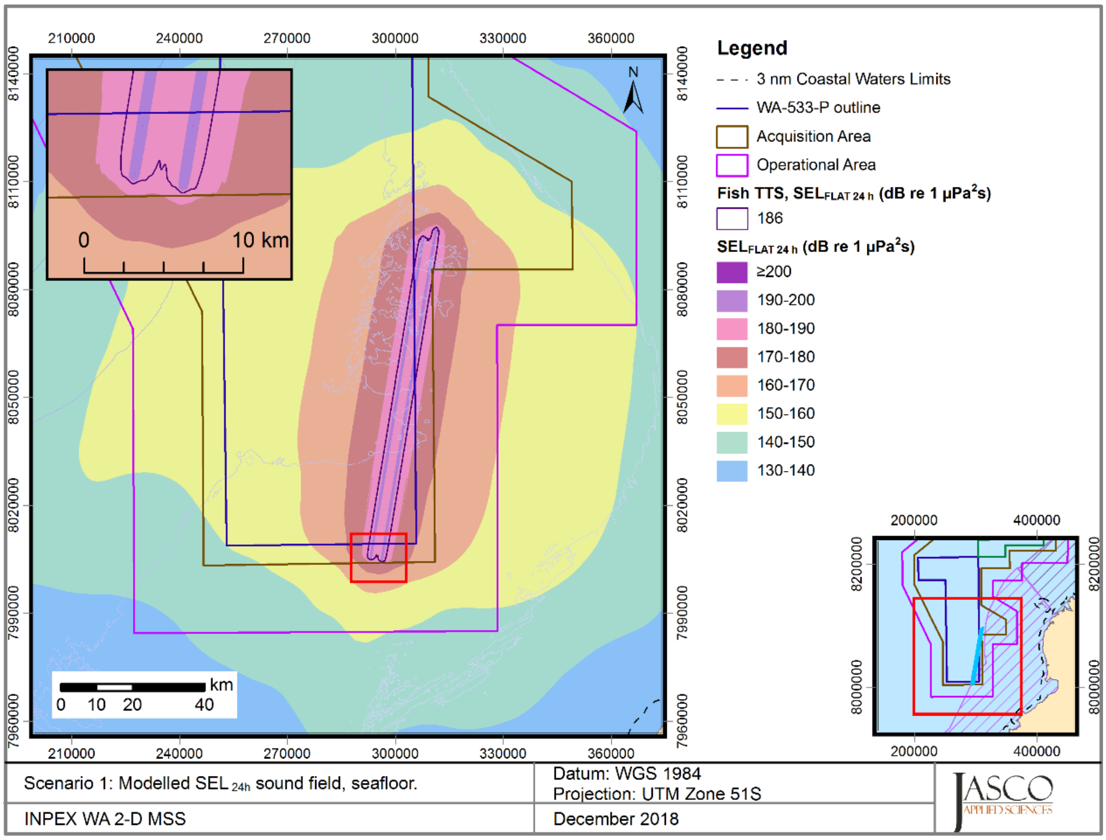


Figure 24. *Scenario 1*: Sound level contour map showing seafloor SEL_{24h} results.

5.3.2. Scenario 2

Table 24. *Scenario 2*: Maximum-over-depth distances (in km) to frequency-weighted SEL_{24h} based marine mammal PTS and TTS thresholds (NMFS 2018) and turtles (Finneran et al. 2017).

Hearing group	**PTS**		
	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)
Low-frequency cetaceans	183	1.35	195.57
Mid-frequency cetaceans	185	—	—
High-frequency cetaceans	155	0.03	1.37
Turtles	204	0.04	3.60
Hearing group	**TTS**		
	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)
Low-frequency cetaceans	168	60.16	8228.74
Mid-frequency cetaceans	170	—	—
High-frequency cetaceans	140	0.19	51.28
Turtles	189	0.33	84.82

A dash indicates the threshold is not reached.

Table 25. *Scenario 2*: Distances to SEL_{24h} based criteria from Popper et al. (2014).

Marine fauna group	**Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)**	**Maximum-over-depth**	
		R_{max} (km)	*Area* (km²)
Mortality and potential mortal injury			
I	219	0.03	1.37
II, Turtles, fish eggs and fish larvae	210	0.03	1.37
III	207	0.03	1.37
Fish recoverable injury			
I	216	0.03	1.37
II, III	203	0.04	3.62
Fish TTS			
I, II, III	186	4.94	1109

A dash denotes a value below the minimum resolution of the modelling.
Fish I–No swim bladder; Fish II–Swim bladder not involved with hearing; Fish III–Swim bladder involved with hearing.

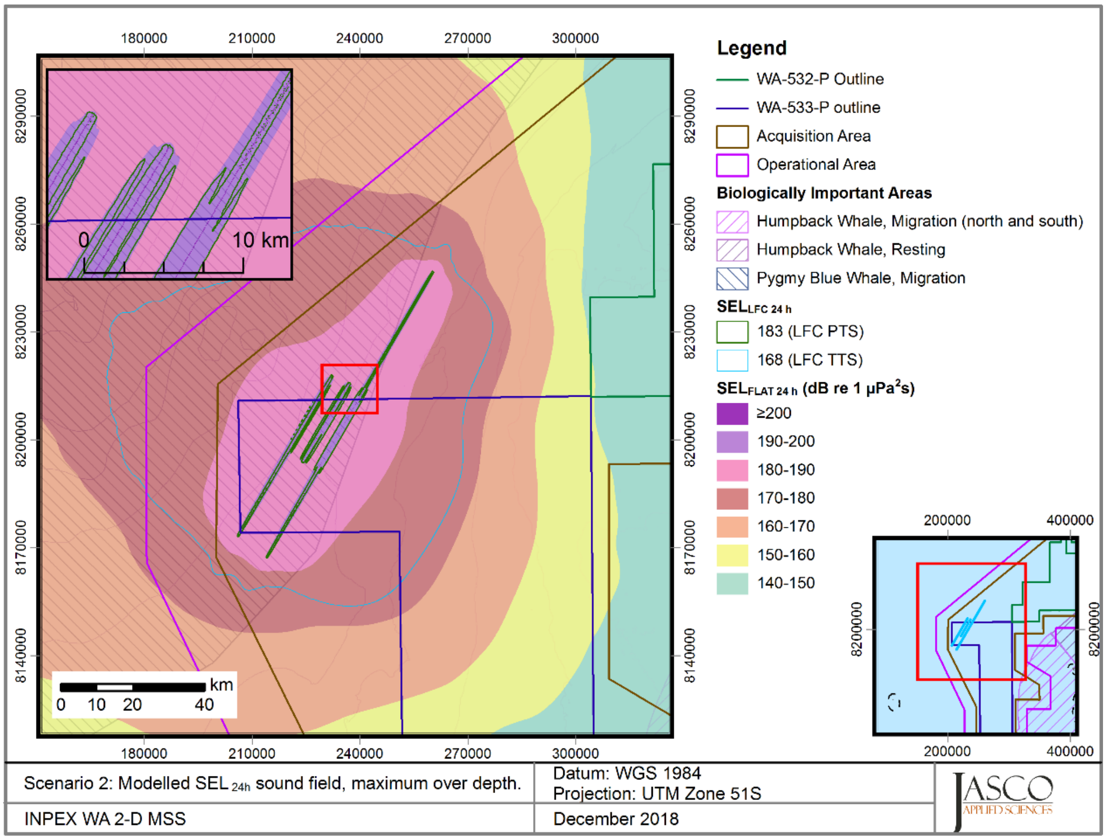


Figure 25. *Scenario 2*: Sound level contour map showing maximum-over-depth SEL_{24h} results.

5.3.3. Scenario 3

Table 26. *Scenario 3*: Maximum-over-depth distances (in km) to frequency-weighted SEL_{24h} based marine mammal PTS and TTS thresholds (NMFS 2018) and turtles (Finneran et al. 2017).

Hearing group	PTS		
	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)
Low-frequency cetaceans	183	2.13	387.22
Mid-frequency cetaceans	185	—	—
High-frequency cetaceans	155	—	—
Sirenians	190	—	—
Turtles	204	—	—
Hearing group	**TTS**		
	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)
Low-frequency cetaceans	168	37.22	4003.93
Mid-frequency cetaceans	170	—	—
High-frequency cetaceans	140	1.63	186.60
Sirenians	175	—	—
Turtles	189	1.63	269.15

A dash indicates the threshold is not reached.

Table 27. *Scenario 3*: Distances to SEL_{24h} based criteria from Popper et al. (2014).

Marine fauna group	Threshold for SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	Maximum-over-depth		At seafloor	
		R_{max} (km)	*Area* (km²)	R_{max} (km)	*Area* (km²)
Mortality and potential mortal injury					
I	219	—	—	—	—
II, Turtles Fish eggs and fish larvae	210	—	—	—	—
III	207	—	—	—	—
Fish recoverable injury					
I	216	—	—	—	—
II, III	203	0.04	2.67	0.02	0.07
Fish TTS					
I, II, III	186	3.50	697.9	2.92	657.8

A dash denotes a value below the minimum resolution of the modelling.
Fish I–No swim bladder; Fish II–Swim bladder not involved with hearing; Fish III–Swim bladder involved with hearing.

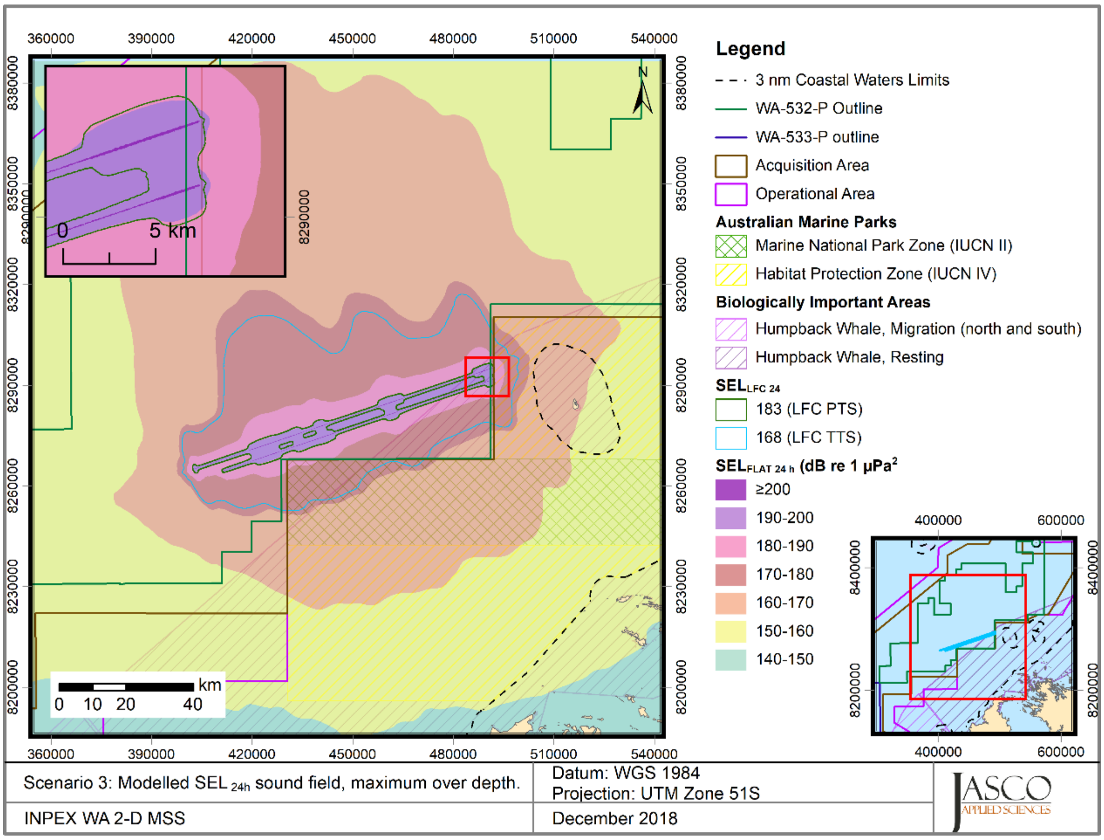


Figure 26. *Scenario 3*: Sound level contour map showing maximum-over-depth SEL_{24h} results.

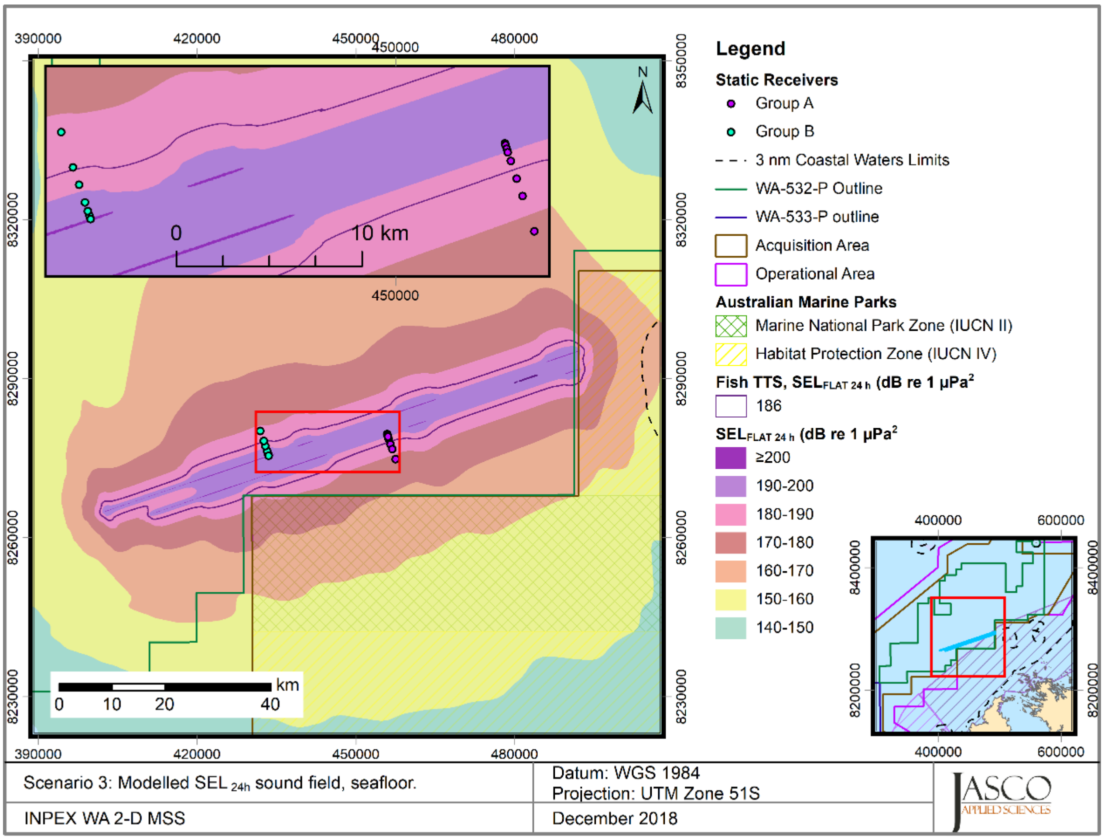


Figure 27. *Scenario 3*: Sound level contour map showing seafloor SEL_{24h} results.

5.3.3.1. Sound levels at static receivers

Sound exposure levels were modelled at static receivers located at eight offset distances (50, 100, 300, 500, 1000, 2000, 3000, and 5000 m) from the closest survey line for each survey line within Scenario 3 (Section 2, Figure 4), with Group A being associated with the southern line and Group B the northern line. The per-pulse and accumulated SEL were plotted as a function of time on a common graph. The results are presented in Figure 32 for seafloor sound levels.

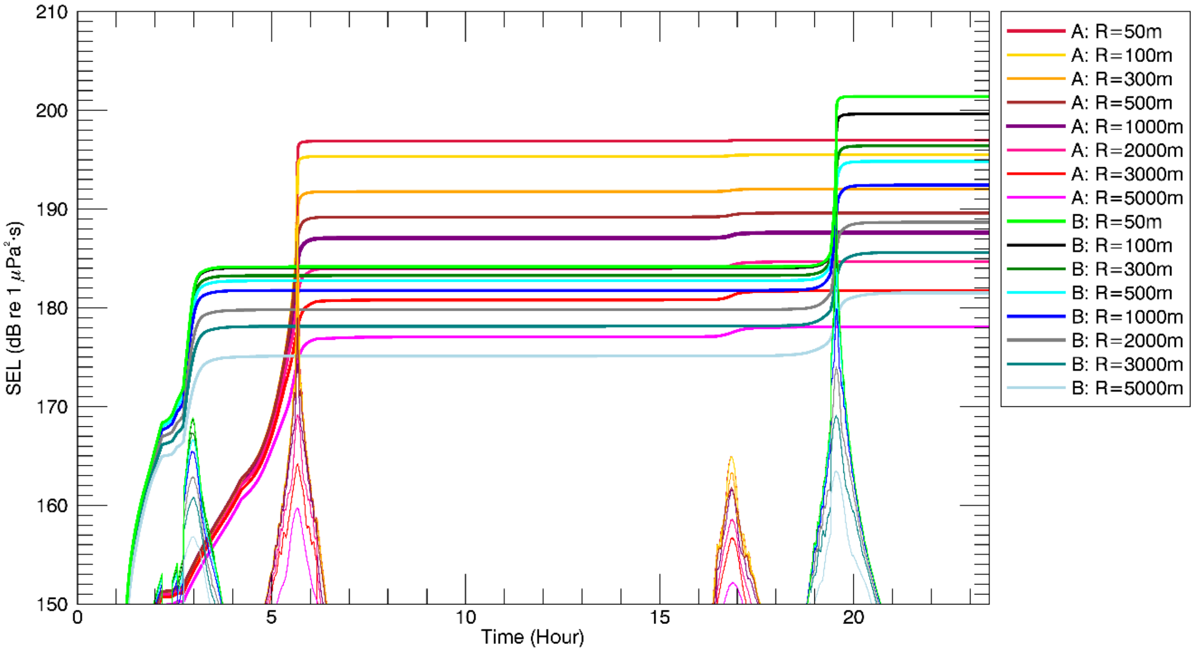


Figure 28. *Scenario 3*: Per-pulse unweighted SEL (thin lines) and accumulated unweighted SEL (thick lines) for nine receivers (denoted by R) located at the seafloor at increasing distance from the survey lines. Gaps in the per-pulse curves correspond to vessel turns.

6. Discussion

6.1. Overview and Source Levels

This modelling study predicted underwater sound levels associated with the planned INPEX WA 2-D MSS. The underwater sound field was modelled for a 3080 in^3 seismic source (Appendix B) with a water column sound speed profile for July. An analysis of seasonal sound speed profiles (Appendix D.3.2) indicated that this month was the most conducive to sound propagation, and as such it was selected to ensure a conservative estimation of distances to received sound level thresholds over the entire survey period. The modelling also accounted for site-specific bathymetric variations (Appendix D.3.1) and local geoacoustic properties (Appendix D.3.3).

Most acoustic energy from the seismic sources is output at lower frequencies, in the tens to hundreds of Hertz. Although there was little difference between the three considered sources in the broadband source levels in the endfire, broadside and vertical directions, the 3080 in^3 source was slightly louder. It also has a more pronounced broadside directivity for 1/3-octave-bands between approximately 100 Hz to about 400 Hz (Appendix B.2), which leads to a noticeable axial bulge in the modelled acoustic footprints. For the modelling sites in shallow water, the low-frequency components associated with the highest spectral levels for the source attenuated rapidly compared to those at higher frequencies.

The overall broadband (10–25000 Hz) unweighted per-pulse SEL source level of the 3080 in^3 array operating at 7 m depth was 224.8 dB 1 μPa^{2}m^{2}s in the broadside direction and 223.6 dB 1 μPa^{2}m^{2}s in the endfire direction. The peak pressure level in the same directions was 249.6 and 246.4 dB re 1 μPa^{2}m^2, respectively. These results are presented in Table 10.

6.2. Per-Pulse Sound Fields

At all sites, the distance to isopleths was longer in the broadside direction compared to the endfire direction, which is apparent in all footprint maps in Section 5.2.2 and Appendix E.1. The array directionality coupled with the bathymetry had a considerable effect on propagation at longer distances, with significantly larger lobes of sound energy extending into the deeper waters at some modelling sites (e.g. Sites 4 (Figure 7) and 7 (Figure 11)). The vertical slice plots (Section 5.2.2.2 and Appendix E.2) assist in demonstrating the rate of change of the bathymetry over distance and the influence on the sound field, with the endfire results for Site 11 (Figure 21) showing strong attenuation in the upslope direction compared to the downslope.

The per-pulse modelling sites encompassed water depths from 45 to 451 m across four geological profiles, with some sites close to shallower areas such as shoals. The distances to isopleths across the 12 modelled sites reflects this environmental variability, with the distances to isopleths for lower sound levels (below 140 dB re 1 μPa^2·s) being longest at the deepest sites (Sites 5 and 6), and shortest at the shallowest site (Site 8). Distances to higher sound levels are greater for Sites 11 and 12, in permit WA-532-P, likely influenced by the different geology in the northern regions of the Acquisition Area.

The distances to PK based potential injury criteria (Section 3.2) for fish at the seafloor do not always decrease with increasing depth (Tables 18–20), a phenomenon related to a complex pattern of destructive surface reflection and constructive critical angle bottom reflections that singularly affect sound propagation in shallow water; the distances could be longer for depths even slightly shallower or deeper.

6.3. Multiple Pulse Sound Fields

The accumulated SEL over 24 hours of seismic operation was modelled considering three realistic acquisition patterns or scenarios within the Acquisition Area but across the two permits. The model predicted the accumulation of sound energy, considering the change in location and the azimuth of the source at each pulse point, which were used to assess possible injury in marine mammals and the

SEL_{24h} based fish and turtle criteria. The results were presented both as maps of the accumulated exposure levels and as tables of ranges to threshold levels and areas exposed above given effects criteria (Section 5.3).

Sound exposure levels were also modelled at static receivers located at various offset distances from the closest survey line in Scenario 3 (Figures 4 and 28). This provides a sense for the accumulation of acoustic energy as the seismic source acquires multiple lines over a 24-hour period. The sampling locations were chosen so they sampled the sound fields early and late in the 24-hour period. The resulting time histories of accumulated SEL show that generally the single nearest pass of the seismic source to a receiver will account for most of the exposure over the 24-hour period. However, depending upon previous exposure within the period, the levels at the receivers close to the track lines late in the period could be higher than those at similarly distances early in the period.

SEL_{24h} is a cumulative metric that reflects the dosimetric impact of noise levels within 24 h, based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The radii that correspond to SEL_{24h} typically represent an unlikely worst-case scenario for SEL-based exposure since, more realistically, marine fauna (mammals or fish) would not stay in the same location or at the same range for 24 hours. Therefore, a reported radius of SEL_{24h} criteria does not mean that any animal travelling within this radius of the source will be injured, but rather that it could be injured if it remained in that range for 24 hours. The reported radii represent the perpendicular distance from to the closest survey line to the relevant isopleth.

6.4. Summary

The findings of the study pertaining each of the metrics and criteria for various marine species of interest are summarised below with references to the result location.

Marine mammal injury and behaviour

- The maximum distance where the NMFS (2014) marine mammal behavioural response criterion of 160 dB re 1 µPa (SPL) could be exceeded varied between 5.52 and 11.19 km (Site 8, 45 m and Site 12, 103 m, permit WA-532-P), Table 13.
- The maximum received SPL, LF-weighted SPL and per-pulse SEL at any of the four locations relevant to calving and resting humpback whales were received at Tasmanian Shoal considering a modelled site 79 km away. The respective levels were 134.6 (L_p; dB re 1 µPa), 120 ($L_{p,LF}$; dB re 1 µPa) and 126.2 (L_E; dB re 1 µPa²·s) (Table 17).
- The results for the criteria applied for marine mammal Permanent Threshold Shift (PTS), NMFS (2018), consider both metrics within the criteria (PK and SEL_{24h}). The longest distance associated with either metric is required to be applied. The table below summarise the maximum distances for PTS, along with the relevant metric and the location of the results within this report.
- The furthest distance from the array that high-frequency cetaceans could experience PTS was 440 m at Site 12 (103 m, permit WA-532-P), a site in a different location to any of the 24-hour SEL scenarios (Table 14).

Table 28. Summary of maximum marine mammal PTS onset distances for SEL_{24h} modelled scenarios (Tables 14, 22, 24 and 26)

Relevant hearing group	Metric associated with longest distance to PTS onset	R_{max} (km)		
		Scenario 1 (WA-533-P)	Scenario 2 (WA-533-P Deep)	Scenario 3 (WA-532-P)
Low-frequency cetaceans†	SEL_{24h}	0.7	1.35	2.13
Mid-frequency cetaceans†	PK	< 0.02	< 0.02	< 0.02
High-frequency cetaceans	PK	0.27	0.22	0.39
Sirenians	PK	NA	NA	0.02

† The model does not account for shutdowns.

- SEL_{24h} is a cumulative metric that reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The corresponding 24-h SEL radii for low-frequency cetaceans were larger than those for peak pressure criteria, but they represent an unlikely worst-case scenario. More realistically, marine mammals (and fish) would not stay in the same location or at the same range for 24 hours. Therefore, a reported radius for 24-h SEL criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with injury (either PTS or TTS) if it remained in that range for 24 hours.

Turtle Behaviour

- The maximum distance where the United States NMFS criterion (NSF 2011) for behavioural effects in turtles of 166 dB re 1 µPa (SPL) could be exceeded varied between 3.09 and 6.13 km (Site 8, 45 m and Site 11, 70 m, permit WA-532-P), Table 13.

Turtle Injury (Finneran et al. 2017)

- The PK turtle injury criteria of 232 dB re 1 µPa for PTS and 226 dB re 1 µPa for TTS from Finneran et al. (2017) was not exceeded at a distance greater than 20 m (horizontal modelling resolution for FWRAM) from the centre of the array. Because the arrays are not a point source (approximately 14 m x 10 m) the actual ranges from the edge of airgun arrays are smaller than the distance from the centre.
- The maximum distance to the SEL_{24h} metric for PTS onset was 40 m and 1.63 km for TTS onset. As is the case with marine mammals, a reported radius for SEL_{24h} criteria does not mean that turtles travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with injury (either PTS or TTS) if it remained in that location for 24 hours.

Fish, turtle injury, fish eggs, and fish larvae

- The modelling study assessed the seafloor and water column ranges for quantitative criteria based on Popper et al. (2014) and considering both PK and SEL_{24h} metrics associated with mortality and potential mortal injury and impairment in:
  - Fish without a swim bladder (also appropriate for sharks in the absence of other information)
  - Fish with a swim bladder that do not use it for hearing
  - Fish that use their swim bladders for hearing
  - Fish eggs and fish larvae
- Water column receptors, assessed at four modelling sites:

  - The maximum distance to sound levels associated with mortality and potential mortal injury on most the sensitive fish groups are associated with the PK metric, and range from 120 m (Sites 1, 5 and 12) to 220 m (Site 7). For fish without a swim bladder, the distance is 60 m at all four sites (Table 14).
- Seafloor receptors, assessed at five modelling sites, along with sites representative of different depths and geoacoustic parameters, three in WA-533-P and five in WA-532-P (depths from 30 to 103 m) (Tables 18–20):
  - The maximum distance to sound levels associated with mortality and potential mortal injury in fish, turtles injury fish eggs and fish larvae is associated with the PK metric in all cases.
  - The maximum distance for the most sensitive fish groups (associated with a PK threshold of 207 dB re 1 µPa) varies between 154 and 185 m for the 3080 in^3 source, and 121 and 171 m for the 2060 in^3 source.
  - The maximum distance for the less sensitive fish groups (associated with a PK threshold of 213 dB re 1 µPa) varies between 54 and 114 m for the 3080 in^3 source, and 57 and 75 m for the 2060 in^3 source.
- Considering the three 24-hour SEL scenarios, and based on Popper et al. (2014), the SEL_{24h} metric criteria for potential TTS could be exceeded within the following distances:
  - 1.58 km of the array at both the seafloor for maximum-over-depth during Scenario 1 (Table 23),
  - 4.94 km for maximum-over-depth during Scenario 2 (Table 25),
  - within 2.92 km at the seafloor and 3.5 km for maximum-over-depth during Scenario 3 (Table 27).

Crustaceans and Bivalves, Sponges and Coral, and Plankton

To assist with assessing the potential effects on these receptors, the following have been determined:

- The maximum received SPL and per-pulse SEL at any of the five locations relevant to the pearl oyster fishery were received at the closest lease to modelling Site 1, 74.5 km away. The respective levels were 101.9 (L_p; dB re 1 µPa) and 121.1 (L_E; dB re 1 µPa^2·s) (Table 16).
- Crustaceans: The sound level of 202 dB re 1 µPa PK-PK from Payne et al. (2008) was considered; it was reached at ranges between 461 and 666 m depending on the modelled site, with range generally increasing with bottom depth (Table 21).
- Sponges and coral: The PK sound level at the seafloor directly underneath the seismic source was estimated at all modelling sites considered for seafloor fish receptors, and compared to the sound level of 226 dB re 1 µPa PK for sponges and corals (Heyward et al. 2018); it was found to reach or just exceed the criterion only at sites with a water depth less than 45 m, with the maximum distance being < 12 m (30 m depth), Tables 18–20.
- Plankton: The distance to the sound level of 178 dB re 1 µPa PK-PK from McCauley et al. (2017) was estimated at all modelling sites through full-waveform modelling using FWRAM; the results ranged from 7.94 km to 12.23 km, Table 15.

Glossary

1/3-octave-band
Non-overlapping passbands that are one-third of an octave wide (where an octave is a doubling of frequency). Three adjacent 1/3-octave-bands comprise a one octave-band. One-third-octave-bands become wider with increasing frequency. Also see octave.

attenuation
The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

auditory weighting function (frequency-weighting function)
Auditory weighting functions account for marine mammal hearing sensitivity. They are applied to sound measurements to emphasise frequencies that an animal hears well and de-emphasise frequencies they hear less well or not at all (Southall et al. 2007, Finneran and Jenkins 2012, NOAA 2013).

azimuth
A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

bandwidth
The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) (ANSI/ASA S1.13-2005 R2010).

bar
Unit of pressure equal to 100 kPa, which is approximately equal to the atmospheric pressure on Earth at sea level. 1 bar is equal to $10^{6\ Pa}$ or $10^{11\ \mu Pa}$.

broadside direction
Perpendicular to the travel direction of a source. Compare to endfire direction.

cetacean
Any animal in the order Cetacea. These are aquatic, mostly marine mammals and include whales, dolphins, and porpoises.

compressional wave
A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called primary wave or P-wave.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

endfire direction
Parallel to the travel direction of a source. Also see broadside direction.

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

functional hearing group
Grouping of marine mammal species with similar estimated hearing ranges. Southall et al. (2007) proposed the following functional hearing groups: low-, mid-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air.

geoacoustic
Relating to the acoustic properties of the seafloor.

hearing threshold
The sound pressure level that is barely audible for a given individual in the absence of significant background noise during a specific percentage of experimental trials.

hertz (Hz)
A unit of frequency defined as one cycle per second.

high-frequency (HF) cetacean
The functional hearing group that represents odontocetes specialised for using high frequencies.

impulsive sound
Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, ANSI S12.7-1986 R2006). For example, seismic airguns and impact pile driving.

low-frequency (LF)cetacean
The functional hearing group that represents mysticetes (baleen whales).

maximum-over-depth
The maximum value over all modelled depths above the sea floor.

mid-frequency (MF) cetacean
The functional hearing group that represents some odontocetes (dolphins, toothed whales, beaked whales, and bottlenose whales).

mysticete
Mysticeti, a suborder of cetaceans, use their baleen plates, rather than teeth, to filter food from water. They are not known to echolocate but use sound for communication. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and the grey whale (*Eschrichtius robustus*).

non-impulsive sound
Sound that is broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically does not have a high peak pressure with rapid rise time (typically only small fluctuations in decibel level) that impulsive signals have (ANSI/ASA S3.20-1995 R2008). Marine vessels, aircraft, machinery, construction, and vibratory pile driving are examples.

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete
The presence of teeth, rather than baleen, characterises these whales. Members of the Odontoceti are a suborder of cetaceans, a group comprised of whales, dolphins, and porpoises. The toothed whales' skulls are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

parabolic equation method
A computationally-efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

peak sound pressure level (PK)
The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak sound pressure level. Unit: dB re 1 µPa

permanent threshold shift (PTS)
A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

pinniped
A common term used to describe all three groups that form the superfamily Pinnipedia: phocids (true seals or earless seals), otariids (eared seals or fur seals and sea lions), and walrus.

point source
A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

power spectrum density
The acoustic signal power per unit frequency as measured at a single frequency. Unit: $\mu Pa^2/Hz$, or $\mu Pa^2 \cdot s$.

power spectrum density level
The decibel level ($10\log_{10}$) of the power spectrum density, usually presented in 1 Hz bins. Unit: dB re 1 $\mu Pa^2/Hz$.

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: p.

pulsed sound
Discrete sounds with durations less than a few seconds. Sounds with longer durations are called continuous sounds.

received level
The sound level measured at a receiver.

signature
Pressure signal generated by a source.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound exposure
Time integral of squared, instantaneous frequency-weighted sound pressure over a stated time interval or event. Unit: pascal-squared second ($Pa^2 \cdot s$) (ANSI S1.1-1994 R2004).

sound exposure level (SEL)
A measure related to the sound energy in one or more pulses. Unit: dB re 1 $\mu Pa^2 \cdot s$.

sound field
Region containing sound waves (ANSI S1.1-1994 R2004).

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

For sound in water, the reference sound pressure is one micropascal ($p_0 = 1$ µPa) and the unit for SPL is dB re 1 µPa:

$$\mathrm{SPL} = 10\log_{10}\left(p^2 / p_0^2\right) = 20\log_{10}\left(p / p_0\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level Unit: dB re 1 µPa.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound pressure level or sound exposure level measured 1 metre from a theoretical point source that radiates the same total sound power as the actual source. Unit: dB re 1 $\mu Pa^2 m^2$ or dB 1 $\mu Pa^2 m^2 s$.

spectrum
An acoustic signal represented in terms of its power (or energy) distribution versus frequency.

temporary threshold shift (TTS)
Temporary loss of hearing sensitivity caused by excessive noise exposure.

transmission loss (TL)
Also called propagation loss, this refers to the decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment.

wavelength
Distance over which a wave completes one oscillation cycle. Unit: meter (m). Symbol: λ.

Literature Cited

[DEWHA] Department of the Environment Water Heritage and the Arts. 2008. *EPBC Act Policy Statement 2.1 - Interaction Between Offshore Seismic Exploration and Whales*. *In*: Australian Government - Department of the Environment, Water, Heritage and the Arts. 14 p. http://www.environment.gov.au/resource/epbc-act-policy-statement-21-interaction-between-offshore-seismic-exploration-and-whales.

[HESS] High Energy Seismic Survey. 1999. *High Energy Seismic Survey Review Process and Interim Operational Guidelines for Marine Surveys Offshore Southern California*. Prepared for the California State Lands Commission and the United States Minerals Management Service Pacific Outer Continental Shelf Region by the High Energy Seismic Survey Team, Camarillo, CA, USA. 98 p. https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB2001100103.xhtml.

[ISO] International Organization for Standardization. 2017. *ISO/DIS 18405.2:2017. Underwater acoustics—Terminology*. Geneva. https://www.iso.org/standard/62406.html.

[NMFS] National Marine Fisheries Service. 2014. *Marine Mammals: Interim Sound Threshold Guidance* (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

[NMFS] National Marine Fisheries Service (US). 1998. *Acoustic Criteria Workshop*. Dr. Roger Gentry and Dr. Jeanette Thomas Co-Chairs.

[NMFS] National Marine Fisheries Service (US). 2016. *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 p.

[NMFS] National Marine Fisheries Service (US). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/webdam/download/75962998.

[NOAA] National Oceanic and Atmospheric Administration (US). 2013. *Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts*. National Oceanic and Atmospheric Administration, US Department of Commerce, and NMFS Office of Protected Resources, Silver Spring, MD, USA. 76 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2015. *Draft guidance for assessing the effects of anthropogenic sound on marine mammal hearing: Underwater acoustic threshold levels for onset of permanent and temporary threshold shifts*. NMFS Office of Protected Resources, Silver Spring, MD, USA. 180 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2016. *Document Containing Proposed Changes to the NOAA Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts*. National Oceanic and Atmospheric Administration and US Department of Commerce. 24 p.

[NSF] National Science Foundation (US), Geological Survey (US), and [NOAA] National Oceanic and Atmospheric Administration (US). 2011. *Final Programmatic Environmental Impact Statement/Overseas. Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the US Geological Survey*. National

Science Foundation, Arlington, VA, USA. https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf.

[ONR] Office of Naval Research. 1998. *ONR Workshop on the Effect of Anthropogenic Noise in the Marine Environment*. Dr. R. Gisiner Chair.

Aerts, L.A.M., M. Blees, S.B. Blackwell, C.R. Greene, Jr., K.H. Kim, D.E. Hannay, and M.E. Austin. 2008. *Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report*. Document Number P1011-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc., and JASCO Applied Sciences for BP Exploration Alaska. 199 p. ftp://ftp.library.noaa.gov/noaa_documents.lib/NMFS/Auke%20Bay/AukeBayScans/Removable%20Disk/P1011-1.pdf.

ANSI S12.7-1986. R2006. *American National Standard Methods for Measurements of Impulsive Noise*. American National Standards Institute, NY, USA.

ANSI S1.1-1994. R2004. *American National Standard Acoustical Terminology*. American National Standards Institute, NY, USA.

ANSI/ASA S1.13-2005. R2010. *American National Standard Measurement of Sound Pressure Levels in Air*. American National Standards Institute and Acoustical Society of America, NY, USA.

ANSI/ASA S3.20-1995. R2008. *American National Standard Bioacoustical Terminology*. American National Standards Institute and Acoustical Society of America, NY, USA.

Austin, M.E. and G.A. Warner. 2012. *Sound Source Acoustic Measurements for Apache's 2012 Cook Inlet Seismic Survey*. Version 2.0. Technical report by JASCO Applied Sciences for Fairweather LLC and Apache Corporation.

Austin, M.E. and L. Bailey. 2013. *Sound Source Verification: TGS Chukchi Sea Seismic Survey Program 2013*. Document Number 00706, Version 1.0. Technical report by JASCO Applied Sciences for TGS-NOPEC Geophysical Company.

Austin, M.E., A. McCrodan, C. O'Neill, Z. Li, and A.O. MacGillivray. 2013. *Marine mammal monitoring and mitigation during exploratory drilling by Shell in the Alaskan Chukchi and Beaufort Seas, July–November 2012: 90-Day Report*. *In*: Funk, D.W., C.M. Reiser, and W.R. Koski (eds.). Underwater Sound Measurements. LGL Rep. P1272D–1. Report from LGL Alaska Research Associates Inc. and JASCO Applied Sciences, for Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 266 pp plus appendices.

Austin, M.E. 2014. Underwater noise emissions from drillships in the Arctic. *In*: Papadakis, J.S. and L. Bjørnø (eds.). *UA2014 - 2nd International Conference and Exhibition on Underwater Acoustics*. 22-27 Jun 2014, Rhodes, Greece. pp. 257-263.

Austin, M.E., H. Yurk, and R. Mills. 2015. *Acoustic Measurements and Animal Exclusion Zone Distance Verification for Furie's 2015 Kitchen Light Pile Driving Operations in Cook Inlet*. Version 2.0. Technical report by JASCO Applied Sciences for Jacobs LLC and Furie Alaska.

Austin, M.E. and Z. Li. 2016. *Marine Mammal Monitoring and Mitigation During Exploratory Drilling by Shell in the Alaskan Chukchi Sea, July–October 2015: Draft 90-day report*. *In*: Ireland, D.S. and L.N. Bisson (eds.). Underwater Sound Measurements. LGL Rep. P1363D. Report from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. For Shell Gulf of Mexico Inc, National Marine Fisheries Service, and US Fish and Wildlife Service. 188 pp + appendices.

Baker, C., A. Potter, M. Tran, and A.D. Heap. 2008. *Sedimentology and Geomorphology of the Northwest Marine Region*. Geoscience Australia Record 2008/07, Canberra, Australia. 220 p.

Buckingham, M.J. 2005. Compressional and shear wave properties of marine sediments: Comparisons between theory and data. *Journal of the Acoustical Society of America* 117: 137-152. https://doi.org/10.1121/1.1810231.

Carnes, M.R. 2009. *Description and Evaluation of GDEM-V 3.0*. US Naval Research Laboratory, Stennis Space Center, MS. NRL Memorandum Report 7330-09-9165. 21 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a494306.pdf.

Collins, M.D. 1993. A split-step Padé solution for the parabolic equation method. *Journal of the Acoustical Society of America* 93(4): 1736-1742. https://doi.org/10.1121/1.406739.

Collins, M.D., R.J. Cederberg, D.B. King, and S. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. *Journal of the Acoustical Society of America* 100(1): 178-182. https://doi.org/10.1121/1.415921.

Coppens, A.B. 1981. Simple equations for the speed of sound in Neptunian waters. *Journal of the Acoustical Society of America* 69(3): 862-863. https://doi.org/10.1121/1.382038.

Day, R.D., R.D. McCauley, Q.P. Fitzgibbon, and J.M. Semmens. 2016. Seismic air gun exposure during early-stage embryonic development does not negatively affect spiny lobster *Jasus edwardsii larvae* (Decapoda:Palinuridae). *Scientific Reports* 6: 1-9. https://doi.org/10.1038/srep22723.

Dragoset, W.H. 1984. A comprehensive method for evaluating the design of airguns and airgun arrays. *16th Annual Offshore Technology Conference* Volume 3, 7-9 May 1984. OTC 4747, Houston, TX, USA. pp. 75–84.

Ellison, W.T. and P.J. Stein. 1999. *SURTASS LFA High Frequency Marine Mammal Monitoring (HF/M3) Sonar: Sustem Description and Test & Evaluation*. Under US Navy Contract N66604-98-D-5725. http://www.surtass-lfa-eis.com/wp-content/uploads/2018/02/HF-M3-Ellison-Report-2-4a.pdf.

Finneran, J.J. and C.E. Schlundt. 2010. Frequency-dependent and longitudinal changes in noise-induced hearing loss in a bottlenose dolphin (*Tursiops truncatus*). *Journal of the Acoustical Society of America* 128(2): 567-570. https://doi.org/10.1121/1.3458814.

Finneran, J.J. and A.K. Jenkins. 2012. *Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis*. SPAWAR Systems Center Pacific, San Diego, CA, USA. 64 p.

Finneran, J.J. 2015. *Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*. Technical report by SSC Pacific, San Diego, CA, USA.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report for Space and Naval Warfare Systems Center Pacific, San Diego, CA, USA. 49 p. http://www.dtic.mil/dtic/tr/fulltext/u2/1026445.pdf.

Finneran, J.J., E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a561707.pdf.

Fisher, F.H. and V.P. Simmons. 1977. Sound absorption in sea water. *Journal of the Acoustical Society of America* 62(3): 558-564. https://doi.org/10.1121/1.381574.

Funk, D., D.E. Hannay, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2008. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–November 2007: 90-day report*. LGL Report P969-1. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for

Shell Offshore Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. 218 p.

Gedamke, J., N. Gales, and S. Frydman. 2011. Assessing risk of baleen whale hearing loss from seismic surveys: The effect of uncertainty and individual variation. *Journal of the Acoustical Society of America* 129(1): 496-506. https://doi.org/10.1121/1.3493445.

Hannay, D.E. and R.G. Racca. 2005. *Acoustic Model Validation*. Document Number 0000-S-90-04-T-7006-00-E, Revision 02. Technical report by JASCO Research Ltd. for Sakhalin Energy Investment Company Ltd. 34 p.

Heyward, A., J. Colquhoun, E. Cripps, D. McCorry, M. Stowar, B. Radford, K. Miller, I. Miller, and C. Battershill. 2018. No evidence of damage to the soft tissue or skeletal integrity of mesophotic corals exposed to a 3D marine seismic survey. *Marine Pollution Bulletin* 129(1): 8-13. https://doi.org/10.1016/j.marpolbul.2018.01.057.

Ireland, D.S., R. Rodrigues, D. Funk, W.R. Koski, and D.E. Hannay. 2009. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–October 2008: 90-Day Report*. Document Number P1049-1. 277 p.

Landro, M. 1992. Modeling of GI gun signatures. *Geophysical Prospecting* 40: 721–747. https://doi.org/10.1111/j.1365-2478.1992.tb00549.x

Laws, R.M., L. Hatton, and M. Haartsen. 1990. Computer modeling of clustered airguns. *First Break* 8(9): 331–338.

Lucke, K., U. Siebert, P. Lepper, A., and M.-A. Blanchet. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *Journal of the Acoustical Society of America* 125(6): 4060-4070. https://doi.org/10.1121/1.3117443.

Lurton, X. 2002. *An Introduction to Underwater Acoustics: Principles and Applications*. Springer, Chichester, UK. 347 p.

MacGillivray, A.O. and N.R. Chapman. 2012. Modeling underwater sound propagation from an airgun array using the parabolic equation method. *Canadian Acoustics* 40(1): 19-25. https://jcaa.caa-aca.ca/index.php/jcaa/article/view/2502/2251.

MacGillivray, A.O. 2018. Underwater noise from pile driving of conductor casing at a deep-water oil platform. *Journal of the Acoustical Society of America* 143(1): 450-459. https://doi.org/10.1121/1.5021554.

Martin, B., K. Bröker, M.-N.R. Matthews, J.T. MacDonnell, and L. Bailey. 2015. Comparison of measured and modeled air-gun array sound levels in Baffin Bay, West Greenland. *OceanNoise 2015*. 11-15 May 2015, Barcelona, Spain.

Martin, B., J.T. MacDonnell, and K. Bröker. 2017a. Cumulative sound exposure levels—Insights from seismic survey measurements. *Journal of the Acoustical Society of America* 141(5): 3603-3603. https://doi.org/10.1121/1.4987709.

Martin, S.B. and A.N. Popper. 2016. Short- and long-term monitoring of underwater sound levels in the Hudson River (New York, USA). *Journal of the Acoustical Society of America* 139(4): 1886-1897. https://doi.org/10.1121/1.4944876.

Martin, S.B., M.-N.R. Matthews, J.T. MacDonnell, and K. Bröker. 2017b. Characteristics of seismic survey pulses and the ambient soundscape in Baffin Bay and Melville Bay, West Greenland. *Journal of the Acoustical Society of America* 142(6): 3331-3346. https://doi.org/10.1121/1.5014049.

Matthews, M.-N.R. and A.O. MacGillivray. 2013. Comparing modeled and measured sound levels from a seismic survey in the Canadian Beaufort Sea. *Proceedings of Meetings on Acoustics* 19(1): 1-8. https://doi.org/10.1121/1.4800553

Mattsson, A. and M. Jenkerson. 2008. Single Airgun and Cluster Measurement Project. *Joint Industry Programme (JIP) on Exploration and Production Sound and Marine Life Proramme Review*. 28-30 Oct. International Association of Oil and Gas Producers, Houston, TX, USA.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, et al. 2000a. *Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid*. Report Number R99-15. Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, Western Australia. 198 p. https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/McCauley-et-al-Seismic-effects-2000.pdf.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, et al. 2000b. Marine seismic surveys: A study of environmental implications. *Australian Petroleum Production Exploration Association (APPEA) Journal* 40(1): 692-708. https://doi.org/10.1071/AJ99048.

McCauley, R.D., R.D. Day, K.M. Swadling, Q.P. Fitzgibbon, R.A. Watson, and J.M. Semmens. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. *Nature Ecology & Evolution* 1(7): 1-8. https://doi.org/10.1038/s41559-017-0195.

McCrodan, A., C.R. McPherson, and D.E. Hannay. 2011. *Sound Source Characterization (SSC) Measurements for Apache's 2011 Cook Inlet 2D Technology Test*. Version 3.0. Technical report by JASCO Applied Sciences for Fairweather LLC and Apache Corporation. 51 p.

McPherson, C.R. and G.A. Warner. 2012. *Sound Sources Characterization for the 2012 Simpson Lagoon OBC Seismic Survey 90-Day Report*. Document Number 00443, Version 2.0. Technical report by JASCO Applied Sciences for BP Exploration (Alaska) Inc. http://www.nmfs.noaa.gov/pr/pdfs/permits/bp_openwater_90dayreport_appendices.pdf.

McPherson, C.R., K. Lucke, B.J. Gaudet, B.S. Martin, and C.J. Whitt. 2018. *Pelican 3-D Seismic Survey Sound Source Characterisation*. Document Number 001583. Version 1.0. Technical report by JASCO Applied Sciences for RPS Energy Services Pty Ltd.

McPherson, C.R. and B. Martin. 2018. *Characterisation of Polarcus 2380 in^3 Airgun Array*. Document Number 001599, Version 1.0. Technical report by JASCO Applied Sciences for Polarcus Asia Pacific Pte Ltd.

Nedwell, J.R. and A.W. Turnpenny. 1998. The use of a generic frequency weighting scale in estimating environmental effect. *Workshop on Seismics and Marine Mammals*. 23–25 Jun 1998, London, UK.

Nedwell, J.R., A.W. Turnpenny, J. Lovell, S.J. Parvin, R. Workman, J.A.L. Spinks, and D. Howell. 2007. *A validation of the dB_{ht} as a measure of the behavioural and auditory effects of underwater noise*. Document Number 534R1231 Report prepared by Subacoustech Ltd. for the UK Department of Business, Enterprise and Regulatory Reform under Project No. RDCZ/011/0004. 74 p. https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-et-al-2007.pdf.

O'Neill, C., D. Leary, and A. McCrodan. 2010. Sound Source Verification. (Chapter 3) *In* Blees, M.K., K.G. Hartin, D.S. Ireland, and D.E. Hannay (eds.). *Marine mammal monitoring and mitigation during open water seismic exploration by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2010: 90-day report*. LGL Report P1119. Prepared by LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service (US), and US Fish and Wildlife Service. pp. 1-34.

Payne, J.F., C. Andrews, L. Fancey, D. White, and J. Christian. 2008. *Potential Effects of Seismic Energy on Fish and Shellfish: An Update since 2003*. Report Number 2008/060. Canadian Science Advisory Secretariat. 22 p.

Payne, R. and D. Webb. 1971. Orientation by means of long range acoustic signaling in baleen whales. *Annals of the New York Academy of Sciences* 188: 110-141. https://doi.org/10.1111/j.1749-6632.1971.tb13093.x.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI*. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. https://doi.org/10.1007/978-3-319-06659-2.

Popper, A.N., T.J. Carlson, J.A. Gross, A.D. Hawkins, D.G. Zeddies, L. Powell, and J. Young. 2016. Effects of seismic air guns on pallid sturgeon and paddlefish. *In* Popper, A.N. and A.D. Hawkins (eds.). *The Effects of Noise on Aquatic Life II*. Volume 875. Springer, New York. pp. 871-878. https://doi.org/10.1007/978-1-4939-2981-8_107.

Porter, M.B. and Y.-C. Liu. 1994. Finite-element ray tracing. *In*: Lee, D. and M.H. Schultz (eds.). *International Conference on Theoretical and Computational Acoustics*. Volume 2. World Scientific Publishing Co. pp. 947-956.

Racca, R.G., A.N. Rutenko, K. Bröker, and M.E. Austin. 2012a. A line in the water - design and enactment of a closed loop, model based sound level boundary estimation strategy for mitigation of behavioural impacts from a seismic survey. *11th European Conference on Underwater Acoustics*. Volume 34(3), Edinburgh, UK.

Racca, R.G., A.N. Rutenko, K. Bröker, and G. Gailey. 2012b. Model based sound level estimation and in-field adjustment for real-time mitigation of behavioural impacts from a seismic survey and post-event evaluation of sound exposure for individual whales. *In*: McMinn, T. (ed.). *Acoustics 2012*. Fremantle, Australia. http://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p92.pdf.

Racca, R.G., M.E. Austin, A.N. Rutenko, and K. Bröker. 2015. Monitoring the gray whale sound exposure mitigation zone and estimating acoustic transmission during a 4-D seismic survey, Sakhalin Island, Russia. *Endangered Species Research* 29(2): 131-146. https://doi.org/10.3354/esr00703.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411-521. https://doi.org/10.1080/09524622.2008.9753846.

Teague, W.J., M.J. Carron, and P.J. Hogan. 1990. A comparison between the Generalized Digital Environmental Model and Levitus climatologies. *Journal of Geophysical Research* 95(C5): 7167-7183. https://doi.org/10.1029/JC095iC05p07167.

Tougaard, J., A.J. Wright, and P.T. Madsen. 2015. Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. *Marine Pollution Bulletin* 90(1-2): 196-208. https://doi.org/10.1016/j.marpolbul.2014.10.051.

Warner, G.A., C. Erbe, and D.E. Hannay. 2010. Underwater Sound Measurements. (Chapter 3) *In* Reiser, C.M., D. Funk, R. Rodrigues, and D.E. Hannay (eds.). *Marine Mammal Monitoring and Mitigation during Open Water Shallow Hazards and Site Clearance Surveys by Shell Offshore Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-Day Report*. LGL Report P1112-1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc., National Marine Fisheries Service (US), and Fish and Wildlife Service (US). pp. 1-54.

Warner, G.A., M.E. Austin, and A.O. MacGillivray. 2017. Hydroacoustic measurements and modeling of pile driving operations in Ketchikan, Alaska [Abstract]. *Journal of the Acoustical Society of America* 141(5): 3992. https://doi.org/10.1121/1.4989141.

Whiteway, T. 2009. *Australian Bathymetry and Topography Grid, June 2009*. GeoScience Australia, Canberra. http://pid.geoscience.gov.au/dataset/ga/67703.

Wood, J., B.L. Southall, and D.J. Tollit. 2012. *PG&E offshore 3-D Seismic Survey Project Environmental Impact Report–Marine Mammal Technical Draft Report*. SMRU Ltd. 121 p. https://www.coastal.ca.gov/energy/seismic/mm-technical-report-EIR.pdf.

Zhang, Z.Y. and C.T. Tindle. 1995. Improved equivalent fluid approximations for a low shear speed ocean bottom. *Journal of the Acoustical Society of America* 98(6): 3391-3396. https://doi.org/10.1121/1.413789.

Ziolkowski, A. 1970. A method for calculating the output pressure waveform from an air gun. *Geophysical Journal of the Royal Astronomical Society* 21(2): 137-161. https://doi.org/10.1111/j.1365-246X.1970.tb01773.x.

Zykov, M.M. and J.T. MacDonnell. 2013. *Sound Source Characterizations for the Collaborative Baseline Survey Offshore Massachusetts Final Report: Side Scan Sonar, Sub-Bottom Profiler, and the R/V Small Research Vessel experimental*. Document Number 00413, Version 2.0. Technical report by JASCO Applied Sciences for Fugro GeoServices, Inc. and the (US) Bureau of Ocean Energy Management.

Appendix A. Acoustic Metrics

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The zero-to-peak sound pressure level (PK; L_{pk}; $L_{p,pk}$; dB re 1 μPa), is the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$L_{p,pk} = 20\log_{10}\left[\frac{\max(|p(t)|)}{p_0}\right] \qquad \text{(A-1)}$$

PK is often included as a criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of a noise event, it is generally a poor indicator of perceived loudness.

The peak-to-peak sound pressure level (PK-PK; $L_{pk\text{-}pk}$; $L_{p,pk\text{-}pk}$; dB re 1 μPa) is the difference between the maximum and minimum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound, $p(t)$:

$$L_{p,pk-pk} = 10\log_{10}\left\{\frac{[\max(p(t)) - \min(p(t))]^2}{p_0^2}\right\} \qquad \text{(A-2)}$$

The sound pressure level (SPL; L_p; dB re 1 μPa) is the rms pressure level in a stated frequency band over a specified time window (T, s) containing the acoustic event of interest. It is important to note that SPL always refers to a rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_0^2\right) \qquad \text{(A-3)}$$

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalization, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL. A fixed window length of 0.125 s (critical duration defined by Tougaard et al. (2015)) is used in this study for impulsive sounds.

The sound exposure level (SEL; L_E; $L_{E,p}$; dB re 1 μPa^2·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)dt \Big/ T_0 p_0^2\right) \qquad \text{(A-4)}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the *N* individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right). \tag{A-5}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LFC,24h}$; Appendix A.3). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should else be specified.

A.2. Marine Mammal Impact Criteria

It has been long recognised that marine mammals can be adversely affected by underwater anthropogenic noise. For example, Payne and Webb (1971) suggested that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR 1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for both injury and disturbance. The following sections summarize the recent development of thresholds; however, this field remains an active research topic.

A.2.1. Injury

In recognition of shortcomings of the SPL-only based injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included peak pressure level thresholds and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas the SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for human; Appendix A.3). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower injury values for LF and HF cetaceans while retaining the filter shapes. Their revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HF cetaceans of 179 dB re 1 µPa^2·s. Because there were no data available for baleen whales, Wood et al. (2012) based their recommendations for LF cetaceans on results obtained from MF cetacean studies. In particular they referenced Finneran and Schlundt (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed. Wood et al. (2012) thus recommended a more conservative TTS-onset level for LF cetaceans of 192 dB re 1 µPa^2·s.

As of 2017, an optimal approach is not apparent. There is consensus in the research community that an SEL-based method is preferable either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2016). The guidance describes injury criteria with new thresholds and frequency weighting functions for the five hearing groups described by Finneran and Jenkins (2012). The latest revision to this work was published in 2018; only the PK criteria defined in NMFS (2018) are applied in this report.

A.3. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.3.1. Marine mammal frequency weighting functions

In 2015, a U.S. Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^2\right]^a\left[1+(f/f_{hi})^2\right]^b}\right)\right] \quad \text{(A-6)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses noise impacts on marine mammals (NMFS 2016, NMFS 2018). Table A-1 lists the frequency-weighting parameters for each hearing group; Figure A-1 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions recommended by NMFS (2018).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
Mid-frequency cetaceans (dolphins, plus toothed, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
High-frequency cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*)	1.8	2	12,000	140,000	1.36
Phocid pinnipeds in water (true seals)	1.0	2	1,900	30,000	0.75
Otariid pinnipeds in water (sea lions and fur seals)	2.0	2	940	25,000	0.64
Sirenians (dugongs and manatees)	1.8	2	4,300	25,000	2.62

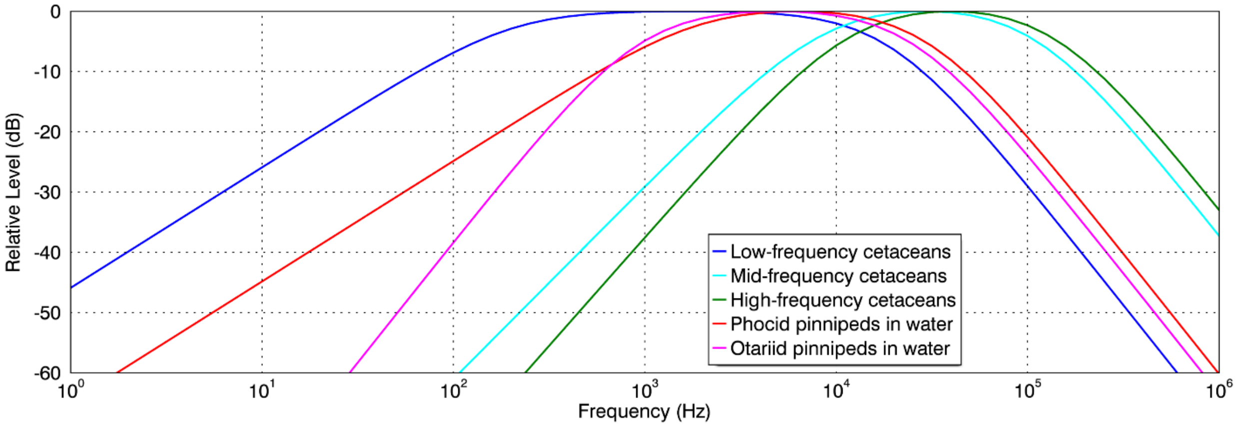


Figure A-1. Auditory weighting functions for functional marine mammal hearing groups (excluding sirenians) as recommended by NMFS (2018).

Appendix B. Acoustic Source Model

B.1. Airgun Array Source Model

The source levels and directivity of the seismic source were predicted with JASCO's Airgun Array Source Model (AASM). AASM includes low- and high-frequency modules for predicting different components of the seismic source spectrum. The low-frequency module is based on the physics of oscillation and radiation of airgun bubbles, as originally described by Ziolkowski (1970), that solves the set of parallel differential equations that govern bubble oscillations. Physical effects accounted for in the simulation include pressure interactions between airguns, port throttling, bubble damping, and generator-injector (GI) gun behaviour discussed by Dragoset (1984), Laws et al. (1990), and Landro (1992). A global optimisation algorithm tunes free parameters in the model to a large library of airgun source signatures.

While airgun signatures are highly repeatable at the low frequencies, which are used for seismic imaging, their sound emissions have a large random component at higher frequencies that cannot be predicted using a deterministic model. Therefore, AASM uses a stochastic simulation to predict the high-frequency (800−25,000 Hz) sound emissions of individual airguns, using a data-driven multiple-regression model. The multiple-regression model is based on a statistical analysis of a large collection of high quality seismic source signature data recently obtained from the Joint Industry Program (JIP) on Sound and Marine Life (Mattsson and Jenkerson 2008). The stochastic model uses a Monte-Carlo simulation to simulate the random component of the high-frequency spectrum of each airgun in an array. The mean high-frequency spectra from the stochastic model augment the low-frequency signatures from the physical model, allowing AASM to predict airgun source levels at frequencies up to 25,000 Hz.

AASM produces a set of "notional" signatures for each array element based on:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

These notional signatures are the pressure waveforms of the individual airguns at a standard reference distance of 1 m; they account for the interactions with the other airguns in the array. The signatures are summed with the appropriate phase delays to obtain the far-field source signature of the entire array in all directions. This far-field array signature is filtered into 1/3-octave-bands to compute the source levels of the array as a function of frequency band and azimuthal angle in the horizontal plane (at the source depth), after which it is considered a directional point source in the far field.

A seismic array consists of many sources and the point source assumption is invalid in the near field where the array elements add incoherently. The maximum extent of the near field of an array (R_{nf}) is:

$$R_{\mathrm{nf}} < \frac{l^2}{4\lambda} \tag{B-1}$$

where λ is the sound wavelength and l is the longest dimension of the array (Lurton 2002, §5.2.4). For example, a seismic source length of l = 21 m yields a near-field range of 147 m at 2 kHz and 7 m at 100 Hz. Beyond this R_{nf} range, the array is assumed to radiate like a directional point source and is treated as such for propagation modelling.

The interactions between individual elements of the array create directionality in the overall acoustic emission. Generally, this directionality is prominent mainly at frequencies in the mid-range between tens of hertz to several hundred hertz. At lower frequencies, with acoustic wavelengths much larger than the inter-airgun separation distances, the directionality is small. At higher frequencies, the pattern of lobes is too finely spaced to be resolved and the effective directivity is less.

B.2. Array Source Levels and Directivity

Figures B-1 through B-4 show the broadside (perpendicular to the tow direction), endfire (parallel to the tow direction), and vertical overpressure signature and corresponding power spectrum levels for the 2970, 3000 and 3080 in^3 arrays.

Horizontal 1/3-octave-band source levels are shown as a function of band centre frequency and azimuth (Figures B-6 through B-8); directivity in the sound field is most noticeable at mid-frequencies as described in the model detail in Appendix B.1.

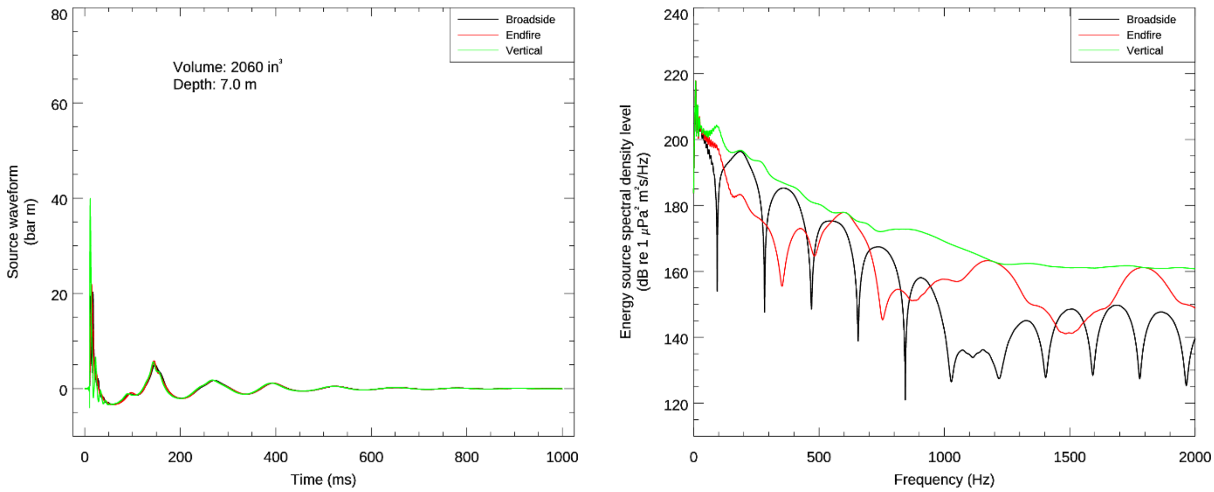


Figure B-1. Predicted source level details for the 2060 in^3 array at a 7 m towed depth. (Left) the overpressure signature and (right) the power spectrum for in-plane horizontal (broadside), perpendicular (endfire), and vertical directions.

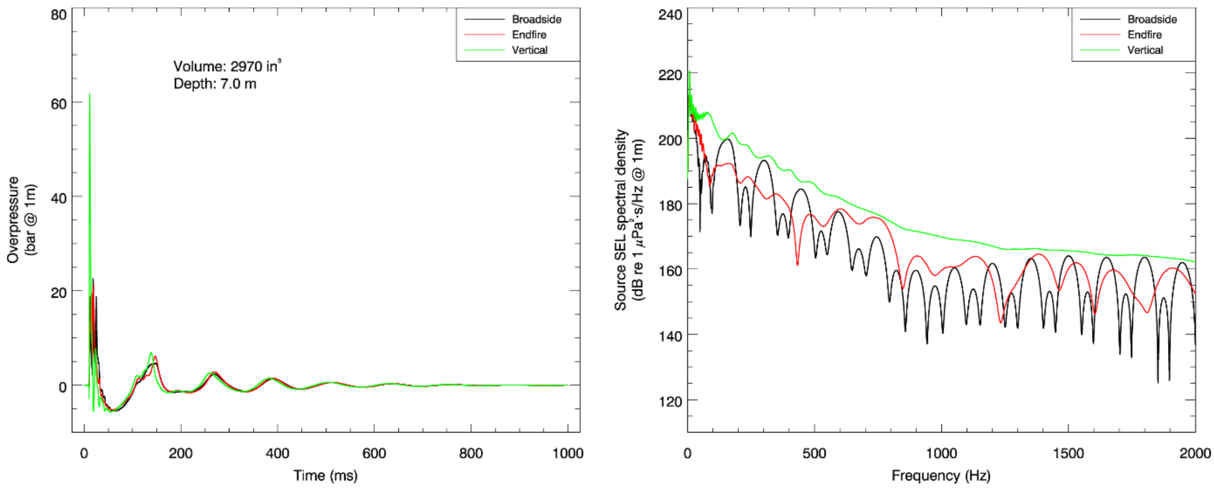


Figure B-2. Predicted source level details for the 2970 in^3 array at a 7 m towed depth. (Left) the overpressure signature and (right) the power spectrum for in-plane horizontal (broadside), perpendicular (endfire), and vertical directions.

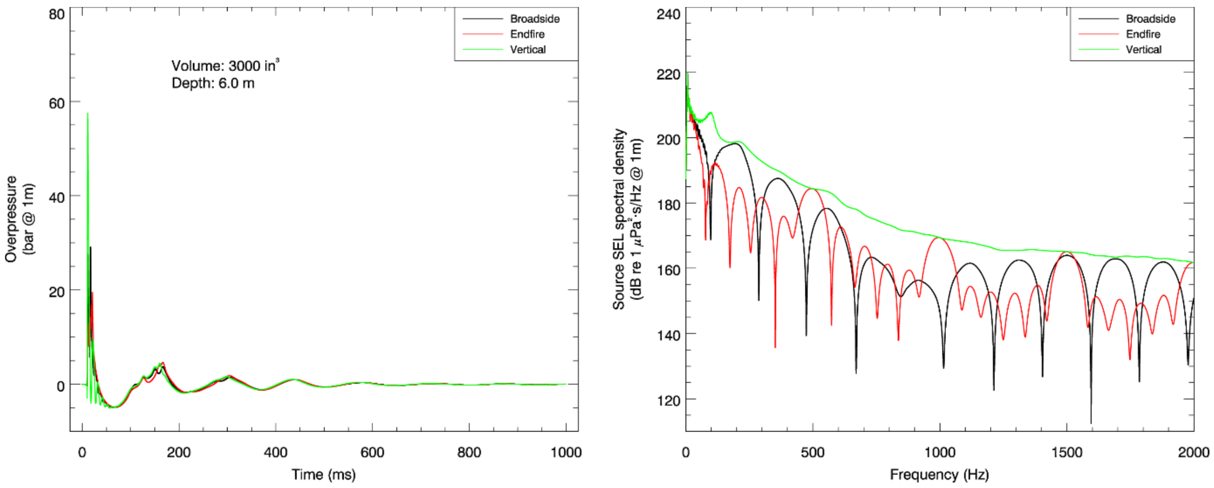


Figure B-3. Predicted source level details for the 3000 in^3 array at a 6 m towed depth. (Left) the overpressure signature and (right) the power spectrum for in-plane horizontal (broadside), perpendicular (endfire), and vertical directions.

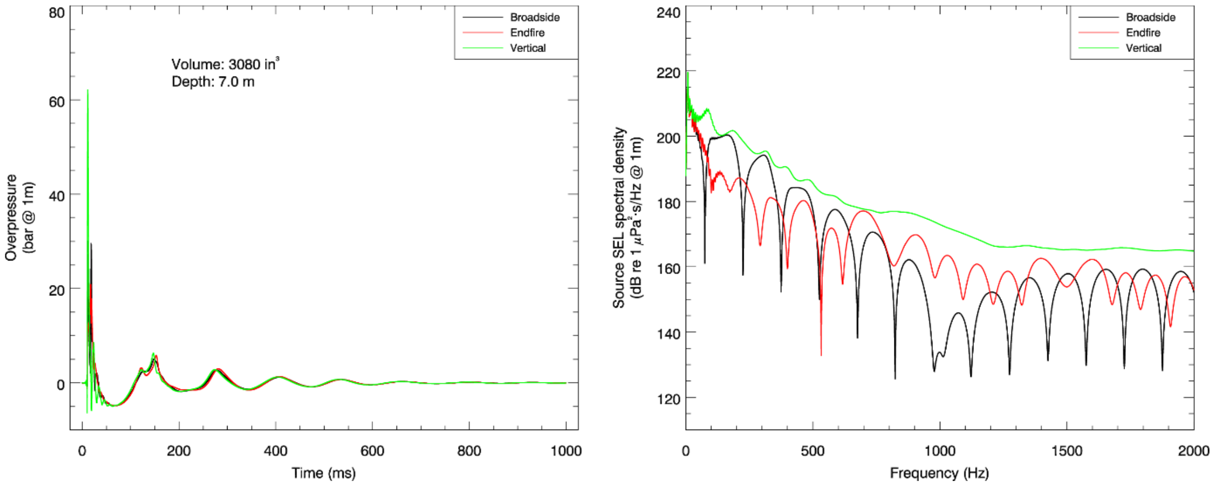


Figure B-4. Predicted source level details for the 3080 in^3 array at a 7 m towed depth. (Left) the overpressure signature and (right) the power spectrum for in-plane horizontal (broadside), perpendicular (endfire), and vertical directions.

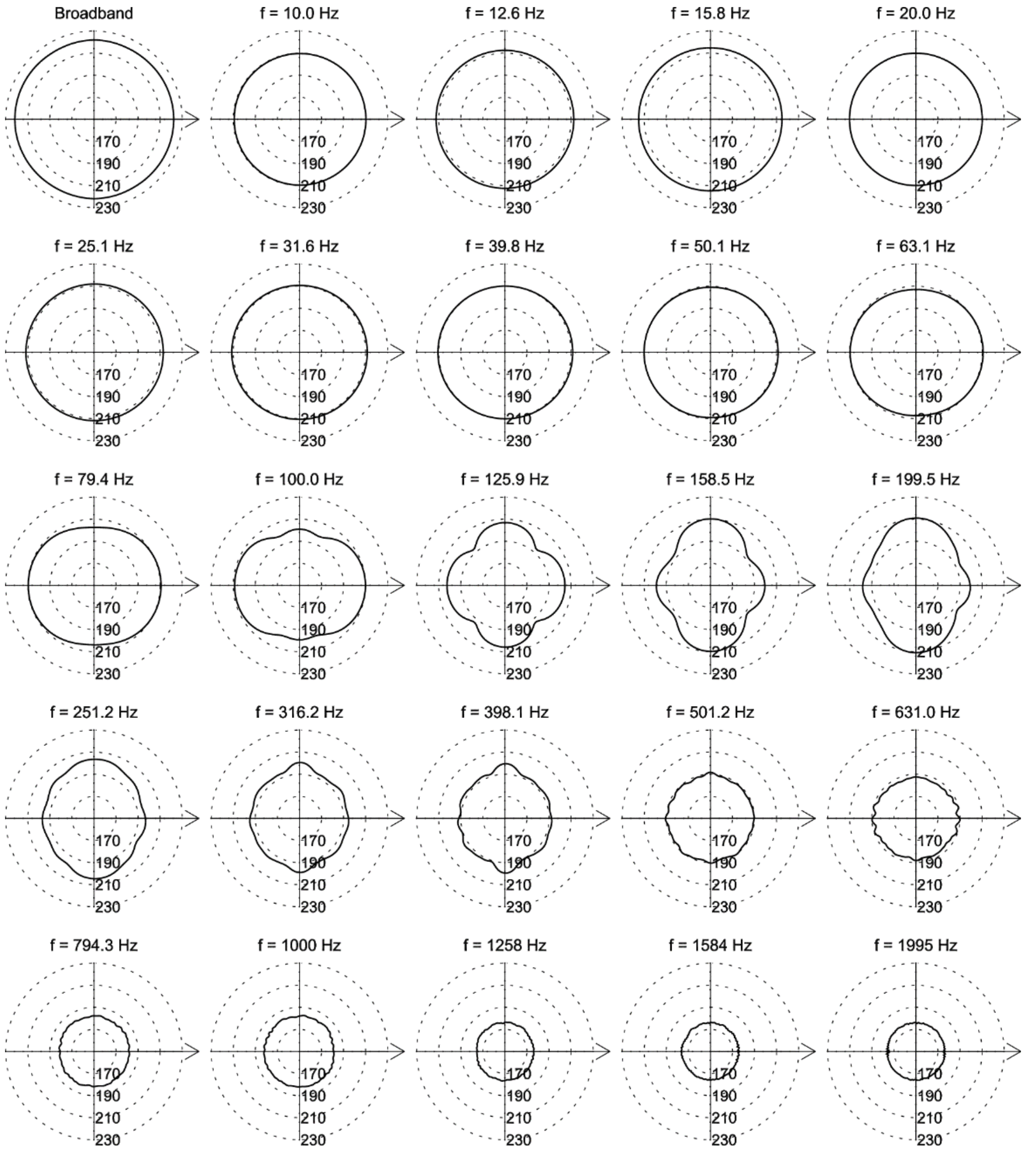


Figure B-5. Directionality of the predicted horizontal source levels for the 2060 in^3 seismic source array, 10 Hz to 2 kHz. Source levels (in dB re 1 µPa^2·s m^2) are shown as a function of azimuth for the centre frequencies of the 1/3-octave-bands modelled; frequencies are shown above the plots. The perpendicular direction to the frame is to the right. Tow depth is 7 m (see Figure B-1).

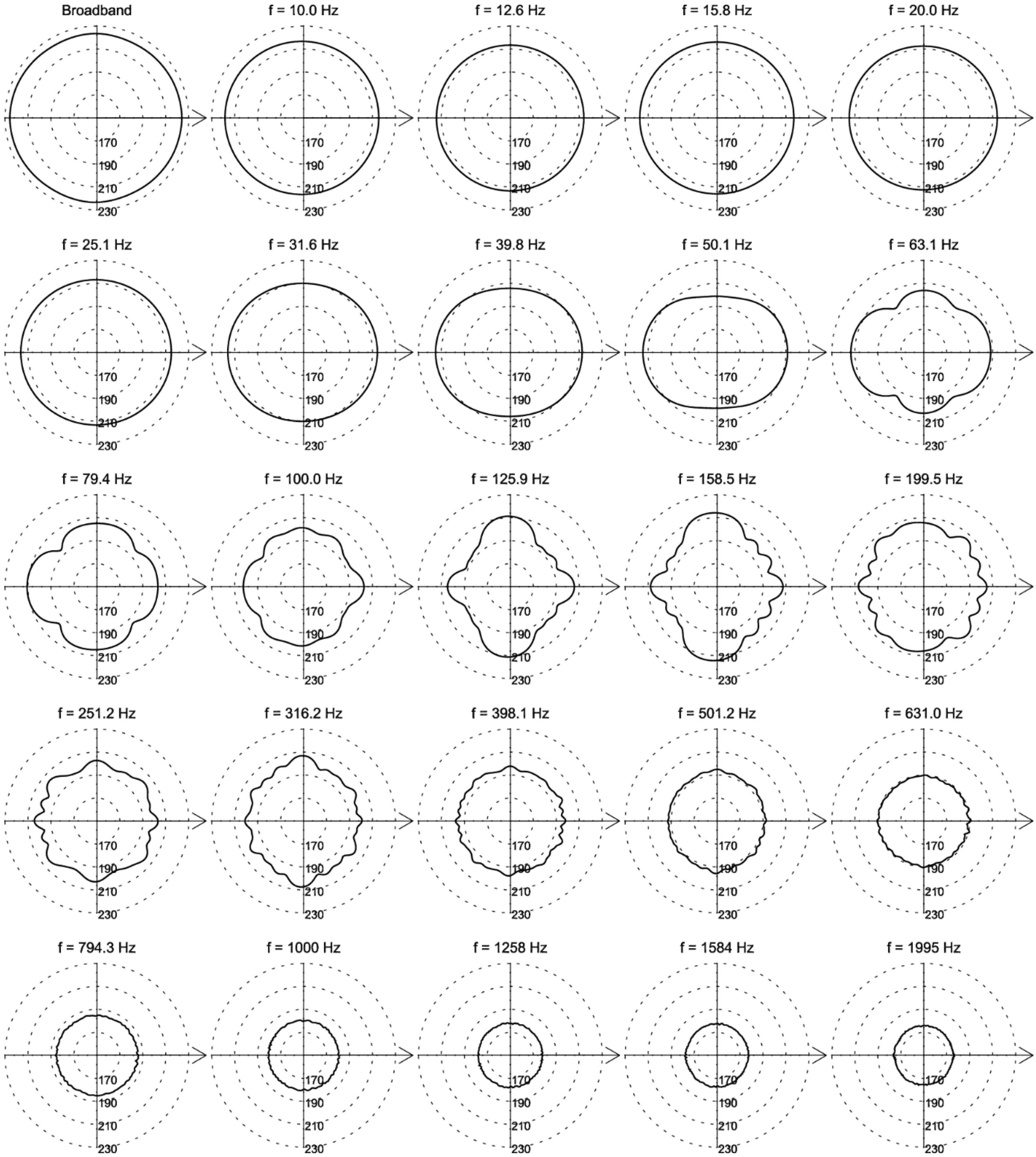


Figure B-6. Directionality of the predicted horizontal source levels for the 2970 in^3 seismic source array, 10 Hz to 2 kHz. Source levels (in dB re 1 µPa^2·s m^2) are shown as a function of azimuth for the centre frequencies of the 1/3-octave-bands modelled; frequencies are shown above the plots. The perpendicular direction to the frame is to the right. Tow depth is 7 m (see Figure B-2).

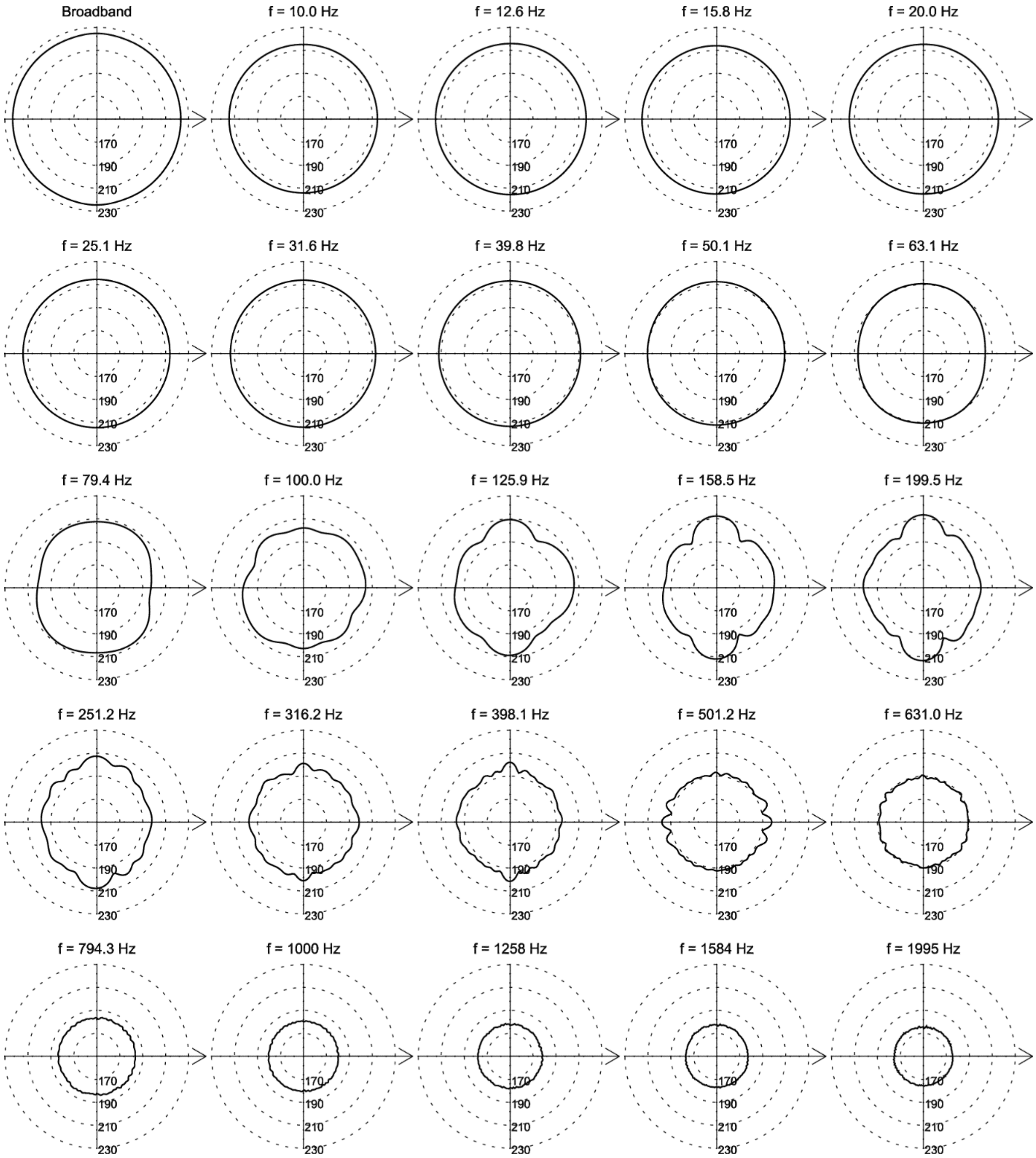


Figure B-7. Directionality of the predicted horizontal source levels for the 3000 in^3 seismic source array, 10 Hz to 2 kHz. Source levels (in dB re 1 µPa^2·s m^2) are shown as a function of azimuth for the centre frequencies of the 1/3-octave-bands modelled; frequencies are shown above the plots. The perpendicular direction to the frame is to the right. Tow depth is 7 m (see Figure B-3).

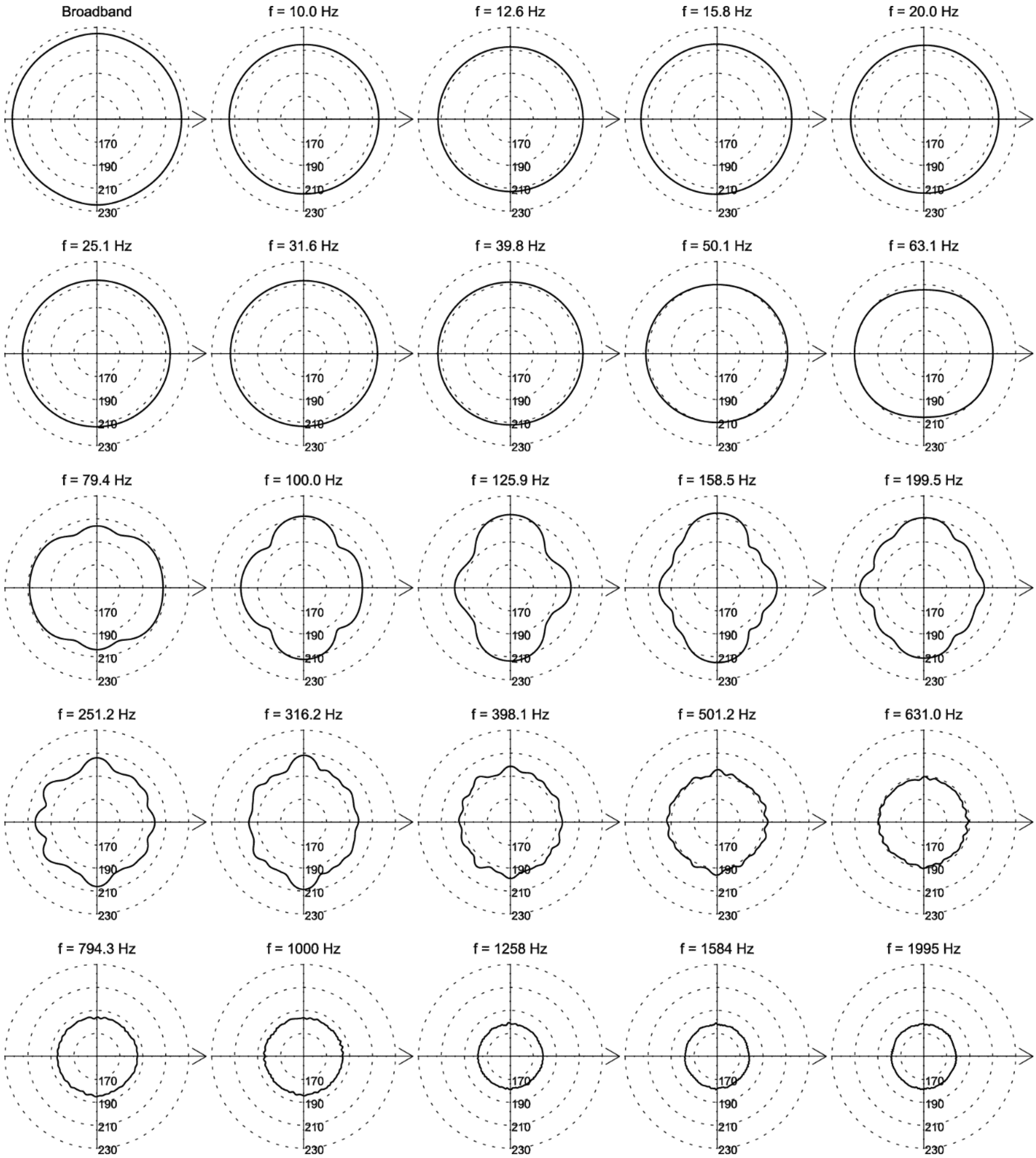


Figure B-8. Directionality of the predicted horizontal source levels for the 3080 in^3 seismic source array, 10 Hz to 2 kHz. Source levels (in dB re 1 µPa^2·s m^2) are shown as a function of azimuth for the centre frequencies of the 1/3-octave-bands modelled; frequencies are shown above the plots. The perpendicular direction to the frame is to the right. Tow depth is 7 m (see Figure B-4).

Appendix C. Sound Propagation Models

C.1. MONM-BELLHOP

Long-range sound fields were computed using JASCO's Marine Operations Noise Model (MONM). Compared to VSTACK, MONM less accurately predicts steep-angle propagation for environments with higher shear speed but is well suited for effective longer-range estimation. This model computes sound propagation at frequencies of 10 Hz to 1.25 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies > 1.25 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

This version of MONM accounts for sound attenuation due to energy absorption through ion relaxation and viscosity of water in addition to acoustic attenuation due to reflection at the medium boundaries and internal layers (Fisher and Simmons 1977). The former type of sound attenuation is significant for frequencies higher than 5 kHz and cannot be neglected without noticeably affecting the model results.

MONM computes acoustic fields in three dimensions by modelling transmission loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding N = 360°/$\Delta\theta$ number of planes (Figure C-1).

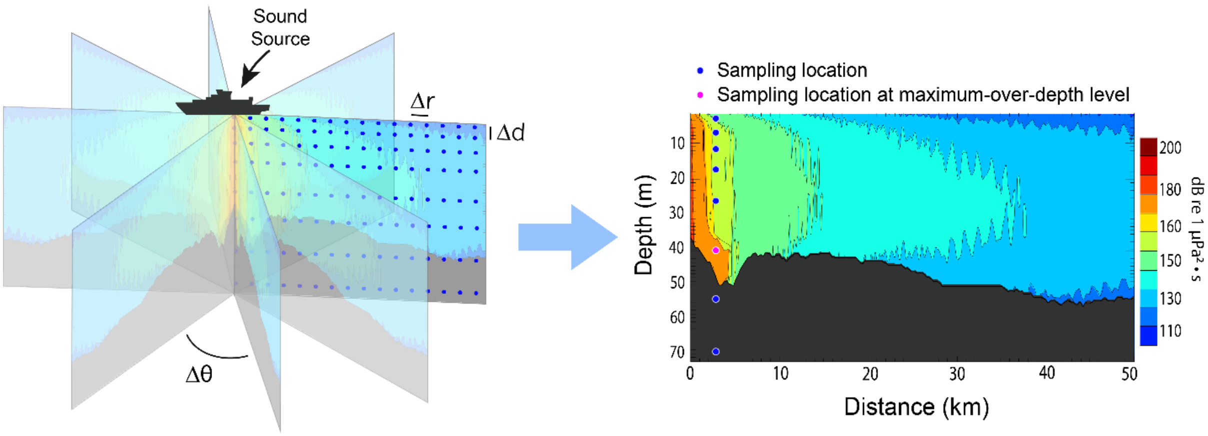


Figure C-1. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic transmission loss at the centre frequencies of 1/3-octave-bands. Sufficiently many 1/3-octave-bands, starting at 10 Hz, are modelled to include most of the acoustic energy emitted by the source. At each centre frequency, the transmission loss is modelled within each of the N vertical planes as a function of depth and range from the source. The 1/3-octave-band received per-pulse SEL are computed by subtracting the band transmission loss values from the directional source level in that frequency band. Composite broadband received per-pulse SEL are then computed by summing the received 1/3-octave-band levels.

The received per-pulse SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. For areas with deep water, sampling is not performed at depths beyond those reachable by marine mammals. The received per-pulse SEL at a surface sampling location is taken as the maximum value that occurs over all samples within the water column, i.e., the maximum-over-depth received per-pulse SEL. These maximum-over-depth per-pulse SEL are presented as colour contours around the source.

An inherent variability in measured sound levels is caused by temporal variability in the environment and the variability in the signature of repeated acoustic impulses (sample sound source verification results is presented in Figure C-2). While MONM's predictions correspond to the averaged received levels, cautionary estimates of the threshold radii are obtained by shifting the best fit line (solid line, Figure C-2) upward so that the trend line encompasses 90% of all the data (dashed line, Figure C-2).

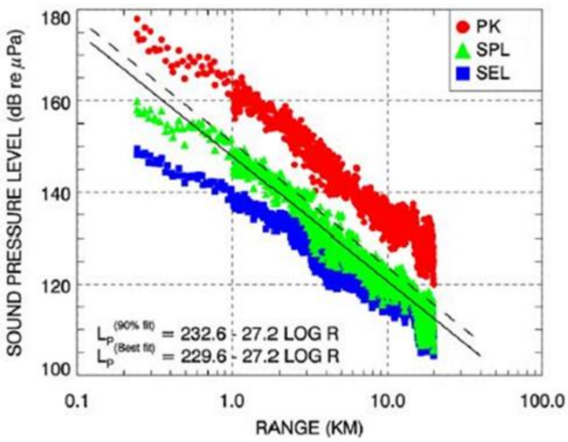


Figure C-2. PK and SPL and per-pulse SEL versus range from a 20 in^3 seismic source. Solid line is the least squares best fit to SPL. Dashed line is the best fit line increased by 3.0 dB to exceed 90% of all SPL values (90th percentile fit) (Ireland et al. 2009, Figure 10).

C.2. Full Waveform Range-dependent Acoustic Model: FWRAM

For impulsive sounds from the seismic source, time-domain representations of the pressure waves generated in the water are required to calculate SPL and PK. Furthermore, the seismic source must be represented as a distributed source to accurately characterise vertical directivity effects in the near-field zone. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic model based on the same wide-angle parabolic equation (PE) algorithm as MONM. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, and it takes the same environmental inputs as MONM (bathymetry, water sound speed profile, and seafloor geoacoustic profile). Unlike MONM, FWRAM computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012).

Besides providing direct calculations of the PK and SPL, the synthetic waveforms from FWRAM can also be used to convert the SEL values from MONM to SPL.

C.3. Wavenumber Integration Model

Sound pressure levels near the seismic source were modelled using JASCO's VSTACK wavenumber integration model. VSTACK computes synthetic pressure waveforms versus depth and range for arbitrarily layered, range-independent acoustic environments using the wavenumber integration approach to solve the exact (range-independent) acoustic wave equation. This model is valid over the full angular range of the wave equation and can fully account for the elasto-acoustic properties of the sub-bottom. Wavenumber integration methods are extensively used in the field of underwater acoustics and seismology where they are often referred to as reflectivity methods or discrete wavenumber methods. VSTACK computes sound propagation in arbitrarily stratified water and seabed layers by decomposing the outgoing field into a continuum of outward-propagating plane cylindrical waves. Seabed reflectivity in the model is dependent on the seabed layer properties: compressional and shear wave speeds, attenuation coefficients, and layer densities. The output of the model can be post-processed to yield estimates of the SEL, SPL, and PK.

VSTACK accurately predicts steep-angle propagation in the proximity of the source, but it is computationally slow at predicting sound pressures at large distances due to the need for smaller wavenumber steps with increasing distance. Additionally, VSTACK assumes range-invariant bathymetry with a horizontally stratified medium (i.e., a range-independent environment) which is azimuthally symmetric about the source. VSTACK is thus best suited to modelling the sound field near the source.

Appendix D. Methods and Parameters

This section describes the specifications of the seismic source that was used at all sites and the environmental parameters used in the propagation models.

D.1. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure D-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure D-1(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure D-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

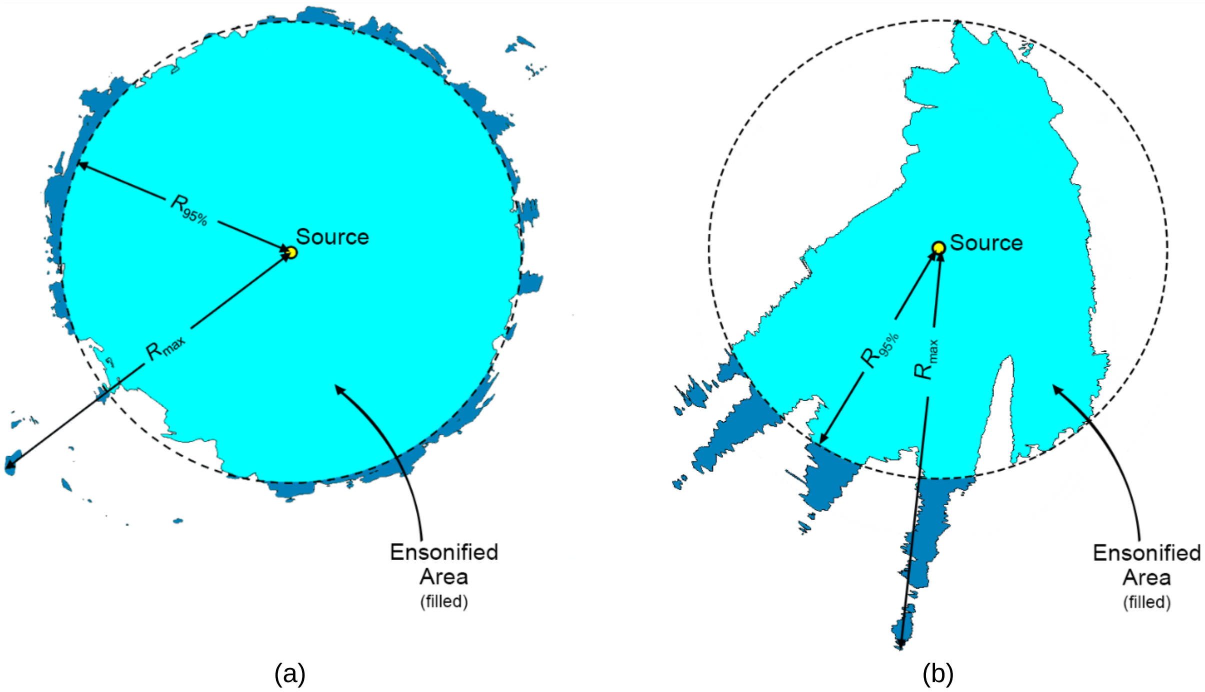


Figure D-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

D.2. Estimating SPL from Modelled SEL Results

The per-pulse SEL of sound pulses is an energy-like metric related to the dose of sound received over the pulse's entire duration. The pulse SPL on the other hand is related to its intensity over a specified time interval. T_{90} is the 90% time window, the time interval often applied to assess seismic pulses (Appendix A). Seismic pulses typically lengthen in duration as they propagate away from their source, due to seafloor and surface reflections, and other waveguide dispersion effects. The changes in pulse length, and therefore T_{90}, affect the numeric relationship between SPL and SEL. Full-waveform modelling was used to estimate T_{90}, but this type of modelling is computationally intensive, and can be prohibitively time consuming when run at high spatial resolution over large areas.

For the current study, FWRAM (Appendix C.2) was used to model synthetic seismic pulses over the frequency range 10–2048 Hz. This was performed along broadside and endfire radials towards the deeper water depths to be conservative. FWRAM uses Fourier synthesis to recreate the signal in the time domain so that both the SEL and SPL from the source can be calculated. The differences between the SEL and SPL were extracted for all ranges and depths that corresponded to those generated from the high spatial-resolution results from MONM. A 125 ms fixed time window positioned to maximize the SPL over the pulse duration was applied. The resulting SEL -to-SPL offsets were averaged in 1 km range bins along each modelled radial and depth, and the 90th percentile was selected at each range to generate a generalised range-dependent conversion function for each site. The range- dependent conversion function was applied to predicted per-pulse SEL results from MONM to model SPL values. Figure D-2 shows the conversion offsets for four; the spatial variation is caused by changes in the received airgun pulse as it propagates from the source.

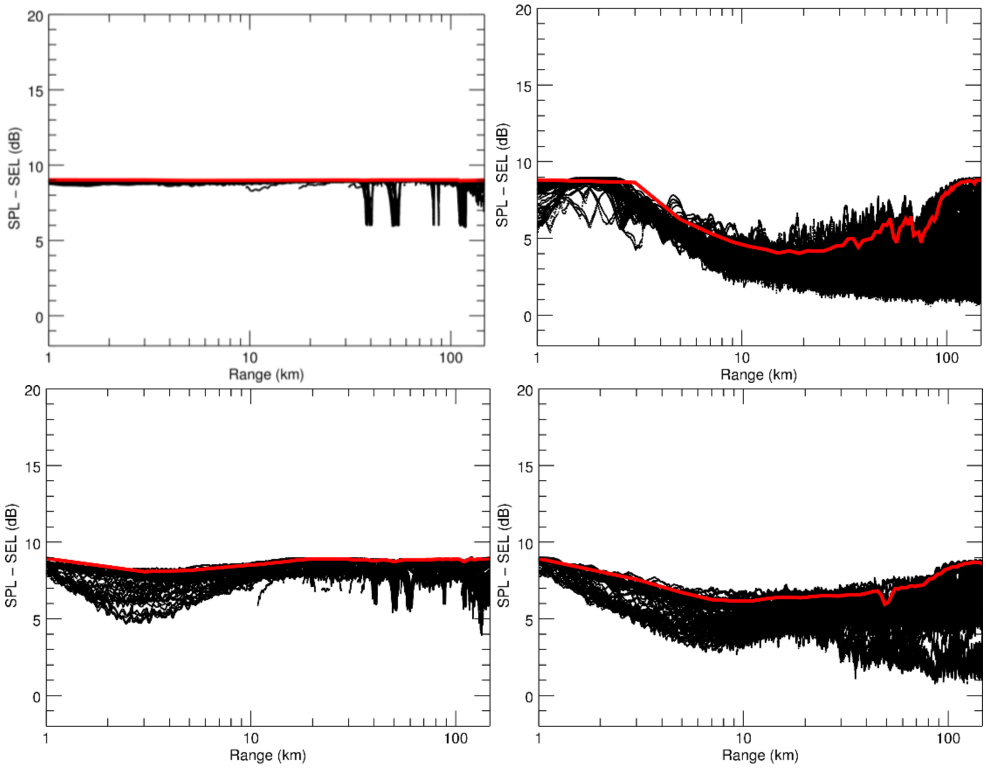


Figure D-2. Range-and-depth-dependent conversion offsets for converting SEL to SPL for seismic pulses. Slices are shown for the 3080 in^3 modelled Site 1 (upper left), Site 5 (upper right), Site 7 (lower left) and Site 12 (lower right). Black lines are the modelled differences between SEL and SPL across different radials and receiver depths; the solid red line is the 90th percentile of the modelled differences at each range.

D.3. Environmental Parameters

D.3.1. Bathymetry

Water depths throughout the modelled area were extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009) for the region shown in

Figure 1

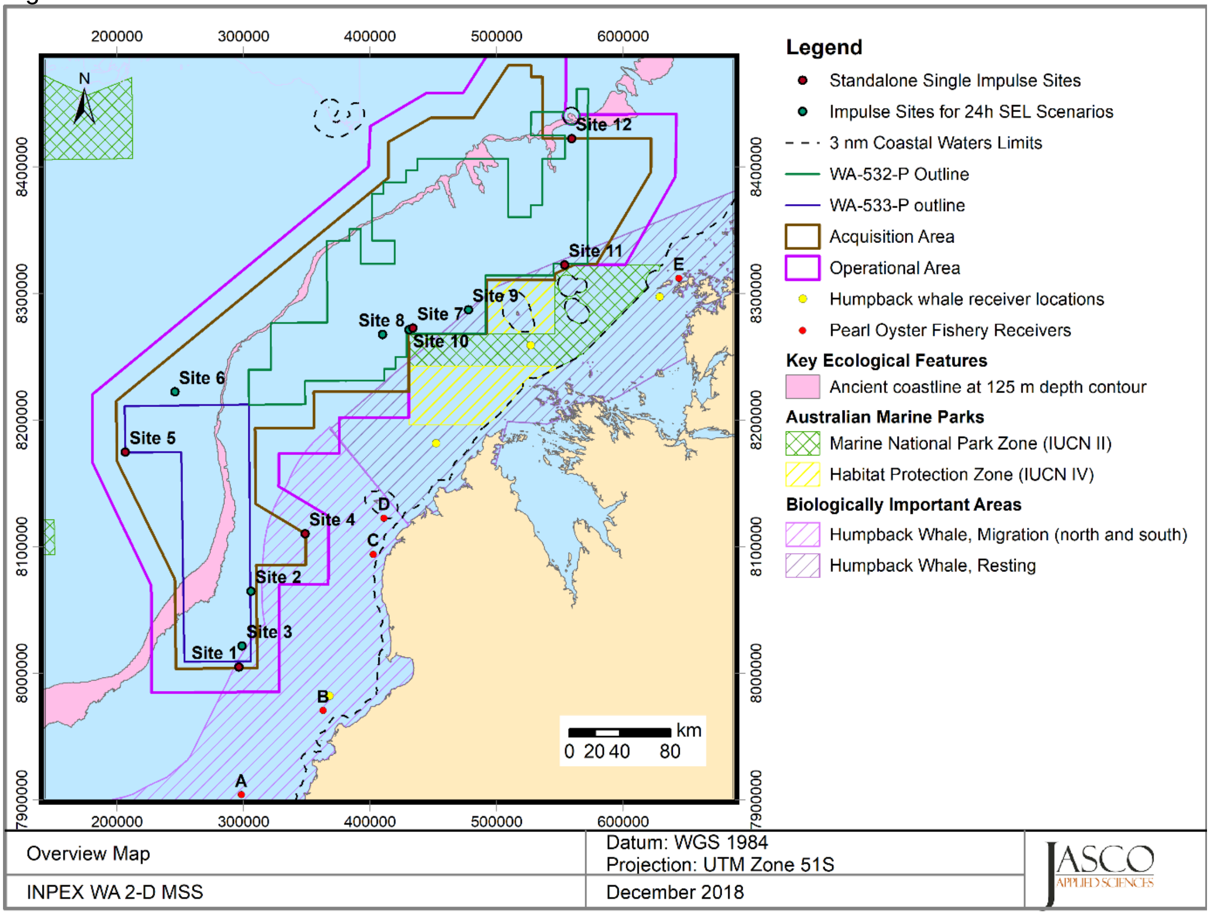


Figure 1. Bathymetry data were extracted and re-gridded onto a Universal Transverse Mercator (UTM) coordinate projection (Zone 51 S) with a regular grid spacing of 100 × 100 m.

D.3.2. Sound speed profile

The sound speed profiles for the modelled sites were derived from temperature and salinity profiles from the U.S. Naval Oceanographic Office's *Generalized Digital Environmental Model V 3.0* (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

Mean monthly sound speed profiles were derived from the GDEM profiles within 200 km box radius of each modelling site. The July sound speed profile is expected to be most favourable to longer-range sound propagation across the entire year. As such, July was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds. Figure D-3. shows the resulting profile used as input to the sound propagation modelling.

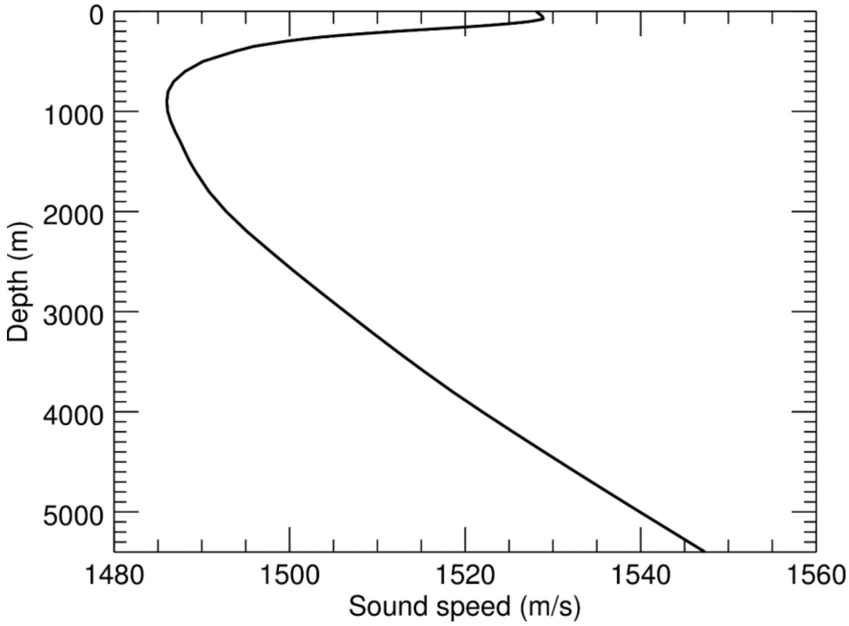


Figure D-3. The final sound speed profile (July) used for the modelling. Profiles are calculated from temperature and salinity profiles from GDEM V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

D.3.3. Geoacoustics

Acoustic transmission loss modelling requires the geoacoustic properties of the seabed and sub-bottom are as representative of the modelling area as possible. Four geoacoustic profiles were compiled for the modelling area based on available data for the depositional environment and lithology for the region.

The study area encompasses areas within the Northern Shelf Province, the Northwest Shelf Province, and Northwest Shelf Transition bioregions (Figure D-4)(Baker et al. 2008). In these areas, the morphology of the study area is dominated by coastal terrace, shelf and slope environments, which effectively define the lithological and sedimentary character of this environment. The dominant fractions of the surficial sediment within each region assist in deriving representative profiles.

Because the modelled area is large and geoacoustic information is limited, a simplified geoacoustic profile was constructed to represent the major features of the sediment column at the modelled sites. The geoacoustic properties for the modelled sites (Tables D-1 to D-4) were estimated from the average parameters based on the sediment model of Buckingham (2005). In the absence of other evidence, it was assumed that surficial sediment characteristics are largely constant with depth, at least to the depths of interest in transmission loss modelling. The profiles used for modelling assumed no distinct layering, which is similar to the majority of the stratigraphic profiles reviewed in this study

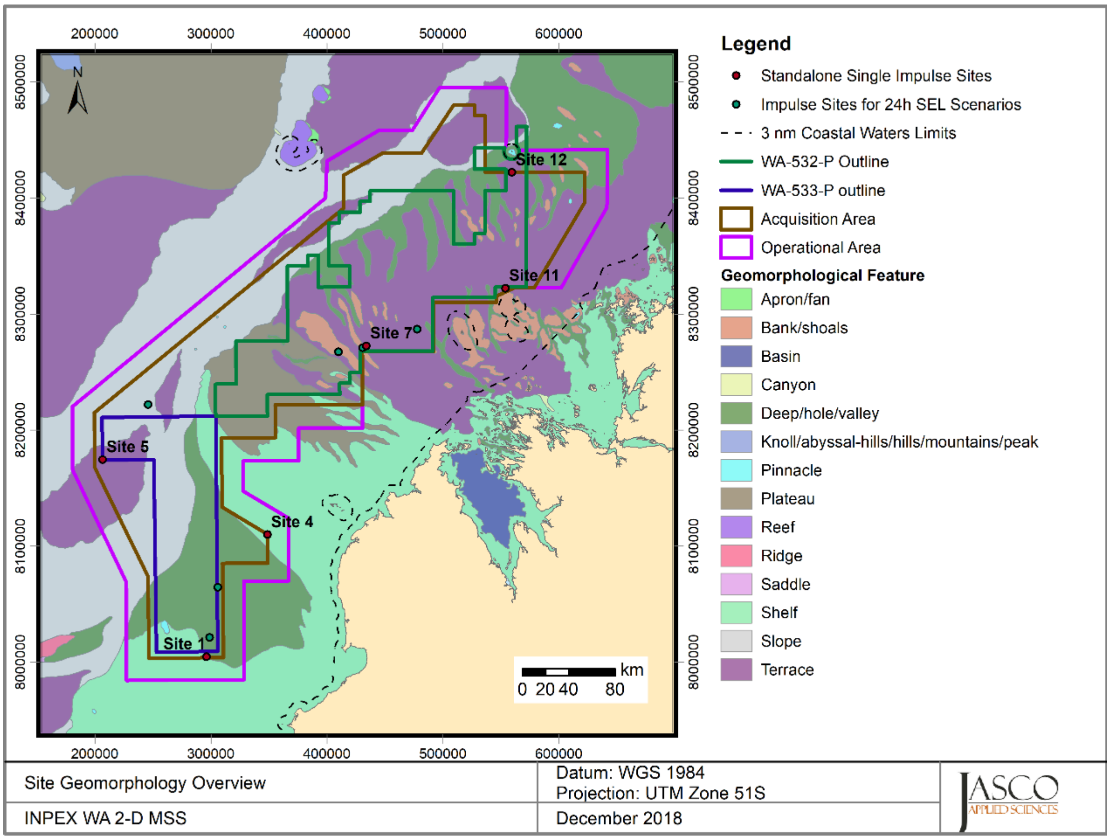


Figure D-4. The geomorphology of the study area.

Table D-1. Estimated geoacoustic profile for Sites 1–4, which represents a gravelly sand bottom. Within each depth range, each parameter varies linearly within the stated range. The compressional wave is the primary wave. The shear wave is the secondary wave.

Depth below seafloor (m)	Material	Density (g/cm³)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0–100.0		1.77–1.93	1646.0–1813.6	0.74–0.82		
100.0–200.0		1.93–2.07	1813.6–1973.6	0.82–0.89		
200.0–300.0	Increasingly consolidated carbonate sand	2.07–2.19	1973.6–2126.2	0.89–0.96	386.5	3.65
300.0–400.0		2.19–2.29	2126.2–2271.4	0.96–1.02		
400.0–500.0		2.29–2.38	2271.4–2409.0	1.02–1.08		

Table D-2. Estimated geoacoustic profile for Sites 5 and 6, which represents a muddy sand bottom. Within each depth range, each parameter varies linearly within the stated range. The compressional wave is the primary wave. The shear wave is the secondary wave.

Depth below seafloor (m)	Material	Density (g/cm^3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0–10	Muddy sand	2.04	1672	0.37	306	3.65
10–20		2.04	1788	0.76		
20–50		2.05	1850	0.94		
50–100		2.07	1968	1.22		
100–200		2.1	2094	1.45		
200–500		2.1	2243	1.73		
>500		2.1	2517	2.13		

Table D-3. Estimated geoacoustic profile for Sites 7–11, which represents a muddy sandy gravel bottom. Within each depth range, each parameter varies linearly within the stated range. The compressional wave is the primary wave. The shear wave is the secondary wave.

Depth below seafloor (m)	Material	Density (g/cm^3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0	Coarse sand	2.09	1827	0.65	350	3.65
10		2.09	2068	1.31		
20		2.09	2199	1.58		
50		2.09	2440	1.97		
100		2.09	2692	2.27		
200		2.09	3025	2.56		
500		2.09	3628	2.89		

Table D-4. Estimated geoacoustic profile for Site 12, which represents a gravelly muddy sand bottom. Within each depth range, each parameter varies linearly within the stated range. The compressional wave is the primary wave. The shear wave is the secondary wave.

Depth below seafloor (m)	Material	Density (g/cm^3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0	Medium sand	2.011	1733.5–1836	0.51–0.84	201.8	3.65
5		2.015	1836–1905.3	0.84–1.04		
10		2.018	1905.3–1998.1	1.04–1.26		
20		2.025	1998.1–2172.6	1.26–1.6		
50		2.047	2172.6–2359.1	1.60–1.86		
100		2.080	2359.1–2594.1	1.86–2.15		
200		2.097	2594.1–3010.2	2.15–2.54		
500		2.097	3010.2	2.54		

D.4. Seismic Sources

The layouts of the seismic sources considered in Appendix B are provided in Figures D-5 to D-8.

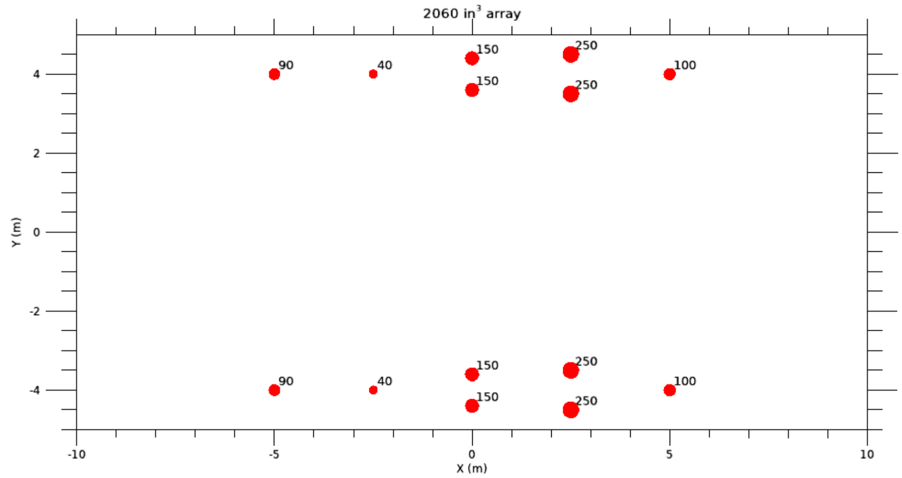


Figure D-5. Layout of the modelled 2060 in^3 seismic source array. Tow depth is 7 m. The labels indicate the firing volume (in cubic inches) for each airgun. Also see Table D-8.

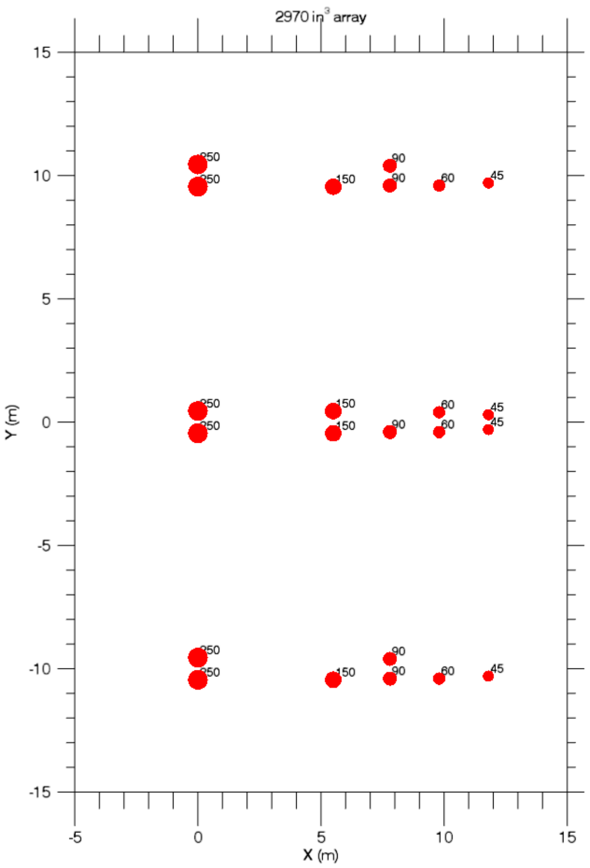


Figure D-6. Layout of the modelled 2970 in^3 seismic source array. Tow depth is 7 m. The labels indicate the firing volume (in cubic inches) for each airgun. Also see Table D-7.

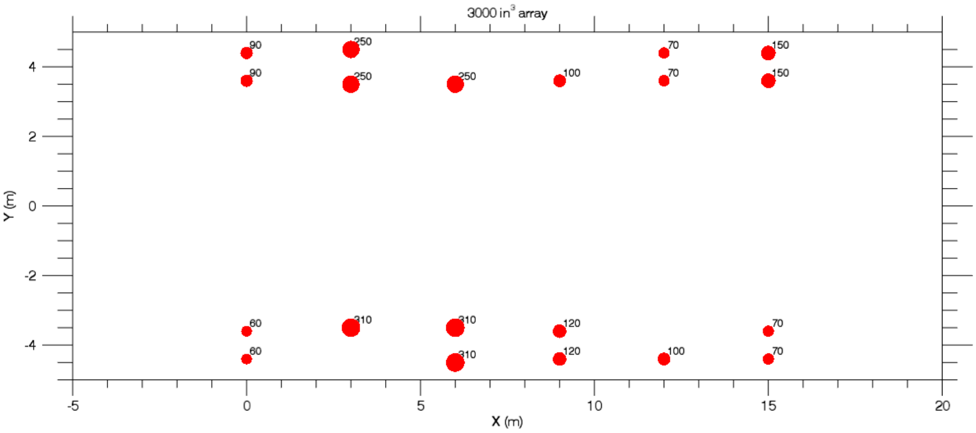


Figure D-7. Layout of the modelled 3000 in^3 seismic source array. Tow depth is 6 m. The labels indicate the firing volume (in cubic inches) for each airgun. Also see Table D-6.

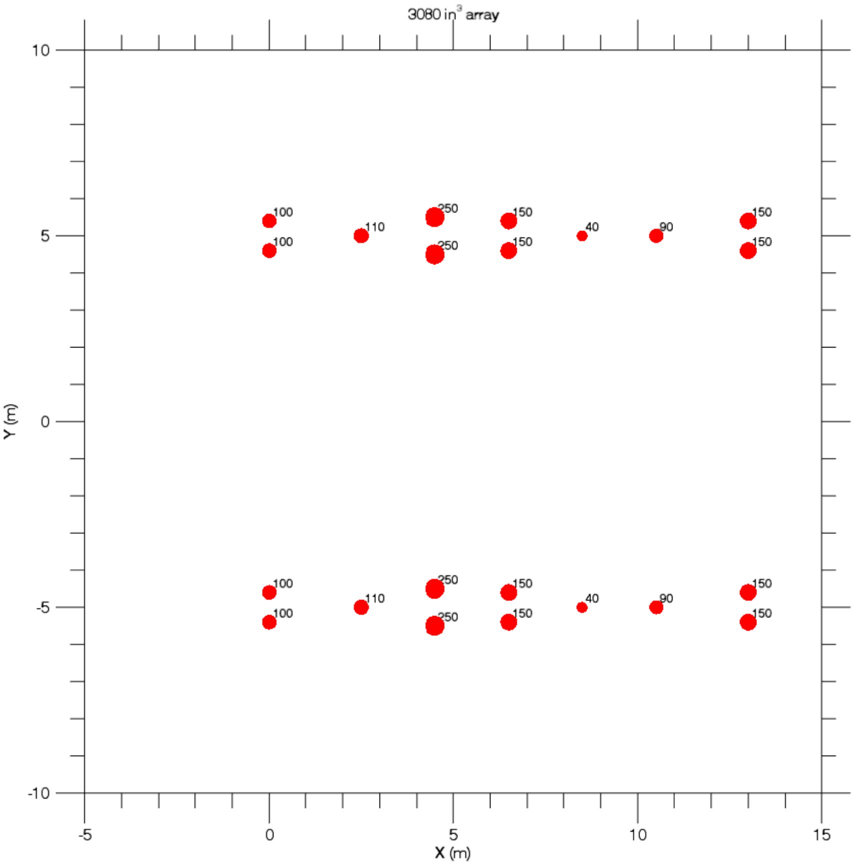


Figure D-8. Layout of the modelled 3080 in^3 seismic source array. Tow depth is 7 m. The labels indicate the firing volume (in cubic inches) for each airgun. Also see Table D-5.

Table D-5. Layout of the modelled 3080 in^3 seismic source array. Tow depth is 7 m. Firing pressure for all guns is 2000 psi. Also see Figure D-8.

Gun	x (m)	y (m)	z (m)	Volume (in^3)	Gun	x (m)	y (m)	z (m)	Volume (in^3)
1	0	5.4	7	100	12	0	−4.6	7	100
2	0	4.6	7	100	13	0	−5.4	7	100
3	2.5	5	7	110	14	2.5	−5	7	110
4	4.5	5.5	7	250	15	4.5	−4.5	7	250
5	4.5	4.5	7	250	16	4.5	−5.5	7	250
6	6.5	5.4	7	150	17	6.5	−4.6	7	150
7	6.5	4.6	7	150	18	6.5	−5.4	7	150
8	8.5	5	7	40	19	8.5	−5	7	40
9	10.5	5	7	90	20	10.5	−5	7	90
10	13	5.4	7	150	21	13	−4.6	7	150
11	13	4.6	7	150	22	13	−5.4	7	150

Table D-6. Layout of the modelled 3000 in^3 seismic source array. Tow depth is 6 m. Firing pressure for all guns is 2000 psi. Also see Figure D-7.

Gun	x (m)	y (m)	z (m)	Volume (in^3)	Gun	x (m)	y (m)	z (m)	Volume (in^3)
1	0	4.4	6	90	11	0	−3.6	6	60
2	0	3.6	6	90	12	0	−4.4	6	60
3	3	4.5	6	250	13	3	−3.5	6	310
4	3	3.5	6	250	14	6	−3.5	6	310
5	6	3.5	6	250	15	6	−4.5	6	310
6	9	3.6	6	100	16	9	−3.6	6	120
7	12	4.4	6	70	17	9	−4.4	6	120
8	12	3.6	6	70	18	12	−4.4	6	100
9	15	4.4	6	150	19	15	−3.6	6	70
10	15	3.6	6	150	20	15	−4.4	6	70

Table D-7. Layout of the modelled 2970 in^3 seismic source array. Tow depth is 7 m. Firing pressure for all guns is 2000 psi. Also see Figure D-6.

Gun	x (m)	y (m)	z (m)	Volume (in^3)	Gun	x (m)	y (m)	z (m)	Volume (in^3)
1	0	10.45	7	250	13	9.8	0.4	7	60
2	0	9.55	7	250	14	9.8	−0.4	7	60
3	5.5	9.55	7	150	15	11.8	0.3	7	45
4	7.8	10.4	7	90	16	11.8	−0.3	7	45
5	7.8	9.6	7	90	17	0	−9.55	7	250
6	9.8	9.6	7	60	18	0	−10.45	7	250
7	11.8	9.7	7	45	19	5.5	−10.45	7	150
8	0	0.45	7	250	20	7.8	−9.6	7	90
9	0	−0.45	7	250	21	7.8	−10.4	7	90
10	5.5	0.45	7	150	22	9.8	−10.4	7	60
11	5.5	−0.45	7	150	23	11.8	−10.3	7	45
12	7.8	−0.4	7	90					

Table D-8. Layout of the modelled 2060 in^3 seismic source array. Tow depth is 7 m. Firing pressure for all guns is 2000 psi. Also see Figure D-5.

Gun	x (m)	y (m)	z (m)	Volume (in^3)
1	5	-4	7	100
2	2.5	-4.5	7	250
3	2.5	-3.5	7	250
4	0	-4.4	7	150
5	0	-3.6	7	150
6	-2.5	-4	7	40
7	-5	-4	7	90
8	5	4	7	100
9	2.5	3.5	7	250
10	2.5	4.5	7	250
11	0	3.6	7	150
12	0	4.4	7	150
13	-2.5	4	7	40
14	-5	4	7	90

D.5. Model Validation Information

Predictions from JASCO's Airgun Array Source Model (AASM) and propagation models (MONM, FWRAM and VSTACK) have been validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally, including the United States and Canadian Artic, Canadian and southern United States waters, Greenland, Russia and Australia

(Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Matthews and MacGillivray 2013, Martin et al. 2015, Racca et al. 2015, Martin et al. 2017a, Martin et al. 2017b, Warner et al. 2017, MacGillivray 2018, McPherson et al. 2018, McPherson and Martin 2018).

In addition, JASCO has conducted measurement programs associated with a significant number of anthropogenic activities which have included internal validation of the modelling (including McCrodan et al. 2011, Austin and Warner 2012, McPherson and Warner 2012, Austin and Bailey 2013, Austin et al. 2013, Zykov and MacDonnell 2013, Austin 2014, Austin et al. 2015, Austin and Li 2016, Martin and Popper 2016) .

Appendix E. Results

E.1. Additional Per-Pulse Sound Field Maps

Supplementary maps for Section 5.2.2.1, maps for six modelling sites included in the accumulated SEL scenarios, Figures E-1 to E-12.

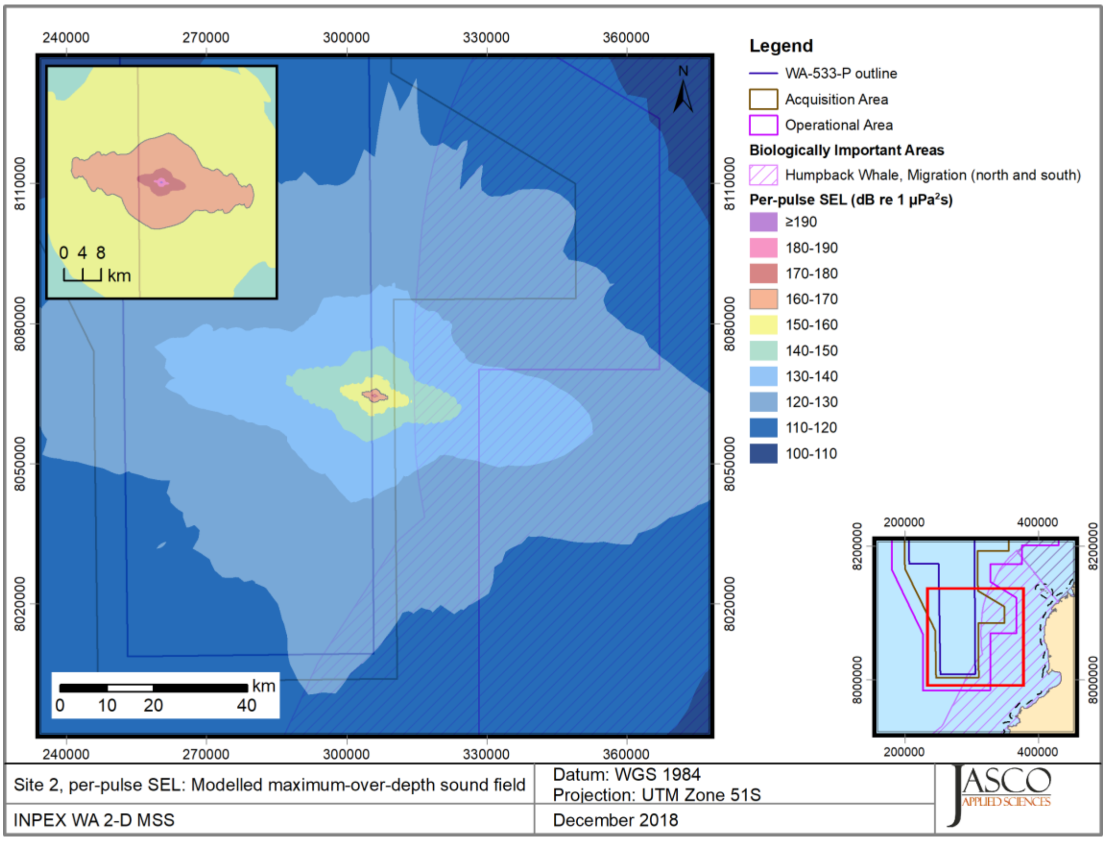


Figure E-1. *Site 2 (WA-533-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

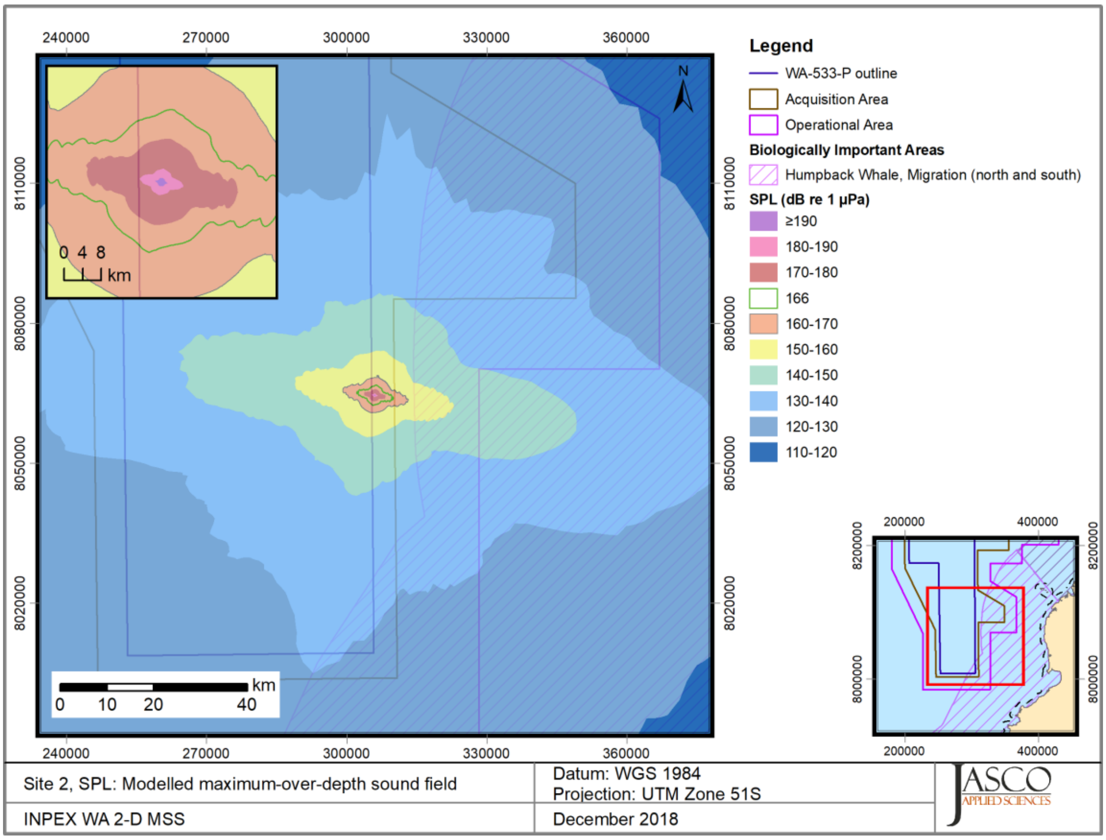


Figure E-2. *Site 2 (WA-533-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

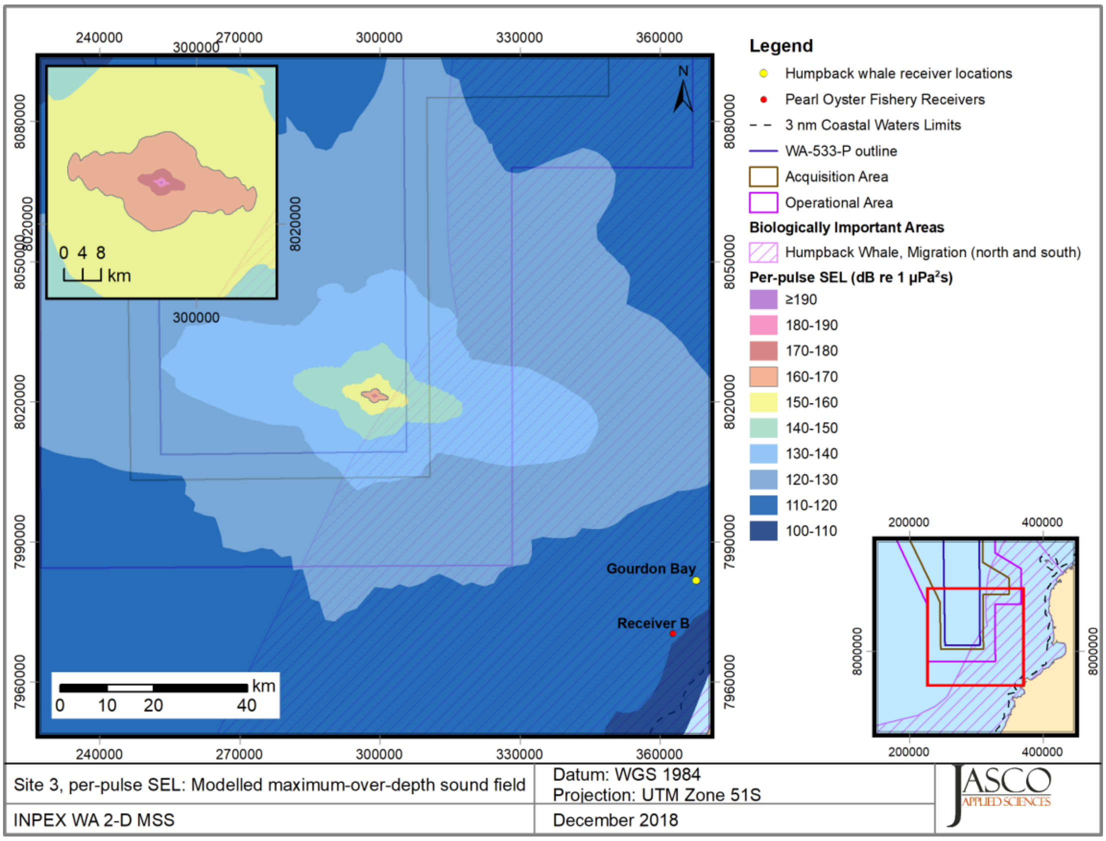


Figure E-3. *Site 3 (WA-533-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

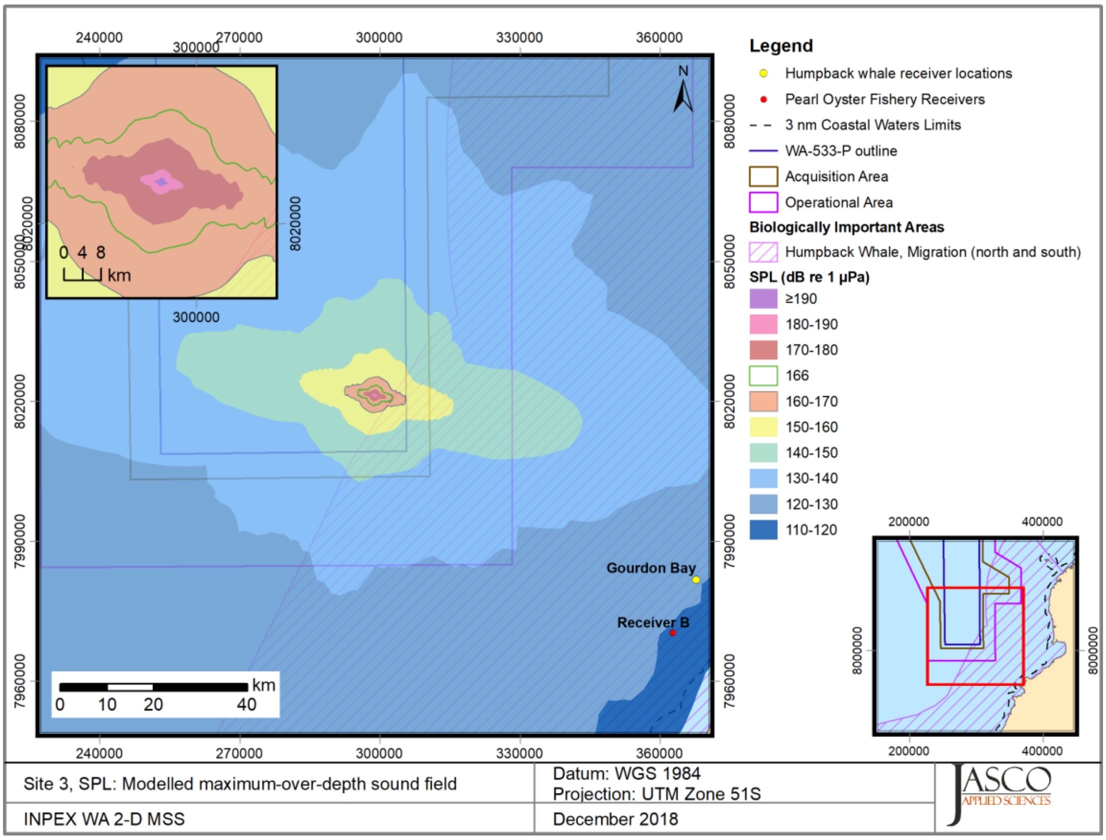


Figure E-4. *Site 3 (WA-533-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

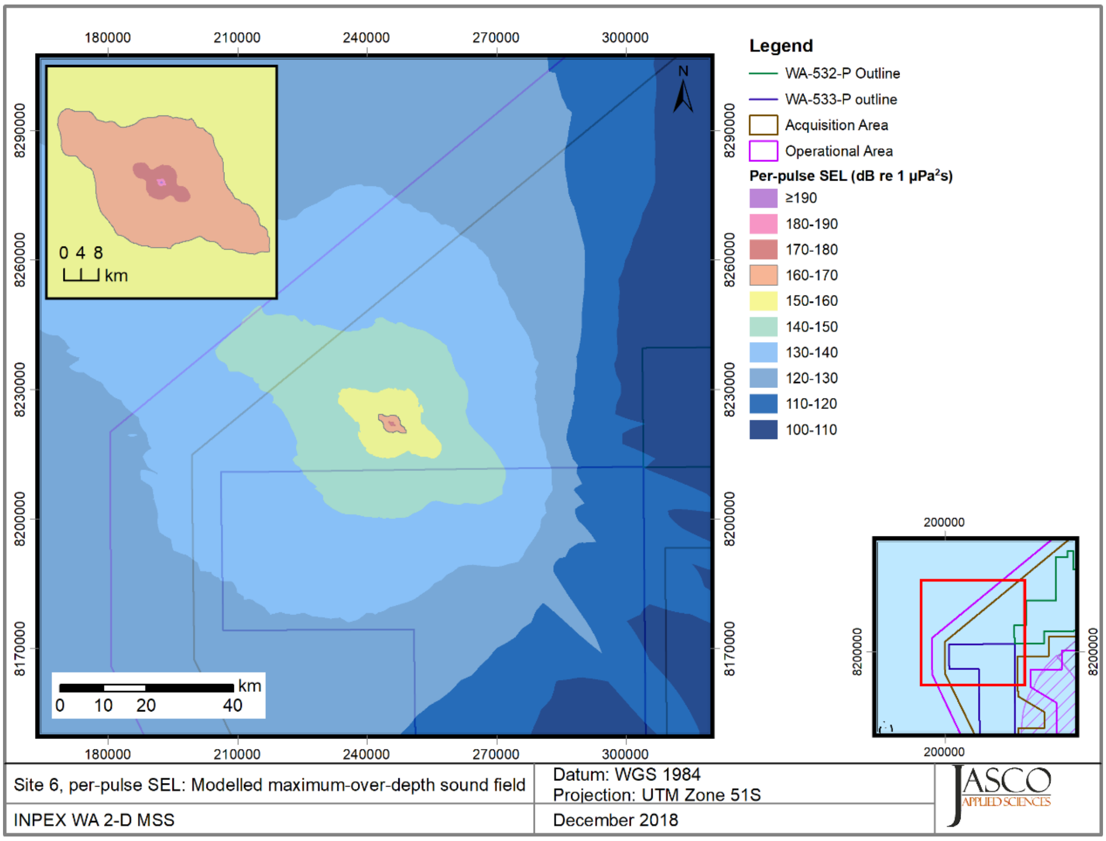


Figure E-5. *Site 6, per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

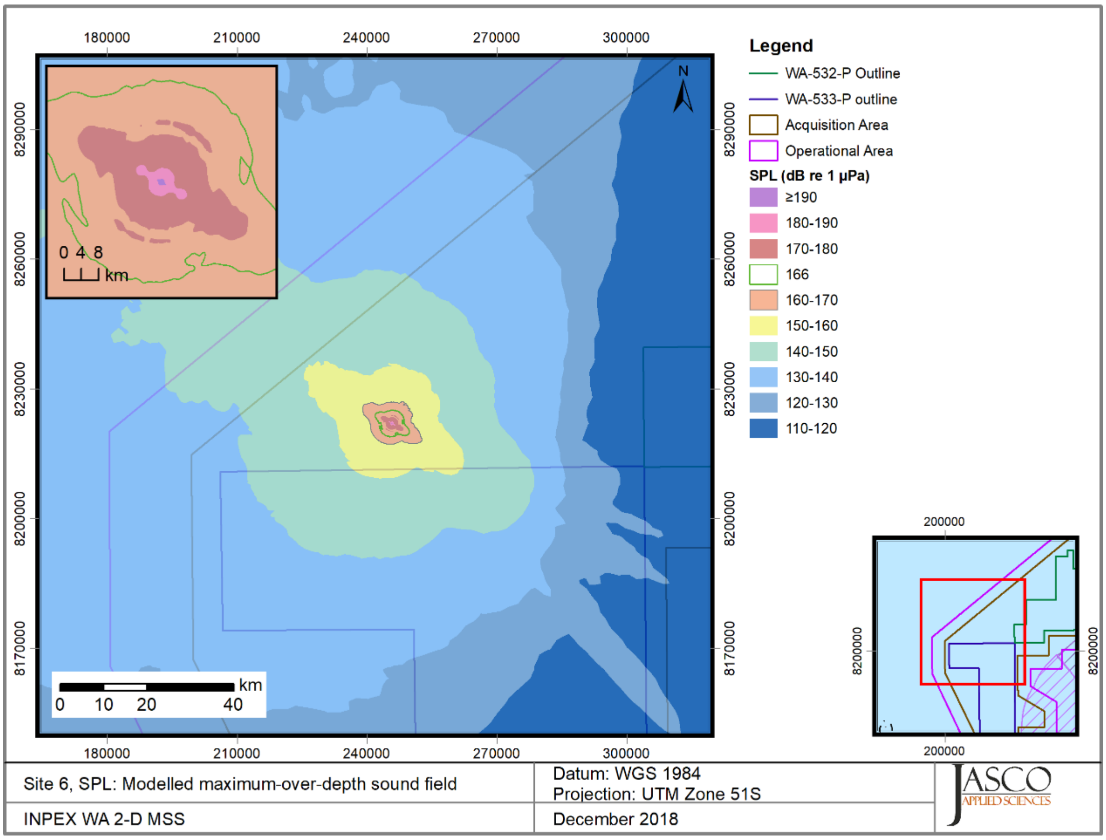


Figure E-6. *Site 6, SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

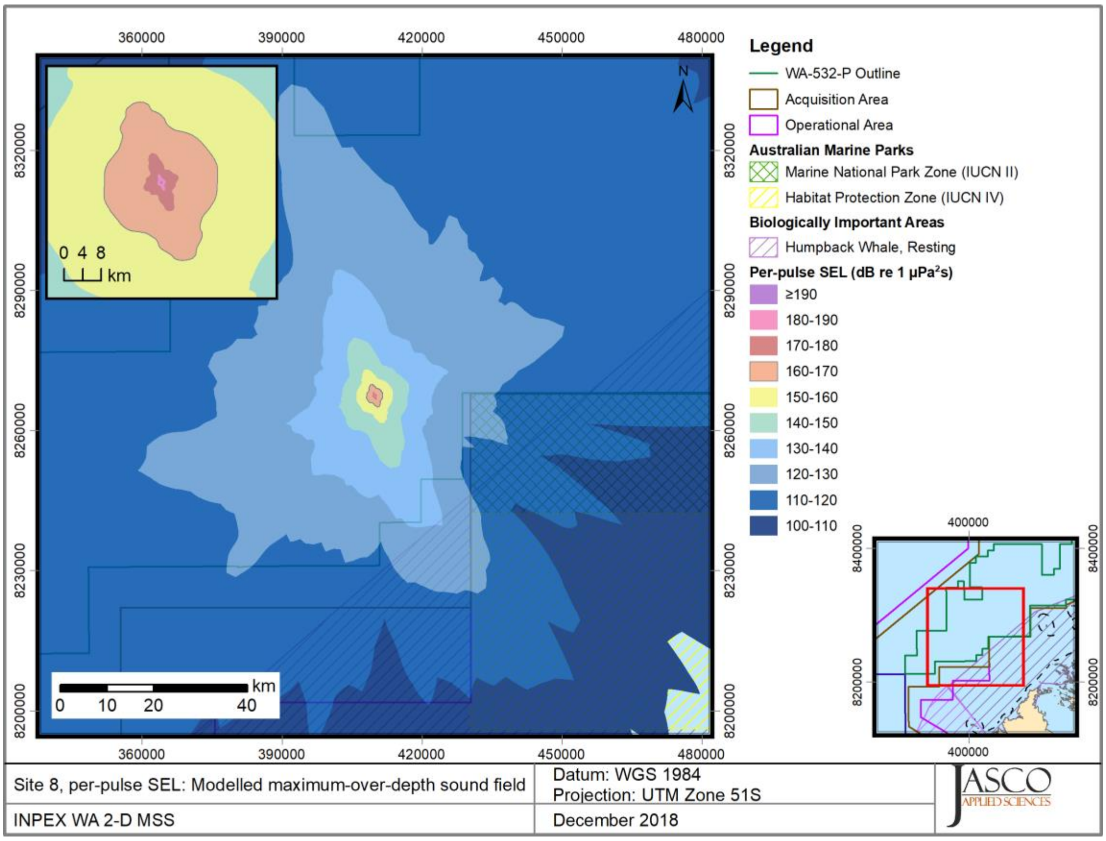


Figure E-7. *Site 8 (WA-532-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

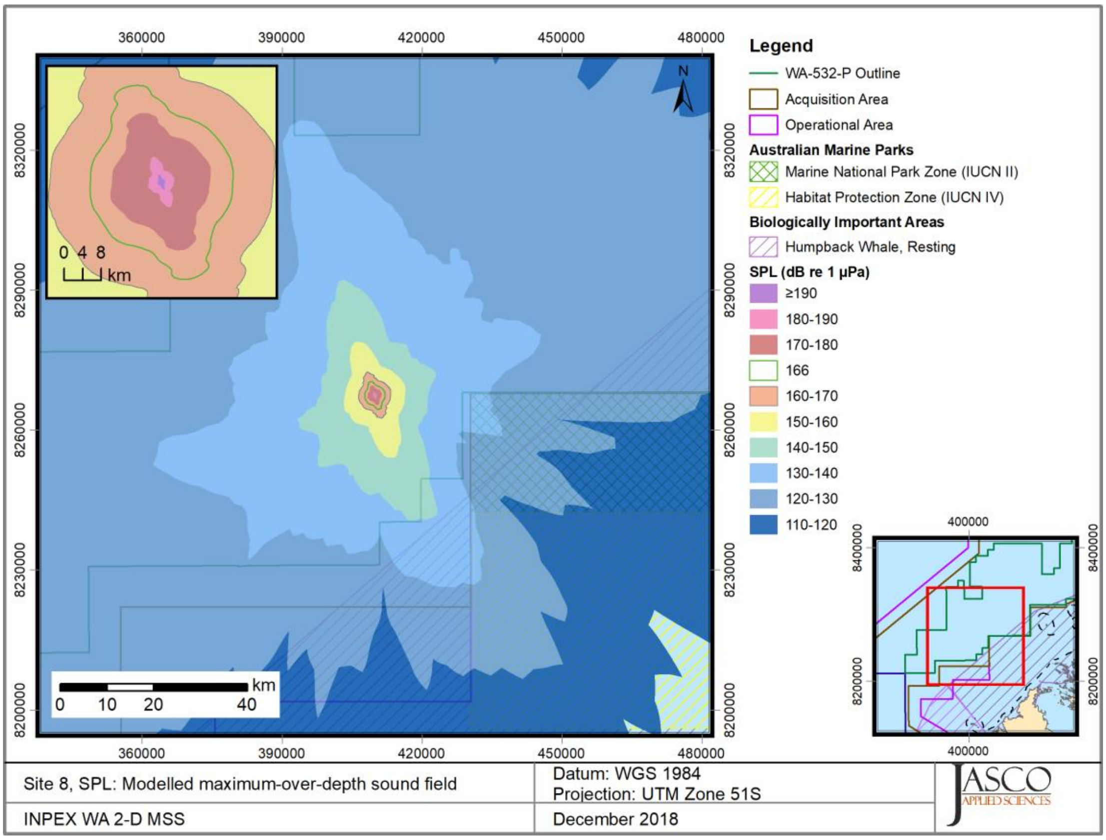


Figure E-8. *Site 8 (WA-532-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

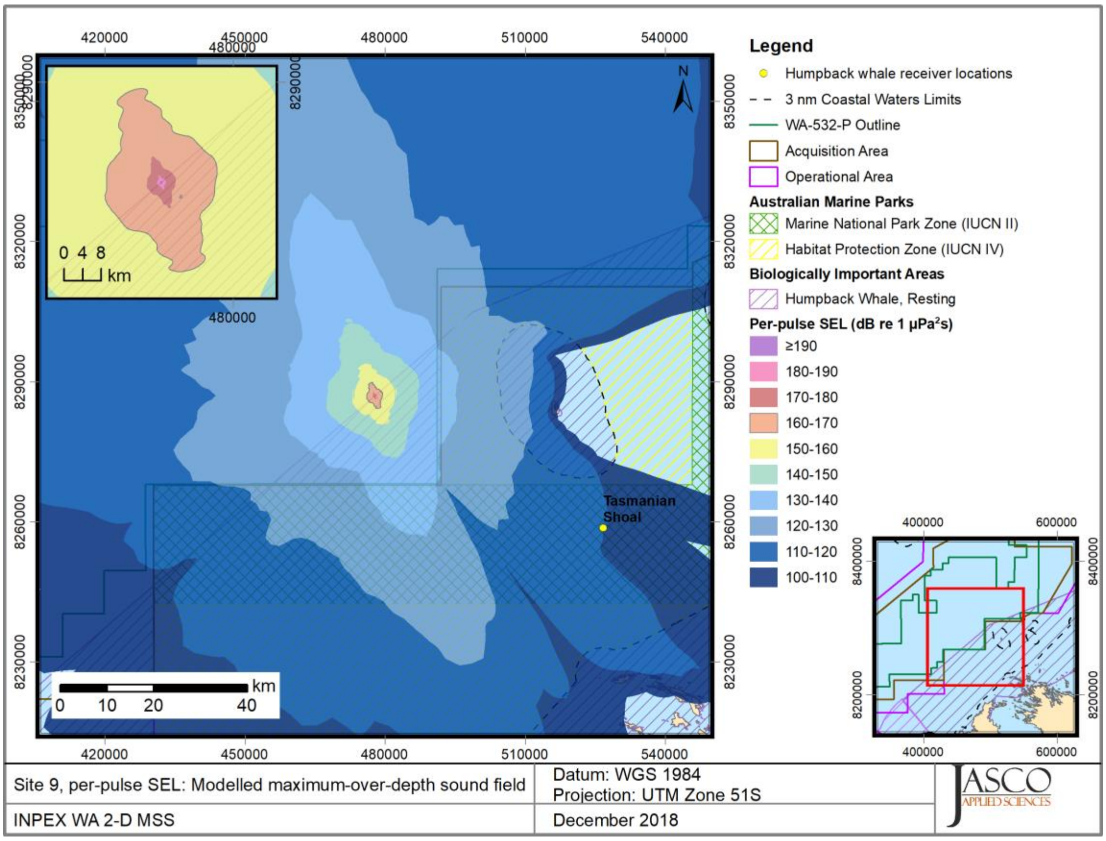


Figure E-9. *Site 9 (WA-532-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

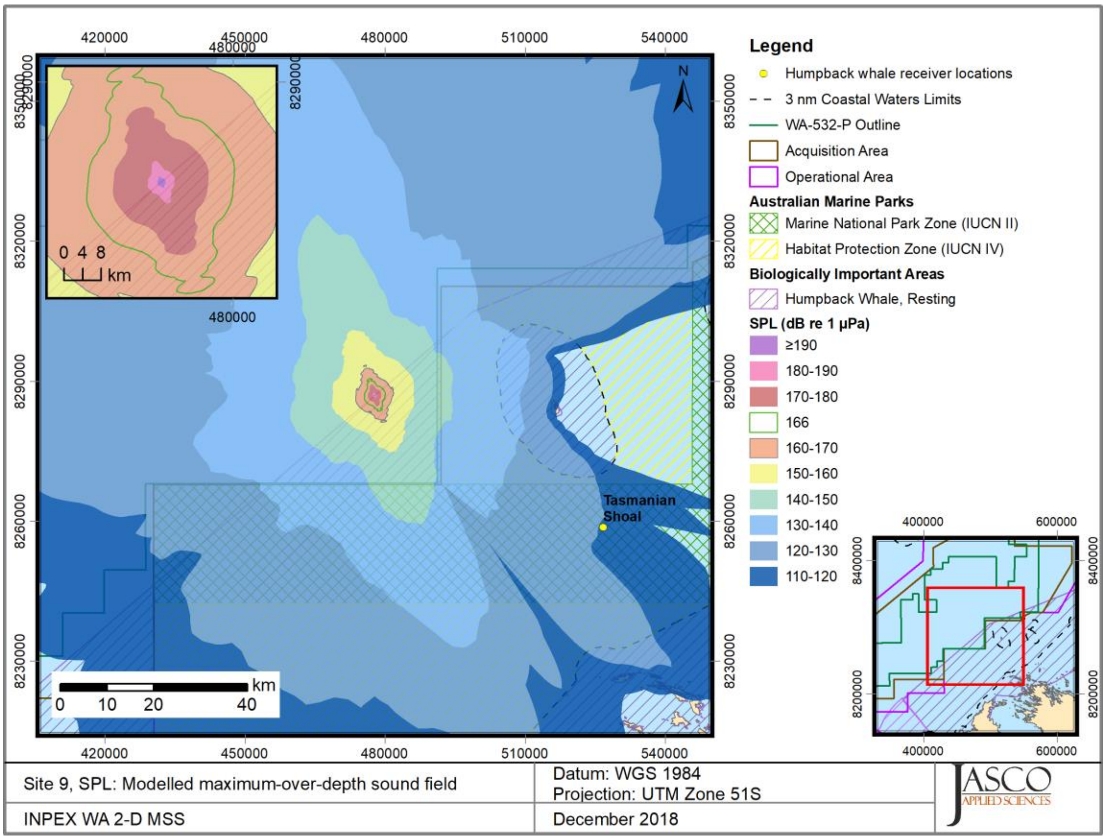


Figure E-10. *Site 9 (WA-532-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

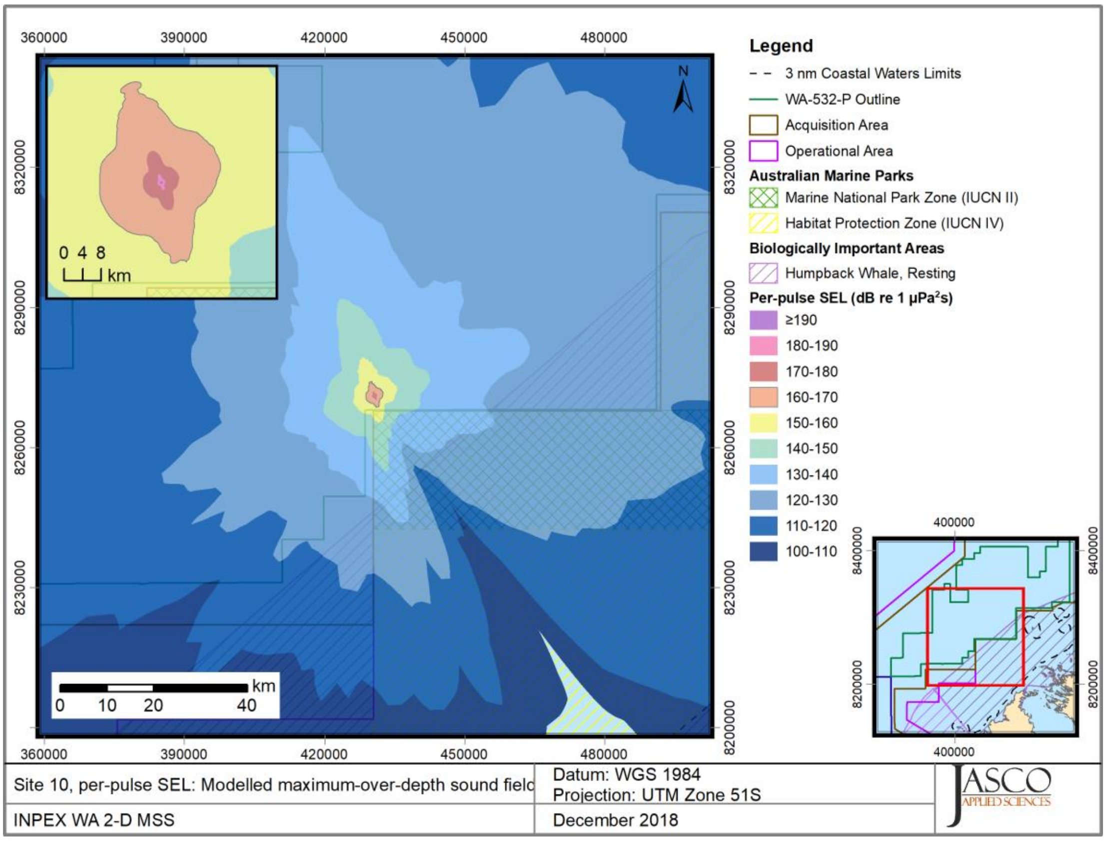


Figure E-11. *Site 10 (WA-532-P), per-pulse SEL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

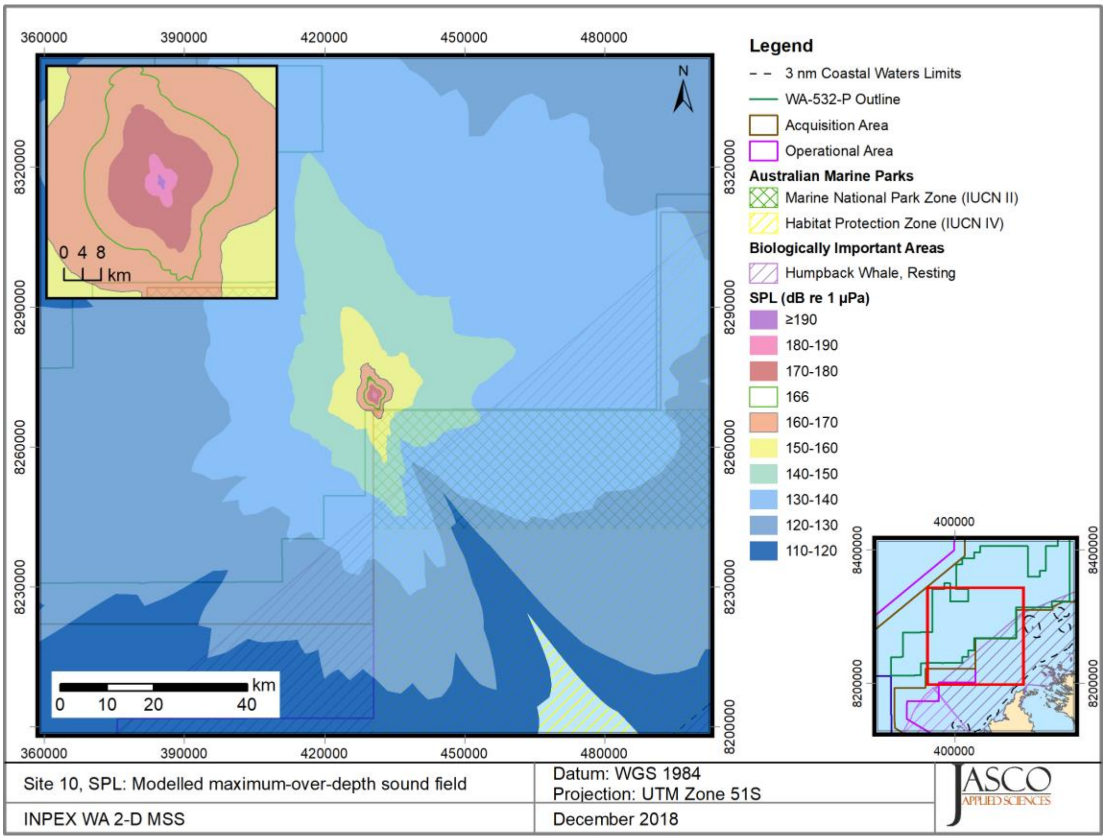


Figure E-12. *Site 10 (WA-532-P), SPL*: Sound level contour map showing unweighted maximum-over-depth results for the 3080 in^3 array.

E.2. SPL Vertical Slice Plots

Supplementary maps for Section 5.2.2.2, vertical slices of the SPL sound fields, Figures E-13 to E-18.

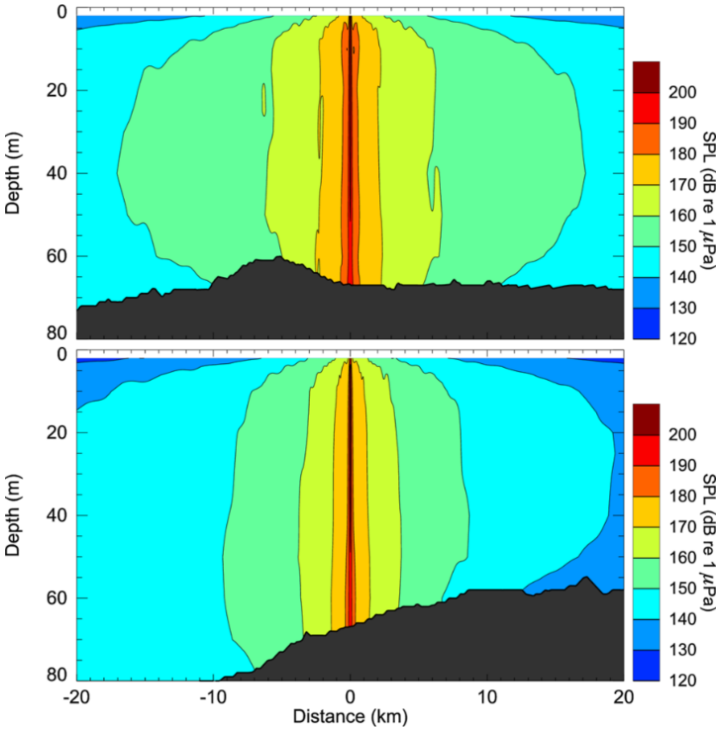


Figure E-13. *Site 1 (WA-533-P), SPL*: Vertical slice of the predicted SPL for the 3080 in^3 array. Levels are shown along the broadside (top) and endfire (bottom) directions.

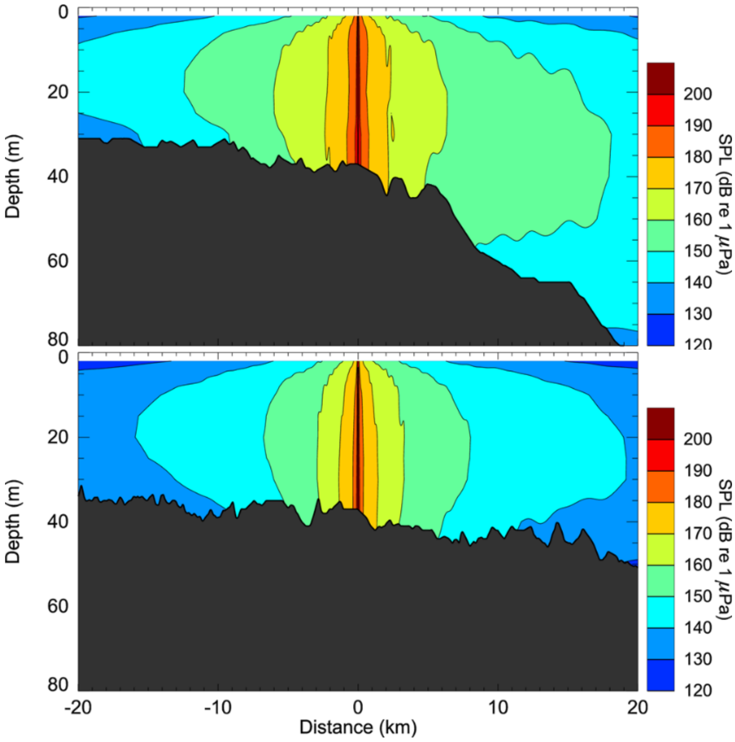


Figure E-14. *Site 4 (WA-533-P), SPL*: Vertical slice of the predicted SPL for the 3080 in^3 array. Levels are shown along the broadside (top) and endfire (bottom) directions.

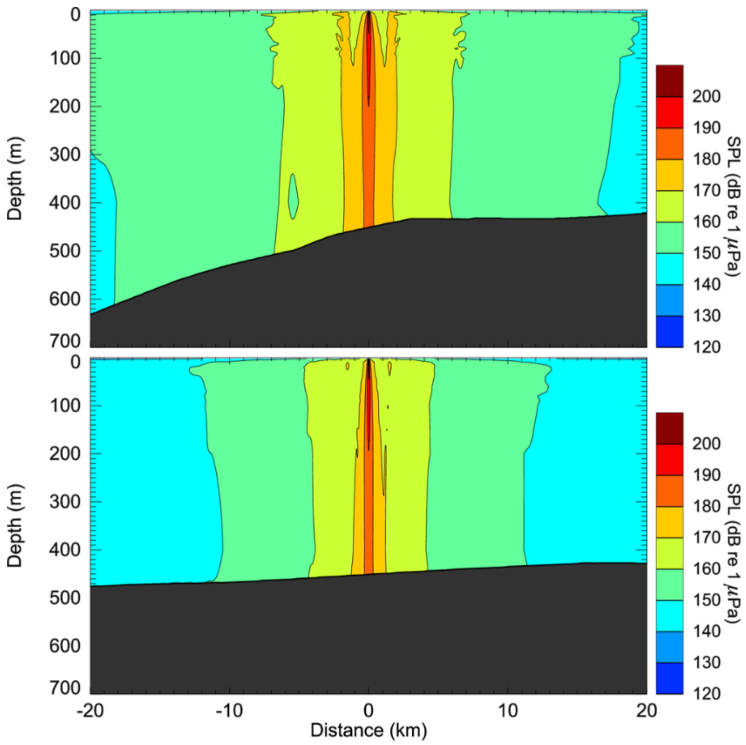


Figure E-15. *Site 5 (WA-533-P), SPL*: Vertical slice of the predicted SPL for the 3080 in^3 array. Levels are shown along the broadside (top) and endfire (bottom) directions.

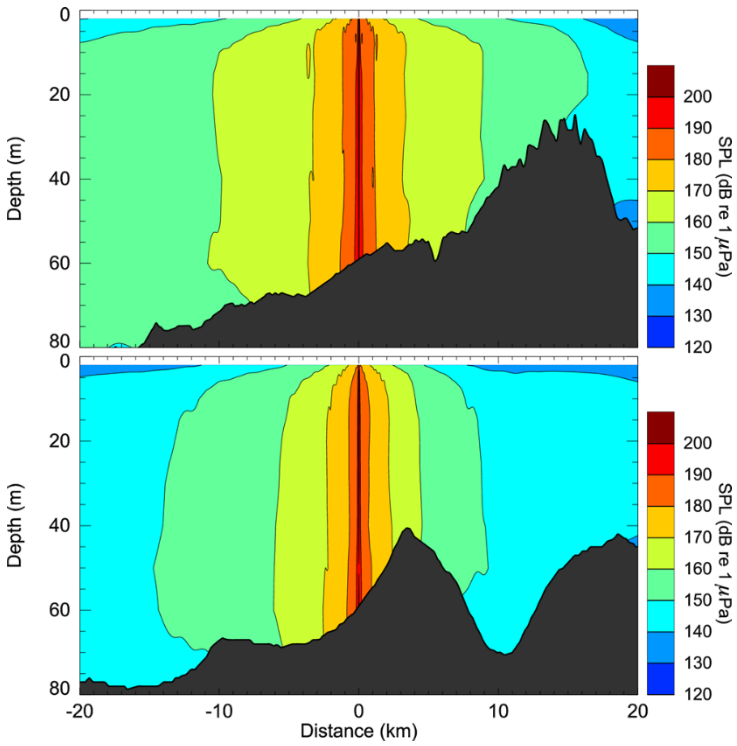


Figure E-16. *Site 7 (WA-532-P), SPL*: Vertical slice of the predicted SPL for the 3080 in^3 array. Levels are shown along the broadside (top) and endfire (bottom) directions.

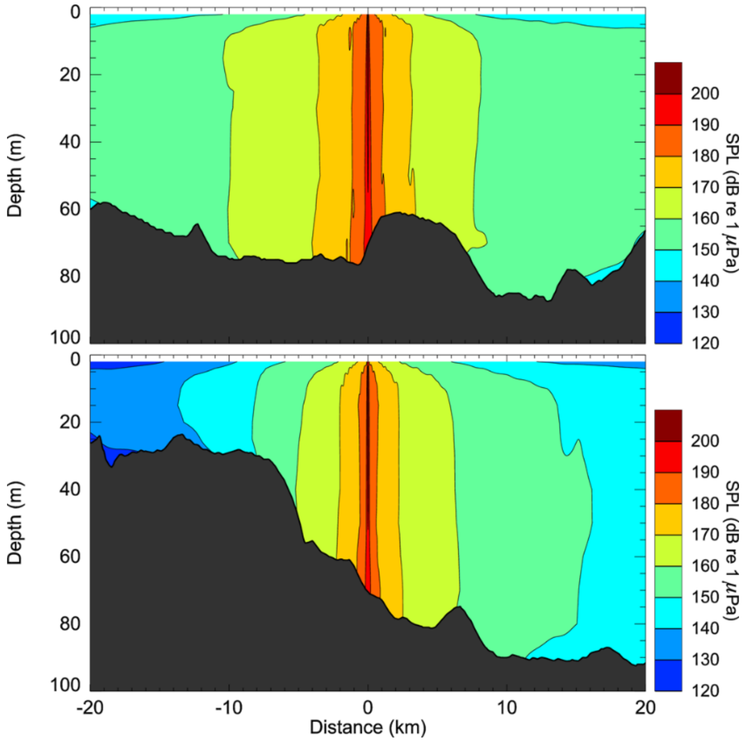


Figure E-17. *Site 11 (WA-532-P), SPL*: Vertical slice of the predicted SPL for the 3080 in^3 array. Levels are shown along the broadside (top) and endfire (bottom) directions.

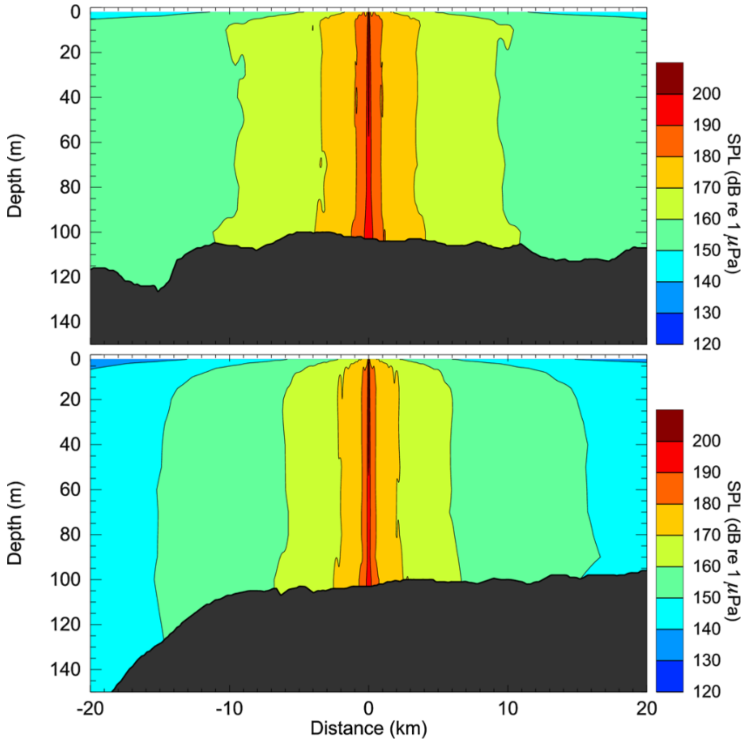


Figure E-18. *Site 12 (WA-532-P), SPL*: Vertical slice of the predicted SPL for the 3080 in^3 array. Levels are shown along the broadside (top) and endfire (bottom) directions.

Appendix E-
Pygmy blue whale exposure assessment (JASCO)

INPEX WA 2-D Marine Seismic Survey

Pygmy Blue Whale Exposure Modelling

Submitted to:

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Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

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Executive Summary

JASCO Applied Sciences performed an acoustic exposure analysis study for pygmy blue whales in the vicinity of the Biologically Important Area for migration where it intersected the planned survey operations for the INPEX WA 2-D Marine Seismic Survey (MSS). Previously, acoustic modelling was conducted for this survey to determine ranges to acoustic exposure thresholds representing the best available science for potential injury and behavioural disruption of marine fauna including marine mammals, turtles and fish (McPherson et al. 2018).

The aim of this study was to employ animal movement (animat) modelling simulations in conjunction with these previously computed three-dimensional sound fields to predict the range at which animals be impacted above threshold criteria for injury and behavioural disturbance. To achieve this, the JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was used to integrate the sound fields with species-typical behaviour. JASMINE results provide an estimate of the probability of sound exposure, which can be compared to acoustic thresholds and then scaled to estimate the number of animals expected to receive sound levels that may cause injury or behavioural disruption.

The behaviour of pygmy blue whales was modelled without migration bias, i.e. the animats were resident in the animat modelling area over the entire modelling period. The two migratory behaviours (migratory dives and exploratory dives) were modelled at an even probability of occurrence. Both of these approaches were chosen to present conservative results due to the limited data available.

Simulations were run for a representative period of 5.2 days, then scaled down to 24 h for easier comparison with ranges to acoustic exposure thresholds. Animat modelling focussed on migrating pygmy blue whales in the migration Biologically Important Area (BIA). Using the distribution of ranges of animats exposed above threshold, the exposure range ($ER_{95\%}$) was computed for comparison with previous range to threshold estimates.

The results of the animat analysis predicted that the $ER_{95\%}$ of migrating pygmy blue whales potentially exposed to sound levels above the NMFS (2018) permanent and temporary threshold shift (PTS and TTS) criteria were 0.20 km and 23.34 km, respectively. $ER_{95\%}$ for exposures above the NMFS (2014) behavioural threshold was 5.74 km.

The estimated 95th percentile ranges for all scenarios were lower than comparable ranges to threshold reported in McPherson et al. (2018). This was expected since previous modelling efforts did not incorporate both moving sources and moving receivers, but rather assumed that, as per the NMFS (2018) criteria, SEL_{24h} is a cumulative metric that reflects the dosimetric impact of noise levels within 24 hours considering that an animal is consistently exposed to such noise levels at a fixed position.

1. Introduction

JASCO Applied Sciences (JASCO) performed an acoustic exposure analysis study for pygmy blue whales (*Balaenoptera musculus brevicauda*) for the planned INPEX WA 2-D Marine Seismic Survey (MSS). Of the surveys described in McPherson et al. (2018), only the northwest portion of the WA-533-P area overlaps with the pygmy blue whale migratory Biologically Important Area.

This report describes the modelled predictions of sound levels that individual migrating pygmy blue whales may receive during survey operations. Sound exposure distribution estimates are determined by moving large numbers of simulated animals (animats) through a modelled time-evolving sound field, computed using specialised sound source and sound propagation models. This approach provides the most realistic prediction of the maximum expected root-mean-square sound pressure level (SPL, L_p) and peak pressure level (PK, L_{pk}), and the temporal accumulation of sound exposure level (SEL, L_E) that are now considered the most relevant sound metrics for impact assessment. The most recent science in the peer-reviewed literature regarding sound propagation and animal movement modelling was used.

Sound level exposure estimates were calculated by comparing pre-determined exposure threshold criteria with computed sound fields generated by the sound source associated with the seismic operation, which were then sampled using computational models of animal movement. A detailed sound modelling study has been conducted previously in McPherson et al. (2018); the results have been used in this acoustic exposure analysis.

2. Exposure Modelling Scenario

For the planned 2-D MSS, source and propagation modelling were conducted to generate 3D sound fields which are used in conjunction with animal movement modelling. The exposure modelling scenario considered a total of 5.2 days of survey tracks. Lines were spaced at 4.8 km and oriented at 31°/211°. The animal movement modelling simulation area was designed to extend to approximately 80km beyond the area of overlap between the pygmy blue whale migratory BIA and the survey area in order to encompass the largest possible ranges to sound exposure thresholds. Simulated animats are seeded only with the BIA to best represent the true spatial distribution of this species. Exposure modelling simulation extents and animat seeding area are shown in Figure 1.

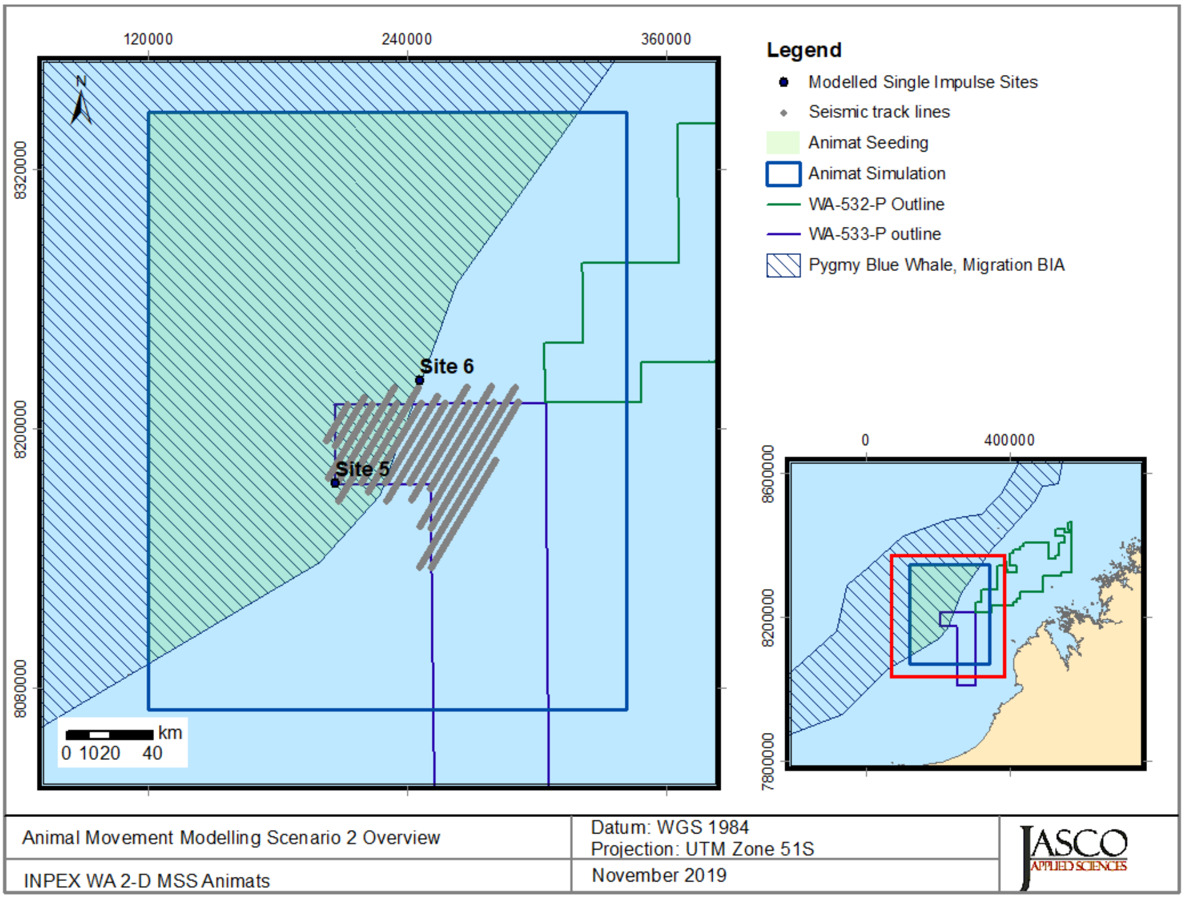

Figure 1. Animat modelling extent, seeded area, and modelled source tracks.

3. Noise Effect Criteria

The noise effect criteria which were considered for pygmy blue whales in the acoustic modelling (McPherson et al. 2018) are summarised in this section to provide context for exposure modelling results.

The sound level metrics of PK, SPL, and SEL, were considered, and the acoustic metrics in this report reflect the updated ISO standard for acoustic terminology, ISO/DIS 18405.2:2017 (2017), more detail is provided in Appendix A.

The noise criteria considered are those suggested by the best available science:

1. Peak pressure levels (PK; L_{pk}) and frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from the U.S. National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS 2018) for the onset of Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) in marine mammals (Table 1).
2. Marine mammal behavioural threshold based on the current interim U.S. National Marine Fisheries Service (NMFS) (2014) of 160 dB re 1 µPa SPL (L_p) for impulsive sound sources (Table 1).

Table 1. Unweighted SPL, SEL_{24h}, and PK thresholds for acoustic effects on marine mammals.

Hearing group	NMFS (2014)	NMFS (2018)			
	Behaviour	PTS onset thresholds* (received level)		TTS onset thresholds* (received level)	
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency cetaceans	160	183	219	168	213
Mid-frequency cetaceans		185	230	170	224
High-frequency cetaceans		155	202	140	196

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.
L_p denotes sound pressure level period and has a reference value of 1 µPa.
L_{pk}, flat–peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa.
L_E denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa^{2}s.
Subscripts indicate the designated marine mammal auditory weighting.

4. Methods

4.1. Acoustic Modelling

A summary of the acoustic modelling presented in McPherson et al. (2018) is included to provide context for the acoustic exposure assessment.

4.1.1. Acoustic Source Model

The pressure signatures of the individual airguns and the composite 1/3-octave-band point-source equivalent directional levels (i.e., source levels) of two seismic sources (3150 and 2650 in^3) were modelled with JASCO's Airgun Array Source Model (AASM).

AASM considers:

- Array layout.
- Volume, tow depth, and firing pressure of each airgun.
- Interactions between different airguns in the array.

The array was modelled over AASM's full frequency range, up to 25 kHz.

4.1.2. Sound Propagation Models

Two sound propagation models were used to predict the acoustic field around the seismic source:

- Combined range-dependent parabolic equation and Gaussian beam acoustic ray-trace model (MONM-BELLHOP, 10 Hz to 25 kHz).
- Full Waveform Range-dependent Acoustic Model (FWRAM, 5 Hz to 1000 Hz).

The models were used in combination to characterise the acoustic fields in terms of SEL, SPL, PK, and PK-PK. MONM-BELLHOP was used to calculate 3D SEL fields as a function of range and depth relative to the source. The 3D SPL fields were computed by applying an SEL to SPL conversion factor to the SEL sound fields. The conversion factor was obtained using FWRAM, which is substantially more computationally expensive than MONM-BELLHOP, but retains the full phase and amplitude information needed to estimate SPL or PK. Since ranges to relevant PTS and TTS PK thresholds were found to be ≤ 60 m and therefore well within the acoustic near-field of the seismic arrays, acoustic sound fields were not generated for this metric at full azimuthal resolution.

4.1.3. Parameter Overview

The specifications of the seismic source and the environmental parameters used in the propagation models are described in detail in McPherson et al. (2018). The following seismic source was considered:

- A 3080 in^3 seismic source array consisting of 2 strings towed at a 7 m depth, with a nominal firing pressure of 2000 psi

The sound speed profile considered were extracted based on the seasonal period that would provide the greatest propagation during the proposed timeframe of the survey. Geological profiles consistent with associated water depths were also used.

4.2. Animal Movement and Exposure Modelling

The JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was used to predict the exposure of animats (virtual marine mammals) to sound arising from the seismic surveys. Sound exposure models like JASMINE integrate the predicted sound field with biologically meaningful movement rules for each marine mammal species (here: pygmy blue whales) that result in an exposure history for each animat in the model. Inside JASMINE, the sound source, which can be stationary or moving (Figure 2), mimics the proposed seismic survey patterns. As shown in Figure 2, animats are programmed to behave like the marine animals that may be present in the area. The parameters used for forecasting realistic behaviours (e.g., diving, foraging, aversion, surface times) are determined and interpreted from marine mammal studies (e.g., tagging studies) where available, or reasonably extrapolated from related species. An individual animat's sound exposure levels are summed over a specified duration, such as 24 hours or the entire simulation, to determine its total received energy, and then compared to the threshold criteria (for detailed information on JASMINE see Appendix A).

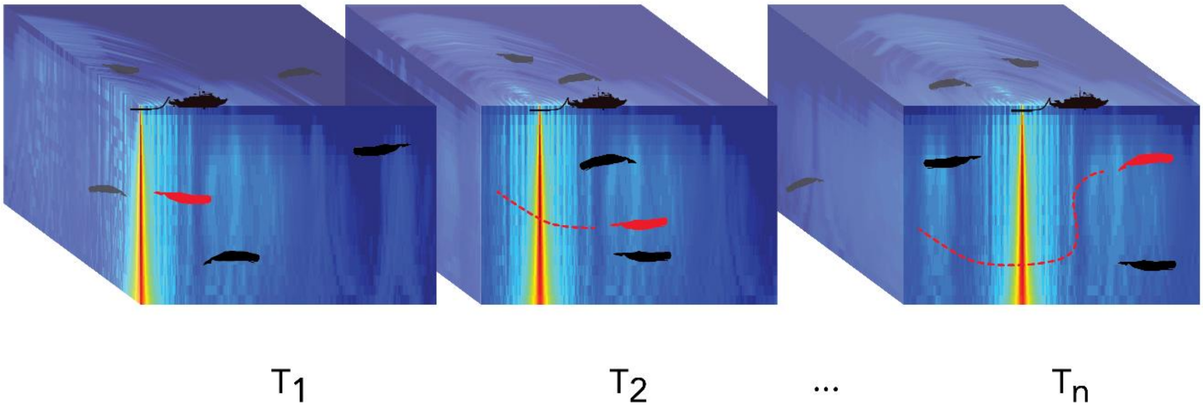

Figure 2. Cartoon of animats in a moving sound field. Example animat (red) shown moving with each time step (T_x). The acoustic exposure of each animat is determined by where it is in the sound field, and its exposure history is accumulated as the simulation steps through time.

4.2.1. Methodology

The exposure criteria for impulsive sounds (described in Section 3) were used to determine the number of animats exceeding thresholds. Model simulations were run with animat densities of 1.0 animats/km^2. To evaluate potential injury (PTS), TTS, and behavioural disturbance, exposure results were obtained using detailed behavioural information for pygmy blue whales described in Section 4.2.2 and summarised in Appendix B. The simulation was run for a representative period of 5.2 days, then scaled down to 24 h for easier comparison with previously modelled results (McPherson et al. 2018).

Pygmy blue whales are found in specific biologically important areas (BIAs) depending on behavioural mode (e.g. migrating or foraging). This was implemented in the animal movement simulation by restricting the spatial distribution of animats to the BIA.

The results from the animal movement and exposure modelling provide a way to estimate ranges to impact thresholds. The range to the closest point of approach (CPA) for each of the animats (simulated animals) is recorded. The $ER_{95\%}$ (95% Exposure Range) is the horizontal range that includes 95% of the animat CPAs that exceed a given impact threshold (Figure 3). Note that within the $ER_{95\%}$ range, there are generally some proportion of animats that did not exceed threshold criteria.

Since the acoustic sound fields showed that TTS and PTS PK ranges to thresholds were small (<60 m), animat exposures for those criteria were estimated by counting the number of animats within threshold ranges estimated from propagation modelling, rather than counting exposures above threshold using full 3D sound fields. For this reason, estimates of 95th percentile ranges were not calculated.

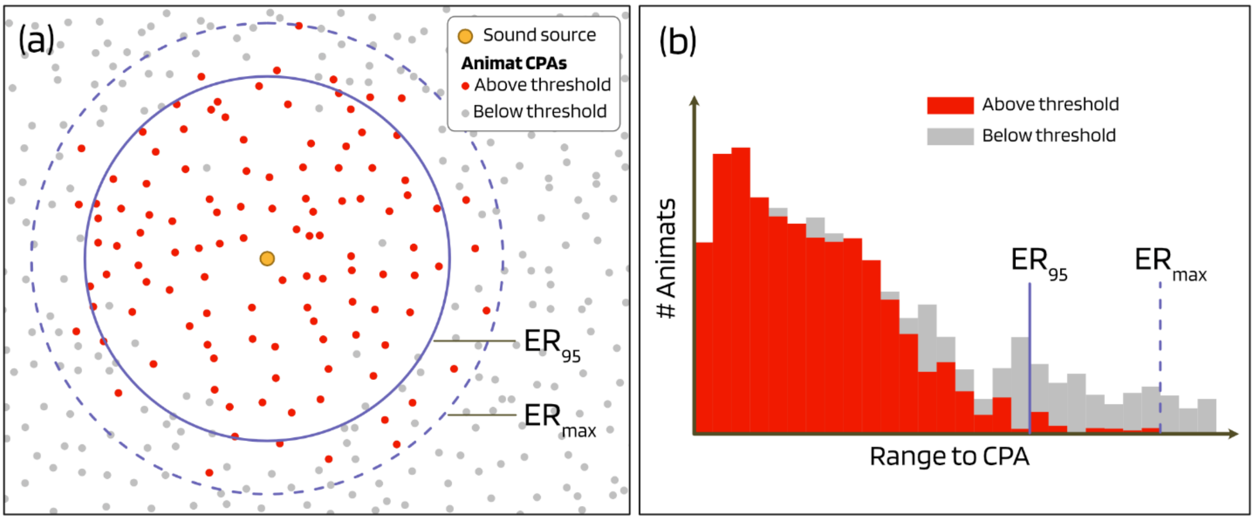

Figure 3. Example distribution of animat closest points of approach (CPAs). Panel (a) shows the horizontal distribution of animats near a sound source. Panel (b) shows the distribution of ranges to animat CPAs. The 95% and maximum Exposure Ranges ($ER_{95\%}$ and ER_{max}) are indicated in both panels.

4.2.2. Animal behaviour

One behavioural profile was considered for pygmy blue whales, that of migration. The research summarised in this section was used to inform the species behavioural definition (Appendix B-3). Detailed, fine-scale diving behaviour of a migrating pygmy blue whale was derived from Owen et al. (2016) who equipped an individual with a multi-sensor tag off the west coast of Australia. The study identified areas of high residence using the horizontal movement data; the analysis of the dive data showed that the depth of migratory dives was highly consistent over time and unrelated to local bathymetry. Blue whales (*Balaenoptera musculus*) are known to primarily migrate and feed in the first few hundred metres of the water column (Croll et al. 2001, Goldbogen et al. 2011), with the deepest dive being reported from a pygmy blue whale being 506 m (Owen et al. 2016).

Owen et al. (2016) identified dives for their tagged animal, a sub-adult, as migratory, feeding, or exploratory behaviour. The mean depth of migratory dives (82% of all dives) was 14 m ± 4 m, and the whale spent 94% of observed time and completed 99% of observed migratory dives at water depths of less than 24 m. A total of 21 feeding dives were identified during the duration of the tag deployment (one week) with a mean maximum depth of 129 ± 183 m (range 13–505 m). The mean maximum depth of exploratory dives (107 ± 81 m, range 23–320 m) was similar to the mean maximum depth of feeding dives (129 m) and did not appear to be related to seafloor depth.

Croll et al. (2001) explicitly reports on non-foraging dives for an adult blue whale, while other research, such as Calambokidis et al. (2007) and Oleson et al. (2007), do not. A digitisation of the data presented in Croll et al. (2001) therefore defines shallow, or migratory dives, to have a mean depth of 26.9 m ± 1.2 m. This migratory dive depth has been used instead of the sub-adult dive depth presented in Owen et al. (2016), however the exploratory dive depth data in Owen et al. (2016), will still be applied.

The behaviour of pygmy blue whales was modelled without migration bias, i.e. the animats were resident in the animat modelling area over the entire modelling period. In reality, pygmy blue whales can be expected to transit through the area in less than half a day (based on McCauley and Jenner 2010); accordingly, the approach used is conservative as it results in higher exposure levels and higher number of animals exposed to levels exceeding the criteria thresholds.

The two migratory behaviours (migratory dives and exploratory dives) were modelled at an even probability of occurrence (i.e. probability for transitioning from one behaviour to another was 0.5 for both) while dive data published by Owen et al. (2016) suggest a higher likelihood for migratory dives to occur. This approach was chosen in the absence of quantitative information on the true proportion between the two dive behaviours.

5. Results

A summary of exposure ranges for migrating pygmy blue whales for the scenario defined in Section 2 is included in Table 2.

Table 2. Summary of animat simulation results for migratory pygmy blue whales. The 95th percentile exposure ranges (km), and the number of real-world individuals exposed above threshold (using the estimated densities) are provided. Estimates related to PTS and TTS criteria (NMFS 2018) and behaviour (NMFS 2014) are normalised to 24 h from the 5.3 days of operation simulated to aid comparison to acoustic modelling results. For comparison, maximum distances to threshold from previously completed acoustic modelling are provided.

Threshold		**Maximum distance (km) to threshold from acoustic modelling**	**Migrating Pygmy Blue Whales Range, $ER_{95\%}$ (km)**
Threshold description	Sound Level (dB)		
TTS, PK	213†	0.06	-
TTS, SEL_{24h}	168‡	60.16	23.19
PTS, PK	219†	0.03	-
PTS, SEL_{24h}	183‡	1.35	0.11
Behavioural response	160#	7.7 or 8.0	5.58

† PK (L_{pk}; dB re 1 µPa)
‡ LF-weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
# SPL (L_p; dB re 1 µPa)
A dash indicates where ranges were not relevant for PK exposures (see Section 4.1.2)

The exposure ranges are strongly dependent on the location of the source relative to the BIA. To demonstrate the impact of this effect, exposure ranges to SEL PTS and TTS thresholds were analysed in 24 h segments. Figure 4 shows the entire track coloured by day of the simulated survey, where the start of the survey is at the north west corner of the survey area. All daily tracks are 24 h in length except for the final day which has a duration of approximately 8.5 hours. Table 3 summarises the exposure ranges computed for each day.

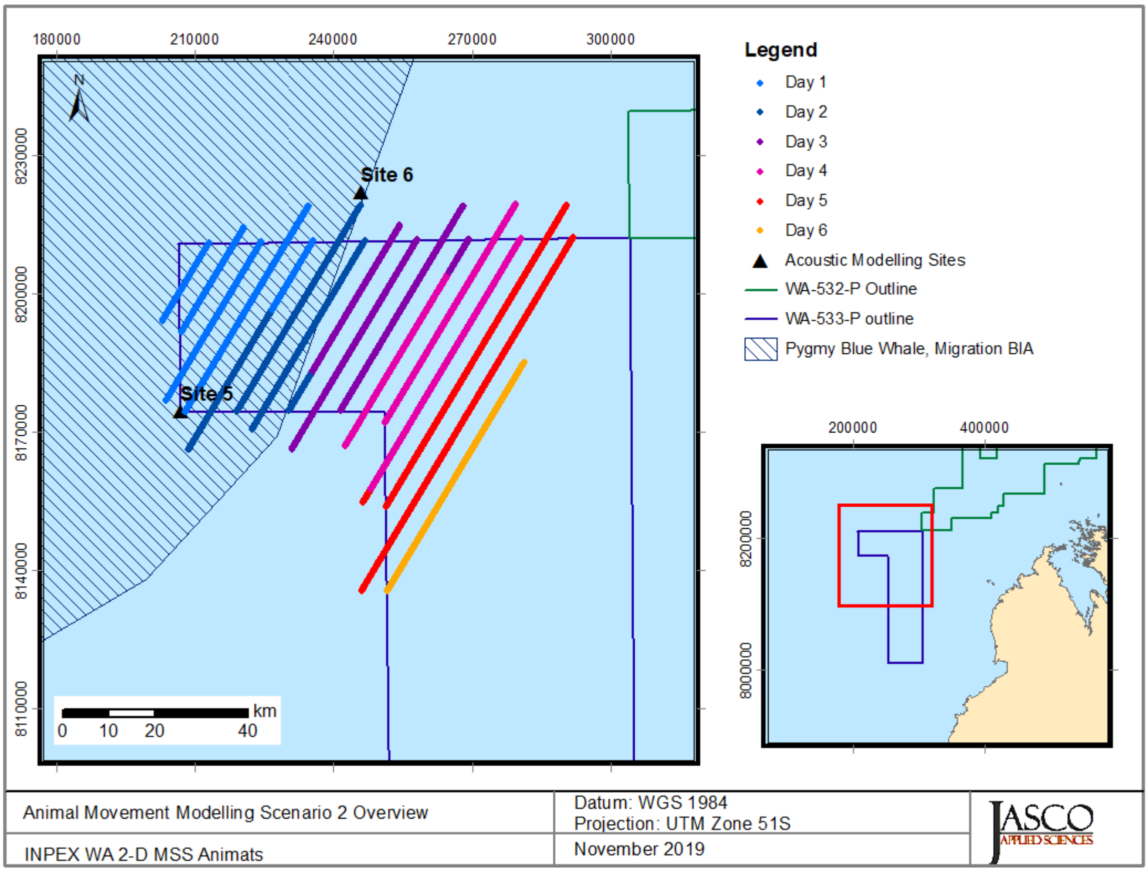

Figure 4. Seismic source tracks used in animal movement modelling, coloured by day of survey.

Table 3. Exposure ranges ($ER_{95\%}$) for both PTS and TTS SEL_{24h} thresholds for each day of the simulated survey.

Survey day	Range, $ER_{95\%}$ (km)	
	PTS, SEL_{24h}	TTS, SEL_{24h}
1	0.09	18.75
2	0.21	19.24
3	0	21.06
4	0	23.37
5	0	0
6	0	0

6. Discussion

The estimated sound fields produced by source and propagation models for the seismic survey were incorporated into a sound exposure model to estimate the range within which 95% of the exposure exceedances occur ($ER_{95\%}$).

Exposure ranges ($ER_{95\%}$) to SEL thresholds were 0.20 km and 23.34 km for PTS and TTS, respectively. All of the $ER_{95\%}$ exposure ranges to SEL thresholds computed from the distributions of migrating pygmy blue whale animats exposed above threshold were lower than the corresponding ranges to threshold estimated from propagation modelling or accumulated SEL_{24h} results presented in McPherson et al. (2018). Previous modelling efforts were inherently more conservative since they did not incorporate the complex interactions of both a moving sound field and moving receivers, but rather assumed a static receiver.

There is potential for behavioural impact, with $ER_{95\%}$ of 5.74 predicted based on exposure modelling. This is only slightly lower than the range predicted by acoustic modelling, but this is unsurprising since it is based on the single loudest exposures experienced by each of the animats in the simulation.

The 24h analysis of $ER_{95\%}$ underscored the fact that most of the impact to pygmy blue whales occurs when the seismic vessel is within, or adjacent to, the BIA boundary. No PTS SEL_{24h} exposures are predicted for the final 4 days of the survey, and no TTS SEL_{24h} exposures are predicted for the final 2 days of the scenario. Any day where the minimum range from the seismic source to the BIA is greater than the $ER_{95\%}$ will have no modelled exposures.

Literature Cited

[HESS] High Energy Seismic Survey. 1999. *High Energy Seismic Survey Review Process and Interim Operational Guidelines for Marine Surveys Offshore Southern California*. Prepared for the California State Lands Commission and the United States Minerals Management Service Pacific Outer Continental Shelf Region by the High Energy Seismic Survey Team, Camarillo, CA, USA. 98 p. https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB2001100103.xhtml.

[ISO] International Organization for Standardization. 2017. *ISO/DIS 18405.2:2017. Underwater acoustics—Terminology*. Geneva. https://www.iso.org/standard/62406.html.

[NMFS] National Marine Fisheries Service. 2014. *Marine Mammals: Interim Sound Threshold Guidance* (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html.

[NMFS] National Marine Fisheries Service (US). 1998. *Acoustic Criteria Workshop*. Dr. Roger Gentry and Dr. Jeanette Thomas Co-Chairs.

[NMFS] National Marine Fisheries Service (US). 2016. *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-55. 178 p.

[NMFS] National Marine Fisheries Service (US). 2018. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/webdam/download/75962998.

[NOAA] National Oceanic and Atmospheric Administration (US). 2013. *Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts*. National Oceanic and Atmospheric Administration, US Department of Commerce, and NMFS Office of Protected Resources, Silver Spring, MD, USA. 76 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2015. *Draft guidance for assessing the effects of anthropogenic sound on marine mammal hearing: Underwater acoustic threshold levels for onset of permanent and temporary threshold shifts*. NMFS Office of Protected Resources, Silver Spring, MD, USA. 180 p.

[NOAA] National Oceanic and Atmospheric Administration (US). 2016. *Document Containing Proposed Changes to the NOAA Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts*. National Oceanic and Atmospheric Administration and US Department of Commerce. 24 p.

[ONR] Office of Naval Research. 1998. *ONR Workshop on the Effect of Anthropogenic Noise in the Marine Environment*. Dr. R. Gisiner Chair.

Acevedo-Gutiérrez, A., D.A. Croll, and B.R. Tershy. 2002. High feeding costs limit dive time in the largest whales. *Journal of Experimental Biology* 205: 1747-1753. https://jeb.biologists.org/content/205/12/1747.

Calambokidis, J., G.S. Schorr, G.H. Steiger, J. Francis, M. Bakhtiari, G. Marshall, E.M. Oleson, D. Gendron, and K. Robertson. 2007. Insights into the Underwater Diving, Feeding, and Calling Behavior of Blue Whales from a Suction-Cup-Attached Video-Imaging Tag (Crittercam).

Marine Technology Society Journal 41(4): 19-29. https://www.ingentaconnect.com/content/mts/mtsj/2007/00000041/00000004/art00006 https://doi.org/10.4031/002533207787441980.

Croll, D.A., A. Acevedo-Gutiérrez, B.R. Tershy, and J. Urbán-Ramírez. 2001. The diving behavior of blue and fin whales: Is dive duration shorter than expected based on oxygen stores? *Comparative Biochemistry and Physiology Part A* 129(4): 797-809. https://doi.org/10.1016/S1095-6433(01)00348-8.

Ellison, W.T., C.W. Clark, and G.C. Bishop. 1987. *Potential use of surface reverberation by bowhead whales, Balaena mysticetus, in under-ice navigation: Preliminary considerations*. Report of the International Whaling Commission. Volume 37. 329-332 p.

Ellison, W.T. and P.J. Stein. 1999. *SURTASS LFA High Frequency Marine Mammal Monitoring (HF/M3) Sonar: Sustem Description and Test & Evaluation*. Under US Navy Contract N66604-98-D-5725. http://www.surtass-lfa-eis.com/wp-content/uploads/2018/02/HF-M3-Ellison-Report-2-4a.pdf.

Finneran, J.J. and C.E. Schlundt. 2010. Frequency-dependent and longitudinal changes in noise-induced hearing loss in a bottlenose dolphin (*Tursiops truncatus*). *Journal of the Acoustical Society of America* 128(2): 567-570. https://doi.org/10.1121/1.3458814.

Finneran, J.J. and A.K. Jenkins. 2012. *Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis*. SPAWAR Systems Center Pacific, San Diego, CA, USA. 64 p.

Finneran, J.J. 2015. *Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*. Technical report by SSC Pacific, San Diego, CA, USA.

Finneran, J.J. 2016. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Technical Report for Space and Naval Warfare Systems Center Pacific, San Diego, CA, USA. 49 p. http://www.dtic.mil/dtic/tr/fulltext/u2/1026445.pdf.

Frankel, A.S., W.T. Ellison, and J. Buchanan. 2002. Application of the acoustic integration model (AIM) to predict and minimize environmental impacts. *OCEANS'02 MTS/IEEE*. pp. 1438-1443.

Goldbogen, J.A., J. Calambokidis, E. Oleson, J. Potvin, N.D. Pyenson, G. Schorr, and R.E. Shadwick. 2011. Mechanics, hydrodynamics and energetics of blue whale lunge feeding: Efficiency dependence on krill density. *Journal of Experimental Biology* 214: 131-146. https://jeb.biologists.org/content/214/4/698.

Houser, D.S. and M.J. Cross. 1999. *Marine Mammal Movement and Behavior (3MB): A Component of the Effects of Sound on the Marine Environment (ESME) Distributed Model*. Version 8.08, by BIOMIMETICA.

Houser, D.S. 2006. A method for modeling marine mammal movement and behavior for environmental impact assessment. *IEEE Journal of Oceanic Engineering* 31(1): 76-81. https://doi.org/10.1109/JOE.2006.872204.

Lucke, K., U. Siebert, P. Lepper, A., and M.-A. Blanchet. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *Journal of the Acoustical Society of America* 125(6): 4060-4070. https://doi.org/10.1121/1.3117443.

McCauley, R.D. and K.C. Jenner. 2010. *Migratory patterns and estimated population size of pygmy blue whales (Balaenoptera musculus brevicauda) traversing the Western Australian coast based on passive acoustics*. Paper SC/62/SH26 presented to the International Whaling Committee Scientific Committee.

McPherson, C.R., J.L. Wladichuk, Z. Alavizadeh, and K. Hiltz. 2018. *Western Australia 2-D Marine Seismic Survey: Acoustic Modelling for Assessing Marine Fauna Sound Exposures*. Document Number 01696. Version 1.0. Technical report by JASCO Applied Sciences for INPEX Operations Australia Pty Ltd.

Nedwell, J.R. and A.W. Turnpenny. 1998. The use of a generic frequency weighting scale in estimating environmental effect. *Workshop on Seismics and Marine Mammals*. 23–25 Jun 1998, London, UK.

Nedwell, J.R., A.W. Turnpenny, J. Lovell, S.J. Parvin, R. Workman, J.A.L. Spinks, and D. Howell. 2007. *A validation of the dB_{ht} as a measure of the behavioural and auditory effects of underwater noise*. Document Number 534R1231 Report prepared by Subacoustech Ltd. for the UK Department of Business, Enterprise and Regulatory Reform under Project No. RDCZ/011/0004. 74 p. https://tethys.pnnl.gov/sites/default/files/publications/Nedwell-et-al-2007.pdf.

Oleson, E.M., J. Calambokidis, W.C. Burgess, M.A. McDonald, C.A. Leduc, and J.A. Hildebrand. 2007. Behavioral context of call production by eastern North Pacific blue whales. *Marine Ecology Progress Series* 330: 269-284. https://www.int-res.com/abstracts/meps/v330/p269-284/.

Owen, K., C.S. Jenner, M.-N.M. Jenner, and R.D. Andrews. 2016. A week in the life of a pygmy blue whale: Migratory dive depth overlaps with large vessel drafts. *Animal Biotelemetry* 4: 17. https://doi.org/10.1186/s40317-016-0109-4.

Payne, R. and D. Webb. 1971. Orientation by means of long range acoustic signaling in baleen whales. *Annals of the New York Academy of Sciences* 188: 110-141. https://doi.org/10.1111/j.1749-6632.1971.tb13093.x.

Sears, R. and W.F. Perrin. 2009. Blue whale: Balaenoptera musculus. *In Encyclopedia of marine mammals*. Elsevier. pp. 120-124.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, et al. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals* 33(4): 411-521. https://doi.org/10.1080/09524622.2008.9753846.

Tougaard, J., A.J. Wright, and P.T. Madsen. 2015. Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. *Marine Pollution Bulletin* 90(1-2): 196-208. https://doi.org/10.1016/j.marpolbul.2014.10.051.

Wood, J., B.L. Southall, and D.J. Tollit. 2012. *PG&E offshore 3-D Seismic Survey Project Environmental Impact Report–Marine Mammal Technical Draft Report*. SMRU Ltd. 121 p. https://www.coastal.ca.gov/energy/seismic/mm-technical-report-EIR.pdf.

Appendix A. **Acoustic Metrics**

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the perceived loudness of sound, especially impulsive noise such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate noise and its effects on marine life. We provide specific definitions of relevant metrics used in the accompanying report. Where possible we follow the ANSI and ISO standard definitions and symbols for sound metrics, but these standards are not always consistent.

The zero-to-peak sound pressure level (PK; L_{pk}; $L_{p,pk}$; dB re 1 μPa), is the maximum instantaneous sound pressure level in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$L_{p,pk} = 20\log_{10}\left[\frac{\max(|p(t)|)}{p_0}\right] \quad \text{(A-1)}$$

PK is often included as a criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of a noise event, it is generally a poor indicator of perceived loudness.

The peak-to-peak sound pressure level (PK-PK; $L_{pk\text{-}pk}$; $L_{p,pk\text{-}pk}$; dB re 1 μPa) is the difference between the maximum and minimum instantaneous sound pressure levels in a stated frequency band attained by an impulsive sound, $p(t)$:

$$L_{p,pk-pk} = 10\log_{10}\left\{\frac{[\max(p(t)) - \min(p(t))]^2}{p_0^2}\right\} \quad \text{(A-2)}$$

The sound pressure level (SPL; L_p; dB re 1 μPa) is the rms pressure level in a stated frequency band over a specified time window (T, s) containing the acoustic event of interest. It is important to note that SPL always refers to a rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)dt \Big/ p_0^2\right) \quad \text{(A-3)}$$

The SPL represents a nominal effective continuous sound over the duration of an acoustic event, such as the emission of one acoustic pulse, a marine mammal vocalization, the passage of a vessel, or over a fixed duration. Because the window length, T, is the divisor, events with similar sound exposure level (SEL) but more spread out in time have a lower SPL. A fixed window length of 0.125 s (critical duration defined by Tougaard et al. (2015)) is used in this study for impulsive sounds.

The sound exposure level (SEL; L_E; $L_{E,p}$; dB re 1 μPa^2·s) is a measure related to the acoustic energy contained in one or more acoustic events (N). The SEL for a single event is computed from the time-integral of the squared pressure over the full event duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)dt \Big/ T_0 p_0^2\right) \quad \text{(A-4)}$$

where T_0 is a reference time interval of 1 s. The SEL continues to increase with time when non-zero pressure signals are present. It therefore can be construed as a dose-type measurement, so the integration time used must be carefully considered in terms of relevance for impact to the exposed recipients.

SEL can be calculated over periods with multiple acoustic events or over a fixed duration. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the *N* individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right). \quad \text{(A-5)}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LFC,24h}$; Appendix A.3). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should else be specified.

A.2. Marine Mammal Impact Criteria

It has been long recognised that marine mammals can be adversely affected by underwater anthropogenic noise. For example, Payne and Webb (1971) suggested that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR 1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for both injury and disturbance. The following sections summarize the recent development of thresholds; however, this field remains an active research topic.

A.2.1. Injury

In recognition of shortcomings of the SPL-only based injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual acoustic injury criteria for impulsive sounds that included peak pressure level thresholds and SEL_{24h} thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas the SEL_{24h} is frequency weighted according to one of four marine mammal species hearing groups: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for human; Appendix A.3). The SEL_{24h} thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower injury values for LF and HF cetaceans while retaining the filter shapes. Their revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HF cetaceans of 179 dB re 1 µPa^2·s. Because there were no data available for baleen whales, Wood et al. (2012) based their recommendations for LF cetaceans on results obtained from MF cetacean studies. In particular they referenced Finneran and Schlundt (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed. Wood et al. (2012) thus recommended a more conservative TTS-onset level for LF cetaceans of 192 dB re 1 µPa^2·s.

As of 2017, an optimal approach is not apparent. There is consensus in the research community that an SEL-based method is preferable either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2016). The guidance describes PTS (and TTS) criteria with new thresholds and frequency weighting functions for the five hearing groups described by Finneran and Jenkins (2012). The latest revision to this work was published in 2018; only the PK criteria defined in NMFS (2018) are applied in this report.

A.3. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.3.1. Marine mammal frequency weighting functions

In 2015, a U.S. Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^2\right]^a\left[1+(f/f_{hi})^2\right]^b}\right)\right] \quad \text{(A-6)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses noise impacts on marine mammals (NMFS 2016, NMFS 2018). Table A-1 lists the frequency-weighting parameters for each hearing group; Figure A-1 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions used in this project as recommended by NMFS (2018).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
Mid-frequency cetaceans (dolphins, plus toothed, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
High-frequency cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*)	1.8	2	12,000	140,000	1.36

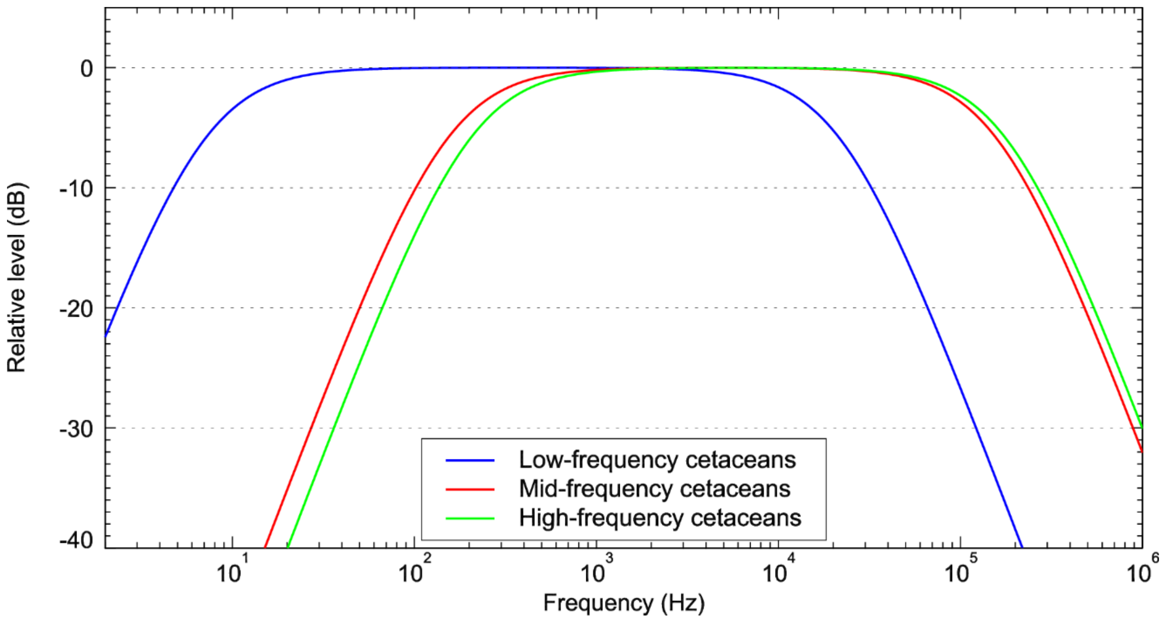

Figure A-1. Auditory weighting functions for functional marine mammal hearing groups used in this project as recommended by NMFS (2018).

Appendix B. **Animal Movement and Exposure Modelling**

Animal movement and exposure modelling takes into account the movement of both sound sources and animals over time. Acoustic source and propagation modelling are used to generate 3D sound fields that vary as a function of range, depth, and azimuth. Sound sources are modelled at several representative sites and the resulting sound fields are assigned to seismic shot locations using the minimum Euclidean distance. The sound received by an animal at any given time depends on its location relative to the source. Since the true locations of the animals within the sound fields are unknown, realistic animal movements are simulated using repeated random sampling of various behavioural parameters. The Monte Carlo method of simulating many animals within the operations area is used to estimate the sound exposure history of the population of simulated animals (animats).

Monte Carlo methods provide a heuristic approach for determining the probability distribution function (PDF) of complex situations, such as animals moving in a sound field. The probability of an event's occurrence is determined by the frequency with which it occurs in the simulation. The greater the number of random samples, in this case the more simulated animats, the better the approximation of the PDF. Animats are randomly placed, or seeded, within the simulation boundary at a specified density (animats/km^2). Higher densities provide a finer PDF estimate resolution but require more computational resources. To ensure good representation of the PDF, the animat density is set as high as practical allowing for computation time. The animat density is much higher than the real-world density to ensure good representation of the PDF. The resulting PDF is scaled using the real-world density.

Several models for marine mammal movement have been developed (Ellison et al. 1987, Frankel et al. 2002, Houser 2006). These models use an underlying Markov chain to transition from one state to another based on probabilities determined from measured swimming behaviour. The parameters may represent simple states, such as the speed or heading of the animal, or complex states, such as likelihood of participating in foraging, play, rest, or travel. Attractions and aversions to variables like anthropogenic sounds and different depth ranges can be included in the models.

The JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was based on the open-source marine mammal movement and behaviour model (3MB, Houser 2006) and used to predict the exposure of animats (virtual pygmy blue whales) to sound arising from the seismic activities. Animats are programmed to behave like the pygmy blue whales likely to be present in the survey area. The parameters used for forecasting realistic behaviours (e.g., diving, foraging, aversion, surface times, etc.) are determined and interpreted from marine species studies (e.g., tagging studies) where available, or reasonably extrapolated from related species. An individual animat's modelled sound exposure levels are summed over the total simulation duration to determine its total received energy, and then compared to the assumed threshold criteria.

JASMINE uses the same animal movement algorithms as 3MB (Houser, 2006), but has been extended to be directly compatible with MONM and FWRAM acoustic field predictions, for inclusion of source tracks, and importantly for animats to change behavioural states based on time and space dependent modelled variables such as received levels for aversion behaviour, although aversion was not considered in this study.

B.1. Animal Movement Parameters

JASMINE uses previously measured behaviour to forecast behaviour in new situations and locations. The parameters used for forecasting realistic behaviour are determined (and interpreted) from marine species studies (e.g., tagging studies). Each parameter in the model is described as a probability distribution. When limited or no information is available for a species parameter, a Gaussian or uniform distribution may be chosen for that parameter. For the Gaussian distribution, the user determines the mean and standard deviation of the distribution from which parameter values are drawn. For the uniform distribution, the user determines the maximum and minimum distribution from which parameter values are drawn. When detailed information about the movement and behaviour of a species are available, a user-created distribution vector, including cumulative transition probabilities, may be used (referred to here as a vector model; Houser 2006). Different sets of parameters can be defined for different behaviour states. The probability of an animat starting out in or transitioning into a given behaviour state can in turn be defined in terms of the animat's current behavioural state, depth, and the time of day. In addition, each travel parameter and behavioural state has a termination function that governs how long the parameter value or overall behavioural state persists in simulation.

The parameters used in JASMINE describe animal movement in both the vertical and horizontal planes. The parameters relating to travel in these two planes are briefly described below.

Travel sub-models

- **Direction**– determines an animat's choice of direction in the horizontal plane. Sub-models are available for determining the heading of animats, allowing for movement to range from strongly biased to undirected. A random walk model can be used for behaviours with no directional preference, such as feeding and playing. In a random walk, all bearings are equally likely at each parameter transition time step. A correlated random walk can be used to smooth the changes in bearing by using the current heading as the mean of the distribution from which to draw the next heading. An additional variant of the correlated random walk is available that includes a directional bias for use in situations where animals have a preferred absolute direction, such as migration. A user-defined vector of directional probabilities can also be input to control animat heading. For more detailed discussion of these parameters, see Houser (2006) and Houser and Cross (1999).
- **Travel rate**–defines an animat's rate of travel in the horizontal plane. When combined with vertical speed and dive depth, the dive profile of the animat is produced.

Dive sub-models

- **Ascent rate**–defines an animat's rate of travel in the vertical plane during the ascent portion of a dive.
- **Descent rate**–defines an animat's rate of travel in the vertical plane during the descent portion of a dive.
- **Depth**–defines an animat's maximum dive depth.
- **Reversals**–determines whether multiple vertical excursions occur once an animat reaches the maximum dive depth. This behaviour is used to emulate the foraging behaviour of some marine mammal species at depth. Reversal-specific ascent and descent rates may be specified.
- **Surface interval**–determines the duration an animat spends at, or near, the surface before diving again.

B.1.1. Exposure integration time

The interval over which acoustic exposure (L_E) should be integrated and maximal exposure (L_p) determined is not well defined. Both Southall et al. (2007) and the NMFS (2018) recommend a 24 h baseline accumulation period, but state that there may be situations where this is not appropriate (e.g., a high-level source and confined population). Resetting the integration after 24 h can lead to overestimating the number of individual animals exposed because individuals can be counted multiple times during an operation. The type of animal movement engine used in this study simulates realistic movement using swimming behaviour collected over relatively short periods (hours to days) and does not include large-scale movement such as migratory circulation patterns. For this study, 5.2 days were modelled, but then scaled down to 24 h.

Ideally, a simulation area is large enough to encompass the entire range of a population so that any animal that could approach the seismic survey area during an operation is included. However, there are limits to the simulation area, and computational overhead increases with area. For practical reasons, the simulation area is limited in this analysis to a maximum distance from the seismic survey operations. In the simulation, every animat that reaches a border is replaced by another animat entering at the opposing border—e.g., an animat crossing the northern border of the simulation is replaced by one entering the southern border at the same longitude. When this action places the animat in an inappropriate water depth, the animat is randomly placed on the map at a depth suited to its species definition. The exposures of all animats (including those leaving the simulation and those entering) are kept for analysis. This approach maintains a consistent animat density and allows for longer integration periods with finite simulation areas.

B.1.2. Seeding density and scaling

The exposure criteria for impulsive sounds were used to determine the number of animats exceeding exposure thresholds. To generate statistically reliable probability density functions, all simulations were seeded with an animat density of 0.5 animats/km^2 over the entire simulation area. To evaluate potential injury or behavioural disruptions, threshold exceedance was determined in a 24 h time window.

B.2. Pygmy blue whale species details

Table B-1. *Migrating pygmy blue whales*: Data values and references input in JASMINE to create diving behaviour (number values represent means [standard deviations] unless otherwise indicated).

Behaviour	Variable	Value	Reference
Migratory dive	Travel direction	Correlated random walk	Houser (2006), D. Houser, pers.comm.
	Perturbation value	10	Houser (2006), D. Houser, pers.comm.
	Termination coefficient	0.2	Houser (2006), D. Houser, pers.comm.
	Travel rate (m/s)	Gaussian 0.78 (0.61)	Sears and Perrin (2009), Owen et al. (2016)
	Ascent rate (m/s)	Gaussian 0.7 (0.2)	Goldbogen et al. (2011)
	Descent rate (m/s)	Gaussian 1.5 (0.1)	Goldbogen et al. (2011)
	Dive depth (m)	Gaussian 26.8 (1.5)	Croll et al. (2001)
	Reversals	No	Owen et al. (2016)
	Surface interval (s)	Gaussian 78.0 (30.2)	Acevedo-Gutiérrez et al. (2002)
	Bout duration (s)	Gaussian 12060 (1800)	Owen et al. (2016)
Exploratory dive	Travel direction	Correlated random walk	Houser (2006), D. Houser, pers.comm.
	Perturbation value	10	Houser (2006), D. Houser, pers.comm.
	Termination coefficient	0.2	Houser (2006), D. Houser, pers.comm.
	Travel rate (m/s)	Gaussian 1.25 (0.42)	Sears and Perrin (2009)
	Ascent rate (m/s)	Gaussian 1.6 (0.5)	Goldbogen et al. (2011)
	Descent rate (m/s)	Gaussian 2.6 (0.5)	Goldbogen et al. (2011)
	Dive depth (m)	Gaussian 107.0 (81.0)	Owen et al. (2016)
	Reversals	No	Owen et al. (2016)
	Surface interval (s)	Gaussian 162.0 (66.0)	Goldbogen et al. (2011)
	Bout duration (s)	Gaussian 516 (120)	Owen et al. (2016)
General	Shore following (m)	30	Approximated
	Depth limit on seeding (m)	100.0 (minimum), 110000.0 (maximum)	Approximated

Appendix F -
Oil Pollution Emergency Plan

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I Initial Response Requirements

An overview of the initial response requirements for vessel masters (VM), client site representative (CSR) and the INPEX incident management team (IMT) is provided in Table I-1.

Table I-1 has been developed to guide the response personnel through the key steps of this OPEP during a Level 2 or Level 3 spill (defined in Section 2.1).

Table I-1 contains an initial response guide for vessel spills, where the Australian Maritime Safety Authority (AMSA) is the Control Agency, however also includes all the steps the INPEX IMT may be required to take, if AMSA requests support from the INPEX IMT.

Information to support the initial and ongoing response requirements are included in this OPEP.

Section

Table I-1: Initial Response Requirements – Vessel spill

Spill from vessel (AMSA Control Agency) Definitions for 'Action by' persons are as follows: **VM** – Vessel Master (Contractor) **CSR** – Client Site Representative (INPEX) **IMT** – Incident Management Team (INPEX)					
VM	CSR	IMT	Immediate Response Actions	Information/Resources	Comments
■			Stop the spill.	Activate vessel shipboard oil pollution emergency plan (SOPEP).	
■			Classify the spill incident level.	See Section 2.1 Spill classification. Table 2-1: Incident classification.	
■			Verbally notify AMSA.	See Section 2.4.2 External agencies notification. Table 2-2: Jurisdictional boundaries for Jurisdictional Authority and Control Agencies. Table 2-3: External notifications matrix. INPEX Emergency Contact Directory (C075-AH-LIS-10002).	AMSA is the designated Control Agency for oil spills from vessels within Commonwealth jurisdiction and are to be notified immediately of all ship-sourced incidents through the AMSA Rescue Coordination Centre (RCC) Australia on +61 2 6230 6811. Upon notification of an incident involving a ship, AMSA will assume control of the incident and respond in accordance with AMSA's National Plan for Maritime Environmental Emergencies.
■			Verbally notify the CSR.	See Section 2.4.1 Initial spill notification.	
■	■		Deploy satellite tracking buoys.	See Section 4.4.1 Operational Monitoring and Evaluation.	2 x tracking buoys located on seismic survey vessel. Additional tracking buoys can be requested for deployment from the INPEX IMT Leader. The location of satellite tracking buoys is maintained in the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002), available on SmartPlant.
	■	■	INPEX CSR to notify IMT Leader via INPEX Emergency Call Centre. IMT Leader notify INPEX Crisis Management Team (CMT) Leader. IMT Leader to activate IMT.	Activate via INPEX Emergency Call Centre. (See Section 2.4.1 Initial spill notification). INPEX Emergency Contact Directory (C075-AH-LIS-10002).	INPEX Emergency Call Centre 24-hour activation numbers are: 1800 305 789. +61 8 6213 6350 +61 439 694 175
■	■		Prepare marine pollution report (POLREP), submit to AMSA and copy to CSR. CSR to forward POLREP to IMT Leader.	POLREP. (See Table 5-1: Oil Spill Response Forms).	
		■	IMT to contact AMSA and confirm POLREP and offer support as per memorandum of understanding (MOU).	See Section 2.2 Jurisdictional Authority and Control Agency.	AMSA and INPEX acknowledge that AMSA retains Control Agency responsibility for all ship sourced marine pollution incidents. INPEX agrees to provide all available support to AMSA in AMSA's performance of its Control Agency responsibilities under the National Plan for Maritime Environmental Emergencies. All resources and capabilities within this OPEP can be implemented, upon AMSA's request. Should AMSA request INPEX IMT support, INPEX IMT to progress with the steps below this row.

Spill from vessel (AMSA Control Agency) Definitions for 'Action by' persons are as follows: **VM** – Vessel Master (Contractor) **CSR** – Client Site Representative (INPEX) **IMT** – Incident Management Team (INPEX)					
VM	CSR	IMT	Immediate Response Actions	Information/Resources	Comments
		■	Develop situational awareness.	See Section 3.1 Gain situational awareness.	During the initial phase of a spill, obtaining and communicating information to allow the establishment of situational awareness is critical for response planning.
		■	Notify Australian Marine Oil Spill Centre (AMOSC).	INPEX Emergency Contact Directory (C075-AH-LIS-10002).	AMOSC will provide support and guidance to the INPEX IMT during any Level 2 or Level 3 spill event. AMOSC's 24-hour mobile number is +61 (0) 438 379 328; email amosc@amosc.com.au Telephone call and e-mail confirmation to AMOSC required for mobilisation of response personnel and equipment, and call-out authorities will be required to confirm they are the IMT Leader to AMOSC. AMOSC will email a service contract for the request of AMOSC resources/personnel. This contract must be completed and signed by the IMT Leader and emailed to AMOSC, prior to AMOSC mobilisation.
		■	Notify additional regulators and stakeholders.	See Section 2.4.2 External agencies notification. Table 2-3: External notifications matrix. INPEX Emergency Contact Directory (C075-AH-LIS-10002).	External agencies contact information is available in the INPEX Emergency Contacts Directory (C075-AH-LIS-10002). If spill is going towards WA shoreline contact the WA DoT Maritime Environmental Emergency Response 24-hour reporting number is (08) 9480 9924.
		■	Initiate 'Immediate Response Measures' - Operational Monitoring and Evaluation – aerial, vessel, and satellite (as appropriate).	See Section 4.4.1 Operational Monitoring and Evaluation.	Must be implemented as a priority, prior to the development of Incident Action Plans. Additional details on Operational Monitoring and Evaluation are also provided in Appendix A - OM03.
		■	Obtain long-term weather forecasts.	For weather forecast service provider see the INPEX Emergency Contact Directory (C075-AH-LIS-10002).	Site–specific, long-term weather forecasts are available through the INPEX subscription to the Bureau of Meteorology (BOM).
		■	Implement oil spill trajectory modelling – Operational Monitoring and Evaluation.	Transmit to spill modelling provider via Oil Spill Trajectory Modelling Request. Oil Spill Response Forms Register (C075-AH-LIS-10006).	Additional details on spill trajectory modelling are also provided in Section 4.4.1 and in Appendix A. RPS modelling request activated via 24/7 duty phone – 0408 477 196, followed by email of modelling request form to response@rpsgroup.com.au
		■	Identify protection priorities.	See Section 3.3 Identify protection priorities.	Figures of the environmental sensitivities and values as defined in the Environment Plan are attached to this checklist in IMT Room 'Environment' folder.
		■	Validate Operational spill impact mitigation assessment (SIMA) template to generate Operational SIMA.	See Section 3.4 Operational SIMA.	The Operational SIMA template provides a summary of key considerations for relevant spill response techniques, and will assist the IMT to determine the appropriate response strategies to include in the Incident Action Plan.
		■	Develop Incident Action Plan (IAP).	See Section 3.5 Develop an Incident Action Plan. Appendix B: INPEX Incident Action Plan template.	Resources descriptions, capabilities and activation processes are provided in Section 4 Spill Response Resources. Utilise this information during the development of the IAP.
		■	Implement IAP.	See Section 4 Spill Response Resources.	

Spill from vessel (AMSA Control Agency) Definitions for 'Action by' persons are as follows: **VM** – Vessel Master (Contractor) **CSR** – Client Site Representative (INPEX) **IMT** – Incident Management Team (INPEX)					
VM	CSR	IMT	Immediate Response Actions	Information/Resources	Comments
		■	Use spill surveillance and reconnaissance data (OM03) to update oil spill trajectory modelling (OM01) outputs.	See Section 4.4.1 Operational Monitoring and Evaluation. Section 4.7 Operational and scientific monitoring.	
		■	Use oil monitoring (OM) program data to determine scientific monitoring (SM) activation.	See Section 4.7.2 Scientific monitoring and Appendix A.	
		■	Terminate response.	See Section 3.6 Response termination and Section 4 Spill Response Resources.	General response termination considerations are provided in Section 3.6 Response termination. Response strategy specific termination criteria considerations are provided in Section 4 Spill Response Resources. OMs and SMs termination criteria are provided in Appendix A.

II Abbreviations and acronyms

Abbreviation/acronym	Description
AIMS	Australian Institute of Marine Science
ALARP	as low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
ANZECC/ARMCANZ	Australian and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australia and New Zealand
AODN	Australian Ocean Data Network
ARP	applied research program
ASV	accommodation support vessel
BACI	before–after, control–impact
BIA	biologically important area
BOM	Bureau of Meteorology
CASA	Civil Aviation Safety Authority
CMT	crisis management team
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cwlth	Commonwealth
DEE	Department of the Environment and Energy (Cwlth) (formerly the Cwlth Department of the Environment)

Abbreviation/acronym	Description
DER	Department of Environmental Regulation (WA)
DIIS	Department of Industry, Innovation and Science (Cwlth)
DMIRS	Department of Mines, Industry Regulation and Safety (WA)
DNP	Director of National Parks (Cwlth)
DPaW	Department of Parks and Wildlife (WA) now WA DBCA
EEZ	exclusive economic zone
EMBA	environment that may be affected
EP	environment plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
ERT	emergency response team
ESP	environmental service provider
FOB	forward operating base
GPS	global positioning system
HSE	health, safety and environment
IAP	incident action plan
I-GEM	Industry–Government Environmental Metadata
IMG	incident management guide

Abbreviation/acronym	Description
IMT	incident management team
ITOPF	International Tanker Owners Pollution Federation Limited
JHA	job hazard analysis
JPDA	Joint Petroleum Development Area
LAT	lowest astronomical tide
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973/1978
MNES	Matter of National Environmental Significance
MoU	memorandum of understanding
MPC	marine pollution coordinator
NATA	National Association of Testing Authorities
National Plan (NatPlan)	National Plan for Maritime Environmental Emergencies
NAXA	Northern Australia Exercise Area
NOAA	National Oceanic and Atmospheric Administration (US)
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority (Cwlth)
nm	nautical mile
OM	Operational Monitoring
OPEP	oil pollution emergency plan
OPGGS (E) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cwlth)

Abbreviation/acronym	Description
OSCP	oil spill contingency plan
OSMP	Operational and Scientific Monitoring Program
OSRL	Oil Spill Response Limited
OWR	oiled wildlife response
PEARS	People, Environment, Assets, Reputation and Sustainability
POLREP	marine pollution report
PPE	personal protective equipment
PTW	permit to work
RCC	Rescue Coordination Centre
SAR	synthetic aperture radar
SCAT	shoreline clean-up and assessment technique
SIMA	spill impact mitigation assessment
SITREP	situation report
SM	scientific monitoring
SHP-MEE	State Hazard Plan – Maritime Environmental Emergencies
SOPEP	shipboard oil pollution emergency plan
TBOSIET	tropical basic offshore safety induction and emergency training
US EPA	United States Environmental Protection Agency
UXO	unexploded ordnance

Abbreviation/acronym	Description
VM	vessel master
WA	Western Australia
WA DBCA	Department of Biodiversity, Conservation and Attractions (WA)
WA DoT	Department of Transport (WA)

1 Introduction

1.1 Purpose

In accordance with Regulation 14(8) of the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS (E) Regulations), the implementation strategy for an environment plan (EP) must include an oil pollution emergency plan (OPEP).

This OPEP has been developed specifically to respond to emergency conditions as described and defined in the INPEX 2D Seismic Survey WA-532-P, WA-533-P and WA-50-L Environment Plan (Doc. No. 532-EPX-EP-001); hereafter referred to as the EP. The scope of this OPEP is consistent with the activities described in Section 3 of the EP.

The purpose of this OPEP is to:

- describe the oil spill emergency response arrangements and capabilities that are in place for the duration of the petroleum activity
- provide high-level guidance and process support for the INPEX Incident Management Team (IMT)
- demonstrate that the intent of Regulation 14(8) of the OPGGS (E) Regulations has been met.

1.2 Plan scope

INPEX defines an Emergency Condition as:

'A hazardous situation (or threat of a hazardous situation) where Company standard operating procedures will not resolve the situation safely or prevent harm to the people, environment or assets. Successful management of an emergency situation will require coordinated action to control the event, correct the consequences and return the function to a safe condition.'

The emergency condition identified in the EP is:

- vessel collision, resulting in a Group II (diesel) spill to the marine environment at the sea surface.

The activity will be conducted within the permit areas (WA-532-P, WA-533-P and WA-50-L), located in Commonwealth waters as shown in Figure 1-1.

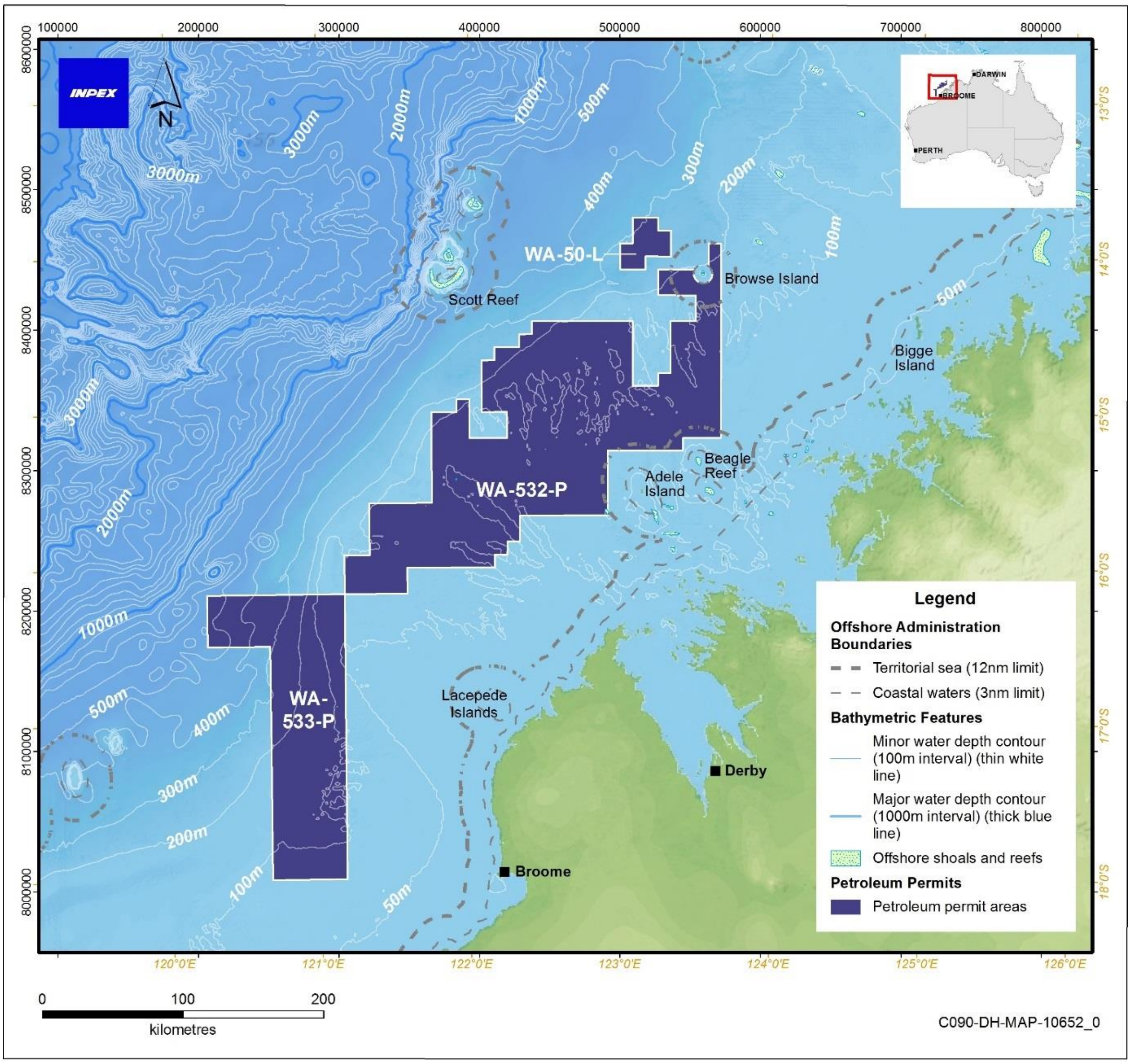


Figure 1-1: Location of WA-532-P, WA-533-P and WA-50-L permit areas

2 Spill classification and responsible agencies

2.1 Spill classification

Under the National Plan for Maritime Environmental Emergencies (AMSA 2019), marine hydrocarbon spills and their response requirements are categorised into three levels, based on a combination of factors:

- the known or inferred spill size, scale and complexity
- the likely fate of the spill
- environmental and socioeconomic values within the vicinity
- the capability of equipment in the field in regard to the spill, and the level of support required to respond.

Table 2-1 summarises the hydrocarbon spill level response models adopted for this OPEP.

In the event of a spill occurring where effective response is considered beyond the immediate response capabilities of INPEX (i.e. a spill above Level 1), the response will be escalated immediately to the next level. Spill volumes are a guide only and not to be strictly applied.

Table 2-1: Incident classification

Incident level	Spill volume (m^3)	Description
1	<10	Generally can be resolved through the application of local or initial response resources (first strike response).
2	10 to 1000	Typically more complex in size, duration, resource management and risk than Level 1 incidents. May require deployment of resources beyond the first strike response.
3	>1000	Characterised by a high degree of complexity, requiring strategic leadership and response coordination. May require national and international response resources.

2.2 Jurisdictional Authority and Control Agency

The NatPlan defines the State/Territory and Commonwealth agencies in the following terms.

Jurisdictional Authority

Any agency which has jurisdictional or legislative responsibilities for maritime environmental emergencies is obligated to work closely with the Control Agency to ensure that incident response actions are adequate.

Control Agency

The organisation that directs and manages the spill response (with response assistance provided by other parties under the direction of the Control Agency). The Control Agency responsibility does not always coincide with that of a Jurisdictional Authority. The Control Agency has the operational responsibility to take action in order to respond to an oil spill in the marine environment in accordance with the relevant contingency plan.

Table 2-2 defines the Jurisdictional Authority and Control Agency responsibilities within relevant jurisdictions.

Control Agency in Commonwealth Waters

The NatPlan specifies that for spills in Commonwealth waters, resulting from a 'Facility', the Operator shall become the Control Agency. Where the spill is not from a Facility (i.e. a vessel spill), AMSA will become the Control Agency.

Under this EP, the only credible spill scenario is a vessel collision, with AMSA as Control Agency.

In the instance that AMSA is the Control Agency, INPEX has committed under Clause 7 of a memorandum of understanding (MoU) between INPEX and AMSA, that INPEX 'agrees to provide all available support to AMSA in AMSA's performance of its Combat (Control) Agency responsibilities' (AMSA and INPEX 2013).

The MoU further states that for ship-sourced marine pollution events:

- AMSA is the designated Combat (Control) Agency for oil spills from vessels within the Commonwealth jurisdiction. Upon notification of an incident involving a ship, AMSA will assume control of the incident and respond in accordance with AMSA's Marine Pollution Response Plan.
- AMSA's Marine Pollution Response Plan is the operational response plan for the management of ship-sourced incidents.
- AMSA is to be notified immediately of all ship-sourced incidents through RCC Australia on +61 2 6230 6811.

2.2.1 Control Agency in WA waters

Incidents involving an oil spill response could result in more than one agency having jurisdictional control across the oil spill response area. This situation is possible where a significant spill (Level 2 or 3) originates from the vessel in Commonwealth waters (where AMSA is the Control Agency) and transitions into (or threatens) WA state waters.

Where there is potential for WA state water impact, under the WA State Hazard Plan - Maritime Environmental Emergencies (SHP-MEE) (WA DoT 2018), the WA Department of Transport (WA DoT) will be the Control Agency for the response activity that occurs within WA state waters.

Table 2-2: Jurisdictional boundaries for Jurisdictional Authority and Control Agencies

Jurisdictional boundary	Spill source	Jurisdictional Authority	Control Agency			Relevant documentation
			Level 1	Level 2*	Level 3*	
Commonwealth waters (3 to 200 nautical miles from territorial sea baseline).	Survey vessel in INPEX permit area.	AMSA	AMSA With support from vessel contractor and INPEX if required.	AMSA With support from vessel contractor, INPEX and AMOSC if required.	AMSA With support from vessel contractor, INPEX and AMOSC if required.	Vessel SOPEP, NatPlan and (this) INPEX OPEP
WA State waters (territorial sea baseline to 3 nautical miles and some areas around offshore atolls and islands (e.g. Browse Island)).	Survey vessel in INPEX permit area.	WA DoT	Vessel Level 1 spill response from vessel, under vessel SOPEP.	WA DoT With support from vessel contractor, INPEX and AMOSC if required	WA DoT With support from vessel contractor, INPEX and AMOSC if required.	Vessel SOPEP, SHP-MEE (WA DoT 2018) and (this) INPEX OPEP

*AMOSC and government agencies may assist the relevant Control Agency for Level 2 and Level 3 spills, as appropriate to the spill characteristics.

2.3 INPEX response team activation

Where a spill is assessed to be Level 2 or Level 3, the IMT shall be activated by the INPEX Survey Supervisor via the INPEX Emergency Call Centre.

Once the IMT has been activated it shall provide support to AMSA (as Control Agency for vessels spills) for implementing spill response control measures, interaction with regulatory authorities and support agencies, monitoring, reporting and response termination.

Further information regarding the INPEX emergency and crisis management organisation can be found within Section 9 of the EP.

2.4 Incident notification

2.4.1 Initial spill notification

The spill observer shall raise the alarm and take action to stop the spill, if possible:

- For a spill observed or detected from a vessel, the Vessel Master shall be notified.
- The Vessel Master shall alert the INPEX Survey Supervisor.
- The INPEX Survey Supervisor shall alert the IMT Leader.
- The IMT Leader shall consult with the CMT (crisis management team) Leader, and jointly determine whether to activate only the IMT or both the IMT and the CMT.

2.4.2 External agencies notification

The Vessel Master shall immediately notify AMSA, who will be the Control Agency for the spill in Commonwealth Waters.

In consultation with AMSA (as the Control Agency), the Vessel Master, Survey Supervisor and IMT Leader (as relevant) shall provide verbal notifications of Level 2 or Level 3 spill events to the organisations listed in Table 2-3.

The IMT Leader, in consultation with AMSA, should consider additional stakeholder notifications, based on values and sensitivities affected. Additional stakeholders for consideration include those listed in Table 5-1 of the EP.

If written forms are required as part of a notification, they can be identified through Table 5-1 of this OPEP.

If activated, the IMT shall notify AMOSC of the spill event. AMOSC shall provide technical support to assist and shall also provide access to oil spill response equipment and personnel, if required. Details of resource availability are provided in Section 4 of this OPEP.

2.4.3 INPEX emergency contacts directory

All relevant contact details required of this OPEP are contained within the INPEX Emergency Contacts Directory (Doc. No. C075-AH-LIS-10002), a hard copy of which is maintained in the IMT Room with an electronic copy available on the incident management system (EMQNet).

The INPEX Emergency Contacts Directory is reviewed at least annually to check all relevant call-off contracts (refer to sections 4.1 and 4.2) are included and all contact numbers are kept up to date.

Table 2-3: External notifications matrix

Contact	Comments	Method	Timing	Responsibility
Spill in any location				
AMOSC (may assist as a support response agency).	Level 2/Level 3 spill – response agency. Alert and put on standby, as required. Activate if spill response escalates in order to mobilise spill response resources.	Phone call and email. Service contract with AMOSC to be signed by IMT Leader. Refer to Table 5-1.	As soon as practicable.	IMT Leader or delegate.
OSRL (may assist as a support response agency).	Level 2/Level 3 spill – response agency. Alert and put on standby as required. Activate if spill response escalates in order to mobilise spill response resources.	Phone call and email.	As soon as practicable.	IMT Leader or delegate.
Oil spill modelling service provider.	Provide POLREP and other relevant event information to activate real-time spill modelling as soon as practicable.	Phone call first, followed by email of modelling request form. Spill modelling request / activation forms. Refer to Table 5-1.	As soon as practicable (must be activated within 2 hours of IMT formation).	IMT Leader of delegate.
Spill in Commonwealth waters				
AMSA duty officer.	Notification is required as soon as possible after the occurrence of the event. If AMSA has already been notified by the vessel ERT, IMT to confirm situational awareness and Control Agency responsibility with AMSA.	Phone call, within two hours. From vessel, the message must begin with the code word "POLREP", then the vessel name, the IMO number and the call sign of the ship. Written report within 24 hours of a request from AMSA, via POLREP form. Refer to Table 5-1. Written update via SITREP as required, via SITREP form. Refer to Table 5-1.	Verbally, within two hours. Written POLREP, within 24 hours. SITREP as required.	Vessel Master, CSR and IMT Leader or delegate (as relevant).
NOPSEMA.	Notification of reportable incidents is required under OPPGS (E) Regulations 2009, Regulations 26, 26A and 26AA.	Phone call, as soon as possible and not later than 2 hours after the occurrence of a Level 2 or Level 3 event only. Written report within three days. Use NOPSEMA report form Report of an accident, dangerous occurrence or environmental incident (FM0831). Refer to Table 5-1.	Verbally, within 2 hours. Written within three days.	INPEX CSR, or INPEX IMT Leader or delegate (as relevant).
Commonwealth Department of the Environment and Energy (DEE).	Notification is required in cases where matters of national environmental significance (MNES) are at risk, or where there is death or injury to protected species. Permits from DEE are required to enter and undertake activities in the Commonwealth marine parks.	Phone call notification within 24 hours of becoming aware of the incident or non-conformance resulting in impacts to MNES. Written / email report within 3 days.	Verbally, within 24 hours. Written, within 3 days.	IMT Leader or delegate (as relevant).

Contact	Comments	Method	Timing	Responsibility
Spill within or heading toward an Australian Marine Park				
Director National Parks (DNP).	Notify the DNP in the event of oil pollution within or heading toward an Australian marine park (AMP), or where an oil spill response action must be taken within an AMP, so far as reasonably practicable, prior to response action being taken.	Phone call to the DNP 24-hour Marine Compliance Duty Officer: 0419 293 465. The notification should include: • titleholder details • time and location of the incident (including name of marine park likely to be affected) • proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) • confirmation of providing access to relevant monitoring and evaluation reports when available; and • contact details for the response coordinator.	As soon as practicable and prior to action being taken within an AMP.	IMT Leader or delegate (as relevant).
Spill heading towards WA State waters (e.g. Browse Island, Kimberley coastline)				
WA Department of Transport (WA DoT).	Jurisdictional Authority and Control Agency for spills in WA waters. Notification is required in the event of a hydrocarbon spill which is predicted to enter WA State waters.	Phone call. Written notification by POLREP. Written update via SITREP, as required. Refer to Table 5-1.	Verbally, within two hours. Written POLREP, within 24 hours. SITREP, as required.	IMT Leader or delegate.
WA Department of Environment Regulation (DER).	Contact in the event of a hydrocarbon spill which is predicted to cause contamination of shorelines.	Phone call, as soon as practicable. Written report within 21 days.	As required.	IMT Leader or delegate.
Spill within or heading toward Defence Practice Areas				
Department of Defence.	Notification is required as soon as practicable in the event of a hydrocarbon spill which is predicted to enter the NAXA, Yampi Sound or any other defence area. Notification may be required if significant vessel mobilisations or activities are required within a Defence Practice Area to ensure response vessels have clearance to access any currently active Defence Practice Areas.	Phone call to Department of Defence – Defence Switchboard. Relevant contacts: Director General Maritime Operations, Headquarters Joint Operations Command. Assistant Secretary, Property Management Branch.	As soon as practicable.	IMT Leader or delegate.
Spill heading towards Indonesia or East Timorese waters				
Department of Industry, Innovation and Science (DIIS).	In the event that a spill is predicted to enter Indonesian or East Timorese waters, or the Joint Petroleum Development Area (JPDA), the Australian Government is required to notify the international governments. DIIS will notify the	Phone call to DIIS.	As soon as practicable.	IMT Leader or delegate, in consultation with CMT.

Contact	Comments	Method	Timing	Responsibility
	Department of Foreign Affairs and Trade, who will notify the relevant foreign government.			

2.5 Pollution report (POLREP)

A marine pollution report (POLREP) is required to be sent to AMSA for any vessel-based spill.

The POLREP should also be sent to the IMT, as it contains the relevant information necessary for the IMT to gain initial situational awareness.

The following information shall be included in the POLREP regarding any vessel spill for reporting and response planning purposes:

- the name of vessel
- the date and time of the spill
- the location of the spill
- details of the spilled material
- the source and cause of the spill
- an estimated volume of the spill
- the vessel/Facility status (stability, condition of the ship etc.)
- the estimated rate of release and maximum credible volume if the spill is ongoing
- the condition of the spill, i.e. stopped/ongoing, contained/uncontained
- the meteorological conditions:
  - air temperature
  - wind speed and direction
  - visibility
- the oceanographic conditions:
  - sea temperature
  - current speed and direction
  - Beaufort sea state.

See Table 5-1 for further information regarding POLREP template and submission timeframes.

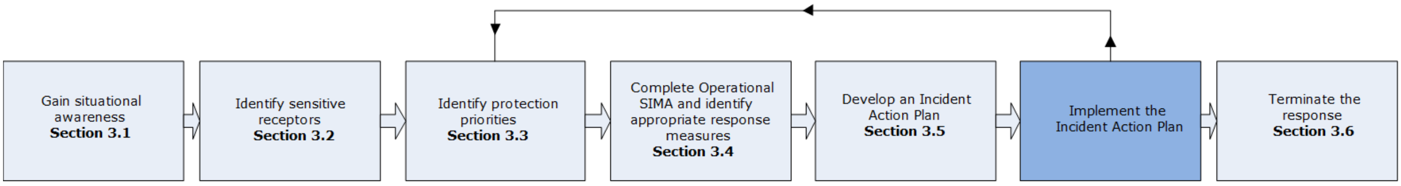
2.6 Immediate (first strike) response measures

The immediate response has been predetermined by the Operational SIMA (see Section 3.4) and must be implemented as soon as practicable, before the development of IAPs.

The immediate response for all Level 2 and Level 3 spill events is Operational Monitoring and Evaluation, as detailed in Section 4.4.1 of this OPEP.

Further details are also provided in Appendix A (OM01 and OM03).

3 Incident action plan (IAP) development



The process for identifying appropriate IAPs is illustrated in Figure 3-1.

Figure 3-1: Typical response procedure

3.1 Gain situational awareness

The IMT will gain situational awareness from all available sources including:

- Operational Monitoring and Evaluation data
- vessel or Facility POLREP
- ongoing updates from the vessel
- long-term weather forecast
- Bureau of Meteorology (BOM) weather stations
- other vessels or Facilities in the vicinity
- other operators' activities.

3.2 Identify sensitive receptors

Particular values and sensitivities with the potential to be exposed to a spill event have been identified within Section 4 of the EP.

The INPEX IMT room is equipped with maps and tools to identify actual/real-time exposure risks.

Where there is a seasonal component associated with a particular value or sensitivity, it is shown in Table 3-1.

Table 3-1: Seasonality of values and sensitivities

Values and sensitivities	Example Locations	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coral spawning (offshore reefs)	Browse Island, Kimberley coast, Rowley Shoals, Scott Reef, Seringapatam Reef, Rowley Shoals, Hibernia Reef												
Green turtle breeding and hatching	Browse Island and Scott Reef (Sandy Islet)*												
	80 Mile Beach, Adele, Lacepede Islands, Cassini and Maret Islands***												
	Mainland east of Mary Island to mainland adjacent to Murrara Island including adjacent offshore islands												
Turtle foraging	Turtle foraging BIA												
Hawksbill turtle nesting	Scott Reef*												
Olive ridley turtle nesting	Kimberley coast*												
Flatback Turtle Nesting	Buccaneer, Bonaparte Archipelago and Eastern Kimberley (including Cape Dommett)***												
	SW Kimberley including Lacepede Islands, Echo Beach and Eighty Mile Beach*												
Humpback whale migration	Kimberley coast							Northern and southern migration					
Humpback whale calving	North-west Commonwealth Marine Reserves Network, Lalang-garram / Camden Sound Marine Park and humpback whale Biologically Important Areas (BIA)***							Whales present in calving grounds					
Blue whale and pygmy blue whale migration	Open ocean (approx. 500 m depth contour)				Northern migration					Southern migration			
Whale shark	Whale shark BIA												
Dugong and Inshore Dolphins	WA coast, North Kimberley Marine Park and Roebuck Bay***												
Seabird feeding, aggregation and breeding	Marine avifauna BIA (e.g Browse Island), Ramsar sites, Kimberley coastline and Pilbara coastline				Breeding and foraging								
Shorebird migration	Migratory birds present in coastal habitats				Northern migration					Southern migration			
Shorebird breeding	Marine avifauna BIA and WA coastline												
Indonesian traditional fishing**	Offshore islands and reefs located within the traditional fishing MoU area.												
Recreational fishing**	Open ocean, NT coastline and WA coast												
Commercial fishing**	Within and adjacent to the permit area.												

Values and sensitivities	Example Locations	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Legend													
	Peak occurrence/activity (reliable and predictable)												
	Intermediate occurrence/activity (less reliable and less predictable)												
	Low occurrence/activity (may vary from year to year)												
	No occurrence												

* Source: DEE (2017).

** Refer to Table 4-8 of the EP for more detail regarding spawning times for individual species, as relevant to each fishery

*** Source: Waples et al. (2019)

3.3 Identify protection priorities

In the event of a spill, the primary aims of the response will be aligned with the NatPlan (AMSA 2019) and the INPEX People, Environment, Assets, Reputation and Sustainability (PEARS) model and include protection of the following, in descending order of priority:

- human health and safety
- habitat and cultural resources (environmental sensitivities)
- rare and/or endangered flora and fauna (environmental sensitivities)
- commercial resources
- amenities.

Table 3-2 illustrates how shoreline protection priorities are determined. Each shoreline location is evaluated based on predicted time to contact and consequence of contact.

The level of consequence associated with identified values and sensitivities is defined within Section 8 of the EP.

Time to contact during a spill event will be based on the location and trajectory (model outputs) and visual observations of the spill.

Table 3-2: Protection priority matrix

		Time to contact			
		<24 hours	24-48 hours	48-72 hours	>72 hours
	Multiplier	4	3	2	1
Catastrophic	6	24	18	12	6
Major	5	20	15	10	5
Significant	4	16	12	8	4
Moderate	3	12	9	6	3
Minor	2	8	6	4	2
Insignificant	1	4	3	2	1

Based on the modelling results for the Group II (marine diesel) (RPS 2019) spill scenarios, the shoreline protection priorities are shown in Table 3-3. Note that only locations with a minimum time to exposure of 336 hours or less were included in the table as anything over two weeks (14 days) is considered outside of the early IMT planning and IAP development cycle.

Table 3-3: Protection priorities for Group II spill event

Location	Minimum time to exposure	Worst-case consequence evaluation (See Section 8 of the EP)	Priority
Browse Island	1 hour	Significant	High (16)
Adele Island	5 hours	Significant	High (16)
Lacapede Islands	34 hours	Significant	Medium (8)
Sandy Islet - Scott Reef	35 hours	Significant	Medium (8)
Buccaneer Archipelago	55 hours	Significant	Medium (8)
Clerke Reef - Rowley Shoals	56 hours	Significant	Medium (8)
North Broome Coast	58 hours	Significant	Medium (8)
Lalang-garram / Camden Sound Marine Park	68 hours	Significant	Medium (8)
Imperieuse Reef - Rowley Shoals	112 hours	Significant	Low (4)
Northern Dampier Peninsula	204 hours	Significant	Low (4)
Bonaparte Archipelago	240 hours	Significant	Low (4)

In the event of a spill, the protection priorities identified should be confirmed by reviewing the specific information relating to the spill received from Operational Monitoring and Evaluation data and predicted time to exposure based on spill model outputs.

Note that WA DoT are the Control Agency in the event of a spill in WA State waters and have the final decision regarding protection priorities, response strategies and tactics.

3.4 Operational SIMA

Strategic spill impact mitigation assessments (SIMAs) for the vessel collision spill scenario is located in Appendix F of the EP. This OPEP provides an 'Operational SIMA Template' for the relevant spill scenario (Group II (marine diesel)). The Operational SIMA template includes a summary of key points from the Strategic SIMA.

During an oil spill emergency event, the IMT will develop an Operational SIMA by evaluating the validity of the assumptions of the Strategic SIMA, which are summarised in the Operational SIMA template including relevant ALARP considerations from Section 8 of the EP. The Operational SIMA would need to consider the specific conditions of the spill event, such as the oil type, spill location and trajectory, the sea state and weather forecast, environmental sensitivities and seasonality, which may have a bearing on the effectiveness and feasibility of implementing various responses.

The outcome of the Operational SIMA will be used in development of the IAP(s).

The Operational SIMA shall remain as a record of the reasoning behind the selection or elimination of various response measures during an actual event.

The Operational SIMA and IAP may need to be revised if additional information arises.

See Table 3-4 for the Operational SIMA templates for Group II spills.

Table 3-4: Operational SIMA template - Group II/Diesel spills

Response measure	Strategic SIMA Summary	ALARP Summary	Operational SIMA comments	IMT Leader sign-off
Operational Monitoring and Evaluation	Operational Monitoring and Evaluation will provide timely information to the IMT, enabling situational awareness to assist with IAP development, implementation and termination of oil spill response strategies. Operational monitoring and evaluation **<u>shall</u>** be implemented for any Level 2/3 spill.	Prioritise the activation of the following activities: Oil Spill Trajectory Modelling, Aerial Surveillance, and deployment of oil spill tracker buoys. Consider the flammability levels and VOC exposure for any oil spill tracker buoy deployments and aerial/vessel observation tasks. Use of crew change helicopters for aerial surveillance should only be during initial stages of a spill, and only when helicopters are not required for other emergency tasks. Longer-term aerial surveillance operations should utilise fixed-wing aircraft. Trained aerial observers should be arranged for longer-term aerial surveillance operations. Vessel surveillance is less efficient than aerial surveillance. Data from opportunistic vessels sightings can be collected, but this should not be a primary strategy for visual observations of slicks over large areas. Consider satellite imagery acquisition to complement longer-term aerial surveillance programs and support OSTM validation.		
Shoreline clean-up	Shoreline clean-up has been consistently found to not enhance ecological recovery of oiled coastlines (Sell et al. 1995) but it may protect other resources in the area, such as birds, marine mammals or subtidal habitats including coral reefs or fish farms (CSIRO 2016). Choosing a particular clean-up technique is dependent on factors such as shoreline type, exposure, sensitivity, amount of oil, persistence of oil, toxicity of oil and rate of natural oil removal (IPIECA 2015). The clean-up of Group II spills on a shoreline is likely to be difficult, generating high volumes of waste in comparison to the volume of oil recovered. Most offshore island shorelines would be expected to 'self-clean' any accumulated Group II oils, due to the lack of adhesiveness of these oil types, the coarse substrate, the high wave energy and high tidal regime. Sensitive shorelines with lower energy, such as mudflats and mangroves on the WA/NT coastline and any coral reefs would likely be damaged by the physical activities associated with shoreline clean-up, and therefore these locations would also be left to self-clean.	Weathered diesel is a relatively non-adhesive oil and is not expected to form a thick adhesive layer on a shoreline. Utilise Operational Monitoring and Evaluation data (including shoreline clean-up assessments) to determine the likely success of any shoreline clean-up response compared to allowing natural weathering to occur. Shoreline clean-up techniques should focus on manual clean-up techniques, such as the use of rakes and shovels. Mechanical clean-up equipment (graders, loaders etc) should not be used to physically collect oil. However, small mechanical aids (e.g. rubber tracked bob-cats) can be used to assist in moving collected oily waste around a shoreline. Careful planning of track routes is required to avoid disturbance of any turtle/bird nesting sites. Personnel and equipment transport to and from the shoreline would be by small utility helicopter and/or vessels. Low sea-states and calm weather are required for use of vessels for shoreline landings. Tide forecasts should also be consulted to ensure appropriate and safe vessel activities. A large support vessel or Facility (with a helicopter pad, if relevant) would need to be used as the accommodation and logistics base for shoreline response personnel at remote locations. Upon successful clean-up of the shoreline, bulka bags/IBCs containing oily contaminated waste would be transferred by helicopter or landing barge to a support vessel, for further transport to the mainland for appropriate disposal with a licenced waste contractor. In general, to reduce wildlife disturbance on small, offshore remote locations, a longer duration response with minimum numbers of response personnel required to achieve the IAP objective is desired.		

Response measure	Strategic SIMA Summary	ALARP Summary	Operational SIMA comments	IMT Leader sign-off
Pre-contact oiled wildlife response	Group II hydrocarbons are not likely to generate a thick surface layer on the ocean surface or on a shoreline. Therefore, there is reduced potential to coat adult nesting turtles or turtle hatchlings as they transit to the ocean, or coat large numbers of seabirds. Wildlife hazing can be an effective control measure when deployed across a limited geographical area and against specific wildlife population, where the surface oil resulting from a spill is largely contained, e.g. at a beach/specific shoreline. Capture and translocation of turtles (adults and hatchlings) from a shoreline to an area away from the slick may provide an environmental benefit, however minimising the time during which turtles (especially hatchlings) are in captivity is critical to success of the operation. Wildlife hazing in the open ocean is inherently unlikely to be effective due to a number of limitations, including numbers of vessels required and associated safety issues, ongoing spread and movement of the slick and hazed animals moving into adjacent areas of the slick. Attempting to capture large numbers (or an entire flock) of healthy seabirds would be very challenging, if not impossible (DPaW and AMOSC 2014), especially at a remote shoreline location (e.g. Browse Island). There is no practicable method to capture healthy seabirds at sea (DPaW and AMOSC 2014). Potential harm to healthy seabirds could occur during the capture process. Any seabirds released would likely fly back to the shoreline from which they originally were captured. Long term veterinary care (e.g. feeding) would be required for any successfully captured birds, until spill weathering or remediation has occurred, and it was safe to release the animals. Animals would be under stress while in veterinary care/rehabilitation facilities and potentially exposed to human and zoonotic diseases, which could be spread to wild populations upon their release.	Wildlife hazing or wildlife capture and translocation in the open ocean should only be considered when Operational Monitoring and Evaluation data clearly indicates that a positive outcome could be achieved. The merits of wildlife hazing or wildlife capture and translocation at a shoreline should be considered by the IMT when Operational Monitoring and Evaluation data indicates that populations of wildlife on a shoreline may be at risk of an inbound spill and conditions are suitable for this activity to occur. There are significant manual handling risks associated with translocating adult turtles, (adult green turtles are often >100kg), which need to be evaluated and managed if this activity is to occur. Therefore, translocation of turtle hatchlings is more likely to be successful. Wildlife response personnel and equipment transport to and from the shoreline would be by small utility helicopter and/or vessels. Low sea-states and calm weather are required for use of vessels for shoreline landings. Tide forecasts should also be consulted to ensure appropriate and safe vessel activities. A large support vessel or Facility (with a helicopter pad, if relevant) would need to be used as the accommodation and logistics base for shoreline response personnel. In general, to reduce wildlife disturbance on small, offshore remote locations, a longer duration response with minimum numbers of response personnel required to achieve the IAP objective is desired.		

Response measure	Strategic SIMA Summary	ALARP Summary	Operational SIMA comments	IMT Leader sign-off
Post-contact oiled wildlife response	Group II hydrocarbons are relatively non-adhesive compared to crude oils, and generally not considered an oil product that would 'coat' the feathers of birds, requiring a full wildlife cleaning response on a shoreline. They are also not likely to generate a thick surface barrier on a shoreline which would coat adult nesting turtles or turtle hatchlings as they transit to the ocean. Capture, relocation, assessment, cleaning and rehabilitation of oiled wildlife has the ability to increase the survival of individuals. ITOPF (2011) note that there are many cases where oiled turtles have been cleaned successfully and returned to the water. Once oiled, it is generally agreed that the bird species present in the Browse Basin region will have very low survival rates, even when rescue and cleaning is attempted. Any seabirds captured, cleaned and released would likely fly back to the shoreline from which they were originally captured. Therefore, long-term veterinary care (e.g. rehabilitation, feeding, etc.) would be required for any successfully captured birds, until spill weathering or remediation had occurred, and it was safe to release the seabirds. Animals would be under stress while in veterinary care/rehabilitation facilities and potentially exposed to human and zoonotic diseases, which could be spread to wild populations upon their release.	Oiled wildlife capture in the open ocean should only be considered when Operational monitoring and evaluation data clearly indicates that a positive outcome could be achieved. The merits of wildlife capture, cleaning and rehabilitation at a shoreline should be considered by the IMT when Operational Monitoring and Evaluation data indicates that populations of wildlife on a shoreline have been impacted by the spill and conditions are suitable for this activity to occur. Wildlife response personnel and equipment transport to and from the shoreline would be by small utility helicopter and/or vessels. Low sea-states and calm weather are required for use of vessels for shoreline landings. Tide forecasts should also be consulted to ensure appropriate and safe vessel activities. A large support vessel or Facility (with a helicopter pad, if relevant) would need to be used as the accommodation and logistics base for shoreline response personnel, including temporary oiled wildlife stabilisation facility. In general, to reduce wildlife disturbance on small, offshore remote locations, a longer duration response with minimum numbers of response personnel required to achieve the IAP objective is desired.		

3.5 Develop an Incident Action Plan

The IMT shall prepare an IAP once it has gained accurate and reliable situational awareness, reviewed protection priorities and completed the Operational SIMA. Note that this section should be read in conjunction with the INPEX Australia Incident Management Plan (0000-AH-PLN-60005) which contains descriptions of IMT roles and the emergency management competency training associated with these roles.

An IAP is typically prepared for response activities beyond the immediate response measures (first strike) timeframe.

The IAP shall:

- establish the overall incident response objectives and strategies – determine what is to be achieved, where, when and by whom?
- ensure continuity of incident control – decisions are made and agreed at one location and cascaded down
- provide for effective use of resources – usage is coordinated from one central location, facilitating more accurate planning and resource allocation.

The IAP shall be the mechanism for oil spill management from the moment it comes into force through to the termination of the response. The intent is that it is used to direct response operations while ensuring that everyone involved in the response is mitigating identified risks and working towards the same objectives and priorities. It shall therefore:

- provide responders with clear strategies on what needs to be done
- supply information on the resources, methods and protocols to be used in order to keep the entire response effective
- provide documentation regarding the decisions, strategies, safety concerns, plans and other key pieces of information critical to achieving the incident response objectives. It will be the document referred to when dealing with post-incident analysis on issues such as cost and legal requirements, as well as the overall effectiveness of the response and its personnel.

The IAP shall be documented and given a period of operational validity (from–to date and time). The plan shall be revisited and updated prior to the next operational period.

The basic steps for IAP development are provided in Table 3-5 and a copy of the INPEX IAP template is provided in Appendix B.

Table 3-5: IAP development

Step	Action
1.	Incident objectives are set. The IMT Leader shall approve the objectives.
2.	IMT tactics meeting to develop supporting strategies and tactics to achieve incident objectives. This involves identifying strategies and tactics that when implemented will achieve incident objectives.
3.	Information is collected in preparation for a planning meeting. Includes resource identification and availability, safety requirements, environmental impact, potential and current situation reports and maps to support the plan to achieve the identified objectives.
4.	Planning meeting to compile information to complete IAP. An overview of the proposed plan is given to the full IMT. This includes the general concept, work assignments, resources, incident projections and an estimated impact of strategies in containing/controlling the incident. After review, any amendments should be captured and incorporated into an overall plan.
5.	IAP developed and approved by IMT Leader. IMT members responsible for areas of plan development provide information for inclusion in the IAP. The IAP is approved by the IMT Leader.
6.	Operations briefing. A briefing is given to inform all members of the IMT and those implementing the plan so they are aware of the planned actions and any specific task allocations they are required to complete. This shall include any safety considerations and need to provide status updates and briefings on incident progress. In early stages of an incident this may be an oral briefing only. In later stages, it is anticipated this will involve written material to support the oral briefing.
7.	IAP dissemination and execution. The IAP is circulated and planned actions and tasks to meet plan objectives are completed as per plan requirements.
8.	Progress against incident objectives is assessed. Situation reports and status briefings provide progress against the objectives and identify any obstacles to achieving objectives. This information is the commencement point for the development of the IAP for the next operational period.
9.	Return to item 1 and develop plan for next operational period as defined by the IMT Leader.

3.6 Response termination

The termination of a response to a Level 2 or Level 3 spill within Commonwealth waters shall be only when the following conditions have been fulfilled, as determined by the IMT Leader, in consultation with AMSA, DEE and AMOSC:

- when the source of the spill has been stopped
- when the objectives of the Incident Action Plans have been met
- when there are no further practicable steps that can be taken to respond to a spill.

The termination of a response to a spill which has entered WA state waters will be the responsibility of WA DoT.

Relevant factors to consider for termination of each response strategy is provided within each strategy sub-section in Section 4.

Termination criteria for the Operational and Scientific Monitoring Programs (OSMP) are detailed in Appendix A.

4 Spill Response Resources

4.1 Support vessel availability

INPEX maintain a range of support vessel call-off contracts with various support vessel providers. Call-off contracts allow for mobilisation of available support vessels, including for oil spill response.

Support vessel contracts range from small ~10–40 m support vessels and landing barges for coastal/nearshore, or light weight equipment activities offshore, to larger ~50–130 m offshore support vessels capable of long-duration responses activities.

Large offshore support vessels can be used as accommodation support vessels, for shoreline response activities. Large vessels with helicopter pads will facilitate faster, more efficient crew changes, which could be required during long duration response activities, or support a light utility helicopter, if required for shoreline response activities.

INPEX requires all vessels to comply with the INPEX Marine Standard (0000-AG-STD-60002) and Vessel Inspection Work Instruction (0000-AG-WIN-60029), which includes processes to enable rapid inspection and approval for use of vessels in emergency situations. In an emergency event where a vessel may be required immediately and is unable to meet marine inspection procedure requirements, the Marine Manager or delegate shall perform a suitable audit of the vessel, which may be performed as a desktop exercise.

The IMT Leader is responsible for the activation and mobilisation of support vessels under the 'manual of authorities' specified in the INPEX Emergency Management Guideline.

Contact details to activate the available support vessel contractors are listed in the INPEX Emergency Contacts Directory (Doc. No. C075-AH-LIS-10002).

4.2 Aviation asset availability

INPEX maintains a range of aviation support call-off contracts with various fixed-wing aircraft and helicopter providers. These call-off contracts allow for mobilisation of available aviation assets, including for oil spill response.

Crew change helicopters can be used for routine crew change activities to approved helicopter pads.

Fixed wing aircraft are best suited to ongoing aerial observations.

Light utility helicopters can be mobilised for specific tasks such as mobilisation of personnel and equipment and removal of waste from remote shoreline locations, or for operational monitoring and evaluation at remote shorelines, where close inspection is required.

INPEX requires all aircrafts to comply with the INPEX Aviation Standard (Doc. No. 0000-AG-STD-60003). In an emergency event where an aircraft may be required and is unable to meet the INPEX Aviation Standard, the Aviation Manager or delegate shall perform a desktop risk assessment, taking into account the nature of the proposed activity and its urgency, before making any exemption.

Contact details for the available aviation asset contractors are listed in the INPEX Emergency Contacts Directory (Doc. No. C075-AH-LIS-10002).

4.3 Oil Spill Preparedness and Response Register

INPEX maintains an internal Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).

This register is maintained on INPEX's Document Management System (SmartPlant)

It can be accessed during any spill event and includes the following information:

- INPEX oil spill response key contracts
- INPEX personnel trained in oil spill response and their level of training
- INPEX oil spill satellite tracking buoys – including their location, servicing schedule and log-in details to the satellite tracking website
- AMOSC equipment register(s) and trained aerial observers
- OSRL support capabilities and activation processes
- Broome, Darwin Port and AMSA stockpile inventory lists, including oiled wildlife response kits.

4.4 Immediate (first strike) response measures and relevant arrangements (resources and equipment)

For the recommended response strategies identified within Operational SIMAs (Section 3.4), a summary and demonstration of preparedness is provided below.

4.4.1 Operational Monitoring and Evaluation

Operational Monitoring and Evaluation does not in itself control or reduce the impacts of the spill, however, it allows response team managers/IMT to maintain situational awareness. This is vital in a number of respects as it:

- addresses some of the key information requirements necessary for spill management:
  - where the spill is
  - how big it is
  - where it is going
  - how long it will take to get there.
- facilitates internal and external initial notification and subsequent reporting
- provides information critical for identifying sensitive receptors under threat, identifies protection priorities, and informs Operational SIMA and IAP development
- identifies the trajectory of the spill and thereby defines the potential stakeholders and environment that may be affected (EMBA) by the oil. This will inform any subsequent scientific monitoring and recovery phase actions.

Depending on the spill type and volume, Operational Monitoring and Evaluation techniques that may be used to gain situational awareness could include:

- oil spill trajectory modelling
- electronic surface tracking buoy(s)
- aerial surveillance
- vessel surveillance
- satellite imagery analysis.

The Operational Monitoring and Evaluation program is effectively comprised of Oil Spill Trajectory Modelling (OM01) and Oil Spill Surveillance and Reconnaissance (OM03). Additional details are provided in Section 4.7 and Appendix A.

Termination of the response will be determined by the IMT in collaboration with relevant stakeholders. This decision will take into consideration factors such as whether:

- the source of the spill has been stopped
- the objectives of the IAPs have been met
- there are no further practicable steps that can be taken to respond to a spill
- whether cleaning techniques have become ineffective
- whether pre-agreed criteria on the level of clean have been achieved and thus situational awareness can be terminated or scaled down
- termination criteria for OM01 and OM03 specified in Appendix A.

Oil spill trajectory modelling

Oil spill modelling can be used to forecast the trajectory and fate of oil plumes resulting from surface or subsurface releases. It can be initiated almost immediately and provides rapid results. However, its accuracy depends on the spill estimates and the predicted metocean data, as well as the reliability of forecasts of wind speed and direction.

Oil spill trajectory modelling is an iterative process, whereby real-time observations from vessel/aerial surveillance, electronic surface tracking buoy data and/or satellite imagery, is used to refine modelling predictions, using both hindcast and forecasting techniques.

INPEX maintain a contract with an oil spill trajectory modelling provider, which enables 24-hour per day access to real-time oil spill modelling capability. Contact details for the provider are contained in the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and oil spill trajectory modelling activation forms can be accessed via the INPEX Oil Spill Forms Register (C075-AH-LIS-10006) (Table 5-1).

Further details regarding oil spill trajectory modelling are provided in Appendix A (refer OM01).

Electronic surface tracking buoys

Electronic surface tracking buoys can be rapidly deployed at, or near to, the site of a spill, from support vessels or helicopters. Thereafter, they drift with the surface currents (their design minimises wind influence). The buoys transmit their global positioning system (GPS) location in near real-time, and the data is delivered to an online data management portal. The buoys enable the trajectory of surface oil to be tracked. However, they are not able to provide information on the direction or strength of subsurface currents, nor the trajectory of dissolved and entrained oil resulting from a subsurface spill.

INPEX maintains ten electronic surface tracking buoys to be strategically placed across various work activities. At least one tracking buoy will remain onshore so it could be deployed from the air to any spill location. It should be noted, however, that deployment of articles from aircraft, including satellite tracking buoys, require Civil Aviation Safety Authority (CASA) permission. INPEX will consider initiating a special helicopter deployment from Broome/Darwin if required, and if CASA permission can be achieved.

For the duration of the seismic survey, two tracking buoys will be located on the seismic survey vessel.

Aerial surveillance

Aerial observation is a very effective way of establishing the location and extent of a spill and verifying predictions of its movement and fate. The INPEX Oil Spill Observation and Dispersant Application Guide (refer to Table 5-1) provides additional guidance on estimating extent and volume of the spill. Key considerations associated with this activity are as follows:

- Flights shall be made regularly and where possible timed at the beginning or end of each day so that results can be used by the IMT and other response agencies.
- Flight paths and timetables should be coordinated.
- Aerial observers shall be trained, experienced and able to reliably detect, recognise and record oil pollution at sea.
- Preferably, there should be a consistency of at least one observer throughout a series of flights, so that variations in reports reflect changes in the state of oil pollution and not differences between the perceptions of observers.
- Aircraft used for aerial observation should preferably feature good, all-round visibility.
- Over the open sea, the use of fixed-wing aircraft (rather than helicopters) is preferable, due to their superior speed and range. The extra margin of safety afforded by a twin-engine or multi-engine aircraft is essential. However, helicopter observations may be required to allow for closer inspection of shorelines, such as at Browse Island or WA coastlines.
- Weather conditions can affect visibility and may therefore make surveillance flying impractical.
- The minimum deployment time of surveillance aircraft and personnel is typically in the order of 24 hours.
- Aircraft of opportunity with untrained observers, such as helicopter flights on crew change and Coastwatch aircraft (via AMSA) can also be requested to provide any relevant information available to them, which may improve situational awareness.

Vessel surveillance

Oil spill surveillance can be carried out from vessels, although its practicality is limited by the number of available vessels and the scale of the spill.

For smaller spills, their dimensions, direction of travel, colour and state of weathering can be reasonably well estimated and reported. For large spills, it would be difficult to accurately estimate the size of a slick from the bridge of a vessel because sight is limited to the horizon. However, it would be possible to determine what is happening to the oil, such as its colour, thickness, weathering and the slick’s direction of travel.

Satellite imagery analysis

Satellite-based remote sensors can be used to detect oil on water and, because such images cover extensive sea areas, they can provide a comprehensive picture of the overall extent of pollution from a spill. The sensors used include those operating in the visible and infrared regions of the spectrum, and synthetic aperture radar (SAR).

Optical observations of oil require clear, daylight skies, thereby severely limiting the application of such systems. SAR, on the other hand, is not limited by the presence of cloud and, since it does not rely on reflected light, remains operational at night. However, radar imagery often includes a number of anomalous features, or false positives, such as algal blooms, wind shadows and rain squalls, which can be mistaken for oil. Consequently, the imagery requires expert interpretation.

The minimum time for satellite imagery in the permit area from commercial suppliers is anticipated to be between 24 and 48 hours.

Arrangements and capabilities

The arrangements and capabilities as described in the subsections above are summarised in Table 4-1.

Table 4-1: Arrangements and capabilities – Operational Monitoring and Evaluation

Technique	Resource capability and availability	Implementation time	Activation
Oil spill trajectory modelling (OSTM)	INPEX maintain a contracted spill modelling service provider for 24-hour support.	OSTM contractor activated within 2 hours of IMT formation.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002). Trajectory modelling activation forms in Table 5-1.
Aerial surveillance	Crew change / SAR helicopters is the initial aerial surveillance capability. Fixed wing aircraft can also be mobilised for longer term aerial surveillance activities.	Crew-change helicopters commence surveillance activities at the spill location within 5 hours of IMT activation. (daylight hours only).	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
	Trained aerial observers can be sourced via AMOSC/AMSA and mobilised to an aircraft.	Commence aerial observation task from Broome/Darwin within 48 hours.	
Vessel surveillance	Smaller support vessel assets less than 40 m in length.	Complete mobilisation and depart Broome/Darwin wharf within 24 hours.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
	Larger support vessels.	Complete mobilisation and depart Broome/Darwin wharf within 48 hours.	
Electronic surface tracking buoy(s)	INPEX has several surface tracking buoys which it positions at operational locations, as deemed appropriate by INPEX. 2 tracking buoys will be located on the seismic survey vessel. At least one tracking buoy will be maintained onshore (i.e. at Broome or Darwin) which can be deployed from an aircraft to any spill location (if CASA has granted permission to undertake this aerial deployment activity).	Immediately where available on the vessels supporting the seismic acquisition 24 hours for tracking buoys located at operational locations / onshore to be deployed by other vessels of opportunity.	Tracking buoy locations managed via the Oil Spill Preparedness and Response Register. Tracking buoys deployed from vessels or aircraft, as directed by the Vessel Master/CSR or IMT. Tracking buoy online tracking tool activated by IMT.
Satellite imagery analysis	Sourced via OSRL and/or AMSA.	Images available in the IMT within 48 hours.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register.

4.5 Secondary response measures and relevant arrangements (resources and equipment)

4.5.1 Shoreline clean-up

The IMT shall consider all Operational Monitoring and Evaluation data to determine potential or actual shoreline contact and potential impacts. The INPEX IMT will need to consider, in consultation with WA DoT, the practicalities, likely success and risks associated with a shoreline clean-up operation, compared with allowing stranded oil to naturally weather.

More detailed planning regarding a shoreline clean-up are available in the Browse Island Oil Spill IMG (X060-AH-GLN-60015). This document also provides guidance on response at any remote shoreline.

There are several logistical options available to conduct shoreline clean-up at Browse Island or other remote shoreline locations.

If weather/sea state conditions are benign, a fully vessel based logistical solution may be practicable. This would involve the use of an accommodation support vessel (ASV) as the Forward Operating Base (FOB), and tenders/landing barges to move people and equipment between the FOB and the shoreline.

If weather conditions or other factors preclude the use of small landing craft, light utility helicopters, launched from an ASV helideck would be required.

Crew changes could occur via vessel or crew change helicopter, depending on the situation.

A shoreline clean-up would most likely involve the mobilisation of personnel and manual cleaning equipment such as rakes and shovels, to remove the oil from the shoreline. Oily contaminated waste would be stored in impermeable bulka bags or other similar small impermeable waste collection containers. The oily waste containers would then most likely be backloaded to the ASV, either using a landing barge or slung underneath a light utility helicopter. The waste would then transport to shore for appropriate disposal.

Large mechanical equipment such as graders would not be appropriate for remote shoreline clean-up (risk of secondary contamination and general difficulty in mobilising this equipment). However, smaller machines such as rubber tracked bob-cats could be used to help transport collected oily waste and other response equipment around the shoreline.

There are significant logistical constraints and HSE risks with flying personnel in light utility helicopters to remote offshore locations or operating out of small vessels at remote offshore locations. Also, there is the potential disturb wildlife populations on small islands by landing large numbers of response personnel. Therefore, the number of shoreline response personnel working in remote locations at any one time will be agreed in consultation with the WA DoT but is likely to be limited to between 20 and 30 people at any one location.

In a typical shoreline response, a worker is expected to clean between 0.5 to 1.0 m^3 of oily waste per day. Given the hot climates of the Browse Basin, a lower estimate of 0.5 m^3 of oily waste, per person, per day would be appropriate.

Depending on the duration of the operations, this may require the establishment of a one or two week on/off roster system, drawing on trained personnel from AMOSC, and other labour hire sources, until the response is terminated.

A decontamination staging post would be established at the clean-up location to enable decontamination of equipment and personnel before demobilisation at the end of each day. Ultimately, all contaminated equipment and personal protective equipment (PPE) would be back-loaded from the location to the mainland for cleaning or appropriate disposal.

During any shoreline clean-up, a daily progress report will be provided by the response team to the IMT Leader regarding the effectiveness of the activity. The report shall include, as a minimum:

- date(s), time(s) and location(s) of shoreline clean-up activities
- the volume of oily waste generated and disposed of
- the overall effectiveness of shoreline clean-up activities (including photographic evidence, where possible).

Shoreline clean-up operations are often considered in three stages; Stage 1 - bulk oil is removed from the shore to prevent remobilisation; Stage 2 - removal of stranded oil and oiled shoreline material which is often the most protracted part of shoreline clean-up, and; Stage 3 - final clean-up of light contamination and removal of stains, if required. Depending upon the nature of the contamination, progression through each of these stages may not be required, depending on the termination criteria set by the IMT.

Termination criteria highlight when continuing clean-up activities may be detrimental to recovery as well as costly (Ecosystem Management and Associates 2008). Termination of response will be determined by the IMT in collaboration with relevant stakeholders and will consider factors including the following:

- the safety of responders
- the current effectiveness of the response
- deteriorating weather conditions (including wind, visibility and sea conditions).

AMSA present guidelines for agreed environmental values and acceptable levels of clean which are useful in guiding the IMT. AMSA (2019) note that the response for shorelines should be terminated when remaining residues are not going to inhibit potential recovery through toxic or smothering effects. Also, ITOPF (2002) suggest the use of three questions to determine when termination of the response should occur:

1) Is the remaining oil likely to damage environmentally sensitive resources?
2) Does it interfere with the aesthetic appeal and amenity use of the shoreline?
3) Is this oil detrimental to economic resources or disrupting economic activities?

If the answers to the questions are no, then there is no rationale to continue shoreline clean up. Ecosystem Management and Associates (2008) suggest that activities can conclude on exposed rocky shores when the shoreline no longer generates sheens that affect sensitive wildlife.

The final decision on whether to activate and terminate a shoreline clean-up response will remain with the WA DoT, as the Control Agency for the WA shorelines.

Arrangements and capabilities

The arrangements and capabilities as described in the subsections above are summarised in Table 4-2.

Table 4-2: Arrangement and capabilities – Shoreline clean-up

Technique	Resource capability and availability	Implementation time	Activation
Shoreline clean-up personnel	Under the WA DoT State Hazard Plan – Marine Environmental Emergency, the relevant Control Agency (WA DoT or INPEX for Commonwealth lands) will provide the On Scene Commander / Division Commander. WA DoT (as Control Agency) may choose to mobilise their own SCAT assessment and initial shoreline clean-up personnel. Additional trained shoreline response personnel would be available through AMOSC Core Group. • Additional personnel, who would receive on the job training would be sourced from: o INPEX environmental service providers o INPEX general offshore labour hire contracts	24 hours to mobilise personnel to Broome/Darwin to board vessels and/or helicopters.	IMT via the Emergency Contacts Directory (C075-AH-LIS-10002).
Shoreline clean-up equipment	WA DoT SCAT/first-strike shoreline clean-up stockpiles are located in Karratha, Fremantle and Albany. Shoreline clean-up equipment can be mobilised from the Broome or Darwin stockpiles. Additional shoreline clean-up equipment can be mobilised through AMOSC/AMSA Tier 2/3 stockpiles, or it can be purchased/hired from retail outlets in Broome/Darwin.	24 hours to mobilise shoreline response equipment from the warehouse to a support vessel alongside in Broome/Darwin Port. 24 hours to mobilise a WA DoT SCAT/shoreline response kit from Karratha to a vessel alongside Broome.	IMT via Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
Helicopters	Crew transfer helicopters (for personnel transfer to designated landing zones only, not to remote shoreline beaches).	INPEX routine crew-change helicopters always available.	IMT via the Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
	Utility helicopters suitable for landing on remote shorelines are available via INPEX aviation call-off arrangements.	Commence mobilisation activities in Broome within 7 days.	
Vessels	Smaller support vessel assets <40 m in length.	Complete mobilisation and depart Broome/Darwin wharf within 24 hours.	IMT via the Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
	Larger platform support vessels / accommodation support vessels.	Complete mobilisation and depart Broome/Darwin wharf within 48 hours.	

4.5.2 Pre-contact and post-contact oiled wildlife response

The INPEX IMT shall consult AMOSC for advice regarding any wildlife response activities, as well as consult the DEE (as the Jurisdictional Authority for wildlife in Commonwealth waters), for any risks from the spill to MNES (including oiled wildlife).

The INPEX IMT shall also consult, via WA DoT, a WA DBCA 'oiled wildlife adviser' to provide support to for any wildlife response activities, including obtaining permits to conduct an OWR in WA State waters and/or Commonwealth waters, as stated above. OWRs along the WA shoreline areas are managed under the West Kimberley Region Oiled Wildlife Response Plan (DPaW and AMOSC 2015).

More detailed planning regarding a shoreline wildlife response is also available in the Browse Island Oil Spill IMG (X060-AH-GLN-60015). This document also provides guidance on response at any remote shoreline location.

AMOSC maintains an 'oiled wildlife response capability register' on behalf of industry to support OWRs. The AMOSC register maintains currency of potential resources, such as:

- equipment and the locations of stockpiles
- response personnel (including global OWR specialists such as Sea Alarm)
- training/exercise materials
- aid (national and international).

WA DBCA and AMOSC have collaboratively developed an OWR model (shown in Figure 4-1) that is based on a small number of OWR adviser(s) who receive specific training at an IMT level to manage an OWR. At a site-management level this is further broken into 'OWR Field Management' who are moderately trained to supervise field response, such as the WA DBCA oiled wildlife advisors and the AMOSC OWR team.

The Oiled Wildlife Rehabilitators Network (fauna care/rehabilitation volunteers, vets, zoo personnel, etc.) is a group of more than 100 Western Australian personnel who have been trained in physical oiled wildlife capture, cleaning, rehabilitation and using the dedicated OWR containers maintained by AMOSC and WA DoT. The Oiled Wildlife Rehabilitators Network personnel are available on a volunteer basis. The list of current personnel is maintained and activated by the WA DBCA.

Philip Island Nature Park (Victoria) have over 100 personnel also trained in OWR. These personnel are available, under a 'best endeavours' MoU agreement with AMOSC.

'General Field Responders' are personnel who receive basic 'just-in-time training' to carry out tasks as directed by personnel with higher levels of OWR training. INPEX maintain service agreements with various environmental service providers and general labour hire companies who can provide personnel to assist as general field responders, who would receive on-the-job training to assist with wildlife response activities.

The OWR Division Coordinator (within the IMT) may engage with qualified veterinarian specialists' to provide in-field expertise and technical support to the OWR Coordinator.

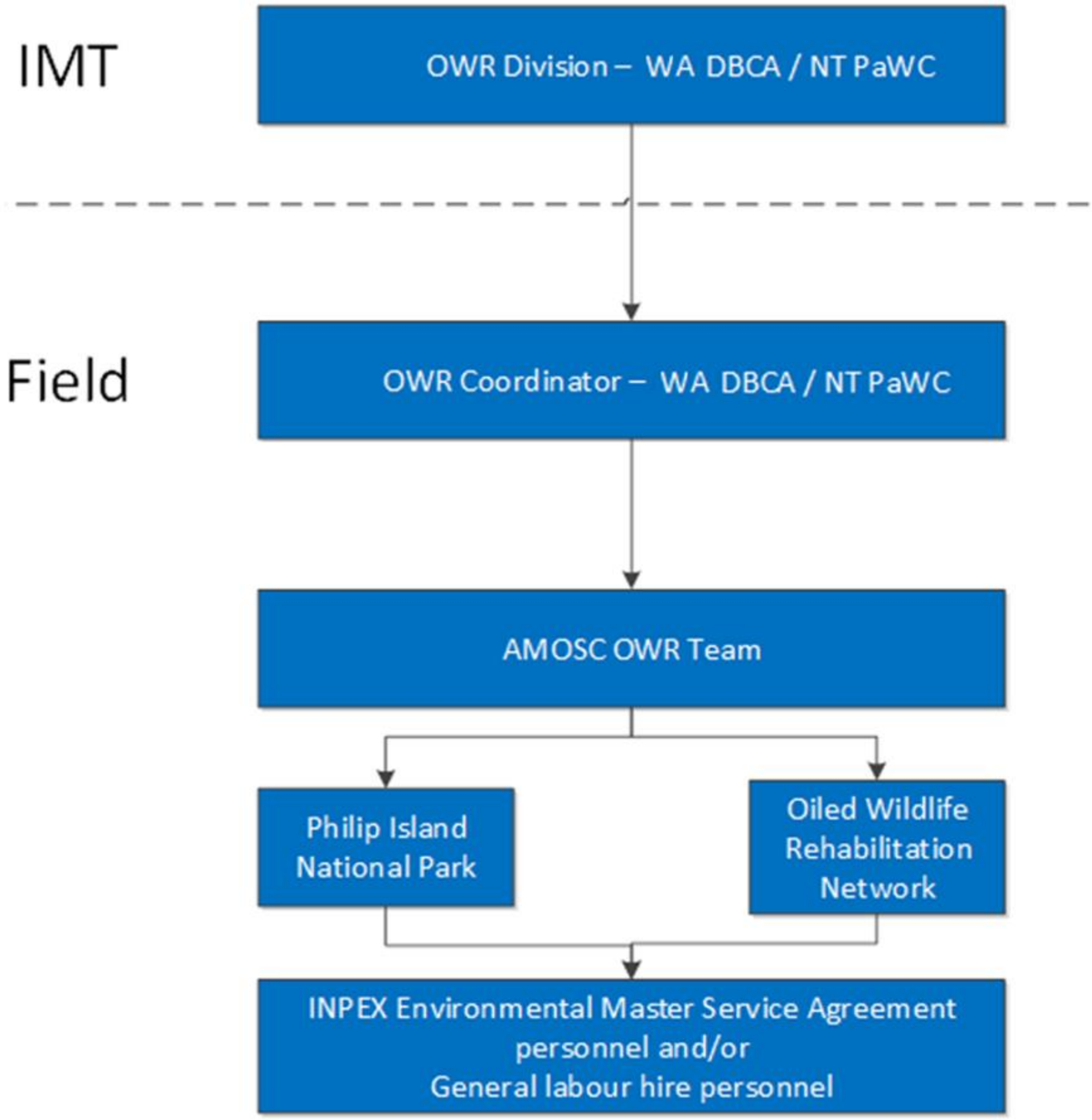


Figure 4-1: Oiled Wildlife Response Division model

There are significant logistical constraints and HSE risks with flying personnel in light utility helicopters to remote offshore locations or operating out of small vessels at remote offshore locations. Also, there is the potential to disturb wildlife populations on small islands by landing large numbers of response personnel. Therefore, the number of oiled wildlife responders working in remote locations at any one time will be agreed in consultation with the WA DBCA oiled wildlife response coordinator but is likely to be limited to between 20 and 30 people at any one location. Depending on the duration of the operations, this may require the establishment of a one or two week on/off roster system, drawing on trained personnel from AMOSC, Oiled Wildlife Rehabilitators Network, WA DBCA and WA DoT (as discussed above), until the response is terminated.

WA DBCA (previously DPaW) (DPaW pers. comm. 2016)[1] indicates that shore-based response priorities would generally consider the following fauna:

- Priority 1: birds endangered, threatened or protected by treaty
- Priority 2: common birds
- Priority 3: adult nesting female turtles (wipe down only)
- Priority 4: turtle hatchlings (potential translocation).

Response priorities at the time will be finalised in consultation with the WA DBCA 'oiled wildlife adviser'.

Under specific circumstances, pre-contact wildlife response could potentially be used to prevent or reduce the impacts of a spill on populations of seabirds and turtles. It is most suitable when used on wildlife affected by persistent oily slicks; however, it may also be considered for residuals from a Group II spills. Operational Monitoring and Evaluation of the spill would provide data regarding spill trajectory and potential wildlife that may be affected by the spill.

Wildlife hazing can be an effective control measure when deployed across limited geographical areas and against specific populations, where the surface oil resulting from a spill is largely contained. Hazing could potentially be used to deter marine fauna, seabirds and shorebirds from entering a spill area. It is not an effective measure against volatile spills which rapidly evaporate, nor does it have particular application against dissolved or dispersed oils.

Techniques include:

- vessel traffic that generates underwater noise and motion
- vessel air horns (where available) to create above-water noise
- vessel fire hoses that direct streams of water in front of whales and other fauna.

Oiled wildlife capture at sea is also theoretically possible; however, it would present significant challenges.

The capture and relocation of turtle nests/eggs prior to oil arrival or following oil arrival onshore to prevent oiling of emerging hatchlings could be achieved using translocation and release. Onshore incubation and release of hatchlings at alternative locations away from the oil spill is possible, as noted in the Gulf of Mexico oil spill where personnel successfully relocated and incubated approximately 25,000 turtle eggs and successfully released approximately 15,000 turtle hatchlings (which is roughly the same proportion as natural hatchling success) (Gaskill 2010).

Helicopter transport is preferred over vessel transport due to the latter being more likely to disturb egg orientation. Egg orientation and temperature variation must be minimised.

An option that is easier, cheaper and less logistically challenging than nest relocation is using fencing above high tide line to fence off potential nesting areas, then monitoring fences to capture and relocate newly emerged hatchlings out of areas at risk from the spill.

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[1] Personal communication, Mr Brad Daws, Department of Parks and Wildlife, Oil Spill Response Wildlife Management Course, Fremantle, pers. comm. 24-26 May 2016

Under specific circumstances, post-contact OWR (wildlife capture, cleaning and rehabilitation) could potentially be used to prevent or reduce the impacts of a spill on populations of seabirds and potentially other marine megafauna. It is most suitable when used on wildlife affected by persistent oily slicks, however it may also be considered for residuals from a Group II spill.

In scenarios where an onshore treatment or rehabilitation facility cannot be located close enough to the site of wildlife collection to be acceptable in terms of wildlife welfare (such as the case at Browse Island and many other WA coastline locations) an 'on-water' facility would need to be established. Details of how to activate this are contained in the Browse Island Oil Spill IMG (X060-AH-GLN-60015).

According to DPaW and AMOSC 2015, an ideal 'on-water' OWR centre would:

- accommodate a minimum of 30 oiled wildlife responders
- have suitable deck space to house at least one 20 metre OWR sea container and air-conditioned holding containers
- have an ability to safely load/unload wildlife to and from adjacent vessels (i.e. through rescue hatches or by using a loading crane)
- be able to facilitate washdown of animals and have the ability to store oily waste or have an oil-in-water separator and holding tanks for waste oil.

A list of potential onshore wildlife rehabilitation facilities is provided in the West Kimberley Region Oiled Wildlife Response Plan (DPaW and AMOSC 2015).

Following a pre or post-contact OWR activity, a report will be provided by the response team to the IMT Leader regarding the effectiveness of the activity. The report shall include, as a minimum:

- date(s), time(s) and location(s) of wildlife capture and release activities
- statistics of daily and total number of wildlife capture, cleaning, rehabilitation, per species
- the overall effectiveness of wildlife response activities (including photographic evidence, where possible).

The final decision on whether to terminate a shoreline wildlife response will remain with the WA DoT, as the Control Agency for WA shorelines.

The Western Australian Oiled Wildlife Response Plan (DPaW and AMOSC 2014) notes that options to assist the IMT make a decision on response termination include setting an agreed threshold for ceasing operations, as well as thresholds for scaling back rescue operations.

Termination of response will be determined by the IMT in collaboration with relevant stakeholders and will consider factors including the following:

- the safety of responders
- the current effectiveness of the response
- deteriorating weather conditions (including wind, visibility, sea conditions)
- habitats are deemed clear from risk of oiling
- lack of presence of oiled wildlife remaining in the affected area; or the numbers of affected wildlife being captured fall towards the agreed threshold for ceasing operations
- stabilisation and transportation of all captured wildlife has taken place

- collection and removal of carcasses has occurred.

The final decision on whether to terminate a shoreline wildlife response will remain with the WA DoT, as the Control Agency for WA shorelines.

Arrangements and capabilities

The arrangements and capabilities as described in the subsections above are summarised in Table 4-3.

Table 4-3: Arrangements and capabilities – Pre-contact and post-contact oiled wildlife response

Technique	Resource capability and availability	Implementation time	Activation
Oiled wildlife response personnel	Under the WA DoT State Hazard Plan – Marine Environmental Emergency, the relevant Control Agency (WA DoT, or INPEX for Commonwealth waters/lands) will provide the On Scene Commander / Division Commander. WA DBCA will provide the in-field Oiled Wildlife Coordinator, and potentially additional wildlife response personnel (via WA DoT, under the West Australian Oiled Wildlife Response Plan, West Kimberley Region Oiled Wildlife Response Plan. Approximately 20–30 trained OWR personnel would be available through the following sources: • AMOSC Oiled Wildlife Response Team • WA DBCA OWR personnel • Oiled Wildlife Rehabilitators Network • Philip Island Nature Park • Additional personnel, who would receive on the job training would be sourced from: o AMOSC core-group o INPEX environmental service providers o INPEX general offshore labour hire contracts.	24 hours to mobilise personnel to Broome/Darwin, to board vessels and/or helicopters.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
Oiled wildlife response kit	Section 3 of the West Kimberley Oiled Wildlife Response Plan identifies a large number of OWR kits, including those located in Broome, Exmouth and Dampier. AMOSC maintains an 'oiled wildlife response capability register' on behalf of industry to support an OWR.	The AMOSC Broome OWR kit is available to mobile to a vessel in Broome Port within 24 hours.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
Helicopters	Crew transfer helicopters (for personnel transfer to designated landing zones only, not to remote shoreline beaches).	INPEX routine crew-change helicopters always available.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
	Utility helicopters suitable for landing on remote shorelines.	Commence mobilisation activities in Broome within 7 days.	
Vessels	Smaller support vessel assets <40 m in length.	Complete mobilisation and depart Broome/Darwin wharf within 24 hours.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
	Larger platform support vessels / accommodation support vessels.	Complete mobilisation and depart Broome/Darwin wharf within 48 hours.	

4.6 Waste management

Waste will be managed in accordance with the INPEX Waste Management Standard (0000-AH-STD-60047), MARPOL 73/78 Annex V – Garbage, relevant Commonwealth and State/Territory regulations regarding disposal of waste generated as a result of spill-response strategies.

As soon as the details of a spill become evident, a Waste Management Plan, developed in consultation with AMOSC and the relevant control agency shall be developed, to ensure the ongoing supply and backload of appropriate waste management equipment.

Based on the maximum credible spill scenarios modelled and expected volumes of oil ashore, large volumes of oily waste are not expected to be generated. Therefore, waste storage on remote shorelines and support vessels can be manage with small, easily transportable waste receptacles.

Table 4-4 outlines the waste storage, disposal and treatment options available for the various oily waste streams.

All waste stored or transferred will be fully documented, including details of exact volume and nature of the waste, date and time, receiver of the waste and destination of the waste, in accordance with vessel Garbage Management Plans and the onshore licenced waste contractor’s waste tracking process.

Table 4-4: Waste storage, disposal and treatment options for hydrocarbon-contaminated waste.

Waste category	On-site storage option	Transport and disposal options	Location of waste management capabilities	End destination
Solid wastes, including oily residue (e.g. waxy residual diesel; oiled organic materials such as sand and seagrass).	Impermeable bulka bags Lined skips/tanks Oil drums 1 m^3 IBCs Industrial waste bags	Oily waste containers will be back-loaded by tender or light utility helicopter to the support vessel for temporary storage offshore, prior to transport to shore. The waste would then transport to shore for appropriate disposal: • recovery and recycling • bioremediation • land farming • incineration • landfill	INPEX Broome supply base	Licensed waste contractor – Broome and/or Darwin.
Solid wastes, including oiled man-made materials (e.g. PPE, booms and sorbent pads).	Impermeable bulka bags Lined skips/tanks Oil drums 1 m^3 IBCs Industrial waste bags	Oily waste containers will be back-loaded by tender or light utility helicopter to the support vessel for temporary storage offshore, prior to transport to shore. The waste would then transport to shore for appropriate disposal: • recovery and recycling • incineration • landfill	INPEX Broome supply base	Licensed waste contractor – Broome and/or Darwin.
Liquid wastes, including diesel and oily water.	Oil drums 1 m^3 IBCs Slops tanks on vessels	Oily waste containers will be back-loaded by tender or light utility helicopter to the support vessel for temporary storage offshore, prior to transport to shore. The waste would then transport to shore for appropriate disposal: • recovery and recycling • incineration Alternatively, a support vessel may use its MARPOL compliant oily water treatment system to treat and dispose of oily water offshore.	Onboard vessels and INPEX supply bases	Licensed waste contractor – Broome and/or Darwin.
Biological oiled waste (e.g. euthanised oiled wildlife).	Impermeable bulka bags Oil drums 1 m^3 IBCs Industrial waste bags	Oily waste containers will be back-loaded by tender or light utility helicopter to the support vessel for temporary storage offshore, prior to transport to shore. The waste would then transport to shore for appropriate disposal: • incineration • landfill	INPEX Broome supply base	Licensed waste contractor – Broome and/or Darwin.

Arrangements and capabilities

The arrangements and capabilities as described in the subsections above are summarised in Table 4-5.

Table 4-5: Arrangements and capabilities – Waste management

Technique	Resource capability and availability	Implementation time	Activation
Waste receptacles	MARPOL compliant vessel oily water storage/treatment systems.	Maintained onboard support vessels.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
	Waste management contractor equipment; • Impermeable bulka bags • Lined skips • Oil drums • Industrial waste bags • 1 m^3 IBCs AMOSC equipment; • Oily waste storage tanks/bladders	Available from licenced waste contractor, to be delivered to Broome supply base within 24 hours. AMOSC waste storage equipment within 24 hours (Broome stockpile) or 48-72 hours (other Australian stockpiles).	
Waste disposal	Waste management contractor will provide; • recovery and recycling • bioremediation • land farming • incineration • landfill • water treatment and discharge	N/A.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
Helicopters	Utility helicopters suitable for landing on remote shorelines.	Commence mobilisation activities in Broome within 7 days	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
Vessels	Smaller support vessel assets <40 m in length.	Commence mobilisation in Broome/Darwin within 24 hours.	IMT via the INPEX Emergency Contacts Directory (C075-AH-LIS-10002) and the Oil Spill Preparedness and Response Register (X060-AH-LIS-70002).
	Larger platform support vessels / accommodation support vessels.	Commence mobilisation in Broome/Darwin within 48 hours.	

4.7 Operational and scientific monitoring

In 2011, an Operational and Scientific Monitoring Program (OSMP) was developed by the Environment Group Browse Basin (of which INPEX is a member). The program encompasses a number of individual Operational Monitoring (OM) and Scientific Monitoring (SM) programs to guide a spill response, assess potential environmental impacts and inform any remediation activities. The OSMP described in this OPEP has been reviewed and refined for the emergency conditions described in Section 8 of the EP. The OSMP is presented in Appendix A, with a division of the OM and SM programs, as follows:

- Operational monitoring is to commence as soon as a spill occurs and aims to characterise the nature and scale of the spill for the duration of the spill. Monitoring is designed to collect information on the predicted spread of the oil and the locations it may impact and, in turn, the OM informs and supports a secondary oil spill response, such as wildlife hazing, as well as the scientific monitoring.
- Scientific monitoring is the investigation component which assesses the overall impact and recovery of the ecosystems which have been exposed to hydrocarbons and response activities, as informed by the OM program.

The OM and SM programs are summarised in sections 4.7.1 and 4.7.2 with further program-specific details, including objectives and triggers for activating and terminating each OM and SM, provided in Appendix A.

Each OM/SM will be tailored, activated and terminated as appropriate to the characteristics, nature and scale of the spill under the supervision of the INPEX IMT Leader, in consultation with:

- the INPEX IMT environmental adviser
- AMOSC
- environmental service providers
- AMSA (for vessel-based spills)
- environmental science coordinators (WA DoT) for spills entering WA waters.

INPEX will maintain a contract with environmental service providers (ESPs) for the implementation of the OM programs within seven days of notification of a Level 2 or Level 3 spill. Details of the ESPs' Operational and Scientific Monitoring programs will be maintained in the ESP's Project Execution Plan.

This contract will ensure the timely activation of field surveys and delivery of results from survey activities/studies. Results arising from OSMP will be technically reviewed by subject matter experts as determined by the ESPs project manager and technical lead prior to submission to the INPEX environment team.

The monitoring programs will be designed to be repeatable so that in the event of a Level 2 or Level 3 spill there is continuity throughout all monitoring phases to detect potential impacts and subsequent recovery. This will include the use of before–after, control–impact (BACI) design or gradient design monitoring programs for impact detection, as appropriate. However, it is important to note that the actual OSMP design will be dependent on the outcomes and any recommendation from baseline monitoring; receptors potentially to be impacted and the nature and scale of the spill. Further details on baseline information are provided in Section 4 of the EP. INPEX will organise and implement the OSMP for spills for which INPEX is the Control Agency (i.e. Facility based spills), as displayed in Figure 4-2.

While AMSA is responsible for monitoring in instances where AMSA is the Control Agency (i.e. vessel-based spills), INPEX will provide support to AMSA in accordance with the MoU (AMSA and INPEX 2013).

The person responsible for activating and terminating the OSMP is the INPEX IMT Leader (in consultation with those personnel listed above), as presented in Figure 4-2.

Consultation with relevant regulatory authorities, regarding progress and outcomes of the OSMP, will occur as part of ongoing notifications and reporting during a Level 2 or Level 3 spill.

All scientific report outputs associated with this OSMP will undergo timely peer review by appropriate subject matter experts; for example, those from contracted environmental service providers.

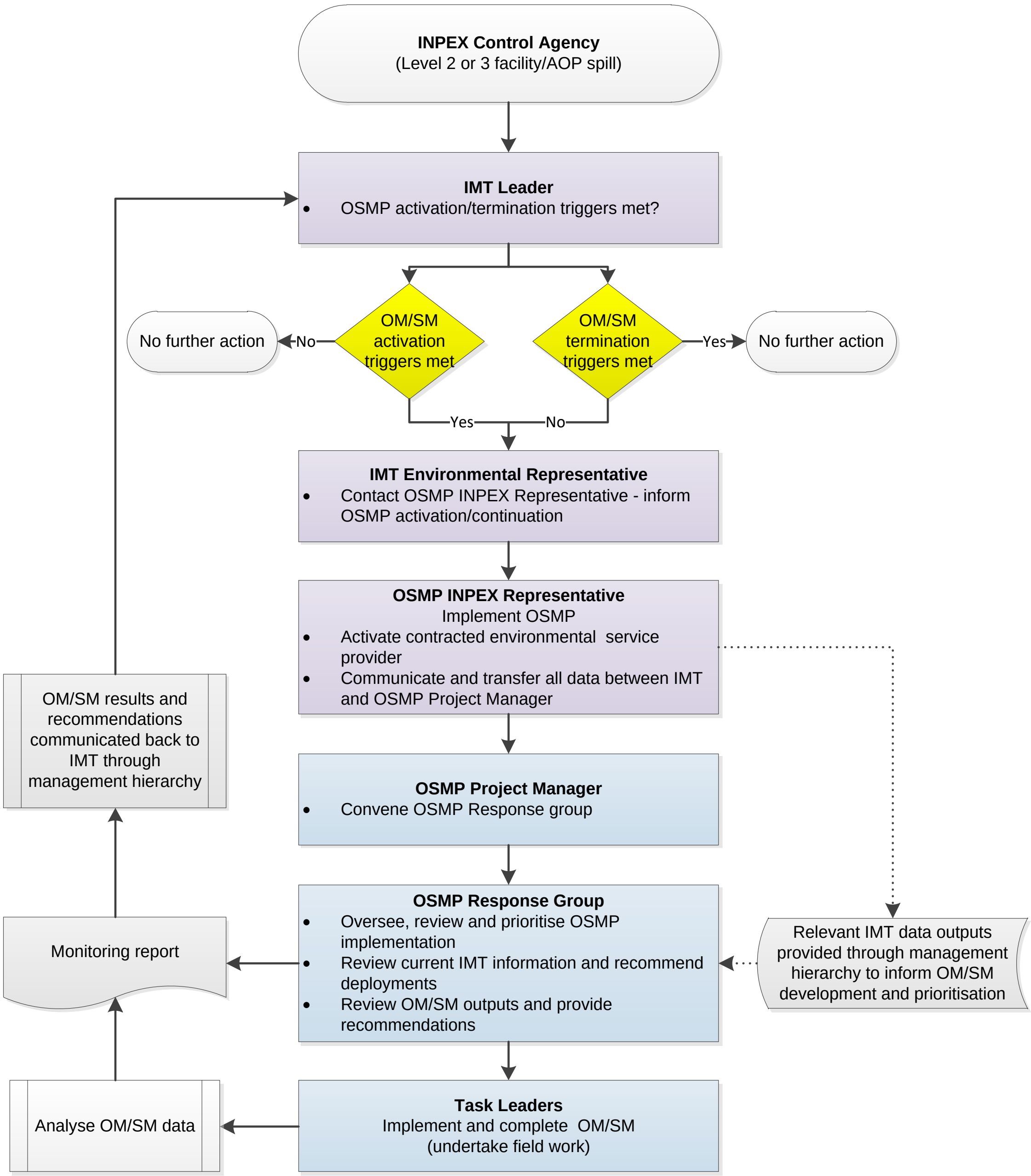

Figure 4-2: OM and SM activation, termination and communication flowchart

4.7.1 Operational monitoring

The focus of the OM program is to assist the IMT to maintain situational awareness by providing information regarding the nature and scale of a spill, and the values and sensitivities at risk.

Information from the OM program also drives the response strategy with regards to triggering and monitoring the effectiveness of secondary response measures, such as wildlife hazing (if required). The data outputs will also be used to trigger the longer-term SM programs (as required).

A summary of the OM programs is provided in Table 4-6. In summary, OM03 and OM01 will be supported by OM04 and OM06. OM04 and OM06 require analysis of water and sediment quality (e.g. laboratory analysis of samples, calibrated field instruments) and will be completed as soon as it is practical to mobilise vessels to the area (nominally seven days). Surface slicks tracked or modelled as part of OM03 and OM01 respectively, may provide an initial indication of the location of any entrained or dissolved hydrocarbons. This will then drive the desktop review of key areas and environmental sensitives at risk from the spill (OM05). Additional details are provided in Appendix A.

Table 4-6: Summary of operational monitoring programs

OM #	Monitoring program	Monitoring method(s)	Data output
OM01	Oil Spill Trajectory Modelling	Forecast and hindcast modelling.	Forecast and hindcast modelling of movement and weathering of oil. This enables the identification of values and sensitivities that may be impacted and drives the response strategy with regards to any secondary response measures and scientific monitoring that may be implemented.
OM03	Oil Spill Surveillance and Reconnaissance	Vessel and aerial surveillance, satellite imagery and satellite tracking buoys.	Assess the colour, consistency, distribution and locations of the surface slicks. Identify values and sensitivities likely to be impacted by the spill. This assists in validation of the model.
OM04	Operational Monitoring of Oil Properties, Behaviour and Weathering at Sea	Vessel-based water sampling.	Assess hydrocarbon physical and chemical properties, as well as the spatial and temporal extent. This assists in validation of the model and identifies any scientific monitoring that may be implemented.
OM05	Pre-emptive Desktop Assessment of Sensitive Resources	Desktop analysis of baseline data.	Detailed analysis of values and sensitivities that may be impacted. Identifies any secondary response measures and scientific monitoring that may be implemented.
OM06	Assessment of the Presence and Quantity of Petroleum Hydrocarbons in Water and Sediments	Vessel-based water and sediment sampling.	Assess hydrocarbon physical and chemical properties, as well as the spatial and temporal extent in water and sediment. This assists in validation of the model and identifies any scientific monitoring that may be implemented.

4.7.2 Scientific monitoring

The SM program does not directly inform spill response operations directed by the INPEX IMT. It does, however, assess the overall impact and subsequent recovery of the identified values and sensitivities to hydrocarbon exposure and oil spill response activities.

SM will only be undertaken in the event of a Level 2 or Level 3 spill and where the information obtained through the OM program indicates values and sensitivities are predicted to be impacted or have been impacted.

SM will be consistent with the nature and scale of the spill and sufficient to inform any remediation activities, where appropriate. It may begin before the termination of similar OM activities. Details on the SM program are provided in Appendix A.

As discussed in Section 8 of the EP, any wind driven entrained components of a Group II surface spill, will remain within the top 30 m (with the vast majority in the top 10 m) of the water column. Therefore, for all surface spills, SM relating to water quality (SM05), sediment quality (SM06) and intertidal and benthic environments (SM07 and SM08) will only be activated where OM indicates potential impacts to areas shallower than –30 m LAT.

All Level 2 and Level 3 spills have the potential to impact planktonic communities. Therefore, SM09 has been included.

A surface diesel spill could potentially impact marine megafauna such as cetaceans, dugongs, turtles, whale sharks and marine avifauna. Therefore, SM10 and SM11 have been included in order to monitor for potential impacts and recovery of MNES within Biologically Important Areas (BIAs) or other identified populations.

As commercial, recreational and traditional fishing all occur within the EMBA, SM12 has been included to understand potential impacts to this sensitivity.

Note that limited information is presented in Appendix A with respect to timings for implementation of the SM program. Unlike the OM program, in order to implement an effective SM program, thorough planning is required to ensure the correct data is collected with respect to confirming potential lasting impacts from a spill. This relies on data outputs generated from the OM program and therefore the planning stage may take additional time. Mobilisation times for the SM program will be as soon as practicable given the context of the area and mobilisation will generally commence within seven days of receipt of notification.

4.7.3 Baseline data to support the OSMP

A range of data has been used to establish the environmental baseline in the Browse Basin as described in Section 4 of the EP. This includes information collected during various environmental surveys completed by INPEX (2006-2009) and the Applied Research Program (ARP) partnership between Shell, INPEX and the Australian Institute of Marine Science (AIMS) (2014–2018). The focus of the ARP was to collect baseline data to inform understanding of the extent, severity and persistence of impacts in the unlikely event that a significant spill occurs during the activity.

In addition to INPEX-collected data, INPEX is also a member of the Industry-Government Environmental Metadata (I-GEM) project. The pilot I-GEM project was completed in 2014 and contains accessible metadata from industry, research institutes and government organisations Australia-wide, which were uploaded to the Australian Ocean Data Network (AODN) portal. Metadata searches can be conducted via the AODN portal and the standalone I-GEM website which contain data sets from the Abrolhos Islands to the Timor Sea, out to the extent of Australia's exclusive economic zone (EEZ).

Published monitoring reports from the Montara spill augment this data both spatially and temporally. Further to this, extensive multi-year monitoring programs have been undertaken by other operators (e.g. Woodside and Shell) in the Browse Basin, which also augment the INPEX data, spatially and temporally, for physical and biological aspects of the environment.

Research institutes and organisations such as AIMS, the Western Australian Museum and Monash University have also conducted long-term monitoring programs in the Browse Basin. This data further increases the environmental understanding of the region. INPEX has also formalised an agreement with WA DBCA which confirms WA DBCA will supply environmental data (including Western Australian Marine Science Institution data (C075-PAW-IPX-LE-00001)) to INPEX Australia in the event of an incident or oil spill in the nearshore/coastal waters of the region.

Information collected from these surveys, as well as the ARP program, provide a substantial baseline on the marine flora, fauna and habitats which may be referenced in the event of a Level 2 or Level 3 spill event. The current states of knowledge for receptors in the Browse region relevant to this OPEP are described in Section 4 of the EP.

4.8 Health and safety

Health and safety considerations will be incorporated into any spill response.

INPEX health and safety objectives are to:

- adhere to the INPEX PEARS philosophy as detailed in the INPEX Emergency and Crisis Management Standard (Doc. No. 0000-AH-STD-60051)
- provide a safe working environment and prevent workplace incidents by managing risks to ALARP
- eliminate, or minimise all environment and community risks to ALARP and ensure any impacts are neither serious nor long-lasting
- ensure the security of INPEX personnel, assets and information.

The IMT should develop a Safety Management Plan utilising the National Plan Guidance on Marine Oil Spill Response Health and Safety document (AMSA 2018).

Contractors are responsible for the development of site-specific risk assessments before undertaking any activities.

The safety of personnel is the primary concern in a spill incident. An individual risk assessment, such as a job hazard analysis (JHA), will always be conducted by a response contactor or other appointed or responsible personnel, such as the HSE manager or supervisor.

If the response is conducted by a Control Agency other than INPEX (i.e. AMSA), that agency is expected to adhere to stringent safety procedures as outlined in their respective oil spill response plans (i.e. the NatPlan).Table 4-7 provides examples of hazards and risks that may be encountered during a response to a spill.

Table 4-7: Examples of health and safety risks from spill response

Hazards	Risks	Prevention and mitigation considerations
Inadequately trained personnel carrying out the response	Lack of appropriate training	Prior to any response being implemented, a HSE Plan must be prepared, and will identify induction/on-the-job training requirements, and associated JHAs etc. All personnel must complete the induction/on-the-job training and sign onto the JHA prior to commencing work. Appropriately qualified personnel, such as AMOSC core-group members, will be appointed as field response team leaders, and will provide on-the-job supervision and training (as required) to other response team members.
Flammability	Fire and explosion	Firefighting capacity of INPEX-contracted vessels and their tenders as per flag state requirements and INPEX standards.
		Permit to work (PTW) system and JHAs applied to all activities.
Toxicity of hydrocarbon	Inhalation, ingestion or contact with skin or eyes leading to dermal irritation or illness	Air quality monitoring equipment, to protect the health of oil spill responder personnel, is available as part of the Broome Supplementary Stockpile.
		PPE including respiratory protection, coveralls, gloves, glasses, boots and barrier gels, to be provided to all personnel working on the response.
		Clean-up area provided for responders to decontaminate and remove soiled clothing. Ample quantity of clean PPE available.
Manual handling	Manual handling injuries	Use of cranes, or large teams of trained personnel, to lift response materials as required.
Slips, trips and	General injury	Hydrocarbon waste and used absorption equipment will have dedicated waste receptacles. Additional supply of absorption material to be located at access and egress points from vessels

falls		and/or in and out of offices, to mitigate the additional risk of slipping on oily surfaces, and to minimise the spread of hydrocarbons.
		Designated and separate, clean and contaminated work areas and movement routes in all work areas.
Working over water	Drowning	Mandatory use of lifejackets when working over water and independent sentry posted to monitor activity. “Man overboard” procedures clearly defined and included in personnel inductions and ongoing training. PTW from vessel master to be in place for personnel working over water.
Dangerous marine fauna	Bites, stings and other injury from marine fauna	No personnel are permitted in the water. Sentry in place whenever personnel are working over the water and to watch for fauna. All work will be done under a PTW from a response contractor. Any personnel retrieving equipment or wildlife from the water will be alert to marine animals. All personnel working to retrieve equipment or wildlife from the water will be equipped with gloves and protective clothing, and all retrieved equipment will be washed to remove any marine life.
Working from helicopters	Helicopter downed	As a minimum, any helicopter working for an INPEX response must meet the INPEX minimum aviation standards. Any personnel working from a helicopter over water must have a completed Tropical Basic Offshore Safety Induction and Emergency Training (TBOSIET) certificate or equivalent.
Excessive working hours	Fatigue	Personnel will work under the applicable working-hour limitations. As a minimum, the INPEX fitness-for-work standard will be used as a template for all INPEX employees.

		There will be monitoring of fatigue and personnel fitness by work supervisors. A roster will be established to allow change-out of personnel as required, depending on the nature and duration of the spill response.
Weather	Dehydration, heatstroke	The INPEX fitness-for-work standard and the fatigue guidelines will be used as minimum requirements.
Quarantine	Human communicable diseases	Browse Island and other locations within the traditional fishing MoU box have the potential for contact between spill response personnel and Indonesian fishermen. Communicable diseases, such as tuberculosis can be transmitted from human to human. Inductions need to communicate that no contact with Indonesian fishermen is permitted, and appropriate controls will be implemented to mitigate this risk.

The Browse Island Oil Spill IMG (X060-AH-GLN-60015) contains completed HAZID reports for helicopter, vessel and shoreline response activities. These HAZID reports should be used to generate HSE plans and associated JHAs for shoreline response activities.

5 INPEX forms and guidance

Table 5-1 has been copied from the Oil Spill Forms Register (C075-AH-LIS-10006).

The table provides rapid access for IMT personnel to forms needed during an oil pollution emergency event. Not all of the forms on this table are relevant to the spill event described in the EP. Please use the most recent version of the controlled copy of the Oil Spill Forms Register (C075-AH-LIS-10006) during an emergency response.

Table 5-1: Oil Spill Response Forms

Form type	Form title	Purpose	Reporting timeframe	Applicable for oil spills in				Document reference (SmartPlant)
				Darwin Harbour	NT	WA	Cwlth Waters	
Notify & Report	NT Oil spill notification report (POLREP) - as per NT OSCP	Notify the following external parties of an oil spill in NT waters: • Darwin Port (DP) for spills inside Darwin Port limits • NT Department of Infrastructure, Planning and Logistics (NT DIPL) – Marine Safety Branch for spills inside Territory waters (but outside Darwin Port limits) • NT Department of Environment and Natural Resources (NT DENR) for spills inside Territory waters and/or Darwin Port limits (NOTE: The NT POLREP is a modified version of AMSA's Marine Pollution Report (POLREP). (IMT Environment to obtain copy).	< 2hrs	✓	✓			C020-AG-FRM-0008
	NT Incident update report (SITREP) – as per NT OSCP	Notify the following external parties of an oil spill in NT waters: DPC for spills inside Darwin Port limits NT DIPL – Marine Safety Branch for spills inside Territory waters (but outside Darwin Port limits) NT DENR for spills inside Territory waters and/or Darwin Port limits (NOTE: The NT SITREP is a modified version of AMSA's Marine Pollution Situation Report (SITREP) available at www.amsa.gov.au) (IMT Environment to obtain copy).	Daily Or as situation changes significantly	✓	✓			C020-AG-FRM-0010
	AMSA harmful substances report (POLREP)	Vessel master to report marine pollution incidents in Commonwealth waters to AMSA. (IMT Environment to obtain copy).	< 2hrs				✓	C075-AH-FRM-10009
	WA Department of Transport - POLREP WA Department of Transport - SITREP	Vessel master to report marine pollution incidents, which **may** threaten WA waters / lands to WA DoT. (IMT Environment to obtain copies of POLREP/SITREP).	Immediately			✓		https://www.transport.wa.gov.au/mediaFiles/marine/MAC-F-PollutionReport.pdf https://www.transport.wa.gov.au/mediaFiles/marine/MAC-F-SituationReport.pdf
	WA Department of Environment Regulation (DER) - Online Pollution Report	Pollution onto WA land (i.e. oil contacting WA shoreline) is to be reported online. (IMT Environment to complete).	< 12 hrs			✓		http://www.der.wa.gov.au/your-environment/reporting-pollution/report-pollution-form

	Offshore occurrence report form (Western Australian Department of Mines & Petroleum (DMP))	Report to DMP for marine incidents within the 3 nautical mile limit (WA State waters) by INPEX IMT Leader. This includes reporting oil spill incidents that originated in commonwealth or NT waters, but moved into WA State waters. (IMT Environment to complete).	< 3 days			✓		DEV-CEX-FM-0002
	Report of a known or suspected contaminated site (*Contaminated Sites Act 2003 (WA)*)	Report to WA DER of a contaminated site on land, shoreline or seabed within WA State waters (within 3 nm). (IMT Environment to complete).	< 21 days			✓		DEV-CEX-FM-0001
	NOPSEMA incident report form (FM0831)	Report to NOPSEMA offshore incidents in accordance with relevant OPEP (typically this is only required for Level 2 or 3 spills). (INPEX IMT Leader to issue report) NOTE: NOPSEMA must be verbally notified within 2 hours after becoming aware of the incident	< 3 days				✓	C075-AH-FRM-10007
Log	Emergency incident log	Record the specific activities undertaken by personnel during an oil spill response (Individual form optional for IMT Carbon copy incident log books also available)	Ongoing during emergency	✓	✓	✓	✓	C020-AG-FRM-0005
	Telephone call record	Record all phone calls, both incoming and outgoing, particularly those to and from government agencies, external support agencies, employees' families, etc. (Individual form optional for IMT Carbon copy incident log books also available)	Ongoing during emergency	✓	✓	✓	✓	C020-AG-FRM-0007
	Dispersant Activity Log	To be completed by vessel master (for dispersant applied by vessel) or by an aerial observer (for dispersant applied by aircraft) (Field personnel to prepare)	Ongoing during emergency	✓	✓	✓	✓	C075-AH-LOG-10000
Situational Awareness	Oil Spill Observation and Visual Dispersant Guide for Aircraft and Vessels	Provide guidance to vessel and aircraft operators on how to identify oil spills; record their location; estimate the oil thickness, quantity of oil and area affected; look for colour changes to oil once dispersant has been applied and assess effectiveness; instructions to take photos or video footage; and reporting protocols. (Field personnel to prepare)	Ongoing during emergency	✓	✓	✓	✓	C075-AH-GLN-10016
	Shoreline clean-up and assessment technique (SCAT)	Assess the state of the shoreline should a spill make contact (or if there is a significant threat of a spill making contact) (IMT Leader to complete).	Prior to shoreline contact (i.e.	✓	✓	✓	✓	C020-AG-FRM-0012

			<12-24 hrs) Ongoing until termination					
Modelling	RPS Search & Rescue request form	Search & request form to activate RPS to conduct trajectory modelling under Contract # 800767 (IMT Environment to request)	Info only	NA	NA	NA	NA	C075-AH-FRM-10001
	RPS Oil Spill Modelling Response Procedures and Interpret Subsequent Results	Procedure: How to Activate RPS Oil Spill Modelling Response Procedures and Interpret Subsequent Results (info only)	Info only	NA	NA	NA	NA	C075-AH-LIS-10006
	RPS oil spill trajectory modelling request form	Modelling request form to activate RPS to conduct oil spill trajectory modelling under Contract # 800767 (IMT Environment to request)	< 2 hrs	✓	✓	✓	✓	C020-AG-FRM-0015
	RPS oil spill trajectory model update form	Update of oil-spill trajectory to RPS (IMT Environmental to request)	Daily	✓	✓	✓	✓	C075-AH-LIS-10006
	RPS Gas or Vapour Plume Modelling request form	Modelling request form to activate RPS to conduct gas and vapour modelling under Contract # 800767 (IMT HS Officer to request)	< 2 hrs	✓	✓	✓	✓	C075-AH-FRM-10003
	RPS Chemical Spill Trajectory Modelling Request Form	Modelling request form to activate RPS to conduct chemical spill trajectory modelling under Contract # 800767 (IMT Environmental to request)	< 2 hrs	✓	✓	✓	✓	C075-AH-FRM-10004
AMOSC/OSRL	AMOSC mobilisation and authorisation form	In order to mobilise AMOSC, a service contract must be completed by the IMT Leader to identify AMOSC requirements for equipment, consumables, personnel, advice and estimated duration. (IMT Leader to sign)	> Level 2 incident	✓	✓	✓	✓	NA
	OSRL notification form	To notify Oil Spill Response Limited of an incident that may requires support under the terms of the Agreement (ORSL #129). (IMT Environmental to request)	> Level 2 incident	✓	✓	✓	✓	C075-AH-FRM-10005
	OSRL mobilisation form	To authorise activation of Oil Spill Response Limited and its resources in connection with an incident under the terms of the Agreement (ORSL #129). (IMT Environmental to request)	> Level 2 incident	✓	✓	✓	✓	C075-AH-FRM-10006

Wildlife Permit	Permit to interfere with EPBC listed species	General permit application for interfering with threatened species and ecological communities, migratory species, whales and dolphins and listed marine species. (IMT Environmental to prepare)	As required	NA	NA	NA	✓	C075-AH-FRM-10010
	Wildlife Status and Situation Report	To record situation of wildlife found, whether they are alive (or dead) and if they have been (or are planned to be) cleaned and/or released. (IMT Environmental to prepare)	As required			✓	✓	Appendix J of C075-AH-REP-10086 (WA Oiled Wildlife Response Plan)
	Wildlife Rescue & Release Form	This form is to accompany any live oiled wildlife from the time it is rescued until it is released or euthanized. The form should record each time an animal is cleaned, transported etc and any general observations (of improvement, decline) made during its rehabilitation. (IMT Environmental to prepare)	As required, per oiled wildlife			✓	✓	Appendix J of C075-AH-REP-10086 (WA Oiled Wildlife Response Plan)
	Fauna Admission Form (Vet to complete)	This form is to be used to when admitting the oiled wildlife to a veterinary clinic. (Vet to prepare)	As required, per oiled wildlife admitted to vet			✓	✓	Appendix J of C075-AH-REP-10086 (WA Oiled Wildlife Response Plan)
WA DoT Cross Jurisdiction Spill	IMT Handover Checklist (cross jurisdictional arrangements)	For use by IPX IMT-Leader, to check handover of relevant incident information to WA DoT IMT-Leader, when INPEX spill moved into WA Waters				✓		PER-2153261255
	IMT Functions and Lead IMT Designations (cross jurisdictional arrangements)	For use by IPX IMT-Leader, and WA DoT IMT-Leader, to define each IMT 'lead' roles, when INPEX spill moved into WA State waters and a cross jurisdictional spill response is underway.				✓		PER-2153261254

6 References

AMOSC–see Australian Marine Oil Spill Centre.

AMSA—see Australian Maritime Safety Authority.

AMSA and INPEX—see Australian Maritime Safety Authority and INPEX Operations Australia Pty. Ltd.

ANZECC/ARMCANZ—see Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

APASA—see Asia-Pacific Applied Science Associates.

Australian and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australia and New Zealand. 2000. *Australian and New Zealand guidelines for fresh and marine water quality*. Australian and New Zealand Environment and Conservation Council, Canberra, and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT.

Australian Maritime Safety Authority. 2019. National plan for maritime environmental emergencies. Australian Maritime Safety Authority, Canberra, ACT. Viewed online on 9 January 2019 at https://www.amsa.gov.au/sites/default/files/2017-01-np-amsa496-national-plan-maritime-environmental-emergencies.pdf.

Australian Maritime Safety Authority. 2015. *Fixed Wing Aerial Dispersant Capability Joint Standard Operating Procedures*. Version 1.2. Australian Maritime Safety Authority, Canberra, Australian Capital Territory.

Australian Maritime Safety Authority. 2018. *National Plan Guidance on: Marine Oil Spill Response Health and Safety.* Reference NP-GUI-026. Australian Maritime Safety Authority, Canberra, Australian Capital Territory.

Australian Maritime Safety Authority and INPEX Operations Australia Pty. Ltd. 2013. Memorandum of Understanding between the Australian Maritime Safety Authority and INPEX Operations Australia Pty. Ltd. (ABN 48 150 217 262) on support for oil spill preparedness and response. INPEX document number C091-IPX-ARA-ME-00001. Document prepared and signed by the Australian Maritime Safety Authority and INPEX Operations Australia Pty. Ltd., Perth, Western Australia.

Commonwealth Scientific and Industry Research Organisation. 2016. *Oil spill monitoring handbook*. CSIRO Publishing, Clayton South, Victoria.

Department of the Environment and Energy. 2017. *Recovery plan for marine turtles in Australia, Commonwealth of Australia 2017*. Department of Environment and Energy, Canberra, ACT.

Department of Parks and Wildlife and Australian Marine Oil Spill Centre. 2014. *Western Australian Oiled Wildlife Response Plan*. Department of Parks and Wildlife, Perth, Western Australia.

Department of Parks and Wildlife and Australian Marine Oil Spill Centre. 2015. *West Kimberley Region Oiled Wildlife Response Plan*. Version 1.1. Department of Parks and Wildlife, Perth, Western Australia, and Australian Marine Oil Spill Centre, Canberra, ACT.

DPaW—see Department of Parks and Wildlife.

DPaW and AMOSC–see Department of Parks and Wildlife and Australian Marine Oil Spill Centre.

Ecosystem Management and Associates. 2008. *Criteria for evaluating oil spill planning and response operations. A report to IUCN, The World Conservation Union*. Report 07-02. Lusby, Maryland.

Gaskill, M. 2010. Turtle rescue plan succeeds. Nature. Viewed online on 21 January 2019 at https://www.nature.com/news/2010/101008/full/news.2010.528.html

ITOPF—see International Tanker Owners Pollution Federation Limited

International Tanker Owners Pollution Federation Limited. 2002. *Termination of shoreline cleanup – A technical perspective.* International Tanker Owners Pollution Federation Limited, London, United Kingdom.

International Tanker Owners Pollution Federation Limited. 2011. *Clean-up of oil from shorelines*. Technical Information Paper 7. International Tanker Owners Pollution Federation Limited, London, United Kingdom.

International Petroleum Industry Environmental Conservation Association. 2015. *A guide to oiled shoreline clean-up techniques. IPIECA-IOGP Good Practice Guide Series, Oil Spill Response Joint Industry Project*. IOGP report 521. International Petroleum Industry Conservation Association, London, United Kingdom.

RPS. 2019. WA-532-P, WA-533-P and WA-50-L Oil Spill Risk Assessment. MAW0757J. Report prepared by RPS Australia West Pty Ltd. Report prepared for INPEX Operations Australia Pty Ltd. Perth, Western Australia.

Sell, D., Conway, L., Clark, T., Picken, G.B., Baker, J.M., Dunnet, G.M. 1995. Scientific criteria to optimize oil spill cleanup. *International Oil Spill Conference Proceedings* 1:595-610.

WA DoT—see Western Australian Department of Transport.

Waples, K. Field, S. Kendrick, A. Johnston, A. and Twomey, L. 2019. *Strategic Integrated Marine Science for the Kimberley Region: Kimberley Marine Research Program Synthesis Report 2012 – 2018.* Prepared by the Western Australian Marine Science Institution, Perth Western Australia.

Warne, M.S., Batley, G.E., van Dam, R.A., Chapman, J.C., Fox, D.R., Hickey, C.W. and Stauber, J.L. 2018. *Revised Method for Deriving Australian and New Zealand Water Quality Guideline Values for Toxicants – update of 2015 version*. Australian and New Zealand Governments and Australian State and Territory Governments, Canberra, ACT.

Western Australian Department of Transport. 2018. *State Hazard Plan Maritime Environmental Emergencies*. Prepared by Western Australian Department of Transport, Perth, for the State Emergency Management Committee, Perth, Western Australia.

APPENDIX A: OPERATIONAL AND SCIENTIFIC MONITORING PROGRAM

The decision-making process for termination of the OM and SM is undertaken by the INPEX IMT Leader, in consultation with AMOSC and the designated ESP. In addition, relevant jurisdictional agencies, including AMSA, WA DoT and WA DBCA (via WA DoT), as relevant to the nature and scale of the spill, will be consulted.

The termination decision-making process includes the following steps:

- Step 1: Review the data collected by the OM and SM against the OM and SM objectives.
- Step 2: Evaluate whether the OM and SM objectives have been achieved and provide the evaluation to the INPEX IMT Leader.
- Step 3: Reach agreement with the INPEX IMT Leader that the termination criteria have been satisfied.
- Step 4: Sign off for termination of the OM and SM by the INPEX IMT Leader.

Code	Title	Aim of the plan	Key objectives	Activation triggers	Termination criteria	Mobilisation time	Service provider
Operational Monitoring							
OM01	Oil Spill Trajectory Modelling	To use computer-based forecasting methods to predict oil-spill movement and guide the management and execution of oil spill response strategies to maximise the protection of environmental and other resources at risk.	Provide forecasting of the movement and weathering of spilled oil. Assist in identifying values and sensitivities that are at risk of contamination.	All Level 2 and Level 3 spills	The oil discharge has ceased and spill modelling outputs (as verified by OM03, OM04 and OM06, where applicable) show no additional values and sensitivities are at risk of oil spill contact.	<2 hours	Oil spill modelling provider (Refer to Table 5-1).
OM03	Oil Spill Surveillance and Reconnaissance	To provide regular, ongoing oil spill surveillance in the event of a spill (aerial, vessel, satellite imagery, oil spill tracking buoys), as appropriate. Identify key breeding/ aggregation/ foraging areas for wildlife groups that may be at risk from the oil spill.	To assess the colour, consistency, distribution and locations of the surface slick. To identify values and sensitivities likely to be impacted by the spill.	All Level 2 and Level 3 spills	Upon completion of the oil spill response operations (Refer to Section 4.5) AND Spill surveillance indicates (and is supported by OM01 outputs) no additional values and sensitivities are at risk of oil spill contact.	<48 hours	Aircraft providers Vessel providers AMOSC/OSRL satellite imagery provider INPEX oil spill tracking buoys.
OM04	Operational Monitoring of Oil Properties, Behaviour and Weathering at Sea	To provide in-field information on the properties, behaviour, extent and weathering of the spilled oil.	Establish the case-specific situation for the released oil, including: • surface and subsurface extent • density • viscosity • wax and asphaltene content • water content (as water-in-oil emulsion) • proportion of residual	All Level 2 and Level 3 spills	Monitoring of the evolution of the oil properties indicates that the released oil has undergone weathering to reach a steady weathered state*. *Steady weathered state is defined as <10% change in percentage of mass for weathering processes for 3 consecutive days (measured weathering rates compared with weathering curves for the spilled	Preparation to deploy field personnel and equipment will commence on notification from INPEX that this OM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification.	Environmental service provider under contract for duration of activities. NATA laboratory for sample analysis.

Code	Title	Aim of the plan	Key objectives	Activation triggers	Termination criteria	Mobilisation time	Service provider
			hydrocarbons over time • proportion of volatile hydrocarbons • proportion of soluble hydrocarbons. Monitor the evolution of these oil properties through time and assess the rate of their reduction or increase.		product, generated through the US National Oceanic and Atmospheric Administration (NOAA) oil spill weathering model ADIOS).		
OM05	Pre-emptive Desktop Assessment of Sensitive Resources	To undertake a rapid desktop assessment of the broad character and ecological integrity of sensitive receptors at risk of impact from a moving oil slick.	Undertake a desktop assessment, to obtain all relevant information in relation to the values and sensitivities that may be affected by the spill. Note: Values and sensitivities for OM05 are defined as those described in Section 4 of the EP, including islands, reefs, shoals and banks, and areas of conservation significance, and BIAs associated with MNES.	All Level 2 and Level 3 spills.	Completion of the desktop assessment of values and sensitivities that were identified by Operational Monitoring (OM01, OM03, OM04 and OM06) as being potentially impacted or contacted by the oil spill.	24 hours	Environmental service provider under contract for duration of activities.
OM06	Assessment of the Presence and Quantity of Petroleum Hydrocarbons in Water and Sediments	To provide a rapid assessment of the presence, type, quantity and character of hydrocarbons in the water and marine sediments to assess the extent of the impact and verify impact predictions for other monitoring plans.	Detect the presence of oil and oil-derived (petrogenic) hydrocarbons in the water column and marine sediments. Determine, if possible, the source of these (i.e. the slick or some other sources). Determine the spatial and temporal distribution of the hydrocarbons. Distinguish between petrogenic and non-petrogenic (natural background) hydrocarbons that are present. Determine the concentrations of the hydrocarbons. Benchmark the level of individual hydrocarbons against trigger levels of concern for aquatic life and human health.	All Level 2 and Level 3 spills	Upon completion of the oil spill response OR Rapid assessment of the hydrocarbons in water and marine sediments has been completed and the operational monitoring has been superseded by relevant SM programs.	Preparation to deploy field personnel and equipment will commence on notification from INPEX that this OM has been triggered. Deployment of field personnel and equipment into the field within 7 days of receipt of notification.	Environmental service provider under contract for duration of activities.
Scientific Monitoring							
SM02	Detailed Characterisation of the Oil	To provide a toxicological assessment of the	Determine the chemical characteristics of the spilled oil throughout a spill response and the	Other scientific monitoring programs are triggered that require information on the	Laboratory results have defined the chemical characteristics of fresh and weathered oil (which	Laboratory testing only; using water and sediment samples	Environmental service provider under contract for

Code	Title	Aim of the plan	Key objectives	Activation triggers	Termination criteria	Mobilisation time	Service provider
	Properties and Ecotoxicological Assessment	spilled oils. To assess the risks posed by short-term exposure (acute effects) or longer term exposure (chronic effects), or both, to potentially impacted values and sensitivities.	character of residual oils as they continue to weather, post-response. Determine the potential adverse effects on values and sensitivities of exposure to fresh and weathered oil, based on the chemical and physical character of the oil.	ecotoxicity of hydrocarbons in the water column and sediments (SM07, SM08, SM09, SM10, SM11 and SM12).	has reached a steady weathered state, as defined in OM04); AND Results have provided contextual information for the potential adverse effects on values and sensitivities exposed to be quantified.	collected from OM04, SM05 and SM06.	duration of activities.
SM05	Monitoring for Hydrocarbons in Marine Waters	To quantify presence and extent, as well as the longer term weathering, persistence and toxicity of hydrocarbon compounds in marine waters, and to assess and verify predicted impacts on values and sensitivities for other SM.	Quantify the temporal and spatial distribution and concentration of hydrocarbon compounds in marine waters in relation to background or reference levels, e.g. ANZECC/ARMCANZ (2000) Determine the sources of any identified hydrocarbons in the water column, e.g. natural, pyrogenic, or petrogenic spill sources. Provide samples to enable toxicity of the hydrocarbon compounds in marine waters to be assessed under SM02.	OM indicates oil contact within 2 km of a shallow, subtidal (–30 m LAT or above) or intertidal location or BIAs associated with MNES; OR Other Scientific Monitoring programs (SM07, SM08, SM09, SM10, SM11 and SM12) are triggered that require information on the presence, extent and toxicity or persistence of hydrocarbons in the water column.	Monitoring results have confirmed the temporal and spatial distribution, concentration and source of hydrocarbons in the water column; AND OM indicates no further values and sensitivities are likely to be contacted; AND Monitoring results have determined petrogenic hydrocarbon concentrations in marine waters are consistent with background or reference levels e.g. ANZECC/ARMCANZ (2000); AND Water samples have been provided for SM02.	Preparation to deploy field personnel and equipment will commence on notification from INPEX that the SM has been triggered. Mobilisation of field personnel and equipment within 7 days of receipt of notification.	Environmental service provider under contract for duration of activities.
SM06	Monitoring for Hydrocarbons in Subtidal and Intertidal Sediments	To understand the behaviour, persistence and fate of hydrocarbons in sediments to provide data to assist in assessing and verifying predicted impacts on key habitats and sensitive receptors.	Determine the distribution (spatial and temporal extent) of oil in shallow, subtidal and intertidal sediments in relation to background or reference levels, e.g. ANZECC/ARMCANZ (2000) Determine the sources of any identified hydrocarbons in sediment, e.g. natural, pyrogenic or petrogenic spill sources. Provide samples to enable toxicity of the hydrocarbon compounds in marine sediments to be assessed under SM02.	OM indicates oil contact within 2 km of a shallow, subtidal (–30 m LAT or above) or intertidal location; OR Other Scientific Monitoring programs (SM07, SM08, SM12) are triggered that require information on the presence, extent and toxicity or persistence of hydrocarbons in benthic sediments.	Monitoring results have confirmed the temporal and spatial distribution, concentration and source of hydrocarbons in the sediments; AND OM indicates no further values and sensitivities are likely to be contacted; AND Monitoring results have determined petrogenic hydrocarbon concentrations in sediments are consistent with	Preparation to deploy field personnel and equipment will commence on notification from INPEX that the SM has been triggered. Mobilisation of field personnel and equipment within 7 days of receipt of notification.	Environmental service provider under contract for duration of activities.

Code	Title	Aim of the plan	Key objectives	Activation triggers	Termination criteria	Mobilisation time	Service provider
					background or reference levels e.g. ANZECC/ARMCANZ (2000); AND Sediment samples have been provided for SM02.		
SM07	Monitoring of Shoreline and Intertidal Benthos to Determine Impacts of Oil Spill and Recovery	To determine and monitor the potential impact of a hydrocarbon spill or response activities and recovery of intertidal benthos and associated organisms.	Collect quantitative data on intertidal habitats and organisms that are at risk from, or have been exposed to, oil. Detect and quantify lethal or sublethal impacts of the spill on intertidal habitats and organisms and monitor recovery to baseline or reference levels.	OM indicates oil contact within 2 km of an intertidal location where sensitive organisms are known to occur.	Impacts to shoreline and intertidal benthos have been quantified and monitoring results indicate no further shoreline and intertidal coastal habitats and organisms are at risk from, or have been exposed to oil; AND Impacted intertidal benthos indicators have returned to baseline or reference levels.	Preparation to deploy field personnel and equipment will commence on notification from INPEX that the SM has been triggered. Mobilisation of field personnel and equipment within 7 days of receipt of notification.	Environmental service provider under contract for duration of activities.
SM08	Monitoring of Subtidal Marine Benthos to Determine Impacts of Oil Spill and Recovery	To determine and monitor the potential impact of a hydrocarbon spill or response activities and recovery of shallow, subtidal benthos and associated organisms.	Collect quantitative data on shallow subtidal habitats and organisms that are at risk from, or have been exposed to oil Detect and quantify lethal or sublethal impacts of the spill on intertidal habitats and organisms and monitor recovery to baseline or reference levels.	OM indicates oil contact within 2 km of a shallow, subtidal (–30 m LAT or above) location where sensitive organisms are known to occur.	Impacts to shallow, subtidal benthos have been quantified and monitoring results indicate no further shallow subtidal benthos and organisms are at risk from, or have been exposed to oil; AND Impacted subtidal benthos indicators have returned to baseline or reference levels.	Preparation to deploy field personnel and equipment will commence on notification from INPEX that the SM has been triggered. Mobilisation of field personnel and equipment within 7 days of receipt of notification.	Environmental Service Provider under contract for duration of activities.
SM09	Determine Impacts of Oil Spill on Plankton Populations and Recovery	To investigate the possible scale of impacts to plankton and the degree to which hydrocarbons may accumulate in populations as a result of a spill event.	Quantify plankton in the vicinity of a spill and at reference sites in the wider region. Determine if there are oil-derived hydrocarbons in plankton. Evaluate the potential for impacts to plankton by the oil spill or response activities. If possible, detect and quantify lethal and, where appropriate, sublethal effects to plankton.	There is a plankton community in the spill vicinity (identified during the course of remote sensing undertaken in OM03) that is likely to support the regionally important natural or commercial resources in the area, or is an important source of recruitment for plankton communities; AND The nature (composition) and magnitude of the spill (volume, area of impact, components, etc.) are sufficient to present a significant risk of exposure and lethal impacts to plankton communities (identified in OM03);	Plankton communities in the vicinity the spill and at reference sites in the wider region have been quantified. Oil-derived hydrocarbon presence in plankton has been determined. Impacts to plankton by the oil spill or response activities have been evaluated. Lethal and sublethal effects to plankton have been quantified.	Preparation to deploy field personnel and equipment will commence on notification from INPEX that the SM has been triggered. Mobilisation of field personnel and equipment within 7 days of receipt of notification.	Environmental Service Provider under contract for duration of activities.

Code	Title	Aim of the plan	Key objectives	Activation triggers	Termination criteria	Mobilisation time	Service provider
				OR A mass spawning event has taken place or is likely to occur within the area of impact.			
SM10	Determine Impact of Oil Spill on Seabirds and Shorebird Populations and Recovery	To assess potential impacts on seabird and shorebird populations within the marine avifauna BIAs, or populations identified by OM01 and/or OM03, which may have been affected by the oil spill or response activities.	Quantify and assess potential impacts to seabirds and coastal bird populations (in particular known breeding colonies) by the spill, and associated response activities, including abundance, mortality, sublethal effects, sickness and oiling. Determine whether oil or response activities were the cause of observed impacts. Monitor the recovery of key behaviour and breeding activities of seabirds and coastal bird populations over time, with regard to reference or baseline levels. Provide information to feed into any restoration or remediation activities that need to be implemented for marine avifauna.	OM indicates oil contact within 2 km of an intertidal location or within a marine avifauna BIA; OR Likely spill contact with any other identified marine avifauna population.	Monitoring results have quantified the lethal or sublethal impacts to seabirds and shorebirds as a result of the oil spill and indicate no new populations are at risk from, or have been exposed to, oil or response activities; AND Key seabird and shorebird behaviour and breeding activities or habitat have been measured and are comparable to baseline or reference levels.	Preparation to deploy field personnel and equipment will commence on notification from INPEX that the SM has been triggered. Mobilisation of field personnel and equipment within 7 days of receipt of notification.	Environmental Service Provider under contract for duration of activities.
SM11	Determine Impact of Oil Spill on Non-Avian Marine Megafauna and Recovery	To assess potential impacts on non-avian marine megafauna within their relevant BIAs, or populations identified by OM01 and/or OM03, which may have been affected by the oil spill or response activities.	Quantify and assess impacts of the spill and associated response activities on non-avian marine megafauna, including abundance, mortality, sublethal effects, sickness and oiling. Determine whether oil or response activities were the cause of observed impacts. Monitor the recovery of key behaviour and breeding activities of non-avian marine megafauna over time, with regard to baseline or reference levels. Provide information to feed into any restoration or remediation activities that need to be implemented for non-avian marine megafauna.	OM indicates oil contact within 2 km of an intertidal location or within a non-avian marine megafauna BIA; OR Likely spill contact with any other identified non-avian marine megafauna population.	Monitoring results have quantified the lethal or sublethal impacts to non-avian marine megafauna to the oil spill and indicate no new populations are at risk from, or have been exposed to, oil or response activities; AND Key non-avian marine megafauna behaviour and breeding activities or habitat have been measured and are comparable to baseline or reference levels.	Preparation to deploy field personnel and equipment will commence on notification from INPEX that the SM has been triggered. Mobilisation of field personnel and equipment within 7 days of receipt of notification.	Environmental Service Provider under contract for duration of activities.
SM12	Determination of the Impact of the Oil Spill on Commercial, Traditional and Recreational Fisheries	To monitor potential impacts of the oil spill and response activities on commercial, traditional and recreational fisheries and	Determine the potential impacts of the oil spill and response activities on commercial, traditional and recreational fisheries and follow their recovery in relation to baseline or reference levels. Evaluate the type and severity of physiological or biochemical changes (as measured by	For surface spills, OM indicates oil contact within 2 km of a shallow, subtidal (−30 m LAT or above) or intertidal location; OR OM predicts contact is possible to commercial, traditional or recreational fisheries species;	Monitoring results have quantified the physiological or biochemical changes and sublethal impacts of the oil spill and clean-up methods on, commercial, traditional and recreational fisheries; AND Contamination in the edible	Preparation to deploy field personnel and equipment will commence on notification from INPEX that the SM has been triggered. Mobilisation of field personnel and	Environmental Service Provider under contract for duration of activities.

Code	Title	Aim of the plan	Key objectives	Activation triggers	Termination criteria	Mobilisation time	Service provider
		subsequent recovery.	biomarkers of fish health) in commercial, traditional and recreational fisheries species affected by the spill, including the identification of potential reproductive impairment. Determine whether oil or response activities were the cause of observed impacts.	OR Advice has been provided to government to restrict, ban or close a fishery. SM12 will commence to provide data for government to enable decisions to be made on when a fishery can be reopened; OR Declarations of intent by commercial fisheries or government agencies to seek compensation for alleged or possible damage.	portion or in the stomach/intestinal contents attributable to the spill is no longer detected; OR No differences are detected in commercial, traditional or recreational fisheries from reference levels; OR The physiological and biochemical parameters in the studied species have returned to baseline levels.	equipment within 7 days of receipt of notification.	

APPENDIX B: INPEX INCIDENT ACTION PLAN TEMPLATE

<table>
<tr><td colspan="6">INPEX – Incident Action Plan</td></tr>
<tr><td>IAP Sequence #</td><td></td><td colspan="2">IAP Issue Date / Time</td><td colspan="2"></td></tr>
<tr><td colspan="2">Incident Name</td><td colspan="4">Operational Period</td></tr>
<tr><td colspan="2"></td><td>From</td><td></td><td>to</td><td></td></tr>
<tr><td colspan="3">IAP Developer - Planning Function Lead</td><td colspan="3">IAP Approver - IMT Leader</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td>Mission Statement</td><td colspan="5">Responsible: IMT Leader</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Situation</td><td colspan="5">Responsible: IMT Leader/Operations
Information from: Incident Status Board</td></tr>
<tr><td>Incident Level:</td><td colspan="5"></td></tr>
<tr><td>Incident Location</td><td colspan="5"></td></tr>
<tr><td>Status:</td><td colspan="5">Is incident contained, escalating , under control</td></tr>
<tr><td>Incident Commenced</td><td colspan="5">Time /Date</td></tr>
<tr><td>Incident Commander Contact Details:</td><td colspan="5"></td></tr>
<tr><td>Brief Description of Incident</td><td colspan="5"></td></tr>
<tr><td>Actions Completed</td><td colspan="5"></td></tr>
<tr><td>Current Situation</td><td colspan="5"></td></tr>
<tr><td>Actions Underway</td><td colspan="5"></td></tr>
<tr><td>Predicted Situation
(at end of operational period)</td><td colspan="5"></td></tr>
<tr><td>Safety Message / Risks</td><td colspan="5">Responsible: H&S Advisor</td></tr>
<tr><td colspan="6">Key message to prevent further injury or hazard exposure for responders plus key risk areas over the operational period</td></tr>
</table>

	Ref	People	Ref	Environment	Ref	Assets	Ref	Reputation	Ref	Sustainability
Incident Objectives	*PO1*		*EO1*		*AO1*		*RO1*		*SO1*	
	PO2		*EO2*		*AO2*		*RO2*		*SO2*	
	PO3		*EO3*		*AO3*		*RO3*		*SO3*	
	PO4		*EO4*		*AO4*		*RO4*		*SO4*	
Strategies										
			EO1		*AO1*		*RO1*		*SO1*	
	PO1									
							RO2		*SO2*	
			EO2		*AO2*					
	PO2									
	PO3									

Tasks		IMT Function responsible		IMT Function responsible		IMT Function responsible		IMT Function responsible		IMT Function responsible

Resources	*Responsible: Logistics Function*	*Information from: Resources Summary Board*
A summary of resources required and being used during Operational period ETD and ETA are to be included.		

Medical Plan	*Responsible:* *HR Function*	*Information from:* *Medical Planning Board*
A summary of casualties, medevacs and medical facilities		
Communications Plan	*Responsible:* *IMT Leader (EA&JV Function can assist if activated by P-CMT Leader)*	*Information from:* *Stakeholder Management Board*
A summary of key stakeholder deadlines and planned engagements or updates required during Operational Period		
Key Timings	*Responsible:* *IMT Leader/Planning*	
A summary of key timings within this Operational Period such as next IMT Update Briefing, Shift Change, etc.		
Administration	*Responsible:* *All*	
Additional specialist functions activated to support incident management. *A summary of administrative arrangements such as feeding, accommodation, security, travel etc.*		

Appendix G-
Strategic Spill Impact Assessment (SIMA) for Surface diesel release

X060-AH-LIS-60032 Spill Impact Mitigation Assessment Surface Diesel Release

Location	N/W WA and NT Waters	Spill Scenario	<500m^3 Marine Diesel Instantaneous Surface Release

Resource Compartment (including values dependent on the resource compartment)	SIMA Stage 2: Predict Outcomes – Potential Relative Impact – No Intervention (natural weathering)		SIMA Stage 3: Balance Trade-Offs - Impact Modification Factors – Prediction of the effectiveness and impact modification potential of the response options: Contain and Recover		Protect and Deflect		Shoreline Clean-up		Chemical Dispersant (near spill location)		Pre-Contact Wildlife Response (Hazing & Translocation)		Post Contact Wildlife Response		In-situ Burn (near spill location)	Operational monitoring and evaluation
		A	B1	A x B1	B2	A x B2	B3	A x B3	B4	A x B4	B5	A x B5	B6	A x B6		
Subtidal Benthic Communities															In-situ is not considered to be safe, effective or feasible.	Operational monitoring and evaluation is implemented under all oil spill scenarios
Benthic primary producer habitat (coral, seagrass, macro-algae and shallow water EPBC species foraging within this habitat)	Moderate	3	1	3	0	0	0	0	-1	-3	0	0	0	0		
Deep-sea features (filter feeding communities, deep water EPBC species foraging areas and Key Ecological Features)	None / Insignificant	1	0	0	0	0	0	0	0	0	0	0	0	0		
Deep-sea unconsolidated muds and sands	None / Insignificant	1	0	0	0	0	0	0	0	0	0	0	0	0		
Intertidal seabed																
Intertidal Coral Reef	Moderate	3	1	3	-2	-6	-1	-3	-1	-3	0	0	0	0		
Mangrove/Mudflats/Samphires	Minor	2	1	2	-1	-2	-1	-2	-1	-2	0	0	0	0		
Sandy Beach	Minor	2	1	2	1	2	1	2	-1	-2	0	0	0	0		
Rocky Shoreline	Minor	2	1	2	1	2	1	2	-1	-2	0	0	0	0		
Macro-Algae and Seagrass	Minor	2	1	2	1	2	-1	-2	-1	-2	0	0	0	0		
Intertidal habitat which is important habitat for protected species (nesting / roosting / foraging)	Moderate	3	1	3	1	3	1	3	-1	-3	1	3	1	3		
Water column																
Lower water column (below photic zone)	None / Insignificant	1	0	0	0	0	0	0	0	0	0	0	0	0		
Upper water column (in photic zone, including plankton and EPBC foraging in the photic zone)	Minor	2	1	2	0	0	0	0	-1	-2	0	0	0	0		
Water surface, including foraging areas for EPBC listed species	Moderate	3	1	3	0	0	0	0	-1	-3	0	0	1	3		
Air	Minor	2	0	0	0	0	0	0	0	0	0	0	0	0		
Socio-economic																
Commercial demersal fisheries	None / Insignificant	1	0	0	0	0	0	0	0	0	0	0	0	0		
Shallow commercial fisheries (including aquaculture)	None / Insignificant	1	1	1	0	0	1	1	-1	-1	0	0	0	0		
Recreational fisheries	None / Insignificant	1	1	1	0	0	1	1	-1	-1	0	0	0	0		
Cultural heritage																
Aboriginal heritage (cultural practices, sites and fishing / foraging)	None / Insignificant	1	0	0	0	0	1	1	0	0	0	0	0	0		
Indonesian traditional fishing	None / Insignificant	1	1	1	0	0	1	1	-1	-1	0	0	0	0		
		Total Impact Mitigation Score		25		1		4		-25		3		6	-	-
		Carried to ALARP evaluation yes/no		Yes		Yes		Yes		No		Yes		Yes	No	Yes

Resource Compartment (including values dependent on the resource compartment)	No Intervention (natural weathering)		Justification for Potential Relative Impact Score
		A	
Subtidal Benthic Communities			
Benthic primary producer habitat (coral, seagrass, macro-algae and shallow water EPBC species foraging within this habitat)	Moderate	3	Subtidal benthic primary producer habitat (BPPH) may be exposed to entrained/dissolved diesel above impact thresholds from a vessel collision in the Browse Basin. The effect of the toxic fractions of entrained/dissolved oil on intertidal coral includes partial mortality of colonies, reduced growth rates, bleaching, reduced photosynthesis, interruption of chemical communication necessary for mass spawning, premature explosion of larvae, decreased growth rates, decreased lipid content, decreased survival of larvae, decreased gonadal development, negative impacts to coral settlement, increased susceptibility to algae colonisation, epidemic diseases, localised tissue rupture, reduced reef resilience and mortality (Hayes et al 1992; Peters et al 1997; Negri & Heyward 2000; Shigenaka 2001; CSIRO 2016). WA DoT (2018) note that coral is sensitive to dissolved hydrocarbons as it causes toxicity at a cellular level. Corals accumulate oil from the water column (Pie et al 2015) making it biologically available to EPBC species foraging in this habitat. Seagrass and macroalgae may be subject to lethal or sublethal toxic effects, including mortality, reduced growth rates and impacts to seagrass flowering. BPPH is collectively considered to be an important resource as it supports a high biomass of fish, cetaceans and seabirds, including foraging EPBC species (DEWHA 2008). Several studies have indicated rapid recovery rates for seagrass and macroalgae may occur even in cases of heavy oil contamination (Connell et al, 1981; Burns et al. 1993; Dean et al. 1998; Runcie & Riddle 2006), but coral is sensitive to oil (and dispersants), making recovery from spills potentially slow (Guzman et al 1994). RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. Therefore, the consequence to benthic primary producer habitat is considered to be Moderate.
Deep-sea features (filter feeding communities, deep water EPBC species foraging areas and Key Ecological Features)	None / Insignificant	1	No impact from surface spill of diesel below 25m (RPS 2019).
Deep-sea unconsolidated muds and sands	None / Insignificant	1	No impact from surface spill of diesel below 25m (RPS 2019).
Intertidal seabed			
Intertidal Coral Reef	Moderate	3	Intertidal coral reefs could be impacted by surface fresh, weathered, entrained and dissolved diesel from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. The effect of diesel on intertidal coral is unlikely to result in significant smothering as diesel is expected to be weathered and in the form of waxy flakes/residues when it arrives in intertidal coral areas. In this form, toxicity is less than fresh diesel (Woodside 2014). The effect of the toxic fractions of entrained/dissolved oil on intertidal coral include partial mortality of colonies, reduced growth rates, bleaching, reduced photosynthesis, interruption of chemical communication necessary for mass spawning, premature explosion of larvae, decreased growth rates, decreased lipid content, decreased survival of larvae, decreased gonadal development, negative impacts to coral settlement, increased susceptibility to algae colonisation, epidemic diseases, localised tissue rupture, reduced reef resilience and mortality (Hayes et al 1992; Peters et al 1997; Negri & Heyward 2000; Shigenaka 2001; CSIRO 2016). WA DoT (2018) note that coral is sensitive to dissolved hydrocarbons as it causes toxicity at a cellular level. Coral reefs are found in isolated locations within the Browse Basin and are considered to be significant benthic primary producers that play a key role in the ecosystem and have an iconic status in the environment (WA DoT 2018). They are considered of high importance to EPBC species that aggregate, nest, roost and forage in the area, hence isolated populations could potentially be exposed in the event of a spill. As spills disperse, intertidal communities are expected to recover (Dean et al. 1998), though the rate of recovery of coral reefs depends on the level or intensity of the disturbance, with recovery rates ranging from 1 or 2 years, to decades (Fucik et al. 1984, French McCay 2009). Impact on the receptor is considered to be Moderate.
Mangrove/Mudflats/Samphires	Minor	2	Mangrove, mudflats and samphire communities may be exposed to entrained/dissolved diesel above impact thresholds from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. Given that mangrove habitats are remote from permit areas, fresh or weathered diesel (both surface and entrained) are unlikely to reach this receptor. The potential effects of entrained and dissolved oil include defoliation and mortality of mangroves (Burns et al. 1993; Duke et al. 2000). Entrained and dissolved oil exposure is only likely to occur at isolated locations amongst a very large and generally contiguous population. The recovery of mangroves from shoreline oil accumulation can be a slow process, due to the long-term persistence of oil trapped in anoxic sediments and subsequent release into the water column (Burns et al. 1993). Any impacts to benthic habitats are expected to be localised and of short to medium term. The potential consequence is considered to be Minor.
Sandy Beach	Minor	2	Sandy beaches could be impacted by surface fresh, weathered, entrained and dissolved diesel from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. The effect of gradual accumulation of oil on the receptor could lead to harm including the increased prevalence of tumours in species (CSIRO 2016). Sandy beaches are the dominant shoreline habitat on offshore islands in the Browse Basin and are considered significant habitat for turtles and seabird nesting. Organisms such as polychaete worms, bivalves and crustaceans generally inhabit sandy beaches but the mobile nature of the sands generally limits diversity. These species provide a valuable food source for resident and migratory sea and shorebirds (DEC/MPRA 2005). Law et al (2011) note that when grain size is between 2 and 64 mm, beaches are not considered especially sensitive to oil spills as they are regularly cleaned by wave action and oil is generally not retained. Offshore island beaches of the Browse Basin are generally coarse grained, due to high wave energy. WA DoT (2018) assessed Kimberley sandy beaches and concluded that they are moderately ecologically sensitive and are moderately difficult to rehabilitate from an oil spill. The potential consequence is considered to be Minor.
Rocky Shoreline	Minor	2	Rocky shorelines could be impacted by surface fresh, weathered, entrained and dissolved diesel from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. This receptor is typically characterised as being a high wind and wave energy environment (CSIRO 2016). Diesel from a spill has the potential to coat the substrate or become stranded by receding tides – but incoming tides also have the potential to remove deposited diesel (Law et al 2011). CSIRO (2016) note that rocky shorelines are not considered sensitive environments, and IPIECA (2017) state that rocky shorelines generally have a diverse and productive intertidal community which are considered resilient to oil spills and short-term oil persistence. WA DoT (2018) note that rocky shorelines are the least susceptible of shoreline types to long term impacts from a spill of both floating and dissolved oil. As such, this receptor is not expected to have issues relating to recovery from an oil spill. The potential consequence for rocky shorelines is considered to be Minor.

Macro-Algae and Seagrass	Minor	2	Macroalgae and seagrass may be exposed to entrained and dissolved diesel above impact thresholds from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. This receptor is unlikely to come into contact with significant amounts of fresh floating surface hydrocarbons, but could potentially be exposed to weathered waxy flakes and residues. WA DoT (2018) note that dissolved oil causes more impacts to algae than floating oil, as it results in cellular level poisoning. The effect of subjecting seagrass and macroalgae to lethal or sublethal toxic effects of oil can result in mortality, reduced growth rates and impacts to seagrass flowering. Several studies have indicated rapid recovery rates may occur even in cases of heavy oil contamination (Connell et al, 1981; Burns et al. 1993; Dean et al. 1998; Runcie & Riddle 2006). Taylor and Rasheed (2011) reported that seagrass meadows were not significantly affected by an oil spill when compared to a non-impacted reference seagrass meadow. Macroalgae support diverse small invertebrates that are the principal food source for a number of inshore fish (WA DoT 2018). Seagrasses provide energy and nutrients for detrital grazing food webs (WA DoT 2018), act as a refuge for fish and invertebrates, and provide a food source for EPBC species such as dugongs and green turtles (DEC 2007). Therefore, the potential consequence is considered to be Minor.
Intertidal habitat which is important habitat for protected species (nesting / roosting / foraging)	Moderate	3	Intertidal habitat may be exposed to fresh, weathered, entrained and dissolved diesel above impact thresholds from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. The effect of diesel on this receptor can result in mortality or harm to benthic primary producers and organisms such as EPBC species that rely on these species for food, or rely on the habitat for nesting and roosting. IPIECA (2014) note that dehydration, gastrointestinal problems and anaemia are commonly found in oiled animals, causing potential long-term effects on reproductive success. They further note that the toxic effects of ingested oil generally impacts the liver, whilst volatile fumes damage lungs resulting in debilitating effects (IPIECA 2014). Oiled aquatic EPBC fauna can further suffer hypothermia, irritations, burns, respiratory problems and loss of waterproofing, leading to them moving onto land (i.e. away from their food source) where they have further difficulty thermoregulating and feeding (IPIECA 2017). Specifically, marine reptiles, including turtles and crocodiles can be exposed to hydrocarbons externally in intertidal areas through direct contact; or internally, by ingesting oil, consuming prey containing oil, or inhaling volatile compounds (Milton et al. 2003). Turtle hatchlings may be particularly vulnerable to toxicity and smothering, as they emerge from nests and make their way over the intertidal area to the water (AMSA 2015; Milton et al. 2003). Birds coated in hydrocarbons can suffer damage to external tissues including skin and eyes, as well as internal tissue irritation in their lungs and stomachs (AMSA 2015; WA DoT 2018). Toxic effects may also result where the product is ingested, either through birds' attempts to preen their feathers (Jenssen 1994; Matcott et al. 2019) or ingested as weathered waxy flakes/residues present on shorelines. There is the potential for short to medium term impacts; however, the overall population viability for any protected species would not be threatened from a vessel collision spill. The cumulative potential consequence is considered to be Moderate.
Water column			
Lower water column (below photic zone)	None / Insignificant	1	No impact from surface spill of diesel below 25m (RPS 2019).
Upper water column (in photic zone, including plankton and EPBC foraging in the photic zone)	Minor	2	The upper water column may be exposed to entrained and dissolved diesel above impact thresholds from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. The effect of entrained and dissolved oil on this receptor include chronic impacts to juvenile fish, larvae and planktonic organisms due to their sensitivity during these life stages, with the worst impacts predicted to occur in smaller species (WA DoT 2018). Whale sharks are filter feeders and are expected to be highly vulnerable to entrained hydrocarbons (Campagna et al 2011) with potential effects including damage to the liver and lining of the stomach and intestines, as well as toxic effects on embryos (Lee 2011). Marine mammals, marine reptiles and marine avifauna could also be impacted through entrained and dissolved hydrocarbon exposure, primarily through ingestion during foraging activities (AMSA 1998). The upper water column is considered to be very important habitat for EPBC species as a large number of BIAs for marine fauna are present in the Browse Basin. It is expected that the upper water column will recover quickly as a vessel collision spill is unlikely to cause significant or cumulative impacts. The consequence is considered to be Minor.
Water surface, including foraging areas for EPBC listed species	Moderate	3	The water surface may be exposed to fresh and weathered surface diesel above impact thresholds from a vessel collision in the Browse Basin. Fresh diesel and weathered waxy flakes/residues can impact marine mammals surfacing, as they are vulnerable to oil exposure. Blue whales and humpback whales (baleen whales), that filter-feed near the surface, could potentially ingest diesel. Spilled hydrocarbons may also foul the fibres of baleen whales impairing food gathering efficiency or fouling prey with hydrocarbons (AMSA 2015). Turtles can be exposed to hydrocarbons if they surface within the spill, resulting in direct contact with the skin, eyes, and other membranes, as well as the inhalation of vapours or ingestion (Milton et al. 2003). Floating oil is considered to impact reptiles more than entrained/dissolved oil because reptiles hold their breath underwater and are unlikely to directly ingest dissolved oil (WA DoT 2018). Other aspects of turtle behaviour, including a lack of avoidance behaviour, indiscriminate feeding in convergence zones, and large, pre dive inhalations, make them vulnerable to spilled oil (AMSA 2015). Hatchlings spend more time on the surface than older turtles, thus increasing the potential for contact with oil slicks (Milton et al. 2003). Aquatic migratory birds are among the most vulnerable and visible species to be affected by surface oil, with oil impacts frequently leading to long-term physiological changes potentially resulting in lower reproductive rates or survival rates (Fingas 2012). The probability of lethal effects is dependent on factors such as timing, location, oceanographic and weather patterns, and the movements of species that forage, feed, nest and inhabit that area (IPIECA 2014), the amount of time spent on the water surface as well as any oil avoidance behaviour (French-McCay 2009). Direct contact with surface hydrocarbons may break down the ability of plumage to maintain body heat, resulting in direct and indirect impacts such as hypothermia, dehydration, drowning and starvation (AMSA 2015; Matcott et al, 2019; Jenssen 1994; IPIECA 2014; ITOPF 2011). Birds resting at the sea surface or surface plunging can be impacted by oil resulting in damage to external tissues, including skin and eyes, and internal tissue irritation in lungs and stomachs (Clark 1984; WA DoT 2018). Toxic effects may also result where hydrocarbons are ingested, as birds attempt to preen their feathers (Jenssen 1994; Matcott et al. 2019). The water surface is considered an important receptor where EPBC listed species forage. It is expected to recover from oil impacts with time, and it is unlikely that there will be cumulative impacts through bioaccumulation up the food chain. The consequence is considered to be Moderate.
Air	Minor	2	Air may be exposed to fresh surface diesel above impact thresholds from a vessel collision in the Browse Basin. Surface oil may lead to high local concentrations of atmospheric volatiles that have the potential to cause harmful impacts to species such as cetaceans if inhaled. Turtles could also be affected by harmful vapours during pre-dive inhalations (Milton et al. 2003). The receptor is not considered to be sensitive, thus is expected to recover in a very short period of time, as the evaporated hydrocarbons are rapidly dispersed by the wind, and evaporation rapidly reduce with time as oil weathers and entrains. Only a very localised area, immediately above the freshest parts of the oil slick would be impacted by evaporating hydrocarbons. The potential consequence is considered to be Minor.

Socio-economic			
Commercial demersal fisheries	None / Insignificant	1	No impact to fish stocks deeper 25 metres (RPS 2019). Commercial demersal fisheries may be exposed to surface, weathered, entrained and dissolved diesel above impact thresholds from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. The effect of diesel on this receptor includes the ability to cause economic loss (through indirect loss of stock and perceived tainting of stock by oil) (WA DoT 2018), impede access to fishing areas from the implementation of an exclusion zone during a spill response; impact seafood quality and employment; plus negatively impact lines and nets (ITOPF 2011). The economic impact from an oil spill is dependent on the species being cultured, as species have different recovery rates. WA DoT (2018) note that dissolved oil will impact finfish, taking 6-8 years for fisheries to recover (due to the time it takes for hatchlings to reach maturity) (WA DoT 2018). This receptor is considered to be important, however a vessel collision spill is unlikely to cause significant impacts to demersal fisheries due to the shallow and localised entrained oil affected area. The real and perceived consequence is considered to be Insignificant.
Shallow commercial fisheries (including aquaculture)	None / Insignificant	1	Shallow commercial fisheries including aquaculture (shallower than 25m, (RPS 2019)) may be exposed to surface, weathered, entrained and dissolved diesel above impact thresholds from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. The effect of diesel on this receptor includes the ability to cause economic loss (through indirect loss of stock and perceived tainting of stock by oil) (WA DoT 2018), impede access to fishing areas from the implementation of an exclusion zone during a spill response; impact seafood quality and employment; plus negatively impact lines and nets (ITOPF 2011). The economic impact from an oil spill is dependent on the stock being cultured, as species have different recovery rates. DoT (2018) note that dissolved oil will have the greatest impact, with oyster farms potentially taking 3-4 years to recover from a spill (DoF 2013), whilst finfish farms could take 6-8 years to recover due to the time it takes for hatchlings to reach maturity. WA DoT (2018) note that the pearling industry relies almost exclusively on sourcing pearl oysters from Eighty Mile Beach (south of Broome) and an area off the Lacepede Islands. There is also other aquaculture in the region including trochus and barramundi (Fletcher et al 2017). WA DoT (2018) note that some wild stocks aquaculture species such as mussels are impacted more by dissolved oil than floating oil due to being filter feeders. This receptor is considered to be important however a vessel collision spill in the Browse Basin unlikely to cause any significant impacts to shallow commercial fisheries (including aquaculture) due to the limited and localised surface and shallow entrained oil and remoteness of the shallow commercial fishing areas and aquaculture to potential release locations. Therefore, the real and perceived consequence is considered to be Insignificant.
Recreational fisheries	None / Insignificant	1	Recreational fisheries (shallower than 25m, RPS 2019)) may be exposed to surface, weathered, entrained and dissolved diesel above impact thresholds from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. The effects of diesel on this receptor includes negatively impacting nets and lines (ITOPF 2011), impeding access to fishing areas from the implementation of an exclusion zone during a spill response and impacting seafood quality and quantity. Recreational fishing is generally concentrated around readily accessible coastal settlements along the Kimberley and NT coastlines (such as Broome, Wyndham and Darwin) and there is little recreational fishing around the offshore Browse Basin due to the distance from land, lack of features of interest and deep waters. Offshore islands, coral reef systems and continental shelf waters of the Browse Basin however are increasingly being targeted by fishing based charter vessels (Fletcher and Santoro 2014) with extended fishing charters operating during certain times of the year. This receptor is considered to be important, however a vessel collision spill is unlikely to cause significant impacts to recreational fisheries due to the limited and localised surface and shallow entrained oil affected area and very limited recreational fishing in the offshore Browse Basin. The real and perceived consequence is considered to be Insignificant.
Cultural heritage			
Aboriginal heritage (cultural practices, sites and fishing / foraging)	None / Insignificant	1	Aboriginal heritage including special places, cultural landscapes, practices and fishing/foraging along the Kimberley and NT coastline are unlikely to be impacted by surface and weathered diesel above impact thresholds from a vessel collision in the Browse Basin. The effect of surface weathered diesel on this receptor includes physically degrading a site, disrupting the harvesting of fish, and area closures could displace Aboriginal people and have implications on cultural identity, health and wellbeing. The receptor is important however is generally remote from any potential vessel collision locations, limiting the scale of imact, and the recovery is expected to be short to medium term. Therefore, consequence is considered to be Insignificant.
Indonesian traditional fishing	None / Insignificant	1	Indonesian traditional fishing areas shallower than 25m (RPS 2019) may be exposed to fresh, weathered surface oil and entrained/dissolved diesel above impact thresholds from a vessel collision in the Browse Basin. RPS (2019) modelling of a 250m3 MGO spill confirmed that at no point would dissolved oil exceed the 500 ppb impact threshold, limiting the potential for toxic effects from an MGO spill. Indonesian traditional fishing occurs within the MoU box which covers Scott Reef and surrounds, Seringapatam Reef, Browse Island, Ashmore Reef, Cartier Island and various banks and shoals. The effect of diesel on these receptor could include reduction and contamination of target species such as sea cucumbers (bêche-de-mer), trochus (top shell snail), reef fish. Exclusion zones during the spill response may also affect access to fishing locations, even if the target species are not affected by diesel. This receptor is considered to be important however a vessel collision spill is unlikely to cause significant impacts to Indonesian traditional fishing due to the limited and localised surface and shallow entrained oil affected area. The real and perceived consequence is considered to be Insignificant.

Containment and Recovery

Overall statement of likelihood of success of Contain and Recovery (C&R):

Aim: This strategy aims to collect oil from the ocean surface using booms and skimmers, generally at or near the release location, where oil concentrations are highest. Floating booms are used to corral and concentrate spilled floating oil into a surface thickness that will allow for mechanical removal (i.e. pumping oil into temporary storage) by devices such as skimmers (IPIECA 2015).

Type of slick: Surface oil is in the form of Group II floating slicks which have a low viscosity and rapidly spread into a thin sheen. Surface oil concentrations will be approximately 10 g/m^2 (~0.01mm, which equates to Bonn code 1/2) up to approximately 160 km from the spill site and weathered oil concentrations reduce down to below 1 g/m^2 up to approximately 300 km from the spill site.

Likely success/effectiveness against slick: O'Brien (2002) notes that spreading of oil is the main obstacle to a successful at sea contain and recovery response, with this type of oil tending to spread so thinly and quickly that skimmers are unable to efficiently skim and recover meaningful quantities. Generally oil needs to be >100 g/m^2 (>0.1mm, which equates to Bonn code 4/5) to feasibly corral oil with a boom and achieve any significant level of oil recovery with skimmers (O'Brien 2002), as booms have limited effect against thin oil films and no effect against a subsurface plume (ITOPF 2011). The initial, gravity-dominated release and spreading is generally complete within minutes to hours after a release (O'Brien 2002)). In the context of the Browse Basin, with high sea surface and air temperatures in all seasons, the spreading of any diesel spill would be very rapid. Diesel spilled from a vessel collision would therefore remain at a thickness of >100g/m^2 for only a very brief period of time, before evaporation and spread effects generating very thin surface slicks, making C&R inefficient and impractical (IPIECA 2017). Where there is any significant diesel slick, flammable/toxic vapours will also be present, and will likely exceed safe exposure thresholds, further reducing response efficiency (as vessels will not be permitted to operate in areas where explosive limits or VOC exposure thresholds are exceeded). Due to the very thin surface slicks, very low rates of recovery would be expected. Note that IPIECA (2015) state that efficiency of contain and recover operations (for any oil type) can vary widely due to operational, environmental and logistical constraints, but usually it is limited to recovering approximately only 5-20% of the initial spilled volume. Contain and recovery is therefore unlikely to be an effective response strategy, with limited chance of any significant surface slick recovery from a Group II spill.

Resource Compartment (including values dependent on the resource compartment)	Impact Modification Score		Justification for Impact Modification Score
		B	
Subtidal Benthic Communities			
Benthic primary producer habitat (coral, seagrass, macro-algae and shallow water EPBC species foraging areas)	Minor mitigation of impact	1	C&R may result in a minor reduction in localised surface oil which may have a minor positive outcome in reducing future entrained oil in the upper water column including submerged BBPH.
Deep-sea features (filter feeding communities, deep water EPBC species foraging areas and Key Ecological Features)	No or insignificant alteration of impact	0	C&R occurs on the surface and has no impact on entrained oil affecting deep sea features.
Deep-sea unconsolidated muds and sands	No or insignificant alteration of impact	0	C&R occurs on the surface and has no impact on entrained oil affecting deep sea unconsolidated muds and sands.
Intertidal seabed			
Intertidal Coral Reef	Minor mitigation of impact	1	C&R may result in a minor reduction on oil on surface, resulting in very minor reduction in surface and entrained oil reaching intertidal zones.
Mangrove/Mudflats/Samphires	Minor mitigation of impact	1	
Sandy Beach	Minor mitigation of impact	1	
Rocky Shoreline	Minor mitigation of impact	1	
Macro-Algae and Seagrass	Minor mitigation of impact	1	
Intertidal habitat which is important habitat for protected species (nesting / roosting / foraging)	Minor mitigation of impact	1	
Water column			
Lower water column (below photic zone)	No or insignificant alteration of impact	0	C&R occurs on the surface and has no impact on entrained oil affecting fully submerged benthic primary producer habitat.
Upper water column (in photic zone)	Minor mitigation of impact	1	C&R may result in a minor reduction in localised surface oil which may have a minor positive outcome in reducing future entrained oil in the upper water column.
Water surface	Minor mitigation of impact	1	C&R may result in a minor reduction in localised surface oil.
Air	No or insignificant alteration of impact	0	Due to the rapid evaporation of diesel and low expected recovery rates of surface oil, C&R activities would not result in any significant change to local atmospheric VOC concentrations.

Socio-economic			
Commercial demersal fisheries	No or insignificant alteration of impact	0	C&R may result in a minor reduction in localised surface oil which may have a minor positive outcome on entrained oil, resulting in no change to oil exposure to demersal fish communities.
Shallow commercial fisheries (including aquaculture)	Minor mitigation of impact	1	C&R may result in a minor reduction in localised surface oil which may have a minor positive outcome in reducing future entrained oil in the upper water column including shallow commercial and recreational fisheries.
Recreational fisheries	Minor mitigation of impact	1	
Cultural heritage			
Aboriginal heritage (cultural practices, sites and fishing / foraging)	No or insignificant alteration of impact	0	C&R may result in a minor reduction in localised surface oil which may have a minor positive outcome in reducing future entrained oil in the upper water column. However, due to distance to aboriginal cultural heritage receptors, the impact mitigation potential is considered to be insignificant.
Traditional Indonesian fishing	Minor mitigation of impact	1	C&R may result in a minor reduction in localised surface oil which may have a minor positive outcome in reducing future entrained oil in the upper water column including shallow traditional fishing habitats.

Protect and Deflect

Overall statement of likelihood of success of Protect and Deflect (P&D):

Aim: This strategy aims to use physical barriers to exclude or restrict the spill contacting specific sensitive receptors or to deflect the spill from these locations; typically onto less sensitive areas.

Type of slick: Surface oil reaching remote shorelines will be in the form of thin floating slicks of weathered diesel which could accumulate over time. Weathered oil would be in the form of waxy flakes and residues which are generally considered to be of lower toxicity than fresh oil (Woodside 2014).

Likely success/effectiveness against slick: Booms could be used to protect and deflect surface spills away from sensitive habitats, but they have limited effect against thin Group II oil films and no effect against subsurface entrained plumes (ITOPF 2011). Generally oil needs to be >100 g/m^2 (>0.1mm, which equates to Bonn Code 4/5) to feasibly corral oil with a boom (O'Brien 2002), as would be required for a P&D response. However diesel on the ocean surface from a vessel collision is unlikely to have slicks >100 g/m^2. Even in a scenario where the best equipment is available, shoreline protect and deflect activities at Browse Island or other exposed remote shoreline locations, would be technically challenging due to the general exposure to unfavourable sea conditions, large tidal range and shallow coral reefs. Generally protect and deflect is limited to sheltered waters, not exposed reef/beach environments. Only under exceptionally calm sea-states and appropriate tides would it be safe to conduct vessel activities to carry-out an effective protect and deflect operation at remote shorelines. MetOcean conditions required for this technique to be successful include <1 m sea-state and low surface currents - but these are frequently exceeded at remote offshore locations in the Browse Basin region. In addition, given the size of the offshore island shorelines (e.g. Browse Island, one of the smallest offshore islands, has an intertidal zone 3km in diameter, 7km in circumference), a substantial number of booms would be needed to be deployed to protect the shorelines, or deflect oil into a collection point on a beach. Anchoring of booms would most likely result in additional damage to the subtidal and intertidal environment (coral reef) surrounding most offshore islands, due to anchor chain drag. Booms themselves would also drag around on the coral intertidal reef during periods of lower tides, potentially resulting in significant physical damage to the benthos of the reef platform and also result in damage to booms. Booms could potentially be held in place by vessels however due to widths of shorelines requiring protection this would most likely require an unfeasibly large number of vessels, and at low tide this isn't practicable in intertidal zones. Most offshore island shorelines would be expected to 'self clean' any accumulated Group II oil due to the lack of adhesiveness, the coarse substrate, the high wave energy and high tidal regime (Fingas 2012), further reducing the impact mitigation potential of protect and deflect at these locations. As a result of the above mentioned factors, protect and deflect would be unlikely to result in any significant deflection or recovery of Group II diesel at remote intertidal/shoreline habitats.

Resource Compartment (including values dependent on the resource compartment)	Impact Modification Score		Justification for Impact Modification Score
		B	
Subtidal Benthic Communities			
Benthic primary producer habitat (coral, seagrass, macro-algae and shallow water EPBC species foraging areas)	No or insignificant alteration of impact	0	P&D occurs on the surface at a shoreline location and will have insignificant impact on entrained oil affecting subtidal benthic primary producer habitat.
Deep-sea features (filter feeding communities, deep water EPBC species foraging areas and Key Ecological Features)	No or insignificant alteration of impact	0	P&D occurs on the surface at a shoreline location and has insignificant impact on entrained oil affecting deep sea features.
Deep-sea unconsolidated muds and sands	No or insignificant alteration of impact	0	P&D occurs on the surface at a shoreline location and has insignificant impact on entrained oil affecting deep sea unconsolidated muds and sands.
Intertidal seabed			
Intertidal Coral Reef	Moderate additional impact	-2	P&D may result in a minor reduction of thin slicks of weathered diesel reaching intertidal receptors. However, anchoring extensive boom arrays would most likely result in physical damage to subtidal and intertidal coral reefs.
Mangrove/Mudflats/Samphires	Minor additional impact	-1	P&D may result in a minor reduction of thin slicks of weathered diesel reaching intertidal receptors. However, due to the extensive scale of mangrove communities along the mainland and islands of the Kimberley and NT coastline, the ability to successfully achieve a benefit from P&D is extremely limited. Anchors/anchor chains also have the potential to damage mangrove aerial root structures and disturb other fragile low-energy shorelines.
Sandy Beach	Minor mitigation of impact	1	P&D may result in a minor reduction of thin slicks of weathered diesel reaching intertidal receptors. A correctly executed shoreline clean-up may result in a positive outcome compared to natural weathering.

Rocky Shoreline	Minor mitigation of impact	1	P&D may result in a minor reduction of thin slicks of weathered diesel reaching intertidal receptors. A correctly executed clean-up on a rocky shoreline may result in a positive outcome compared to natural weathering.
Macro-Algae and Seagrass	Minor mitigation of impact	1	P&D may result in a minor reduction of thin slicks of weathered diesel reaching intertidal receptors. However, anchoring extensive boom arrays would most likely result in physical damage to subtidal and intertidal coral reefs.
Intertidal habitat which is important habitat for protected species (nesting / roosting / foraging)	Minor mitigation of impact	1	P&D may result in a minor reduction of thin slicks of weathered diesel reaching intertidal receptors. A correctly executed clean-up on a sandy beach or rocky shoreline may result in a positive outcome, including protected species such as marine avifauna and turtles who utilise these habitats.
Water column			
Lower water column (below photic zone)	No or insignificant alteration of impact	0	P&D does not reduce the amount of entrained oil affecting the lower water column.
Upper water column (in photic zone)	No or insignificant alteration of impact	0	P&D does not reduce the amount of entrained oil affecting the upper water column.
Water surface	No or insignificant alteration of impact	0	P&D would only occur near shorelines and would not result in any significant reduction to the volume of oil on the water surface.
Air	No or insignificant alteration of impact	0	P&D would only occur at shorelines remote form the spill release location. The weathered slick will not have any significant volatile components remaining, and therefore P&D would have no effect on local atmospheric conditions.
Socio-economic			
Commercial demersal fisheries	No or insignificant alteration of impact	0	P&D would result in insignificant reduction in entrained oil, resulting in no change to oil exposure to commercial demersal fisheries.
Shallow commercial fisheries (including aquaculture)	No or insignificant alteration of impact	0	P&D would result in insignificant reduction in oil on surface or entrained oil, resulting in no change to oil exposure to shallow commercial fisheries including aquaculture sites.
Recreational fisheries	No or insignificant alteration of impact	0	P&D would result in insignificant reduction in oil on surface or entrained oil, resulting in no change to oil exposure to fish communities, thus no change to recreational fishing.
Cultural heritage			
Aboriginal heritage (cultural practices, sites and fishing / foraging)	No or insignificant alteration of impact	0	P&D would result in insignificant reduction in oil on surface and entrained oil, resulting in no change to impacts on Aboriginal heritage.
Traditional Indonesian fishing	No or insignificant alteration of impact	0	P&D would result in insignificant reduction in oil on surface and entrained oil, resulting in no change to impacts on Indonesian traditional fishing areas.

Shoreline Clean-Up

Overall statement of likelihood of success of Shoreline Clean-Up:

Aim: Using various physical means to clean up oil from affected shorelines to reduce impacts on sensitive receptors or to avoid any reintroduction of the hydrocarbon to the marine environment. It is often viewed as a three step process, with the first phase involving bulk collection of oil floating against the shoreline or stranded on it; phase two involving in-situ treatment of shoreline substrate and phase three involving removal of any remaining residues (final polish) (IPIECA 2015).

Type of slick: Diesel spilled from a vessel collision in the Browse Basin is expected to have undergone several physical and biological weathering processes, such as photo oxidation and biodegradation by the time it strands on a shoreline. Weathered diesel reaching a remote shoreline will be in the form of thin floating slicks which could accumulate over time. Impacts to ecological receptors from exposure to weathered oil (waxy flakes and residues) are far less than those associated with exposure to fresh oils, which have higher levels of toxicity (Milton et al, 2003; Hoff & Michel 2014; Woodside 2014). Group II oils are relatively non-adhesive and will not form a thick adhesive barrier on a shoreline (Fingas 2012).

Likely success/effectiveness against slick: Shoreline clean-up has been consistently found to not enhance ecological recovery of oiled coastlines (Sell et al 1995) but it may protect other resources in the area, such as birds, marine mammals or subtidal habitats including coral reefs or fish farms (CSIRO 2016). Choosing a particular clean-up technique is dependent on factors such as shoreline type, exposure, sensitivity, amount of oil, persistence of oil, toxicity of oil and rate of natural oil removal (IPIECA 2015). Mechanical cleaning is generally not an appropriate technique for offshore/remote shorelines, and manual techniques involving rakes and shovels would likely be required. The clean-up of Group II spills from a beach or shoreline is likely to be difficult, generating high volumes of waste in comparison to the oil recovered. Browse Island and other similar offshore shorelines would be expected to naturally ‘self-clean’ any accumulated Group II oils, due to factors such as the lack of adhesiveness of these oil types, the coarse substrate present and the high wave energy and high tidal regime (Fingas 2012). Typically, inaccessible rocky coves are highly exposed and are best left to naturally clean (IPIECA 2015). ITOPF (2011) also note that for a number of sensitive shoreline types, such as mangroves, natural cleaning is the preferred option in order to minimise the damage caused from clean-up activities. Thus shoreline clean-up would be most effective in areas which are expected to receive large amounts of shoreline oil; where chosen activities don't physically break/damage sensitive habitat such as coral or mangroves; and in areas which are not expected to self clean.

Resource Compartment (including values dependent on the resource compartment)	Impact Modification Score		Justification for Impact Modification Score
		B	
Subtidal Benthic Communities			
Benthic primary producer habitat (coral, seagrass, macro-algae and shallow water EPBC species foraging areas)	No or insignificant alteration of impact	0	Shoreline clean-up will have no impact on entrained oil in benthic primary producer habitat within subtidal areas.
Deep-sea features (filter feeding communities, deep water EPBC species foraging areas and Key Ecological Features)	No or insignificant alteration of impact	0	Shoreline clean-up will have no impact on entrained oil affecting filter feeding communities within subtidal areas.
Deep-sea unconsolidated muds and sands	No or insignificant alteration of impact	0	Shoreline clean-up will have no impact on entrained oil affecting deep-sea unconsolidated muds and sands in subtidal areas.
Intertidal seabed			
Intertidal Coral Reef	Minor additional impact	-1	Shoreline clean-up on an intertidal coral reef would result in physical damage/breaking of coral structures, therefore a net damage to the eco-system.
Mangrove/Mudflats/Samphires	Minor additional impact	-1	Shoreline clean-up within mangrove/low energy ecosystems is likely to result in more physical damage/breaking of mangrove root structures than benefit from any oil removed.
Sandy Beach	Minor mitigation of impact	1	Shoreline clean-up of sandy beaches is a well understood, well documented spill response technique, which can reliably remove thick oil from the eco-system. This is beneficial for species such as turtles who nest on sandy beaches. However, in the case of a condensate spill, the likely oil accumulating on a shoreline remote from the release location is likely to be very thin, and possibly not recoverable. Natural weathering on high energy beaches may be just as effective as attempting to clean-up very thin, non-adhesive slicks.
Rocky Shoreline	Minor mitigation of impact	1	Shoreline clean-up of rocky shorelines is a well understood, well documented spill response technique, which has the ability to remove some oil from the eco-system. However, certain techniques like steam cleaning and high pressure blasting are known to cause more harm than allowing the oil to naturally weather. Therefore, this technique would likely be successful, provided the correct clean-up techniques are chosen.

Macro-Algae and Seagrass	Minor additional impact	-1	Shoreline clean-up within intertidal macro-algae/seagrass ecosystems would likely result in more physical disturbance to plant/root structures than benefit from any oil removed.
Intertidal habitat which is important habitat for protected species (nesting / roosting / foraging)	Minor mitigation of impact	1	If it is deemed that the amount of hydrocarbons expected to impact shorelines is large enough that a shoreline clean up will have positive impacts, then the removal of oil from the intertidal zones would likely result in reduction in harm to the benthic primary producers and associated food sources utilised by foraging protected fauna such as seabirds. Also, removal of oil reaching a turtle nesting beach would be of benefit to turtle nesting success. However, due to the type (generally non-toxic and non-adhesive weathered oil), shoreline clean-up of weathered diesel may only have limited positive effect compared to natural weathering. Caution is required, as additional physical damage can occur in sensitive intertidal environments, and the general presence of responders can result in additional disturbance to natural wildlife behaviours and processes, especially seabirds and turtle nesting etc.
Water column			
Lower water column (below photic zone)	No or insignificant alteration of impact	0	Shoreline clean-up will have insignificant impact on entrained oil in the lower water column.
Upper water column (in photic zone)	No or insignificant alteration of impact	0	Shoreline clean-up will have insignificant impact on entrained oil in the upper water column.
Water surface	No or insignificant alteration of impact	0	Shoreline clean-up will have insignificant impact on thin surface slicks on the water surface.
Air	No or insignificant alteration of impact	0	As oil will have significantly weathered by the time it reaches a shoreline, clean-up activities will result in no net change to impacts to air quality.
Socio-economic			
Commercial demersal fisheries	No or insignificant alteration of impact	0	There would be no reduction in entrained oil, resulting in no significant change to fish communities, and thus commercial demersal fisheries.
Shallow commercial fisheries (including aquaculture)	Minor mitigation of impact	1	Reduction in oil remobilising from a shoreline into intertidal habitats may result in less harm to intertidal fish nurseries and foraging habitats. However damage to these ecosystems could occur, through physical damage associated with shoreline clean-up in sensitive intertidal environments.
Recreational fisheries	Minor mitigation of impact	1	Reduction in oil remobilising from a shoreline into intertidal habitats may result in less harm to intertidal fish nurseries and foraging habitats. However damage to these ecosystems could occur, through physical damage associated with shoreline clean-up in sensitive intertidal environments.
Cultural heritage			
Aboriginal heritage (cultural practices, sites and fishing / foraging)	Minor mitigation of impact	1	Shoreline clean-up may reduce oil damage to Aboriginal heritage sites along the Kimberley / NT coastline, however care would be required to ensure important sites are not damaged during the clean-up process.
Traditional Indonesian fishing	Minor mitigation of impact	1	Reduction in oil remobilising from a shoreline into intertidal habitats may result in less harm to intertidal fish nurseries and foraging habitats. However damage to these ecosystems could occur, through physical damage associated with shoreline clean-up in sensitive intertidal environments.

Chemical Dispersant - Surface

Overall statement of likelihood of success of Chemical Dispersant:

Aim: To remove oil from the sea's surface via dispersant spraying from vessels and aircraft, thus reducing the amount of oil reaching birds, mammals and other organisms - as well as coastal habitats, socioeconomic features and shorelines (IPIECA 2015).

Type of slick: Surface oil is in the form of Group II floating slicks which have a low viscosity and rapidly spread into a thin sheen. They will be approximately 10 g/m^2 up to approximately 160 km from the spill site and approximately 1 g/m^2 up to approximately 300 km from the spill site.

Likely success/effectiveness against slick: The National Research Council (2005) notes that the window to use dispersants is early, typically within hours to 2 days of a spill, then after that, weathering makes oil more difficult to disperse (due to increased viscosity). Rapid dispersion of dispersant-treated oil begins at a wind speed of approximately 7 knots with wave heights of 0.2 to 0.3 metres (IPIECA 2015). Conditions where wave energy is too low, oil droplets may resurface after being applied with dispersant due to oil not being effectively dispersed into the water column. Dispersant becomes challenging in high winds and rough seas, where floating oil will be over-washed or temporarily submerged (IPIECA 2015). Whilst dispersants reduce the amount of oil on the surface that can affect wildlife, they also increase the exposure of dispersed oil in the upper water column to other wildlife. It is expected that dispersant will not significantly change the proportion of surface oil which would become entrained as the sea-state changes. Therefore, given surface diesel slicks will rapidly entrain with increasing wind-speed, dispersant will have limited effect when compared with natural entrainment processes.

Generally oil slicks needs to be >100 g/m^2 (>0.1mm, which equates to Bonn code 4/5) to feasibly achieve a successfully dispersant operation. However diesel from a vessel collision on the ocean surface is unlikely to have slicks >100 g/m^2. Where there are any significant diesel slick, flammable/toxic vapours will also be present, and will likely exceed safe exposure thresholds, further reducing response efficiency (as vessels will not be permitted to operate in areas where explosive limits or VOC exposure thresholds are exceeded). Due to the very thin surface slicks, very low rates of successful dispersal would be expected. Therefore, surface dispersant application on a diesel vessel slick would not be an effective response strategy.

Resource Compartment (including values dependent on the resource compartment)	Impact Modification Score		Justification for Impact Modification Score
		B	
Subtidal Benthic Communities			
Benthic primary producer habitat (coral, seagrass, macro-algae and shallow water EPBC species foraging areas)	Minor additional impact	-1	Chemical dispersant and additional entrained oil would result in negative impacts to shallow water BPPH. However, impacts would be minor, provided dispersant applied at a significant distance from the BPPH.
Deep-sea features (filter feeding communities, deep water EPBC species foraging areas and Key Ecological Features)	No or insignificant alteration of impact	0	Chemical dispersant would result in an insignificant increase in any additional oil reaching deep water locations, regardless of chemical dispersant application on the surface.
Deep-sea unconsolidated muds and sands	No or insignificant alteration of impact	0	
Intertidal seabed			
Intertidal Coral Reef	Minor additional impact	-1	Dispersant is generally considered ineffective at significantly increasing entrainment of thin sheens of marine diesel, compared to natural rates of entrainment. A significant volume of dispersant would need to be applied to result in any change, therefore this would result in negative impacts, due to additional chemicals on the surface and in the shallow water column, which could negatively impact on sensitive shallow/intertidal receptors such as corals, seagrass etc, and the biota who depend on them, including invertebrates, and mega-fauna who forage in these zones.
Mangrove/Mudflats/Samphires	Minor additional impact	-1	
Sandy Beach	Minor additional impact	-1	
Rocky Shoreline	Minor additional impact	-1	
Macro-Algae and Seagrass	Minor additional impact	-1	
Intertidal habitat which is important habitat for protected species (nesting / roosting / foraging)	Minor additional impact	-1	

Water column			
Lower water column (below photoic zone)	No or insignificant alteration of impact	0	No oil reaching deep water locations, regardless of dispersant application on surface.
Upper water column (in photic zone)	Minor additional impact	-1	Dispersed oil can cause marine organisms inhabiting the upper water column to be briefly exposed to dispersed oil which can potentially have toxic effects. Dispersant is generally considered ineffective at significantly increasing entrainment of thin sheens of marine diesel, compared to natural rates of entrainment. A significant volume of dispersant would need to be applied to result in any change, therefore this would result in negate impacts, due to additional chemicals on the surface and in the shallow water column.
Water surface	Minor additional impact	-1	
Air	No or insignificant alteration of impact	0	A very slight reduction in VOCs in local atmosphere could occur as a result of dispersant application and additional entrainment. However additional chemical dispersant mist in the local atmosphere would likely offset any reduction in VOCs.
Socio-economic			
Commercial demersal fisheries	No or insignificant alteration of impact	0	No oil reaching deep water locations, including demersal fish habitat, regardless of chemical dispersant application on surface.
Shallow commercial fisheries (including aquaculture)	Minor additional impact	-1	Chemical dispersant and additional entrained oil would result in negative impacts to shallow commercial fisheries.
Recreational fisheries	Minor additional impact	-1	Chemical dispersant and additional entrained oil would result in negative impacts to recreational fisheries.
Cultural heritage			
Aboriginal heritage (cultural practices, sites and fishing / foraging)	No or insignificant alteration of impact	0	As any dispersant application would occur within offshore waters, and as there would likely be significant naturally entrained of a diesel spill due to natural wind effects, surface dispersant application would result in an insignificant change in dispersed/entrained oil reaching traditional Aboriginal areas of the Kimberley and NT coastline.
Traditional Indonesian fishing	Minor additional impact	-1	Chemical dispersant and additional entrained oil could result in negative impacts to shallow water BPPH which support Indonesian traditional fishing target species. However, impacts would be minor, provided dispersant applied at a significant distance from the BPPH.

Pre-Contact Wildlife Response (Hazing and Translocation)

Overall statement of likelihood of success of Pre-contact OWR (hazing and relocation/displacement):

Aim: Hazing involves discouraging animals from entering oiled areas by encouraging them to move into low-risk unoiled areas, in an attempt to prevent them from becoming oiled (IPIECA 2017). Hazing techniques include vessels generating underwater noise and motion, vessel air horns making above-water noise and fire hoses directing streams in front of fauna. Translocation/displacement involves removing wildlife who are at risk of becoming oiled from the spill environment in an attempt to prevent them from becoming oiled (IPIECA 2017). This includes holding animals in captivity until the risk of oiling is over, or relocating them to another area not affected by the oil spill (IPIECA 2017).

Type of slick: Surface oil is in the form of Group II floating slicks which have a low viscosity and rapidly spread into a thin sheen. They will be approximately 10 g/m^2 up to approximately 160 km from the spill site and approximately 1 g/m^2 up to approximately 300 km from the spill site. Group II oils are relatively non-adhesive, and oil reaching shorelines is likely to have undergone weathering and will be in the form of waxy flakes and residues which are generally considered to be of lower toxicity than their unweathered counterparts (Milton et al, 2003; Hoff & Michel 2014; Woodside 2014).

Likely success/effectiveness against slick: Wildlife hazing in the open ocean is inherently unlikely to be effective due to a number of limitations;

1) effectiveness depends upon the deployment of numerous ocean-going vessels (as opposed to smaller vessels which can be used near to the shore);
2) against a spreading plume (i.e. away from the immediate source of the spill), the technique becomes entirely impracticable;
3) there are significant safety issues associated with a spill of diesel and vessel masters will not approach the source of the spill, or fresh areas of slick, while the spill is still ongoing; and
4) without the constraints of a shoreline or other geographical feature, the technique may cause wildlife to move into other areas of the spill area instead of away from it.

Wildlife hazing is most suitable when used near sensitive shoreline habitats against persistent oily slicks, such as IFO, HFO or crude oil spills - but in the case of a Group II vessel collision, oil slicks are thin and not considered particularly adhesive, therefore reducing the likelihood and severity of impacts on wildlife. Additionally, hazing isn't considered an effective measure against volatile spills which rapidly evaporate.

In regard to wildlife translocation, IPIECA (2014) advise that the difficulty of capturing wildlife safely and maintaining their health during relocation should not be underestimated, and that working with live or dead animals has health and safety issues including potential injuries (bites, scratches) or zoonotic diseases. Risks to wildlife are high during pre-emptive capture and the risks of oiling need to be weighed against the risk of injury, death etc. (IPIECA 2014). The translocation of turtles from beaches and islands would likely require the capture of large numbers of hatchlings, followed by translocation to a location far from the slick (to prevent surface oil impacts on released hatchlings). The prolonged retention of hatchlings has been demonstrated to be detrimental to hatchling swimming speed and survival, even in short periods (6 hours) of retention (Pilcher and Enderby 2001). Attempting to capture large numbers (or an entire flock) of healthy seabirds would be very challenging, if not impossible (DPaW 2014), especially at a remote shoreline location (such as Browse or Cartier Island). There is no practicable method to capture healthy seabirds at sea (DPaW 2014). Potential harm to healthy seabirds could occur during the capture process. Any seabirds released would likely fly back to the shoreline from which they originally were captured. Therefore, long term veterinary care (feeding etc.) would be required for any successfully captured birds, until spill weathering or remediation has occurred and it was safe to release the animals. An evaluation would need to be undertaken, to ensure the released animals do not pose a disease risk (human/zoonotic diseases), to the wild population into which they are released.

Resource Compartment (including values dependent on the resource compartment)	Impact Modification Score		Justification for Impact Modification Score
		B	
Subtidal Benthic Communities			
Benthic primary producer habitat (coral, seagrass, macro-algae and shallow water EPBC species foraging areas)	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Deep-sea features (filter feeding communities, deep water EPBC species foraging areas and Key Ecological Features)	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Deep-sea unconsolidated muds and sands	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Intertidal seabed			
Intertidal Coral Reef	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Mangrove/Mudflats/Samphires	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Sandy Beach	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Rocky Shoreline	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Macro-Algae and Seagrass	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Intertidal habitat which is important habitat for protected species (nesting / roosting / foraging)	Minor mitigation of impact	1	Wildlife hazing of flocks of seabirds may temporarily prevent oiling of individuals or small proportions of a local/regional populations, however it is not likely effective across a broad geographical area. Even conducting wildlife hazing in the nearshore environment at an isolated location such as Browse Island would be of logistically challenging and potentially not result in any significant impact mitigation. Hazing of seabirds to prevent them landing on an oiled shoreline may temporarily prevent impacts, whilst shoreline clean-up is occurring. Capture and translocation of turtle hatchlings away from the oiled shoreline, and release in the open ocean is potentially feasible. Therefore, undertaking pre-contact oiled wildlife response at a shoreline may reduce the number of protected species of a local population from being oiled.
Water column			
Lower water column (below photic zone)	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Upper water column (in photic zone)	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Water surface	No or insignificant alteration of impact	0	Wildlife hazing and/or translocation of seabirds or other megafauna, such as cetaceans and turtles in the open ocean, using vessel presence, vessel noise or at sea capture is highly unlikely to be successful. It may be possible to temporarily (minutes / hours), prevent a few individuals of a protected species from entering a small geographic area affected by a slick. However, over the longer term duration and geographic area of a well-blowout scenario, there would be no alteration to the level of oiling of wildlife populations using this strategy in the open ocean.
Air	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Socio-economic			
Commercial demersal fisheries	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Shallow commercial fisheries (including aquaculture)	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Recreational fisheries	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Cultural heritage			
Aboriginal heritage (cultural practices, sites and fishing / foraging)	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.
Traditional Indonesian fishing	No or insignificant alteration of impact	0	Not relevant for pre-contact oiled wildlife response.

Post Contact Oiled Wildlife Response

Overall statement of likelihood of success of Post-contact OWR:

Aim: Post-contact wildlife response involves capturing oiled wildlife - and if necessary, cleaning, rehabilitating and releasing them.

Type of slick: Surface oil is in the form of Group II floating slicks which have a low viscosity and rapidly spread into a thin sheen. They will be approximately 10 g/m^2 up to approximately 160 km from the spill site and approximately 1 g/m^2 up to approximately 300 km from the spill site. Group II oils are relatively non-adhesive, and oil reaching shorelines is likely to have undergone weathering and will be in the form of waxy flakes and residues which are generally considered to be of lower toxicity than fresh oil (Milton et al, 2003; Hoff and Michel 2014; Woodside 2014). Note that Group II hydrocarbons are relatively non-adhesive compared to crude oils, and are generally not considered an oil product that would 'coat' the feathers of birds, requiring a full wildlife cleaning response on a shoreline.

Likely success/effectiveness against slick: Capture, relocation, assessment, cleaning and rehabilitation of oiled wildlife has the ability to increase the survival of individuals. ITOPF (2011) note that there are many cases where oiled turtles have been cleaned successfully and returned to the water. Any seabirds captured, cleaned and released would likely fly back to the shoreline from which they originally were captured. Once oiled, it is generally agreed that birds have a very low survival rate, even when rescue and cleaning is attempted (Bourne et al. 1967; Holmes and Cronshaw 1977; Croxall 1977; Ohlendorf et al. 1978; Chapman, 1981; Ford et al., 1982; Samuels and Lanfear, 1982; Varoujean et al., 1983; Ford, 1985; Evans and Nettleship 1985; Fry 1987; Seip et al. 1991; Anderson et al. 2000). French-McCay (2009) produced mortality estimates of 99% for surface swimmers, 35% for aerial divers and raptors, and 5% for aerial seabirds. Samuels and Lanfear (1982) estimated that 95% of oiled seabirds die. ITOPF (2011) note that penguins and pelicans are often the exception as they are generally more resilient than many other species, however they are not present in the Browse Basin. IPIECA (2014) advise working with live or dead animals has health and safety issues including potential injuries (bites, scratches) or zoonotic diseases. An evaluation would need to be undertaken, to ensure any released animals do not pose a disease risk (human/zoonotic diseases), to the wild population into which they are released.

Resource Compartment (including values dependent on the resource compartment)	Impact Modification Score		Justification for Impact Modification Score
		B	
Subtidal Benthic Communities			
Benthic primary producer habitat (coral, seagrass, macro-algae and shallow water EPBC species foraging areas)	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Deep-sea features (filter feeding communities, deep water EPBC species foraging areas and Key Ecological Features)	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Deep-sea unconsolidated muds and sands	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Intertidal seabed			
Intertidal Coral Reef	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Mangrove/Mudflats/Samphires	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Sandy Beach	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Rocky Shoreline	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Macro-Algae and Seagrass	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Intertidal habitat which is important habitat for protected species (nesting / roosting / foraging)	Minor mitigation of impact	1	Post-contact OWR has the ability to increase the likelihood of survival of oil-affected EPBC species (individuals, or small proportion of a local population) in the intertidal/shoreline habitats. However, the seabird species of the Browse Basin are generally not expected to survive the capture, cleaning and rehabilitation process. Capture, cleaning and release of marine turtles would have a greater likelihood of success.
Water column			
Lower water column (below photic zone)	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Upper water column (in photic zone)	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Water surface	Minor mitigation of impact	1	It is possible that some individuals of protected species, which have been oiled and are unable to fly, could be captured in the open ocean and relocated to an oiled wildlife treatment facility. Therefore, whilst there is a very low probability of survival, under the right circumstances a positive environmental outcome, for a limited number of individuals of a protected species could be achieved.
Air	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Socio-economic			
Commercial demersal fisheries	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Shallow commercial fisheries (including aquaculture)	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Recreational fisheries	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Cultural heritage			
Aboriginal heritage (cultural practices, sites and fishing / foraging)	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.
Traditional Indonesian fishing	No or insignificant alteration of impact	0	Not relevant for post-contact oiled wildlife response.

In Situ Burn

Overall statement of likelihood of success of In-situ burn (ISB):

Aim: In-site burning rapidly removes the volume of spilled oil's hydrocarbon vapours in place, via combustion or burning (IPIECA 2016). This technique reduces the need to collect, store, transport and dispose recovered oil, plus it can shorten the overall response time (IPIECA 2016).

Type of slick: Surface oil is in the form of Group II floating slicks which have a low viscosity and rapidly spread into a thin sheen. They will be approximately 10 g/m^2 up to approximately 25 km from the spill site and approximately 1 g/m^2 up to approximately 110 km from the spill site.

Likely success/effectiveness against slick: ISB requires wave heights typically below 1 m and wind speeds below 10 knots (IPIECA 2016) which are frequently exceeded at remote offshore locations in the Browse Basin region. Overseas experience shows that burns can be conducted safely, but the most discernible disadvantage is the resulting dark smoke plumes caused by the combustion of oil (IPIECA 2016). Carbon dioxide, soot (PM 2.5), water, polyaromatic hydrocarbons, volatile organic compounds, carbonyls, carbon monoxide, sulphur dioxide and potentially other gases can result from an in-situ burn, which has the potential to affect human and animal health (IPIECA 2016). IPIECA (2016) note that tests and information from previous burns indicate that ISB has little effect on water quality. Burn residue (i.e. burned oil depleted of volatiles and precipitated soot) rarely sinks and smothers benthic species (IPIECA 2016). Plus it is unlikely that Group II burn residue will cause smothering as this generally only occurs for heavier crudes (IPIECA 2016). IPIECA (2016) further note that burn residue is less toxic to aquatic biota than weathered oil.

To implement an effective in-situ burn response, a minimum surface hydrocarbon thickness of 2-5 mm (2000 - 5000 g/m^2) is required to be present. In the case of a vessel collision, the surface slick is not expected to meet the required thickness (i.e. only 10 g/m^2 or 0.1 mm expected thickness in the immediate area of the release). Booms would be required to corral the spill, in an attempt to generate additional oil thickness, but this in turn is expected to exceed the VOC exposure thresholds for the workforce, and also may result in concentrations exceeding the lower explosive limit. Given this, and the lack of suitable booms available for in-situ burns in Australia, implementation of this response in an open ocean, high current environment is not considered to be safe, effective or feasible, especially against the thin sheen and hazardous atmospheric conditions associated with a diesel spill.

Resource Compartment (including values dependent on the resource compartment)	Impact Modification Score		Justification for Impact Modification Score
		B	
Subtidal Benthic Communities			
Benthic primary producer habitat (coral, seagrass, macro-algae and shallow water EPBC species foraging areas)			
Deep-sea features (filter feeding communities, deep water EPBC species foraging areas and Key Ecological Features)			
Deep-sea unconsolidated muds and sands			
Intertidal seabed			
Intertidal Coral Reef			
Mangrove/Mudflats/Samphires			
Sandy Beach			
Rocky Shoreline			
Macro-Algae and Seagrass			
Intertidal habitat which is important habitat for protected species (nesting / roosting / foraging)			
Water column			
Lower water column (below photic zone)			
Upper water column (in photic zone)			
Water surface			
Air			

Socio-economic			
Commercial demersal fisheries			
Shallow commercial fisheries (including aquaculture)			
Recreational fisheries			
Cultural heritage			
Aboriginal heritage (cultural practices, sites and fishing / foraging)			
Traditional Indonesian fishing			

References

Anderson, D. W., Newman, S.H., Kelly, P.R., Herzog, S.K. and Lewis, K.P. 2000. An Experimental Soft-Release of Oil-Spill Rehabilitated American Coots (Fulica americana): I. Lingering Effects on Survival, Condition and Behavior. Environmental Pollution 107: 285–294.

Asia-Pacific Applied Science Associates (APASA). 2012. Basset Deep Well: Quantitative Spill Risk Assessment. J0172 Rev 2. Prepared for INPEX Operations Australia Pty 27/11/2012

Australian Maritime Safety Authority (AMSA). 2015. *The Effects of Maritime Oil Spills on Wildlife including Non-avian Marine Life*. Accessed online 14/11/2018 at <http://www.amsa.gov.au/environment/maritime-environmental-emergencies/national-plan/general-information/oiled-wildlife/marine-life/index.asp>.

Australian Maritime Safety Authority (AMSA). 1998. National Plan (document now superseded): *The effects of maritime oil spills on wildlife including non-avian marine life*. Accessed 16 July 2015 at <https://www.amsa.gov.au/environment/maritime-environmental-emergencies/national-plan/General-Information/oiled-wildlife/marine-life/index.asp>.

Bourne, W.R.P., Parrack J.D. and Potts G.R. 1967. Birds Killed in the Torrey Canyon Disaster. Nature 215: 1123–1125.

Burns, K.A., Garrity, S.D. and Levings, S.C. 1993. How many years before mangrove ecosystems recover from catastrophic oil spills? *Marine Pollution Bulletin.* 26(5):239–248

Campagna, C., Short, F.T., Polidoro, B.A., McManus, R., Collette, B.B., Pilcher, N.J., Mitcheson, Y.S., Stuart, S.N. and Carpenter, K.E. 2011. Gulf of Mexico oil blowout increases risks to globally threatened species. *BioScience* 61:393–397.

Chapman, B.R. 1981. *Effects of the Ixtoc I Oil Spill on Texas Shorebird Populations*. pp. 461–465 in American Petroleum Institute, Proceedings of the 1981 Oil Spill Conference. American Petroleum Institute, Washington, D.C.

Clark, R.B. 1984. Impact of oil pollution on seabirds. Environmental Pollution 33:1–22.

Connell, D.W., Miller, G.J. and Farrington, J.W. 1981. Petroleum hydrocarbons in aquatic ecosystems—behavior and effects of sublethal concentrations: Part 2. *Critical Reviews in Environmental Science and Technology* 11(2):105–162.

Commonwealth Scientific and Industry Research Organisation (CSIRO). 2016. Oil spill monitoring handbook. CSIRO Publishing, Clayton South, Victoria.

Croxall, J.P. 1977. *The Effects of Oil on Seabirds*. Rapport Procès-Verbal Reunion Conseil International pour L'Exploration de la Mer 171: 191–195.

Dean, T.A., Stekoll, M.S., Jewett, S.C., Smith, R.O. and Hose, J.E. 1998. Eelgrass (Zostera marina L.) in Prince William Sound, Alaska: effects of the Exxon Valdez oil spill. Marine Pollution Bulletin 36: 201–210.

DoF. 2013. Pearl Oyster, Webpage managed by the Department of Fisheries Western Australia, accessed December 2017. Last updated 24 April 2013. [http://www.fish.wa.gov.au/Species/Pearl-Oyster/Pages/default.aspx]

Department of Environment and Conservation (DEC). 2007. Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017: Management Plan No. 55. Department of Environment and Conservation, Perth, Western Australia

Department of Environment and Conservation (DEC) and Marine Parks and Reserves Authority (MPRA). 2005. Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015. Department of Environment and Conservation and Marine Parks and Reserves Authority. Perth, Western Australia.

Department of the Environment, Water, Heritage and the Arts (DEWHA). 2008. North Marine Bioregional Plan bioregional profile: a description of the ecosystems, conservation values and uses of the North Marine Region.

Department of Parks and Wildlife (DPaW). 2014. *Western Australian Oiled Wildlife Response Plan (WAOWRP*). Department of Parks and Wildlife, Perth, WA.

Duke, N., Burns, K,. Swannell, J., Dalhaus, O. and Rupp, R. 2000. Dispersant use and a bioremediation strategy as alternative means of reducing impacts of large oil spills on mangroves: the Gladstone field trials. *Marine Pollution Bulletin*. Vol 41, Issues 7–12:403–412.

Evans, P.G.H. and Nettleship, D.N. 1985. *Conservation of the Atlantic Alcidae*. pp. 427–488 in Nettleship, D.N. and Birkhead, T.R. (eds.). The Atlantic Alcidae. Academic Press, London, UK.

Fingas. 2012. The Basics of Oil Spill Cleanup – Third Edition. CRC Press. Boca Raton, Florida.

Fletcher WJ, Mumme MD and Webster FJ (eds). 2017. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2015/6: The State of the Fisheries. Department of Fisheries, Western Australia.

Fletcher, W.J. and Santoro, K. (eds). 2014. Status reports of the fisheries and aquatic resources of Western Australia 2013/14: The state of the fisheries. Department of Fisheries, Western Australia.

Ford, R.G., Wiens, J.A., Heinemann D. and Hunt G.L. 1982. Modelling the Sensitivity of Colonially Breeding Marine Birds to Oil Spills: Guillemot and Kittiwake Populations on the Pribilof Islands, Bering Sea. *Journal of Applied Ecology* 19:1–31.

Ford, R.G. 1985. *A Risk Analysis Model for Marine Mammals and Seabirds: A Southern California Bight Scenario*. Final Report to U.S. Department of the Interior, Minerals Management Service MMS 85-0104, Pacific OCS Region, Los Angeles, CA.

French-McCay, D.P. 2009. State of the art and research needs for oil spill impact assessment modelling. pp. 601-653, 2009 in Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Emergencies Science Division, Environment Canada, Ottawa, ON, Canada.

Fry, D.M. 1987. *Seabird Oil Toxicity Study*. Report submitted by Nero and Associates, Inc. to Minerals Management Service, U.S. Department of Interior, Washington, D.C., USA.

Fucik, K.W., Bight, T.J. and Goodman K.S. 1984. Measurements of damage, recovery, and rehabilitation of coral reefs exposed to oil. pp. 115–134 in Cairns Jr., J. and Buikema Jr., A.L. (eds.), *Restoration of Habitats Impacted by Oil Spills*, Butterworth Publishers, Boston, MA.

Guzman H.M., Burns K.A., Jackson B.C. 1994. Injury, regeneration and growth of Caribbean reef corals after a major oil spill in Panama. Marine Ecology Progress Series 105, 231–241.

Hayes M., Hoff R., Michel J., Scholz D. and Shigenaka G. 1992. An introduction to Coastal Habitats and Biological Response to an Oil Spill. Report prepared by the Hazardous Materials Response and Assessment Division National Oceanic and Atmospheric Administration.

Hoff, R. and Michel, J. 2014. Oil spills in mangroves: planning and response considerations. US Department of Commerce. National Oceanic and Atmospheric Administration (NOAA), Seattle, Washington.

Holmes, W.N. and Cronshaw, J. 1977. *Biological Effects of Petroleum on Marine Birds*. pp. 359–398 in Malins, D.C. (ed.), Effect of petroleum on arctic and subartic marine environments and organisms. Vol. II: Biological effects. Academic Press, New York, USA.

Hook S.E., Osborn H.L., Spadaro D.A., Simpson S.L. 2014b. Assessing mechanisms of toxicant response in the amphipod Melita plumulosa through transcriptomic profiling. Aquatic
Toxicology 146, 247–257. doi:10.1016/j.aquatox.2013.11.001

International Petroleum Industry Environmental Conservation Association (IPIECA). 2014. Wildlife resopnse preparedness. IPIECA-IOGP Good Practice Guide Series,
Oil Spill Response Joint Industry Project (OSR-JIP). IOGP Report 516. London, UK.

International Petroleum Industry Environmental Conservation Association (IPIECA). 2015a. A guide to oiled shoreline clean-up techniques. IPIECA-IOGP Good Practice Guide Series, Oil Spill Response Joint Industry Project (OSR-JIP). IOGP report 521. London, UK.

International Petroleum Industry Environmental Conservation Association (IPIECA). 2015b. At-sea containment and recovery. IPIECA-IOGP Good Practice Guide Series,
Oil Spill Response Joint Industry Project (OSR-JIP). IOGP report 522. London, UK.

International Petroleum Industry Environmental Conservation Association (IPIECA). 2015c. Dispersants: surface application. IOGP report 532. London, UK.

International Petroleum Industry Environmental Conservation Association (IPIECA). 2017b. Key principles for the protection, care and rehabilitation of oiled wildlife. IPIECA-IOGP Good Practice Guide Series, Oil Spill Response Joint Industry Project (OSR-JIP). IOGP Report 583. London, UK.

International Tanker Owners Pollution Federation (ITOPF). 2011. Effects if Oil Pollution on the Marine Environment - Technical Information Paper. Published by the International Tanker Owners Pollution Federation Limited, London UK.

Jenssen, B.M. 1994. Review article: Effects of oil pollution, chemically treated oil, and cleaning on the thermal balance of birds. *Environmental Pollution*, 86:207–215.

Law R.J., Kirby M.F., Moore J., Barry J., Sapp M., Balaam J. 2011. PREMIAM – pollution response in emergencies marine impact assessment and monitoring: post-incident monitoring guidelines. In Science Series Technical Report No. 146. Cefas, Lowestoft, UK, <www.cefas.defra.gov.uk/premiam>.

Lee, K. 2011. *Toxicity Effects of Chemically Dispersed Crude Oil on Fish*. International Oil Spill Conference Proceedings 2011(1):163.

Matcott, J., Baylis, S., and Clarke, R.H. 2019. The Influence of Petroleum oil films on the feather structure of tropical and temperate seabird species. Marine Pollution Bulletin 138: 135-144.

Milton, S., Lutz, P. and Shigenaka G. 2003. Oil Toxicity and Impacts on Sea Turtles. In Shigenaka, G. (ed.), *Oil and Sea Turtles: Biology, Planning, and Response*. National Oceanic and Atmospheric Administration (NOAA), Seattle, Washington.

Montagna P.A., Baguley J.G., Cooksey C., Hartwell I., Hyde .LJ., Hyland J.L. et al. 2013. Deep-sea benthic footprint of the Deepwater Horizon blowout. PLoS One 8, e70540. doi:10.1371/journal.pone.0070540

Murawski S.A., Hogarth W.T., Peebles EB, Barbeiri E. 2014. Prevalence of external skin lesions and polycyclic aromatic hydrocarbon concentrations in Gulf of Mexico fishes, post
Deepwater Horizon. Transactions of the American Fisheries Society 143, 1084–1097.

National Research Council (NRC). 2005. Oil Spill Dispersants: Efficacy and Effects. The National Academies Press. Washington, DC.

Negri, A.P. and Heyward, A.J. 2000 Inhibition of fertilization and larval metamorphosis of the coral *Acropora millepora* (Ehrenberg, 1834) by petroleum products. *Marine Pollution Bulletin* 41(7–12):420–427.

O'Brien, M. 2002. At-sea recovery of heavy oils - A reasonable response strategy? 3rd Forum on High Density Oil Spill response. The International Tanker Owners Pollution Federation Limited (ITOPF). London, UK.

Ohlendorf, H.M., Risebrough R.W. and Vermeer, K. 1978. *Exposure of Marine Birds to Environmental Pollutants*. U.S. Fish and Wildlife Service Wildlife Research Report 9.

Peters E.C., Gassman N.J., Firman J.C., Richmond R.H., Power EA .1997. Ecotoxicology of tropical marine ecosystems. Environmental Toxicology and Chemistry 16, 12–40. doi:10.1002/etc.5620160103

Pie HV, Heyes A, Mitchelmore C.L. 2015. Investigating the use of oil platform marine fouling invertebrates as monitors of oil exposure in the Northern Gulf of Mexico. The Science of the Total Environment 508, 553–565. doi:10.1016/j.scitotenv.2014.11.050

Pilcher N.J., and Enderby. S. 2001. Effects of prolonged retention in hatcheries of green turtle (Chelonia mydas) hatchling swimming speed and survival. Journal of Herpetology. 35(4): 633–638.

RPS. 2018. WA-343-P Quantitative Spill Risk Assessment. West Perth, Western Australia.

RPS. 2019. INPEX Ichthys Phase 2 Development WA-50-L Oil Spill Risk Assessment. MAW0796J. Report prepared by RPS for INPEX Operations Australia, Perth, Western Australia.

Runcie, J.W. and Riddle, M.J. 2006. Diel variability in photosynthesis of marine macroalgae in ice-covered and ice-free environments in East Antarctica. European Journal of Phycology 41(2):223–233.

Samuels, W.B. and Lanfear K.J. 1982. Simulations of seabird damage and recovery from oil spills in the northern gulf of Alaska. Journal of Environmental Management 15: 169–182.

Seip, K.L., Sandersen, E., Mehlum, F. and Ryssdel, J. 1991. Damages to seabirds from oil spills: comparing simulation results and vulnerability indexes. Ecological Modellin, 53: 39–59.

Sell D, Conway L, Clark T, Picken GB, Baker JM, Dunnet GM. 1995 Scientific criteria to optimize oil spill cleanup. International Oil Spill Conference Proceedings 1995(1), 595–610.

Shigenaka, G. 2001. *Toxicity of Oil to Reef Building Corals: A Spill Response Perspective*. National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum, National Ocean Service, Office of Research and Restoration 8, Seattle, USA.

Simberloff, D. 2009. The role of propagule pressure in biological invasions. The Annual Review of Ecology, Evolution, and Systematics 40:81-102.

Taylor H and Rasheed M. 2011. Impacts of a fuel oil spill on seagrass meadows in a subtropical port, Gladstone, Australia – The value of long-term marine habitat monitoring in high risk areas. Marine Pollution Bulletin 63:431-437.

Varoujean, D.H., Baltz, D.M., Allen, B., Power, D., Schroeder, D.A. and Kempner, K.M. 1983. *Seabird-Oil Spill Behavior Study*. Report by Nero and Associates, Inc. to U.S. Department of the Interior, Minerals Management Service, Reston, VA.

WA Department of Transport (WA DoT). 2018. Provision of Western Australian Marine Oil Pollution Risk Assessment - Protection Priorities - Protection Priority Assessment for Zone 1: Kimberley - Draft Report. Perth, Western Australia.

Woodside Energy Ltd. 2014. Browse FLNG Development, Draft Environmental Impact Statement. EPBC 2013/7079. November 2014. Woodside Energy Ltd., Perth, Western Australia.