WA-437-P Geotechnical and Geophysical Survey Environment Plan

PROJECT / FACILITY	WA-437-P Geotechnical and Geophysical Survey
REVIEW INTERVAL (MONTHS)	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s *Managerial/Technical/Site*	Approver
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ACRONYMS

Abbreviation	Description
°C	Degrees Celsius
ACN	Australian Company Number
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
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
AMSA	Australian Maritime Safety Authority
APASA	Asia-Pacific Applied Sciences Associates
ASBTIA	Australian Southern Bluefin Tuna Industry Association
BIAs	Biologically Important Areas
BOD	Biological Oxygen Demand
CAES	Catch and Effort System
CAMBA	China Australia Migratory Bird Agreement
CD	Conservation Dependent
CE	Critically Endangered
CH_4	Methane
CM	Control Measure
CMID	Common Marine Inspection Audit
CO_2	Carbon Dioxide
CSIRO	Australian Commonwealth Scientific and Industrial Research Organisation
CTDs	Conductivity, Temperature, Depth meters
DAFF	Department of Agriculture, Fisheries and Forestry
DAHs	Dissolved Aromatic Hydrocarbons
DAWR	Department of Agriculture and Water Resources (Commonwealth)
DBCA	Department of Biodiversity, Conservation and Attractions (WA)
DMP	Department of Mines and Petroleum (WA) – now Department of Mines, Industry Regulation and Safety

Abbreviation	Description
DoAWE	Department of Agriculture, Water and the Environment
DoD	Department of Defence (WA)
DoEE	Department of Energy and Environment (Commonwealth)
DoT	Department of Transport (WA)
DPIRD	Department of Primary Industries and Regional Development
EMBA	Environment that May Be Affected
EP	Environment Plan
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
EPOs	Environmental Performance Outcomes
EPSs	Environmental Performance Standards
ESD	Ecologically Sustainable Development
g/cm^3	Gram per cubic centimetre
g/m^2	Gram per square metre
GHG	Greenhouse Gas
HFO	Heavy Fuel Oil
hrs	Hours
HSE	Health Safety and Environment
Hz	Hertz
IAPP	International Air Pollution Prevention
IBA	Important Bird Area
IFO	Intermediate Fuel Oil
IKU	Marine Diesel analogue from the SINTEF Oil Weathering Model
IMCA	International Marine Contractors Association
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMDG	International Maritime Dangerous Goods
IMS	Invasive Marine Species
IMT	Incident Management Team
ISPP	International Sewage Pollution Prevention
ITOPF	International Tanker Owners Pollution Federation Ltd
IUCN	International Union for Conservation of Nature
JAMBA	Japan Australia Migratory Bird Agreement
JASURAUS	Underwater cable system

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Abbreviation	Description
JRCC	Joint Rescue Coordination Centre
KEF	Key Ecological Feature
kHz	Kilo hertz
km	Kilometre
km/hr	Kilometres per hour
km^2	Square kilometres
KPI	Key Performance Indicator
LMS	Listed Migratory Species
LTS	Listed Threatened Species
m	Metres
m/s	Metres per second
m^3	Cubic metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MDO/MGO	Marine Diesel Oil/Marine Gas Oil
MFO	Marine Fauna Observer
MNES	Matters of National Environmental Significance
MoC	Management of Change
MODU	Mobile Offshore Drilling Unity
MSS	Marine Seismic Survey
N/A	Not Applicable
N_2O	Nitrous Oxide
NEBA	Net Environmental Benefit Analysis
nm	Nautical Mile
NMFS	National Marine Fisheries Service (US)
NMSC	(Australian) National Marine Safety Committee
NOPTA	National Offshore Petroleum Titles Administrator
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NO_x	Oxides of Nitrogen
NWA	North West Alliance
NWCS	North West Cable System
NWS	North West Shelf
OCNS	Offshore Chemical Notification Scheme
ODS	Ozone Depleting Substance

Abbreviation	Description
OPEP	Oil Pollution Emergency Plan
OPGGS (E) Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OSRL	Oil Spill Response Limited
OSRT	Oil Spill Response Team / Oiled Shoreline Response Team
OVID	Offshore Vessel Inspection Document
OWM	Oil Weathering Model
OWRP	Oiled Wildlife Response Plan
PAH	Polycyclic Aromatic Hydrocarbon
PFTIMF	Pilbara Fish Trawl Interim Managed Fishery
PHGFC	Port Hedland Game Fishing Club
PK	Peak
PMS	Planned Maintenance System
PMST	Protected Matters Search Tool
PPA	Pearl Producers Association
ppb	Parts per billion
ppm	Parts per million
PROWRP	Pilbara Regional Oiled Wildlife Response Plan
PTS	Permanent threshold shift
RMS	root mean square
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SBRUVS	Stereo baited remote underwater video system
ROV	Remote Operated Vehicle
SDS	Safety Data Sheet
SIMOPs	Simultaneous Operations
SINTEF	Norwegian applied research organisation
SMPEP	Shipboard Marine Pollution Emergency Plan
SOLAS	Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SOx	Oxides of Sulphur
SPRAT	Species Profile and Threats database
TTS	Temporary threshold shift
VOO	Vessel of Opportunity
WA	Western Australia

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Abbreviation	Description
WAF	Water Accommodated Fraction
WAFIC	Western Australian Fishing Industry Council
WAOWRP	WA Oiled Wildlife Response Plan
WDCS	Whale and Dolphin Conservation Society

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Appendices

0. EP Summary

An Environment Plan (EP) summary has been prepared from material provided in this EP. This summarises the items listed in **Table 0-1**, as required by Regulation 11(4) of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009.

Table 0-1: EP Summary Table

EP Summary Material Requirement	Relevant EP Section
Details of the titleholders nominated liaison person for the Activity	**Section 1.3.1**, page 19
The location of the Activity	**Section 2.2**, page 22
A description of the Activity	**Section 2**, pages 22 - 28
A description of the receiving environment	**Section 3**, pages 29 - 103
Consultation already undertaken and plans for ongoing consultation	**Section 4**, pages 101 - 121
Details of the environmental impacts and risks	**Section 6 and 7**, pages 128 - 294
The control measures for the Activity	**Section 8.3.2**, pages 297 - 311
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 8**, pages 295 - 334
Response arrangements in the oil pollution emergency plan	**Section 8.10**, page 316 (EP);and **Section 4**, pages 38 – 40 (OPEP)

1. Introduction

Santos WA Northwest Pty Ltd (Santos) plans to conduct a geotechnical and geophysical survey within Permit WA-437-P which is located approximately 145 kilometres (km) north of Port Hedland, offshore Western Australia (WA).

Santos has previously undertaken seismic, geophysical and geotechnical surveys and exploration drilling activities within the Bedout Sub-basin and have identified and confirmed viable hydrocarbons. To support future development of WA-437-P, further geotechnical and geophysical data is required.

1.1 Activity Overview

Santos plans to conduct the WA-437-P Geotechnical and Geophysical Survey (the Survey) in the Bedout Sub-basin. The Survey may be conducted in one or two phases depending on technical and logistical requirements. Auxiliary activities include support vessels and helicopters. This EP covers all the survey, vessel and helicopter operations within the Operational Area. The survey vessel will be static during geotechnical data collection and mobile during geophysical operations, targeting pre-determined locations based on available data for the area.

Geotechnical data acquisition will comprise of:

+ in-situ penetration testing;
+ borehole sampling via piston coring, vibrocoring or rock coring (substrate pending); and
+ box coring.

During the Survey Geophysical data will consist of:

+ single beam echo sounder (SBES);
+ multi beam echo sounder (MBES);
+ side scan sonar (SSS); and
+ Sub-bottom profiling (SBP).

To allow flexibility regarding vessel availability, approval timings, budget cycles, environmental sensitivities and other factors, the Survey is proposed to commence as early as Q2 2020 (pending approvals) and could be completed as late as Q4 2021. Data acquisition will only take approx. 60 days to complete (for both phases).

1.2 Purpose of this Environment Plan

This EP has been prepared in accordance with the *Offshore Petroleum and Greenhouse Gas Storage* (*Environment*) *Regulations 2009* (OPGGS(E)R) for assessment and acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). This EP details the environmental impacts and risks associated with the Survey (the 'Activity') and demonstrates how these will be reduced to as low as reasonably practicable (ALARP) and to an acceptable level.

The EP provides an implementation strategy that will be used to measure and report on environmental performance during planned activities and unplanned events. The environmental management of the Activity described in the EP complies with the Santos Environmental Management Policy (QE-91-IQ-00047_REV 5) (**Figure 1-1**) and with all relevant legislation. This EP documents relevant stakeholder consultation performed during the planning of the Activity. This EP will be valid from the date that it is accepted by NOPSEMA, until submission and acceptance of Regulation 25A end-of-operation of EP notification.

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1.3 Titleholder

OPGGS(E)R 2009 Requirements
Regulation 15. Details of titleholder and liaison person.
(1) The environment plan must include the following details for the titleholder: a) name; b) business address; c) telephone number (if any); d) fax number (if any); e) email address (if any); and f) if the titleholder is a body corporate that has an Australian Company Number (ACN) (within the meaning of the *Corporations Act 2001*). (2) The environment plan must also include the following details for the titleholder's nominated liaison person: a) name; b) business address; c) telephone number (if any); d) fax number (if any); and e) email address (if any).

1.3.1 Details of Titleholder

Santos WA Northwest Pty Ltd is the titleholder undertaking the Activity within Permit WA-437-P. Titleholder details are provided in **Table 1-1**.

Table 1-1: Titleholder details

Titleholder	ACN / ABN	Permit % Interest	Address
Santos WA Northwest Pty Ltd	**ACN** 009 140 854 **ABN** 58 009 140 854	60	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: Offshore.environment.admin@santos.com
Santos WA Southwest Pty Limited	**ACN** 050 611 688 **ABN** 63 050 611 688	20	
Carnarvon Petroleum Ltd	**ACN** 002 688 851 **ABN** 60 002 688 851	20	Business Address: 2/76 Kings Park Rd, West Perth, Western Australia 6005 Telephone number: (08) 9321 2665 Fax number: (08) 9321 8867 Email address: admin@cvn.com.au

1.3.2 Details for Santos' Nominated Liaison Person

Details for Santos' Nominated Liaison Person for the Activity are as follows:

Name: Paul Burren (Dorado Development Manager)

Business address: Level 7, 100 St Georges Terrace, Perth, WA 6000

Telephone number: (08) 6218 7100

Email address: Offshore.environment.admin@santos.com

Additional information about Santos and its operations can be obtained from the website at: www.santos.com.

1.3.3 Notification Procedure in the Event of Changed Details

If there is a change in the titleholder, the titleholder's nominated liaison person or a change in the contact details for the titleholder or liaison person, Santos will notify NOPSEMA in writing and provide the updated details.

1.4 Environmental Management Framework

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Requirements (4) The environment plan must: a) describe the requirements, including legislative requirements, that apply to the Activity and are relevant to the environmental management of the Activity; and b) demonstrate how those requirements will be met.
Regulation 16. Other information in the environment plan.
The environment plan must contain the following: a) a statement of the operator's corporate environmental policy.

1.4.1 Environmental Management Policy

The Activity will be conducted in accordance with the Santos Environmental Management Policy (QE-91-IQ-00047_REV 5) (**Figure 1-1**) and relevant legislative requirements presented within **Appendix A,** inclusive of references to the relevant EP sections where the legislation may prescribe or control how the Activity is undertaken. **Sections 6, 7** and **8** of this EP detail and evaluate impacts and risks from planned activities and unplanned events, provide control measures, set environmental performance outcomes and standards, and provide the strategy for ensuring environmental performance is achieved, as outlined within the EP.

1.4.2 International Legislation

Australia is signatory to numerous international conventions and agreements that obligate the Commonwealth government to prevent pollution and protect specified habitats, flora and fauna. Those that are relevant to the Activity are detailed in **Appendix A.**

1.4.3 Commonwealth Legislation

All activities conducted under the EP will comply with legislative requirements established under relevant Commonwealth legislation, and in line with applicable best practice guidelines and management procedures. These are further detailed in **Appendix A**.

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Environment, Health & Safety

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Policy

Our Commitment

Santos is committed to being the safest oil and gas operator in Australia and preventing harm to people and the environment

Our Actions

We will:

1. Integrate environment, health and safety management requirements into the way we work and ensure that we comply with all relevant environmental, health and safety laws
2. Include environmental, health and safety considerations in business planning, decision making and asset management processes
3. Identify, effectively control, monitor and ensure awareness of risks that have the potential for serious harm to people and the environment
4. Lead a strong and consistent environment, health and safety culture across all aspects of business
5. Work proactively and collaboratively with our stakeholders and the communities in which we operate
6. Set, measure, review and monitor objectives and targets to demonstrate proactive processes in place to continuously reduce the risk of harm to people and the environment
7. Report publicly on our environmental health and safety performance

Governance

The Environment Health Safety and Sustainability Committee is responsible for reviewing the effectiveness of this policy.

This policy will be reviewed at appropriate intervals and revised when necessary to keep it current.

Kevin Gallagher

Managing Director & CEO

Status: APPROVED

Document Owner:	Jodie Hatherly, General Counsel & Vice President, Legal, Risk and Governance		
Approved by:	The Board	Version:	2

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Figure 1-1: Santos Environmental Management Policy

2. Activity Description

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Description of the Activity: (1) The environment plan must contain a comprehensive description of the Activity including the following: a) the location or locations of the Activity; b) general details of the construction and layout of any facility; c) an outline of the operational details of the Activity (for example, seismic surveys, exploration drilling or production) and proposed timetables; and d) any additional information relevant to consideration of environmental impacts and risks of the Activity. Note: An environment plan will not be capable of being accepted by the Regulator if an Activity or part of the Activity, other than arrangements for environmental monitoring or for responding to an emergency, will be undertaken in any part of a declared World Heritage property – see regulation 10A.

2.1 Background and Objectives

Santos has previously undertaken seismic, geophysical and geotechnical surveys and exploration drilling activities within the Bedout Sub-basin and have identified and confirmed viable hydrocarbons. To support future development of WA-437-P, further geotechnical and geophysical data is required.

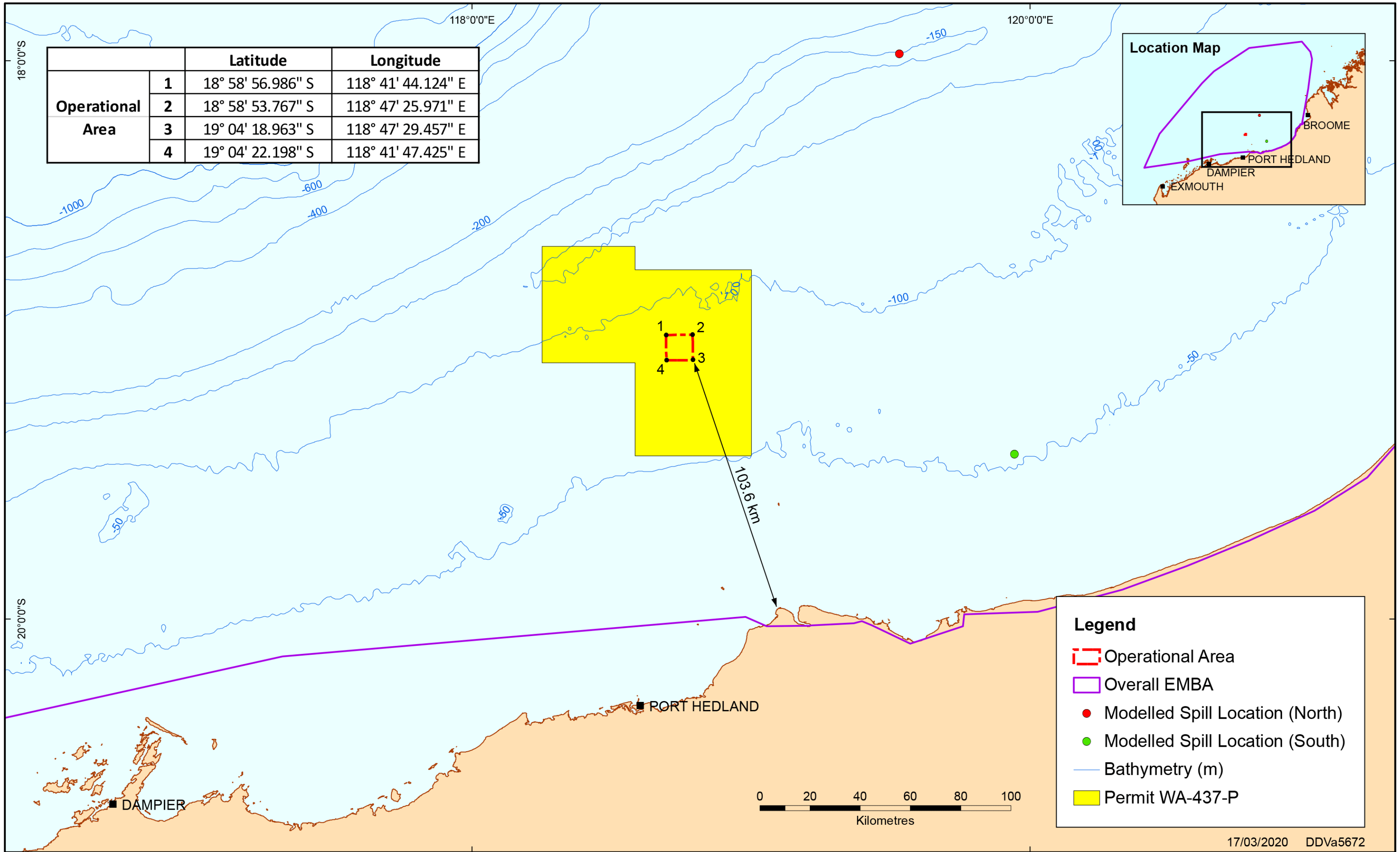
The objective of the Survey is to acquire additional geotechnical and geophysical data required to support pre-engineering studies for any future developments. The Survey will specifically aim to:

+ acquire geotechnical samples to support facilities design and seabed stability studies;
+ calibrate/interpret existing geophysical records;
+ acquire geological cores to aid in understanding the local geology and inform design of piling and anchor layout on the seafloor as required for future development;
+ conduct dissipation testing to determine soil strength and support data informing soil stratigraphy delineation to inform engineering requirement and layout of future facilities piling locations; and
+ conduct SBP to identify shallow formation structures below the seafloor.

2.2 Location

Permit WA-437-P is situated approximately 145 km north of Port Hedland (**Figure 2-1**) with depths ranging from approximately 86–94 m (LAT).

For the purposes of this EP, an Operational Area has been defined as a subset of Permit WA-437-P, which represents a 10 km x 10 km area encapsulating all potential geotechnical and geophysical survey locations. The Operational Area is shown in **Figure 2-1**.



		Latitude	Longitude
Operational Area	1	18° 58' 56.986" S	118° 41' 44.124" E
	2	18° 58' 53.767" S	118° 47' 25.971" E
	3	19° 04' 18.963" S	118° 47' 29.457" E
	4	19° 04' 22.198" S	118° 41' 47.425" E

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WA-437-P GEOTECHNICAL AND GEOPHYSICAL SURVEY
LOCATION AND OPERATIONAL AREA

Figure 2-1 Geotechnical and geophysical location and operational area

2.3 Survey Duration and Timing

The Survey has been planned as follows:

+ Phase 1 to commence as early as Q2 2020;
+ Phase 2 may follow Phase 1 or commence as part of a subsequent mobilisation during 2020/2021; and
+ Both phases will be completed by December 2021.

The timing of the Survey is dependent upon vessel availability, weather conditions, the receipt of the required statutory approvals and the control measures within this EP.

Data acquisition is estimated to be completed within the following durations:

+ Phase 1 estimated to take 15 days to complete; and
+ Phase 2 estimated to take 45 days to complete.

The above durations do not however provide for vessel transit times, potential delays caused by ocean conditions, weather downtime, standby and equipment failure or other delays relative to the survey plan, as these factors are difficult to predict or quantify. Should additional time be required to complete the survey objectives, Santos will assess the situation in accordance with the Santos Management of Change Procedure (refer to **Section 8.9**).

2.4 Survey Design

Under this EP, the Survey will utilise a survey vessel to undertake the following potential geotechnical and geophysical investigations:

+ Geotechnical Investigation:
  - in-situ penetration testing;
  - borehole sampling via piston coring, vibrocoring or rock coring (substrate pending); and
  - box coring.
+ Geophysical Survey:
  - single beam echo sounder (SBES);
  - multi beam echo sounder (MBES);
  - side scan sonar (SSS); and
  - sub-bottom profiling (SBP).

Support operations such as vessel, Remote Operated Vehicle (ROV) and helicopter-based support activities may also be required as part of the activities described within this EP.

2.4.1 Geotechnical Investigation Techniques

Geotechnical investigations will consist of seabed sediment sampling and testing at pre-determined locations and target depths within the Operational Area (**Section 2.2** and **Figure 2-1**).

Sediment penetration testing will be conducted using piezocone penetration tests (PCPTs), cone penetration tests (CPT), T-Bar or similar probe test. Further detail is provided in **Section 2.4.1.1**.

Borehole sampling will involve collection of piston cores or vibrocores (vibrocore being used where piston core recovery is not possible) or rock cores, depending on hardness of sampling location substrate (for further detail refer to **Section 2.4.1.2** and **Section 2.4.1.3**).

Box coring may be required for seabed surface sediment sampling if the CPT readings are not consistent (for further detail refer to **Section 2.4.1.4**).

A summary of the survey data collection parameters is provided in **Table 2-1.**

Table 2-1: Geotechnical data collection parameters

Parameter		Anticipated Geotechnical Survey Parameters
Water depth (LAT)		86-94 m
In-situ penetration testing	Number of test locations	14
	Target depth (m)	3–100 m
	Total disturbance footprint (m^2)	42
Borehole sampling	Number sample locations	9
	Target depth (m)	3–100 m
	Total volume of sediment (m^3)	27
Box coring	Number of test locations	As required (max 23)

2.4.1.1 In-situ Penetration Testing

All penetration testing methods are similar in that a penetrometer (probe) is pushed into the seabed at a constant rate while continuously measuring the resistance, friction and water pressure. Although the exact equipment is not yet known the system type will depend on sediment types encountered.

Typical penetration testing systems consist of a seabed frame and a hydraulic powered drive unit which push a probe into the sediment. The frame has a footprint on the seabed of approximately 3 m^2. The closed-loop hydraulic system will contain approximately 50 L of fluid.

Upon completion of each test, the complete penetration testing system will be retrieved to the vessel, leaving no equipment on the seabed. The probe is approximately 40 mm in diameter.

2.4.1.2 Borehole Sampling - Piston Coring / Vibrocore

Piston coring involves a steel sample tube of approximately 85–105 mm diameter, penetrating the seabed whilst freefalling under its own weight, which results in a footprint of <15 m^2. No subsea hydraulic systems or electrical connections are required for the operation of a piston corer.

A vibrocore system has a vibration unit mounted to the top, generally driven by electric motors powered by a subsea cable connected to the survey vessel. No hydraulic systems are required for operation. The vibrocore system also utilises a sample tube of approximately 85–105 mm diameter.

Upon completion of each vibrocore, the complete vibrocore system will be retrieved to the vessel, leaving no equipment on the seabed.

2.4.1.3 Sampling / Rock Coring

Rotary borehole sampling using an open-centred drill bit may be required to sample seabed sediments and rock. The exact sampling system to be used is not yet known; if a seabed sampling system is selected, it will comprise of a seabed base frame which will have a footprint of approximately 14 m^2. Power and control to the seabed sampling system will likely be provided by a subsea electrical cable.

Upon completion of each core, the complete sampling system will be retrieved to the survey vessel, leaving no equipment on the seabed. The coring system is approximately 100 mm in diameter.

Cuttings consisting of inert material will be generated by coring operations. The volume of the material to be produced will be minimal as the majority of the core will be retrieved to the survey vessel for analysis. Any remaining cuttings is expected to settle in close proximity to the sampling locations. Cuttings will range in size from very coarse to very fine particles with up to 3.5 cubic meters (m^3) of cuttings per hole.

Fluid is required to lubricate the face of the drill bit used for coring, which keeps the boreholes clean (free from cuttings) and prevents the borehole from collapsing during the coring process. Seawater is the primary constituent of fluids used for geotechnical investigation. One or more chemically inert water-based muds (WBM) may be added to seawater if challenging boring conditions are encountered. As the survey is still in the design stage fluids to be used are yet to be confirmed; however all fluids will be selected as per Santos's chemical selection process. The volume of WBM to be used will depend on the drilling depth achieved, based on the maximum target depth of 100 m, the volume of drilling fluid for each borehole is estimated to be approximately 5 m^3.

It should be noted that all seabed sediment sampling proposed within the scope of this EP is for geotechnical purposes only; no drilling of petroleum bearing reservoirs is proposed as part of the scope of this EP.

2.4.1.4 Box Coring

Additional sampling by way of box coring may be required if previously described methods are not possible or penetration testing results are inconsistent. The box corer can penetrate the seabed up to 1 m under its own weight. The sample is retained in the box section at the base of the unit which is approximately 0.5 m^3. The box corer has a footprint of <5 m^2. No subsea hydraulic systems or electrical connections are required for the operation of a box corer.

Upon completion of each box core (approximately 0.3 m^3), the complete box coring system will be retrieved to the survey vessel, leaving no equipment on the seabed.

2.4.2 Geophysical Survey Techniques

Geophysical survey techniques will include:

- SBES – for further detail refer to **Section 2.4.2.1**;
- MBES – for further detail refer to **Section 2.4.2.2**;
- SSS – for further detail refer to **Section 2.4.2.3**; and
- SBP – for further detail refer to **Section 2.4.2.4**.

2.4.2.1 Single Beam Echo Sounder

SBES surveys will enable the collection of bathymetry data and the correlation of depth information. This type of survey uses a sonar system to transmit short pulses of sound energy, analysing the return signal from the seafloor or other objects.

2.4.2.2 Multi Beam Echo Sounder

MBES surveys will enable the collection of bathymetry data and the correlation of depth information across a swath of seabed. This type of survey uses a sonar system to transmit short pulses of sound energy, analysing the return signal from the seafloor or other objects.

2.4.2.3 Side Scan Sonar

SSS identifies any sea floor debris which may cause damage to the jack up Mobile Offshore Drilling Unity (MODU) support legs. SSS involves towing a set of transducers mounted on either side of a 'tow fish' approximately 10-20 m above the seabed, producing pulses at high frequencies to create an image of morphological features and differences in seabed texture.

2.4.2.4 Sub Bottom Profiling

SBP allows the near-seabed stratigraphy to be evaluated for hazards and to confirm it will be providing adequate foundations for supporting the MODU when it is elevated above the water. SBP utilises an acoustic source typically towed just behind the vessel, with a hydrophone towed approximately 25 m behind the vessel to record the reflected sound waves.

Different SBP systems (pinger, compressed high intensity radar pulse (CHIRP) and boomer/sparker systems) are used depending on the objectives of the survey, water depths and prior knowledge of seabed geology with the main difference between each SBP system being the operating frequency.

2.5 Activity Vessels

Two potential vessels could be used for the project, one to conduct the survey, and another in a supporting role. Representative vessels are outlined below.

The specific vessel to undertake the Survey has not yet been confirmed. For environmental assessment purposes, a vessel such as the Mermaid Vigilant, a 83.6 m multi-role support vessel, has been considered (**Figure 2-2**); the intent being to assess impacts and risks of the largest typical vessel so that the assessment is conservative and allows for flexibility. The largest single fuel tank on any vessel to be used for the survey will contain no more than 650 $m^3$of fuel oil. Bunkering and/or vessel to vessel fuel transfers have been assessed within this EP as a contingency should it be required. A support vessel may be required to undertake support functions such as refuelling and resupply.

The survey vessel will either be moving (for example during geophysical data acquisition) or will use dynamic positioning to maintain location (during coring activities etc). Anchoring may be required for safety/emergency reasons.

The vessel may be mobilised either from international waters or domestically from within Australia and will comply with the relevant maritime safety requirements and marine order requirements as appropriate for the survey vessel.

Figure 2-2: Anticipated survey vessel type

The specific vessel to support the Survey has not yet been confirmed; however a reasonable proxy is likely to be the MMA Searcher, a 54 m multi-role support vessel, or a similar vessel of opportunity (**Figure 2-3**).

The support vessel will either be moving or will use dynamic positioning to maintain location, unless anchoring is required for safety or emergency reasons.

The vessel may be mobilised either from international waters or domestically from within Australia and will comply with the relevant maritime safety requirements and marine order requirements as appropriate for the survey vessel.

Figure 2-3: Indicative support vessel type

2.5.1 Ultra-Short Base Line Positioning

USBL (Ultra-Short Base Line) acoustic positioning system will be utilised on board the survey vessel to locate the position of subsea equipment which is being lowered to the seabed. A transceiver mounted to the underside of the survey vessel will detect the range and bearing from a transponder mounted to specific subsea sampling equipment.

2.6 Helicopters

Helicopters may be used primarily for crew change and to assist in emergencies (eg. Medevac) as required, and occasionally equipment transfer. Helicopter flights may occur during the survey, dependent on the survey timing, crew change requirements and logistical constraints.

2.7 Anticipated emissions, discharges and wastes

All vessels will adhere to the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* for the duration of the Survey. The Act aims to protect the marine environment from pollution by oil and other harmful substances discharged from ships in Australian waters. It also invokes certain requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) Convention such as those relating to discharge of noxious liquid substances, sewage, garbage and air pollution. Vessels greater than 400 gross tonnes are required to have pollution emergency plans in place and provided for emergency discharges from ships.

Routine liquid discharges from the vessels may include treated sewage, greywater, cooling water, oily water (bilge), deck run-off and desalination brine (if a reverse osmosis system is used). Atmospheric emissions will include exhaust gases from fuel combustion. Other environmental emissions include light emissions from vessel decks, accommodation, navigation and safety systems; and noise emissions from above and below the water (e.g. engine noise, survey equipment).

3. Description of the Environment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Description of the environment (2) The environment plan must: a) describe the existing environment that may be affected by the Activity; and b) include details of the particular relevant values and sensitivities (if any) of that environment.

3.1 Environment that May Be Affected (EMBA)

This section summarises the key physical, biological, socio-economic and cultural characteristics of the environment that may be affected (EMBA), both from planned activities and unplanned events associated with the Activity. The description of the environment applies to two areas:

+ The Operational Area; and
+ The EMBA, shown in **Figure 3-1**.

The EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of a worst-case oil spill. Most planned and unplanned events associated with the Activity may affect the environment up to a few kilometres from the Operational Area e.g. from noise emissions (as identified in **Section 6.4**). A large unplanned hydrocarbon spill would extend substantially beyond this (**Section 7.1**).

The unplanned vessel hydrocarbon spill EMBA represents the overall EMBA for activities conducted under this EP.

3.1.1 Unplanned Vessel Hydrocarbon Spill EMBA

Credible unplanned vessel hydrocarbon spill scenarios that have been considered for the EMBA and assessed in **Section 7** of this EP are outlined in **Table 3-1**. Modelling previously undertaken for the Keraudren Extension 3D Marine Seismic Survey (MSS) ('Keraudren Survey') (Santos 2019) has been utilised for the Survey. Two release locations were previously modelled, which are approximately 130 km away, one to the North-Northwest and one to the North East of the Operational Area (**Figure 2-1**). Stochastic hydrocarbon dispersion and fate modelling applied to the largest credible hydrocarbon spill scenario (the release of 1,065 cubic meters (m^3) of marine diesel oil / marine gas oil (MDO / MGO); **Section 7.1)**, was undertaken at each location to inform the EMBA.

The spill trajectories from the two modelled release locations have been combined and the resulting extent has been applied to the Operational Area to form the Survey EMBA, as shown in **Figure 3-1**. It should be noted that this EMBA represents a very conservative assessment as the largest single tank size of any vessel during the Survey has been assessed as 650 m^3, and the EMBA is based on two release locations relevant to the much larger Keraudren Survey Area compared to this Survey's 10 x 10 km Operational Area.

While the EMBA represents the largest possible spatial extent that could be affected by the worst-case hydrocarbon spill event, it is important to understand that the stochastic modelling considers 120 different simulations for any one spill event (with two events modelled in total). Simplistically, each simulation considers a different combination of metocean conditions over time. An actual spill event is more likely to be represented by only one of the simulations and hence, have a much smaller spatial footprint. An example of a single simulation modelled (i.e. a deterministic model) for this Activity is illustrated in Figure 3-1 to demonstrate a more realistic spatial extent for any hydrocarbon phase of the worst-case spill scenario (i.e. a deterministic EMBA). This single simulation was selected from the 240 modelled simulations (i.e. 120

simulations at each of the two modelled locations) to indicate the worst-case spill in relation to potential for shoreline contact.

Table 3-1: Summary of largest credible unplanned vessel hydrocarbon spill scenarios

Event	Hydrocarbon Type	Modelled Spill Volume	Comment	Section
Hydrocarbon spill Marine Diesel Oil/Marine Gas Oil (MDO/MGO) from vessel collision – surface release	MDO/MGO	1,065 m^3	Modelled spill volume based on the predicted largest fuel tank on a vessel.	**7.1**
Hydrocarbon spill (MDO/MGO) during refuelling	MDO/MGO	37.5 m^3	Spill volume based on 15 minutes of flow at a pumping rate of 150 m^3/hr.	**7.2**

3.2 Environmental Values and Sensitivities

A comprehensive description of the environmental values and sensitivities of the existing environment within the EMBA (as required by Regulation 13(3) of the OPGGS(E)R), is provided for in Santos' *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062). It is a compilation of environmental values and sensitivities including physical, biological, social, economic and cultural features within the marine and coastal environment that are relevant to all of Santos' activities, not specifically to this EP. A copy of the document is provided in **Appendix B**.

Specific to this EP, the Department of Agriculture, Water and the Environment (DoAWE) Protected Matters Search Tool (PMST) associated with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was used to determine potential receptors such as Matters of National Environmental Significance (MNES) within the Operational Area and the EMBA. The results of these searches are provided in **Appendix C.**

A summary of the information derived from the Protected Matters Search, Bioregional Plans and the identified Fauna Recovery Plans of relevance to the Operational Area and the EMBA is provided in this section.

3.2.1 Bioregions

Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, the Operational Area is within the North West Shelf Province (**Figure 3-2**). The EMBA overlaps the following provinces (**Figure 3-2**):

- the Northwest Shelf Province;
- the Northwest Province;
- the Northwest Transition; and
- the Timor Province.

The presence of marine and coastal habitats within the Operational Area and EMBA is summarised in **Table 3-2** and a detailed description of these habitats with reference to the IMCRA provincial bioregions is provided in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

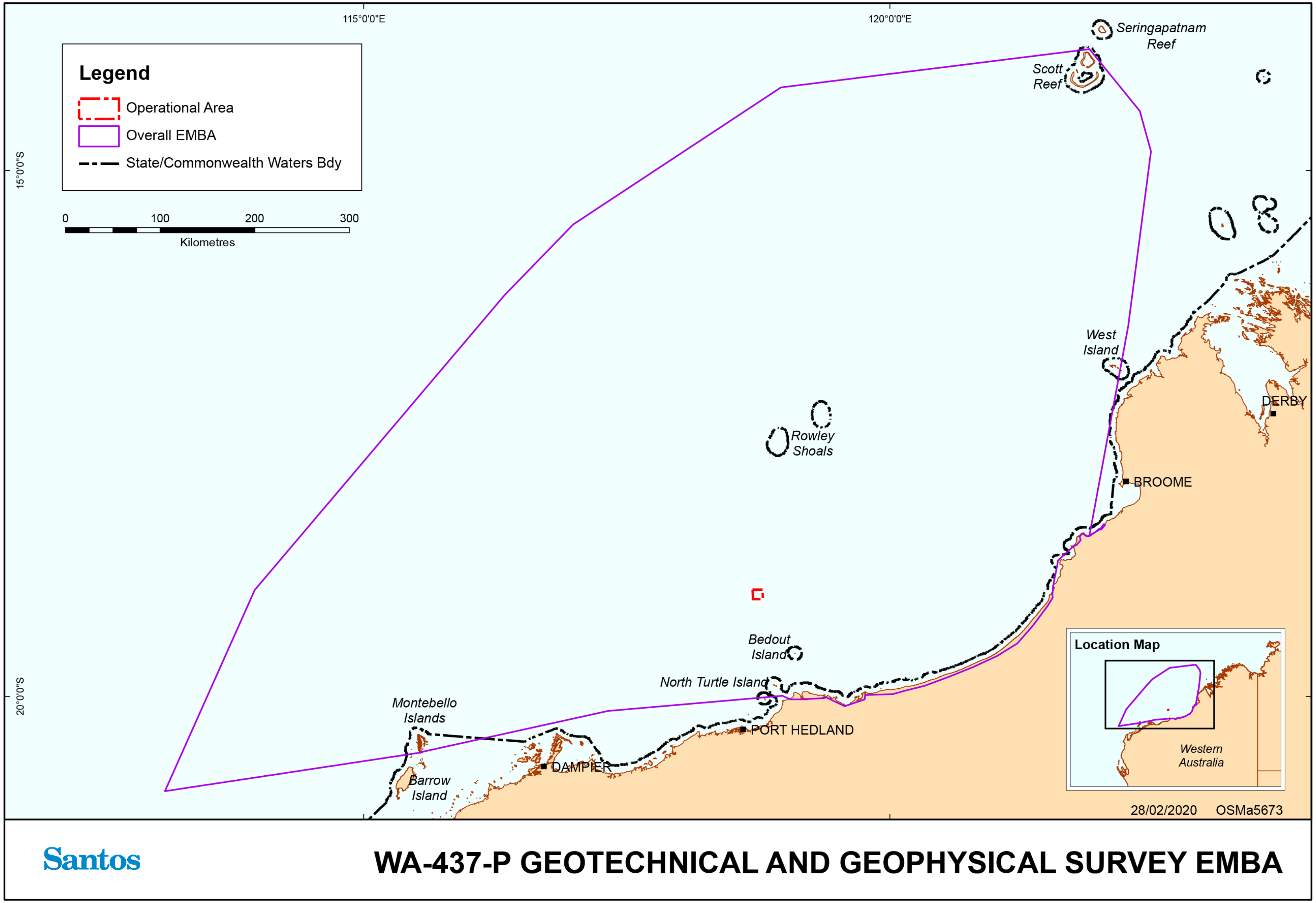

Figure 3-1: Survey EMBA

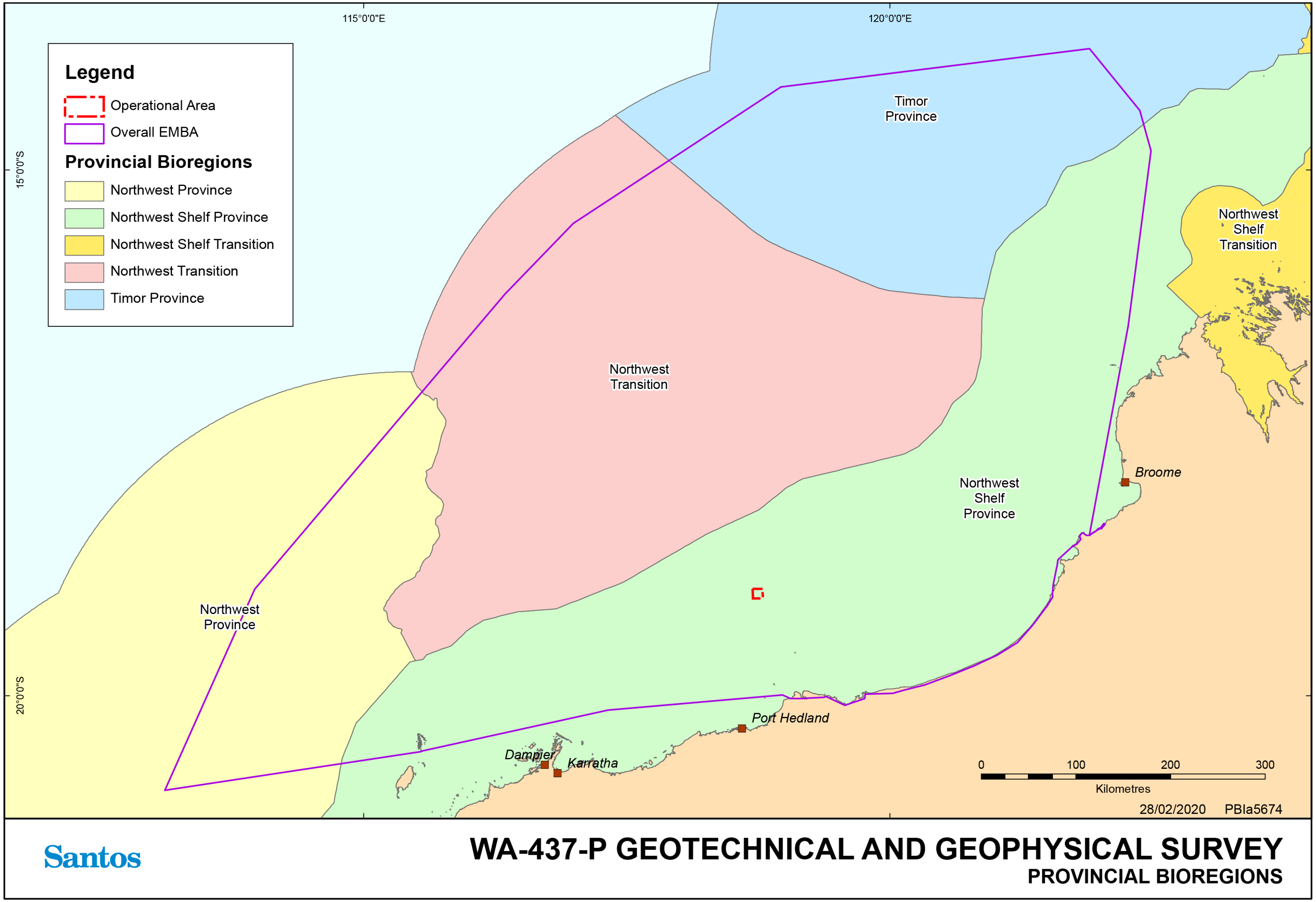

Figure 3-2: IMCRA 4.0 Provincial Bioregions within the EMBA

Table 3-2: Receptors listed according to presence within the Operational Area and EMBA

Category	Receptor	Operational Area Presence	EMBA Presence				Relevant activities (planned) / events (unplanned) that may impact on the receptors
			Northwest Province	Northwest Transition	Northwest Shelf Province	Timor Province	
Water Column	Plankton Fish Turtles Cetaceans Seabirds	✓	✓	✓	✓	✓	Planned • Noise emissions • Light emissions • Planned operational discharges Unplanned • Hazardous and non-hazardous unplanned discharges - liquid • MDO/MGO release from vessel collision • Minor hydrocarbon release • Marine fauna collisions • Introduction of invasive marine species • Spill response operations
Benthic Habitats	Coral reefs (including emergent oceanic shoals)	x	x	✓	✓	✓	Unplanned • MDO/MGO release from vessel collision • Introduction of invasive marine species • Spill response operations
	Seagrass	x	x	x	✓	✓	Unplanned • MDO/MGO release from vessel collision • Introduction of invasive marine species • Spill response operations

Category	Receptor	Operational Area Presence	EMBA Presence				Relevant activities (planned) / events (unplanned) that may impact on the receptors
			Northwest Province	Northwest Transition	Northwest Shelf Province	Timor Province	
	Macroalgae	x	x	✓	✓	✓	Unplanned • MDO/MGO release from vessel collision • Introduction of invasive marine species • Spill response operations
	Non-coral benthic invertebrates	✓	✓	✓	✓	✓	Planned • Physical disturbance • Noise emissions • Planned operational discharges Unplanned • Hazardous and non-hazardous unplanned discharges - solid • MDO/MGO release from vessel collision • Introduction of invasive marine species • Spill response operations
Shoreline habitats	Mangroves / shorebirds	x	x	x	✓	x	Unplanned • MDO/MGO release from vessel collision • Spill response operations
	Intertidal mud / sand flats/ shorebirds	x	x	x	✓	x	
	Sandy beaches / shorebirds / turtle nesting	x	x	x	✓	x	
	Intertidal rock platforms	x	x	x	✓	x	

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Category	Receptor	Operational Area Presence	EMBA Presence				Relevant activities (planned) / events (unplanned) that may impact on the receptors
			Northwest Province	Northwest Transition	Northwest Shelf Province	Timor Province	
	Rocky shorelines	x	x	x	✓	x	

3.2.2 Protected / Significant Areas

Protected areas and key ecological features (KEF) identified in the EMBA are detailed in **Table 3-3, Figure 3-3** (protected areas) and **Figure 3-4** (KEFs); with the exception of the various islands discussed in **Section 3.2.2.1**. These areas are further described in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

The conservation values and management zones associated with Australian Marine Parks (AMPs) identified to occur in the EMBA, and the relevant management objectives are detailed in **Section 3.2.2.2** in addition to information provided in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

The Eighty Mile Beach, Rowley Shoals and Montebello Islands State Marine Parks are also located in the EMBA. The conservation values and management objectives associated with these State Marine Parks are summarised in **Section 3.2.2.3**, in addition to information provided in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

There are no World Heritage properties located in the EMBA. There are two Commonwealth Heritage places and one National Heritage place located in the EMBA, 'Mermaid Reef - Rowley Shoals' and 'Scott Reef and Surrounds Commonwealth Area', and the 'West Kimberley', respectively. These are described further in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

3.2.2.1 Islands

No islands or emergent reef systems are located within the Operational Area. Several islands and emergent reefs are located within the EMBA that provide intertidal and shoreline habitats for a variety of marine fauna and ecological communities. These islands and reefs are summarised below.

Bedout Island is located 65 km south of the Operational Area and is an A-class nature reserve. The island is a low and undulating, 0.3 square kilometres (km^2) sandy cay on limestone bedrock, heavily vegetated with *Spinifex longifolius*. Bedout Island supports breeding birds such as masked booby, white-bellied sea eagle, silver gull, crested tern and lesser crested tern (BirdLife International, 2018). Burbidge *et al.* (1987) report numbers of occupied nests of brown booby (approximately 10,000), masked booby (approximately 178) and lesser frigate bird (2,290) surveyed in 1984 on Bedout Island. Bedout Island is fringed by coral reef and provides seabird and turtle foraging habitat.

North Turtle Island is an A-class nature reserve located 90 km south of the Operational Area. The island is fringed by coral reef and provides turtle and seabird nesting and foraging habitat (BHP, 2011; Davidson and Thomas-Dans, Landscope article, undated).

Bedwell Island on Clerke Reef and **Cunningham Island** on Imperieuse Reef are located 194km and 152km respectively from the Operational area and consist of unvegetated sand cays about 2 m and 3.7 m high respectively. Bedwell Island is home to one of only two colonies of red-tailed tropicbirds in WA (the other being located at Ashmore Reef and Cartier Island outside of the EMBA), along with several other bird species. Bedwell Island also provides occasional nesting habitat for a small number of hawksbill and green turtles. Both Bedwell Island and Cunningham Island are known resting sites for migratory birds (DoEC 2007).

The Montebello Islands (Trimouille, North-west, Bluebell and Hermite Island). The Montebello Islands, located 350 km south-west of the Operational Area, consist of 315 low-lying islands and islets. The islands support mangrove communities and are fringed by extensive coral reefs, with macroalgae and sparse patches of seagrass (Parks and Wildlife Service, 2017). The islands also provide habitat for significant green, hawksbill, flatback turtle nesting populations.

The Lacepede Islands are located 422 km north-east of the Operational Area. They comprise four flat sand and coral rubble cay islands surrounded by platform coral reef and seagrass habitats. The islands support thousands of birds including brown boobies, roseate terns and lesser frigate birds (BirdLife International, 2018). The islands and surrounding waters are also significant for turtle nesting, inter-nesting and foraging, supporting regionally significant populations of nesting green turtles and flatback turtles (DoEE, 2017).

Sandy Islet, Scott Reef, located 634 km from the Operational Area, is a sandy, low lying bank which provides nesting habitat for two species of marine turtle. The island is surrounded by an emergent shelf atoll, Scott Reef, and is located on the edge of the broad continental shelf, about 300 km from mainland north-western Australia. Scott Reef is regionally significant because of its high representation of species not found in coastal waters off WA and for the unusual nature of its fauna which has affinities with the oceanic reef habitats of the Indo-West Pacific as well as the reefs of the Indonesian region (DoE 2014).

Rowley Shoals, located 141 km from the Operational Area, comprises three distinct reef systems, Imperieuse Reef, Clerke Reef and Mermaid Reef, each located approximately 30 to 40 km apart. The reefs rise vertically to the surface from depths of between 500 and 700 m. Mermaid Reef includes low lying sandy cays which are completely submerged at high tide and therefore fall under Australian Government jurisdiction (Commonwealth waters). The other two reefs, Clerke Reef and Imperieuse Reef are emergent reefs with sandy islets above the high-water mark and are managed as the WA Rowley Shoals Marine Park. The marine reef fauna of the Rowley Shoals is considered to be exceptionally rich and diverse, including species typical of the oceanic coral reef communities of the Indo-West Pacific. As many of these species are not found in the inshore tropical waters of northern Australia, such populations are of regional significance (DSEWPac 2012a).

Table 3-3: Protected areas and features within the EMBA

Value/Sensitivity	Name	Approximate distance to Operational Area (km)
Australian Marine Parks (AMP)	Eighty Mile Beach AMP: Multiple Use Zone – International Union for Conservation of Nature (IUCN) VI0F0F[1]	49
	Argo-Rowley Terrace AMP: Multiple Use Zone – IUCN VI	139
	Argo-Rowley Terrace AMP: Special Purpose Zone (Trawl) – IUCN VI	153
	Mermaid Reef AMP: National Park Zone – IUCN II	210
	Montebello AMP: Multiple Use Zone – IUCN VI	304
	Kimberley AMP: Multiple Use Zone – IUCN VI	320
	Argo-Rowley Terrace AMP: National Park Zone – IUCN II	422
	Gascoyne AMP: Multiple Use Zone – IUCN VI	548
State Marine Parks	Eighty Mile Beach	120
	Rowley Shoals	141
	Montebello Islands	350
Islands	Bedout Island	65
	North Turtle Island	90
	Cunningham Island (Imperieuse Reef)	152
	Bedwell Island (Clerke Reef)	194

[1] International Union for Conservation of Nature (IUCN) categories are presented in Roman numerals.

Value/Sensitivity	Name	Approximate distance to Operational Area (km)
	Trimouille Island (Montebello Group)	358
	North-west Island (Montebello Group)	360
	Bluebell Island (Montebello Group)	363
	Hermite Island (Montebello Group)	364
	Lacepede Islands	422
	Sandy Islet (Scott Reef)	634
Wetlands of International Importance (Ramsar)	Eighty Mile Beach	139
Key Ecological Features	Ancient coastline at 125 m depth contour	16
	Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	133
	Glomar Shoals	201
	Continental slope demersal fish communities	338
	Exmouth Plateau	454
	Canyons linking the Argo Abyssal Plain with the Scott Plateau	506
	Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	612

3.2.2.2 Australian Marine Parks

The Operational Area does not overlap with any AMP or any other protected areas, however, the EMBA overlaps the following marine parks: Eighty Mile Beach AMP, Argo-Rowley Terrace AMP, Mermaid Reef AMP, Kimberley AMP, Gascoyne AMP and Montebello AMP. Values for these AMPs are summarised in **Table 3-4** below and are described further in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

Management plans for AMPs have been developed and came into force on 1 July 2018. Under these plans AMPs are allocated conservation objectives (IUCN Protected Area Category) based on the Australian IUCN reserve management principles in Schedule 8 of the EPBC Regulations 2000. These principles determine what activities are acceptable within the different zones of the AMP network. As the Operational Area does not overlap any AMPs, there are no AMPs that restrict the undertaking of the surveys. Therefore, the Activity will be undertaken in compliance with the AMP network zone rules. In the event of spill response operations being required within an AMP, emergency spill response activities are allowed in accordance with the *Australian National Plan for Maritime Environmental Emergencies* (MEE) without the need for a permit, class approval or Activity licence or lease issued by the Director of National Parks.

Table 3-4: Values of Australian Marine Parks overlapping the EMBA

Commonwealth Marine Park	Management Zone/s	Values
Eighty Mile Beach AMP	Multiple Use Zone (VI)	The Eight Mile Beach Marine Park protects the following conservation values: • Foraging areas for migratory seabirds; • Important foraging areas for marine turtles adjacent to significant nesting sites; • Part of the migratory pathway of the protected humpback whale; • Areas adjacent to important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish; • Protection for terrace, banks and shoal habitats; • Communities and seafloor habitats of the North West Shelf Province; • Sea country valued for indigenous cultural identify.
Argo-Rowley Terrace AMP	• Multiple Use Zone (VI) • Special Purpose Zone (Trawl) • National Park Zone (II)	The Argo-Rowley Marine Park is located approximately 270 km north-west of Broome, WA. Important conservation values include: • Foraging areas that are important for migratory seabirds as well as the endangered loggerhead turtle; • Important habitat and foraging for sharks; • Migratory pathway for pygmy blue whales; • Protection for communities and habitats of the deeper offshore waters of the region; • Seafloor features including aprons and fans, canyons, continental rise, knolls/abyssal hills and the terrace and continental slope; • Communities and seafloor habitats of the North West Shelf Province and Timor Province bioregions; • Connectivity between the existing Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park; and • Two key ecological features: Canyons linking the Argo Abyssal Plain with the Scott Plateau and Mermaid Reef and Commonwealth waters surrounding Rowley Shoals.
Mermaid Reef AMP	National Park Zone (II)	During periods of high tide, Mermaid Reef is completely submerged underwater and protects the following conservation values: • National and international significant habitats including coral formations, geomorphic features and diverse marine life; • Key area for over 200 species of hard corals and 12 classes of soft corals with coral formations in pristine condition; • Important areas for sharks; • Important foraging for marine turtles;

Commonwealth Marine Park	Management Zone/s	Values
		• Important area for toothed whales, dolphins, tuna and billfish; • Important resting and feeding sites for migratory seabirds; • A migratory pathway for the pygmy blue whale; • The reserve, along with nearby Rowley Shoals Marine Park, provides the best geological example of shelf atolls in Australia; and • Examples of the seafloor habitats and communities of the Northwest Transition.
Kimberley AMP	• Multiple Use Zone (VI) • National Park Zone (II)	The Kimberley Marine Park protects the following conservation values: • Important foraging areas for migratory seabirds, dugongs, dolphins and threatened and migratory marine turtles; • Important migratory pathway for nursery areas for the protected humpback whale; • Migratory pathway for pygmy blue whales; • Adjacent to important foraging and pupping areas for sawfish and important nesting sites for green turtles; • Protection for communities and habitats of waters offshore of the Kimberley coastline; • Representation of continental shelf, slope, plateau, pinnacle, terrace, banks and shoals and deep hole/valley seafloor features; • Communities and seafloor habitats; and • Two key ecological features: the ancient coastline at the 125 m depth contour and the continental slope demersal fish communities.
Gascoyne AMP	Multiple Use Zone VI	The Gascoyne Marine Park protects the following conservation values: • Important foraging areas for migratory seabirds threatened and migratory hawksbill and flatback turtles and vulnerable and migratory whale shark; • A continuous connectivity corridor from shallow depths around 15 m out to deep offshore waters on the abyssal plain at over 5,000 m; • Seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise. It also provides protection for sponge gardens in the south of the reserve adjacent to WA coastal waters; • Ecosystem examples from the surrounding provinces; • Four key ecological features: Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula, Commonwealth waters adjacent to Ningaloo Reef, Continental slope demersal fish communities and Exmouth Plateau;

Commonwealth Marine Park	Management Zone/s	Values
		• The canyons in the reserve are believed to be associated with the movement of nutrients from deep water over the Cuvier Abyssal Plain onto the slope where mixing with overlying water layers occurs at canyon heads; and • The reserve therefore provides connectivity between the inshore waters of the existing Ningaloo Commonwealth Marine Park and the deeper waters of the area.
Montebello AMP	Multiple Use Zone (VI)	The Montebello Marine Park is located offshore of Barrow Island and 80 km west of Dampier extending from the Western Australian state water boundary and is adjacent to the Western Australian Burrow Island and Montebello Island Marine Parks. The park protects the following marine values: • Foraging areas for migratory seabirds; • Areas used by vulnerable and migratory whale sharks for foraging; • Foraging areas marine turtles which are adjacent to important nesting sites; • Section of the north and south bound migratory pathway of the humpback whale; • Shallow shelf environments with depths ranging from 15-150 m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features; • Seafloor habitats and communities of the North West Shelf Province provincial bioregions; and • One key ecological feature for the region: the ancient coastline at the 125 m depth contour.

3.2.2.3 State Marine Parks

There are three State Marine Parks located in the EMBA. The Operational Area does not overlap any State Marine Parks. The three Marine Parks (MPs) include: the Rowley Shoals Marine Park, Montebello Islands Marine Park and Eighty Mile Beach Marine Park. Values for these MPs are outlined briefly in **Table 3-5** below and are described further in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

Table 3-5: State Marine Parks overlapping the EMBA

State Marine Park	Values
Rowley Shoals Marine Park	The Rowley Shoals are situated approximately 140 km north-west of the Operational area and comprise of three oceanic systems, approximately 30 to 40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Rowley Shoals Marine Park is characterised by intertidal and subtidal coral reefs, exceptionally rich and diverse marine fauna and high-water quality. These attributes and the low level of use of the area contribute to the Park's unique qualities. The Rowley Shoals are of national and international significance.
Montebello Islands Marine Park	The Montebello Islands Marine Park is located approximately 350 km south west of the Operational area and 20 km north of Barrow Island. The Park protects more than 58,000 ha of ocean surrounding more than 250 low-lying islands. The complex system of reefs, lagoons and channels support a large range of habitats, and marine flora and fauna. The area supports a minimum of 150 species of hard coral, 450 species of fish, 630 species of molluscs and 170 species of sea stars, urchins and other echinoderms (Department of Environment and Conservation, 2007a).
Eighty Mile Beach Marine Park	Eighty Mile Beach Marine Park covers almost 210 km^2 of the remote north-west coast of WA. The area supports feeding grounds for migratory shorebirds and waders and is listed under the Ramsar Convention. It also supports a significant nesting population of flatback turtles which are endemic to northern Australia (Department of Fisheries, 2015).

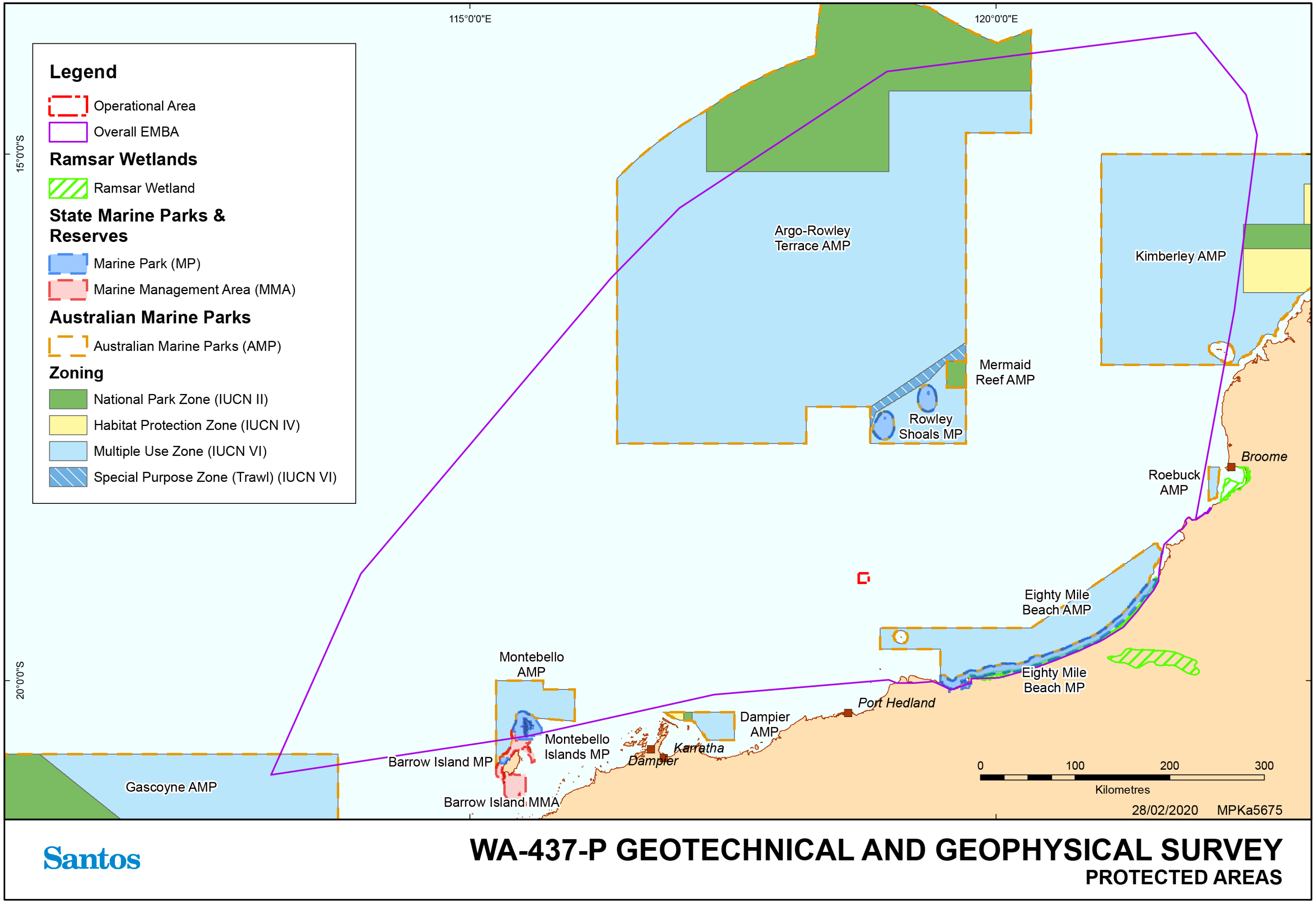
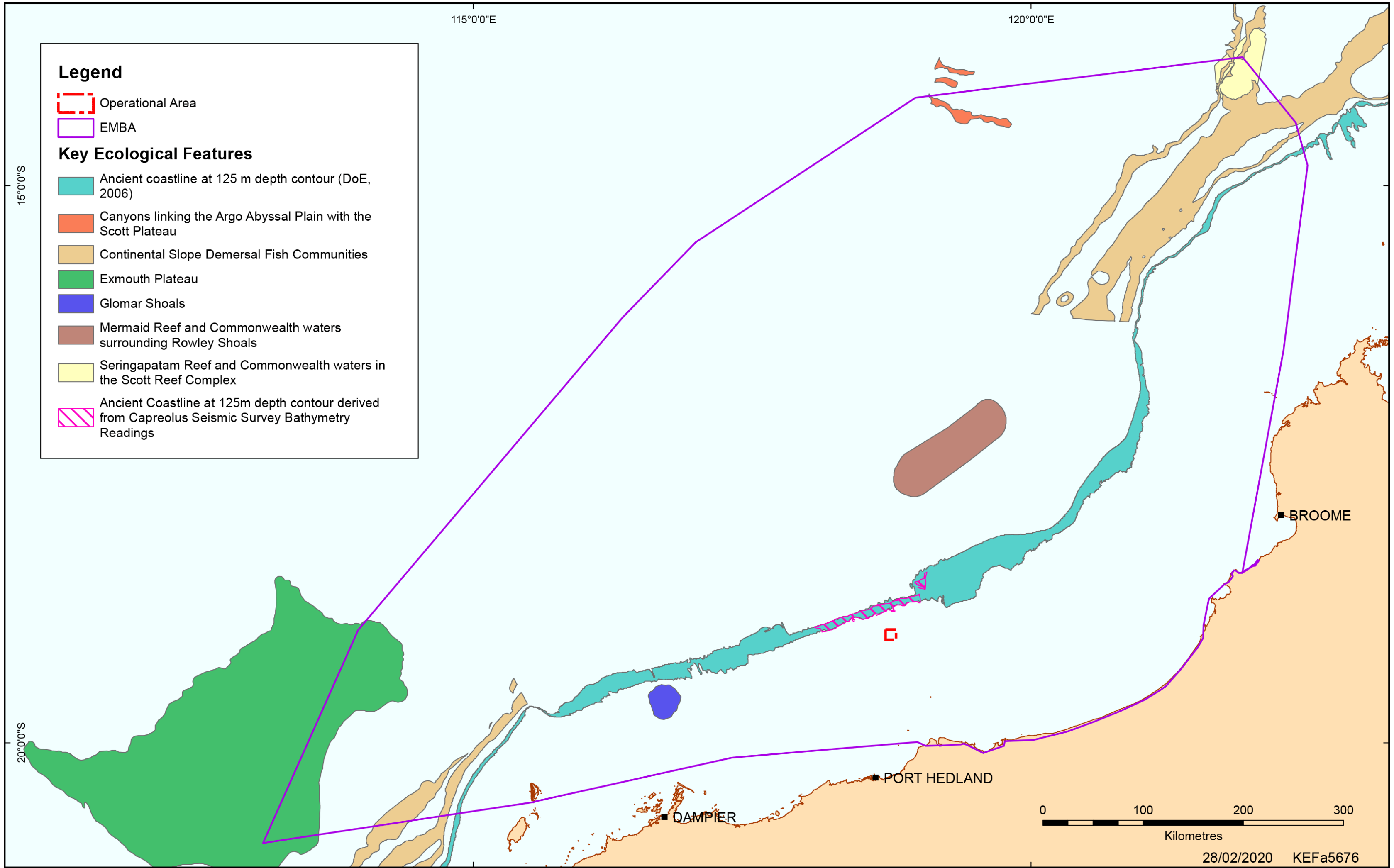


Figure 3-3: Protected areas within and adjacent to the EMBA



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WA-437-P GEOTECHNICAL AND GEOPHYSICAL SURVEY
KEY ECOLOGICAL FEATURES

Figure 3-4: Key ecological features within and adjacent to the EMBA

3.2.3 Marine Fauna

The PMST was used to identify Listed Threatened Species (LTS) and Listed Migratory Species (LMS) relevant to the Operational Area and the EMBA (**Appendix C**). The PMST report identified 14 LTS and 29 LMS for the Operational Area, and 42 LTS and 82 LMS for the EMBA.

An examination of the Species Profile and Threats (SPRAT) database showed that some LTS are not expected to occur in the marine and coastal environments due to their terrestrial distributions. These species will not come into contact with any potential hydrocarbon spill, or be exposed to underwater noise emissions, and therefore will not be discussed further.

Species listed as threatened, migratory or conservation dependent which occur or potentially occur within the EMBA (except those excluded above) are summarised in **Table 3-6**. The relevant planned activities and unplanned events that may affect them are also discussed in **Table 3-6**. Threatened and migratory species within these listed groups are described in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**). Conservation dependent species are not described in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062); they are summarised below.

Biologically Important Areas (BIAs) and habitats critical to the survival of a species, such as an aggregation, breeding, resting, nesting or feeding areas or known migratory routes, for marine mammals, marine turtles, fish and sharks, and seabirds are shown in **Figure 3-6** to **Figure 3-8.** The BIAs and habitats critical to the survival of a species are described in the *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

Table 3-7 lists those species that may be affected by the identified threats described in Species Conservation and Recovery Management Plans due to planned or unplanned events associated with the Activity. Cross references to the relevant EP section for the assessment of impacts and risks are also provided in **Table 3-7.**

The following environmental values and sensitivities have been identified as being relevant to the Activity, with information provided in the following subsections to supplement the information available in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**):

+ Epibenthos in 86 to 94 m water depth (Section 3.2.3.1);
+ Fish associated with the ancient coastline at 125 m depth contour KEF (Section 3.2.3.2);
+ EPBC Act-listed threatened and migratory fish species (Section 3.2.3.3);
+ Conservation dependent fish species (Section 3.2.3.4);
+ Humpback whale migration (Section 3.2.3.5);
+ Pygmy blue whale migration (Section 3.2.3.6);
+ Marine turtles (Section 3.2.3.7); and
+ Seabirds (Section 3.2.3.8).

Table 3-6: Environmental values and sensitivities – EPBC Act-listed threatened, migratory and conservation dependent marine fauna reported by the Protected Matters Search Tool

EPBC Act status: CE= Critically Endangered, E= Endangered V= Vulnerable, M= Migratory, CD = Conservation Dependent

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	Scientific name						
Fish, Sharks and Rays							
Dwarf sawfish	*Pristis clavata*	V; M	X	Habitat preference for shallow estuarine waters and therefore presence is not expected	✓	Breeding known to occur BIAs for pupping, nursing and foraging	**Unplanned** – MDO/MGO release from vessel collision – Spill response operations
Freshwater sawfish	*Pristis pristis*	V; M	X	Habitat preference for inshore coastal, estuarine and river environments and therefore presence is not expected	✓	Species or habitat known to occur BIAs for pupping and foraging	
Northern River Shark	*Glyphis garricki*	E	X	Species not expected to occur	✓	Species or species habitat known to occur	
Grey nurse shark (west coast population)	*Carcharias taurus*	V	X	Species not expected to occur	✓	Species or species habitat known to occur	**Unplanned** – MDO/MGO release from vessel collision
Green sawfish	*Pristis zijsron*	V, M	✓	Species or species habitat known to occur however habitat preferences tend to restrict distribution to shallower coastal waters	✓	Breeding known to occur BIAs for pupping, nursing and foraging	**Planned** – Noise emissions – Light emissions – Planned operational discharges **Unplanned** – Marine fauna collision – Hazardous and non-hazardous unplanned discharges - solid
Giant manta ray	*Manta birostris*	M	✓	Species or species habitat may occur	✓	Species or habitat likely to occur	
Great white shark	*Carcharodon carcharias*	V, M	✓	Species or habitat may occur but is less common in tropical waters	✓	Species or habitat may occur	

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	**Scientific name**						
Longfin mako	*Isurus paucus*	M	✓	Species or habitat likely to occur	✓	Species or habitat likely to occur	– Hazardous and non-hazardous unplanned discharges - liquid – Minor hydrocarbon release – MDO/MGO release from vessel collision – Spill response operations
Narrow sawfish	*Anoxypristis cuspidata*	M	✓	Habitat preference for inshore coastal, estuarine and river environments but may occur in the Operational Area	✓	Species or habitat known to occur	
Reef manta ray	*Manta alfredi*	M	✓	Species or species habitat may occur	✓	Species or habitat known to occur	
Shortfin mako shark	*Isurus oxyrinchus*	M	✓	Species or habitat likely to occur	✓	Species or habitat likely to occur	
Whale shark	*Rhincodon typus*	V; M	✓	Foraging, feeding or related behaviour known to occur BIA for foraging	✓	Foraging, feeding or related behaviour known to occur BIA for foraging	
Southern bluefin tuna	*Thunnus maccoyii*	CD	X	Species not expected to occur	✓	Species or species habitat known to occur	
Scalloped hammerhead shark	*Sphyra lewini*	CD	X	Species not expected to occur	✓	Species or species habitat known to occur	
Marine Mammals							
Antarctic minke whale	*Balaenoptera bonaerensis*	M	X	Species not expected to occur	✓	Species or habitat may occur	**Unplanned** – Marine fauna collision – Hazardous and non-hazardous unplanned discharges - solid
Dugong	*Dugong dugon*	M	X	Distribution strongly associated with seagrass habitat, which does not occur in the Operational Area	✓	Species or habitat known to occur but typically found in shallow coastal waters. BIA for foraging	

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	**Scientific name**						
							– Hazardous and non-hazardous unplanned discharges - liquid – Minor hydrocarbon release – MDO/MGO release from vessel collision
Blue whale (includes Pygmy blue whale)	*Balaenoptera musculus intermedia and B. m. brevicauda*	E; M	✓	Migration route and BIA located 103 km NW of the Operational Area.	✓	BIA for foraging, distribution and migration	**Planned** – Noise emissions – Planned operational discharges – Spill response operations **Unplanned** – Marine fauna collision – Hazardous and non-hazardous unplanned discharges - solid – Hazardous and non-hazardous unplanned discharges - liquid – Minor hydrocarbon release – MDO/MGO release from vessel collision
Bryde's whale	*Balaenoptera edeni*	M	✓	Species or habitat may occur	✓	Species or habitat likely to occur	
Fin whale	*Balaenoptera physalus*	V; M	✓	Species or species habitat may occur	✓	Foraging, feeding or related behaviour likely to occur	
Humpback whale	*Megaptera novaeangliae*	V; M	✓	Migration route and BIA located approximately 20 km to the south of the Operational Area	✓	EMBA is within migration BIA, and also crosses the breeding / calving / nursery ground in the north-east	
Indo-Pacific humpback dolphin	*Sousa chinensis*	M	X	Species not expected to occur	✓	Species or habitat known to occur	
Killer whale	*Orcinus orca*	M	✓	Species or habitat may occur	✓	Species or habitat may occur	
Sei whale	*Balaenoptera borealis*	V; M	✓	Species or species habitat may occur	✓	Foraging, feeding or related behaviour likely to occur within area	
Sperm whale	*Physeter macrocephalus*	M	X	Species not expected to occur	✓	Species or habitat may occur	

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	Scientific name						
Spotted bottlenose dolphin	*Tursiops aduncus*	M	✓	Species or species habitat may occur	✓	Species or habitat likely to occur	
Australian Snubfin Dolphin	*Orcaella heinsohni*	M	X	Species not expected to occur	✓	Species or habitat likely to occur	**Unplanned** – MDO/MGO release from vessel collision
Marine Reptiles							
Flatback turtle	*Natator depressus*	V; M	✓	Species or species habitat likely to occur No overlap with Habitat Critical to survival of the species	✓	Breeding known to occur BIAs for nesting, inter-nesting, mating, foraging and migration corridor Habitat Critical to survival of the species – 60 km radius around Eighty Mile Beach	**Planned** – Noise emissions – Light emissions – Planned operational discharges **Unplanned** – Marine fauna collision – Hazardous and non-hazardous unplanned discharges - solid – Hazardous and non-hazardous unplanned discharges - liquid – Minor hydrocarbon release – MDO/MGO release from vessel collision – Spill response operations
Green turtle	*Chelonia mydas*	V; M	✓	Species or species habitat likely to occur No overlap with Habitat Critical to survival of the species	✓	Breeding known to occur within area BIAs for foraging and inter-nesting	
Leatherback turtle	*Dermochelys coriacea*	E; M	✓	Species or species habitat likely to occur No overlap with Habitat Critical to survival of the species	✓	Breeding likely to occur within area No overlap with BIAs or Habitat Critical to survival of the species	
Hawksbill turtle	*Eretmochelys imbricata*	V; M	✓	Species or species habitat known to occur	✓	Breeding known to occur within area	

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	**Scientific name**						
				No overlap with Habitat Critical to survival of the species		BIA for foraging, inter-nesting , nesting, and mating	
Loggerhead turtle	*Caretta caretta*	E; M	✓	Species or habitat known to occur No overlap with Habitat Critical to survival of the species	✓	BIA for foraging and internesting Foraging, feeding or related behaviour known to occur within area	
Olive Ridley Turtle, Pacific Ridley Turtle	*Lepidochelys olivacea*	E, M	**X**	Species not expected to occur	✓	Foraging, feeding or related behaviour likely to occur	
Short-nosed seasnake	*Aipysurus apraefrontalis*	CE	**X**	Habitat preference for reef flats or shallow waters along the outer reef edge in water depths to 10 m	✓	Species or species habitat likely to occur	**<u>Unplanned</u>** – Hazardous and non-hazardous unplanned discharges - solid – MDO/MGO release from vessel collision
Salt-water crocodile	*Crocodylus porosus*	M	**X**	Species not expected to occur	✓	Species or habitat likely to occur	**<u>Unplanned</u>** – MDO/MGO release from vessel collision – Spill response operations
Seabirds							
Lesser frigate bird	*Fregata ariel*	M	✓	Species likely to occur BIA for breeding, foraging	✓	Breeding known to occur BIA for breeding	**<u>Planned</u>** – Noise emissions – Light emissions – Planned operational discharges
Greater frigate bird	*Fregata minor*	M	✓	Species may occur	✓	Species or habitat known to occur BIA for breeding, foraging	

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	**Scientific name**						
Common noddy	*Anous stolidus*	M	✓	Species may occur	✓	Species or habitat likely to occur	– Atmospheric emissions **Unplanned** – Hazardous and non-hazardous unplanned discharges - solid – Hazardous and non-hazardous unplanned discharges - liquid – Minor hydrocarbon release – MDO/MGO oil release from vessel collision – Spill response operations
White-tailed tropicbird	*Phaethon lepturus*	M	X	Species not expected to occur	✓	Breeding likely to occur BIA for breeding	
Streaked shearwater	*Calonectris leucomelas*	M	✓	Species likely to occur	✓	Species or habitat known to occur	
Abbott's booby	*Papasula abbotti*	E	X	Species not expected to occur	✓	Species or habitat may occur	
Brown booby	*Sula leucogaster*	M	X	Species not expected to occur	✓	Breeding known to occur BIA for breeding	
Australian fairy tern	*Sternula nereis nereis*	V	X	Species not expected to occur	✓	Breeding known to occur	
Crested tern	*Thalasseus bergii*	M	X	Species not expected to occur	✓	Breeding known to occur	**Unplanned** – Hazardous and non-hazardous unplanned discharges - solid – Hazardous and non-hazardous unplanned discharges - liquid – Minor hydrocarbon release – MDO/MGO release from vessel collision – Spill response operations
Roseate tern	*Sterna dougallii*	M	X	Species not expected to occur	✓	Breeding known to occur BIA for breeding and resting	
Caspian tern	*Hydroprogne caspia*	M	X	Species not expected to occur	✓	Breeding known to occur	
Little tern	*Sternula albifrons*	M	X	Species not expected to occur	✓	Breeding known to occur BIA for breeding and resting	
Wedge-tailed shearwater	*Ardenna pacifica*	M	X	Species not expected to occur	✓	Breeding known to occur BIA for breeding	
Southern giant-petrel	*Macronectes giganteus*	E, M	X	Species not expected to occur	✓	Species or habitat may occur	

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	Scientific name						
Fork-tailed swift	*Apus pacificus*	M	X	Species not expected to occur	✓	Species or habitat likely to occur	
Masked booby	*Sula dactylatra*	M	X	Species not expected to occur	✓	Breeding known to occur	
Australian Lesser Noddy	*Anous tenuirostris melanops*	V	X	Species not expected to occur	✓	Species or species habitat may occur within area	
Bridled Tern	*Onychoprion anaethetus*	M	X	Species not expected to occur	✓	Breeding known to occur	
Red-tailed Tropicbird	*Phaethon rubricauda*	M	X	Species not expected to occur	✓	Breeding known to occur	
Red-footed Booby	*Sula sula*	M	X	Species not expected to occur	✓	Breeding known to occur BIA for breeding, foraging	
Lesser crested turn	*Sterna bengalensis*	M	X	Species not expected to occur	✓	Breeding known to occur BIA for breeding, foraging	
Fairy tern	*Sternula nereis*	M	X	Species not expected to occur	✓	Breeding known to occur BIA for breeding, foraging	
Shorebirds							
Eastern curlew	*Numenius madaga-scariensis*	CE; M	✓	Species reportedly may occur but unlikely given coastal and shoreline habitat preference	✓	Species or habitat known to occur	**Planned** – Noise emissions – Light emissions – Planned operational discharges – Atmospheric emissions **Unplanned**
Osprey	*Pandion haliaetus*	M	X	Species not expected to occur	✓	Breeding known to occur BIA for breeding	

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	**Scientific name**						
Pectoral sandpiper	*Calidris melanotos*	M	✓	Species reportedly may occur but unlikely given coastal and shoreline habitat preference	✓	Species or habitat likely to occur	– Hazardous and non-hazardous unplanned discharges - solid – Hazardous and non-hazardous unplanned discharges - liquid – Minor hydrocarbon release – MDO/MGO release from vessel collision – Spill response operations
Red knot	*Calidris canutus*	E, M	✓	Species reportedly may occur but unlikely given coastal and shoreline habitat preference	✓	Species or habitat known to occur	
Common sandpiper	*Actitis hypoleucos*	M	✓	Species reportedly may occur but unlikely given coastal and shoreline habitat preference	✓	Species or habitat known to occur	
Curlew sandpiper	*Calidris ferruginea*	CE, M	X	Species not expected to occur	✓	Species or habitat known to occur	
Sharp-tailed sandpiper	*Calidris acuminata*	M	✓	Species reportedly may occur but unlikely given coastal and shoreline habitat preference	✓	Roosting known to occur	
Great Knot	*Calidris tenuirostris*	CE, M	X	Species not expected to occur	✓	Roosting known to occur	Unplanned MDO/MGO release from vessel collision Spill response operations
Common greenshank	*Tringa nebularia*	M	X	Species not expected to occur	✓	Species or habitat known to occur	
Greater Sand Plover, Large Sand Plover	*Charadrius leschenaultii*	V	X	Species not expected to occur	✓	Roosting known to occur	
Oriental plover	*Charadrius veredus*	M	X	Species not expected to occur	✓	Roosting known to occur within area	

Santos

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	**Scientific name**						
Oriental pratincole	*Glareola maldivarum*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Bar-tailed godwit	*Limosa lapponica baueri*	V, M	X	Species not expected to occur	✓	Species or habitat known to occur	
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbieri*	CE	X	Species not expected to occur	✓	Species or habitat known to occur	
Australian painted-snipe	*Rostratula australis*	E	X	Species not expected to occur	✓	Species or habitat likely to occur	
Swinhoe's Snipe	*Gallinago megala*	M	X	Species not expected to occur	✓	Roosting likely to occur	
Pin-tailed Snipe	*Gallinago stenura*	M	X	Species not expected to occur	✓	Roosting likely to occur	
Broad-billed Sandpiper	*Limicola falcinellus*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Asian Dowitcher	*Limnodromus semipalmatus*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Black-tailed Godwit	*Limosa limosa*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Little Curlew	*Numenius minutus*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Whimbrel	*Numenius phaeopus*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Ruff	*Philomachus pugnax*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Pacific Golden Plover	*Pluvialis fulva*	M	X	Species not expected to occur	✓	Roosting known to occur within area	

Santos

Value/Sensitivity		EPBC Act status	Operational Area presence	Assessment of values or sensitivities within the Operational Area	EMBA presence	Assessment of values or sensitivities within EMBA	Relevant activities / events
Common name	Scientific name						
Grey Plover	*Pluvialis squatarola*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Grey-tailed Tattler	*Tringa brevipes*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Marsh Sandpiper	*Tringa stagnatilis*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Common Redshank	*Tringa totanus*	M	X	Species not expected to occur	✓	Roosting known to occur within area	
Terek Sandpiper	*Xenus cinereus*	M	X	Species not expected to occur	✓	Roosting known to occur within area	

Santos

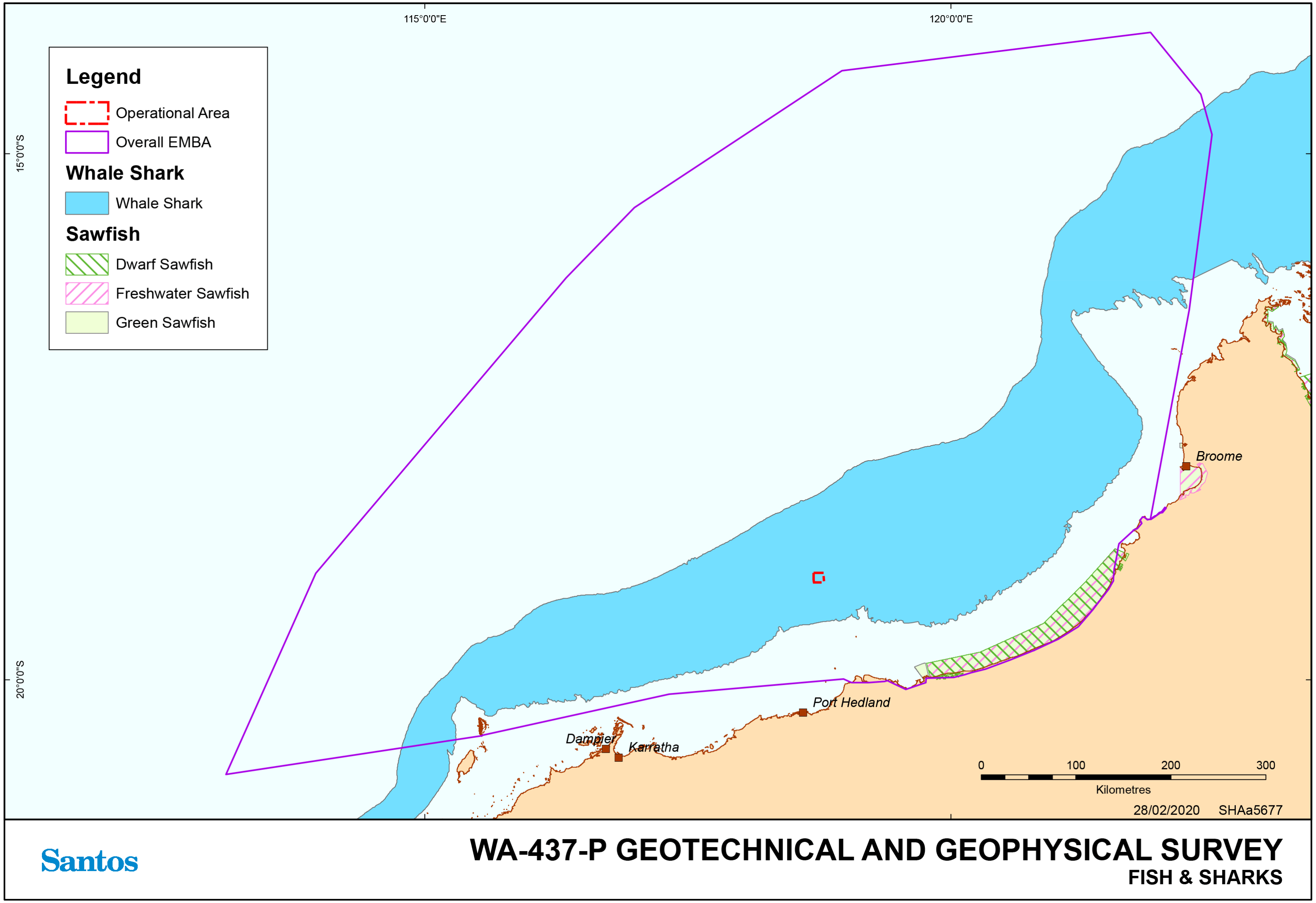

Figure 3-5: BIAs for EPBC Act-protected fish and sharks within the EMBA

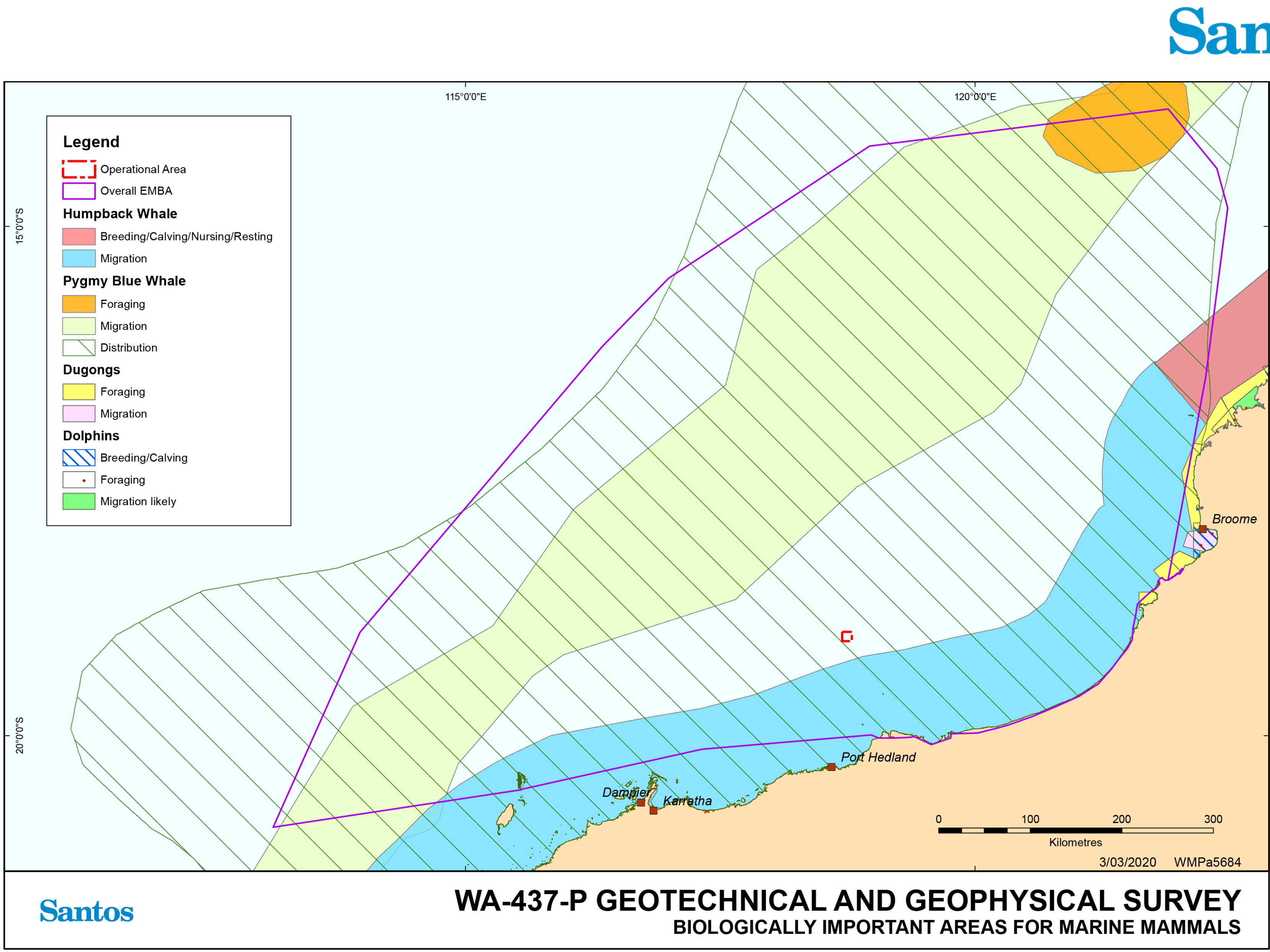

Figure 3-6: BIAs for EPBC Act-protected marine mammal species within the EMBA

Santos

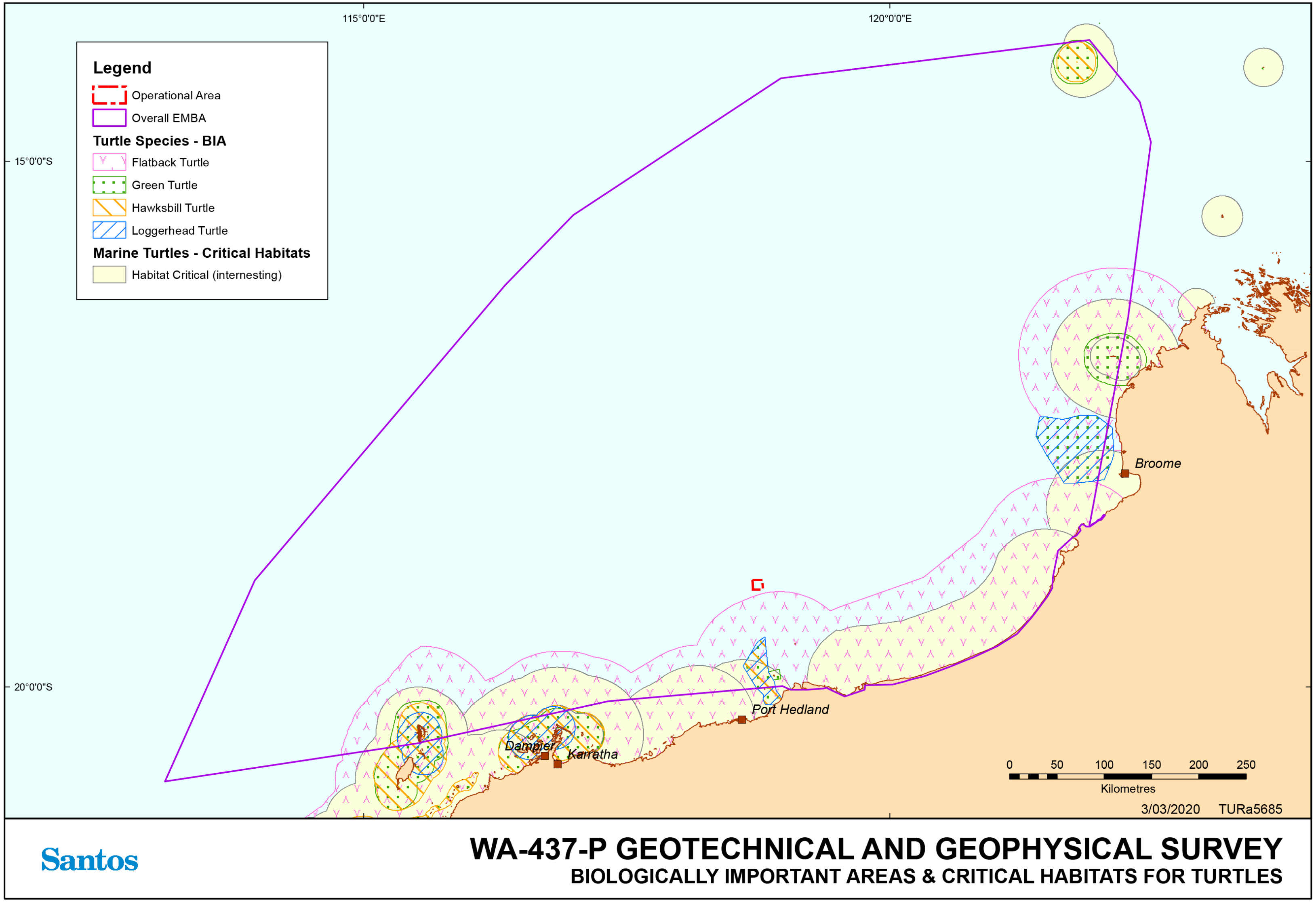

Figure 3-7: BIAs and Habitat Critical for EPBC Act-protected turtles within the EMBA

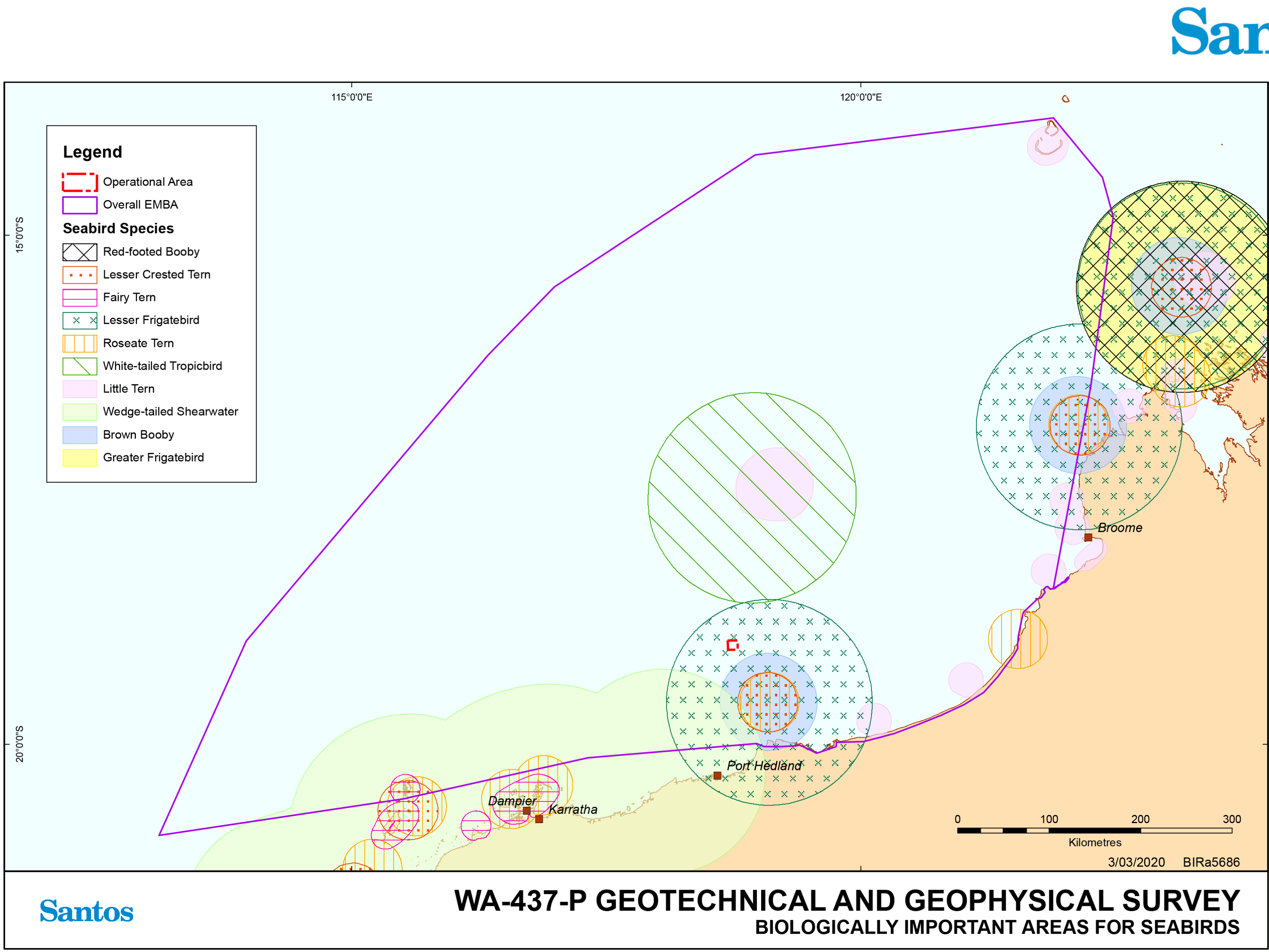

Figure 3-8: BIAs for EPBC Act-protected seabird species within the EMBA

Table 3-7: Relevant threats identified in Recovery Plans and Conservation Advice for species that occur or may occur within the EMBA and which may be affected by the Activity

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Activity	EP Section
Fish and Sharks	Dwarf sawfish	Sawfish and River Sharks Multispecies Recovery Plan (2015)	Habitat degradation and modification	• Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life. • Take into account and protect BIAs for sawfish and river sharks when assessing the impact of proposed activities in the marine environment.	6.2, 7.1 –7.7
	Green sawfish	Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish)	Habitat degradation and modification	• Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life. • Take into account and protect BIAs for sawfish and river sharks when assessing the impact of proposed activities in the marine environment.	6.2, 7.1 –7.7
		Sawfish and River Sharks Multispecies Recovery Plan (2015)			6.2, 7.1 –7.7
	Freshwater sawfish	Approved Conservation Advice for *Pristis pristis* (largetooth sawfish) (2014).	Habitat degradation/ modification	• Implement measures to reduce adverse impacts of habitat degradation and/or modification. • Take into account and protect BIAs for sawfish and river sharks when assessing the impact of proposed activities in the marine environment.	6.2, 7.1 –7.7
	Great white shark	Recovery plan for the White Shark (*Carcharodon carcharias*) (2013)	Ecosystem effects as a result of habitat modification and climate change	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	6.2, 6.5, 7.1 –7.7

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Activity	EP Section
	Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015)	Boat strike from large vessels	• Minimise transit time of large vessels in areas close to marine features likely to correlate with whale shark aggregations (Ningaloo Reef, Christmas Island and the Coral Sea) and along the northward migration route.	7.6
			Habitat disruption from mineral exploration, production and transportation	• Implement measures to reduce adverse impacts of habitat disruption.	6.2, 7.1 –7.7
			Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on whale sharks. • Take into account and protect BIAs for whale sharks when assessing the impact of proposed activities in the marine environment.	7.5
	Northern river shark	Approved Conservation Advice for *Glyphis garricki* (Northern River Shark) (2014)	Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life. • Take into account and protect BIAs for sawfish and river sharks when assessing the impact of proposed activities in the marine environment.	7.5
Mammals	Blue whale (includes pygmy blue whale)	Blue Whale Conservation Management Plan 2015 - 2025 (2015)	Noise	• Anthropogenic noise in distribution areas will be managed such that any blue whale continues to utilise the area without injury	6.4
			Habitat modification	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	6.4 – 6.9, 7.1 –7.5
			Vessel disturbance	• 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 whale distribution occurs and, if required, implement appropriate mitigation measures.	7.6

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Activity	EP Section
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015)	Pollution (persistent toxic pollutants)	• Implement measures to manage and reduce, where possible waste generation. • Reduce and, where possible, eliminate any adverse impacts of marine debris.	6.5 – 6.9, 7.1 – 7.5
			Vessel strike	• Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	7.6
			Habitat degradation	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	6.5 – 6.9, 7.1 – 7.5
	Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)	Noise Interference	• For actions involving acoustic impacts on humpback whale calving, resting, feeding areas, or confined migratory pathways site specific acoustic modelling should be undertaken (including cumulative noise impacts).	6.4
			Habitat degradation	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	6.5 – 6.9, 7.1 – 7.5
			Entanglement (marine debris)	• Reduce and, where possible, eliminate any adverse impacts of marine debris.	7.5
			Vessel Strike	• Ensure the risk of vessel strike on humpback whales is considered and, if required appropriate mitigation measures are implemented to reduce the risk of vessel strike. • All collisions with whales in Commonwealth waters are reported via the National Ship Strike Database.	7.6
	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015)	Pollution (persistent toxic pollutants)	• Implement measures to manage and reduce, where possible, waste generation.	6.8, 6.9, 7.1 – 7.5
			Vessel strike	• Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	7.6
			Habitat degradation including pollution (increasing port expansion and	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	6.5 – 6.9, 7.1 – 7.5

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Activity	EP Section
			coastal development)		
Reptiles	Green turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Deteriorating water quality	• Implement measures to manage and reduce, where possible waste generation.	6.6
			Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on marine turtles.	7.5
			Light pollution	• Manage artificial light from onshore and offshore sources to ensure biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue.	6.3
			Vessel disturbance	• Manage activities to ensure marine turtles are not displaced from identified Habitat Critical to the survival and biological important areas.	7.6
			Noise	• Manage activities to ensure marine turtles are not displaced from identified Habitat Critical to the survival and biological important areas.	6.4
	Hawksbill turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Deteriorating water quality	• Implement measures to manage and reduce, where possible, waste generation.	6.6
			Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on marine turtles.	7.5
			Light pollution	• Manage artificial light from onshore and offshore sources to ensure biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue.	6.3
			Vessel disturbance	• Manage activities to ensure marine turtles are not displaced from identified Habitat Critical to the survival and biological important areas.	7.6
			Noise	• Manage activities to ensure marine turtles are not displaced from identified Habitat Critical to the survival and biological important areas.	6.4
	Flatback turtle	Recovery plan for marine turtles in	Deteriorating water quality	• Implement measures to manage and reduce, where possible, waste generation.	6.6
			Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on marine turtles.	7.5

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Activity	EP Section
		Australia 2017 – 2027 (2017)	Light pollution	• Manage artificial light from onshore and offshore sources to ensure biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue.	6.3
			Vessel disturbance	• Manage activities to ensure marine turtles are not displaced from identified habitat critical to the survival and biological important areas.	7.6
			Noise	• Manage activities to ensure marine turtles are not displaced from identified Habitat Critical to the survival and biological important areas.	6.4
	Leatherback turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Deteriorating water quality	• Implement measures to manage and reduce, where possible, waste generation.	6.6
			Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on marine turtles.	7.5
			Light pollution	• Manage artificial light from onshore and offshore sources to ensure biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue.	6.3
			Vessel disturbance	• Manage activities to ensure marine turtles are not displaced from identified habitat critical to the survival and biological important areas.	7.6
			Noise	• Manage activities to ensure marine turtles are not displaced from identified Habitat Critical to the survival and biological important areas.	6.4
	Loggerhead turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Deteriorating water quality	• Implement measures to manage and reduce, where possible, waste generation.	6.6
			Marine debris	• Reduce and, where possible, eliminate any adverse impacts of marine debris on marine turtles.	7.5
			Light pollution	• Manage artificial light from onshore and offshore sources to ensure biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue.	6.3
			Vessel disturbance	• Manage activities to ensure marine turtles are not displaced from identified habitat critical to the survival and biological important areas.	7.6
			Noise	• Manage activities to ensure marine turtles are not displaced from identified Habitat Critical to the survival and biological important areas.	6.4

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Activity	EP Section
	Short-nosed seasnake	Commonwealth Conservation Advice on *Aipysurus apraefrontalis* (short-nosed seasnake) (2011)	Degradation of reef habitat	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1, 7.3
Birds	Australian lesser noddy	Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (2015)	Habitat loss, disturbance and modification	• Manage disturbance at important sites when Australian lesser noddy are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5
	Bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica baueri* (bar-tailed godwit western Alaskan) (2016)	Habitat loss and degradation from pollution	• Manage disturbance at important sites when bar-tailed godwits are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Activity	EP Section
	Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (2015)	Habitat loss and degradation from pollution	• Manage disturbance at important sites when curlew sandpipers are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5
	Eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (2015)	Habitat loss and degradation from pollution	• Manage disturbance at important sites when eastern curlews are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5
	Northern Siberian bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica menzbieri* (bar-tailed godwit northern Siberian)(2016)	Habitat loss and degradation from pollution	• Manage disturbance at important sites when northern Siberian bar-tailed godwits are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5
	Red knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (2016)	Pollution/contamination impacts	• Implement measures to manage and reduce, where possible, waste generation.	6.6, 6.8
			Disturbance	• Manage disturbance at important sites when red knots are present.	7.6
			Habitat loss and degradation	• Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5

Taxa	Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Activity	EP Section
	Abbott's booby	Conservation advice *Papasula abbotti* Abbott's booby (northern Siberian) (2015)	Modification and destruction of breeding habitat	• Manage disturbance at important sites when Abbott's booby are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5
	Australian painted snipe	Approved Conservation Advice for *Rostratula australis* (Australian painted snipe) (2013)	Habitat loss, disturbance and modification	• Manage disturbance at important sites when Australian painted snipes are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5
	Common sandpiper, red knot, oriental plover, oriental pratincole, bar tailed godwit, common greenshank	Wildlife conservation plan for migratory shorebirds (2015)	Habitat degradation/ modification (oil pollution)	• Manage disturbance at important sites migratory shorebirds are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5

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Taxa	Common Name	Recovery Plan / Conservation Advice	Threats identified as relevant to the Activity	Requirements / advice relevant to the Activity	EP Section
	Great knot	Approved Conservation Advice for *Calidris tenuirostris* (great knot) (2016)	Habitat loss and degradation	• Manage disturbance at important sites when great knots are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5
	Greater sand plover	Approved Conservation Advice for *Charadrius leschenaultii* (greater sand plover) (2016)	Habitat loss and degradation from pollution	• Manage disturbance at important sites when greater sand plovers are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5
	Lesser sand plover	Approved Conservation Advice for *Charadrius mongolus* (lesser sand plover) (2016)	Habitat loss and degradation from pollution	• Manage disturbance at important sites when lesser sand plovers are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5
	Australian fairy tern	Approved Conservation Advice for *Sternula nereis nereis* (Australian fairy tern) (2011)	Habitat loss, disturbance and modification from pollution	• Manage disturbance at important sites when Australian fairy terns are present. • Implement measures to reduce adverse impacts of habitat degradation and/or modification.	7.1 – 7.5

3.2.3.1 Epibenthos in 86 to 94 m water depth

As described in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**), the North West Shelf Province Bioregion, in which the Operational Area is situated, supports low density benthic communities of bryozoans, molluscs and echinoids. Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) benthic habitat mapping found at depths of approximately 100 m across the breadth of the North West Shelf similar benthic habitats of a mix of riffled muddy sands together with gravel to pebble sized rubble, cobbles, boulders and some rock outcrops (Williams et al. 2010).

An RPS benthic habitat and community survey was conducted in 75 m to 138 m water depths and overlapped the operational area (**Figure 3-9**). The RPS survey (2019b) showed the benthic habitats across the operational area were broadly homogeneous and comprised of two main types- silt/sand sediment and low relief hard substrate habitats. Soft sediment habitats were more widespread and often supported by sparse to medium density tube worm communities where the sediments were finer and appeared more stable (not rippled by seabed currents). Areas of coarser bare sand were generally rippled, indicating they are being moved by seabed currents. These more mobile sediments tend to support less well-developed biotic assemblages.

Most of the area of soft sediment is underlain by a hard pavement reef. Where the reef is exposed, it has been colonised by epibiota. The epibiotic assemblages were dominated by filter-feeding organisms which is typical of the North West Shelf.

No high conservation significant ecological values, habitats, communities of species were identified and the habitats and communities within the Operational Area were very well represented in the local area and region (RPS, 2019b).

The Operational Area does not overlap benthic habitats relied on by sensitive species or habitats designated as Key Ecological Features.

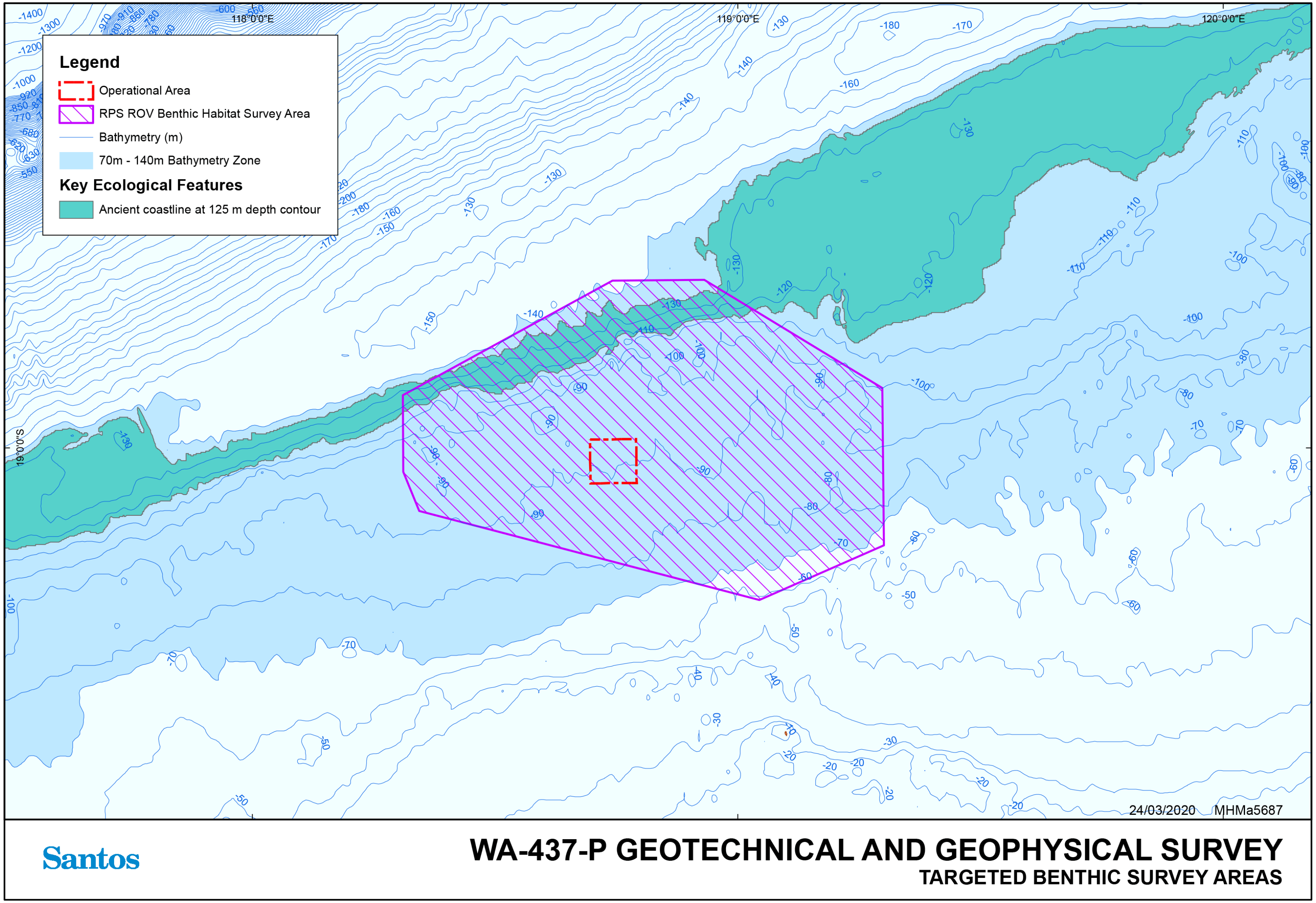

Figure 3-9: Targeted RPS (2019b) benthic habitat video survey area overlapping the Operational Area

3.2.3.2 Fish associated with the ancient coastline KEF

The ancient coastline at the 125 m depth contour KEF is situated approximately 16 km to the north of the Operational Area. As described in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**), the ancient coastline at the 125 m depth contour KEF is thought to provide areas of hard substrate that may contribute to higher biological diversity. The RPS benthic habitat and community surveyed (RPS, 2019b) the Ancient coastline in 125 m water depth KEF situated just north of the Operational area. The study found all sites surveyed had soft sediment habitats with sparse epibiotic communities similar to many other parts of the survey area. There were no records or benthic features, for example high profile reef with abundant fish of commercial or in particular conservation significance or importance to the ecology of the region.

Santos commissioned a study to describe the fishes associated with the ancient coastline at the 125 m depth contour KEF (RPS 2019a). Key findings from the survey in relation to the ancient coastline at the 125 m depth contour KEF were:

- A total of 643 fish from 39 species and 17 families were recorded across the 3 KEF study locations, with goldband snapper (*Pristipomoides multidens*) and yellow spotted rock cod (*Epinephelus areolatus*) being the only commercially important species observed at these locations on the KEF;
- No escarpment, complex relief, emergent bedrock or complex epibiota assemblages were recorded on video or observed on the vessel sounder at the KEF survey sites;
- Limited variation in fish assemblages of the KEF were observed between the three KEF study locations;
- Although within-site variability was high, abundances of fish species were low in the area, comprising relatively mobile demersal fish species; and
- The four most ubiquitous species were lunartail pufferfish (72% deployments), threadfin bream (67% deployments), longnose trevally (59% deployments) and giant trevally (47% deployments).

3.2.3.3 EPBC Act-listed Threatened and Migratory Fish Species

The BIAs for EPBC Act-protected fish and sharks are shown in **Figure 3-5**.

The whale shark foraging BIA overlaps with the Operational Area. 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 (Reynolds *et al*. 2017; Sleeman *et al*. 2007; Wilson *et al*. 2006). This migration route has been identified as a BIA which follows the 200 m isobath and extends from Ningaloo to waters in the north Kimberley region.

Aggregation timing of whale sharks at Ningaloo Reef is from March to June (Wilson *et al*. 2006). The small size and general absence of female whale sharks from Ningaloo Reef suggests that the region may be more important for feeding than breeding (Norman and Stevens 2007).

The BIA that overlaps the Operational Area represents waters where solitary whale sharks may forage during the migration from Ningaloo. This migration occurs primarily in Spring (September to November).

The EMBA also overlaps the foraging, pupping and nursing BIAs for dwarf sawfish, green sawfish and freshwater sawfish (**Figure 3-5**).

3.2.3.4 Conservation Dependent Fish Species

Two fish species listed as CD under the EPBC Act, the southern bluefin tuna (*Thannus maccoyli*) and the scalloped hammerhead shark (*Sphyra lewini*), have been identified in the EMBA but are not described in the *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**) document.

Southern Bluefin Tuna

The southern bluefin tuna occurs throughout waters 30–50 °S but mainly in the eastern Indian Ocean and south-western Pacific Ocean. In Australian waters, the species ranges from northern WA, around the southern coast to northern New South Wales. Spawning occurs in warm waters south of Java, to the north-west of the Operational Area (**Figure 3-10**), from August to April, with a peak during October-February (Honda *et al*. 2010). Following spawning, juveniles migrate south following the Western Australian coast, with juveniles commonly found in coastal waters off southern Australia during summer, and in deeper, temperate oceanic waters during winter (Phillips *et al*., 2009). Juveniles inhabit inshore waters (Honda *et al.* 2010) where they are thought to congregate at reefs, lumps and seamounts (Fujioka *et al*. 2010). Southern bluefin tuna may occur within the EMBA, particularly during summer/autumn when juveniles migrate southwards.

Scalloped Hammerhead Shark

The scalloped hammerhead shark is widely distributed in tropical and sub-tropical waters, primarily inhabiting shallow coastal shelfs. In Australia, the species ranges from Geographe Bay in WA, around the northern coast to Wollongong in New South Wales (Harry *et al*. 2011). Pupping has been reported year-round on the east coast of Australia, peaking during November and December, with juveniles remaining in shallow inshore habitats (Harry *et al*. 2011). The species is highly mobile but rarely ventures into deep offshore waters. Hammerhead sharks have been observed close inshore, even entering estuarine habitats, as well as offshore to depths up to 275 m. Accordingly, the hammerhead shark may in shallower depths of the EMBA but is not expected in the Operational Area. A recent study recorded five individuals on the ancient coastline at the 125 m depth contour KEF using Stereo baited remote underwater video system (SBRUVS) (See **Section 3.2.3.2**).

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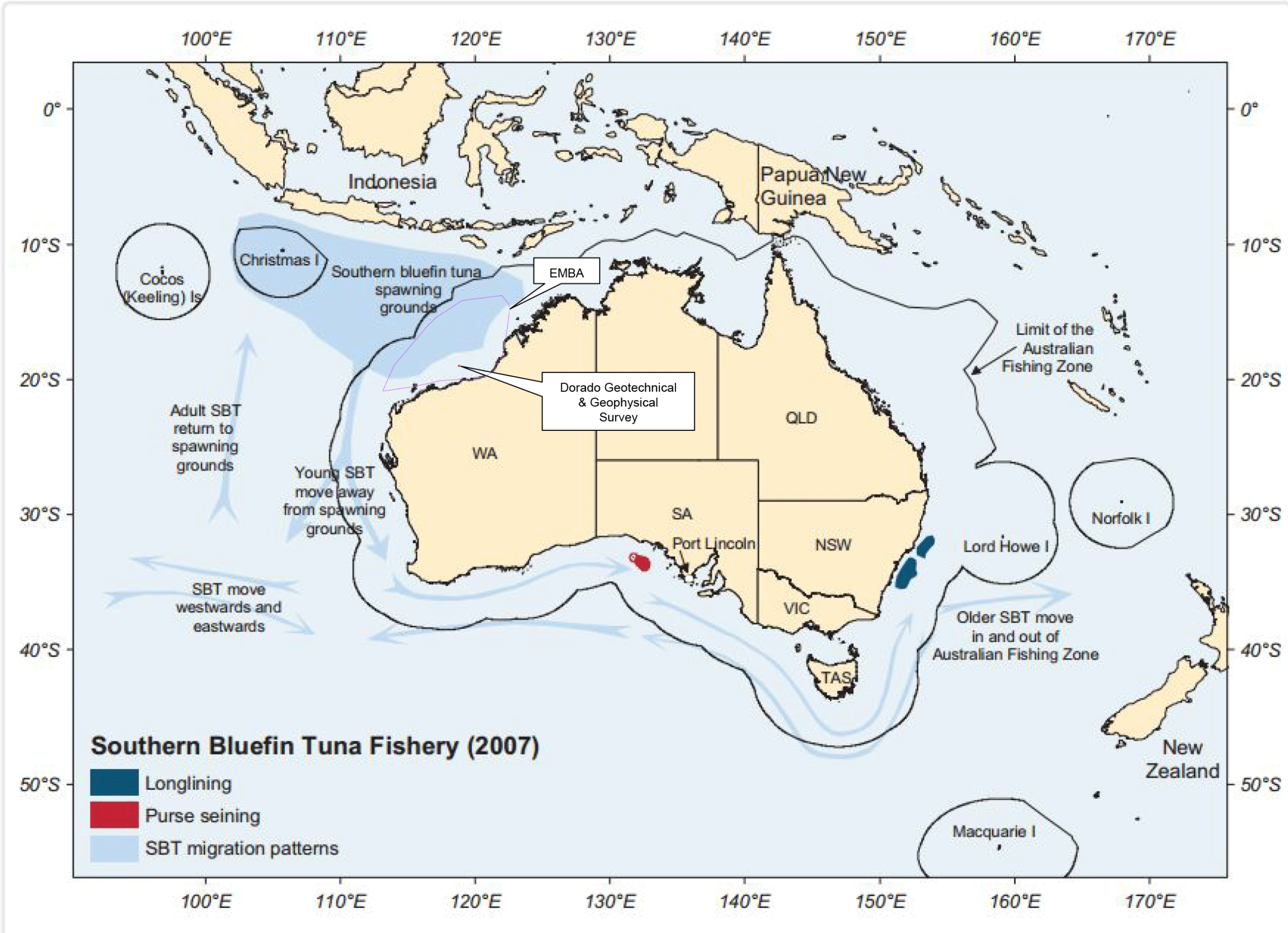

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WA-437-P GEOTECHNICAL AND GEOPHYSICAL SURVEY

SOUTHERN BLUEFIN TUNA SPAWNING GROUNDS

Figure 3-10: Indicative spawning grounds for the southern bluefin tuna

3.2.3.5 Humpback Whale Migration

Humpback whales traverse waters off the west coast of Australia as they migrate annually from summer feeding grounds in Antarctica to the nearshore waters of the Kimberley region where they breed and calve during winter. The waters up to 50 km along the coast of north-west WA are designated as a migration BIA (**Figure 3-6**). The humpback whale migration BIA is situated approximately 20 km to the south of the Operational Area. Characteristics of the northern and southern migrations are summarised in **Table 3-8**.

During the northbound migration, the data presented in Jenner *et al.* (2001) indicates the whales appear to remain within the 200 m isobath near the Montebello Island before moving closer to shore as they head further north to the calving grounds in the Kimberley. The humpback whale migration corridor is not an identified aggregation area or critical habitat; whales are in transit and are migrating from their southern polar 'summer' feeding grounds to their northern tropical 'winter' calving / breeding grounds.

The northern migration across the North West Shelf towards resting and calving grounds in the Kimberley region may occur from as early as June through to August and the southward migration from September to October, though actual timing of annual migration may vary by as much as 3 weeks from year to year due to food availability in the Antarctic (Jenner *et al.* 2001; Thums *et al*. 2018). Peak northward migration across the North West Shelf is identified from late July to early August, and peak southward migration from late August to early September. Data collected between 1995 and 1997 by the Centre for Whale Research indicates that the period for peak northern migration into the calving grounds in the Kimberley is mid to late July and the peak for southern migration from the Kimberley is in the first half of September.

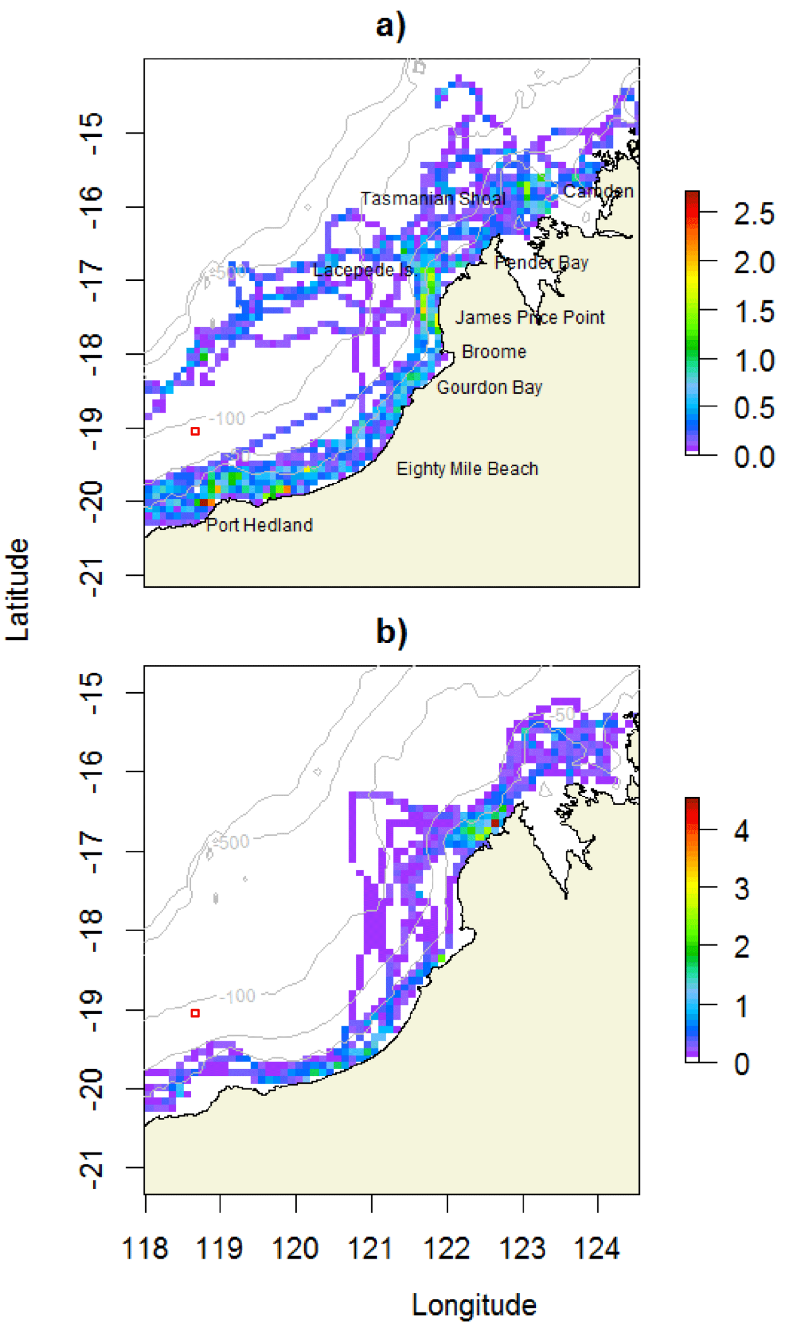
Based on migration data presented in Thums *et al.* (2018), migrating individuals will generally travel to the north and the south of the Operational Area (**Figure 3-11**). This migration data collected over 2008, 2009 and 2011 for tagged humpback whales shows no migration paths that overlap with the Operational Area (**Figure 3-11**). Whilst it is possible for a migrating individual to traverse the Operational Area the time spent within the area would likely be a matter of hours (i.e., <0.5 days; **Figure 3-11**).

Marine fauna sightings data was collected during a previous Santos seismic survey, between May and July 2019 included 42 confirmed sightings of humpback whales. The first sighting occurred on 8 June 2019. Occasional sightings of humpback whales were subsequently made every few days throughout June, becoming more frequent in late June and through to mid-July when multiple sightings were made most days. The final recorded humpback whale sighting was on 15 July 2019, following completion of the survey . Of all 42 humpback whale sightings, 38 were made at latitudes greater than 19˚S, which is south of the Operational Area and in water depths less than 90 m. The other four sightings were made to the north-west of the Operational Area in water depths of approximately 150 m or greater. These sightings are broadly consistent with the data presented in Jenner *et al.* (2001), Thums *et al.* (2018) and the basis for the migration BIA, where the majority of the migrating humpback population pass through these waters within approximately 100 km of the coast, with a relatively small number of animals passing further offshore (RPS 2019c).

Table 3-8: Key periods for migrating humpback whales in the vicinity of the Operational Area

Migrations	Description	Timing
Northbound migration: Port Hedland to Broome	Peaks July and tapers off by August (may vary by 3 weeks from year to year). Extends further from the coast compared to the southern migration, in water depths up to 200 m with the greatest number of animals in water depths of approximately 50 m (**Figure 3-11**).	Commences in June. Peaks in late July - Early August
Southbound migration: Broome to Port Hedland	Southerly migration in this area is contracted in a narrower band than the northerly migration route generally occurring closer to the coast within the 50 m isobath, and generally in waters less than 35 m deep (**Figure 3-11**).	Commences in August. Peaks late September - Early October

Migrations	Description	Timing
Note: This information has been sourced from Jenner *et al.* (2001); TSSC (2015a); DMP (2003); and Thums *et al.* (2018).		



Number of days spent by northbound (a) and southbound (b) humpback whales per 10 km × 10 km grid cell for the Kimberley Region, within proximity of the Dorado Geotechnical and Geophysical survey area, from tagged humpback whales from 2008, 2009 and 2011. (source Thums et al, 2018).

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NORTHBOUND AND SOUTHBOUND HUMPBACK WHALES MIGRATION DURATIONS (2008-2011)

Figure 3-11: Northbound (a) and southbound (b) humpback whales migration durations (2008-2011) in relation to the Operational Area (denoted by a red square) (Thums et al. 2018).

3.2.3.6 Pygmy Blue Whale Migration

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 slope, typically at depths between 500 m and 1,000 m on the way to grounds in the Banda and Molucca Seas near Indonesia, where calving is understood to occur (Double *et al.* 2012).

The northern migration passes the Perth Canyon from January to May and north bound animals have been detected off Exmouth and the Montebello Islands between April and August (Double *et al*. 2012, McCauley and Jenner 2010). During the southern migration, pygmy blue whales pass south of the Montebello Islands and Exmouth from October to the end of January, peaking in late November to early December (Double *et al*. 2012).

Tagging surveys have shown pygmy blue whales migrating northward past the North West Cape after which they travelled approximately 240 km offshore (Woodside 2012). During the southern migration, Gavrilov *et al*. (2018) found that pygmy blue whales tended to travel southward much further away from the coast, at distances of up to 400 km from shore.

The BIA for migrating pygmy blue whales is located approximately 103 km north-west of the Operational Area. A broader distribution BIA indicates where pygmy blue whales may also occur outside of the key migration route, which overlaps the Operational Area. Further, at the most northerly limit of the EMBA there is a pygmy blue whale foraging BIA in waters surrounding Scott reef (**Figure 3-6**).

Marine fauna sightings data collected during previous Santos surveys in the region between May and July 2019 did not include any confirmed pygmy blue whale sightings. This is likely due to the distance of the survey from the known migration route. Similarly, very few or no pygmy blue whales are expected to occur within the Operational Area (RPS 2019c).

3.2.3.7 Marine Turtles

The BIAs and Habitat Critical to the survival of turtles are shown in **Figure 3-7**. The EMBA overlaps with BIAs for flatback, green, hawksbill and loggerhead turtles. These turtle species and BIAs are described in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

The Operational Area does not intersect with any regional turtle BIAs, with closest Habitat Critical for survival approximately 75 km from Operational Area.

In the Kimberley and Pilbara regions of Western Australia, from approximately the Lacepede Islands to Exmouth, there is a mid-summer peak nesting season for flatback turtles. More specifically, nesting and inter-nesting in the Pilbara and south-west Kimberley stocks occurs between October and March with a peak period of December to January (DoEE, 2017). Flatback turtle hatchlings do not have an offshore pelagic phase. Instead, hatchlings grow to maturity in shallow coastal waters thought to be close to their natal beaches (DoEE, 2017).

Although turtles remain close to nesting beaches during the inter-nesting period, there is evidence that some flatback turtles undertake long-distance migrations between breeding and feeding grounds. A survey carried out in the region between 2005 and 2012 identified the distances 73 female flatback turtles travelled to their foraging grounds; 11 remained within 100 km of their rookeries, four migrated an average of 400 km and 58 migrated between 1,000 and 1,500 km (Pendoley *et al*. 2014).

3.2.3.8 Seabirds

The BIAs and Habitat Critical to the survival of seabirds are shown in **Figure 3-8**. The EMBA overlaps with BIAs for 11 seabirds species. These seabird species and BIAs are described in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

The Operational Area overlaps the breeding and foraging BIA for the lesser frigatebird. However, no key nesting, roosting or resting areas for this or any other species of bird are present within the Operational Area.

The closest nesting sites for the lesser frigate bird are located on Bedout Island which is approximately 65 km from the Operational Area.

3.2.4 Socio-economic

The section describes the socio-economic values within the EMBA being commercial fisheries, shipping, recreational fishing, oil and gas industry, tourism, cultural heritage, submarine cables and defence activities. As active and socio-economically important co-users of the marine environment within the Operational Area and surrounds, the focus of this section is on commercial fishers.

3.2.4.1 Commercial Fisheries

Commonwealth and Western Australian State-managed fisheries overlapping the EMBA are illustrated in **Figure 3-12** and **Figure 3-13** respectively.

Identification of relevant fisheries within the Bedout Sub-basin has been ongoing since 2008 through consultation with the WA Department of Primary Industries and Regional Development (DPIRD) and West Australian Fishing Industry Council (WAFIC). Further, Santos continually updates its understanding of the fisheries through reviews of annual status of the fishery reports published by DPIRD and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), other relevant fisheries management publications, and fishery catch and effort data (**Section 3.2.4.2**).

A review of available fishery management information for pelagic and demersal finfish fisheries indicated that whilst fisheries management measures includes annual quotas, and closure of specific areas all the time, none of the fisheries have specific time periods of closure for spawning/ aggregation.

Five Commonwealth-managed commercial fisheries have management areas that intersect with the EMBA, however, not all the fisheries are active within the full extents of the management areas. Based on historical fishing effort data (Patterson et al. 2019): Species for three Commonwealth fisheries may occur within the Operation Area but no active fishing within the Operation Area was identified (**Table 3-10**):

+ Western Tuna and Billfish Fishery (Cwlth);
+ Western Skip Jack (Cwlth); and
+ Southern Blue Fin Tuna (Cwlth).

3.2.4.2 FishCube Data

Santos requested annual catch and effort data (FishCube data) from DPIRD for fisheries understood to operate within or near to the operational area. Data was assessed for 60 nm x 60 nm and for 10 nm x 10 nm Catch and Effort System (CAES) blocks for the following:

+ Catch and effort data for the most recent 10 years (2009-2018, aggregated); Southern Blue Fin Tuna (Cwlth); and
+ Annual catch and effort data for each of the most recent 5 years (2014, 2015, 2016, 2017, 2018).

Due to confidentiality reasons, 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 year or less than three vessels over the complete six-year period). 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.

The FishCube database (DPIRD 2019) identified that three state fisheries had recent fishing effort recorded within the CAES blocks that overlapped the Operational Area. These fisheries are:

+ Pilbara Fish Trawl (Interim) Managed Fishery (WA);
+ Pilbara Line Fishery (WA); and
+ Pilbara Trap Managed Fishery (WA).

Table 3-9: FishCube Data Summary

Migrations	Description
Pilbara Fish Trawl (Interim) Managed Fishery (WA).	The Pilbara Fish Trawl (Interim) Managed Fishery overlaps WA-437-P geotechnical and geophysical Operational Area. According to the Fish Cube Data for 2009-2018 monthly fishing catch was recorded for every month between 2014-2018 with the only exception being 2016 where no monthly catch effort was recorded for the months of January, July, August and December. There is no particular pattern in fishing effort from year to year within the Operational Area.
Pilbara Line Fishery (WA).	The Pilbara Line Managed Fishery overlaps the Operational Area. According to the Fish Cube Data for 2009-2018 the data indicates the last monthly catch for the Pilbara Line Managed Fishery was in August 2016. The data indicates the Operational Area is not frequented by the Pilbara Line Fisheries.
Pilbara Trap Managed Fishery (WA).	The Pilbara Trap Managed Fishery overlaps the Operational Area. According to the Fish Cube Data for 2009-2018, fish catch was last recorded in 2018. According to the Fish Cube Data the Pilbara Trap Managed Fishery has no particular pattern in relation to fishing effort and is fished sporadically.

While the boundaries of several other fisheries overlap the Operational Area, no fishing effort in the Operational Area has been identified through review of historical fishing data. No pearl oyster licence holders are known or expected to dive in the Operational Area due to the water depth being too deep within the Operational Area for pearl oysters.

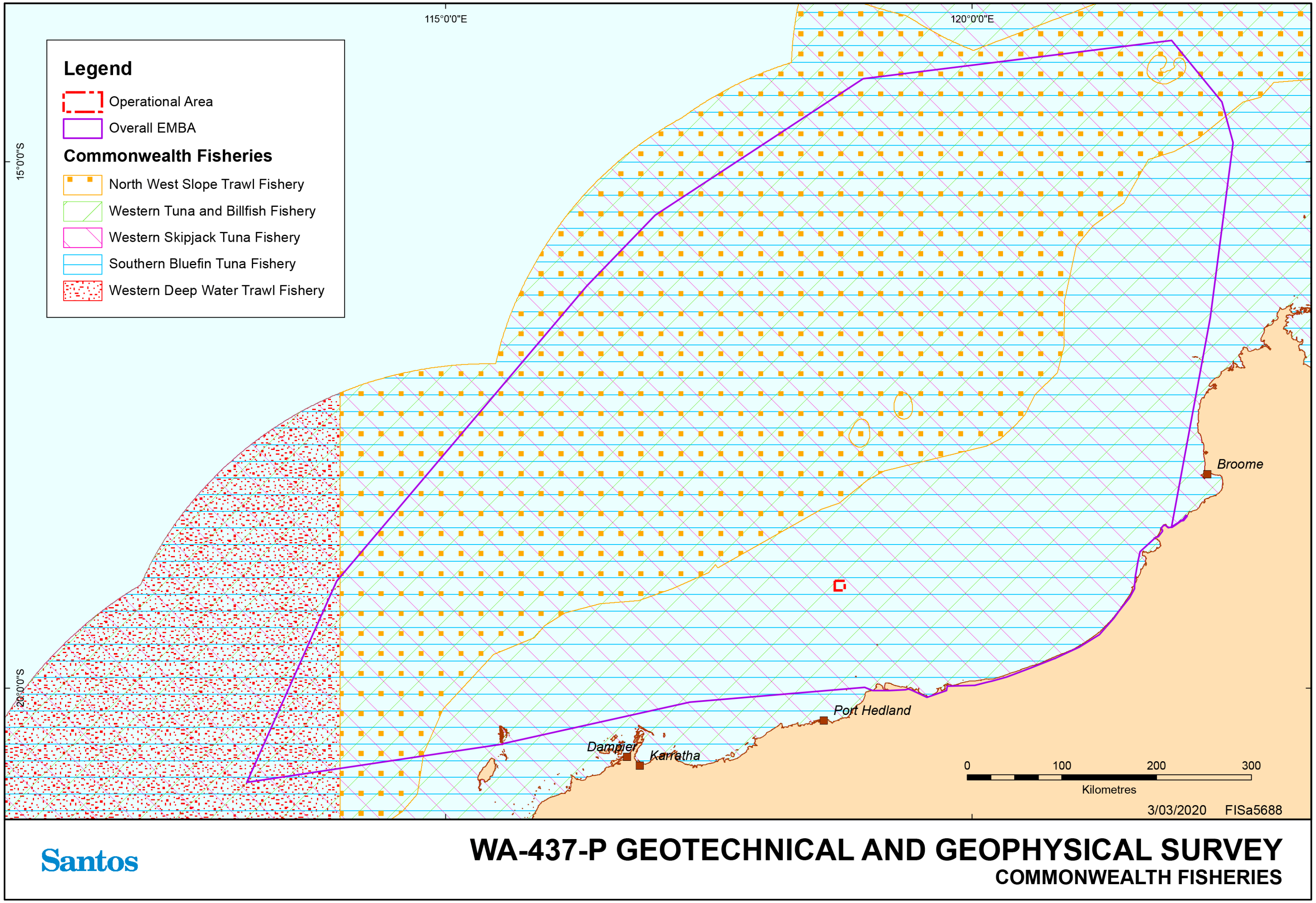

Figure 3-12: Commonwealth-managed fisheries within the EMBA

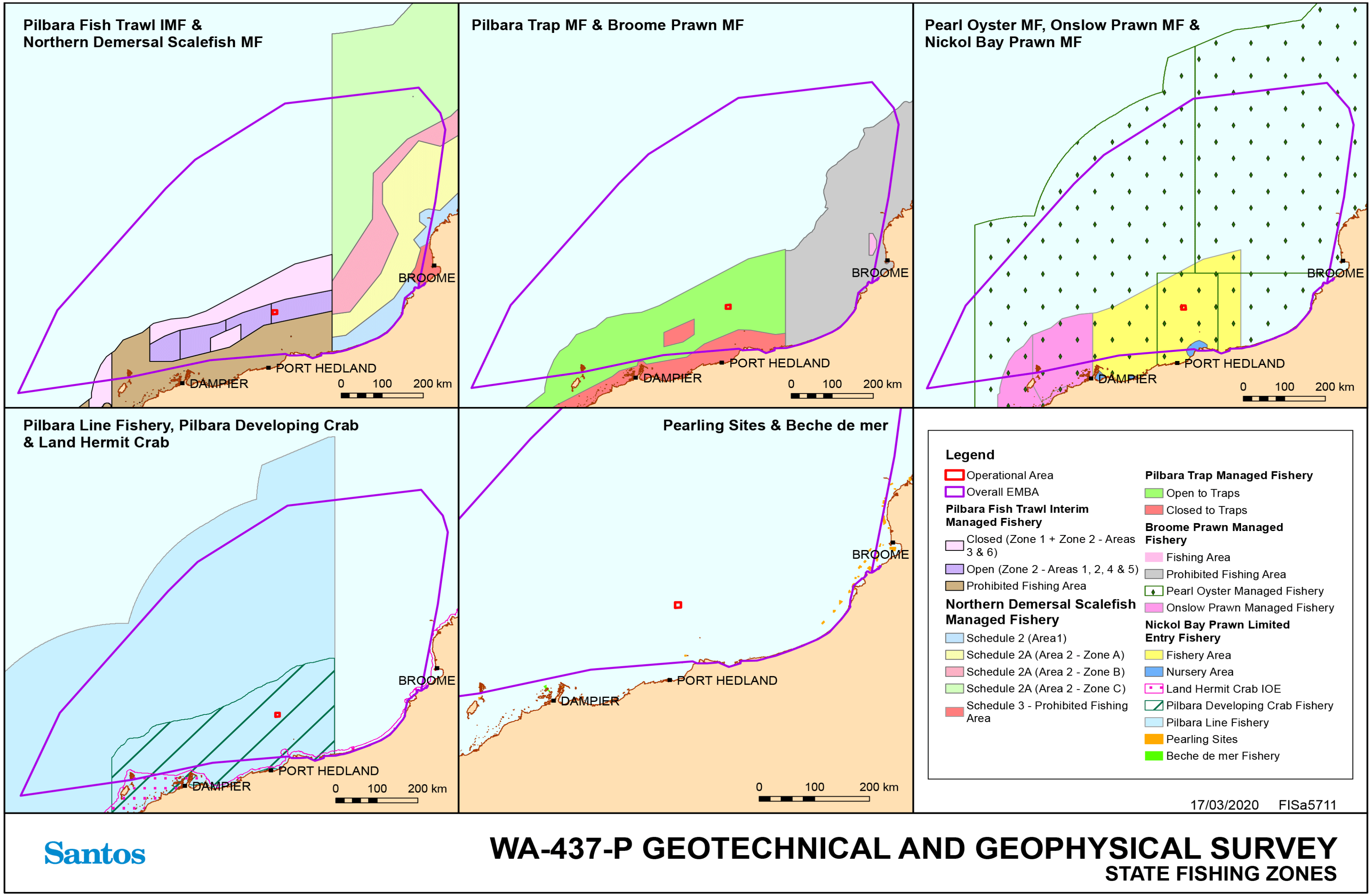

Figure 3-13: State-managed fisheries within the EMBA

Table 3-10: State-managed and Commonwealth-managed fisheries overlapping the Operational Area and EMBA

Fishery	Licence Area Description	Gear Types	Key Target / Indicator Species	Summary of Fishing Activities	Operational Area Presence	Relevant Events
Commonwealth-Managed Fisheries						
North West Slope Trawl Fishery Harte & Curtotti (2018) Patterson *et al*. (2018) Patterson *et al*. (2019) Mazioumi *et al*. (2020)	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ).	Deep water demersal trawling	• Australian scampi (*Metanephrops australiensis*) • Smaller quantities of velvet scampi (*M. velutinus*) and Boschma's scampi (*M. boschmai*) are also harvested. • Mixed deep-water snappers are also a component of the catch.	Fishing occurs on the continental slope in water depths greater than 200 metres (m). 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. Four fishing permits and two vessels were active in the fishery during the 2016-17 fishing season. Total catch in the 2016-17 fishing season was 57.8 tonnes over 114 days of fishing effort. Fishing effort increased in the 2017-2018 season. Total catch was 79.7 tonnes over 219 days.	No overlap of fishing activities with the Operational Area. The fishery occurs in the EMBA. Target species are most common on Globigerina ooze (deep sea muds rich in the shells of planktonic organisms) at depths of 420-500m.	Unplanned: - Hazardous and non-hazardous unplanned discharges - solid - Hazardous and non-hazardous unplanned discharges - liquid - Minor hydrocarbon release - MDO/MGO release from vessel collision - Spill response operations
Western Tuna and Billfish Fishery Williams *et al*. (2018)	The Western Tuna and Billfish Fishery covers the sea area west from the tip of Cape York in Queensland, around WA, 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 WA and South Australia. Between 2014 and 2018, 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).	There is no recent fishing effort within the EMBA or on the North West Shelf. Tuna and billfish may occur in the Operational Area.	None
Western Skipjack Fishery Australian Fisheries Management Authority (2019)	The Western Skipjack Tuna Fishery is located in all Australia waters west of 142° 30′ 00°E, out to 200 nm from the coast (Patterson *et al*., 2019).	Purse seine Some pole and line	Skipjack tuna (*Katsuwonus pelamis*)	There has been no fishing effort in the Skipjack Tuna Fishery since the 2009 season, and in that season, Activity concentrated off South Australia (Patterson *et al*. 2019). Fishing in the Skipjack Tuna Fishery is opportunistic, and highly dependent on availability and the domestic cannery market. Currently, no domestic cannery has active contracts for skipjack tuna.	No overlap of fishing activities with the Operational Area or EMBA. Target species may occur in Operational Area from time to time.	None

Fishery	Licence Area Description	Gear Types	Key Target / Indicator Species	Summary of Fishing Activities	Operational Area Presence	Relevant Events
Southern Bluefin Tuna Fishery Patterson et al (2019)	Fishery includes all waters of Australia, out to 200 nm from the coast. Young fish move from spawning grounds in the north-east Indian Ocean into the Australian EEZ and southward along the Western Australian coast (Patterson *et al*., 2019).	Purse seine Pelagic longline	Southern Bluefin tuna	Most of the Australian catch has been taken by purse seine, targeting juvenile tuna in the Great Australian Bight. Australian domestic longliners operating along the east coast catch some tuna and recreational fishing has increased (Patterson *et al*. 2019). No current effort on North West Shelf (NWS), fishing activity is concentrated in the Great Australian Bight and off South-east Australia (Patterson *et al*. 2019).	No overlap of fishing activities with the Operational Area or EMBA. Target species may occur in Operational Area from time to time.	None
Western Deepwater Trawl Fishery Mazloumi et al (2019)	The Western Deepwater Trawl Fishery (WDTF) operates in Commonwealth waters off the coast of WA between the western boundary of the Southern and Eastern Scalefish and Shark Fishery in the south (115°08'E) and the western boundary of the North West Slope Trawl Fishery (NWSTF) in the north (114°E). There have been recent changes to the boundary of this fishery to more closely align with the 200 m isobath.	Demersal trawl	Key target species: • orange roughy • oreos • boarfish • eteline and apsiline snapper • sea bream	Total fishing effort was comparatively low between 2005–06 and 2016–17. Only three vessels were active in 2017–18, trawl-hours increased markedly to just over 1,100 hours. Total catch had been relatively low in recent years, consisting mostly of deepwater bugs, with minimal catch of finfish. However, catches increased in 2017–18, consisting mostly of ruby snapper, deepwater bugs and mixed fish.	No overlap of fishing activities with the Operational Area or EMBA.	None
State-Managed Fisheries						
Pilbara Fish Trawl Interim Managed Fishery (PFTIMF) Newman *et al*. (2017a)	The PFTIMF is situated in the Pilbara region in the north-west of Australia. It occupies the waters north of latitude 21°35’S and between longitudes 114°9’36”E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath. The Fishery consists of two zones; Zone 1 in the south west of the Fishery (which is closed to trawling) and Zone 2 in the north, which consists of six management areas, Areas 1 to 6. Areas 1, 2, 4 and 5 are open to trawl fishing all year round. The total area of these areas is 6,900 nm^2 (23,666 km^2).	Demersal trawl	Bluespotted emperor (*Lethrinus punctulatus*) Red emperor (*Lutjanus sebae*) Rankin cod (*Epinephelus multinotatus*) Goldband snapper (*Pristipomoides multidens*) Other demersal snapper, emperor, cod and grouper species are also caught.	In 2018, the total catch for the PTIMF was 1,975 tonnes, making up 75% of the total catch by the Pilbara Demersal Scalefish Fisheries (PDSF), comprising the trawl, trap and line fisheries. In the 2018 season, there were 11 licences in this fishery held by four licence holders. According to FishCube data up to four vessels were active during the 2018 season. Fishing occurs year-round.	Fishing activity and target species may occur within the Operational Area.	<u>Planned:</u> - Interaction with other marine users - Noise emissions <u>Unplanned:</u> - Hazardous and non-hazardous unplanned discharges - solid - Hazardous and non-hazardous unplanned discharges - liquid - Minor hydrocarbon release - MDO/MGO release from vessel collision - Spill response operations

Fishery	Licence Area Description	Gear Types	Key Target / Indicator Species	Summary of Fishing Activities	Operational Area Presence	Relevant Events
Pilbara Trap Managed Fishery (PTMF) Newman *et al.* (2017a)	The Pilbara Trap Managed Fishery lies north of latitude 21°44'S and between longitudes 114°9.6'E and 120°00'E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath.	Demersal fish traps	Bluespotted emperor (*Lethrinus punctulatus*) Red emperor (*Lutjanus sebae*) Rankin cod (*Epinephelus multinotatus*) Goldband snapper (*Pristipomoides multidens*) Other demersal snapper, emperor, cod and grouper species are also caught.	In the 2018 season, there were six licenses in the Pilbara Trap Fishery, held between two operators. According to FishCube data less than three vessels were active for majority of the season, with a third vessel active only in July. In 2018, the total catch for the PTMF was 562 tonnes, making up 21% of the total catch by the PDSF. Fishing occurs year-round.	Fishing Activity and target species may occur in the Operational Area. FishCube data for the last six years reports that a maximum of 3 vessels have operated in fishing blocks that overlap the Operational Area. Fishing effort occurs over an area of 86,006 km^2. The Operational Area overlaps with 100 km^2 (0.12%) of the area of fishing effort. Less than three vessels have operated in the Operational Area each year for the last six years.	Planned: - Interaction with other marine users - Noise emissions Unplanned: - Hazardous and non-hazardous unplanned discharges - solid - Hazardous and non-hazardous unplanned discharges - liquid - Minor hydrocarbon release - MDO/MGO release from vessel collision - Spill response operations
Pilbara Line Fishery (PLF) Newman *et al.* (2017a)	The PLMF fishing boat licensees are permitted to operate anywhere within "Pilbara waters", bounded by a line commencing at the intersection of 21°56'S latitude and the high water mark on the western side of the North West Cape on the mainland of WA; west along the parallel to the intersection of 21°56'S latitude and the boundary of the Australian Fishing Zone and north to longitude 120°E.	Demersal long line	Goldband snapper (*Pristipomoides multidens*) Ruby snapper (*Etelis carbunculus*) Other demersal snapper, emperor, cod and grouper species are also caught.	In the 2018 season there are nine individual licences in the Pilbara Line Fishery, held by seven operators. According to FishCube data less than three vessels were active during the season. The total catch in 2018 for the PLF was 95 tonnes, making up 4% of the total catch by the PDSF. Fishing occurs year-round.	Fishing activity and target species may occur within the Operational Area. FishCube data reports that less than three vessels have operated in fishing blocks that overlap the operational area each year for the last 5 years.	Planned: - Interaction with other marine users - Noise emissions Unplanned: - Hazardous and non-hazardous unplanned discharges - solid - Hazardous and non-hazardous unplanned discharges - liquid - Minor hydrocarbon release - MDO/MGO release from vessel collision - Spill response operations
Northern Demersal Scalefish Managed Fishery (NDSMF) Newman *et al.* (2008) Newman *et al.* (2017a)	The Northern Demersal Scalefish Managed Fishery licence area includes waters off the north-west coast of 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 (nm)). 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 m depth contour and is further subdivided into Zones A, B and C.	Fish traps. Handlines and droplines also permitted in the fishery.	Red emperor (*Lutjanus sebae*) Goldband snapper (*Pristipomoides multidens*) 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 m water. Most catch occurs in Zone B of Area 2. Fishing occurs year-round. Vessels in the fishery operate out of Broome and 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. Traps are typically set for 4-5 hours or left overnight before being pulled. Eight vessels operated in the fishery between 2013 and 2015, reducing to seven vessels 2015 and 2017.	No overlap of fishing activities with the Operational Area. The fishery occurs in the EMBA.	Unplanned: - Hazardous and non-hazardous unplanned discharges - solid - Hazardous and non-hazardous unplanned discharges - liquid - Minor hydrocarbon release - MDO/MGO release from vessel collision - Spill response operations

Fishery	Licence Area Description	Gear Types	Key Target / Indicator Species	Summary of Fishing Activities	Operational Area Presence	Relevant Events
Mackerel Managed Fishery **(Area 2 – Pilbara)** Lewis and Brand-Gardner (2017) Mackie *et al*. (2010)	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 Operational Area overlaps Area 2 – Pilbara sector.	Primarily surface or mid-water trolling by line. Jigging methods are also used.	Spanish mackerel (*Scomberomorus commerson*) 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 nearshore waters with fishing effort occurring in water depths of <60 m. The fishery operates year-round, however, most fishing effort occurs from April/May to October/November. In the Pilbara sector, approximately 65% of effort has historically occurred from July to August. The commercial catch of Spanish mackerel from all sectors of the fishery has been 270-330 tonnes per year since 2006.	Fishing activity and target species may occur in the Operational Area. FishCube data reports that less than three vessels have operated in fishing blocks that overlap the Operational Area each year for the last 5 years.	Planned: - Interaction with other marine users - Noise emissions Unplanned: - Hazardous and non-hazardous unplanned discharges - solid - Hazardous and non-hazardous unplanned discharges - liquid - Minor hydrocarbon release - MDO/MGO release from vessel collision - Spill response operations
Pearl Oyster Fishery Hart *et al*. (2018) Hart *et al*. (2019)	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 (200nm). The licence area is subdivided into four zones. 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.	Drift diving in waters up to 35 m depth	Indo-Pacific, silver-lipped pearl oysters (*Pinctada maxima*).	Drift diving, with divers towed behind vessels, allows collection of legal-sized pearl oysters from the seabed by hand. 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. 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 principal fishing grounds, holding sites and pearl farms are in waters off Eighty Mile Beach and Broome. A single approved pearl farm lease is located near North Turtle Island and pearl diving activities have previously occurred in coastal waters near Port Hedland and the De Grey river mouth.	The Operational Area occurs within the boundaries of Zone 2 of the fishery. Pearl diving activities are not expected due to the restriction of pearl diving operational activities to shallow diving depths below 35 m. The Operational Area lies in water depths of approximately 86 m to 94 m.	Unplanned: - MDO/MGO release from vessel collision - Spill response operations
Nickol Bay Prawn Managed Fishery (NBPMF) Kangas *et al*. (2017)	The boundaries of the NBPMF are all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120°east longitude on the landward side of the 200 m isobath. The NBPMF incorporates the Nickol Bay, Extended Nickol Bay, Depuch and De Grey size-managed fish grounds.	Trawl	Banana prawns Brown tiger prawns	The total landings of major penaeids for the 2017 season were 227.1 tonnes. Fishing effort in 2017 increased to 281 boat days, well up on the low effort of 43 boat days in 2016 (Kangas *et al*., 2017).	FishCube data reports did not record any fishing effort in fishing blocks that overlap the Operational Area. Target species are predominantly found in shallow, turbid nearshore waters.	Unplanned: - MDO/MGO release from vessel collision - Spill response operations

Fishery	Licence Area Description	Gear Types	Key Target / Indicator Species	Summary of Fishing Activities	Operational Area Presence	Relevant Events
Broome Prawn Kangas *et al*. (2017)	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'.	Trawl	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.	No overlap between the fishery and the Operational Area. The fishery occurs in the EMBA.	Unplanned: - MDO/MGO release from vessel collision - Spill response operations
Onslow Prawn Kangas *et al*. (2017)	The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200 m depth isobath'.	Trawl	Brown tiger prawns Banana prawns	The total landings in 2017 were negligible. Only 5 days of fishing effort was undertaken (one boat) in 2017.	No overlap between the fishery and the Operational Area. The fishery occurs in the EMBA.	Unplanned: - MDO/MGO release from vessel collision - Spill response operations
WA North Coast Shark Fishery (WANCSF) Department of Fisheries (2005)	The WANCSF include Australian waters north of Broome, from longitude 120° E to 123°45' E (Koolan Island).	Long line	Dusky whaler shark Sandbar shark Gummy shark Whiskery shark	This fishery is currently closed to protect the breeding grounds of the resource which support the two southern shark fisheries. No fishing effort since 2008/09.	The fishery is currently closed. Target species may occur within the Operational Area.	None
Pilbara Crab Managed Fishery (PDCMF) Johnston *et al*. (2017)	The boundaries of the PDCMF are consistent with the boundaries of the NBPMF and Onslow Prawn Fishery, which includes waters between 114°39.9' E and 120° E, and on the landward side of the 200 m depth isobath.	Traps	Blue swimmer crab	Crabbing Activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational Activity occurring in and around Nickol Bay. Blue swimmer crabs are targeted by the PDCMF within inshore waters around Nickol Bay using hourglass trap (Gaughan and Santoro, 2018).	FishCube data shows no fishing effort within the Operational Area. Consultation with WAFIC has indicated that while they do mostly fish nearshore (less than 50 m of water) they may venture into deeper waters.	Unplanned: - MDO/MGO release from vessel collision - Spill response operations
Marine Aquarium Fish Managed Fishery (MAFMF) Newman *et al*. (2018a)	The MAFMF can operate in all State waters (between the Northern Territory border and South Australian border).	Hand collection, diving	Various species of fish, coral, algae, seagrass and invertebrates	The fishery is typically more active in waters south of Broome with higher levels of effort around the Capes region, Perth, Geraldton, Exmouth and Dampier.	Activities in the Operational Area are unlikely due to the depth and the dive-based method of collection. FishCube data shows no fishing effort within the Operational Area.	Unplanned: - MDO/MGO release from vessel collision - Spill response operations

Fishery	Licence Area Description	Gear Types	Key Target / Indicator Species	Summary of Fishing Activities	Operational Area Presence	Relevant Events
Specimen Shell Managed Fishery Hart *et al*. (2019)	The fishing area includes all Western Australian waters between the high-water mark and the 200 m isobath.	Hand collection, wading, diving in shallow coastal waters. One licence exemption permits the use of ROV.	Various shells	The main method of specimen shell collection is by hand, by a small group of divers operating from small boats in shallow coastal waters or by wading along coastal beaches below the high-water mark. A current Exemption permits the use of a remote-controlled underwater vehicle at depths of up to 300 m. This is a limited entry fishery with 23 active licences in 2016. A maximum of 2 divers are allowed in the water per licence at any one time and specimens may only be collected by hand. Remotely operated vehicles were limited to one per license in 2016.	Specimen shell collection activities with ROV may potentially occur in the Operational Area but are unlikely. FishCube data shows no fishing effort within the Operational Area.	Planned: - Interaction with other marine users - Noise emissions Unplanned: - Hazardous and non-hazardous unplanned discharges - solid - Hazardous and non-hazardous unplanned discharges - liquid - Minor hydrocarbon release - MDO/MGO release from vessel collision - Spill response operations
Beche-de-mer Fishery Gaughan *et al*. (2018)	The beche-de-mer fishery is permitted to operate throughout Western Australian waters except for a number of specific closures around the Dampier Archipelago, Cape Keraudren, Cape Preston and Cape Lambert, the Rowley Shoals and the Abrolhos Islands.	Hand collection, diving	Sandfish (*H. scabra*) Redfish (*A. echinites*)	Sea cucumbers (also known as bêche-de-mer or trepang) are collected by hand by divers and waders in shallow waters throughout the Kimberley region as part of the Bêche-de-Mer Fishery (State of the Fisheries 2016-17). The Western Australian beche-de-mer fishery is primarily based in the northern half of the State, from Exmouth Gulf to the Northern Territory border, however fishers do have access to all Western Australian waters not specifically closed to fishing (Gaughan & Santoro, 2018).	No Activity within the Operational Area. Target species are unlikely to occur in the Operational Area due to the water depths.	Unplanned: - MDO/MGO release from vessel collision - Spill response operations
Hermit Crab Fishery Newman *et al*. (2018a)	The HCF is permitted to fish WA waters north of Exmouth Gulf (22° 30'S).	Land-based hand collection	Australian land hermit crab (*Coenobita variabilis*)	Activity is land based and occurs on beaches along large areas along the Western Australian coastline.	No fishing Activity or target species in the Operational Area.	Unplanned: - MDO/MGO release from vessel collision - Spill response operations
Kimberley Gillnet and Barramundi Managed Fishery Newman *et al*. (2018b)	The KGBF includes all WA waters north of 19° south latitude and west of 129° east longitude and within three nm of the high-water mark of the mainland of WA and the waters of King Sound south of 16°21.47´ S.	Gillnet and other	Barramundi (*Lates calcarifer*)	The fishery operates in the nearshore and estuarine waters of the Kimberley. It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi by any means.	No fishing Activity or target species in the Operational Area.	Unplanned: - MDO/MGO release from vessel collision - Spill response operations
Abalone Managed Fishery Strain *et al*. (2018)	The fishery covers all Western Australian coastal waters, which are divided into 8 management areas.	Hand collection, diving	Roe's abalone Brownlip abalone Greenlip abalone	Abalone are collected by hand in shallow coastal waters in the south-west of WA. The target species do not occur in tropical waters. The management area covering waters north of Moore River (near Perth) is closed.	No fishing Activity or target species in the Operational Area or EMBA.	None

Fishery	Licence Area Description	Gear Types	Key Target / Indicator Species	Summary of Fishing Activities	Operational Area Presence	Relevant Events
South West Coast Salmon Fishery Smith and Grounds (2018)	The fishery includes all WA waters north of Cape Beaufort (south coast) except Geographe Bay.	Seine net	Australian salmon	The South West Coast Salmon Managed Fishery operates on various beaches south of the metropolitan area.	No fishing Activity or target species in the Operational Area or EMBA.	None
West Coast Deep Sea Crustacean Managed Fishery How and Orme. (2015)	The boundaries of this fishery include all the waters lying north of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150m isobath out to the extent of the Australian Fishing Zone.	Fish traps	Crystal crab (*Chaceon albus*)	Fishing effort and the target species occurs on the west and south coasts of WA, primarily in water depths of 400–900 m.	No fishing Activity or target species in the Operational Area or EMBA.	None

3.2.4.3 Other Socio-Economic Receptors

Other socio-economic considerations, such as shipping (**Figure 3-14**), recreational fishing, oil and gas industry, tourism, and cultural heritage, submarine cables and defence activities, in relation to the Operational Area and EMBA are summarised in **Table 3-11**. More detailed descriptions of socio-economic considerations are provided in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**).

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Table 3-11: Socio-economic receptors within the EMBA

Value/Sensitivity	Description	Operational Area Presence	Relevant events within the Operational Area	Relevant events within the EMBA
Shipping	The Operational Area is situated between two designated shipping fairways, the northern shipping fairway is approximately 12.53 km from the Operational Area and the southern shipping fairway is approximately 6.53 km from the Operational Area(**Figure 3-19**). These shipping fairways service Port Hedland. Commercial shipping using NWS waters includes iron ore carriers, oil and LNG tankers and other vessels proceeding to or from the ports of Dampier, Port Walcott, Port Hedland, Barrow and Varanus islands, and Onslow. Large cargo vessels carrying freight bound or departing from Fremantle also transit along the WA coastline heading north and south in deeper waters.	x	None	Unplanned Marine gas oil released from a vessel collision within the Operational Area Spill response operations
Recreational and charter boat fishing	Santos has consulted for all previous activities in the Bedout Basin. No comments were received following consultation for this activity. Previous consultation with Recfishwest identified that recreational fishing often occurs around the Port Hedland port marker buoys. In consultation with the Port Hedland Game Fishing Club and Port Hedland Volunteer Marine Rescue, it was identified that recreational fishing Activity may occur 50 nm offshore, with some locals targeting game fish up to the 50 m water depth and the area surrounding Bedout Island. Therefore, no interaction with recreational fishers is anticipated in the Operational Area but may occur in EMBA. Within the North Coast bioregion as a whole, recreational fishing is experiencing growth, with a distinct seasonal peak in winter when the local population increases significantly. Increased recreational fishing has also been attributed to those involved in the construction or operation of developments within the region.	x	None	Planned Noise emissions Unplanned Marine gas oil released from a vessel collision within the Operational Area Spill response operations
Indigenous, subsistence or customary fishing	Indigenous marine users or customary fishing could occur in the Operational Area. However, no interactions with traditional fishers has been recorded during previous activities conducted by Santos in adjacent Operational Areas.	x	None	None
Oil and gas activities	The area of the NWS is a major oil and gas hub in Australia, with several companies operating on the NWS. The Activity occurs in a particularly isolated	x	None	None

Value/Sensitivity	Description	Operational Area Presence	Relevant events within the Operational Area	Relevant events within the EMBA
	area of the NWS with respect to the main oil and gas operational and exploratory fields. There are currently no existing facilities in the Operational Area. The nearest operating facility is Woodside's Angel oil field and associated infrastructure, located approximately 240 km west of the Operational Area. Exploration Activity, such as seismic surveys and exploration drilling, could occur within and surrounding the Operational Area over the life of this EP.			
Tourism	Santos was advised during consultation for previous activities in the Bedout Basin, and within this permit (Keraudren Survey, Santos 2019) that there is no offshore tourism industry that operates from Port Hedland, unlike other North West towns like Exmouth and Broome. A low level of recreational diving may occur in the waters surrounding Bedout Island.	x	None	<u>Planned</u> Noise emissions <u>Unplanned</u> Marine gas oil released from a vessel collision within the Operational Area Spill response operations
Cultural heritage	A search of the online aboriginal heritage Inquiry system was undertaken along shoreline areas within the EMBA from the Montebello Islands, along the coastline to Broome and then north to the Lacepede Islands. The search identified 30 registered aboriginal heritage sites protected under the *Aboriginal Heritage Act 1972* as potentially occurring along the coastal margins of the EMBA. These sites may include artefacts, engraving sites or other ceremonial sites; however, are not likely to be impacted in a spill scenario. The listed sites, mapping and supporting reports are provided in **Appendix C**. Another search of the online aboriginal heritage inquiry system in the same shorelines areas identified 11 other heritage places in the EMBA. These sites may include water source, or mythological uses. Similarly, these sites are not	x	None	None

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Value/Sensitivity	Description	Operational Area Presence	Relevant events within the Operational Area	Relevant events within the EMBA
	likely to be impacted in a spill scenario. The listed sites, mapping and supporting reports are provided in **Appendix C**. One identified 'other Heritage place' is Bedout Island, which is located 96 km north-east of Port Headland and 65 km south of the Operational Area, within the EMBA. The Island is a nature reserve and an Important Bird Area (IBA) as classified by BirdLife International (2018), supporting significant breeding colonies of seabirds. There are no historic shipwrecks or sunken aircraft (older than 75 years) located within the Operational Area. There are however 25 historic shipwrecks located in the EMBA, the closest being the twin-screw steamer Koombana which sunk in 1912,and is located approximately 39 km south of the Operational Area. There is also one sunken aircraft located in the EMBA off Eighty Mile Beach, the Dornier Do-24 X-36 (1942), located approximately 264 km east of the Operational Area.			
Communications	Two optical submarine telecommunication cables traverse the EMBA and are situated approximately 10 km to the west of the Operational Area (Figure 3-15**).** These are the Underwater Cable System (JASURAUS) system that connects Port Hedland to Jakarta and the North West Cable System (NWCS) which connects offshore oil and gas facilities in the Browse, Bonaparte and Carnarvon Basins to onshore locations.	x	None	<u>Unplanned</u> Marine gas oil released from a vessel collision within the Operational Area Spill response operations
Defence	No designated defence areas overlap the Operational Area as shown in **Figure 3-16.**The nearest RAAF bases are the Curtin RAAF base located approximately 454 km north-east and the Learmonth RAAF base located approximately 580 km south-west. Additionally, there are two training and practice areas located near the Learmonth Base, approximately 380 km (training area) and 530 km (practice area) south-west of the Operational Area. These overlap with the most western portion of the EMBA.	x	None	<u>Unplanned</u> Marine gas oil released from a vessel collision within the Operational Area Spill response operations

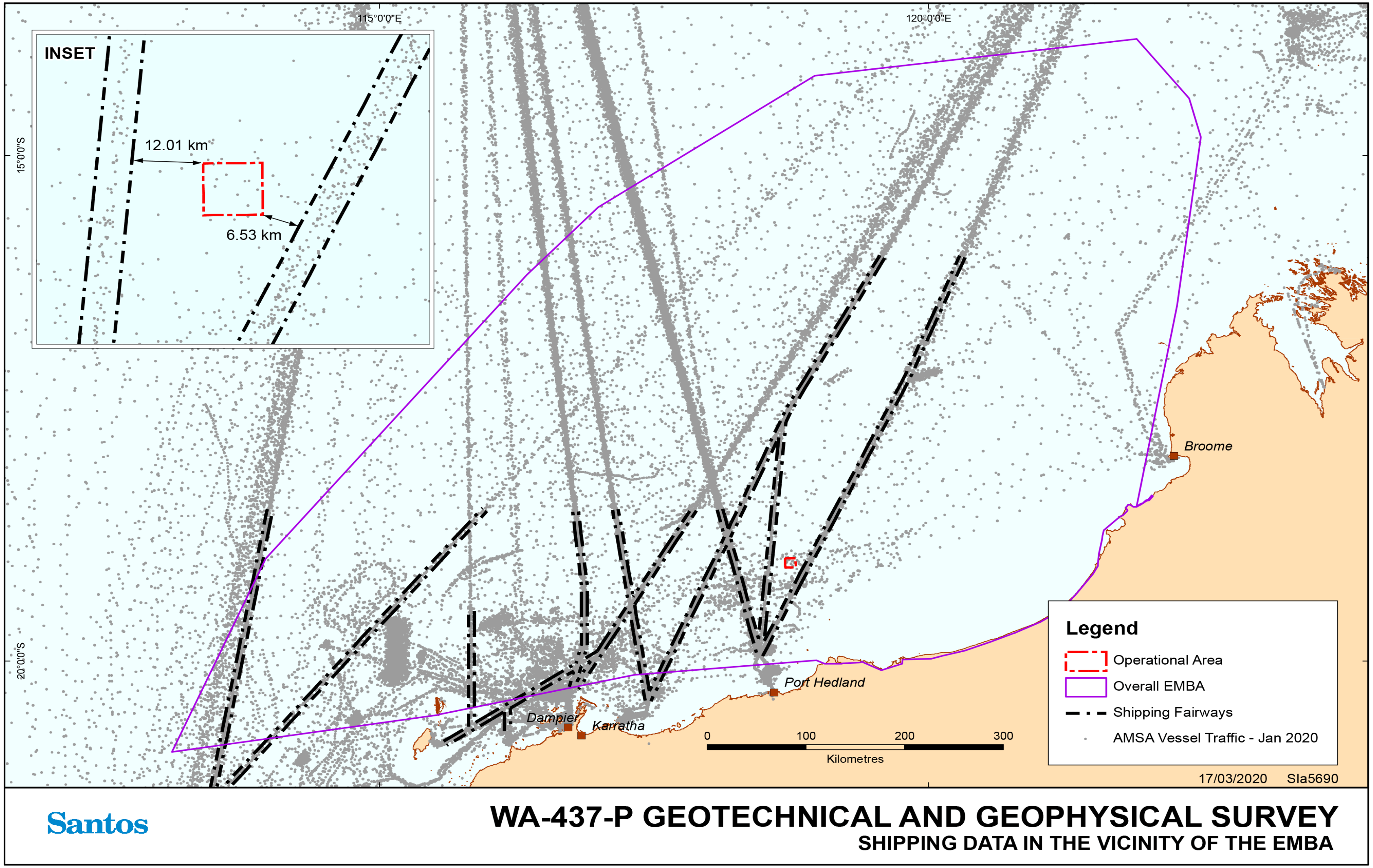

Figure 3-14: Australian Maritime Safety Authority (AMSA) vessel traffic and shipping fairways within the EMBA

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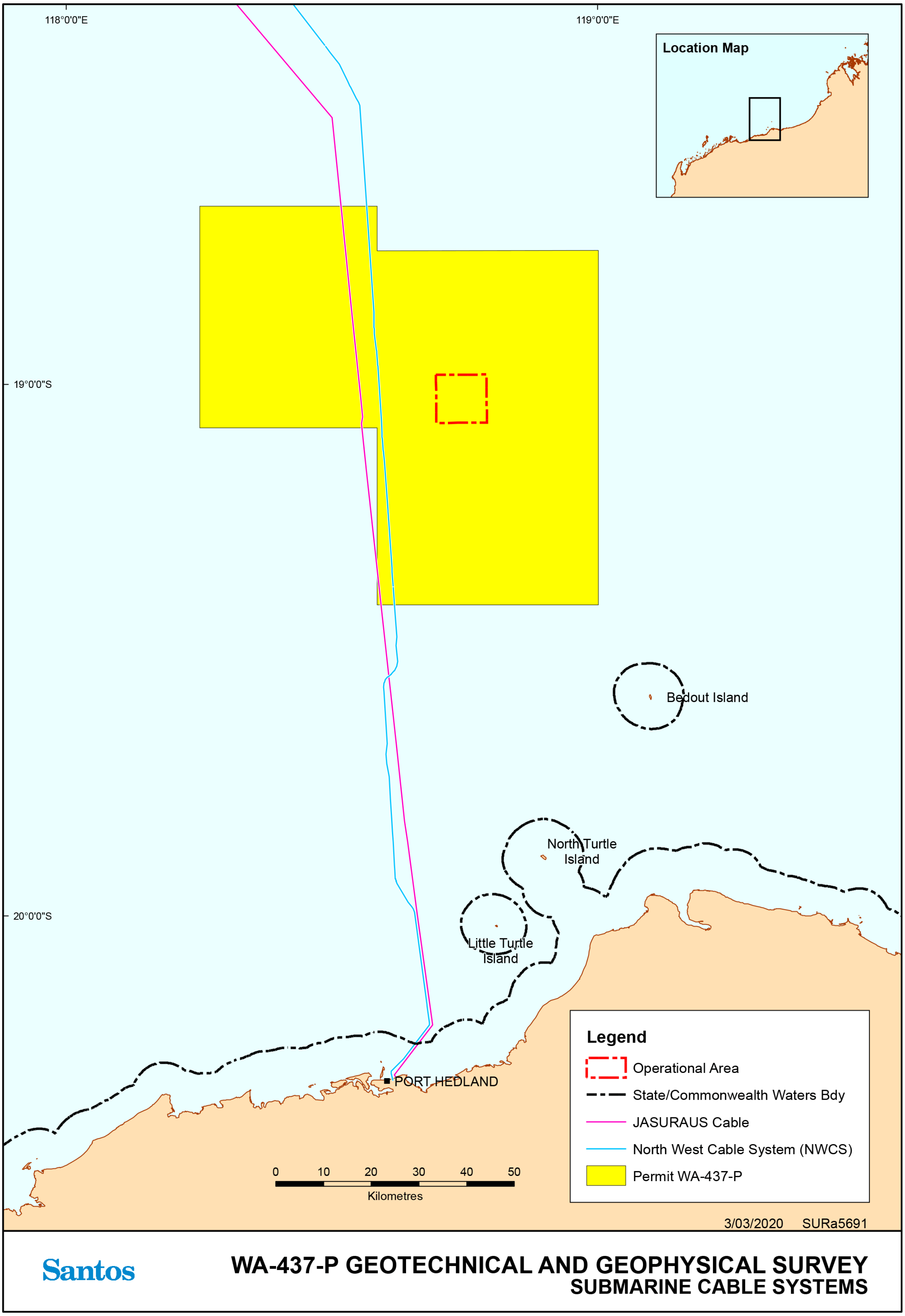

Figure 3-15: Location of the North West Cable System and JASURAUS cable

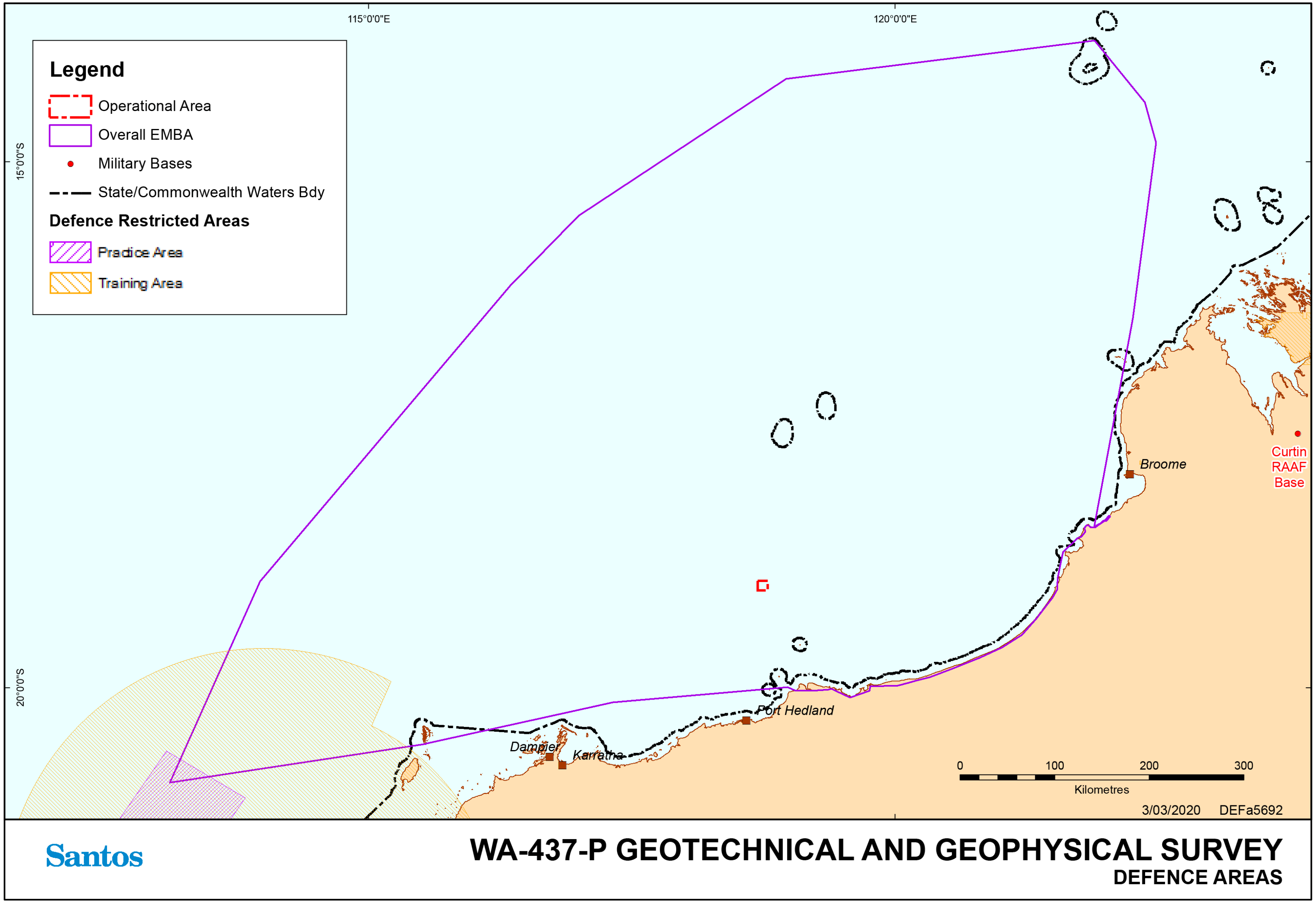

Figure 3-16: Defence areas in the vicinity of the Operational Area

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3.2.5 Periods of Peak Sensitivity or Activity

Timing of peak sensitivity or Activity for threatened species and other relevant, significant sensitivities is provided in **Table 3-12.**

Table 3-12: Periods of peak sensitivity or Activity windows of sensitivity for the EMBA

Categories	Receptors (critical life cycle stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Activity timing													
Physical environment and habitats	Coral (spawning periods)												
	Macroalgae	Growing			Shedding fronds					Growing			
	Other benthic habitats												
	All shoreline habitats												
Protected / significant areas	Protected Areas												
Commercial fish species	Goldband snapper peak spawning												
	Pink snapper peak spawning (Rare within North Coast Bioregion and overlap with the Operational Area)												
	Rankin cod peak spawning												
	Red emperor peak spawning												
	Spanish mackerel peak spawning												
	Pearl oyster spawning												
	Bluespotted Emperor												
	Dusky whaler pupping[6]	May occur throughout year											
	Whiskery shark pupping[7]												
	Blacktip shark (Australian) pupping												
	Sandbar shark pupping												
	Gummy shark pupping	Peak pupping periods unknown											
	Fish – other species	Timing of spawning Activity varies between species											
	Sharks												

Categories	Receptors (critical life cycle stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Activity timing													
Threatened and migratory Marine Fauna	Whale shark – level of Activity for the EMBA, not region			Aggregations at Ningaloo Coast				Post-aggregation foraging and migration					
	Marine Mammals												
	Humpback whale (migration at Port Hedland - Broome)[5]												
	Pygmy blue whale migration				Northern							Southern	
	Marine Reptiles												
	Hawksbill turtles resident adult and juveniles[1]	Widespread throughout NW Shelf waters, highest density of adults and juveniles over hard bottom habitat (coral reef, rocky reef, pipelines etc.)											
	Hawksbill turtle (mating aggregations[1])												
	Hawksbill turtle (nesting and internesting[1])												
	Hawksbill turtle (hatching[1])												
	Flatback turtles (resident adult and juveniles[1])	Widespread throughout NW Shelf waters, increased density over soft bottom habitat 10 – 60m deep, post hatchling age classes and juveniles spread across shelf waters											
	Flatback turtle (mating aggregations[1])												
	Flatback turtle (nesting and internesting[1])												
	Flatback turtle (hatching[1])												
	Green turtles (resident adult and juveniles[1])	Widespread throughout the NW Shelf waters, highest density associated with seagrass beds and macro algae communities, high density juveniles in shallow waters off beaches, amongst mangroves and in creeks											
	Green turtle (mating aggregations[1])												
	Green turtle nesting and internesting[1])												
	Green turtle (hatching[1])												
	Loggerhead turtles (resident adult and juveniles[1])	Widespread throughout the NW Shelf waters, increased density associated with soft bottom habitat supporting their bivalve food source, juveniles associated with nearshore reef habitat											
	Loggerhead turtle (mating aggregations[1])												

Categories	Receptors (critical life cycle stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Activity timing													
	Loggerhead turtle (nesting and internesting[1])												
	Loggerhead turtle (hatching[1])												
	Leatherback turtles												
	Seabirds												
	Lesser frigatebird breeding												
	Brown booby breeding												
	Tern breeding												
Conservation Dependent Fauna	Southern bluefin tuna												
	Scalloped hammerhead shark (East Coast)												
Socioeconomic receptors	**Commercial Managed Fisheries**												
	North West Slope Trawl Fishery												
	State Managed Fisheries												
	Pearl Oyster Managed Fishery												
	Mackerel Managed Fishery[4]												
	All other fisheries												
	Oil and gas												
	Shipping												
	Tourism/recreational[4]												
	Communications	NWCS and JASUARUS cable presence											

	Peak Activity, presence reliable and predictable	[1] Information provided by K. Pendoley and DoEE 2017
	Lower level of abundance/Activity/presence	[2] No Activity in NW Marine Region
	Activity not occurring	[3] No recent Activity in Australia

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Categories	Receptors (critical life cycle stages)		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Activity timing														
		Activity can occur throughout year	[5] Location and Estimated Period of Humpback Whale Activity in WA (DMP, 2003)											
			[6] Last, P.R.; Stevens, J.D. (2009). Sharks and Rays of Australia (second ed.). Harvard University Press. pp. 269–270.											
			[7] Simpfendorfer, C. & Unsworth P. (1998) Reproductive biology of the whiskery shark, *Furgaleus macki*, off south-western Australia. *Marine and Freshwater Research* 49(7) 687 - 793											

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4. Stakeholder Consultation

OPGGS(E)R 2009 Requirements
Regulation 9AB
If the Regulator's provisional decision under regulation 9AA is that the environment plan includes material apparently addressing all the provisions of Division 2.3 (Contents of an environment plan), the Regulator must publish on the Regulator's website as soon as practicable: (a) the plan with the sensitive information part removed; and (b) the name of the titleholder who submitted the plan; and (c) a description of the Activity or stage of the Activity to which the plan relates; and (d) the location of the Activity; and (e) a link or other reference to the place where the accepted offshore project proposal (if any) is published; and (f) details of the titleholder's nominated liaison person for the Activity.
Regulation 16
16 The environment plan must contain the following: (b) a report on all consultations under regulation 11 A of any relevant person by the titleholder, that contains: (i) a summary of each response made by a relevant person; and (ii) an assessment of the merits of any objection or claim about the adverse impact of each Activity to which the environment plan relates; and (iii) a statement of the titleholder's response, or proposed response, if any, to each objection or claim; and (iv) a copy of the full text of any response by a relevant person.

4.1 Summary

Santos has been active in the Bedout Sub-basin since exploration drilling activities commenced in 2014, and up until 2019 has drilled nine exploration wells in permits WA-435-P and WA-437-P including Phoenix South 1, 2 and 3 wells, Roc-1 and Roc-2 wells, Dorado-1, 2 and 3 wells and Roc South-1 well. Additional exploration activities include the Keraudren 3D MSS undertaken by Santos in July 2019, and the proposed Keraudren Extension 3D MSS (currently under assessment with NOPSEMA).

With this history, Santos is familiar with local community stakeholders and other users of the marine environment in the region. Stakeholders **(Table 4-1**) were informed of activities covered in this EP via several channels of engagement commencing in February 2020, including:

+ WA-437-P Geotechnical & Geophysical Survey Consultation package distributed to identified stakeholders, and
+ WA-437-P Geotechnical & Geophysical Survey Consultation package for Commercial Fishers distributed to identified fishing licence holders.

Based on Santos' experience with previous EPs, and from subsequent stakeholder feedback and regulator discussions, the primary stakeholder issue of concern for this Activity is:

+ interaction with other marine users and commercial fishers addressed in **Section 6.1**.

Santos has considered all stakeholder responses and assessed the merits of all objections and claims about the potential impact of the proposed Survey. The process adopted to assess these claims is outlined in **Section 4.4**. A summary of Santos' response statements to the objections and claims is provided in **Table 4-2.**

Santos considers that consultation with relevant stakeholders has been adequate to inform the development of this EP. Notwithstanding this, Santos recognises the importance of ongoing stakeholder consultation and notification and these are described in **Table 8-3.**

4.2 Stakeholder Identification

Santos understands retaining a broad licence to operate depends on the development and maintenance of positive and constructive relationships with a comprehensive group of stakeholders in the community, government, non-government, other business sectors and other users of the marine environment. Fostering effective consultation between Santos and relevant stakeholders is an important part of this process.

Santos began the stakeholder identification process for this EP with a review of its stakeholder database, including stakeholders consulted for other recent activities in the area. The list of stakeholders was then reviewed and refined based on the defined Operational Area (**refer to Section 2.2**), the EMBA (**refer to Section 3.1**) and the relevance of the stakeholder according to Regulation 11A of the (OPGGS (E) Regulations) 2009 and NOPSEMA Bulletin #2 Clarifying statutory requirements and good practice consultation (November, 2019). More specifically, stakeholders for this EP were identified through the following:

+ Regular review of legislation applicable to petroleum and marine activities;
+ Identification of marine user groups and interest groups active in the area (e.g., commercial fisheries, other oil and gas producers, merchant shipping, etc.);
+ A review of the DPIRD FishCube data;
+ Updated fishing licence holder contact details, from these identified fisheries, as provided by DPIRD;
+ Utilisation of the WAFIC Oil and Gas consultation services to advise on 'relevant' commercial fisheries and fishers, and to review and distribute fishery-specific consultation material;
+ Discussions with identified stakeholders to identify other potentially impacted persons;
+ Active participation in industry bodies and collaborations (e.g., APPEA, Australian Marine Oil Spill Centre (AMOSC), NERA); and
+ Records from previous consultation activities in the area, including previous Bedout Basin drilling activities, Keraudren 3D MSS and consultation for proposed Keraudren Extension MSS.

Currently identified stakeholders and an assessment of their relevance under the OPGGS (E) Regulations for the purposes of consultation for this Activity are listed in **Table 4-1.**

Table 4-1: Assessment of relevance of identified stakeholders for the proposed Activity

Stakeholder	Relevant to Activity	Relevance / Reason for Engagement
Commonwealth government departments/agencies		
Australian Hydrographic Office (AHO)	Considered relevant persons under Regulation 11A(1) (a)	The AHO is the part of the Commonwealth Department of Defence (DoD) responsible for maintaining and disseminating nautical charts, including the distribution of Notice to Mariners. The Operational Area is in commonwealth waters.
Australian Maritime Safety Authority (AMSA)	Considered relevant persons under Regulation 11A(1) (a)	AMSA is the statutory and control agency for maritime safety and vessel emergencies in Commonwealth Waters. AMSA is a relevant agency when proposed offshore activities may impact on the safe navigation of commercial shipping in Australian waters. The Operational Area is in commonwealth waters.

Department of Defence (DoD)	Considered relevant persons under Regulation 11A(1) (a)	DoD is a relevant agency where the proposed Activity may impact operational requirements; encroach on known training areas and/or restricted airspace, or when nautical products or other maritime safety information is required to be updated. The Operational Area is in commonwealth waters.
Australian Fisheries Management Authority (AFMA)	Considered relevant persons under Regulation 11A(1) (a)	AFMA is responsible for managing Commonwealth fisheries and is a relevant agency where the Activity has the potential to impact on fisheries resources in AFMA managed fisheries. The Operational Area intersects with commonwealth managed fisheries.
Department of Agriculture and Water Resources (DAWR) – Biosecurity (marine pests)	Considered relevant persons under Regulation 11A(1) (a)	The DAWR (marine pests) has primary policy and regulatory responsibility for managing biosecurity for incoming goods and conveyances, including biosecurity for marine pests. The Department is the relevant agency where an offshore Activity has the potential to transfer marine pests between installations and mainland Australia. The Operational Area is in commonwealth waters.
Department of Agriculture and Water Resources (DAWR) – Fisheries	Considered relevant persons under Regulation 11A(1) (a)	DAWR (fisheries) has primary policy responsibility for promoting the biological, economic and social sustainability of Australian fisheries. The Department is the relevant agency where the Activity has the potential to negatively impact fishing operations and / or fishing habitats in Commonwealth waters. The Operational Area intersects with commonwealth managed fisheries.
Department of Agriculture and Water Resources (DAWR) – Biosecurity (vessels, aircraft and personnel)	Considered relevant persons under Regulation 11A(1) (a)	DAWR (vessels and aircraft) has inspection and reporting requirements to ensure that all conveyances (vessels, installations and aircraft) arriving in Australian territory comply with international health regulations and that any biosecurity risk is managed. The department is the relevant agency where the titleholder's Activity involves: • the movement of aircraft or vessels between Australia and offshore petroleum activities either inside or outside Australian territory • the exposure of an aircraft or vessel (which leaves Australian territory not subject to biosecurity control) to offshore petroleum activities.
Director of National Parks (DNP)	Considered relevant persons under Regulation 11A(1) (a)	The DNP is the statutory authority responsible for administration, management and control of Commonwealth marine reserves (CMRs). The Director of National Parks is a relevant person for consultation where: • the Activity or part of the Activity is within the boundaries of a proclaimed Commonwealth marine reserve; • activities proposed to occur outside a reserve may impact on the values within a Commonwealth marine reserve; and / or • an environmental incident occurs in Commonwealth waters surrounding a Commonwealth marine reserve and may impact on the values within the reserve. The Operational Area is approximately 48km south-east of the Eighty Mile Beach Australian Marine Park.
State government departments / agencies		

Department of Transport (DoT)	Considered relevant persons under Regulation 11A(1) (b)	DoT is the control agency for marine pollution emergencies in State waters.
Department of Primary Industries and Regional Development (DPIRD)	Considered relevant persons under Regulation 11A(1) (b)	DPIRD is responsible for managed West Australian State fisheries. The Operational Area intersects with state managed fisheries.
Department of Biodiversity, Conservation and Attractions (DBCA)	Considered relevant persons under Regulation 11A(1) (b)	DBCA is a relevant State agency responsible for the management of State marine parks and reserves and protected marine fauna and flora. The Operational Area is approximately 121 km to the northwest of the closest state marine reserves (Eighty Mile Beach).
Department of Mines, Industry Regulation and Safety (DMIRS)	Considered relevant persons under Regulation 11A(1) (c)	Department responsible for the management of offshore petroleum in the adjacent State waters.
Industry bodies		
Western Australian Fishing Industry Council (WAFIC)	Considered relevant persons under Regulation 11A(1) (e)	WAFIC is the peak industry body representing the interests of the WA commercial fishing, pearling and aquaculture sector. The Operational Area intersects with State-managed fisheries.
Commonwealth Fisheries Association (CFA)	Considered relevant persons under Regulation 11A(1) (e)	The CFA was engaged as a representative body for Commonwealth fisheries. The Operational Area intersects with several Commonwealth-managed fisheries. The CFA is also listed on the AFMA website as a contact for petroleum operators to use when consultation with fishing operators is required.
Marine Tourism WA (MTWA)	Considered relevant persons under Regulation 11A(1) (e)	MTWA represents the charter sector in WA. Charter fishing may occur within the proposed area of Activity. MTWA is identified as being able to assist in reaching its membership to inform them of survey timing should this be requested.
Pearl Producers Association (PPA)	Considered relevant persons under Regulation 11A(1) (e)	The PPA is the peak representative organisation of The Australian South Sea Pearling Industry. PPA membership includes all *Pinctada maxima* pearl oyster licensees that operate within the Australian North-west Bioregion. The PPA has requested, via WAFIC, all information on behalf of their stakeholders.
Recfishwest	Considered relevant persons under Regulation 11A(1) (e)	Recfishwest is the peak body representing recreational fishers in WA. Recreational fishing may occur within the proposed area of Activity. Recfishwest is identified as being able to assist in reaching its membership to inform of survey timing should this be requested.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Considered relevant persons under Regulation 11A(1) (e)	ASBTIA represents the Australian SBT industry. ASBTIA is also listed on the AFMA website as a contact for petroleum operators to use when consultation with Commonwealth fishing operators is required.
Community / Port Hedland		
Town of Port Hedland	Considered relevant persons under Regulation 11A(1) (e)	Port Hedland is the nearest community to Santos' WA-437-P permit. The Town of Port Hedland is the local government body for the region.
Pilbara Port Authority	Considered relevant persons under Regulation 11A(1) (e)	Pilbara Ports Authority manages port land at Dampier, Port Hedland, Ashburton and Cape Preston East, and facilitates the

		development of land and leases to support port-related industries. Port Hedland is the nearest port to the Activity.
Port Hedland Game Fishing Club (PHGFC)	Considered relevant persons under Regulation 11A(1) (e)	The PHGFC was identified as a potentially relevant stakeholder as recreational fishing may occur within the proposed area of Activity. PHGFC is identified as being able to assist in reaching its membership to inform of survey timing should this be requested.
GT Diving	Considered relevant persons under Regulation 11A(1) (e)	Suggested as potentially relevant stakeholder with information regarding recreational diving activities offshore Port Hedland.
Care for Hedland	Considered relevant persons under Regulation 11A(1) (e)	Port Hedland-based Non-government Organisation (NGO). Focused primarily on turtle conservation, with an interest in whales. Santos has chosen to consult with as part of informing good environmental management practices.
Commercial fisheries		
Mackerel Managed Fishery (Area 2)	Considered relevant persons under Regulation 11A(1) (d)	Based on consultation with WAFIC, the Mackerel Managed Fishery (Area 2) boundary overlaps the proposed Operational Area and is therefore potentially impacted by the Activity and should be consulted. On advice from WAFIC, engagement is up to 100 metre water depth.
Pilbara Line Fishery	Considered relevant persons under Regulation 11A(1) (d)	Based on consultation with WAFIC, the Pilbara Line Fishery boundary overlaps the proposed survey Operational Area and is therefore potentially impacted by the Activity and should be consulted.
Pilbara Trap Managed Fishery	Considered relevant persons under Regulation 11A(1) (d)	Based on consultation with WAFIC, the Pilbara Trap Managed Fishery boundary overlaps the proposed Operational Area and is therefore potentially impacted by the Activity and should be consulted.
Pilbara Fish Trawl Interim Managed Fishery	Considered relevant persons under Regulation 11A(1) (d)	Based on consultation with WAFIC, the Pilbara Fish Trawl Interim Managed Fishery boundary overlaps the proposed Operational Area and is therefore potentially impacted by the Activity and should be consulted.

4.3 Stakeholder Consultation

The approach to stakeholder consultation for this EP follows the process adopted by Santos for all its EPs. Some modifications to this approach have been made based on feedback from WAFIC, commercial fishers and NOPSEMA. These include:

+ Providing more detailed information to commercial fishers, targeted to their fishery, in the initial consultation packs;
+ Engaging WAFIC to assist in the review and distribution of commercial fisher consultation material;
+ Refinements to the stakeholder identification process to clearly identify and maintain current lists of ‘relevant’ persons, and
+ Clearly documenting and tracking notification commitments to relevant persons.

Key stakeholders were contacted prior to providing the WA-437-P Geotechnical & Geophysical Survey Consultation package to increase Activity awareness and to encourage two-way communication. Stakeholders, wherever possible, were provided personal emails with information tailored to their functions, interests and activities, including outlining why they have been identified as a relevant stakeholder.

The consultation package contains details such as an Activity summary, location map, coordinates, water depth, distance to key regional features, vessel exclusion zone details and estimated timing and duration. This consultation package outlined potential risks and impacts together with a summary of proposed management control measures. Stakeholders were encouraged to provide feedback on the proposed Activity.

Individual fishing licence holders, identified in consultation with WAFIC, were provided the *WA-437-P Geotechnical & Geophysical Survey Information for Commercial Fishers* consultation package by email (and one by post).

Commercial fishers were provided additional information which included:

+ Maps and information relevant to a specific fishery;
+ Information about the timing and duration of the survey, and
+ Information on Operational Area access and concurrent operations.

The intent of providing this level of information early in the consultation process was to facilitate each party proceeding with their business in a safe and efficient manner, and to minimise the extent of interruption by the Activity on commercial fishing operators' to the lowest practicable level.

Stakeholders were afforded at least four weeks to review consultation packs, although Santos accepted stakeholder feedback after this period.

Table 4-2 Consultation summary for Activity

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td colspan="3">Commonwealth departments/agencies</td></tr>
<tr><td rowspan="3">Australian Hydrographic Office (AHO)</td><td colspan="2">AHO was provided the WA-437-P Geotechnical & Geophysical Survey consultation package via email on 28 February 2020.
AHO acknowledged receipt of information 28 February 2020.
No formal response has been received from the AHO.
AHO notification requirements, as requested by AMSA (refer to below), are addressed in Table 8-2.
AHO has previously requested notification once Activity commences, as addressed in Table 8-2.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="2">Australian Maritime Safety Authority (AMSA)</td><td colspan="2">AMSA was provided the WA-437-P Geotechnical & Geophysical Survey consultation package via email on 28 February 2020.
AMSA responded on 28 February 2020 advising:
the Master should notify AMSA’s Joint Rescue Coordination Centre (JRCC) for promulgation of radio-navigation warnings at least 24-48 hours before operations commence. JRCC will also need to be advised when operations start and end [REQUEST 001].
Santos should contact the AHO at no less than four working weeks before operations, with details relevant to the operations. The AHO will promulgate the appropriate Notice to Mariners (NTM), which will ensure other vessels are informed of activities [REQUEST 002].
to obtain a vessel traffic plot showing Automatic Identification System (AIS) traffic data for your area of interest, please visit AMSA’s spatial data gateway and Spatial@AMSA portal to download digital data sets and maps [INFORMATION 001].
Santos responded to AMSA on 30 March 2020 confirming AMSA's requirement will be addressed in the EP, and provided the section reference in the EP.

Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	[REQUEST 001] Santos will notify AMSA's JRCC at least 24–48 hours before operations commence for each survey and advise when operations start and end. Notification requirements are addressed in **Table 8-2**, CM-1.	Santos responded to AMSA confirming JRCC notification requirements have been addressed in **Table 8-2**,**Table 8.3** CM-1 of the EP.
	[REQUEST 002] Santos will notify the AHO no less than four working weeks before operations commence. Notification requirements are addressed in **Table 8-2**, CM-1.	Santos responded to AMSA confirming AHO notification requirements have been addressed in **Table 8-2**, CM-1 of the EP.
	[INFORMATION 001] Santos notes the information provided on traffic data.	Santos responded to AMSA and noted the information provided.
Department of Defence (DoD)	DoD was provided the *WA-437-P Geotechnical & Geophysical Survey* Consultation package via email on 28 February 2020. This stakeholder has previously requested continued liaison with AHO, to ensure the AHO is notified prior to the actual commencement of activities. Notification requirements are addressed in **Table 8-2** No formal response has been received from the DoD. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Australian Fisheries Management Authority (AFMA)	AFMA was provided the *WA-437-P Geotechnical & Geophysical Survey* Consultation package via email on 28 February 2020. No formal response received from AFMA. AFMA has previously advised it is important to consult with all fishers who have entitlements to fish within the proposed survey area. This can be done through the relevant fishing industry associations or directly with fishers who hold entitlements in the area. Santos has consulted directly with relevant fishers and fishing industry associations as outlined in Table 4-2. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Department of Agriculture and Water	The department was provided the *WA-437-P Geotechnical & Geophysical Survey* Consultation package via email on 28 February 2020. No formal response has been received from the Department.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Resources (DAWR) – Biosecurity (vessels, aircraft and personnel)</td><td colspan="2">Santos has addressed biosecurity requirements in section 7.7.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Department of Agriculture and Water Resources (DAWR) – Biosecurity (marine pests)</td><td colspan="2">The department was provided the WA-437-P Geotechnical & Geophysical Survey Consultation package via email on 28 February 2020.
No formal response has been received from the Department.
Santos has addressed marine pest requirements in section 7.7.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Department of Agriculture and Water Resources (DAWR) – Fisheries</td><td colspan="2">The department was provided the WA-437-P Geotechnical & Geophysical Survey Consultation package via email on 28 February 2020.
No formal response has been received from the Department.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Director of National Parks (DNP)</td><td colspan="2">The Director of National Parks (DNP) was provided the WA-437-P Geotechnical & Geophysical Survey Consultation package via email on 28 February 2020.
DNP responded on 26 March 2020 and advised:
Based on the factsheet provided, the planned activities do not overlap any Australian Marine Parks. Therefore there are no authorisation requirements from the DNP [INFORMATION 001].
To assist in the preparation of an EP for petroleum activities that may affect Australian marine parks, NOPSEMA has worked closely with Parks Australia to develop and publish a guidance note that outlines what titleholders need to consider and evaluate. In preparing the</td></tr>
</table>

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Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))
	EP, you should consider the Australian marine parks and their representativeness. In the context of the management plan objectives and values, you should ensure that the EP **[INFORMATION 002]**: ○ identifies and manages all impacts and risks on Australian marine park values (including ecosystem values) to an acceptable level and has considered all options to avoid or reduce them to as low as reasonably practicable. ○ clearly demonstrates that the activity will not be inconsistent with the management plan. • DNP can confirm that we do not require further notification of progress made in relation to this activity unless details regarding the activity change and result in an overlap with or new impact to a marine park, or for emergency responses (see details below) **[INFORMATION 003]**. • Emergency responses: The DNP should be made aware of oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park as soon as possible. Notification should be provided to the 24 hour Marine Compliance Duty Officer on 0419 293 465. The notification should include **[REQUEST 001]**: ○ titleholder details ○ time and location of the incident (including name of marine park likely to be effected) ○ 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. Santos responded to DNP on 30 March 2020 confirming DNP requirements will be addressed in the EP, and provided the section reference in the EP. Santos considers the level of consultation to be adequate and will address any additional comments from the DNP should they arise in the future. .

Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))
[INFORMATION 001] Santos notes there are no authorisation requirements from the DNP	Santos responded to DNP and acknowledged their feedback.
[INFORMATION 002] Santos confirms it has followed the NOPSEMA guidance note in preparation of the EP	Santos responded to DNP and confirmed their advice.
[INFORMATION 003] Santos notes DNP do not require further notification of progress made in relation to this activity unless details regarding the activity change and result in an overlap with or new impact to a marine park, or for emergency responses.	Santos responded to DNP and acknowledged their feedback.

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	[REQUEST 001] Santos accepts DNP notification requirements and confirmed the DNPs notification requirements are addressed in Section 5 of the Oil Pollution Emergency Plan (OPEP) for the activity.	Santos responded to DNP and confirmed their notification requirements are addressed in Section 5 of the OPEP.
State Government Departments		
Department of Transport (DoT)	DoT was provided the *WA-437-P Geotechnical & Geophysical Survey* Consultation package via email on 28 February 2020. DOT responded on 12 March 2020 and advised: • If there is a risk of a spill impacting State waters from the Activity, please ensure that the Department of Transport is consulted as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018) which can be accessed here - https://www.transport.wa.gov.au/mediaFiles/marine/MAC_P_Westplan_MOP_OffshorePetroleumIndGuidance.pdf **[REQUEST 001].** Santos responded on 20 March 2020 and provided the Department the information required as per the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response Consultation Arrangements (September 2018). Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	[REQUEST 001] As per the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response Consultation Arrangements (September 2018), Santos provided DOT copies of: • the WA-437-P Geotechnical and Geophysical Survey OPEP DoT consultation package. • the OPEP being submitted to NOPSEMA, a final copy will be sent to you upon acceptance by NOPSEMA.	Santos responded to the Department and provided the information requested.
Department of Primary Industries & Regional Development (DPIRD)	DPIRD was provided the *WA-437-P Geotechnical & Geophysical Survey* Consultation package via email on 28 February 2020. No formal response has been received from the Department. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	No assessment required.	No response required.
Department of Biodiversity and Conservation Attractions (DBCA)	DBCA was provided the *WA-437-P Geotechnical & Geophysical Survey* Consultation package via email on 28 February 2020. DBCA responded on 4 March 2020 and advised that based on the documentation provided for review and other readily available information, DBCA has no comments in relation to its responsibilities under the *Conservation and Land Management Act 1984* and *Biodiversity Conservation Act 2016*. **[INFORMATION 001]** Santos responded to DBCA on 9 March 2020 and acknowledged their response. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	[INFORMATION 001] Santos accepts the advice provided by DBCA.	Santos responded to DBCA and acknowledged their advice.
Department of Mines, Industry Regulation and Safety (DMIRS)	DMIRS was provided the *WA-437-P Geotechnical & Geophysical Survey* Consultation package via email on 28 February 2020. No formal response received from the Department. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Fishing bodies		
Western Australian Fishing Industry Council (WAFIC)	<u>WAFIC Fee for Service</u> Santos emailed WAFIC on 24 February 2020 to request WAFIC's fee for service to assist with the identification of relevant fisheries and communication with individual fishers. WAFIC responded via email on 24 February and accepted the fee for service request. Santos emailed WAFIC on 28 February 2020 providing a consultation pack for review, including fishery specific maps. WAFIC responded on 4 March 2020, and in summary: • confirmed the following fisheries as relevant and potentially affected parties to the EP:	

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))
	○ Pilbara Line Fishery ○ Pilbara Trap Managed Fishery ○ Pilbara Fish Trawl Interim Managed Fishery ○ Mackerel Managed Fishery (Area 2) • the PPA requests all information on behalf of their stakeholders. • provided feedback on the consultation pack for commercial fishers, including a request for a clearer definition of geophysical and geotechnical surveys and information on the timing of the survey relative to peak fishing activities. Santos emailed WAFIC on Tuesday 10 March 2020 with revised consultation material to address the additional information request. This included: • a clearer definition of geophysical and geotechnical surveys. • information on fishing effort data used to help inform survey timing. • a summary of Santos' commitments to help manage interaction with commercial fishers. WAFIC emailed Santos on Tuesday 10 March 2020, and in summary: • confirmed the revised consultation material will be sent to: ○ Pilbara Trap Managed Fishery ○ Pilbara Fish Trawl Interim Managed Fishery ○ Pilbara Line Fishery ○ Mackerel Manged Fishery (Area 2 & up to 100 m water depth) ○ Pearl Producers Association ○ ASBTIA ○ CFA • confirmed consultation was not required with Nickol Bay Prawn fishery. • thanked Santos for the information on fish catch data history. • thanked Santos for reconfirming its commitment to commercial fishers to: ○ provide notification prior to the commencement and on cessation of the survey; ○ ensure a visual and radar watch is maintained on the vessel bridge at all times;

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))
	○ not restrict commercial fishing access to the Operational Area and commit to concurrent operations, where safety of either vessel is not compromised; and ○ ensure Santos vessels transiting to and from the Operational Area avoid commercial vessels that are actively fishing. WAFIC emailed Santos commercial fisher consultation material to agreed fishers on Tuesday 10 March 2020. Santos copied in on all emails. WAFIC emailed Santos on Tuesday 10 March confirming all emails sent, plus one consultation pack by post. <u>WAFIC Consultation</u> WAFIC was provided the *WA-437-P Geotechnical & Geophysical Survey* Consultation package, including commercial fishery specific maps via email on 11 March 2020. WAFIC responded on 11 March 2020 and provided the following comments: • Thank you for the overarching information and information specific to the commercial fishing sector and in particular to fisheries which may be potentially impacted by the Geotechnical & Geophysical Survey In WA-437-P **[INFORMATION 001]** • We especially note that the Pilbara Trawl and Pilbara Trap fisheries both have recorded fishing effort all year round within the relevant fishing block that overlaps the proposed Operational Area, however, Santos has noted that no particular pattern was identified in relation to peak fishing effort therefore Santos has determined that there is no best possible or worst possible period for the survey to be undertaken to minimise interaction with commercial fishers. WAFIC acknowledges that the Operational Area is contained within a 10km x 10km block, nonetheless need to stress this is a productive commercial fishing block with the potential for interaction and impacts on commercial fishing activities **[REQUEST 001].** • WAFIC notes that the nature of commercial fishing for both Pilbara Trawl and Pilbara Trap is that vessel / fishing relocation and movement is restrictive compared to other fisheries and other fishing methods. We appreciate prior notifications but stress the onus on avoidance and the cost of avoidance is not borne by commercial fishers. Usually commercial fishers do their best to avoid a survey during acquisition because it is usually the path of least inconvenience. However, there could be times during this geotechnical and geophysical survey that both parties (fishers and Santos) are in the same area at the same time. Vessel skippers have areas that they prefer to fish, scoping out new grounds can be a mixed and time consuming process. **[REQUEST 002].** • Thank you for re-affirming that Santos will **[INFORMATION 002**]. ○ Provide notification prior to the commencement and on cessation of the survey; ○ Ensure a visual and radar watch is maintained on the vessel bridge at all times; ○ Not restrict commercial fishing access to the Operational Area and commit to concurrent operations, where safety of either vessel is not compromised; and ○ Ensure Santos vessels transiting to and from the Operational Area avoid commercial vessels that are actively fishing.

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	• WAFIC look forward to the next update in due course and should this EP be approved, a proactive communication process between the Pilbara Trawl and Pilbara Trap fishers **[INFORMATION 003]**. Santos responded to WAFIC on 30 March 2020 and addressed each of the matters raised in their correspondence of 11 March 2020 (refer assessment of stakeholder objections and claims). This included a reference to where their matters had been addressed in the EP. Santos acknowledges WAFICs support and guidance in the preparation of consultation materials for commercial fishers and in the identification of relevant and potentially affected parties. Santos considers the level of consultation to be adequate and will address any further comments from WAFIC should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	[INFORMATION 001] Santos acknowledges WAFICs support and guidance in the preparation of consultation materials for commercial fishers and in the identification of relevant and potentially affected parties.	Santos responded to WAFIC and acknowledged assistance provided.
	[REQUEST 001] Santos assessed recorded fishing effort for the relevant fisheries and determined that there is no best possible or worst possible period for the survey to be undertaken to minimise interaction with commercial fishers. Santos acknowledges the Operational Area intersects with commercial fisheries in the area and acknowledges the potential for interaction and impacts on commercial fishing activities**.** Santos has put in place several management measures to help address this concern (**INFORMATION 003**}.	Santos responded to WAFIC and provided information on fishing effort data used to help inform survey timing. Santos responded to WAFIC and reaffirmed commitments in the EP to help manage interaction with commercial fishers.
	[REQUEST 002] Santos notes the information provided by WAFIC on the nature of fishing operations for the Pilbara Trawl and Pilbara Trap Fisheries. Santos appreciates this information and has put in place several management measures to help address this concern [**INFORMATION 003**}.	Santos responded to WAFIC and reaffirmed commitments in the EP to help manage interaction with commercial fishers.
	[INFORMATION 002] Santos acknowledges WAFICs input in the preparation of consultation materials for commercial fishers. Santos has put in place the following management measures (included here and cross references to the sections in the WA-437-P Geotechnical and Geophysical Survey Environment Plan): • Relevant stakeholders will be notified prior to the commencement and on cessation of the survey (Section 4.4).	Santos responded to WAFIC and acknowledged assistance provided. Santos confirmed where the commitments are addressed in the EP.

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	• Relevant maritime notices issued (section 6.1.3) • A visual and radar watch will be maintained on the vessel bridge at all times (Section 6.1.3). • Santos will not restrict commercial fishing access to the operational area and is committed to concurrent operations, where safety of either vessel is not compromised (Section 6.1.3). • Vessels transiting to and from the Operational Area will avoid commercial vessels that are actively fishing (Section 6.1.3). • Survey vessel will be prohibited from recreational fishing within the operational area (Section 6.1.3).	
	[INFORMATION 003] Santos notes WAFIC comment.	Santos responded and acknowledged WAFIC's comments.
Commonwealth Fisheries Association (CFA)	The CFA was provided the Santos WA-437-P Geotechnical & Geophysical Survey consultation package via WAFIC on Tuesday 10 2020. No formal response received from the CFA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Pearl Producers Association (PPA)	The PPA was provided the Santos WA-437-P Geotechnical & Geophysical Survey Commercial Fishers consultation package (for the Pearl Oyster Managed Fishery) via WAFIC on Tuesday 10 2020. No formal response received from the PPA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	ASBITA was provided the Santos WA-437-P Geotechnical & Geophysical Survey consultation package via WAFIC on Tuesday 10 2020. No formal response received from ASBTIA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Recfishwest	Recfishwest was provided the WA-437-P Geotechnical & Geophysical Survey consultation package via email on 28 February 2020. Recfishwest responded on 28 February 2020 advising: • it is unlikely that this Activity will impact recreational fishers given distance from shore**. [INFORMATION 001].** Santos responded to Recfishwest on 28 February 2020 and confirmed their comments would be provided in Section 4 of the EP. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	[INFORMATION 001] Santos accepts the advice provided by Recfishwest.	Santos responded to Recfishwest and acknowledged their advice.
Marine Tourism WA (MTWA)	MTWA was provided the WA-437-P Geotechnical & Geophysical Survey consultation package via email on 28 February 2020. No response received to date. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Community/Port Hedland		
Town of Port Hedland (TOPH)	TOPH was provided the WA-437-P Geotechnical & Geophysical Survey consultation package via email on 28 February 2020. TOPH acknowledged receipt of the information on 28 February 2020. No formal response received from the TOPH. This stakeholder has previously requested a briefing on the proposed Dorado Development. Santos will meet with the TOPH to provide a briefing as requested.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required</td><td>No response required.</td></tr>
<tr><td rowspan="3">Pilbara Ports Authority</td><td colspan="2">The Pilbara Ports Authority was provided the WA-437-P Geotechnical & Geophysical Survey consultation package via email on 28 February 2020.
No response received to date.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Port Hedland Game Fishing Club (PHGFC)</td><td colspan="2">The PHGFC was provided the WA-437-P Geotechnical & Geophysical Survey consultation package via email on 28 February 2020.
No response received to date.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Care for Hedland</td><td colspan="2">Care for Hedland was provided the WA-437-P Geotechnical & Geophysical Survey consultation package via email on 28 February 2020.
No response received to date.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
GT Diving (Port Hedland)	GT Diving was provided the WA-437-P Geotechnical & Geophysical Survey consultation package via email on 28 February 2020. No response received to date. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
State managed fisheries		
Mackerel Managed Fishery (Area 2)	These licence holders (up to 100 metre water depth) were provided the WA-437-P Geotechnical & Geophysical Survey Commercial Fisher consultation package (for Mackerel Managed Fishery (Area 2)) via WAFIC on Tuesday 10 March 2020. No comments received to date from individual fishers in this fishery. Santos has also consulted directly with relevant representative bodies. Refer to WAFIC comments Table 4-2. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Pilbara Line Fishery	These licence holders were provided the WA-437-P Geotechnical & Geophysical Survey Commercial Fisher consultation package (for Pilbara Line Fishery) via WAFIC on Tuesday 10 March 2020. No comments received to date from individual fishers in this fishery. Santos has also consulted directly with relevant representative bodies. Refer to WAFIC comments Table 4-2. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Pilbara Trap Managed Fishery	These licence holders were provided the WA-437-P Geotechnical & Geophysical Survey Commercial Fisher consultation package (for Pilbara Trap Managed Fishery) via WAFIC on Tuesday 10 March 2020.	

Santos

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">No comments received to date from individual fishers in this fishery.
Santos has also consulted directly with relevant representative bodies. Refer to WAFIC comments Table 4-2.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
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<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Pilbara Fish Trawl Interim Managed Fishery</td><td colspan="2">These licence holders were provided the WA-437-P Geotechnical & Geophysical Survey Commercial Fisher consultation package (for Pilbara Fish Trawl Interim Managed Fishery) via WAFIC on Tuesday 10 March 2020.
No comments received to date from individual fishers in this fishery.
Santos has also consulted directly with relevant representative bodies. Refer to WAFIC comments Table 4-2.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
</table>

4.4 Ongoing Consultation

Stakeholder consultation for this Activity will be ongoing and Santos will work with stakeholders before, during and after the Activity. Should new stakeholders be identified (**Section 4.2**), they will be added to the stakeholder database and included in all future correspondence as required, including Activity-specific notifications.

Santos, as a marine user, understands there will be the need to interact and communicate with other marine users to ensure mutual and individual stakeholder goals are met. Santos has identified the need for ongoing engagement with the fishing industry**.**

To this end, Santos commits to the following ongoing stakeholder consultation process:

+ Prior to commencement of the Activity, Santos will notify all relevant stakeholders listed, or as revised, in **Table 4.2.** The notification will include information on Activity timing, vessel movements and vessel details;
+ Upon completion of the Activity, Santos will provide a cessation notification to the relevant stakeholders listed, or as revised, in **Table 4-2**. The final cessation notification will advise stakeholders that the Activity has ended;
+ Santos' Quarterly Consultation Update (see **Section 4.5**) will also contain relevant details of this Activity until cessation; and
+ Up to date knowledge of stakeholders will be managed as described in **Section 8.16.**

Where practicable and if available, Santos will endeavour to use the WAFIC consultation services to help distribute Activity notifications to relevant commercial fishers.

Santos will assess any additional stakeholder objections or claims in accordance with **Section 4.4.**

4.5 Quarterly Consultation Update

Activities covered under this EP will be included in Santos' *Quarterly Consultation Update* until they can be listed as a 'completed Activity', with updates scheduled for approximately March, June, September and December annually.

The Quarterly Consultation Update is circulated to a broad group of Santos stakeholders, including many of the stakeholders identified in **Table 4-2.**

If stakeholders request additional information or raise concerns on any Activity listed in a Quarterly Consultation Update, a dialogue with these stakeholders can continue during or post the preparation of an EP and will be recorded for future reference. Santos commits to respond and address any comments to the satisfaction of both parties and keep any consultation on file during and post acceptance of an EP.

4.6 Addressing Consultation Feedback

Santos Consultation Coordinator is available before, during and after the Activity to ensure opportunities for stakeholders to provide feedback are available.

Santos will maintain records of all stakeholder consultation related this this EP and Activity.

4.7 Stakeholder-related Control Measures, Performance Outcomes and Standards

Control measures and performance outcomes and standards for stakeholder consultation are included in **Section 8.3.1.**

If, in stakeholder consultation, a change to any control measure or Activity outlined in this EP is required, Santos will undertake an internal assessment using the management of change process (**Section 8.9**).

5. Impact and Risk Assessment Methodology

5.1 Terminology

Common terms applied during the impact and risk assessment process, and used in this EP, are defined in **Table 5-1**. For a more comprehensive listing of the terms and definitions used in environmental impact and risk assessment, refer to Santos' *Environmental Risk Identification and Analysis Procedure (EA-91-IG-004)*.

Table 5-1: Impact and risk assessment terms

Name	Definition
Acceptable level of impact or risk	Determined for both impacts and risks. The acceptable level of planned impacts is in part determined by the severity (consequence) of the impact following control measures being implemented. The acceptable level of unplanned impacts is in part determined from its risk ranking following control measures being implemented. For both impacts and risks, the acceptable level is also determined from a demonstration of the ALARP principle, consistency with the Environmental Management Policy, consistency with all applicable legislation, consistency with the principles of Ecologically Sustainable Development (ESD) as defined under the EPBC Act, and consideration of relevant stakeholder consultation when determining control measures.
ALARP	The ALARP principle is that the residual impacts and risk shall be `as low as reasonably practicable'. It has particular connotations as a route to reduce impacts and risks when considering law, regulation and standards. For an impact or risk to be ALARP it must be possible to demonstrate that the cost involved in reducing the impact or risk further would be grossly disproportionate to the benefit gained. The ALARP principle arises from the fact that infinite time, effort and money could be spent on the attempt of reducing a risk to zero. It should not be understood as simply a quantitative measure of benefit against detriment. It is more a best common practice of judgement of the balance of impact or risk and environmental/societal benefit.
Aspect	Element of an organisation's activities or products or services that can interact with the environment.
EMBA	Environment that may be affected by planned or unplanned events.
Environment	The environment (physical, biological and socio-economic) within the spatial extent over which the planned Activity will occur.
Environmental consequence	The severity of an impact in terms of its adverse effects on the environment.
Environmental impact	Any change to the environment, whether adverse or beneficial, wholly or partly resulting from the planned Activity.
Environmental risk	Applies to unplanned events. Risk is a function of the likelihood of the unplanned event occurring and the severity (consequence) of the environmental impact that arises from that event.
Grossly disproportionate	Where the sacrifice (cost and effort) of implementing a control measure to reduce impact or risk, grossly exceeds the environmental benefit to be gained.
Hazard	A situation with the potential to cause harm.
Likelihood	Probability of an unplanned event occurring.
Non-routine planned event	An attribute of the planned Activity that results in some level of environmental impact and may occur or will occur infrequently during of the planned Activity.
Planned Activity	The Activity to be undertaken including the services, equipment, products, assets, personnel, timing, duration and location.
Receptor	A feature of the environment that may have environmental, social and/ or economic values.

Name	Definition
Routine planned event	An attribute of the planned Activity that results in some level of environmental impact and will occur continuously or frequently through the duration of the planned Activity.
Unplanned event	An event that results in some level of environmental impact and may occur despite preventative safeguards control measures in place. An unplanned event is not intended to occur during the Activity.

5.2 Summary of the Environmental Impact and Risk Assessment Approach

5.2.1 Overview

Santos WA operates under an overarching Risk Management Policy (QE-91-IF-10050). Santos WA's Risk Management Framework(QE-91-IF-10051) underpins the Risk Management Policy and is consistent with the requirements of *AS/NZS ISO 31000 Risk Management – Guidelines* (2018). The key steps are illustrated in **Figure 5-1**.

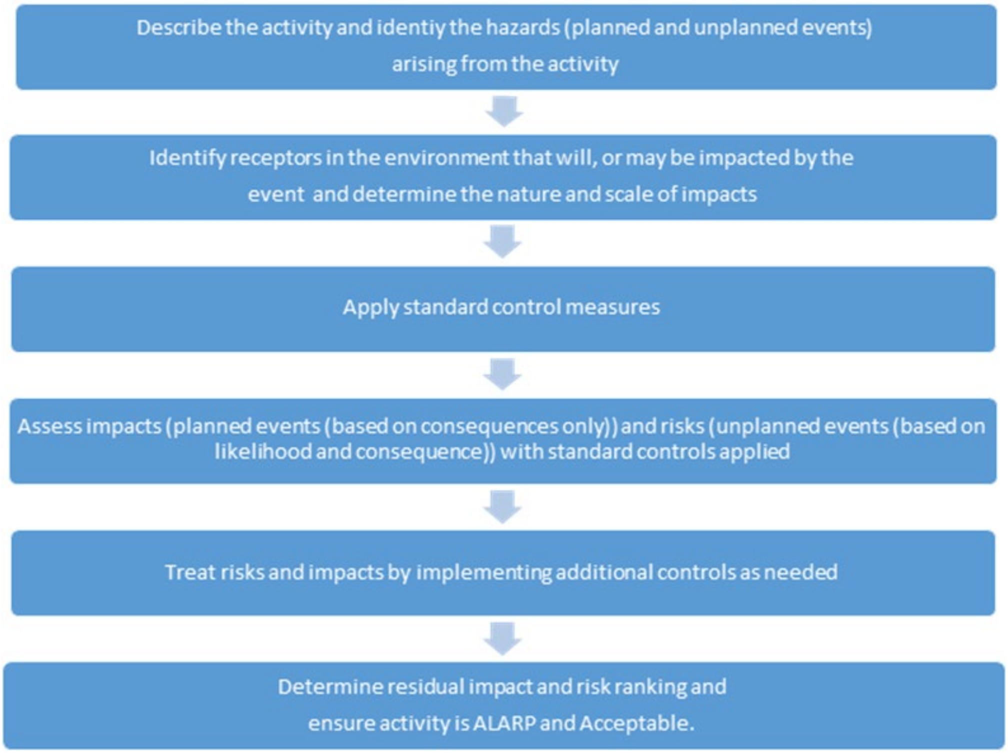

Figure 5-1: Environmental impact and risk assessment process

Santos' *Environmental Risk Identification and Analysis Procedure* (EA-91-IG-004) includes consideration of the following key areas in an impact and risk assessment:

- Description of the Activity (including location and timing);
- Description of the environment (potentially affected by both planned and unplanned activities);
- Identification of relevant persons;
- Identification of legal requirements ('legislative controls') that apply to the Activity;
- the Environmental Management Policy (**Figure 1-1**);
- Principles of ESD; and
- Santos acceptable levels of impact and risk.

These factors were considered in environmental impact and risk assessment workshops. The risk workshop took place on Wednesday 19th February 2020 and involved participants from Santos WA as well as specialist environmental consultants with knowledge of the existing environment and the proposed Activity.

The workshop actions are distributed to relevant personnel and there is continual liaison with the business units to refine the activity description and consequence assessments to ensure suitable control measures are implemented.

5.2.2 Describe the Activity and Hazards for Planned and Unplanned Events

The Activity is described in **Section 2** of this plan. An assessment against the Activity was undertaken and the environmental events identified. The outcome of this assessment is detailed in the relevant sub-sections of **Sections 6** and **7**. A summary of the environmental events identified for the Activity are present in **Table 5-2**.

Table 5-2: Activity – Aspect Relationships for Planned Activities and Unplanned Events

	Planned									Unplanned						
	Interaction with Other Marine Users	Seabed Disturbance	Light Emissions	Underwater noise Emissions	Atmospheric Emissions	Sewage, Grey Water and Putrescible waste	Cooling Water and Brine	Deck Drainage and Treated Bilge	Drilling Fluids	Hydrocarbon Spill (vessel collision)	Minor Hydrocarbon Release	Spill Response Operations	Hazardous and Non-Hazardous Discharges: Liquids	Hazardous and Non-Hazardous Discharges: Solids	Marine Fauna Collision	Introduction of Invasive Marine Species
Geophysical Survey Techniques																
Single beam echo sounder (SBES)	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
Multi beam echo sounder (MBES)	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
Side scan sonar (SSS)	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
Geotechnical Survey Techniques																
Penetration Testing (PCPT / T-Bar)	-	✓	-	✓	-	-	-	-	-	-	-	-	-	✓	-	✓
Piston Coring / Vibracore	-	✓	-	✓	-	-	-	-	-	-	✓	✓	-	✓	-	✓
Rock Coring / Drilling	-	✓	-	✓	-	-	-	-	-	-	✓	✓	-	✓	-	✓
Box Corer	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
USBL	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
General vessel and Support Operations																
Vessel Operations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ROV	-	✓	-	-	-	-	-	-	-	-	-	✓	-	-	✓	✓
Helicopter	-	-	-	✓	-	-	-	-	-	-	-	✓	-	-	-	-

5.2.3 Determine the Nature and Scale of Impacts and Identify Receptors that Will or May Be Impacted

The extent of actual or potential impacts from each planned or unplanned event is assessed using, where required, modelling (e.g. hydrocarbon spills) and scientific reports. The duration of the event is also described including the potential duration of any impacts should they occur. Receptors identified as potentially occurring within impacted area(s) are detailed in **Sections 6** and **7**.

5.2.1 Describe the Control Measures, Environmental Performance Outcomes, Environmental Performance Standards and Measurement Criteria

For each planned and unplanned event, a set of control measures, environmental performance outcome(s), environmental performance standards and measurement criteria is identified. The definitions of these terms are consistent with the OPGGS(E)R.

5.2.2 Determine the Impact Consequence Level and Risk Rankings (on the basis that all control measures have been implemented)

This step looks at the causal effect between the aspect/hazard and the identified receptor. Impact mechanisms and any thresholds for impacts are determined and described, using scientific literature and modelling where required. Impact thresholds for different critical life stages are also identified where relevant.

The consequence level of the impact is then determined for each planned and unplanned event based on the severity of the impact to relevant receptors within the following categories:

+ Threatened/migratory/local fauna;
+ Physical environment/habitat;
+ Threatened ecological communities;
+ Protected areas; and
+ Socio-economic receptors.

This process determines a consequence level, based on set criteria for each receptor category, and takes into consideration the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem or industry level.

For unplanned events, a risk ranking is also determined using an assessment of the likelihood (likelihood ranking) of the event as well as the consequence level of the potential impact should that event occur.

Impacts to social and economic values are also considered based on existing knowledge and feedback from stakeholder consultation. From Santos' historic and ongoing consultation with stakeholders, it is evident that the social and economic values in the region are of interest.

The process and definitions supporting the consequence, likelihood and risk ranking determination are included within the *Environmental Risk Identification and Analysis Procedure* (EA-91-IG-00004). The Santos consequence matrix and risk matrix are provided in **Appendix E**.

The EMBA is defined in the relevant section using, where available, modelling, scientific reports or any additional justification. The level of information required to determine the impact or risk assessment is dependent on nature and scale.

5.2.1 Evaluating if Impacts and Risks are ALARP

For planned and unplanned events, an ALARP assessment is undertaken to demonstrate that the standard control measures adopted reduce the impact (consequence level) or risk to ALARP. This process relies on demonstrating that further potential control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. If this cannot be demonstrated, then further control measures are adopted. The level of detail included within the ALARP assessment is based upon the nature and scale of the potential impact or risk. For example, more detail is required for a risk ranked as `medium' compared to a risk ranked as `low'.

5.2.2 Evaluating the Acceptable Level of Impact and Risk

Santos considers an impact or risk associated with the proposed Activity to be of an acceptable level if the following criteria are met:

+ The consequence of a planned event is ranked as A (negligible) or B (minor); or a risk of impact from an unplanned event is ranked low to medium;
+ An assessment has been completed to determine if further information/studies are required to support or validate the consequence assessment;
+ Assessment and management of risks has addressed the principles of ESD, as defined in Section 3A of the EPBC Act:
    - a) decision-making processes should effectively integrate 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;
    - 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;
    - d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making;
    - e) improved valuation, pricing and incentive mechanisms should be promoted.
+ Demonstration that the acceptable levels of impact and risks have been informed by relevant species recovery plans, threat abatement plans and conservation advice;
+ Legal and regulatory requirements are met;
+ Control measures and performance standards are consistent with the Santos Environmental Management Policy;
+ Control measures and performance standards are consistent with industry standards and best practice guidance;
+ Control measures and performance outcomes and standards are consistent with stakeholder expectations; and
+ Proposed control measures have been demonstrated to reduce the impact or risk to ALARP.

5.2.3 Non-credible Events

The following unplanned events were deemed not credible scenarios and are not discussed further in this section:

Hydrocarbon spill due to vessel grounding

Vessel grounding can occur due to a loss of propulsion or to navigational error resulting in the vessel running aground in shallow areas. Vessel grounding and subsequent fuel tank rupture was not considered a credible scenario for this Activity since the Operational Area is situated in deep water and there are no chartered reefs or islands that could pose a grounding hazard in the Operational Area.

6. Environmental Impact Assessment for Planned Events

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Evaluation of environmental impacts and risks (5) The environment plan must include: a) details of the environmental impacts and risks for the Activity; b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and c) details of the control measures that will be used to reduce the impacts and risks of the Activity to as low as reasonably practicable and an acceptable level. (6) To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: a) all operations of the Activity; and b) potential emergency conditions, whether resulting from accident or any other reason. *Environmental performance outcomes and standards* (7) The environment plan must: a) set environmental performance standards for the control measures identified under paragraph (5)(c); b) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured; and c) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

Santos' environmental assessment identified nine potential sources of environmental impacts associated with planned events for this Activity. The consequence rankings resulting from the environmental assessment are summarised in **Table 6-1**. A comprehensive risk and impact assessment for each of the planned events, and subsequent control measures proposed by Santos to reduce the risk and impacts to ALARP and acceptable levels are detailed in the following sub-sections.

Table 6-1: Summary of the consequence level rankings for hazards associated with planned activities

Section Reference	Hazard	Final consequence ranking
6.1	Interactions with other marine users	A-Negligible
6.2	Seabed disturbance	A-Negligible
6.3	Light emissions	A-Negligible
6.4	Underwater noise emissions	A-Negligible
6.5	Atmospheric emissions	A-Negligible
6.6	Sewage, greywater and putrescible waste	A-Negligible
6.7	Cooling water and brine	A-Negligible
6.8	Deck drainage and treated bilge	A-Negligible
6.9	Planned operational discharges	A-Negligible

6.1 Interaction with Other Marine Users

6.1.1 Description of Event

Aspect	Sources of impact to other marine users may occur as a result of, but not limited to: • survey vessel moving or stationary through the Operational Area creating a collision risk or temporary displacement of marine user groups. • 500 m exclusion zone around the survey vessel for safety reasons limiting access for marine users during the Activity. The presence of the survey and/or support vessel in the Operational Area could potentially inhibit or be an inconvenience to marine user groups including tourism, commercial shipping, fishing and other oil and gas activities. For commercial fishing licence holders, the level of interaction could lead to temporary displacement to fishing grounds. The presence of the survey vessel and/or towed equipment (during the geophysical component of the survey) could pose a collision risk (refer to **Section 7.1**).
Extent	Operational Area
Duration	For the duration of the Activity, as described in **Section 2**.

6.1.2 Nature and Scale of Environmental Impacts

Santos has identified the following stakeholders as potential marine users of the Operational Area; commercial fishers, recreational fishers, commercial shipping, and other petroleum-related vessels. These users maybe temporarily displaced by the physical presence of the survey vessel. The potential effects of noise from vessels and helicopters on marine users, specifically commercial fishers, is addressed in **Section 6.4.**

Commercial Fishers

Commercial fishers have been identified as relevant stakeholders and are considered to be the main marine user within the Operational Area. There are three Commonwealth and six State fisheries that overlap the Operational Area and are actively fished (See **Section 3.2.4**). These are summarised in **Table 3-10**.

An analysis of the current fishery closures, depth range of the Activity, historical fishing effort data, fishing methods and consultation feedback (refer to **Section 4 and Table 3-10**) has revealed that there is a low potential for interaction with commercial fisheries. None of the Commonwealth fisheries identified in **Section 3.2.4** are likely to be active in the Operational Area. For state managed fisheries the 2009-2018 FishCube data (DPIRD 2019) indicated:

+ The Pilbara Trap Managed Fishery and the Pilbara Fish Trawl (Interim) Managed Fishery has recorded fishing effort all year round within the relevant fishing blocks that overlap the Operational Area, however no particular pattern was identified in relation to peak fishing effort;
+ The Pilbara Line Managed Fishery has recorded no fishing effort since 2016 within the relevant fishing blocks that overlaps the Operational Area. Prior to that fishing effort occurred variably in the months of May through to August; and
+ Both the Mackerel Managed Fishery (Area 2) and the Nickol Bay Prawn Limited Entry Fishery recorded no fishing effort within the fishing block that overlaps with the proposed Operational Area.

The loss of fishing grounds due to the presence of the Operational Area will be minimal and temporary. The Operational Area will cover an area of 0.195% (100 km^2/51,380 km^2) of the Pilbara Fish Trawl (Interim) Managed Fishery and 0.115% (100 km^2/87,120 km^2) of the Pilbara Trap Managed Fishery. Therefore, any impacts will be temporary with Phase 1 and Phase 2 of the Survey lasting approximately 15 days and 45 days respectively.

Pearl oyster licence holders do not operate/dive in water depths greater than 40 m. As the Operational Area is situated in water depths of 86–94 m no pearl diving activities are expected to occur. Therefore, displacement of Pearl oyster licence holders is not expected.

Recreational Fishers

Santos has not identified any charter boats operating out of Port Hedland (**Section 3.2.4.4**), and there is no identified offshore tourism industry within or near the Operational Area.

Recreational activities such as boating, snorkelling, diving, and fishing activities are more likely to occur in shallower waters around Bedout Island (approximately 65 km from the Operational Area). Encounters with recreational boats within the deeper, remote offshore waters of the Operational Area is not expected.

Commercial Shipping

The nearest recognised shipping routes are approximately 6.5 km to the east and approximately 12 km to the west of the Operational Area (**Figure 3-14**). Analysis of historical AIS shipping data indicates that vessels operating in the area are cargo vessels, specifically iron ore carriers. Vessel traffic is largely confined to the two designated shipping fairways servicing Port Hedland. AIS data (AMSA 2020) details a combined average of eleven vessel movements within both transit lanes per day. Other vessels within the area are commonly proceeding to and from other major ports in the area (ports of Dampier, Port Walcott, Port Hedland, Barrow Island, Varanus Island and Onslow). Should commercial vessels need to deviate from planned routes to avoid the Activity vessel, this may slightly increase transit times and fuel consumption. As the Operational Areas is in open waters with no grounding or navigational hazards, it is not likely that any such deviation would increase the potential for vessel collision or grounding.

Petroleum Industry

The NWS is a major oil and gas hub in Australia, with several companies operating within the area. The Activity occurs in a particularly isolated area of the NWS with respect to the main oil and gas operational and exploratory fields. There are currently no existing facilities in or near the Operational Area. The nearest operating facility is Woodside's Angel oil field and associated infrastructure, located approximately 240 km from the Operational Area.

6.1.3 Environmental Performance Outcomes and Control Measures

Environmental Performance Outcomes (EPOs) relating to this event include:

+ EPO-1 – Reduce impacts on other marine users through the provision of information to relevant stakeholders such that they are able to plan for their activities and avoid unexpected interference.

The Control Measures considered for this Activity are shown below with Environmental Performance Standards and Measurement Criteria for the EPOs described in **Section 8.3.**

Control Measure (CM) Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-01	Maritime Notices	Ensures other marine users are aware of the presence of the survey vessel, and static data collection.	Costs associated with the personnel time in issuing notifications and closing out queries and responses.	**Adopted** – Benefits considered to outweigh negligible costs. Maritime requirement to issue marine notices.
CM-02	Stakeholder consultation	Ensures other marine users, such as commercial fishers, are aware of upcoming survey operations so they can plan their business accordingly.	Limited additional costs to Santos. Stakeholders time required to review consultation material and communicate with Santos.	**Adopted** – Benefits considered to outweigh negligible costs. Important control to ensure other marine users are aware of upcoming geotechnical activities and potential business disruptions. Provides an opportunity for Santos and stakeholders to discuss additional ways of minimising on-water interference and business disruptions.
CM-03	Exclusion zone (safety) established to reduce potential for collision or interference with other marine user activities.	Requested 500 m exclusion zones around the survey and support vessel prevents other vessels from getting too close and causing damage to equipment of either party.	No additional costs to Santos. Other marine users may be temporarily excluded from small areas, disrupting their activities.	**Adopted** – The requested exclusion of other marine users is temporary. Marine users will still be able to access the Operational Area. Normal navigation at sea process whereby shipping vessels avoid navigational risks. Hence, the safety benefits to all marine users outweighs any potential costs.
CM-26	Navigation equipment and procedures	Reduces the risk of collisions with other marine users.	Negligible costs of acquiring and operating navigation equipment, as required by maritime law.	**Adopted** – The safety benefits of having navigation equipment and procedures outweighs any cost. This is a maritime requirement.
CM-15	Constant bridge watch	Crew of vessels will maintain constant bridge watch, including for third party vessels which	No additional costs.	**Adopted** – No additional costs. This is a maritime requirement.

Control Measure (CM) Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
		may be approaching or enter the exclusion zone.		
CM-25	Vessels fitted with AIS systems and radars	Reduces risk of impact from vessel collisions.	Negligible as the survey vessel should be fitted with AIS.	**Adopted** – The safety benefits of having AIS outweigh any costs. This is a maritime requirement.
Additional control measures				
CM-04	Avoidance of other active marine users, where safe to do so	Vessels have some ability to avoid others under own propulsion (even at anchor) in unlikely event that interaction with marine user requires survey vessel to avoid other user. Note primary controls around stakeholder engagement and navigational lighting will limit this requirement.	Minor costs associated with increase in duration of activities, should data collection need to be halted to move survey vessel. Likely such costs can be avoided thorough stakeholder consultation and standard maritime navigation protocols.	**Partially adopted –** Where safe to do so, vessel can move to avoid other marine users. However, primary controls to avoid other marine users is thorough stakeholder engagement.
CM -05	Project vessels recreational fishing restrictions	No additional pressure placed on fisheries resources associated with project vessels during operations within Operational Area.	No additional costs.	**Adopted –** no recreational fishing from vessels engaged in the project within Operational Area.
CM-30	Support vessel in place during the Activity to reduce potential for collision or interference with other marine users	Identifies and communicates with approaching third-party vessels to ensure exclusion (safety) zone is observed, preventing potential interaction or interference.	Additional costs of contracting a support vessel.	**Not Adopted** – Cost outweighs the benefit.

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6.1.4 Impact and Consequence Ranking

Receptor	Consequence Level
Interaction with other marine users	
Threatened / Migratory Fauna	N/A – related to socio-economic receptors only.
Physical Environment/ Habitat	
Threatened ecological communities	
Protected Areas	
Socio-economic receptors	Commercial fishing, shipping and tourism in the Operational Area is expected to be low. To negate any impacts to commercial fisheries Santos WA has committed to: • Providing notification prior to the commencement and on cessation of the survey; • Ensuring a visual and radar watch is maintained on the vessel bridge at all times; • Not restricting commercial fishing access to the Operational Area and commit to concurrent operations, where safety of either vessel is not compromised; and • Ensuring Santos vessels transiting to and from the Operational Area avoid commercial vessels that are actively fishing. Other marine users will not be restricted from entering the Operational Area. However, given the low manoeuvrability and slow speed of the survey vessel, it is possible that third party commercial vessels may be required to deviate from planned routes to avoid the survey vessel. Since the survey vessel will be continually relocating potential displacement from any one location within the Operational Area will be temporary and **negligible**. Santos has not identified through consultation any tourism activity in the Operational Area or surrounds. Recreational fishers may be present at Bedout Island and surrounding waters; however, they will not be displaced by the survey vessel. It is unlikely indigenous users of the marine environment or traditional fishers will be present within the Operational Area given the vast distance offshore. AMSA require a high level of communication during the Activity (Marine Notices, NTM, AUSCOAST warnings), therefore, reducing the likelihood of interaction with other sea users (e.g. private leisure craft, etc.).
Overall worst-case consequence	A – Negligible

6.1.5 ALARP Evaluation

No alternative options to the use of vessels are possible in order to undertake marine based operational activities. If the management controls are adhered to, then the risk of interfering with other users of the sea will have been reduced to ALARP.

Stakeholders have been informed of the proposed Activity as detailed in **Section 4**. Throughout the duration of EP preparation, details of the Activity have been communicated to relevant stakeholders as appropriate. In consultation, stakeholders are made aware of the proposed area from which other marine users may be excluded for the duration of the Activity and the potential schedule. No concerns have been raised by stakeholders regarding the potential exclusion from the proposed Operational Area. The proposed management controls for marine user interaction are considered appropriate to manage the risk to ALARP.

6.1.6 Acceptability Evaluation

Is the consequence ranked as (Negligible) or B (Minor)?	Yes – A (Negligible).
Is further information required in the consequence assessment?	No – Sufficient information is available to understand the nature and scale of potential impacts, and to assess impact consequence. Ongoing engagement with commercial fishers will be used to validate the impact assessment and ensure the proposed control measures are effectively implemented.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes - Management consistent with COLREGS, *Safety of Life at Sea* (SOLAS) 1974 and *Navigation Act 2012*.
Are performance standards consistent with the Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance standards consistent with stakeholder expectations?	Yes – Control measures and associated performance standards have been included to address stakeholder concerns. Relevant stakeholders were sent details on Santos' proposed concurrent operations. Santos will continue to assess the merits of any stakeholder claims or objections on the proposed control measures and performance standards and will continue to engage with stakeholders as committed.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

6.2 Seabed disturbance

6.2.1 Description of Event

Aspect	Seabed disturbance has the potential to alter benthic habitats from physical disturbance and the discharge of borehole cuttings. Physical disturbance will occur from the following: • In-situ Penetration Testing: total footprint ~42 m^2 • Borehole Sampling - Piston Coring / Vibrocore: total footprint: ~27 m^2 • Sampling / Rock Coring: total footprint (if required) ~126 m^2 • Box coring: total footprint (if required) 115 m^2 • ROV operations: footprint (if required) 3 m^2 The indicative total footprint on the seabed associated with deployment of benthic sampling equipment (borehole and coring) to sample approximately 23 samples is expected to be limited to a total footprint area of approximately 69 m^2. If difficult sampling conditions are encountered and rotary borehole and/or box coring are required, this may slightly increase to ~126 m^2. Borehole cuttings will be minimal as most of the sample will be retained for analysis. An indication as to the volume of cuttings potentially generated by these Activities is that each of the nine cores will comprise a volume of a maximum of 0.785 m^3 (based upon an area of 0.05 m^2 *100 m) and any cuttings are expected to be significantly less than this as the cores are recovered to the survey vessel. The vessel will hold station using dynamic positioning propellers or be in transit. Anchoring is not anticipated unless required in an emergency or for safety reasons. An ROV may be utilised to retrieve dropped objects or sampling equipment; however, is not expected to contact the seabed. These activities may result in minor and localised seabed disturbance, sedimentation or water quality impacts (i.e. increased turbidity).
Extent	Localised: within the Operational Area
Duration	For the duration of the Activity, as described in **Section 2**.

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6.2.2 Nature and Scale of Environmental Impact

Physical Environment

The use of sampling equipment for the survey will directly contact the seafloor and will result in localised impact (direct and indirect) to water quality, seabed features and the benthic environment in the Operational Area.

Temporary or permanent direct loss of benthic habitat and associated biota and degradation of water quality will potentially occur during survey activities.

Benthic habitats which could be impacted are expected to comprise of soft sediment infauna communities, which are found in predominantly unvegetated soft sediment substrates (as described in **Section 3.2.2.3**). The Operational Area does not overlap benthic habitats relied on by sensitive species or habitats designated as Key Ecological Features (RPS, 2019b).

The benthic biota in the region of the Operational Area is very similar to that of the wider region, with low species abundance and high species richness (RPS, 2019b). No significant seabed features or biota have been found in the immediate region of the Operational Area. The scale of potential habitat loss and seabed disturbance from localised survey activities are negligible in comparison to the vast area of soft substrata habitats and limestone pavement habitats in the NWS region (RPS, 2019b). The small disturbance area (42 m^2) from planned Activities will therefore not have a significant impact on benthic biota or habitat.

Indirect impacts associated with a temporary (several hours) and localised (within tens of m) decline in water quality due to increased suspended sediments or sedimentation of the seabed are not expected to affect any values and sensitivities of regional importance. Localised impacts within the Operational Area will not result in indirect impacts (i.e. turbidity) to nearby shoals and banks, offshore reefs or islands given their distance from the Activity.

6.2.3 Environmental Performance Outcomes and Control Measures

EPOs relating to this event include:

+ EPO-7 – No unplanned seabed disturbance.

The Control Measures considered for this Activity are shown below with Environmental Performance Standards and Measurement Criteria for the EPOs described in **Section 8.3**.

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CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-08	Standard geotechnical survey data collection procedure implemented	Survey data collection surveys procedure consider minimisation of seabed disturbance to ensure optimal data and is mindful of seabed impact.	No additional costs.	**Adopted** – standard procedure given compliance with survey data collection aligns with HSE and QAQC protocol.
Additional control measures				
CM-09	Vessels use dynamic positioning to maintain location, unless anchoring is required for emergency or safety reasons	Reduced reliance on anchoring removes risk of seabed disturbance associated with use of vessels within Operational Area.	Minimal additional costs, given DP is pre-existing on vessels. Costs associated with fuel and maintenance costs of DP.	**Adopted –** negligible costs outweighed by benefits. Further**,** reliance on DP as part of normal operating procedure is widely used in maritime industries.
CM-10	Consider pre-existing geophysical data in sample target location identification	Knowledge of seabed and potential environmental sensitivities is known prior to conducting geotechnical data collection through preliminary geophysical data collection, hence able to avoid seabed disturbance associated with geotechnical data collection in locations which are display characteristics indicating environmental sensitivity (i.e. hard substrate or uneven seafloor).	No additional costs given geophysical data collection prior to geotechnical data is standard practice.	**Adopted** – is standard practice to collect geophysical data prior to geotechnical data.
CM-07	Dropped object prevention and recovery procedure	Recovery time from seabed disturbance increases, with increasing exposure/duration of Activity causing disturbance (i.e. dropped object staying in situ for longer increases extent of damage to benthic habitats).	Additional costs associated with potential increase duration of data collection, and additional personnel and equipment required to recover object as per safe procedure.	**Adopted –** where safe to do so, benefits outweigh negligible additional costs and time to recover dropped object.
CM-11	ROV operating procedure	Where required, ROV will be used as per standard operating procedure to ensure ROV is working optimally. As such ROV use has reduced likelihood of seabed disturbance.	No additional costs as per best practice.	**Adopted –** negligible costs outweighed by benefits of following best practice protocol.

6.2.4 Impact and Consequence Ranking

Receptor	Consequence Level
Epibenthos in 86 to 94 m water depth	
Threatened / Migratory Fauna	Given the small scale of the Activity, minor and short-term nature of indirect impacts and the regional availability of the habitats present, seabed and benthic habitat disturbance is not expected to impact threatened/migratory species. No threatened/migratory fauna species were identified in the Operational Area where seabed disturbance will occur. The consequence level is therefore assessed as negligible (A).
Physical Environment/ Habitat	Impacts from seabed disturbance are expected to be localised, and indirect impacts may result in short-term increases in turbidity to the immediate vicinity of grab sampling, PCPT and coring activities. Given that habitats within the Operational Area are representative of those within the wider region, and the localised disturbance, impacts to the physical environment/habitat are assessed as negligible (A).
Threatened ecological communities	Not applicable – no threatened ecological communities are identified in the Operational Area where seabed disturbance could occur.
Protected Areas	Not applicable – no protected areas are identified in the Operational Area where seabed disturbance could occur.
Socio-economic receptors	**Negligible** impacts to fisheries from seabed disturbance, given negligible consequence to fauna (fish stock). Any minor alternation or modification to habitats is not expected to impact commercial fishery target species based on the small size of disturbance from the activities proposed. Based on the impact assessment (**Section 6.2.2**), consequence to commercial fisheries has been assessed as **negligible**.
Overall worst-case consequence	A – Negligible

6.2.5 ALARP Evaluation

The survey activities to be undertaken in Commonwealth waters are unavoidable. There are no practicable alternatives in order to proceed in a successful and safe manner to reduce seabed disturbance associated with the operational activities. Management controls and data collection procedures are designed to limit the extent of direct seabed disturbance.

The activities within the Operational Area occur in benthic habitats (i.e. primarily soft sediments with little epifauna) that are widely represented at a regional scale on the NWS (RPS 2019b). Impacts will be localised within the Operational Area and in the immediate vicinity of the sampling equipment. The placement of equipment may leave indentations on the seabed and cause a temporary increase in turbidity, however impacts will be limited to surface sediments. Given the localised nature of activities which may cause seabed and benthic habitat disturbance, and expected rapid recovery time, environmental impacts are expected to be negligible. The proposed management controls for seabed disturbance are considered appropriate to manage the risk to ALARP.

6.2.6 Acceptability Evaluation

Is the consequence ranked as A (Negligible) or B (Minor)?	Yes – maximum consequence of seabed disturbance is A (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.

Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Control measures and associated performance standards have been included to address stakeholder concerns. Identified stakeholders were sent details on Santos' proposed operations. Santos will continue to assess the merits of any stakeholder claims or objections on the proposed control measures and performance standards and will continue to engage with stakeholders as committed.
Are performance standards consistent with the Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

The potential consequence of seabed disturbance on receptors is discussed in **Section 6.2.5**. With the control measures in place including compliance with industry standards and legislation, no significant impacts are expected. As such, the risk is considered acceptable.

6.3 Light Emissions

6.3.1 Description of Event

Aspect	During the Activity, safety and navigational lighting on the vessels will generate light emissions that may potentially affect marine fauna behaviour. The minimum level of lighting proposed is required for safety and navigational purposes on board vessels, therefore it cannot be eliminated if the proposed Activity is to proceed. The *Navigation Act 2012* requires vessels to be well lit for safe navigation. Vessels are required to show lights when operating at night to indicate their position and survey vessels must indicate their limited ability to manoeuvre during Survey operations. Spot lighting may also be used on an as-needed basis e.g., equipment deployment and retrieval. Lighting will typically consist of bright white (i.e., metal halide, halogen, fluorescent) lights.
Extent	The light assessment boundary of 20 km from the source will be used as the extent of light exposure, in accordance with National Light Pollution Guidelines for Wildlife (Commonwealth of Australia, 2020).
Duration	Navigational and task lighting will be required on a 24-hour basis for the duration of the Activity as described in **Section 2**.

6.3.2 Nature and Scale of Environmental Impacts

Continuous lighting may result in localised alterations to normal marine fauna behaviours for fish, sharks, marine turtles and seabirds, as discussed below for each fauna group. Potential impacts are more likely in instances when the light source is stationary. Although the vessel will be stationary during the geotechnical component of the survey, sampling operations will require the vessel to be stationary for short periods only as the survey vessel will be moving to multiple sampling locations.

The National Light Pollution Guidelines for Wildlife (Commonwealth of Australia, 2020) have been published to minimise the adverse impacts on marine fauna from artificial lighting. According to the guidelines, a 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15–18 km away and fledgling seabirds grounded in response to artificial light 15 km away (Commonwealth of Australia 2020).

Marine Mammals

Artificial lighting has the potential to affect marine fauna by altering use of visual cues for orientation, navigation or other purposes, resulting in behavioural responses which can alter foraging and breeding activity, and create competitive advantage to some species and reduce reproductive success and/or survival in others. Cetaceans and other marine mammals are not known to be significantly attracted to light sources at sea, and therefore disturbances to behaviour are unlikely to occur. There is no evidence to suggest that artificial light sources impact on the migratory, feeding or breeding behaviours of cetaceans. Cetaceans predominantly utilise acoustic senses to survey their environment, rather than visual cues (Simmonds et al. 2004).

Marine turtles

The light assessment boundary (20 km from the Operational Area boundary) overlaps the flatback turtle inter-nesting BIA. No nesting or breeding areas are located within the light assessment boundary given the distance of the Operational Area from emergent land (approximately 65 km to Bedout Island, 126 km to Eighty Mile Beach and 90 km to North Turtle Island) and the associated nearshore waters where marine turtles breed.

North Turtle Island which is approximately 90 km south of the Operational Area is the closest land mass noted to be a foraging area for turtles. A summary of surveys in BHP (2011) lists North Turtle Island as being a foraging habitat for adult hawksbill and flatback turtles and both adult and juvenile green turtles. It is therefore possible that individual turtles may be encountered in the Operational Area, however, their presence is likely to be incidental and transitory only.

The Recovery Plan for Marine Turtles in Australia: 2017-2027 (DoEE, Commonwealth of Australia 2017a) highlights artificial light as one of several threats to marine turtles. Specifically, the plan indicates that artificial light may reduce the overall reproductive output of a stock, and therefore recovery of the species, by:

- inhibiting nesting by females;
- creating pools of light that attract swimming hatchlings and increase their risk of predation; and
- disrupting hatchling orientation and sea finding behaviour. Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may 'entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon *et al.*, 1992).

Transient individual marine turtles may be present in the Operational Area. Hawksbill, leatherback and loggerhead turtles are unlikely to be encountered in large numbers given the Operational Area is not located in proximity to nesting, inter-nesting or important foraging habitat for these species. Potential impacts to marine turtles from light emissions during the Survey is limited to transient individuals including flatback turtle hatchlings. The presence of the flatback turtle inter-nesting BIA suggests flatback turtle hatchlings may be exposed to increased predation within the light assessment boundary (Thums *et al.*, 2016). This likelihood is significantly reduced considering the light source will not be stationary for extended periods.

The Recovery Plan for Marine Turtles in Australia: 2017-2027 specifies the following priority actions for the Pilbara genetic stock of flatback turtles in relation to artificial light:

- Manage artificial light from onshore and offshore sources to ensure biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue.

Light emissions from the vessel will not be visible at nesting beaches or nearshore dispersal areas (i.e. the closest nesting beach is approximately 106 km from the light assessment boundary). The remote offshore location of the Survey from nesting beaches prevents disturbance to nesting adults or emerging/dispersing hatchings from light emissions.

The potential impacts of light emissions to turtles from the activities are expected to be restricted to localised attraction and temporary disorientation. There will be no long-term or residual impacts due to the continual movement of the vessel to sampling locations and the lack of overlap with habitat critical areas associated with nesting adults and emerging/dispersing hatchlings. It is considered that the Activity will not compromise the objectives as set out in the Recovery Plan for Marine Turtles and the impact of lighting associated with the Activity to turtles is negligible.

Fish and sharks

There are no features within the light assessment boundary (20 km from the Operational Area boundary) where fish are likely to be site-attached, only transient foraging fish are expected. However, the boundary overlaps the whale shark foraging behaviours BIA located northward from Ningaloo along the 200 m isobath. The Species Profile and Threats Database and Conservation Advice for the whale shark does not identify light emissions as a threat (TSSC 2015b).

Fishes will likely not be affected by navigational lighting for mariners (Morandi et al, 2018). However, other light emissions from the survey vessel (such as deck lights for survey requirements) in the Operational Area may result in localised aggregation of fish in the immediate vicinity of the vessel. This may result in an increase in predation on prey species aggregating in the area, or exclusion of nocturnal foragers/predators from the area (Marchesan et al. 2006). Artificial light can also influence dial vertical migration patterns of plankton (including planktonic life stages of some fish species) in the surface waters and lead to migrations that occur outside of the optimal window for that species (Gibson et al. 2001, cited in Morandi, 2018). The areas affected would be highly localised and short-term due to the transient nature of the survey and limited to night-time operations.

Overall, a short-term localised increase in fish activity as a result of vessel lighting is expected to occur, however, with negligible impacts.

Seabirds

The light assessment boundary (20 km from the Operational Area boundary) overlaps the breeding and foraging BIAs for the lesser frigatebird and the brown booby. No key nesting, roosting or resting areas are located within the light assessment boundary. The lesser frigatebird and brown booby are listed as marine and migratory and do not have a recovery plan or conservation advice. Light has not been identified as a threat to the lesser frigatebird or brown booby (DoE 2020a; DoE 2020b).

Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie *et al*. 2008). The light sources associated with the vessel may also provide enhanced capability for seabirds to forage at night. The vessel will be in the Operational Area for up to 15 and 45 days for Phase 1 and Phase 2 respectively. However, the vessels will be stationary for only short periods with regular movement to sampling locations and are therefore unlikely to attract large numbers of seabirds.

Light emissions from the Survey are likely to change the behaviour of seabirds including the lesser frigatebird and brown booby within the light assessment boundary. Seabirds have been shown to be attracted to artificial light sources, however, the low level of light emitted from vessels is unlikely to lead to large scale changes in species abundance or distribution (Commonwealth of Australia 2020). Given the absence of key aggregation sites within the light assessment boundary, potential impacts are likely to be limited to short-term behavioural effects with no decrease in local population size, area of occupancy of species or loss or disruption of habitat critical / disruption to the breeding cycle. It is considered that the Activity will not result in population impacts to seabirds and the impact of lighting associated with the Activity to seabirds is negligible.

6.3.3 Environmental Performance Outcomes and Control Measures

EPOs relating to this event include:

+ EPO-6 – Reduce impacts to marine fauna from vessel lighting by reducing lighting to that required by safety and navigational lighting requirements.

The control measures considered for this Activity are shown below with Environmental Performance Standards and Measurement Criteria for the EPOs described in **Section 8.3**.

Santos

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-12	Lighting will be used as required for safe navigation and operations.	Minimum lighting required for safe navigation and operations to comply with International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and SOLAS/AMSA Marine Orders. Unnecessary lighting (not required for safety and navigation) will be switched off further reducing light spill and likelihood of artificial lighting impacts on fauna from vessel lighting operations.	No additional costs anticipate, given is standard practice.	**Adopted** – given additional cost negligible
Additional control measures				
N/A	Review lighting and change to a type (colour / HPS) that has less impact.	Could reduce potential impacts of artificial light on certain fauna.	High cost to complete lighting change-out on vessels in area of low sensitivity and may compromise safe work requirements.	**Not Adopted** – Cost outweighs the benefit.
N/A	Limit or exclude night-time operations.	Would eliminate potential impacts of artificial light during hours of darkness when light sources are more apparent and potential impacts are greatest.	Would double duration of the Activity; increase impacts or potential impacts in other areas including increase in waste, air emissions, risk to navigation and increase potential for vessel collision.	**Not Adopted** – Given the minimal risk of impacts to turtles occurring, the costs of extending Activity duration outweigh the benefits.

Santos

6.3.4 Impacts and Consequence Ranking

Receptor	Consequence Level
Light emissions	
Threatened / Migratory Fauna	Light emissions from the Survey may result in change in behavioural responses to fishes, sharks, marine turtles and seabirds. *Fishes and sharks* The light assessment boundary overlaps a foraging BIA for whale sharks. No long term or population impacts to whale sharks are predicted thus the consequence level is assessed as **A-negligible**. *Marine turtles* The light assessment boundary overlaps an inter-nesting BIA for flatback turtles. The potential impacts of light emissions to turtles from the activities are expected to be restricted to localised attraction and temporary disorientation. There will be no long term or residual impacts due to the near continual movement of the vessels to survey locations and the lack of overlap with habitat critical areas associated with nesting adults and emerging/dispersing hatchings. No long term or population impacts to marine turtles are predicted thus the consequence level is assessed as **A-negligible.** *Seabirds* The light assessment boundary overlaps the breeding and foraging BIAs for the lesser frigate bird and brown booby. Seabirds have been shown to be attracted to artificial light sources, however, the low level of light emitted from vessels is unlikely to lead to large scale changes in species abundance or distribution (Commonwealth of Australia 2020). Impacts to seabirds will be limited to short-term behavioural effects with no decrease in local population size, area of occupancy of species or loss or disruption of Habitat Critical / disruption to the breeding cycle. It is considered that the Activity will not result in population impacts to seabirds and the impact of lighting associated with the Activity to seabirds is A-**negligible**.
Physical Environment/ Habitat	Not applicable – no physical environments and/or habitats are identified in the area where light emissions could occur other than open water, which will not be impacted.
Threatened ecological communities	Not applicable – no threatened ecological communities are identified in the area where light emissions could occur.
Protected Areas	Not applicable – no protected areas are identified in the area where light emissions could occur.
Socio-economic receptors	Not applicable – lighting is not expected to cause an impact to socio-economic receptors other than as a visual cue for avoidance of the area.
Overall worst-case consequence	A – Negligible Given the considerable distance offshore from turtle and seabird nesting sites and associated nearshore waters, disruption to nesting activities are not be expected. There is a low probability that individual turtles and seabirds will be attracted by the light source at sea for a short period.

6.3.5 ALARP Evaluation

There are no safe alternatives to the use of artificial lighting on the vessels. Artificial lighting is required on a 24-hour basis for navigational safety in the area and additional light is required to allow the Activity to proceed safely on a 24-hour basis for occupational health and safety reasons.

Santos has considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a) to minimise lighting impacts on marine turtles, especially flatback turtles. The impacts of lighting to the receiving environment are well understood and the consequence is expected to be low. The Operational Area is 126 km from the nearest nesting beach (Eighty Mile Beach), this distance is considerably further than the EPA's estimated light influence distance of approximately 1.5 km (EPA, 2010). The National Light Pollution Guidelines for Wildlife (Commonwealth of Australia 2020) precautionary threshold of 20 km, suggests impacts are not expected on fauna including turtles at nesting beaches (inter-nesting adults or emerging hatchlings). Artificial lighting impacts from operational Activities will be limited to short-term behavioural effects on transient marine turtles, fish and seabirds. The risks of using 24-hour artificial lighting at an intensity to allow work to proceed are considered ALARP with the control measure adopted.

6.3.6 Acceptability Evaluation

Is the consequence ranked as A (Negligible) or B (Minor)?	Yes – maximum consequence from light emissions is A (Negligible).
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with *Navigation Act 2012,* Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a) and National Light Pollution Guidelines for Wildlife (DoEE, 2020)
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

The potential consequences of anthropogenic light sources in the Operational Area are likely to be insignificant in nature and restricted to turtle, fish and bird species that are transient in the area. The scale of the anticipated impacts is not expected to be significant, with a small number of individual turtles, fish and birds that may potentially be affected in the immediate area; the nature of the impact will generally be restricted to behavioural effects. Given the temporary nature of the Activity, as well as the anticipated negligible consequences of lighting from the Activity, the Activity is considered to be conducted in a manner that is consistent with the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a). With the adopted control measure and short-term nature of the Survey, the impacts of artificial lighting to the receiving environment are considered environmentally acceptable

6.4 Underwater Noise Emissions

6.4.1 Description of Event

Aspect	Underwater noise emissions will be generated by: • the survey vessel activities • the geophysical survey equipment, including SBES, MBES, SSS, and a SBP; and • underwater acoustical positioning equipment. • helicopter activities in the Operational Area. Noise originating from these sources could potentially have the following effects on marine fauna: • Masking of vocalisations / signals from predators / prey; • Modification of fauna behaviour (avoidance / attraction / disruption of normal behaviour); and • Physical injury to fauna from exposure to excessive noise (barotrauma, hearing loss).
Extent	Localised: A representative survey vessel will have sound levels which do not exceed the marine mammal behavioural disturbance threshold beyond 1800 km during survey activities, and 7.5 km when holding station under dynamic positioning. Localised: A conservative estimate for the use of geophysical equipment (SBESs, MBESs, SSS and SBP) is within a few hundred metres radius depending on the Activity characteristics. Localised: A conservative estimate for the use of underwater positioning equipment (USBL) is within hundreds of metres of the source Localised: Helicopter noise will be highly localised as the majority of the noise will not transfer into the water.
Duration	For the duration of the Activity, as described in **Section 2**.

6.4.1.1 Noise generated from vessels

Noise associated with vessel Activity that could impact marine fauna includes noise generated by vessel thrusters, engines and propellers, as well as noise emitted onboard which is converted to underwater noise through the hull (e.g. from heavy machinery). The main source of vessel noise will be from propellers or Dynamic Positioning (DP) thrusters. For the purpose of this impact assessment, survey representative vessels (refer **Section 2.5**) have been used.

Survey vessel

Noise will be generated during transit, towing of geophysical sources and seafloor sampling. The vessels under consideration have total power levels (main propellers and thrusters) of between 7380 and 8960 kW (9900 to 12000 hp). A reasonable proxy for transiting can be calculated considering measurements of similar vessels within this class (MacGillivray et al. 2018) on JASCO's Underwater Listening Station (ULS) (Hannay et al. 2016). Offshore supply vessels at 9 kts were considered in McPherson et al. (2019a), and these have been scaled based upon speed to consider survey operations at 4.5 kts, resulting in an estimated monopole source level of 169 dB re 1 µPa @ 1m. DP operations have been estimated to be equivalent to that of the dive support vessel DSV Fu Lai (MacGillivray 2006), a 12,832 hp vessel, measured operating at 20% and 30% of capacity. Therefore, the monopole source level of the survey representative vessel (refer Section **2.5**), the MMA Vigilant, under DP is estimated to be 178.2 dB re 1 µPa @ 1m.

Support vessel

Noise from the MMA Searcher representative survey vessel (54m long 3200 HP (2386 kW)) have been approximated from vessels with greater installed power. The sound levels from the representative support vessel are likely to be less then to those from R/V Ocean Pioneer, a 62-m long 5600 HP (4175 kW) vessel. The R/V Ocean Pioneer was measured during transit at 10 kts and found to have a monopole source level of 166.3

dB re 1 µPa @ 1m (Chorney et al. 2011). In this study, in the arctic in 46 m of water, the maximum distance to 120 dB re 1 µPa was found to be 1600 m. Scaling the measurements of the R/V Ocean Pioneer at 10 kts, to estimate the MMA Searcher at 6 kts results in an estimated monopole source level of 153 dB re 1 µPa @ 1m. The R/V Ocean Pioneer was measured under DP, and calculated to have a 95% fit source level of 175.9 dB re 1 µPa @ 1m (Chorney et al. 2011).

To place this in context with other studies, McCauley (1998) measured underwater sound levels from the Pacific Ariki, a 64 m long support vessel with 8000 HP (6000 kW) main engines during calm conditions in the Timor Sea in 110 m of water while transiting at 11 kts, and found the distance to 120 dB re 1 µPa to be approximately 1 km.

The 54 m long 3200 HP (2386 kW) Mermaid Searcher representative survey vessel (refer **Section 2.5**) is likely over-estimated when considering either the Ocean Pioneer or the Pacific Ariki, due to the higher speeds and more powerful engines, although the work-rate of the engines, and thus output power and noise, will depend upon speed and sea-state, and the propagation will depend upon the location.

The thrusters on the MMA Searcher are significantly smaller than the main engines (only 600 kW total installed thruster power, compared to 2386 kW). However, for comparison to the survey vessel, the same scaling approach was taken for DP, using the known measurement power level of the DSV Fu Lai and applying scaling for the total installed power on the MMA Searcher. Therefore, the monopole source level of the representative vessel, the MMA Searcher, under DP is estimated to be 172 dB re 1 µPa @ 1m.

Estimates of ranges to sound levels

Practical spreading loss, $15\log_{10}$(Range) (Urick, 1983), is a reasonably conservative approach to take in waters on the continental shelf, representing a balance between spherical and cylindrical spreading. The estimated ranges using this approach are shown in **Table 6-2**.

Table 6-2: Estimated vessel sound levels

Vessel and Operation	Estimated range to 120 dB re 1 µPa (SPL) (km)†
Survey vessel, 4.5 kts (survey)	1.8
Survey vessel, DP	7.5
Support vessel, 6 kts (transit)	0.15
Support vessel, DP	2.9

†using practical spreading loss ($15\log_{10}$(Range)).

Considering the monopole source levels for both vessels under different operational states, and operating in a single location for 24 hours, allows the accumulated sound levels to be estimated through the addition of $10*\log_{10}$ (time in seconds) to sound levels. This approach can be used to calculate the unweighted Sound Exposure Level (SEL), which can be used in a conservative comparison against relevant SEL impact assessment thresholds. This has been calculated only for the survey vessel under DP, as this is the scenario which is associated with the highest monopole source levels, but also when the vessel is likely to be stationary for a longer period of time.

6.4.1.2 Underwater acoustic positioning

An acoustic pulse is transmitted by the transceiver and detected by the subsea transponder, which replies with its own acoustic pulse. This return pulse is detected by the shipboard transceiver. The time from the transmission of the initial acoustic pulse until the reply is detected is measured by the USBL system and is converted into a range. To calculate a subsea position, the USBL calculates both a range and an angle from the transceiver to the subsea beacon. Angles are measured by the transceiver, which contains an array of transducers. The transducer will then send sound signals, typically at 19 to 33 kHz to a USBL transponder.

A typical and widely used USBL system is the Sonardyne Ranger USBL. The source level and frequency range of this system from previous field measurements (Warner and McCrodan, 2011) were found to be 18-36 kHz and 204 dB re 1 µPa @1m (SPL). The per-pulse SEL source level was 173 dB re 1 µPa^{2}s @ 1 m, and the measured maximum Peak (PK) was approximately 170 dB re 1 µPa at 30 m. This source can be considered an impulsive sound source for impact assessment purposes for this Activity. Austin et al. (2012) calculated the distances to SPL isopleths for the Ranger USBL in open water and found the distance to 160 dB re 1 µPa (SPL) to be 36 m. Considering 1000 impulses at 40 m range through summing the received SEL from each impulse results in an unweighted SEL of 144 dB re 1 µPa^{2}s, which can be used in a conservative comparison against relevant SEL impact assessment thresholds.

6.4.1.3 Single and Multibeam Echo Sounder

Typical MBESs used in survey work include the Reson Seabat and the R2Sonic products. These systems operate at 200-400kHz, with a variable total beam width, although 60° is common. For example, the transmit power from a R2Sonic 2024 echo sounder is up to 221 dB re 1 µPa @1m (SPL), with a short (15 µs to 1ms) pulse width, however the operational power level and pulse width influence the potential sound fields. This source can be considered an impulsive sound source for impact assessment purposes for this Activity. Measurements for the R2Sonic 2024 were reported in Martin et al. (2012), who measured a maximum SPL of 162 dB re 1 µPa at 4 m, with the system operating at an average pulse length of 0.11 ms. The accumulated SEL over 363 measured pulses was 121.5 dB re 1 µPa^{2}s. Measurements of another similar system, the Reson SeaBat 8101 MBES operating at 240 kHz were reported in Chorney et al. (2011). These measurements show that at 40 m, the PK levels are approximately 170 dB re 1 µPa, and the per-pulse SEL 130 dB re 1 µPa^2·s. Zykov (2013) modelled an R2Sonic 2022, another similar MBES, and found that the sound levels would not exceed an unweighted 171 dB re 1 µPa^2·s more than 2 m from the source while conducting a 2.5 h geophysical survey. Additionally, this sonar generates only high frequency signals, and as such will only be relevant for fauna with sensitivity to signals of approximately 200 kHz or higher, which excludes low-frequency cetaceans, fish, and turtles.

SBESs are less powerful then MBESs, therefore the information supplied for MBES is considered representative of the potential outputs from SBES.

6.4.1.4 Side Scan Sonar

SSS typically output signals at 100 to 450 kHz, for example the EdgeTech 4200-FS Digital Towfish operating at 120 and 410 kHz has been studied in similar surveys). Measurements of an EdgeTech 4200 were reported in Crocker and Fratantonio (2016) for 100 and 400 kHz modes, with a maximum per-pulse source level of 176 dB re 1 µPa^{2}s @ 1m (SEL), 205 dB re 1 µPa @ 1m (SPL) and 210 dB re 1 µPa @1m (PK). Austin *et al*. (2013)also measured the system during an operational program, focusing on the 120 kHz impulses. The authors reported a PK of less than 175 dB re 1 µPa and an SPL of less than 170 dB re 1 µPa at 39 m, with the distance from pulses to an SPL of 160 dB re 1 µPa calculated to be 130 m. The sonar is highly directional, based on the configuration of the transducers, and thus has a focused beam of energy, with distances to sound levels outside the beam significantly less than those in the beam. Towfish SSS are towed close to the seafloor, typically 10 to 20 m above the seabed, thus the beam will be restricted to a swath close to the seabed. Additionally, this type of sonar generates only high frequency signals, and as such will only be relevant for fauna with sensitivity to signals of approximately 110 kHz or higher, as shown in Austin et al. (2013), which excludes low-frequency cetaceans, fish, and turtles.

6.4.1.5 Sub Bottom Profiler

Based on a review of the geophysical equipment to be used for survey it was identified that the SBP boomer and CHIRP types were most relevant to the assessment of potential impacts to receptors, due to their operating frequencies and source sound levels. Within each type, there are different models with different output sound levels.

Recent work in the Otway Basin in similar water depths (McPherson and Wood, 2017, and Wood and McPherson 2019) considered two representative systems: a range of boomers (AP3000, AA251, AA300 and AA301) and an Edgetech X-star system CHIRP. The Edgetech X-star CHIRP SBP is installed on a towfish, lower and upper limits of the sonar's frequency band are 2 and 16 kHz, respectively, providing a sound pressure level of 191.7 dB re 1 µPa. This source was found to not exceed the National Marine Fisheries Service (US) (NMFS) (2018) thresholds for Permeant Threshold Shift (PTS) or Temporary Threshold Shift (TTS), and that a sound level of 160 dB re 1 µPa (SPL) was reached at 2 m from the source.

The assessment of the four boomers identified the AA301 has having the highest peak source pressure level of 215 dB re 1 μPa^2m^2, with others ranging from 210.8 to 212 dB re 1 μPa^2m^2. The per-pulse SEL the modelling results presented in McPherson and Wood (2017) for SEL_{24h} from the AP3000 boomer are considered to be appropriate approximations of the potential sound fields and ranges to SEL_{24h} impact criteria for the range of SBP boomers (Wood and McPherson 2018). The modelling study detailed in the Beach Energy Otway Basin Geophysical Operations Environment Plan found that the NMFS (2018) thresholds for PTS in low and mid-frequency cetaceans, including those for accumulated SEL, were not exceeded, and that a sound level of 160 dB re 1 µPa (SPL) was reached at 145 m from the source.

The work presented in support of the Beach Energy Otway Basin Geophysical Operations Environment Plan is relevant as the water depth is similar, the geology is also based upon a sand and calcarenite environment, and that the relevant ranges are close to the source, thus the environment beyond a few water depths has no influence on predictions.

6.4.1.6 Noise Generated from a Helicopter

Sound traveling from a source in the air (e.g., a helicopter) to a receiver underwater is affected by both in-air and underwater propagation processes, which are further complicated by processes occurring at the air-seawater surface interface (e.g., wind and waves). The level of noise received underwater depends on source altitude and lateral distance, receiver depth, water depth, and other variables.

Helicopter engine noise is emitted at various frequencies; however, the dominant tones are generally of a low frequency below 500 Hertz (Hz) (Richardson et al., 1995). Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. Noise also reduces with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude, with sound penetrating water at angles <13°. The noise from the flyover of a Bell 214 helicopter (stated to be a noisy model) has been recorded underwater (Richardson et al., 1995). The recorded broadband sound level was 109 dB re 1 µPa (SPL) when the helicopter was 152 m from the surface, with dominant frequencies below 500 .

6.4.2 Nature and Scale of Environmental Impacts

The Operational Area only overlaps with a foraging BIA for whale sharks, and breeding and foraging BIA for the lesser frigatebird. The Operational Area does not overlap with protected areas, including Australian Marine Parks. Use of sound in the underwater environment is important for marine animals, particularly cetaceans, to navigate, communicate and forage effectively, along with reptiles, sharks/rays and other fish, for a range of functions such as social interaction, foraging and orientation. Underwater noise may impact on marine fauna in the following ways:

+ Attraction;
+ Increased stress levels;
+ Disruption to underwater acoustic cues;
+ Localised avoidance;
+ Disturbance, leading to behavioural changes or displacement from areas;

- Masking or interference with other biologically important sounds such as communication or echolocation (used by certain cetaceans for location of prey and other objects);
- Physical injury to hearing or other organs; and
- Indirectly by inducing behavioural and physiological changes in predator or prey species.

The nature and scale of impacts must be considered in the context of the ambient noise environment. Ambient underwater noise levels are dependent on location, and are often dominated by local wind noise, waves, biological noise and ship traffic. Wind speed and seabed conditions have a clear influence on the ambient noise level. Coral reefs are one of the noisiest habitats in the ocean, with sources such as breaking swells, snapping shrimp and fish choruses (Amoser and Ladich, 2005). Broadband levels on reefs are typically 95–110 dB re 1 µPa with a high proportion of low frequency noise (Tolimieri et al., 2000). Fish choruses are capable of raising background noise levels to 120–130 dB re 1 µPa (McCauley, 2011). Anthropogenic underwater noise sources in the region comprise shipping and small vessel traffic, petroleum-production and exploration-drilling activities and sporadic petroleum seismic surveys.

The survey will involve the vessel, acoustic positioning through USBL, SBES, MBES, SSS and boomer and CHIRP SBP, as detailed in **Section 2.4**. These sound sources are both non-impulsive (vessel) and impulsive (USBL, MBES, SSS, and boomer and CHIRP SBP), and thus require the consideration of different criteria to assess their potential impact.

Marine fauna respond variably when exposed to underwater noise from anthropogenic sources, with effects dependent on a number of factors, including distance from the sound source, water depth and bathymetry, the animal's hearing sensitivity, type and duration of sound exposure and the animal's Activity at time of exposure. Broadly, the effects of sound on marine fauna can be categorised as:

- acoustic masking – anthropogenic sounds may interfere with, or mask, biological signals, therefore reducing the communication and perceptual space of an individual. Auditory masking impacts may occur when there is a reduction in audibility for one sound (signal) caused by the presence of another sound (noise). For this to occur the noise must be loud enough and have a similar frequency to the signal and both signal and noise must occur at the same time.
- behavioural response – behavioural impacts will depend on the audible frequency range of each potential receptor in relation to the frequency of the noise, as marine animals will only respond to acoustic signals they can detect, as well as the intensity of the noise. The intensity of behavioural responses of marine mammals to sound exposure ranges from subtle responses, which may be difficult to observe and have little implications for the affected animal, to obvious responses, such as avoidance or panic reactions. The context in which the sound is received by an animal affects the nature and extent of responses to a stimulus. The threshold for elicitation of behavioural responses depends on received sound level, as well as multiple contextual factors such as the Activity state of animals exposed to different sounds, the nature and novelty of a sound, spatial relations between a sound source and receiving animals, and the gender, age, and reproductive status of the receiving animal.
- physiological impacts – auditory threshold shift (temporary and permanent hearing loss) – marine fauna exposed to intense sound may experience a loss of hearing sensitivity, or even potentially mortal injury. Hearing loss may be in the form of a TTS from which an animal recovers within minutes or hours, or a PTS from which the animal does not recover.

Available threshold criteria associated with behavioural and physiological impacts for sensitive receptors have been derived from a number of sources (NMFS, 2018; NMFS 2014; Popper et al 2014). These criteria have been compared with measured and predicted sound levels for different sound sources to assess potential impacts.

6.4.2.1 Marine mammals

No known aggregation, resting, breeding or feeding areas for cetaceans lie in close proximity to the Operational Area. However, cetaceans may travel through the area, with the Operational Area being within the distribution BIA for the blue whale and 20 km north of the migration BIA for the humpback whale. The closest foraging BIA for dugongs is 300 km from the Operational Area, therefore the presence of dugongs is very unlikely. The relevant species are described in **Section 3.2.3**, and includes both low and mid-frequency cetaceans.

Table 6-3 and **Table 6-4** detail receptor noise impact and behavioural thresholds for continuous noise (vessels) and impulsive noises (survey equipment).

Table 6-3: Continuous Noise: Acoustic effects of continuous noise on marine mammals: Unweighted SPL and SEL_{24h} thresholds

Hearing Group	NMFS (2014)	NMFS (2018)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (Lp; dB re 1 µPa)	Weighted SEL_{24h} (LE,24h; dB re 1 µPa2·s)	Weighted SEL_{24h} (LE,24h; dB re 1 µPa2·s)
Low-frequency cetaceans	120	199	179
Mid-frequency cetaceans		198	178
Sirenians (dugong)		206	186

Table 6-4: Impulsive Noise: 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 (Lp; dB re 1 µPa)	Weighted SEL_{24h} (LE,24h; dB re 1 µPa2·s)	PK (Lpk; dB re 1 µPa)	Weighted SEL_{24h} (LE,24h; dB re 1 µPa2·s)	PK (Lpk; dB re 1 µPa)
Low-frequency cetaceans	160	183	219	168	213
Mid-frequency cetaceans		185	230	170	224
Sirenians (dugong)		190	226	175	220

6.4.2.1.1 Potential impacts from survey vessel

Auditory masking impacts may occur when there is a reduction in audibility for one sound (signal) caused by the presence of another sound (noise). For this to occur the noise must be loud enough and have a similar frequency to the signal and both signal and noise must occur at the same time. Therefore, the closer the marine mammal is to the vessel, and the more overlap there is with their vocalisation frequencies, the higher the probability of masking. The potential for masking and communication impacts is therefore classified as high near the vessel (within tens of metres), moderate within hundreds to low thousands of metres (Clark et al, 2009).

There is a potential for auditory masking impacts to marine mammals due to vessel noise however impacts are considered temporary and localised because the marine fauna and the survey vessel will be almost constantly moving and therefore no single area will be impacted for any length of time.

The estimated distances to behavioural and physiological thresholds (as listed in **Table 6-3**) for marine mammals are provided in **Table 6-5**.

Table 6-5: Estimated distances to behavioural and physiological thresholds (as listed in Table 6-3) for marine mammals from vessels

Potential Marine Fauna Receptor	Estimated Distance	Justification
PTS†		
Low-Frequency (LF) cetaceans	80 m	Based upon accumulation of unweighted SEL over 24 h for a vessel with a source level of 178.2 dB re 1 µPa (SPL), and applying practical spreading loss, see **Section 6.4.1.1**
Mid-Frequency (MF) cetaceans and dugongs	Not predicted to occur	Not predicted to occur for vessels with a significantly greater power output (McPherson et al. 2019b)
TTS†		
Low-Frequency (LF) cetaceans	1729 m	Based upon accumulation of unweighted SEL over 24 h for a vessel with a source level of 172.2 dB re 1 µPa (SPL), and applying practical spreading loss, **Section 6.4.1.1**.
Mid-Frequency (MF) cetaceans and dugongs	Not predicted to occur	Not predicted to occur for vessels with a significantly greater power output (McPherson et al. 2019b)
Behaviour		
Low-Frequency (LF) cetaceans	0.15 to 7.5 km, operation and vessel dependent	See **Table 6-2**.
Mid-Frequency (MF) cetaceans and dugongs		

†Considered for survey vessel under dynamic positioning only, as this is the most conservative scenario.

6.4.2.1.2 Potential impacts from survey equipment and positioning equipment

The sound levels from positioning equipment are described in **Sections 6.4.1.2**. The proposed equipment has sound levels which could reach the threshold for behavioural disturbance (**Table 6-4**) within 36 m. A nominal accumulation scenario for 1000 impulses results in an unweighted accumulated SEL significantly below thresholds for PTS and TTS in marine mammals. The measured PK at 30 m was 170 dB re 1 µPa, therefore considering both SEL and PK metrics within the criteria (**Table 6-4**), PTS and TTS are not predicted to occur from the positioning equipment.

The sound levels from MBES are described in **Section 6.4.1.3.** The measurement study from Martin et al. (2012) indicates that the threshold for behavioural disturbance (**Table 6-4**) could be exceeded within less than 10 m. PTS and TTS due to SEL is not predicted to occur, considering that a measurement of along a trackline with a closest point of approach of 4 m didn't result in accumulated unweighted levels higher than 121.5 dB re 1 µPa2s. PTS and TTS considering PK is unlikely to occur given the measurement of 170 dB re 1 µPa PK at 40 m. Therefore, considering both SEL and PK metrics within the criteria (Table 6-4), PTS and TTS due to the MBES are not predicted to occur.

The sound levels from SSS are described in **Section 6.4.1.4**. The measurement study Austin et al. (2013) indicates that the threshold for behavioural disturbance (**Table 6-4**) could be exceeded within less than 130 m for marine mammals within the highly directional source output beam pattern. The reported per-pulse sound levels at 40 m are similar to those from the MBES, which isn't predicted to exceed either the PTS or

TTS criteria considering both SEL and PK metrics (**Table 6-4**), this similarly applies to SSS which is not predicted to exceed the PTS or TTS criteria also. Additionally, the per-pulse peak pressure source level of the SSS (**Section 6.4.1.4**) is below the PK criteria threshold, therefore the criteria cannot be exceeded.

The sound levels from the two SBP systems (**Section 6.4.1.5**) of greatest risk, a boomer SBP and a CHIRP SBP, are described in **Section 6.4.1.5**. The modelling results from McPherson and Wood (2017) and Wood and McPherson (2019) indicates that the threshold for behavioural disturbance (**Table 6-4**) could be exceeded within less than 145 m for the boomer. PTS due to SEL is not predicted to occur, although the SEL_{24h} threshold for TTS could be exceeded within 10 m of the source. None of the PK metric criteria (**Table 6-4**) are exceeded.

Survey and positioning equipment could cause masking of vocalisations of cetaceans due to the overlap in frequency range between signals and vocalisations. However, due to the limited propagation range of the relevant frequencies (higher frequencies attenuate rapidly), the range at which the impact could occur will be small, within hundreds of meters. The masking will apply to MF cetaceans for the positioning equipment, MBES, and SSS, with all signals above 2 kHz. The boomer SBP could potentially mask vocalisations from LF cetaceans, as it has a primary frequency range from 100 to 1000 Hz, however the low source levels mean the ranges will be small to moderate, within hundred to low thousands of meters.

Given the transient and mobile nature of the survey, the operating frequencies and noise maxima of the survey equipment (detailed in **Section 6.4.1**) effects of noise on marine mammals is expected to be limited to behavioural responses within up to a few kilometres of the survey vessel depending on the heading range of the receptors.

6.4.2.1.3 Potential impacts from helicopters

Reactions of whales to circling aircraft (fixed wing or helicopter) are sometimes conspicuous if the aircraft is below an altitude of 300 m, uncommon at 460 m and generally undetectable at 600 m (NMFS, 2014). The effects on whales seem transient, and occasional overflights probably have no long-term consequences on cetaceans (NMFS, 2014). Observations by Richardson and Malme (1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single helicopter passes by low-flying helicopters ferrying personnel and equipment to offshore operations at altitudes above 150 m. Leatherwood et al. (1982) observed that minke whales responded to helicopters at an altitude of 230 m by changing course or slowly diving.

6.4.2.2 Marine reptiles

Marine turtles use sounds for navigation, to avoid predators and to find prey (Dow Piniack 2012). Turtles have been shown to become agitated to sound pressure levels above 175 dB re 1 µPa (McCauley et al. 2000). The threshold level of 166 dB re 1 µPa is used as a behavioural disturbance response by turtles (NSF 2011).

The Recovery Plan for Marine Turtles (Commonwealth of Australia, 2017) notes there is limited information available on the impact of noise on marine turtles and that the impact of noise on turtle stocks may vary depending on whether exposure is short (acute) or long term (chronic). Turtles have been shown to respond to low frequency sound, with indications that they have the highest hearing sensitivity in the frequency range 100–700 Hz (Bartol and Musick, 2003).

No numerical thresholds have been developed for impacts of continuous sources (e.g. vessel noise) on marine turtles. However, Popper *et al.* (2014) have developed risk-based criteria, and these are presented in **Table 6-6**. Survey equipment and positioning equipment are considered impulsive sources for this assessment, therefore the criteria from Popper *et al.* (2014) for seismic airguns, an impulsive source, has been adopted (**Table 6-7**).

Table 6-6: Continuous Noise: Criteria for vessel noise exposure for turtles, adapted from Popper et al. (2014)

Potential Marine Fauna Receptor	Masking	Behaviour	TTS	Recoverable injury	Mortality and Potential mortal injury
Marine Turtle	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F)Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of meters, intermediate (I) - hundreds of meters, and far (F) – thousands of meters.

Table 6-7: Impulsive noise: Criteria for impulsive noise exposure for turtles, adapted from Popper et al. (2014)

Potential Marine Fauna Receptor	Masking	Behaviour	TTS	Recoverable injury	Mortality and Potential mortal injury
Marine Turtle	(N) Low (I) Low (F)Low	(N) High (I) Moderate (F) Low	(N) High (I)Low F) Low	(N) High (I) Low (F) Low	> 210 dB SEL_{24h} or > 207 dB PK

6.4.2.2.1 Potential impacts from survey vessel

Based on the criteria detailed within **Table 6-6** there is a low risk of any injury to marine turtles from vessel noise (**Section 6.4.1.1**). Behavioural changes, e.g. avoidance and diving, are only predicted for individuals in close proximity to the Activity vessels (high risk of behavioural impacts within tens of metres of a vessel and moderate risk of behavioural impacts within hundreds of metres of a vessel). There is a high risk of masking within hundreds of meters of the vessel, and a moderate risk of masking within thousands of metres from the vessel. Turtles have not been shown to have a reliance on sound for finding food or avoiding predators. Sounds potentially could be used by turtles in a social manner to synchronise activities during the nesting season (Ferrara et al. 2014), however this has not been demonstrated for sea turtles. The noises are relatively quiet (Ferrara et al. 2014), and thus would only have a limited range of detection by turtles even in ideal conditions, with masking from natural sounds likely. The impacts from masking are expected to be low.

6.4.2.2.2 Potential impacts from survey equipment and positioning equipment

The sound levels of the survey equipment and positioning equipment (Table 6-3, Description of Event and Section 6.4.1) are below those associated with the PK criteria for injury (Table 6-7) beyond a few metres, and are low enough that SEL criteria will not be reached (McPherson and Wood, 2017)). Recoverable injury and TTS could occur within tens of metres applying the relative risk criteria from Popper et al, (2014) (Table 6-7). Behavioural changes, e.g. avoidance and diving, are only predicted for individuals in close proximity to the source (high risk of behavioural impacts within tens of metres of source and moderate risk of behavioural impacts within hundreds of metres of the source).

Turtles are unlikely to experience masking even at close range to the source from all sources except the boomer SBP. This is in part because the sounds from most survey and positioning equipment (except the boomer SBP) are all outside of the hearing frequency range for turtles, which for green and loggerhead turtles is approximately 50–2000 Hz, with highest sensitivity to sounds between 200 and 400 Hz (Ridgway et al. 1969, Ketten and Bartol 2005, Bartol and Ketten 2006, Bartol 2008, Yudhana et al. 2010, Piniak et al. 2011, Lavender et al. 2012, 2014). The boomer SBP could potentially mask turtle hearing, as it has a primary frequency range from 100 to 1000 Hz, however the low source levels mean the ranges will be small to moderate, within hundred to low thousands of meters.

6.4.2.2.3 Potential impacts from helicopters

Helicopter noise will be intermittent during the Activity, and given the low sound levels of helicopters (**Section 6.4.1.6**) below the thresholds for behavioural impacts, PTS and TTS, it is unlikely that they will disturb turtles, therefore an assessment has not been conducted.

6.4.2.3 Sea snakes

There is limited information on the effects of noise on sea snakes. A current research project investigating the impacts of seismic surveys found that hearing sensitivity of sea snakes is similar to species of fish without a swim bladder (discussed below). Therefore, it is considered that there is a moderate risk in the near and intermediate distances (which extends hundreds of metres) of behavioural impacts to sea snakes, with the impacts being limited to temporary avoidance of the area.

6.4.2.4 Sharks, fish and rays

All fish species can detect noise sources, although hearing ranges and sensitivities vary substantially between species (Dale et al., 2015). Sensitivity to sound pressure seems to be functionally correlated in fishes to the presence and absence of gas-filled chambers in the sound transduction system. These enable fishes to detect sound pressure and extend their hearing abilities to lower sound levels and higher frequencies (Ladich and Popper, 2004; Braun and Grande, 2008). Based on their morphology, Popper et al. (2014) classified fishes into three animal groups comprising:

+ Fishes with swim bladders whose hearing does not involve the swim bladder or other gas volumes;
+ Fishes whose hearing does involve a swim bladder or other gas volume; and
+ Fishes without a swim bladder that can sink and settle on the substrate when inactive.

Thresholds for PTS and recoverable injury are between 207 dB PK and 213 dB PK (depending on the presence or absence of a swim bladder), and the threshold for TTS is 186 dB SELcum (Popper *et al*., 2014). Given there is no exposure criteria for sharks and rays, the same criteria are adopted, though typically sharks and rays do not possess a swim bladder.

Individual demersal fish may be impacted in the vicinity of the Activity and tuna and billfish and other mobile pelagic species may transverse the Operational Area. However, the Operational Area is not known to be an important spawning or aggregation habitat for commercially caught targeted species. Therefore, no impacts to fish stocks are expected.

The criteria defined in Popper *et al.* (2014) for continuous (**Table 6-8**) and impulsive (**Table 6-9**) noise sources has been adopted.

Table 6-8 Continuous noise: Criteria for noise exposure for fish, adapted from Popper et al. (2014)

Potential Marine Fauna Receptor	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB SPL for 48 h	158 dB SPL for 12 h	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of meters, intermediate (I) - hundreds of meters, and far (F) – thousands of meters.

Table 6-9: Impulsive noise: Criteria for noise exposure for fish, adapted from Popper et al. (2014)

Potential Marine Fauna Receptor	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
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

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of meters, intermediate (I) - hundreds of meters, and far (F) – thousands of meters.

6.4.2.4.1 Potential impacts from vessels

Based on criteria developed by Popper *et al.* (2014) for noise impacts on fish, vessel noise has a low risk of resulting in mortality and a moderate risk of TTS impacts when fish are within tens of metres of a vessel. The most likely impacts to fish from noise will be behavioural responses. Popper et al. (2014) identified a moderate risk of behavioural impacts to fish in near (tens of metres) and intermediate distances (hundreds of metres) from the noise source. Masking could occur within thousands of metres under a worst-case scenario of vessel operations, however typically any effect will be limited to within hundreds of metres.

6.4.2.4.2 Potential impacts from survey equipment and positioning equipment

Based on available criteria from Popper et al (2014), potential impacts of survey and positioning equipment on fish have been assessed. Impulsive noises from survey equipment could result in physiological impacts to fish located within metres of the sound source considering the results presented in **Section 6.4.1**. The distances at which this could occur is less than 1.6 m from the source (McPherson and Wood, 2017). The likelihood of fish being close enough to the sound source for physiological impacts to occur is considered remote.

Behavioural impacts to fish from survey equipment noise will be limited to behavioural responses within metres of the noise source. Fish (including sharks and rays) may be temporarily displaced from the vicinity of the noise emissions. The only survey equipment with energy below 1 kHz is the boomer SBP, all other equipment which operates at higher frequencies is unable to be heard by most fish, which further reduces the risk of impact (Ladich and Fay 2013).

The impact of masking is low at all ranges, apart from fish who specialise in pressure detection, which can be impacted in a moderate way at thousands of meters. However, this is only relevant for the boomer SBP, as all other sources have signals outside the hearing range of most fish in the region, which reduces the risk of impact.

6.4.2.4.3 Potential impacts from helicopters

The low sound levels of helicopters (**Section 6.4.1.6**), it is unlikely that they will disturb fish, therefore an assessment has not been conducted.

6.4.2.5 Protected and significant areas

The Operational Area does not overlap with any AMP or any other protected areas. No recognised breeding or resting area for cetaceans, shark turtle or fish species are known to occur in the Operational Area. The closest inter-nesting buffer BIAs for the flatback turtle is 4 km to the south of the Operational Area. Impacts to turtles from noise are discussed above.

6.4.2.6 Socio-economic

Impacts to fish may result in indirect impacts to fisheries in the Operational Area, with impacts restricted to moderate within hundreds of meters of the vessel as detailed above. With the majority of the noise emissions being of short duration and of limited extent, any impact on commercial or recreational fishing is expected to be minimal.

6.4.2.7 Invertebrates

Underwater noise emissions from the Activity are not expected to cause a change in behaviour to benthic invertebrates and the consequence level is assessed as negligible.

6.4.2.7.1 Potential impacts from vessels

To date, there is no convincing evidence for any significant effects induced by non-impulsive noise in invertebrates. Plankton, including fish eggs and larvae, and pelagic invertebrates could drift into close proximity to high-energy noise sources (e.g., bow thrusters). However, any negative impacts that could occur would be restricted to within metres of the sound source. At such a localised extent, impacts would be negligible at an ecosystem or population level.

6.4.2.7.2 Potential impacts from survey equipment and positioning equipment

For impulsive noise and benthic invertebrates, the source is an important consideration in the assessment. Low frequency sources, such as the boomer SBP, can be considered for the purposes of this assessment in the context of scientific findings relevant to seismic surveys, with no other information available to suggest a more appropriate alternative. Therefore, for the boomer SBP, the sound levels defined in *Day et al.* 2016 and Payne *et al.* 2008 are considered appropriate to guide an impact assessment (**Table 6-10**).

Table 6-10: Impulsive noise: sound levels relevant to invertebrates

Receptor	Sound levels
Invertebrates: effect at the seafloor (Day et al. 2016)	186–190 dB SEL 192–199 dB SEL_{24h} 209–212 dB PK-PK
Invertebrates: no effect at the seafloor (Payne et al. 2008)	202 dB PK-PK

Site specific modelling was not conducted against these thresholds for this survey. However, the Beach Energy Otway Basin Geophysical Survey acoustic modelling, Wood, M. A. and C. R. McPherson (2019), for the boomer SBP, did. This work, as described above, was in similar water depths and geological environment, therefore the results can be used to conduct a high-level assessment. The site-specific study in the Otway found that none of the sound levels listed in **Table 6-10** were exceeded. This result is estimated to be appropriate for this survey.

There are no thresholds or information available for the assessment of the potential impacts from high-frequency sources such as SSS or MBES on either water column or benthic invertebrates. These sources are often used to assess and quantify plankton densities, including within McCauley et al (2017), who used a Simrad EK60 echosounder operating at 120 kHz.

6.4.2.7.3 Potential impacts from helicopters

The low sound levels of helicopters (**Section 6.4.1.6**), it is unlikely that they will disturb invertebrates, therefore an assessment has not been conducted.

6.4.3 Description of Cumulative and Additive events

Cumulative and Additive Seismic Impacts	
Aspect	Cumulative and additive impacts refer to situations where successive survey noise activities (either seismic or geophysical surveys) are undertaken over the same area, or where concurrent survey activities occur throughout the region, affecting the same environmental or socio-economic receptors. It is recognised that the effects resulting from surveys, when considered collectively, may result in a greater level of impact or risk than the effects arising solely from the WA-437-P Geotechnical and Geophysical Survey. The two types of impact are defined as follows: • **Cumulative impacts** – Cumulative impacts are considered where the spatial footprint of impacts from previous seismic surveys have occurred over the same area as impacts from the WA-437-P Geotechnical and Geophysical Survey. Cumulative impacts will only occur where the effects of previous surveys overlap the same area and when recovery of the impacts from these seismic surveys has not occurred prior to the WA-437-P Geotechnical and Geophysical Survey commencing. • **Additive impacts** – Additive impacts are different from cumulative impacts and are assessed separately. Additive impacts may result from other surveys, where the effects may or may not overlap spatially, but when taken together have an additive or incremental effect on the same receptors. Additive impacts may occur if other surveys are undertaken concurrent with the WA-437-P Geotechnical and Geophysical Survey and within the range and extent of the same receptors, for example, where both surveys overlap with the distribution of the same population of a marine species or with the same commercial fishery. Cumulative and additive impacts are assessed in relation to the aspects of underwater noise emissions and the physical interaction of the seismic survey activities with other marine users. This section does not assess cumulative impacts from surveys that may occur after the WA-437-P Geotechnical and Geophysical Survey. It is not possible to anticipate what surveys will be planned after this Survey and it is the responsibility of future survey proponents to assess the potential cumulative impacts in their EPs.
Extent	Operational Area (cumulative impacts) North West Marine Region (additive impacts)
Duration	For the duration of the Activity as described in **Section 2**.

6.4.4 Nature and Scale of Cumulative Impacts

The assessment within the Santos Keraudren Survey EP represents previous and potential seismic surveys of relevance to the region, and the Operational Area for the WA-437-P Geotechnical and Geophysical Survey, which lies within the Operational Area of the Keraudren Survey.

The extent of the potential impact of the WA-437-P Geotechnical and Geophysical Survey on relevant receptors is a key consideration in the assessment of cumulative impacts. As the extent of potential acoustic disturbance on receptors is significantly less than that of the Keraudren Survey, based on the assessment presented in **Section 6.4.3**, the cumulative impacts have not been assessed further.

6.4.5 Nature and Scale of Additive Impacts

During this Survey, the Keraudren Survey and other seismic surveys may also occur in the region. The Keraudren Survey EP describes seismic surveys in the region which either had EPs accepted or that are under assessment by NOPSEMA. The WA-437-P Geotechnical and Geophysical Survey may occur at the same time as the Keraudren Survey, if so this Survey will have spatial overlap.

It is important to note that, while some of these seismic surveys may occur at the same time as both the Keraudren Survey and this Activity, it is not credible for all the surveys to occur concurrently or in short succession; or for the entire stated maximum survey areas to be acquired. The large area multi-client surveys are only likely to occur if underwritten by oil and gas operators, and only a proportion of the large area would be acquired. For commercial reasons some of the seismic surveys may not proceed at all.

The extent of potential acoustic disturbance on receptors for the this Survey is significantly less than that of the Keraudren Survey, based on the assessment presented in **Section 6.4.3**, and the extent will fall within the extents of the Keraudren Survey assessment. Therefore, in terms of additive impacts, only the Keraudren Survey has been considered.

6.4.5.1 Sound fields from concurrent survey activities

The additive effects of concurrent seismic surveys in the region include:

+ the effects of multiple individual sound fields in separate geographic locations resulting in spatially separate areas of disturbance, such as when surveys occur at distance from one another; and
+ the potential interaction of sound fields produced by separate surveys, where soundwaves from the separate seismic sources may be received either in synchrony ("in synch") or out of synchrony ("out of synch").

The interaction of two seismic sound fields is a complex issue. An approximation of the implications for concurrent activities of multiple seismic surveys close to the Keraudren Survey was conducted and presented in **Section 6.4.3** of the Keraudren Survey EP. This assessment considered two concurrent sources with per-pulse source sound exposure levels (SEL) representative of typical seismic survey sound sources.

At longer ranges, low-frequency components of a signal dominate, and thus the frequency range of different sources should be considered when assessing additive sound fields. Therefore, consideration of additive sound levels has been conducted for the loudest low-frequency source from the WA-437-P Geotechnical and Geophysical Survey, the boomer SBP, with the Keraudren Survey source.

The maximum per-pulse source SEL of the boomer SBP is 180 dB 1 μPa^2m^2s, significantly lower than 225 dB 1 μPa^2m^2s, the per-pulse source SEL of the 3260 in^3 source considered for the Keraudren Survey. The extent of impacts, detailed in **Section 6.4.2**, are significantly different. For example, the maximum range to the marine mammal behavioural response criterion of 160 dB re 1 µPa (SPL) within the Keraudren Survey varied between 5.66 and 8.84 km, however for the boomer SBP they are predicted to only be 145 m.

Therefore, any additive impacts are expected to be negligible.

Table 6-11: Evaluation of potential additive impacts resulting from the Activity

Receptor category	Description of potential additive impacts
Plankton	No further additive impacts are expected beyond those already assessed for the Keraudren Survey.
Invertebrates	No further additive impacts are expected beyond those already assessed for the Keraudren Survey.
Fish	Behavioural impacts in most demersal and pelagic fish are expected to occur at distances of tens or hundreds of metres from the seismic source used in Keraudren Survey, returning to normal within minutes or hours. Behavioural impacts to fish from geotechnical survey equipment noise will be limited to behavioural responses within metres of the noise source. Therefore, no further additive impacts are expected beyond those already assessed for the Keraudren Survey.

Sharks	No further additive impacts are expected beyond those already assessed for the Keraudren Survey.
Cetaceans	Behavioural disturbances from seismic surveys may result in cetaceans deviating from their course and avoiding the seismic source in proximity to individual survey areas. Given the contrasting ranges to behavioural disturbance from the two concurrent surveys, (**Section 6.4.4**), additional impacts from the geotechnical survey equipment noise are expected to be negligible, and the impacts beyond those already assessed for the Keraudren Survey are not expected.
Marine turtles	Additional impacts from the geotechnical survey equipment noise are expected to be negligible. Therefore, no further additive impacts are expected beyond those already assessed for the Keraudren Survey.
Commercial fisheries	Behavioural impacts to fish are outlined above. No further additive impacts are expected beyond those already assessed for the Keraudren Survey.
Other socio- economic	No further additive impacts are expected beyond those already assessed for the Keraudren Survey.

6.4.6 Environmental Performance and Control Measures

EPO relating to this hazard include:

- EPO-9 – No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed fauna during activities.

The control measures considered for this Activity are shown below with Environmental Performance Standards and measurement criteria for the EPOs described in **Table 8-2**.

The priority action plan for turtles is set out in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017), which states to manage anthropogenic activities to ensure marine turtles are not displaced from identified Critical Habitat. The recovery plan identifies that a precautionary approach should be applied with surveys that have the potential to cause noise interference when undertaken within inter-nesting habitat.

The conservation advice for humpback whales identifies threats from anthropogenic noise and sets out management actions (controls) to address the threat. The assessment of noise emissions has determined that the Activity may have a behavioural impact from anthropogenic noise during the Activity. Therefore, the following two relevant controls from the conservation advice for humpback whales have been assessed:

- Site specific acoustic modelling (as per Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)); and
- Noise management plan (as per Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)).

Control Measures considered for this Activity are outlined below.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-13	Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from vessel and survey equipment, because if they are sighted, then Activity can cease and/or vessels can slow down or move away	Operational costs to adhere to marine fauna interaction restrictions, such as vessel speed and direction, are based on legislated requirements and must be adopted.	**Adopted** – Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos WA. Control drives compliance with EPBC Regulations (Part 8).
CM-14	Constant bridge watch on survey vessel	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost – industry practice	**Adopted** – industry practice, benefits outweigh cost.
N/A	Undertake site specific acoustic modelling as per Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015))	Increase the knowledge of potential impacts. However, noise emissions from geophysical surveys are already well documented.	Additional cost to undertake site specific acoustic modelling.	**Rejected** – Cost is disproportionate to increase in environmental benefit.
N/A	Develop a noise management plan as per approved Conservation Advice for Megaptera novaeangliae (humpback whale) (2015)).	Potential reduction in impacts to marine fauna	Additional cost to develop a noise management plan for a short duration Activity (i.e. a few days) that is low risk to marine fauna.	**Rejected** – Cost is disproportionate to increase in environmental benefit.
N/A	Dedicated Marine Fauna Observer (MFO)	Improved ability to spot and identify marine fauna at risk of impact from vessel and survey noise.	Additional cost of contracting specialist MFO.	**Rejected** – Risk of animals being encountered is too low to justify additional cost of MFO, i.e. cost is disproportionate to environmental benefit.

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N/A	Schedule activities to avoid coinciding with sensitive periods for marine fauna present in the Operational Area	Potential reduction in impact of noise to some sensitive receptors	Impracticable to schedule activities to avoid all listed marine fauna due to variability in timing of environmentally sensitive periods and the constant or unpredictable presence of some species. Short duration Activity (i.e. a few days) that is low risk to marine fauna.	**Rejected** – Cost is disproportionate to increase in environmental benefit

6.4.7 Impacts and Consequence Ranking

Receptor	Consequence Level
Noise from operation of equipment and vessels	
Threatened / Migratory / Protected Fauna	Noise emitted by vessels and the survey Activity will be short in duration and has a limited extent (**Section 6.4.2.1** and **Section 6.4.2.2**). Potential PTS to low-frequency cetaceans could occur within 80 m of the centre of the vessel (considering a vessel that is 80 m long) if the vessel and the cetacean remained in the same place for 24 hours. However, the vessel will never remain in the one position for this long during the geophysical survey activities, and as cetaceans are also always moving, the potential for this impact is extremely low. Furthermore, by implementing the above control measures whereby project vessels will not travel greater than 6 knots within 300 m of a cetacean or turtle (caution zone) and will not approach closer than 100 m from a whale means PTS would not be experienced. Any potential related marine fauna behavioural impacts are expected to be temporary and short ranged and are not expected to lead to long-term changes in individual behaviour (e.g. migration) or lead to changes at the population level. Noise impacts to marine fauna is assessed as being **negligible**.
Physical Environment/ Habitat	Not applicable – noise will not impact the physical environment itself, only the species mentioned above utilising it.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which noise emissions are expected.
Protected Areas	Not applicable- The Operational Area does not overlap with protected areas, including Australian Marine Parks
Socio-economic receptors	Noise levels are not expected to impact on socio-economic receptors due to their low Activity level within the vicinity of the Operational Area. Impacts to fish may result in indirect impacts to fisheries in the area. However, considering the noise emissions are localised, the available catch area for commercial fishermen and the area over which commercial species spawn, impacts to fisheries are considered acceptable and assessed as having a **negligible** impact on socio-economic receptors.
Overall worst-case consequence	A - Negligible

6.4.8 ALARP Evaluation

The use of the survey vessel and survey equipment is unavoidable if the planned Activity is to proceed. Equipment maintenance will keep the noise levels to within normal operating limits, which will also aid in reducing the likelihood of impacts to sensitive receptors.

The selection of equipment is based on the operational objectives of the Activity. The equipment selected is generally tailored to the specific scope and location. Noise from the vessel will be sufficient for sensitive marine fauna to exhibit avoidance behaviour away from the Activity to greater than the limited extent that the equipment would cause physiological impacts (within a few meters). The use of equipment is necessary to undertake the survey to inform planned future activities. No viable alternatives exist.

The use of helicopters to transfer personnel to and from the survey vessel may be necessary to allow operational activities to occur safely and effectively, and to provide for a rapid method of transferring to and from the survey vessel in the case of an emergency.

Santos WA have considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) and Approved Conservation Advice when developing the controls relevant to potential operational activities to minimise noise impacts on marine cetaceans, sharks, fish and marine turtles. Management controls are in place to reduce operating noise including vessel and helicopter operational protocols, and to adhere to the fauna interaction management stated in Part 8 of the *Environment Protection and Biodiversity Conservation Regulations 2000*. As such, noise emitted during the activities is not expected to significantly impact on marine fauna within the receiving environment.

Additional controls were identified and considered but rejected, as detailed in **Section 6.4.6.** Therefore, the risks to marine fauna from noise associated with the project activities are considered to be ALARP.

6.4.9 Acceptability Evaluation

Is the consequence ranked as A (Negligible) or B (Minor)?	Yes – maximum consequence from underwater noise emissions is A (Negligible).
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the risks consistent with the principles of ESD?	Yes – Activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Controls implemented during the Activity will minimise the potential impacts to species identified in Recovery Plans as having the potential to be impacted by noise emissions. Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017), and Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale).
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – no concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

No significant impacts are expected from noise for sensitive receptors in the Operational Area given the localised and temporary and intermittent nature of the underwater emissions associated with planned activities.

Minimal behavioural changes are expected from all marine fauna in the Operational Area, and therefore the negligible impacts expected from these noise sources are considered environmentally acceptable. No long-term harm is expected to result to EPBC listed marine fauna during operational activities. Through adherence to Santos WA's *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003), which drives compliance with EPBC Policy Statement Part 8, the Activity is considered acceptable to undertake in the area. In addition, no concerns from stakeholders (including fisheries) have been raised to indicate that the Activity will have any unacceptable impacts to socio-economic receptors.

6.5 Atmospheric Emissions

6.5.1 Description of Event

Atmospheric Emissions	
Aspect	The use of fuel (specifically MDO/MGO) to power vessel engines, helicopters, generators, mobile and fixed plant and equipment will result in emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SO_x) and nitrous nitrogen oxides (NO_x). Vessels may also use an incinerator for waste combustion during the Activity. Vessels may utilise ozone-depleting substances (ODS) in closed-system rechargeable refrigeration systems.
Extent	Gaseous emissions, under normal circumstances, may cause localised reduction in air quality, quickly dissipating into the surrounding atmosphere.
Duration	For the duration of the Activity, as described in **Section 2**, localised and temporary impacts to air quality will occur.

6.5.2 Nature and Scale of Environmental Impacts

The potential impacts from the release of air emissions identified above include:

- Deterioration of local and regional air quality; and
- Contribution to regional, national and global greenhouse gas emissions.

GHG are a natural part of the atmosphere. The atmosphere allows most sunlight (solar short-wave radiation) to enter and warm the earth. As the surface of the earth cools, it emits infrared radiation (heat), some of which is absorbed by gases in the atmosphere and radiated back to earth. This is called the greenhouse effect. The main gases responsible for this effect are water vapour, CO_2 and N_2O. Other GHG include perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6). Of these six gases, there would be no emissions of PFCs, HFCs or SF_6 from the Activity.

Ozone is a naturally occurring molecule that forms a gaseous layer mostly in the upper atmosphere (the stratosphere) 15-30 km above the surface of the earth and protects life on earth by absorbing ultra-violet radiation from the sun. Scientific evidence indicates that the balance of stratospheric ozone has been upset by the production and release into the atmosphere of ODS, including chlorofluorocarbons, halons, CH_3CCl_3 (Methyl chloroform), carbon tetrachloride, hydrochlorofluorocarbons (a synthetic greenhouse gas) and methyl bromide. ODS and synthetic GHG (HFCs, PFCs and SF_6) are widely used, e.g. in refrigerators, air conditioners and fire extinguishers. These gases deplete the ozone layer by releasing chlorine and bromine atoms into the stratosphere, which destroy ozone molecules. These and other ozone depleting substances (ODS) also contribute to varying extents to the enhanced greenhouse effect. ODS will not be deliberately released during the course the Activity. ODS air emissions would only occur in the event of damaged or faulty refrigeration equipment. Based on the information available, the atmospheric emissions that are a key focus in terms of potential environmental impacts are:

- GHG (principally CO_2); and
- Oxides of nitrogen.

Hydrocarbon combustion may result in atmospheric emissions of GHG (such as CO_2, CH_4 and N_2O) and non-GHG (such as NO_X and SO_X). Air emissions will be similar to other vessels operating in the region for both petroleum and non-petroleum activities.

Atmospheric emissions have the potential to result in a temporary, localised reduction of air quality in the environment immediately surrounding the discharge point which could affect seabirds and humans in the immediate vicinity of the Activity. Atmospheric emissions also have the potential to contribute to regional, national and global greenhouse gas emissions.

As the activities will occur in offshore waters, the combustion of fuels and incineration in such remote locations will not impact on air quality in coastal towns with the nearest town to the Operational Area being approximately 140 km south (Port Hedland). The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere.

Accidental release and fugitive emissions of ODS has the potential to contribute to ozone layer depletion. Maintenance of refrigeration systems containing ODS is on a routine, but infrequent basis, and with controls implemented, the likelihood of an accidental ODS release of material volume is considered rare.

6.5.3 Environmental Performance and Control Measures

Environmental Performance Outcomes relating to this hazard include:

+ EPO-4 – Emissions to air meet legislated requirements; and
+ EPO-5 – Reduce impacts to air quality from planned emissions associated with the Activity.

The Control Measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-16	Air pollution prevention certification as per MARPOL Annex VI.	Ensure vessels are operating with acceptable emissions as per international standards. Ensure compliance with MARPOL Annex VI requirements as appropriate for vessel class.	No additional costs, as this is a regulatory requirement.	**Adopted** – no additional costs
CM-17	Compliance with Marine Order 97: Marine Pollution Prevent – Air Pollution (Division 7).	Ensure vessels are operating with acceptable emissions for vessel class as per Australian standards.	No additional costs, as this is a regulatory requirement.	**Adopted** – no additional costs
CM-18	All vessel engines to be maintained in accordance with vessel class requirements.	Operating efficiency of the vessels engines is maintained through routine maintenance requirements thus ensuring emissions for vessel class are acceptable.	No additional costs, is industry best practice.	**Adopted** -– benefits negligible compared to costs
CM-19	Ozone-depleting substance (ODS) handling procedures as per MARPOL Annex VI.	Where present, ensure vessels ODS are managed in a way that is responsible and as per international standards. Ensure compliance with MARPOL Annex VI requirements as appropriate for vessel class.	No additional costs, as is regulatory requirement.	**Adopted** – no additional costs
CM-20	Waste incineration managed in accordance with MARPOL Annex VI and Marine Order 97 as appropriate	Where present, ensure vessels incinerators are managed in a way that is responsible and as per international standards. Ensure compliance with MARPOL and Marine Order 97 requirements as appropriate for vessel class.	No additional costs, as is regulatory requirement.	**Adopted** – no additional costs
Additional control measures				
N/A	No incineration during vessel-based operations activities.	Eliminates emissions associated with incineration activities during the Activity.	Would result in significant cost associated with ship to shore of Project waste. Cost include cost for fuel, emissions associated with vessel transit, additional HSE	**Not adopted –** benefits negligible compared to costs

			associated with shoring waste safely and additional vessel maintenance.	
N/A	Scheduling of maintenance activities to limit number of vessel/helicopter movements required.	Reduces emission associated with vessel/helicopter transit. However, results in unacceptable safety limitations.	No additional costs, however is required for safe operations.	**Not adopted –** benefits negligible compared resultant increase in risks to Project safety.
N/A	Prohibit use of ODS.	Eliminates emissions associated with ODS activities during the Activity.	Lack of refrigeration systems on-board the vessels would lead to unacceptable workplace conditions (i.e. air conditioning) and poor food hygiene standards, limiting the vessels' ability to undertake the Activity, therefore there is no practical solution to the use of refrigeration. It is noted that ODS is rarely found on vessels.	**Not adopted –** benefits negligible compared resultant increase in risks to Project safety.
N/A	Use incinerators and engines with higher environmental efficiency.	Reduces Activity emissions associated with incinerators and engines.	Significant cost in changing unknown vessel equipment.	**Not adopted –** benefits negligible disproportionate to costs

6.5.4 Impact and Consequence Ranking

Receptor	Consequence Level
Air emissions	
Threatened / Migratory Fauna	Emissions from the Activity are relatively small and will, under normal circumstances quickly dissipate into the surrounding atmosphere. Any potential impacts are not expected to result in a decrease in local population sizes particularly to seabirds or disruption to breeding cycles. The consequence of air emissions to fauna is **negligible**.
Physical Environment / Habitat	The Activity may result in the deterioration of local and regional air quality. Gaseous and particulate emissions will, under normal circumstances quickly dissipate into the surround environment. The consequence is assessed as **negligible**.
Threatened ecological communities	Not applicable – these receptors will not be impacted by air emissions.
Protected Areas	
Socio-economic receptors	As the activities occur in offshore waters, the combustion of fuels and ODS releases in these remote locations will not impact on air quality in coastal towns. The quantities of gaseous emissions are relatively small and will under normal circumstances, quickly dissipate into the surrounding atmosphere. The highly dispersive nature of local winds (i.e. strong and consistent) is expected to reduce potentially harmful or 'noticeable' gaseous concentrations within a short distance from the vessels. The consequence of air emissions to fauna is **negligible**.
Overall worst-case consequence level	A – Negligible Given the short duration of the Survey, and near constant movement of the vessel, emissions from the combustion of fuel and ODS releases on board the vessel/s will be localised and rapidly disperse and not affect sensitive receptors in the vicinity of the Operational Area (including the health or amenity of the nearest towns).

6.5.5 ALARP Evaluation

Power generation through combustion of fossil fuels is essential to undertaking the Activity to power the vessels and equipment on-board. Given the routine maintenance of these closed systems by suitably qualified personnel, all practicable management measures are considered to have been implemented and the likelihood of significant impacts occurring have been reduced to ALARP.

There are no other control measures that may practicably or feasibly be adopted to reduce impacts further, additional controls were identified and considered but not adopted, as detailed in **Section 6.5.3**. The implementation of these control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

6.5.6 Acceptability Evaluation

Is the consequence ranked as A (Negligible) or B (Minor)?	Yes – maximum consequence from atmospheric emissions is A (Negligible).
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with Protection of the Sea (Prevention of Pollution from Ships) Act 1983, MARPOL Annex VI and/or Marine Order 97, as appropriate.

Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

Atmospheric emissions from vessels are permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which reflect MARPOL Annex VI and Marine Order 97 requirements. The vessels will use MDO/MGO, which is lower in sulphur compared to heavy fuel oil (HFO). The fuel oil will meet regulated sulphur content levels in order to control emission quality. As an internationally accepted standard that is utilised industry wide, compliance with MARPOL standards is considered to be an appropriate management measure in this case. Vessels may also use an incinerator to dispose of combustible waste when outside of 500 m of other facilities.

The overall impacts to the atmosphere and sensitive receptors are expected to be negligible if the emission management is adhered to and impacts from emissions that are generated by the Activity are considered environmentally acceptable.

6.6 Planned Discharge – Sewage, Greywater and Putrescible Waste

6.6.1 Description of Event

Aspect	During the Survey, the vessel will routinely discharge non-toxic substances to the marine environment as described below. The vessel will not be stationary for long periods during the Activity, so the discharge locations will be constantly changing. Sewage The volume of sewage is directly proportional to the number of persons on-board the vessels. Approximately 170 L of sewage/ greywater will be generated per person per day. Treated sewage will be disposed in accordance with MARPOL Annex IV. Food waste Putrescible waste will consist of approximately 1 L of food waste per person per day. Food waste will be disposed of in accordance with MARPOL Annex V.
Extent	The small volumes discharged may cause localised nutrient enrichment, organic and particulate loading, toxic impacts to marine fauna, thermal impacts and increased salinity.
Duration	For the duration of the Activity, as described in **Section 2**; water quality conditions will return to normal within minutes to hours of cessation of discharges.

6.6.2 Nature and Scale of Environmental Impacts

The potential environmental impacts from routine operational discharges include:

+ temporary localised decline in water quality in the immediate vicinity of the discharge;
+ localised increase in Biological Oxygen Demand (BOD); and
+ localised increase in turbidity of surrounding waters.

Planned discharges associated with the Activity will be small and intermittent, with volumes dependent on a range of variables. Sewage, greywater and putrescible waste discharges from vessels supporting the oil and gas industry typically ranges between 0.04 and 0.45 m^3 per day per person (depending on waste production rates and sewage systems available onboard) (EMSA, 2016). It is expected that there will be no more than 60 personnel on board, and that the Survey will last for no more than 15 days for Phase 1 and 45 days for Phase 2. The discharge point will be frequently moving as the vessel moves between target areas. The discharge of non-hazardous wastes to the marine environment may result in a localised reduction in water quality in the vicinity of the release location. This would be expected to be temporary (minutes to hours) and localised. The discharges are expected to be dispersed and diluted rapidly, with concentrations of discharges significantly dropping within a short distance from the discharge point. Monitoring of sewage discharges for an offshore floating liquified natural gas (FLNG) project (Woodside 2014) determined that a 10 m^3 sewage discharge reduced to approximately 1% of its original concentration within 50 m of the discharge location. Changes to ambient water quality outside of the Operational Area is considered unlikely to occur.

Eutrophication

The discharges of treated sewage and grey water may result in localised increases in nutrient concentrations, exert BOD on the receiving waters and may promote localised elevated levels of phytoplankton and bacteria Activity due to nutrient inputs. However, dispersion and dilution of discharges is expected to be rapid as the discharges are of low volume and short duration, and the Operational Area is located in water depths of between 86–94 m dominated by open ocean currents, resulting in short-term changes to the surface water quality within the Operational Area.

Changes to Predator-Prey Dynamics

The discharge of sewage and macerated food wastes will create a localised and temporary food source and may attract scavenging marine fauna or seabirds to the source which in turn can attract predatory species.

Discharges will be localised and temporary as they will be quickly broken down by a combination of microbial action, consumed by scavenging fauna and/or dispersed by wave action and local ocean currents. This is likely to limit the impacts of putrescible waste discharges to within the vicinity of the discharge and to be temporary in nature.

6.6.3 Environmental Performance Outcomes and Control Measures

Environmental Performance Outcomes relating to this hazard include:

+ EPO-3 – Discharges to sea meet legislated permissible discharge requirements; and
+ EPO-8 – No unplanned objects, emissions or discharges to sea or air.

The Control Measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

CM Reference	Control Measure	Environmental benefit	Potential cost/issues	Evaluation
CM-21	Sewage treatment system (STP)	Reduces potential impacts of inappropriate discharge of sewage at sea or additional emissions associated with ship to shore of waste. Ensure compliance with relevant Marine Orders and MARPOL requirements as appropriate for vessel class.	Personnel cost associated with ensuring vessel STP certificates are in place during vessel contracting and in pre-mobilisation audits and inspections, and in reporting discharge levels.	**Adopted** - benefits of ensuring vessel has STP is the minimal costs associated with alternative ship to shore and HSE risks.
CM-42	Waste (garbage) management procedure	Reduced potential impacts of inappropriate putrescible waste (includes food) disposal at sea or additional emission associated with returning wastes to shore. Ensures compliance with relevant MARPOL requirements.	Personnel cost associated with ensuring compliance with waste management procedures. These costs are standard cost associated with vessels of a certain class operating offshore.	**Adopted** – benefit of compliance with procedures are minimal compared with alternative ship to shore.
Additional control measures				
N/A	Storage of all wastes on-board for disposal onshore.	Eliminates risks to receiving environment associated with deteriorating water quality as a consequence of Activity sewage and grey water discharge by avoiding requirement to discharge.	Increased fuel consumption and increased atmospheric emissions, associated with vessel transit to port to unload the wastes, and by land transport to the nearest disposal facility. Increased energy consumption and atmospheric emissions would also result from the disposal (e.g. incineration, treatment etc.) of the wastes on land.	**Not adopted** – cost associated with fuel and emissions disproportionate to cost of having STP.

6.6.4 Impact and Consequence Ranking

Receptor	Consequence Level
Planned Discharge – Sewage and Greywater	
Threatened / Migratory Fauna Physical Environment/ Habitat	Operational discharges may result in localised water quality perturbations and alteration to marine fauna behaviour, however, given that vessels will either be continually moving or stationary for limited periods within the Operational Area, any effect will be temporary in nature. Sensitive receptors that may be impacted include pelagic fish and sharks at the sea surface, marine turtles, and marine mammals, and seabirds. Given that the Activity will be for a limited duration (approximately 15 days Phase 1; approximately 45 days Phase 2) from a frequently moving discharge point, in deep waters (86–94 m), impacts will be limited to short-term water quality impacts and temporary behavioural effects observed in sensitive receptors. Impacts to water quality will be experienced in the discharge mixing zone, which will be localised and will occur only as long as the discharges occur (i.e. no sustained impacts), therefore, recovery will be measured in hours to days. Only short-term behavioural impacts are expected with no decrease in local population size / area of occupancy of species / loss or disruption of Habitat Critical / disruption to the breeding cycle / introduction of disease. Planned operational discharges are therefore expected to have **negligible** impact on marine fauna and habitat within the receiving environment nor compromise the objectives of Recovery Plans for threatened and migratory marine fauna.
Socio-economic receptors	Not applicable – operational discharges are not expected to impact on socio-economic receptors.
Threatened ecological communities	Not applicable – no physical environments and/or habitats identified in the area where operational discharges are expected to disperse other than open water, which will not be impacted.
Protected Areas	Not applicable – no protected areas are identified in the area where operational discharges could occur.
Overall worst-case consequence	A - **Negligible** Given the distance offshore, the small volumes discharged, the frequently moving discharge point and the well-mixed waters of the Operational Area.

6.6.5 ALARP Evaluation

Vessel/s are required to undertake the Survey. On-board treatment of most wastes and subsequent discharge to the marine environment, are considered to be the most environmentally sound method of disposal, given alternatives have additional atmospheric emissions associated.

Considering that the discharge streams will either be treated to a level unlikely to cause significant environmental harm or will be of a nature not considered to pose significant risk to the receiving environment; the assessed residual consequence for this impact is negligible and cannot be reduced further. Vessels will operate in accordance with relevant regulations and legislation as detailed in **Section 6.6.3**. Additional controls were identified and considered, but not adopted as detailed in **Section 6.6.3**. The implementation of these control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

6.6.6 Acceptability Evaluation

Is the consequence ranked as A (Negligible) or B (Minor)?	Yes – maximum Planned Discharge – Sewage, Greywater and Putrescible Waste consequence is rated **A** (**negligible**).
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes - Management consistent with Protection of the Sea (Prevention of Pollution from Ships) Act 1983, MARPOL Annex I, Annex IV and Annex V, and/or Marine Orders 94, 95 and 96 as appropriate, and relevant recovery plans.
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

The potential impacts of routine discharges from vessels to the marine environment are well understood and there are legislative requirements in place to manage risks. The application of legislative requirements is considered appropriate to manage the impact; particularly due to the well-mixed offshore marine waters (86–94 m) of the Operational Area. Small volumes of wastewaters discharged into open ocean conditions will be rapidly diluted and dispersed.

Release of non-hazardous discharges into the sea from vessels in Australian waters is permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which reflects MARPOL Annex I, IV and V and Marine Orders 91, 95 and 96 as requirements. The operational discharges are not expected to significantly impact the receiving environment with control measures proposed and compliance with all MARPOL requirements. The MARPOL standard is considered to be the most appropriate standard given the nature and scale of the Activity. These standards are internationally accepted and utilised industry-wide, therefore compliance with the relevant and appropriate MARPOL requirements and standards is expected to reduce the potential for environmental impacts to a level which is considered environmentally acceptable.

Deteriorating water quality is identified as a potential threat to turtles, some birds and shark species according to their relevant Recovery Plan or Approved Conservation Advice (**Table 3-7**). However, the planned discharges associated with sewage, grey water and putrescible waste are not expected to significantly impact the receiving environment, resulting in short term and localised water quality deterioration only. The Activity will be conducted in a manner that is considered acceptable and consistent with identified Recovery Plans and conservation advice.

6.7 Planned Discharge – Cooling Water and Brine

6.7.1 Description of Event

Aspect	During the Survey, the vessel will routinely discharge non-toxic substances to the marine environment as described below. The vessel will not be stationary for long periods during the Activity, so the discharge locations will be constantly changing. <u>Cooling water</u> Seawater is used as a heat exchange medium for the cooling of machinery engines. Seawater is drawn from the ocean and flows counter-current through closed-circuit heat exchangers, transferring heat from the vessel engines and machinery to the seawater. The seawater is then discharged to the ocean (i.e. it is a once-through system). Cooling water temperatures vary depending upon the vessel's engine workload and Activity. <u>Brine</u> Brine generated from the water supply systems on-board the vessels will be discharged to the ocean at a salinity of approximately 10% higher than seawater. The volume of the discharge is dependent on the requirement for fresh (or potable) water and would vary between vessels and the number of people on-board.
Extent	The small volumes discharged may cause localised nutrient enrichment, organic and particulate loading, toxic impacts to marine fauna, thermal impacts and increased salinity.
Duration	For the duration of the Activity, as described in **Section 2**.

6.7.2 Nature and scale of Environmental Impact

The potential environmental impacts from routine operational discharges include:

- temporary localised decline in water quality in the immediate vicinity of the discharge;
- localised increase in turbidity of surrounding waters;
- temporary and localised increase in sea surface water temperature; and
- temporary and localised increase in sea surface salinity.

Planned discharges associated with the Activity will be small and intermittent, with volumes dependent on a range of variables. The discharge point will be frequently moving, as the vessel will not be stationary for long periods. The discharge of non-hazardous wastes to the marine environment may result in a localised reduction in water quality in the vicinity of the release location. This would be expected to be temporary (minutes to hours) and localised. The discharges are expected to be dispersed and diluted rapidly, with concentrations of discharges significantly dropping within a short distance from the discharge point. Changes to ambient water quality outside of the Operational Area is considered unlikely to occur.

<u>Salinity Increases</u>

The desalination of seawater results in a discharge of brine with a slightly elevated salinity (around 10% higher than seawater). Once discharged to the marine environment, the desalination brine, being of greater density than seawater, will sink and disperse in the currents. On average, seawater has a salt concentration of 35 ppt. The volume of the discharge is dependent on the requirement for fresh (or potable) water and the number of people on board the vessel.

Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20–30% (Walker and McComb 1990), and it is expected that most pelagic species would be able to tolerate short-term exposure to the slight increase in salinity caused by the discharged brine.

Given the relatively low volume of discharge, low salinity increase and, open water surrounding the vessels, impact on the water quality in the Operational Area is expected to be negligible, temporary and localised.

<u>Changes in Temperature</u>

Cooling water will be discharged at a temperature above ambient seawater temperature. Upon discharge, it will be subjected to turbulent mixing and transfer of heat to the surrounding waters.

A study undertaken by Woodside (2008) detailed temperature dispersion modelling shows that the water temperature of discharged water will decrease rapidly as it mixes with the receiving waters. It identified discharge waters were less than 1°C (degrees Celsius) above background levels within 100 m (horizontally) of the discharge point. Vertically, the discharge will be within background levels within 10 m of the discharge point (Woodside 2008).

Given the relatively short duration of the Activity, low volume of cooling water, temperature differential, the deep open water surrounding the vessels, impact on water quality is expected to be low and short-term and within the immediate vicinity of the discharge.

6.7.3 Environmental Performance Outcomes and Control Measures

+ EPO-3 – Discharges to sea meet legislated permissible discharge requirements; and
+ EPO-8 – No unplanned objects, emissions or discharges to sea or air.

The Control Measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM - 22	Chemical Selection Process	Ensures that planned discharges to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through Offshore Chemical Notification Scheme (OCNS); or have a completed Santos ecotoxicological risk assessment so that only environmentally acceptable chemicals are used.	Personnel time associated with chemical selection and approval as per chemical selection process.	**Adopted** – benefits outweigh minor costs
Additional control measures				
N/A	Discharge cooling water above sea level to allow it to cool further before mixing at sea surface.	Reduces temperature gradient between water discharge and ambient waters temperature, resulting in reduced potential environmental impact. However, given water depths of the Operational Area the risk of impacting sensitive environmental receptor is unlikely.	High costs to alter a vessel to allow for discharge of cooling water at different height, not feasible on all vessels, reduction in temperature would be minimal compared to cost of altering the discharge height.	**Not adopted** – cost disproportionate to benefits
N/A	Storage of cooling and brine water onboard, prior to discharge onshore	Eliminates risks to receiving environment associated with deteriorating water quality as a consequence of Activity cooling water and brine by avoiding requirement to discharge.	Increased fuel consumption and increased atmospheric emissions, associated with vessel transit to port to unload the wastes, and by land transport to the nearest disposal facility. Increased energy consumption and atmospheric emissions would also result from the disposal (e.g. incineration, treatment etc.) of the wastes on land.	**Not adopted** – cost associated with fuel and emissions disproportionate to risk and costs of discharging within approved conditions.

6.7.4 Impact and Consequence Ranking

Receptor	Consequence Level
Planned Discharge – Cooling Water and Brine	
Threatened / Migratory Fauna Physical Environment/ Habitat	Planned cooling water and brine operational discharges may result in localised water quality perturbations and alteration to marine fauna behaviour. Given the relatively deep water depths, vessel/s will be either be continually moving or stationary for limited periods of time within the Operational Area. Any effect to fauna or the local environment will be temporary in nature. Sensitive receptors that may be impacted include pelagic fish and sharks at the sea surface, marine turtles, and marine mammals. Given the Activity will be for a limited duration (approximately 15 days Phase 1; approximately 45 days Phase 2) from a frequently moving discharge point, in deep waters (86–94 m), impacts will be limited to short-term water quality impacts and temporary behavioural effects observed in fish. Impacts to water quality will be experienced in the discharge mixing zone, which will be localised and will occur only as long as the discharges occur (i.e. no sustained impacts), therefore, recovery will be measured in hours to days. Only short-term behavioural impacts are expected with no decrease in local population size / area of occupancy of species / loss or disruption of Habitat Critical / disruption to the breeding cycle / introduction of disease. Planned cooling water and brine operational discharges are therefore expected to have **negligible** impact to marine fauna within the receiving environment nor compromise the objectives of Recovery Plans for threatened and migratory marine fauna.
Socio-economic receptors	Not applicable – operational discharges are not expected to impact on socio-economic receptors.
Threatened ecological communities	Not applicable – no physical environments and/or habitats identified in the area where operational discharges are expected to disperse other than open water, which will not be impacted.
Protected Areas	Not applicable – no protected areas are identified in the area where operational discharges could occur.
Overall worst-case consequence	A - **Negligible** Given the distance offshore, the small volumes discharged, the frequently moving discharge point on the vessel and the well-mixed waters of the Operational Area.

6.7.5 ALARP Evaluation

Vessels are required to undertake the Survey. The production of cooling water and brine during vessel operations is standard industry practice. Considering that variations to temperature and salinity in local waters will be at a level which is unlikely to cause significant environmental harm or will be of a nature not considered to pose significant risk to the receiving environment; the assessed residual consequence for this impact is negligible and cannot be reduced further. Vessels will operate in accordance with relevant regulations and legislation as detailed in **Section 6.7.3**. Additional controls were identified and considered, but not adopted as detailed in **Section 6.7.3**. The implementation of these control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

6.7.6 Acceptability Evaluation

Is the consequence ranked as A (Negligible) or B (Minor)?	Yes – maximum Planned Discharge – Cooling Water and Brine consequence is rated A (**negligible**).
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes - Management consistent with Protection of the Sea (Prevention of Pollution from Ships) Act 1983, MARPOL Annex I, Annex IV and Annex V, and/or Marine Orders 94, 95 and 96 as appropriate, and relevant recovery plans.
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

6.8 Planned Discharge – Deck Drainage and Treated Bilge

6.8.1 Description of Event

Aspect	During the Survey, the vessel will routinely discharge non-toxic substances to the marine environment as described below. The vessel will not be stationary for long periods during the Activity, so the discharge locations will be constantly changing. Deck drainage Deck drainage from sea spray, rainfall or wash-down operations would discharge to the marine environment. The deck drainage would contain particulate matter and residual chemicals such as cleaning chemicals, oil and grease. Assessment of an unplanned spillage of other environmentally hazardous chemicals and liquid waste are discussed in **Section 7.4**. Oily water (i.e. bilge water) discharges While in the Operational Area, the vessel may discharge oily water after treatment to <15 parts per million (ppm) oil-in-water content in a MARPOL approved oily water filter system separator.
Extent	Operational Area
Duration	For the duration of the Activity, as described in **Section 2**.

6.8.2 Nature and scale of Environmental Impact

The potential environmental impacts from routine operational discharges include:

- temporary localised decline in water quality in the immediate vicinity of the discharge; and
- temporary toxicity to marine flora and fauna (bilge water discharges).

Planned discharges associated with the Activity will be small and intermittent, with volumes dependent on a range of variables. The discharge point will be “moving”, as the vessels are not stationary. The discharge of non-hazardous wastes to the marine environment may result in a localised reduction in water quality in the vicinity of the release location. This would be expected to be temporary (minutes to hours) and localised. The discharges are expected to be dispersed and diluted rapidly, with concentrations of discharges significantly dropping within a short distance from the discharge point. Changes to ambient water quality outside of the Operational Area is considered unlikely to occur.

Santos

Oily Water

Oily water discharged from vessels will be treated to a concentration (<15 ppm of oil-in-water content) that is unlikely to lead to any impacts to the receiving environment. The low concentrations of any oil and grease residues in deck drainage and bilge water discharged to the marine environment, will rapidly dilute and disperse, therefore the potential for toxicity from hydrocarbon residues is considered low.

6.8.3 Environmental Performance Outcomes and Control Measures

+ EPO-3 – Discharges to sea meet legislated permissible discharge requirements.
+ EPO-8 – No unplanned objects, emissions or discharges to sea or air.

The Control Measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-22	Chemical Selection Process	Ensures that planned discharges to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through OCNS; or have a completed Santos ecotoxicological risk assessment so that only environmentally acceptable products are used.	Personnel time associated with chemical selection, approval and procurement as per chemical selection process.	**Adopted** – benefits outweigh minor costs
CM-23	Oily water treatment system (OWTS)	Reduces potential impacts of inappropriate discharge of oily water at sea or additional emissions associated with ship to shore of waste. Ensure compliance with relevant Marine Orders and MARPOL requirements as appropriate for vessel class.	Personnel cost associated with ensuring vessel OWTS certificates are in place during vessel contracting and in pre-mobilisation audits and inspections, and in reporting discharge levels.	**Adopted** - benefits of ensuring vessel has OSTS is the minimal costs associated with alternative ship to shore.
CM-34	General chemical management procedures	Reduces potential for inappropriate discharge of water at sea, through appropriate handling, to maintain planned discharges to sea meet the criteria for not being harmful to the marine environment.	Personnel time associated with vessel inspection and implementation.	**Adopted** – benefits outweigh minor costs
CM-24	Deck cleaning and product selection	Reduces potential impacts of inappropriate discharge of water to sea associated with deck cleaning.	Personnel time associated with chemical selection, approval and procurement as per chemical selection process.	**Adopted** – benefits outweigh minor costs
CM-28	Vessel spill response plans (Shipboard Oil Pollution Emergency Plan (SOPEP)/ (Shipboard Marine Pollution Emergency Plan (SMPEP))	Clean up of hydrocarbon spills to deck in accordance with vessel SOPEP/SMPEP reduces potential impacts of inappropriate discharge of water to sea.	Personnel time associated with maintaining SOPEP stocks and appropriate waste disposal.	**Adopted** – benefits outweigh minor costs
Additional control measures				

N/A	Mandatory closed drain system to prevent deck drainage discharged overboard.	Eliminates risk of oily water from deck being discharged overboard without treatment. Ensures wastewater is directed to OWTS for treatment prior to discharge.	Increased cost due to treatment system required, modifications to vessels, storage space required for containment of drained liquids, increase in transfers to vessels resulting in increased potential impacts and risks. Increased transfers results in increased fuel usage, increased safety risks to personnel during transfer (e.g. crushing between skips), increase in crane movements.	**Not adopted –** cost associated with potential vessel modifications disproportionate to benefit
N/A	Storage of all wastes on-board for disposal onshore.	Eliminates risks to receiving environment associated with deteriorating water quality as a consequence of discharging oily water to the environment.	Increased fuel consumption and increased atmospheric emissions, associated with vessel transit to port to unload the wastes, and by land transport to the nearest disposal facility. Increased energy consumption and atmospheric emissions would also result from the disposal (e.g. incineration, treatment etc.) of the wastes on land.	**Not adopted** – cost associated with fuel and emissions disproportionate to cost of having to treat waste water prior to discharge.

6.8.4 Impact and Consequence Ranking

Receptor	Consequence Level
Planned Discharge – Cooling Water and Brine	
Threatened / Migratory Fauna Physical Environment/ Habitat	Deck drainage and treated brine operational discharges may result in localised water quality perturbations and alteration to marine fauna behaviour. The vessels will either be continually moving or stationary for limited periods within the Operational Area, Any effect to fauna or the environment will be temporary in nature given the deep water depths and subsequently large mixing zone for planned cooling water and brine discharges. Sensitive receptors that may be impacted include pelagic fish and sharks at the sea surface, marine turtles, and marine mammals, and seabirds. Given the Activity will be for a limited duration (approximately 15 days Phase 1; approximately 45 days Phase 2) from a frequently moving discharge point, in deep waters (86–94 m), impacts will be limited to short-term water quality impacts and temporary behavioural effects observed in fish and seabirds. Impacts to water quality will be experienced in the discharge mixing zone, which will be localised and will occur only as long as the discharges occur (i.e. no sustained impacts), therefore, recovery will be measured in hours to days. Only short-term behavioural impacts are expected with no decrease in local population size / area of occupancy of species / loss or disruption of Habitat Critical / disruption to the breeding cycle / introduction of disease. Deck drainage and treated brine operational discharges is assessed as having a **negligible** impact to marine fauna within the receiving environment and will not compromise the objectives of Recovery Plans for threatened and migratory marine fauna.
Socio-economic receptors	Not applicable – operational discharges are not expected to impact on socio-economic receptors.
Threatened ecological communities	Not applicable – no physical environments and/or habitats identified in the area where operational discharges are expected to disperse other than open water, which will not be impacted.
Protected Areas	Not applicable – no protected areas are identified in the area where operational discharges could occur.
Overall worst-case consequence	A - Negligible Given the distance offshore, the small volumes discharged, the frequently moving discharge point and the well-mixed waters of the Operational Area.

6.8.5 ALARP Evaluation

Vessels are required to undertake the Survey. Deck drainage and the discharge of treated oily water is standard industry practice. Considering variations to water quality in local waters will be at a level which is unlikely to cause significant environmental harm or will be of a nature not considered to pose significant risk to the receiving environment; the assessed residual consequence for this impact is negligible and cannot be reduced further. Vessels will operate in accordance with relevant regulations and legislation as detailed in **Section 6.8.3**. Additional controls were identified and considered, but not adopted as detailed in **Section 6.8.3**. The implementation of these control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

6.8.6 Acceptability Evaluation

Is the consequence ranked as A (Negligible) or B (Minor)?	Yes – maximum Planned Discharge – Cooling Water and Brine consequence is rated A (**negligible**).
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes - Management consistent with Protection of the Sea (Prevention of Pollution from Ships) Act 1983, MARPOL Annex I, Annex IV and Annex V, and/or Marine Orders 94, 95 and 96 as appropriate, and relevant recovery plans.
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

6.9 Planned Discharge – Drilling Fluids

6.9.1 Description of Event

Aspect	During the Survey, the coring process may require water-based fluid to lubricate the face of the drill bit during rotary borehole sampling, keeping the boreholes clean (free from cuttings) and prevent the borehole from collapsing during the coring process. As the project is still in the design stage geotechnical drilling fluids are yet to be confirmed however, all fluids will be selected as per Santos's chemical selection process. The volume of the drilling fluid to be used will depend on the drilling depth achieved, however, based on a maximum borehole target depth of 100 m, it is expected that volumes of drilling fluid for each borehole will be approximately 5 m^3.
Extent	Operational Area
Duration	For the duration of the Activity, as described in **Section 2,** water quality conditions will return to normal within minutes to hours of cessation of discharges.

6.9.2 Nature and scale of Environmental Impact

The potential environmental impacts from routine operational discharges include:

+ temporary localised decline in water quality in the immediate vicinity of the discharge; and
+ temporary localised change to sediment quality in the immediate vicinity of the discharge.

The discharge of WBM to the marine environment may result in a localised reduction in water and sediment quality in the vicinity of the release location. This would be expected to be temporary (minutes to hours) and localised. The discharges are expected to be dispersed and diluted rapidly given the deep water depths, with concentrations of discharges significantly dropping within a short distance from the discharge point.

Water Quality

The minimal cuttings with adhered fluids will settle rapidly within close proximity to the borehole, with finer particles (~10% of the discharge volume) dispersing further within ocean currents. Although turbidity and inert chemical concentrations will be high around the borehole, drilling cuttings and drilling fluids are expected to settle and disperse rapidly, resulting in short-term and highly localised change in water quality at the seabed. Changes to ambient water quality outside of the Operational Area is considered unlikely to occur.

Sediment Quality

Drilling cuttings and fluids discharged during drilling operations may result in the change in sediment quality, as cuttings tend to clump together and settle rapidly, with thicker cuttings piles generally located downstream from the discharge. Field studies summarised by IAOGP (2016) for production drilling, found that cuttings and adhered WBM could be detected either visually or through increases in barium concentrations within 10–150 m of the source. Cuttings for borehole samples will be negligible in comparison resulting in a highly localised impact.

6.9.3 Environmental Performance Outcomes and Control Measures

+ EPO-3 – Discharges to sea meet legislated permissible discharge requirements.
+ EPO-7 – No unplanned seabed disturbance.

The Control Measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM- 22	Chemical Selection Process	Ensures that planned discharges to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through OCNS; or have a completed Santos ecotoxicological risk assessment so that only environmentally acceptable products are used.	Personnel time associated with chemical selection, approval and procurement as per chemical selection process.	**Adopted** – benefits outweigh minor costs
Additional control measures				
None identified given small volumes of water-based muds (WBM) associated with geotechnical drilling scope of work and consequence negligible.				

6.9.4 Impact and Consequence Ranking

Receptor	Consequence Level
Planned Discharge – Drilling Fluids	
Threatened / Migratory Fauna	Not applicable – no threatened / migratory fauna are identified in the area where discharges could occur.
Physical Environment/ Habitat	Drilling fluids may result impact localised water and sediment quality the limited number of sample sites within the Operational Area and the open ocean environment any effect will be temporary in nature. Impacts to water quality will be localised with recovery measured in hours to days. Planned drilling fluid discharges are therefore expected to have a **negligible** impact to the receiving environment.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area where discharges could occur.
Protected Areas	Not applicable – no protected areas identified in the area where discharges could occur.
Socio-economic receptors	Not applicable – discharges are not expected to impact on socio-economic receptors.
Overall worst-case consequence	A - Negligible Given the distance offshore, the small volumes discharged, the frequently moving discharge point and the well-mixed waters of the Operational Area.

6.9.5 ALARP Evaluation

Section 2 outlines all proposed geotechnical and geophysical survey techniques. There are no additional practicable alternatives in sampling techniques in order to achieve the technical objectives of the Activity. Considering that the use and volumes of drilling fluids will be either limited and unlikely to cause significant environmental harm or will be of a nature not considered to pose significant risk to the receiving environment; the assessed residual consequence for this impact is negligible and cannot be reduced further. A reduction in water and sediment quality is expected to be temporary and localised. With nine samples required to be taken (with the exact locations yet to be confirmed), the potential disturbance from each sample will be insignificant.

6.9.6 Acceptability Evaluation

Is the consequence ranked as A (Negligible) or B (Minor)?	Yes – maximum Planned Discharge – Drilling Fluids consequence is rated **A** (**negligible**).
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes - Management consistent with Protection of the Sea (Prevention of Pollution from Ships) Act 1983, MARPOL Annex I, Annex IV and Annex V, and/or Marine Orders 94, 95 and 96 as appropriate, and relevant recovery plans.
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

7. Environment Assessment of Unplanned Events

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Evaluation of environmental impacts and risks (5) The environment plan must include: d) details of the environmental impacts and risks for the Activity; e) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and f) details of the control measures that will be used to reduce the impacts and risks of the Activity to as low as reasonably practicable and an acceptable level. (6) To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: c) all operations of the Activity; and d) potential emergency conditions, whether resulting from accident or any other reason. *Environmental performance outcomes and standards* (7) The environment plan must: d) set environmental performance standards for the control measures identified under paragraph (5)(c); e) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured; and f) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

Santos' environmental assessment identified seven potential sources of environmental risks associated with the unplanned events for this Activity. The results of the environmental assessment are summarised in **Table 7-1**. A comprehensive risk and impact assessment for each of the unplanned events, and subsequent control measures proposed by Santos to reduce the risk and impacts to ALARP, are detailed in the following sub-sections.

Table 7-1: Summary of the environmental risks for events associated with unplanned events

Hazard	Consequence	Likelihood	Residual Risk Level
MDO/MGO release from vessel collision (surface)	C (Moderate)	2 (Very unlikely)	Low
Minor hydrocarbon release	A (Negligible)	3 (Unlikely)	Low
Spill response operations	C (Moderate)	2 (Very unlikely)	Low
Hazardous and non-hazardous unplanned discharges – liquid	A (Negligible)	2 (Very Unlikely)	Low
Hazardous and non-hazardous unplanned discharges - solid	C (Moderate)	2 (Very unlikely)	Low
Marine fauna collisions	A (Negligible)	2 (Very Unlikely)	Low
Introduction of invasive marine species	C (Moderate)	1 (Rare)	Low

7.1 Marine Diesel Oil/Marine Gas Oil (MDO/MGO) Release from Vessel Collision (Surface)

As previously outlined for this Activity, Santos are using existing modelling undertaken for an adjacent Santos proposed seismic Activity (Keraudren Survey, in assessment with NOPSEMA), which has modelled a more conservative MGO/MDO spill volume of 1,065 m^3.

Santos has not undertaken survey specific modelling for this Activity, based on having undertaken a number of modelling studies for MGO/MDO spills for historic activities in the Bedout Basin, and within permit WA-437-P. In evaluating the spill modelling undertaken to date Santos considers the most recent modelling completed for the Keraudren Survey to be appropriate to use for impact assessment and spill response based on:

+ The modelling presented being conservative as the volume is approximately 60% greater (1,065 m3 modelled vs potential spill volume during survey of 650 m3);
+ The modelling was undertaken for two potential spill locations both of which have much closer proximity to sensitive receptors than the Operational Area. The southern location is closer to the Eighty Mile Marine Beach Marine Park (9.92 km versus 48.61 km) than the proposed Operational Area for the survey and the northern location is closer to Rowley shoals Marine Park (25.02 km verses 136.33 km) (refer **Figure 7-1**);
+ Whilst the modelled locations are to the east of the Operational Area, the EMBA from a smaller MGO/MDO spill within the Operational Area is likely to not intersect different protected areas and sensitivities than the modelled spills. Santos does not consider that there would be additional impacts to the receptors west of the Operational Area that are not already described or included within the EMBA, as the spill volume modelled is significantly larger, and therefore has a larger EMBA than that associated with 650m3 spill volume;
+ The Operational Area does not have any significant features within the area or nearby that would create a significant difference in the model output if modelling were to be undertaken for a spill within the Operational Area;
+ The two modelled spill locations (northern and southern) cover a range of water depths (150 m in the north and 50 m in the south) where the spill may occur and the water depths within the Operational Area (86–94 m (LAT)) are within the range modelled; and
+ The metocean conditions at the two modelled locations are likely to be similar to those experienced within the Operational Area.

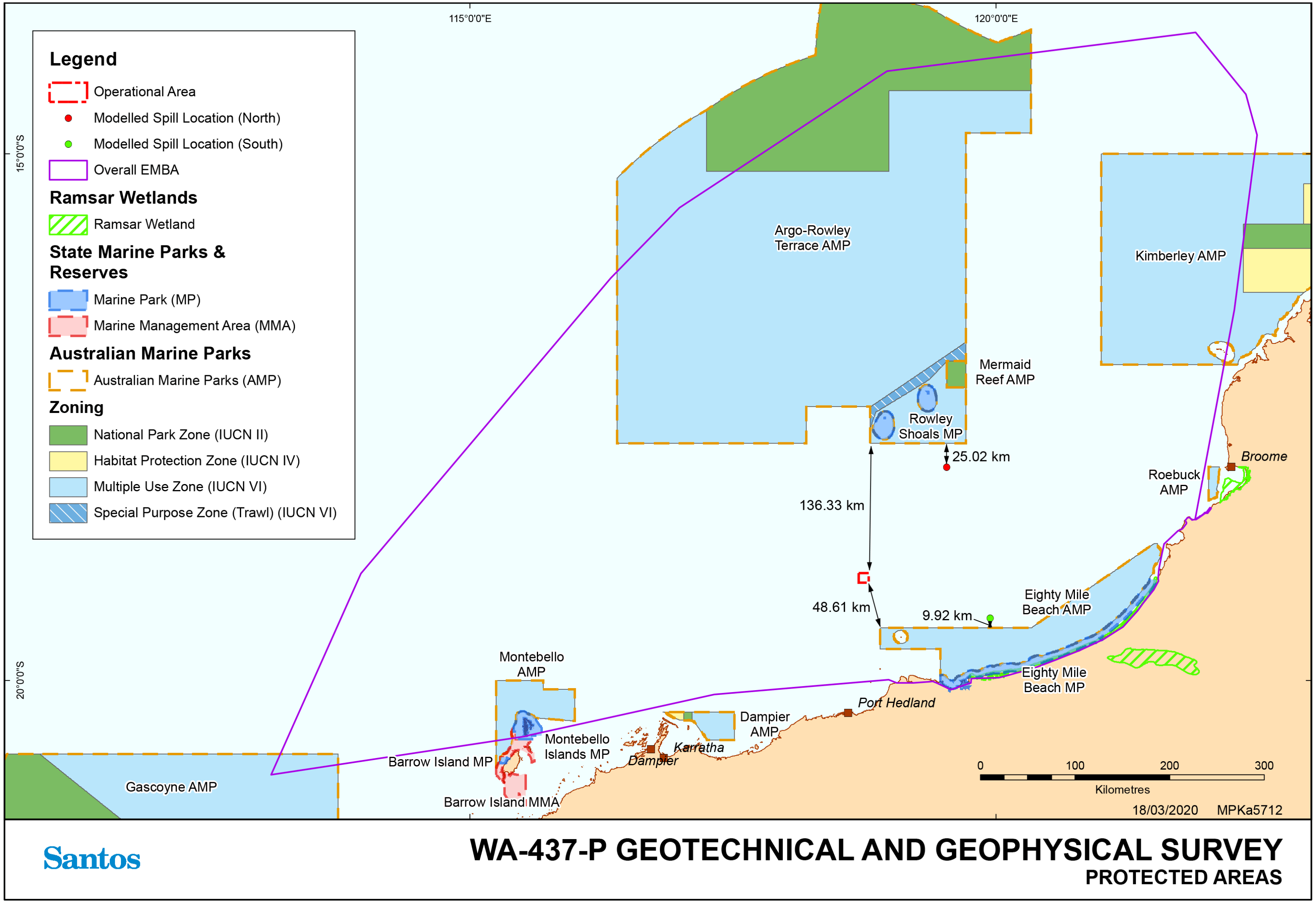

Figure 7-1: Comparison of Operational Area and Keraudren Extension MSS modelled spill locations and associated spill EMBA

7.1.1 Description of Event

Hydrocarbon spills from a ruptured vessel fuel tank as result of a collision	
Event	MDO/MGO spills have the potential to impact on the marine environment through reduction in water quality and exposure to fauna and habitats. *Worst-Credible MDO/MGO Spill* There is a possibility of a vessel collision occurring within the Operational Area between vessels. The worst-case environmental incident resulting from a vessel collision is the rupturing of a vessel fuel tank resulting in the release of MDO/MGO to the environment. Vessel collision could occur due to factors such as human error, poor navigation, vessel equipment failure or poor weather. The maximum credible spill from a collision can be determined from the usable volume of the largest single fuel tank which for the Survey has been assessed as 650 m^3. A tank rupture as a result of vessel grounding is not considered a credible scenario as the water depths are approximately 86–94 m and there are no emergent features within the Operational Area. It is noted that in addition to MDO/MGO, small volumes of unused Intermediate Fuel Oil (IFO) and HFO could be stored on the vessels. Restrictions will be in place to limit volumes and require storage to be restricted to tanks that do not have direct exposure to the marine environment (as described in **Section 7.1.4**). Therefore, a spill of IFO/HFO is not considered credible for this assessment.
Extent	**<u>Environment that May be Affected</u>** Existing modelling has been utilised to determine the EMBA for this Activity. As a conservative measure, the EMBA has been based on a maximum credible spill volume for the Activity as 1,065 m^3, modelled from a release location to the east of the Operational Area. The Keraudren Extension MSS modelled the 1,065 m^3 MDO/MGO spill at two release locations, one in an offshore location (northern release location) approximately 130 km north east of the Operational Area and one in a nearshore location (southern release location) approximately 130 km south east extent of the Operational Area (GHD 2019) (**Section 7.1.2**). The spill locations are approximately 150 km apart. The assessment of impacts in this section are based on the modelling results from the Keraudren Extension MSS Activity. This wider area is defined using low hydrocarbon exposure values in order to identify the full potential extent of the EMBA (as described in **Section 3**). The EMBA is illustrated in **Figure 3-1**. While the EMBA represents the largest possible spatial extent that could be affected by the worst-case hydrocarbon spill event, it is important to understand that the stochastic modelling used to define the EMBA considers 120 different simulations for any one spill event. In reality, an actual spill event is more likely to be represented by only one of the simulations and hence, have a much smaller spatial footprint. **<u>Modelled Extent of a Spill</u>** The potential extent of an MDO/MGO spill described is based on the low hydrocarbon exposure values from the spill modelling for surface, in-water (entrained and dissolved) and accumulated shoreline hydrocarbons, as described in **Section 7.1.2.3**. The low exposure values are used to identify all values and sensitivities that may be contacted in the event of a spill. It is noted that moderate and high exposure values are used in this assessment to identify the potential for ecological impacts to sensitive receptors (**Section 7.1.2.3**). The potential extent of floating MDO/MGO at or above the low exposure value of 1 grams per square metre (g/m^2), is a maximum of approximately 250 km from the southern modelled location and approximately 350 km from the northern modelled location in any season. Total water accommodated fraction (WAF) in the water column above the low exposure value of 10 parts per billion (ppb) is predicted to occur up to approximately 250–260 km from the release site in any season for both the northern and southern locations. Similarly, dissolved WAF in the water column above the low exposure value of 10 ppb is predicted to occur up to approximately 250–260 km from the modelled locations in any season for both the northern and southern locations. Time-

	integrated dissolved WAF above the low exposure value of 4,800 ppb.hr was predicted to occur only in sparse patches within approximately 60–70 km of both the northern and southern locations. Accumulation of hydrocarbon on shorelines at the low exposure value (10 g/m^2) is predicted to potentially occur between Bedout Island, approximately 100 km to the west-southwest of the modelled location, and Roebuck-Eighty Mile Beach, approximately 250 km to the northeast, from the southern modelled release location. From the northern modelled release location Rowley Shoals (Mermaid Reef AMP, Clerke Reef and Imperieuse Reef (Rowley Shoals Marine Park)) and Eighty Mile Beach are predicted to potentially be exposed at the low exposure value. Refer to **Table 7-3** for the exposure values used in the MDO/MGO Spill Modelling. **Appendix F** further describes the environmental significance of the selected exposure values. Refer to **MDO/MGO Spill Modelling Results** summary (**Section 7.1.2.5**).
Duration	MDO/MGO fuel at the sea surface will spread rapidly in the direction of the prevailing wind and surface currents. Evaporation contributes to a substantial proportion of removal of the spilled MDO/MGO on the sea surface during calm conditions, while entrainment of droplets within the water column will increasingly contribute to removal of surface oil as wind speed increases. There is a very low chance for emulsion formation. It is estimated through modelling under realistic weather conditions that surface hydrocarbons would decrease to below 1% of the total mass within 3 days (in moderate wind conditions, 5 m/s) through dispersion and evaporation. In conditions of sustained energetic winds (10 m/s), the surface oil is expected to be entirely evaporated and dispersed after 12 hours. Refer to **MDO/MGO Spill Modelling Results** summary (**Section 7.1.2.5**).

7.1.2 Quantitative Spill Modelling

The following sections describe the modelling results for the two release locations used in the Keraudren Extension MSS Activity MGO/MDO spill modelling and adopted for this survey, as described in **Section 7.1.1**.

7.1.2.1 Type of Release

All vessels will use MDO/MGO, the largest usable volume within a fuel tank of any vessel used during the survey will be 650 m^3. The release volume modelled was 1065 m^3.

GHD (2019) uses Marine Diesel (IKU) analogue from the SINTEF Oil Weathering Model to inform the hydrocarbon characteristics for the modelling. The characteristics of the Marine Diesel (IKU), selected as the analogue for the MDO/MGO release is presented in **Table 7-2**. Marine Diesel (IKU) is a mixture of predominantly semi-volatile and low-volatility hydrocarbons, with a low percentage of volatile C4 to C10 hydrocarbons (3%) and a greater proportion moderate to very low volatile C11 to C20 hydrocarbons (97%). IKU Marine diesel has no residual persistent hydrocarbons after weathering (GHD, 2019). The heavier (low volatile) components of the oil have a tendency to entrain into the upper water column due to wind-generated waves but can subsequently resurface if wind waves abate.

Table 7-2: Characteristics of MDO/MGO

<table>
<tr><th rowspan="3">Oil Type</th><th rowspan="3">Initial density gram per cubic centimetre (g/cm³) (20°C)</th><th rowspan="3">Viscosity (cP) (20°C)</th><th>Component</th><th>Volatiles (%)</th><th>Semi-volatiles (%)</th><th>Low Volatility (%)</th><th>Residual (%)</th><th>Aromatics (%)</th></tr>
<tr><th rowspan="2">Boiling Points (°C)</th><th><175</th><th>175-275</th><th>275-375</th><th>>375</th><th rowspan="2">Of whole oil <380 °C BP</th></tr>
<tr><th colspan="3">NON-PERSISTENT</th><th>PERSISTENT</th></tr>
<tr><td>Marine Diesel (IKU) [SINTEF modelling analogue]</td><td>0.843</td><td>3.9</td><td>% of total</td><td>3</td><td>52</td><td>45</td><td>0</td><td>2.9</td></tr>
</table>

Source: GHD (2019)

7.1.2.2 Modelling Inputs

To determine the spatial extent of a potential MDO/MGO hydrocarbon spill, GHD conducted modelling of a 1,065 m^3 MDO/MGO release. Modelling was conducted at two release locations (northern offshore location from the Keraudren Extension MSS Operational Area and a southern nearshore location, refer Figure **7-1**.

The selection of two release locations ensured that the modelled spill trajectories determined a worst -case hydrocarbon oil exposure to environmental sensitivities from a diesel spill within the Keraudren Extension Operational Area. The northern release point provides the potential worst case contact with receptors (Rowley Shoals) to the north (refer to **Table 7-5**, **Figure 7-4** and **Figure 7-6)**. The southern release point provides for the worst case contact with shorelines to the south (refer to **, Figure 7-3** and **Figure 7-4**). This method was applied, rather than modelling at numerous locations, as there are no significant features within the area or nearby that would create a significant difference in the model output. No additional shoreline receptors were contacted as a result of overlaying the spill trajectories along these boundaries and therefore the metrics relating to shoreline accumulation (volume and time) from the modelled scenarios along the northern and southern extents remain applicable.

Key parameters considered for the MDO/MGO spill modelling are:

g) API gravity: 36.4°;

h) Pour point: -36°C;

i) Duration of spill: Instantaneous (conservative modelling approximation);

j) Location of release: Surface spill;

k) Volume of hydrocarbon: 1,065 m^3; and

l) Time of year: any month of the year.

Stochastic Modelling

Stochastic modelling was performed on an instantaneous surface release of 1,065 m^3 of MDO/MGO with 120 stochastic model simulations, with a simulation period of 4 weeks allowing sufficient duration for modelled hydrocarbon concentrations to drop below the minimum exposure values (refer to **Section 7.1.2.3).** Modelling was conducted at any time of year to ensure weather and hydrodynamic conditions provide the worst-case extent of the hydrocarbon release scenario, ensuring conservatism in the modelling. It is noted that the EMBA from the stochastic modelling covers a larger area than the area that would be affected during any single spill event. The EMBA therefore represents the predicted maximum extent where exposure values could be exceeded from all modelling runs under different weather and metocean conditions (120 runs per release location in total).

Deterministic Modelling

In addition to the stochastic modelling, single-trajectory modelling (deterministic) was also undertaken to provide an example of the EMBA for a single spill and to characterise shoreline loading (i.e. loads) and the mass balance of the released oil in the marine environment (e.g. proportion of released oil lost to decay or volatilisation, and proportion remaining as droplets). The deterministic simulation is therefore representative of single spill event under certain wind and current conditions. The stochastic trajectory selected to run in deterministic mode was that with the largest predicted volume ashore from a single model run across all geographic receptors. The selected simulation was from the nearshore release location, resulting in a predicted accumulated oil mass of 358 tonnes at Eighty Mile Beach.

It is noted that this deterministic model is an immensely conservative estimate of the potential oil load ashore for the Survey, given the nearshore release location is approximately 130 km south east of the Operational Area, and has a closer proximity to the shoreline.

7.1.2.3 Exposure Values

The outputs of the quantitative hydrocarbon spill modelling are used to assess the environmental risk, if a credible hydrocarbon spill scenario occurred, by defining which areas of the marine environment could be exposed to hydrocarbon levels exceeding exposure values that may result in impact to sensitive receptors. The degree of impact will depend on the sensitivity of the biota contacted, the duration of the contact (exposure) and the toxicity of the hydrocarbon mixture making the contact. The toxicity of a hydrocarbon will change over time, due to weathering processes altering the composition of the hydrocarbon.

The modelling considered four key physical or chemical phases of hydrocarbons that pose differing environmental and socioeconomic risks: surface hydrocarbons, total WAF; or entrained hydrocarbons, dissolved water-accommodated fraction and shoreline accumulated hydrocarbons. The modelling used defined hydrocarbon exposure values, as relevant for risk assessment and oil spill planning, for the various hydrocarbon phases. To ensure conservatism in the environmental assessment process, the exposure values applied to the model are selected to adopt the most sensitive receptors that may be exposed, the longest likely exposure times and the more toxic hydrocarbons.

Exposure values applied for surface hydrocarbons, total WAF hydrocarbons (entrained), dissolved WAF and accumulated hydrocarbons ashore used in the modelling study are summarised in **Table 7-3**. The adopted exposure values are based primarily on the exposure values defined in NOPSEMA Bulletin #1 Oil Spill Modelling (April 2019). The environmental significance of these exposure values is described in **Appendix F.**

Table 7-3: Summary of the exposure values applied in the GHD (2019) modelling

Exposure Values			Description
Surface hydrocarbons (floating) (g/m^2) [1]	Low	1	This value represents the area where a visible sheen may be present on the surface but is below concentrations at which ecological impacts are expected to occur. It predicts the potential for some socio-economic impact (visual/aesthetic).
	Moderate	10	This represents the minimum oil thickness at which ecological impacts (e.g. to birds and marine mammals) are expected to occur.
	High	50	This value is the estimated minimum floating hydrocarbon threshold for containment and recovery and informs response planning.

Total water accommodated fraction (entrained) (ppb) [1]	Low	10	This value establishes the planning area for scientific monitoring based on potential for exceedance of water quality triggers.
	Moderate	100	This represents potential toxic effects, particularly sublethal effects to sensitive species.
	High	-	N/A
Dissolved water accommodated fraction (ppb) [1]	Low	10	This value establishes the planning area for scientific monitoring based on potential for exceedance of water quality triggers.
	Moderate	50	This represents potential toxic effects, particularly sublethal effects to highly sensitive species.
	High	400	This value represents toxic effects including lethal effects to sensitive species.
Time-integrated dissolved water accommodated fraction (ppb.hrs)[2]	Low	-	N/A
	Moderate	4,800	Time-based exposures are based on the instantaneous exposure values integrated across a 96-hour interval. They are considered more representative of the potential for toxic effects to sensitive species than using the instantaneous exposure, which are considered highly conservative.
	High	38,400	
Accumulated hydrocarbons (shoreline) (g/m^2) [1]	Low	10	This value represents light oiling (equivalent to 2 teaspoons of oil per m^2) and predicts the potential for some socio-economic impact (visual/aesthetic).
	Moderate	100	This represents the minimum oil thickness at which potential lethal ecological impacts (e.g. to intertidal invertebrates) may occur. It also predicts areas likely to require clean-up effort
	High	1000	This value predicts areas likely to require intensive clean-up effort.

[1] Instantaneous exposure values sourced from NOPSEMA Bulletin #1 Oil Spill Modelling (April 2019)

[2] Ecological receptors may not be impacted instantaneously. Toxicity effects from hydrocarbons occur based upon the rate of uptake of toxic compounds (primarily the dissolved aromatic hydrocarbons), the duration of exposure and the rate the organism is able to metabolise hydrocarbons. Toxicity to aquatic organisms is, therefore, dependent on duration of exposure, such that a brief exposure may not affect an organism, but prolonged exposure may result in toxicity effects. The exposure values used for the in-water concentrations of dissolved aromatic hydrocarbons consider a time-integrated exposure (a concentration multiplied by the number of hours exposed at that concentration), in the units of parts per billion multiplied by hours (ppb.hrs), which is an appropriate criterion for identifying potential impacts on the marine environment comparative to peak instantaneous concentrations (French-McCay 2002, 2016).The 96-hour exposure interval is representative of acute exposures, whereas some chronic toxicity effects may require a longer exposure duration.

7.1.2.4 MDO/MGO Weathering Assessment

A preliminary analysis of MDO/MGO weathering was undertaken with the SINTEF Oil Weathering Model (GHD, 2019). Oil Weathering Model (OWM) predicts the weathering (i.e. mass balance partitioning) of hydrocarbons under steady state met-ocean conditions. The OWM simulation was run for sustained wind speeds of 1 m/s (low wind conditions), 5 m/s (moderate wind conditions) and 10 m/s (high winds). The simulation is based on a standard test case of 100 m^3 of hydrocarbon released instantaneously onto the sea surface. The 100 m^3 volume is a GHD internal standard for consistency between weathering assessments, findings are applied to the 1,065 m^3 credible spill. The result of the analysis is presented in **Figure 7-1** for Marine Diesel (IKU) (the SINTEF oil library modelling analogue). Marine Diesel (IKU) has a similar density to light crude oils.

Under low winds (1 m/s), 60% of the surface slick is predicted to remain after 120 hours (5 days). Under moderate winds, 40% of the initial surface slick is predicted to remain after 24 hours, decreasing further to approximately 10% after 48 hours and approximately 1% after 72 hours. With sustained high winds (10 m/s), the surface slick is predicted to have been almost entirely evaporated and dispersed after 12 hours. It should be noted that extreme wind conditions are not likely to be sustained for long periods in normal metocean conditions. The hydrocarbon has a very low tendency for emulsion formation, with only approximately 1% water content entrained into the surface slick after 120 hours for all wind conditions assessed.

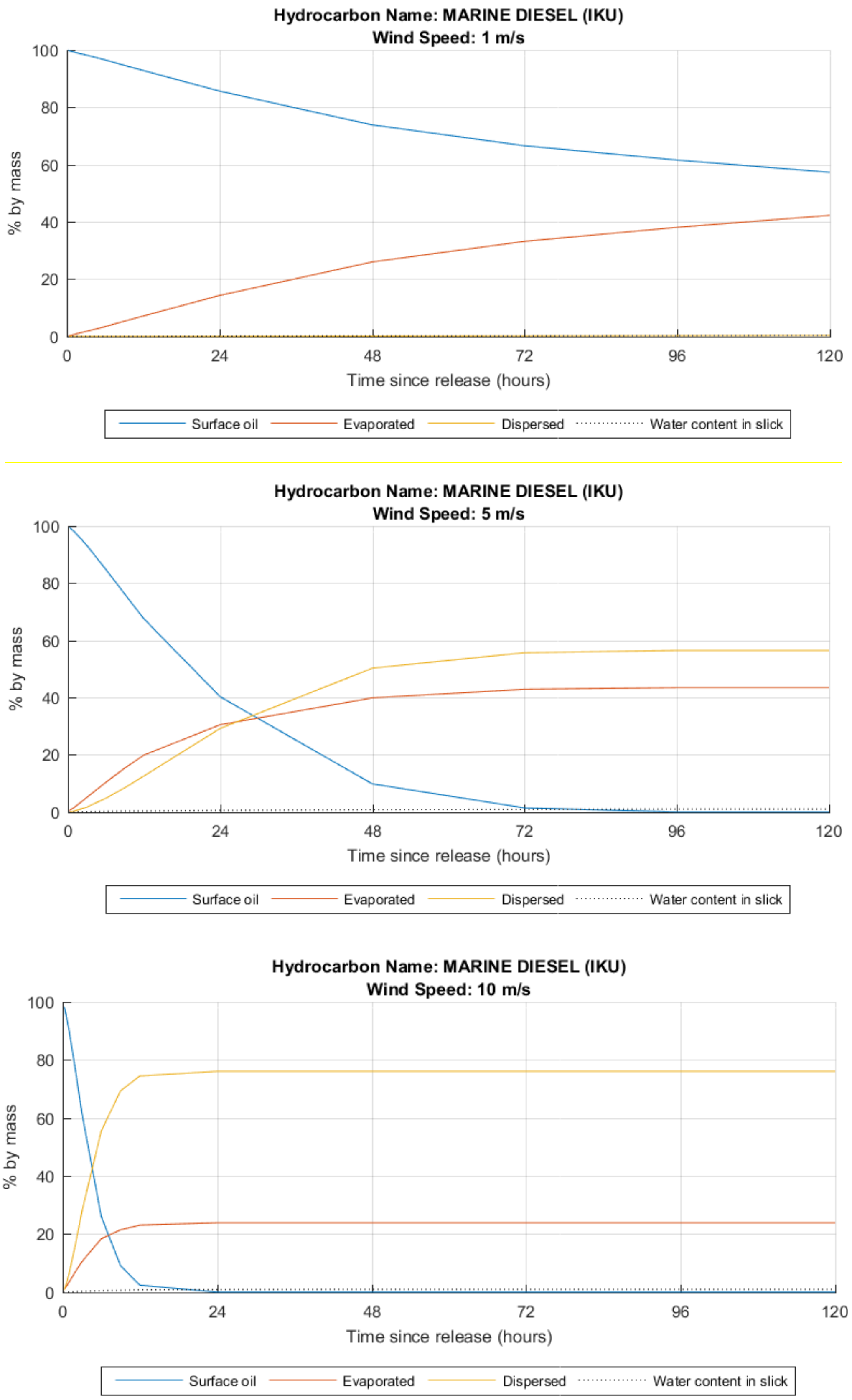

Figure 7-2: Simulated weathering of the SINTEF Marine Diesel (IKU) hydrocarbon for constant wind speeds of 1 m/s (top), 5 m/s (middle) and 10 m/s (bottom)

7.1.2.5 Stochastic Spill Modelling Results

A summary of the stochastic spill modelling results is provided below, with a tabulated summary of the results provided in **Table 7-9**.

Sea Surface Hydrocarbons

Surface oiling was assessed at three exposure values representing low exposure (1 g/m^2, visual/aesthetic impacts), moderate exposure (10 g/m^2, lower limit for potential ecological impacts), and high exposure (50 g/m^2, approximating concentrations that can be effectively targeted during spill response).

Southern Modelled location

Surface oil above the low exposure value (1 g/m^2) was predicted to extend up to a maximum of approximately 250 km from the southern release location (refer to **Figure 7-3** and **Figure 7-4**). The maximum spatial extent for the moderate (10 g/m^2) and high (50 g/m^2) exposure values were predicted to reduce to approximately 200 km and 170 km, respectively. Key receptors (as defined by Santos for the purpose of oil spill impact assessment and response planning) predicted to be contacted by surface hydrocarbons above the moderate exposure value (10 g/m^2) include Eighty Mile Beach AMP (with a contact probability of 64% and a minimum time to contact of 0.3 days); Eighty Mile Beach (with a contact probability of 11% and a minimum time to contact of 2.3 days); the coastal area between Port Hedland and Eighty Mile Beach, and Bedout Island (both with a contact probability of 1.7% and a minimum time to contact of 2.3 to 2.4 days).

Northern Modelled Location

Surface oil above the low exposure threshold (1 g/m^2) was predicted to extend up to approximately 350 km from the northern release location (**Figure 7-5** and **Figure 7-6**). The maximum spatial extent for the moderate (10 g/m^2) and high (50 g/m^2) thresholds were predicted to reduce to approximately 200 km and 160 km, respectively. Key receptors predicted to be contacted by surface oil above the moderate exposure value (10 g/m^2) include the Rowley Shoals Surrounds (with a contact probability of 25% and a minimum time to contact of 0.6 days); and Mermaid Reef AMP, Imperieuse Reef and Clerke Reef (Rowley Shoals Marine Park) (with a contact probability of less than 2.5% and a minimum time to contact of 2.3 to 6.6 days).

Hydrocarbons Ashore

Shoreline oiling was assessed at three contact thresholds representing low exposure (10 g/m^2, visual/aesthetic impacts), moderate exposure (100 g/m^2, generally requiring clean-up effort), and high exposure (1,000 g/m^2, requiring intensive clean-up effort).

Southern Modelled location

Shoreline accumulation at the low exposure value (10 g/m^2) was predicted to occur between Bedout Island (14% probability), approximately 100 km to the west-southwest of the release location, and Roebuck-Eighty Mile Beach (21% probability), approximately 250 km to the northeast (refer to **Table 7-4** and **Figure 7-3**). Shoreline accumulation above the moderate and high exposure values (100 g/m^2 and 1,000 g/m^2 respectively) was predicted at Bedout Island (1-4% probability) and mainland shorelines (8-12% probability). However, accumulation along mainland shorelines reduced in spatial extent to an area of approximately 160-180 km along Eighty Mile Beach to the east of the release location.

The maximum predicted shoreline loading across all shorelines was approximately 358 tonnes, which occurred entirely at Eighty Mile Beach at the low exposure value. Lower maximum shoreline loadings were also predicted for the shoreline between Port Hedland and Eighty Mile Beach (approximately 22 tonnes, noting the very low (<1 %) contact probability) and Bedout Island (approximately 12 tonnes) at the low exposure value.

Minimum arrival times of less than 1 week were predicted for most contacted shorelines. The fastest predicted arrival time was 2.2 days at Bedout Island (low exposure threshold).

Northern Modelled Location

Shoreline loading at low exposure (10 g/m^2) was predicted to occur at the Rowley Shoals emergent/intertidal features of Mermaid Reef AMP (27% probability), Clerke Reef (31% probability) and Imperieuse Reef (29% probability) (Rowley Shoals Marine Park), located in relative proximity to the release location (80-100 km away) (**Figure 7-3)**. Low exposure was predicted with a very low probability at Eighty Mile Beach (1% probability) and Roebuck-Eighty Mile Beach (2% probability), approximately 250 km to the southeast. Shoreline contact at the medium (100 g/m^2) and high (1,000 g/m^2) thresholds was predicted to occur at the three Rowley Shoals receptors only (1-10% probability), with no mainland loadings.

The maximum predicted shoreline loading across all shorelines was approximately 335 tonnes, which occurred primarily at Imperieuse Reef (Rowley Shoals Marine Park) at the low exposure threshold. The maximum predicted total accumulated load at this receptor for the high exposure threshold was similar (approximately 330 tonnes), indicating the vast majority of all oil on the shoreline during this realisation was present above the 1,000 g/m^2 exposure threshold. Lower maximum accumulated shoreline loadings were also predicted for Mermaid Reef AMP (approximately 152 tonnes) and Clerke Reef (approximately 70 tonnes) at the low exposure threshold, with very low loadings at Eighty Mile Beach (approximately 0.04 tonnes) and Roebuck – Eighty Mile Beach (approximately 0.7 tonnes).

Short minimum arrival times of approximately 3 days were predicted for the Rowley Shoals receptors, with longer minimum arrival times of approximately 12 days for Eighty Mile Beach and Roebuck - Eighty Mile Beach at the low exposure threshold.

Total Water Accommodated Fraction

The total WAF was assessed at two contact thresholds representing low exposure (10 ppb, potential exceedance of water quality triggers) and moderate exposure (100 ppb, potential effects).

Southern Modelled location

Entrainment of the surface slicks resulted in total WAF concentrations above the low exposure value (10 ppb) primarily up to 250 km from the southern release site. Some isolated exceedances of the low exposure value were predicted up to approximately 350 km away (**Figure 7-3**). Exceedances of the moderate exposure value (100 ppb) were predicted to occur up to a maximum of approximately 210 km from the southern release site.

Key receptors predicted to be contacted by entrained oil plumes above the moderate exposure value (100 ppb) include Eighty Mile Beach AMP (with a contact probability of 65% and a minimum time to contact of 0.3 days); Eighty Mile Beach (with a contact probability of 7% and a minimum time to contact of 2.3 days); the coastal area between Port Hedland and Eighty Mile Beach, and Bedout Island (both with a contact probability of 1.7% and a minimum time to contact of 2.3 to 3 days).

Northern Modelled Location

Entrainment of the surface slicks resulted in total WAF concentrations above the low exposure value (10 ppb) primarily up to 260 km from the northern release site. However, some isolated exceedances of the low exposure value were predicted up to approximately 500 km away (**Figure 7-5**). Exceedances of the moderate exposure value (100 ppb) were predicted to occur up to a maximum of approximately 180 km from the northern release site.

Key receptors predicted to be contacted by entrained oil plumes above the moderate exposure value (100 ppb) include Rowley Shoals surrounds (with a contact probability of 23% and a minimum time to contact of 0.7 days); Imperieuse Reef and Clerke Reef (Rowley Shoals Marine Park) (with a contact probability of less than 2.5% and a minimum time to contact of 2.3 to 8.7 days).

Dissolved WAF

Dissolved WAF was assessed at three contact thresholds representing low exposure (10 ppb, potential exceedance of water quality triggers), medium exposure (50 ppb, potential sub-lethal toxic effects to sensitive species) and high exposure (400 ppb, potential toxic lethal effects to sensitive species). Time-

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integrated dissolved WAF was also assessed at two exposure values, namely a low exposure value of 4,800 ppb.hr and a high exposure value of 38,400 ppb.hr.

Southern Modelled location

Dissolved WAF above the low and moderate exposure values (10 and 50 ppb respectively) was predicted to occur to a maximum distance of approximately 220 km from the southern spill location (**Figure 7-3**). Concentrations above the high exposure value (400 ppb) were predicted to occur in sparse patches typically within approximately 100 km of the release location.

Key receptors predicted to be contacted by dissolved WAF above the moderate exposure value (50 ppb) include Eighty Mile Beach AMP (with a contact probability of 64% and a minimum time to contact of 0.3 days); Eighty Mile Beach (with a contact probability of 7% and a minimum time to contact of 2.3 days); the coastal area between Port Hedland and Eighty Mile Beach, and Bedout Island (both with a contact probability of 1.7% and a minimum time to contact of 2.2 to 2.4 days).

Time-integrated dissolved WAF above the low exposure value (4,800 ppb.hr) was predicted to occur only in sparse patches within approximately 70 km of the southern spill site. There were no exceedances of the high threshold (38,400 ppb.hr) predicted by the modelling. The only receptor predicted to be contacted at the low exposure value was Eighty Mile Beach AMP, with a contact probability of 8%.

Northern Modelled Location

Dissolved WAF above the low exposure value (10 ppb) was predicted to occur to a maximum distance of approximately 250 km from the northern spill location (**Figure 7-6)**. Concentrations above the moderate (50 ppb) and high (400 ppb) exposure values were predicted to extend to approximately 180 km and 150 km of the northern release location respectively.

Key receptors predicted to be contacted by dissolved WAF above the moderate exposure value (50 ppb) include Rowley Shoals surrounds (with a contact probability of 22% and a minimum time to contact of 0.7 days); Imperieuse Reef and Clerke Reef (Rowley Shoals Marine Park) (with a contact probability of less than 2.5% and a minimum time to contact of 2.3 to 6.6 days).

Time-integrated dissolved WAF above the low exposure value (4,800 ppb.hr) was predicted to occur only in sparse patches within approximately 60 km of the northern spill site. There were no exceedances of the high threshold (38,400 ppb.hr) predicted by the modelling. The only receptor predicted to be contacted at the low exposure value was Rowley Shoals surrounds, with a contact probability of 2%.

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Table 7-4: Probability of contact by hydrocarbons exceeding exposure values applied in the GHD (2019) modelling for the Southern modelled location

Sensitive Receptor Location	Total Contact Probability (%) (NC = No Contact)												
	Surface Hydrocarbons			Hydrocarbons Ashore			Total WAF (Entrained)		Dissolved WAF			Time-Integrated Dissolved WAF	
	>1 g/m^2	>10 g/m^2	>25 g/m^2	>10 g/m^2	>100 g/m^2	>1,000 g/m^2	>10 ppb	>100 ppb	>10 ppb	>50 ppb	>400 ppb	>4,800 ppb.hr	>38,400 ppb.hr
Port Hedland-Eighty Mile Beach	2.5	1.7	NC	0.8	0.8	0.8	3.3	1.7	1.7	1.7	NC	NC	NC
Eighty Mile Beach	20.8	10.8	4.2	20.8	11.7	7.5	22.5	6.7	17.5	6.7	NC	NC	NC
Eighty Mile Beach AMP	69.2	64.2	53.3	NC	NC	NC	85.0	65.0	71.7	64.2	34.2	7.5	NC
Roebuck - Eighty Mile Beach	NC	NC	NC	0.8	NC	NC	NC	NC	NC	NC	NC	NC	NC
Bedout Island	2.5	1.7	0.8	14.2	4.2	0.8	10.8	1.7	3.3	1.7	NC	NC	NC
Rowley Shoals surrounds	NC	NC	NC	NC	NC	NC	0.8	NC	NC	NC	NC	NC	NC

Table 7-5: Probability of contact by hydrocarbons exceeding exposure values applied in the GHD (2019) modelling for the Northern modelled location

Sensitive Receptor Location	Total Contact Probability (%) (NC = No Contact)												
	Surface Hydrocarbons			Hydrocarbons Ashore			Total WAF (Entrained)		Dissolved WAF			Time-Integrated Dissolved WAF	
	>1 g/m^2	>10 g/m^2	>25 g/m^2	>10 g/m^2	>100 g/m^2	>1,000 g/m^2	>10 ppb	>100 ppb	>10 ppb	>50 ppb	>400 ppb	>4,800 ppb.hr	>38,400 ppb.hr
Mermaid Reef AMP	2.5	1.7	0.8	26.7	10.0	2.5	16.7	2.5	3.3	1.7	NC	NC	NC
Clerke Reef MP	1.7	0.8	NC	30.8	10.0	0.8	20.0	0.8	2.5	0.8	NC	NC	NC
Imperieuse Reef MP	3.3	2.5	1.7	29.2	5.8	1.7	17.5	2.5	3.3	2.5	NC	NC	NC
Rowley Shoals surrounds	29.2	25.0	18.3	NC	NC	NC	54.2	23.3	28.3	21.7	13.3	1.7	NC
Eighty Mile Beach	NC	NC	NC	0.8	NC	NC	NC	NC	NC	NC	NC	NC	NC
Roebuck - Eighty Mile Beach	NC	NC	NC	1.7	NC	NC	NC	NC	NC	NC	NC	NC	NC
Kimberley AMP	0.8	NC	NC	NC	NC	NC	2.5	NC	NC	NC	NC	NC	NC
Glomar Shoals	NC	NC	NC	NC	NC	NC	0.8	NC	NC	NC	NC	NC	NC
Scott Reef South	NC	NC	NC	NC	NC	NC	0.8	NC	NC	NC	NC	NC	NC

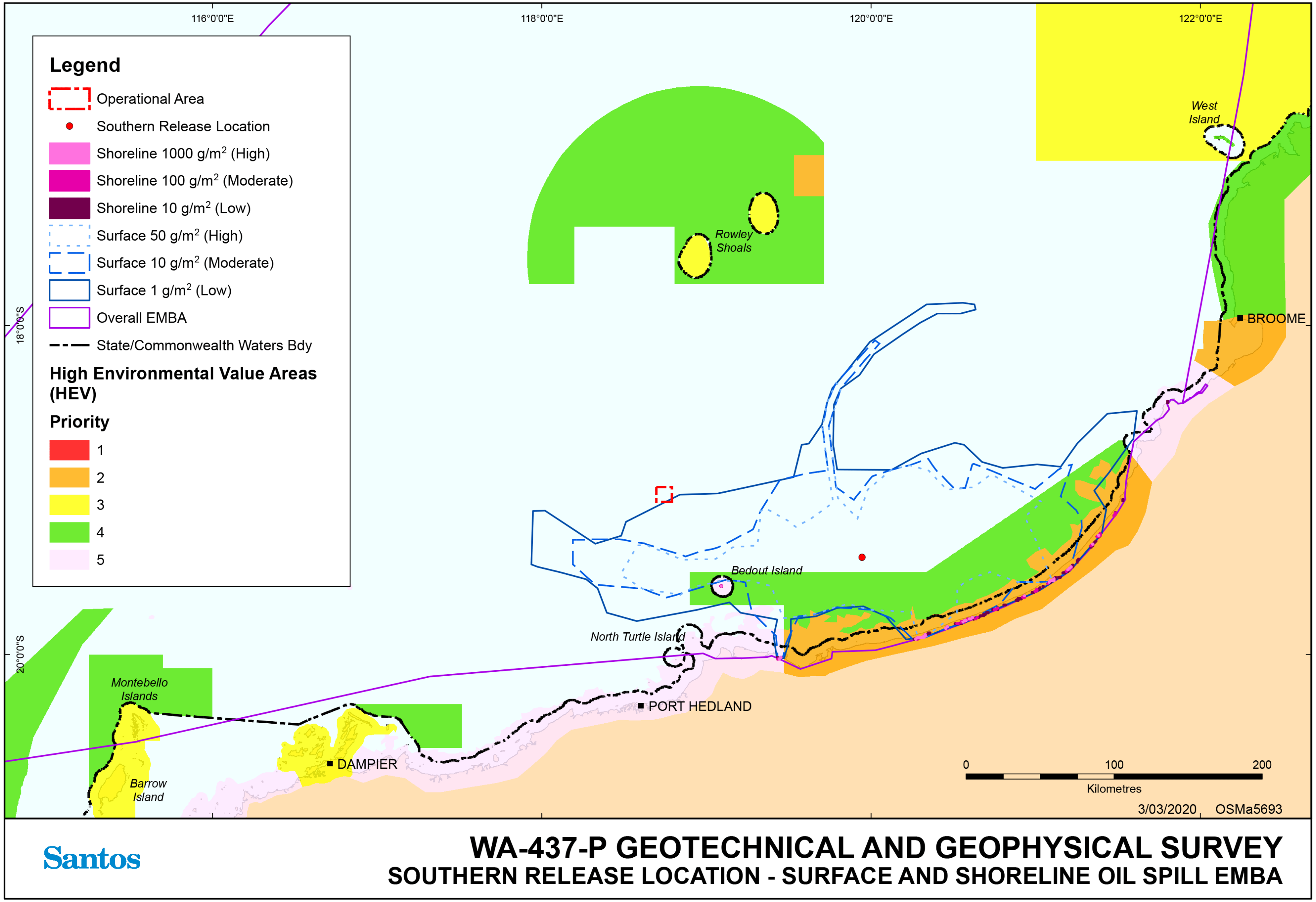

Figure 7-3: Modelled EMBA from the southern modelled location of MDO/MGO (diesel) spill for low, moderate and high exposure values of surface oil and shoreline accumulation)

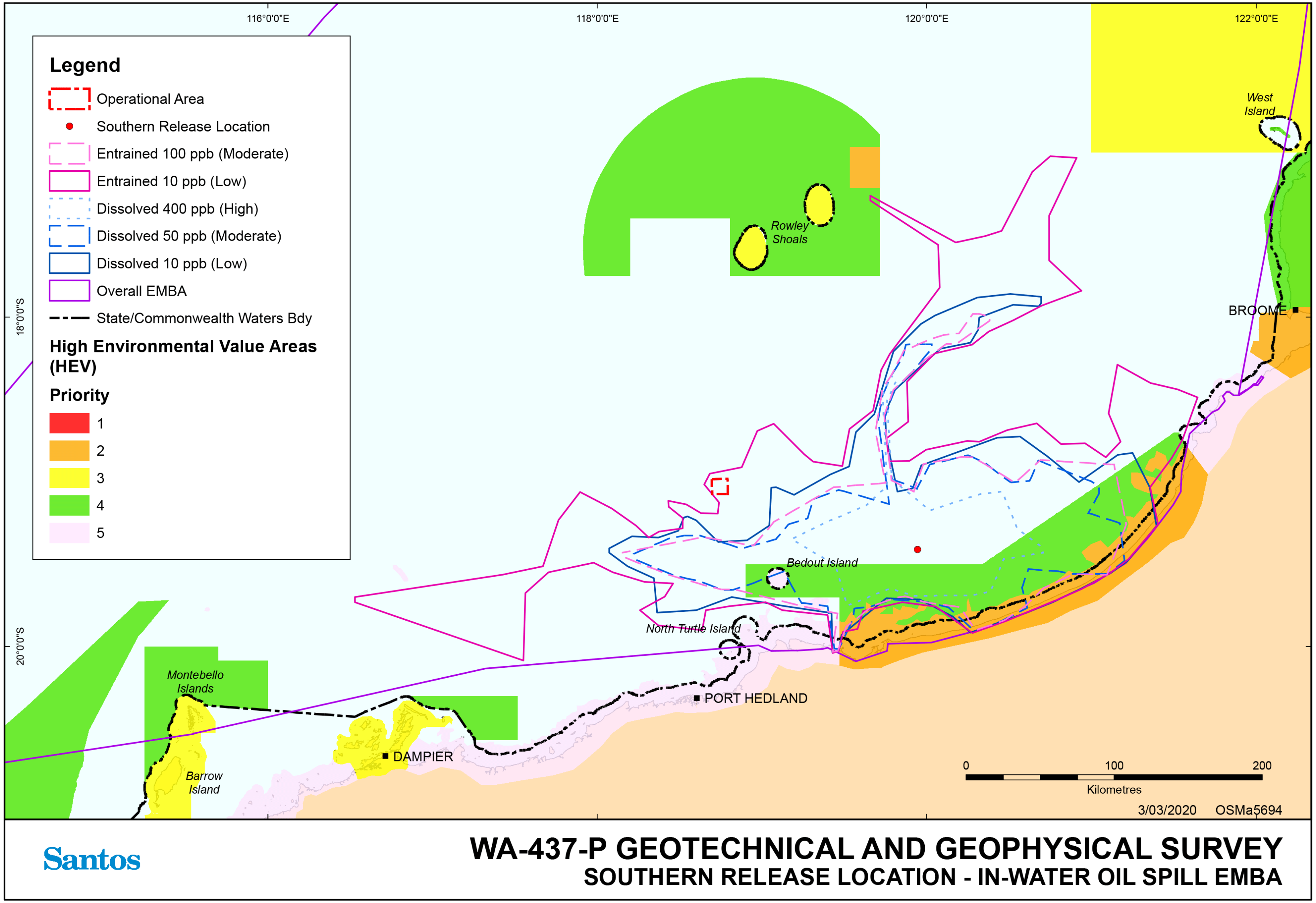

Figure 7-4: Modelled EMBA from the southern modelled location of MDO/MGO (diesel) spill for low, moderate and high exposure values of entrained (total WAF) and dissolved oil

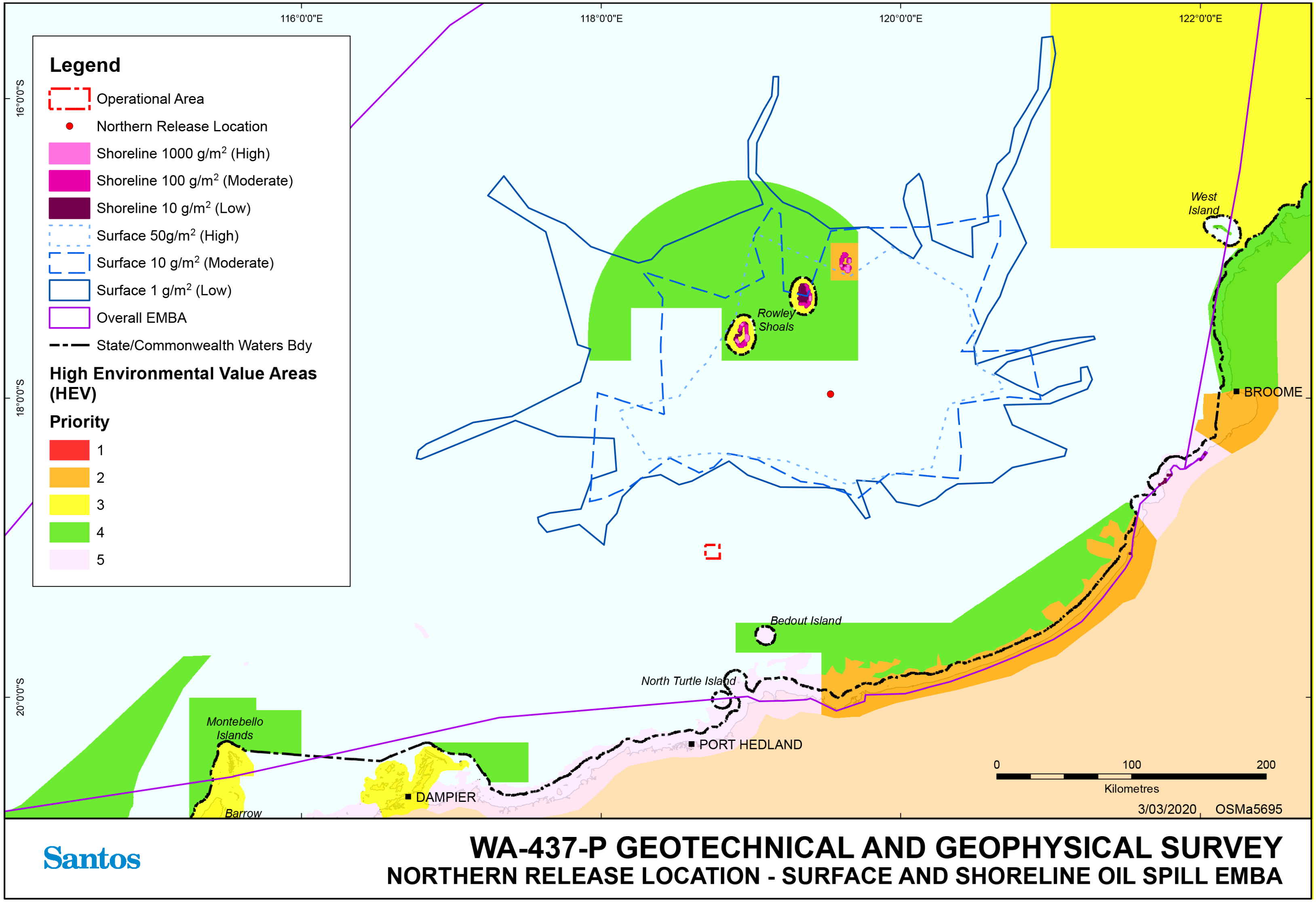

Figure 7-5: Modelled EMBA from the northern modelled location of MDO/MGO (diesel) spill for low, moderate and high exposure values of surface oil and shoreline accumulation)

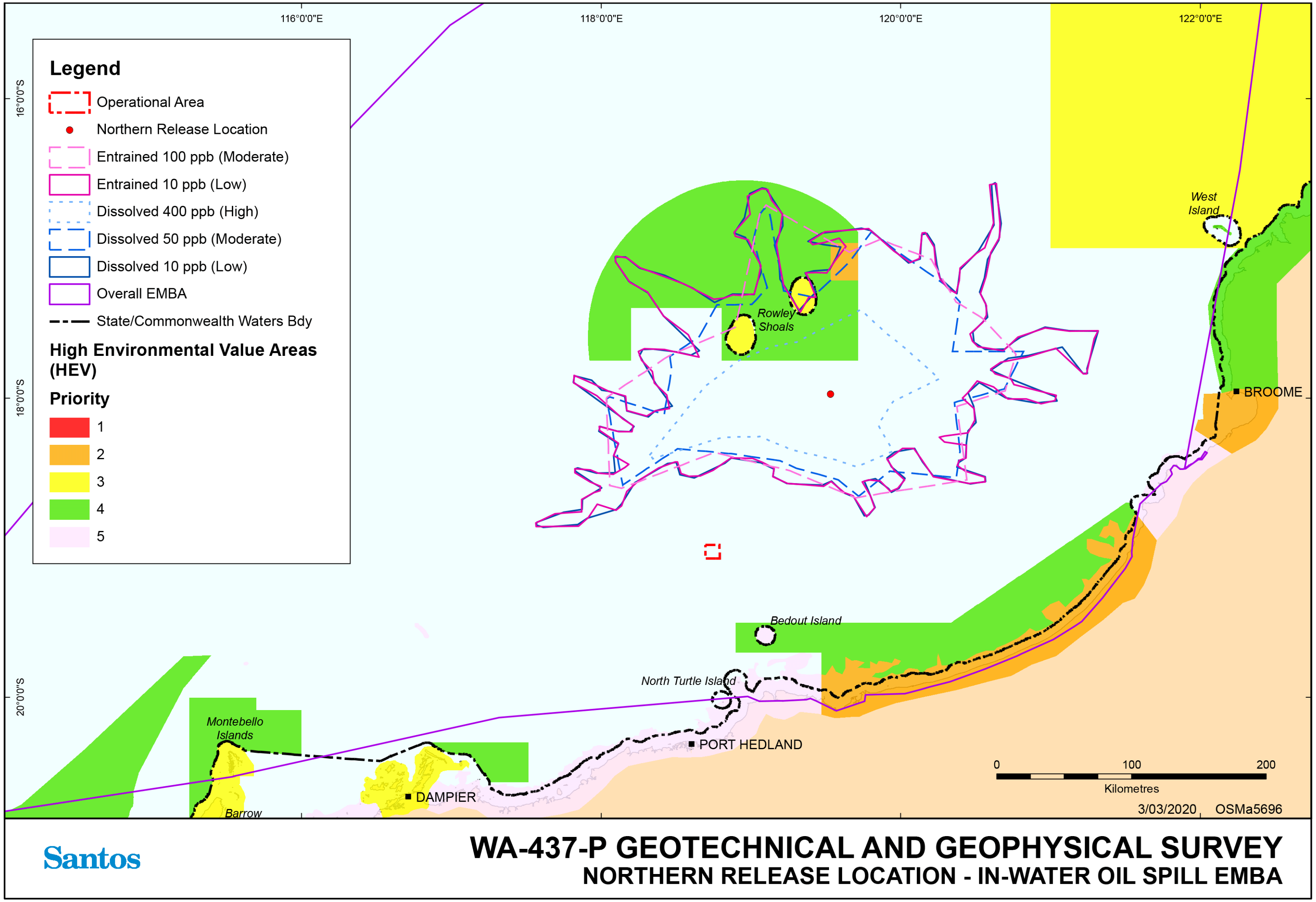

Figure 7-6: Modelled EMBA from the northern modelled location of MDO/MGO (diesel) spill for low, moderate and high exposure values of entrained (total WAF) and dissolved oil

7.1.2.6 Deterministic Spill Modelling Results

For the single trajectory modelled in deterministic mode, the surface oil, total WAF and dissolved WAF is predicted to be transported to the southwest towards Eighty Mile Beach, arriving at the shoreline after 6 days. Snapshot outputs at 1-week post-release reveal the influence of the shoreline washing mechanism in the deterministic simulation which results in localised remobilisation of a portion of the oil from the shoreline into a surface slick, total WAF, and dissolved WAF. This remobilised portion of oil is transported back towards the northwest by prevailing currents and winds after 1 week for time-averaged surface oil concentrations of surface oil greater than 1 g/m^2).

Eighty Mile Beach was the only receptor contacted by shoreline oil above the low exposure threshold of 10 g/m^2 for this single spill trajectory. Shoreline oiling was predicted to reach a peak load of 358 tonnes at 7.5 days. Weathering processes over the following approximately 3 weeks were predicted to reduce the shoreline oil mass to approximately 210 tonnes by day 28.

7.1.3 Nature and Scale of Environmental Impacts

Hydrocarbon spills will cause a decline in water quality and can cause chemical (e.g. toxic) and physical (e.g. coating of emergent habitats, oiling of wildlife at sea surface) impacts to marine species. The severity of the impact of a hydrocarbon spill depends on the magnitude of the hydrocarbon spill (i.e. extent, duration) and sensitivity of the receptor.

<u>Potential Receptors: Fish, sharks, cetaceans, marine reptiles, seabirds and shorebirds. Shorelines habitats and associated fauna and flora.</u>

A loss of MDO/MGO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column. Transient fauna may traverse the area and may also be potentially impacted by a spill. A general description of potential pathways and impacts to sensitive receptors through hydrocarbon exposure and potential toxicity effects is provided in **Table 7-6** (refer to **Appendix F** for further detail). It is noted that contact with hydrocarbons above the moderate exposure values is considered to be the minimum concentrations to potentially result in ecological impacts.

Potential impacts of MDO/MGO to sensitive receptors found within the EMBA are summarised in **Table 7-7**.

Table 7-6: Physical and chemical pathways and oil impacts to marine organisms

Receptor	Physical pathway		Chemical pathway	
	Exposure	Potential impacts	Exposure	Potential impacts
Rocky shore	Shoreline loading and attachment may result in thin and sporadic coating of MDO/MGO residue. Degree of oil coating is dependent upon the energy of the shoreline area, the type of the rock formation and continual biodegradation of the MDO/MGO.	Impacts to flora and fauna, where relevant for the habitat type, as per below.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation. Impacts to flora and fauna as per below.	Impacts to sessile flora and fauna (invertebrates) where relevant for the habitat type, as per below.
Sandy shore	Shoreline loading and water movement may allow MDO/MGO residue to filter down into sediments, continue to biodegrade on the surface or remobilise into surf zone. Degree of loading is dependent upon the energy and tidal reach of the shoreline, the type of the sandy shore and continual weathering of the MDO/MGO.	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts to infauna.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts (mortality) to infauna through toxic effects and smothering.
Intertidal flats	Shoreline loading and water movement may allow MDO/MGO residue to filter down into sediments or continue to biodegrade on the surface or remobilise into surf zone. Degree of loading is dependent upon the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the MDO/MGO.	Indirect impacts to foraging habitats for birds and turtles. Direct impacts to infauna.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Indirect impacts to foraging habitats for birds. Direct impacts (mortality) to infauna through toxic effects and smothering.
Mangroves	Coating of root system reducing air and salt exchange. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the MDO/MGO.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output.	External contact by oil and adsorption across cellular membranes.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output.

Receptor	Physical pathway		Chemical pathway	
	Exposure	Potential impacts	Exposure	Potential impacts
		Reduced seed viability.		Reduced seed viability. Growth abnormalities.
Algae and seagrass	Coating of leaves/thalli reducing light availability and gas exchange. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the MDO/MGO.	Bleaching or blackening of leaves. Defoliation. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Bleaching or blackening of leaves. Defoliation. Disease. Reduced growth. Reduced reproductive output. Reduced seed/ propagule viability.
Hard corals	Coating of polyps, shading resulting in reduction on light availability. Degree of coating is dependent upon the metocean conditions, dilution, if corals are emergent at all and continual weathering of the MDO/MGO.	Bleaching. Increased mucous production. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities.
Invertebrates	Coating of adults, eggs and larvae. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the MDO/MGO.	Mortality Behavioral disruption Impaired growth	Ingestion and inhalation. External contact and adsorption across exposed skin and cellular membranes. Uptake of dissolved aromatic hydrocarbons across cellular membranes. Reduced mobility and capacity for oxygen exchange.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities.

Receptor	Physical pathway		Chemical pathway	
	Exposure	Potential impacts	Exposure	Potential impacts
				Behavioural disruption.
Fish, sharks and rays	Coating of adults but primarily eggs and larvae - Reduced mobility and capacity for oxygen exchange.	Mortality. Oxygen debt. Starvation. Dehydration. Increased predation. Behavioural disruption.	Ingestion. External contact and adsorption across exposed skin and cellular membranes. Uptake of dissolved aromatic hydrocarbons across cellular membranes (e.g. gills).	Mortality. Cell damage. Flesh taint. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.
Birds	Light coating. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the MDO/MGO.	Feather and skin irritation and damage. It is commonly thought that MDO/MGO does not cause problems to wildlife due to the lack of visible oiling, however, may be toxic (WAOWRP 2014).	Ingestion (during feeding or preening). External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine reptiles	Light coating. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the MDO/MGO.	Behavioural disruption. It is commonly thought that MDO/MGO does not cause problems to wildlife due to the	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response.

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Receptor	Physical pathway		Chemical pathway	
	Exposure	Potential impacts	Exposure	Potential impacts
		lack of visible oiling, however, may be toxic (WAOWRP 2014).		Disease. Reduced growth. Reduced hatchling success. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine mammals	Light coating – fur damage and matting, reduced mobility and buoyancy (for applicable species). Coating of feeding apparatus in some species (i.e. baleen whales).	It is commonly thought that MDO/MGO does not cause problems to wildlife due to the lack of visible oiling, however, may be toxic (WAOWRP 2014).	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth Reduced reproductive output. Growth abnormalities. Behavioural disruption.

Table 7-7: Potential for exposure of sensitive receptors found within the overall EMBA to hydrocarbons

Receptor	Impacts of MDO/MGO
Marine fauna	
Plankton (including zooplankton; fish and coral larvae)	The hydrocarbon spill EMBA has the potential to overlap with spawning of some fish species given the year round spawning of some species, and overlap in peak spawning periods of others (**Table 3-12**). Coral spawning in the region occurs during the proposed Activity (**Table 3-12**), however, no significant coral reef habitat exists in the EMBA. In the unlikely event of a spill occurring, fish larvae may be impacted by MDO/MGO entrained in the water column. Following release, the MDO/MGO will rapidly evaporate and disperse in the offshore environment, reducing the concentration and toxicity of the spill. Given duration of fish spawning periods, lack of suitable habitat for aggregating fish populations near the surface, combined with the quick evaporation and dispersion of MDO/MGO, impacts to overall fish populations are not expected to be significant.
Marine mammals	Eleven migratory cetacean species were identified by the EPBC Protected Matters search within the EMBA (**Section 3**). Of these, one is listed as endangered (blue whale (considered to be the pygmy blue whale sub-species)) and three as vulnerable (humpback whale, fin whale and sei whale). The hydrocarbon spill EMBA overlaps with the pygmy blue whale distribution and migration BIA and humpback migration BIA. Large number of individuals of either species are not expected to pass through the area, since the Activity will not overlap spatially with the pygmy blue whale migration BIA. There is a minor overlap with a foraging BIA for Dugong along the Kimberley coast within the overall EMBA. It is noted that there is no contact for surface or in-water hydrocarbons predicted by spill modelling at the southern or northern release location, above moderate exposure values that may result in ecological impacts. Impacts to dugong habitat within the BIA are therefore not expected. Other migratory cetaceans may encounter either surface or water column MDO/MGO, however, the absence of any known feeding, resting or breeding areas within the EMBA means significant numbers are unlikely to be impacted. For environmental impacts through hydrocarbon exposure and toxicity to marine mammals, refer to **Table 7-6.**
Marine reptiles	Eight species of threatened marine reptile were identified as possibly being impacted by a spill. Short-nosed seasnake, flatback, hawksbill, leatherback, green, olive ridley and loggerhead turtles are widely dispersed at low densities across the NWS and in the unlikely event of a MDO/MGO spill occurring, individuals traversing open water may come into contact with water column or surface MDO/MGO. The presence of saltwater crocodile is restricted to the shoreline locations close to Broome (particularly around creeks and estuarine habitat), where they may come into contact with accumulated hydrocarbons. The hydrocarbon spill EMBA overlaps with the flatback, green, loggerhead and hawksbill BIAs as well as habitat designated as critical for internesting flatbacks such as that adjacent to Eighty Mile Beach. As such there is a risk of transient adults encountering surface and in-water MDO/MGO. Modelling results indicate a shoreline loading of approximately 358 tonnes (GHD 2019) in the worst-case scenario (with probability of up to 21% for oiling greater than 10 g/m^2). For environmental impacts through hydrocarbon exposure and increased toxicity to marine reptiles, refer to **Table 7-6**. The Recovery Plan for Marine Turtles in Australia: 2017-2027 (Commonwealth of Australia 2017a) highlights acute chemical discharge as one of several threats to marine turtles.
Seabirds and shorebirds	Twelve threatened species, as identified by the EPBC Protected Matters database search, may be encountered during the Activity, of which eight have a BIA for breeding within the hydrocarbon spill EMBA. Seabird BIAs include lesser frigate bird, brown booby, lesser crested tern, white-tailed tropicbird, roseate tern, little tern, wedge- tailed shearwater and osprey breeding, with either egg laying or chick provisioning possibly occurring during the Activity. Surface and entrained MDO/MGO is unlikely to impact

Receptor	Impacts of MDO/MGO
	nesting or egg laying individuals in colonies, however, it is possible that breeding individuals could come into contact with surface or entrained MDO/MGO while foraging. Given the rapid evaporation and dispersion of MDO/MGO (99% of the hydrocarbon expected to evaporate or disperse after 3 days under moderate winds), significant impacts at the population level are not anticipated and therefore the risk of surface and entrained MDO/MGO to seabirds is considered low. Potential impacts to seabirds/shorebirds from exposure/contact with MDO/MGO are further detailed in **Table 7-6.**
Fish and sharks	The NWS supports a diverse assemblage of fish, including 456 species of finfish, particularly in shallower water near the mainland and islands. Threatened species identified by the EPBC Protected Matters search include the white shark, whale shark, grey nurse shark green, freshwater and dwarf sawfish, northern river shark; and two conservation dependent species (scalloped hammerhead shark and bluefin tuna) which may be present in the affected area. Given the absence of critical habitat for most of these species, significant numbers are not expected to be impacted. The Activity Operational Area overlaps with the whale shark foraging BIA and the whale shark peak post-aggregation migrating presence in the EMBA (May – June). While this BIA is for foraging, it is not for high density prey where congregations are expected, so impacts would be limited to transient migrating individuals. Given the distance to the nearest whale shark aggregation location (Ningaloo Marine Park, 490 km southwest of the Operational Area) and due to the nature of the hydrocarbon release (99% of the hydrocarbon expected to evaporate or disperse after 3 days under moderate winds) significant impacts to whale sharks are not expected. White sharks and sawfish could be present at low densities all year round within the Operational Area and EMBA, however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted if an unplanned release were to occur. For further detailed environmental impacts through hydrocarbon exposure and toxicity effects, refer to **Table 7-6.**
Socio-economic	
Fisheries	MDO/MGO in the water column can have toxic effects on fish (as outlined above) reducing catch rates and rendering fish unsafe for consumption. In addition to the effects of total WAF and dissolved WAF, exclusion zones surrounding a spill can directly affect fisheries by restricting access for fishers. Both water column and surface MDO/MGO have the potential to lead to temporary financial losses.
Tourism	Aquatic recreational activities such as boating, diving and fishing occur around Bedout Island or Eighty Mile Beach but are concentrated in the vicinity of the population centres such as Dampier, Onslow and Broome **(Table 3-11**). Tourism in Port Hedland is less prolific and given the small volumes potentially accumulated, any impacts are likely to be temporary and localised. In the waters within and immediately surrounding the Operational Area, tourism activities are expected to be low, however exclusion zones surrounding a spill will reduce access for vessels for the duration of the response undertaken for spill clean-up (if applicable).
Shipping	The Operational Area is adjacent to with two north-south oriented lanes servicing Port Hedland (**Figure 3-14**). Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable); vessel may have to take large detours leading to potential delays and increased costs.
Defence	No designated defence areas overlap the Operational Area and there is only a minor overlap of defence areas by the western portion of the EMBA, therefore interference of defence activities due to an MDO/MGO spill is likely to be minimal.
Shipwrecks	Surface hydrocarbons will have no impact on shipwrecks. Hydrocarbons in the water column from a vessel collision will remain in the surface waters and is therefore unlikely to have an impact on shipwrecks.

Receptor	Impacts of MDO/MGO
Indigenous	The level of activities undertaken by indigenous users is expected to be low, if any, therefore interference due to an MDO/MGO spill are likely to be minimal, however in event there is a requirement for land based response activities/ disturbance, relevant representatives will be contacted as outlined in Section 5 of the Oil Pollution Emergency Plan.
Existing oil and gas Activity	Exclusion zones surrounding spills will reduce access potentially leading to delays to work schedules with subsequent financial implications. Although other Santos activities may occur in the Operational Area, no operating facilities occur in the Operational Area. Other operating facilities occur in the EMBA with the closest being Woodside's Angel oil field and associated infrastructure, located approximately 280 km from the Keraudren Operational Area and 240 km from the Operational Area (beyond the area predicted to be contacted by surface hydrocarbons). Impacts to other oil and gas operators are therefore considered unlikely.
KEFs	KEFs overlapping the EMBA are described in **Section 3.2.2** and **Appendix B** and are summarised below. <u>Ancient Coastline at 125 m Depth Contour</u> Contributes to higher diversity and enhanced species richness relative to soft sediment habitat Attracts opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish <u>Mermaid Reef and Commonwealth waters surrounding Rowley Shoals</u> Regionally important in supporting high species richness, higher productivity and aggregations of marine life associated with the adjoining reefs <u>Glomar Shoals</u> A submerged feature situated at a depth of 33–77 m Regionally important for potentially high biological diversity and localised productivity Known to be an important area for a number of commercial and recreational fish species <u>Continental Slope Demersal Fish Communities</u> Provides important habitat for demersal fish communities, characterised by high endemism and species diversity Other KEFs identified within the EMBA are located more than 450 km from the Operational Area and are therefore not expected to be contacted by hydrocarbons exceeding thresholds that may result in ecological impacts. These include: • Canyons linking the Argo Abyssal Plain with the Scott Plateau • Seringapatam Reef and Commonwealth waters in the Scott Reef Complex • Exmouth Plateau. The values and sensitivities of the KEFs are generally related to benthic habitats and communities which support areas of enhanced diversity and productivity. A loss of MDO/MGO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column and therefore impacts to the habitats of the KEFs is not considered likely. Impacts to sensitivities within the upper waters above the KEFs are outlined above.
Protected areas	Protected areas are described in **Section 3.2.2** and potential impacts to protected areas are discussed in **Section 7.1.6.** Protected areas within the EMBA

Receptor	Impacts of MDO/MGO
	include: • Eighty Mile Beach AMP and State Marine Park • Mermaid reef AMP • Argo-Rowley Terrace AMP • Rowley Shoals State Marine Park • Kimberley AMP • Bedout Island Other protected areas identified within the EMBA are located more than 300 km from the Operational Area and are therefore not expected to be contacted by hydrocarbons exceeding thresholds that may result in ecological impacts or impacts to socio-economic or heritage receptors (refer to the stochastic modelling results in **Section 7.1.2.5**). These include: • Montebello AMP and Montebello Islands State Marine Park • Gascoyne AMP • Lacepede Islands • Scott Reef

7.1.4 Environmental Performance and Control Measures

Environmental Performance Outcomes relating to this hazard include:

+ EPO-10 – No loss of containment of hydrocarbon to the marine environment.

The Control Measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**

CM Reference	Control measure (CM)	Environmental benefit	Potential cost/issues	Evaluation
CM-01	Notices to Mariners	Ensures other marine users are aware of the presence of the survey vessel, and the relatively slow speed and restricted manoeuvrability of the survey vessel during data collection.	Costs associated with the personnel time in issuing notifications and closing out queries and responses	**Adopted** – Benefits considered to outweigh negligible costs. Maritime requirement to issue marine notices.
CM-02	Stakeholder consultation	Ensures other marine users, such as commercial fishers, are aware of upcoming survey operations so they can plan their business accordingly.	Limited additional costs to Santos. Stakeholders time required to review consultation material and communicate with Santos.	**Adopted –** Benefits considered to outweigh negligible costs.
CM-03	Exclusion zone established to reduce potential for collision or interference with other marine user activities.	Requested 500 m exclusion zones around the survey vessel during survey data collection prevents other vessels from getting too close and causing damage to equipment of either party.	No additional costs to Santos. Other marine users may be temporarily excluded from areas, disrupting their activities.	**Adopted** – The requested exclusion of other marine users is temporary. Marine users will still be able to access the Operational Area. Normal navigation at sea process whereby shipping vessels avoid navigational risks. Hence, the safety benefits to all marine users outweighs any potential costs.
CM-06	Appropriate Seafarer Competency and Certification	Ensures vessel crew are aware of vessel safety procedure and process to ensure most efficient incident response.	No additional costs, standard qualification for persons in industry	**Adopted –** Standard maritime qualification for persons in industry.
CM-07	Dropped object prevention procedure	Impacts to environment are reduced by reducing risk of dropped objects damaging the hull resulting in surface spill.	Personnel costs involved in implementing procedures and in incident reporting	**Adopt** – Benefits considered to outweigh negligible costs.
CM-15	Constant bridge watch	Crew of support vessels and the survey vessel will maintain constant bridge watch, including for third party vessels which may be approaching or enter the exclusion zone.	No additional costs.	**Adopted –** No additional costs. This is a maritime requirement.

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CM Reference	Control measure (CM)	Environmental benefit	Potential cost/issues	Evaluation
CM-25	Vessels fitted with AIS systems and radars	Reduces risk of impact from vessel collisions.	Negligible as the survey vessel required to be fitted with AIS.	**Adopted** – The safety benefits of having AIS outweigh any costs. This is a maritime requirement.
CM-26	Navigation equipment and procedures	Reduces the risk of interference and collisions with other marine users.	Negligible costs of acquiring and operating navigation equipment, as required by maritime law.	**Adopted** – The safety benefits of having navigation equipment and procedures outweighs any cost. This is a maritime requirement.
CM-27	Oil pollution emergency plan (OPEP)	The OPEP outlines response plans to be implemented in the event of an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted –** Benefits of ensuring procedures are developed and followed and measures implemented outweighs the costs.
CM-28	Vessel spill response plans (SOPEP/SMPEP)	Vessel spill response plans (SOPEP/SMPEP) outline responses to be implemented in the event of an unplanned release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of implementing response strategies.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented and that the vessel is compliant outweighs the costs.
CM-29	Refuelling and Chemical Transfer Procedure	Ensures approved procedures are followed to reduce risks of spill and that appropriate controls are in place to limit in event of an incident.	Negligible cost, standard procedure	**Adopted –** Benefits considered to outweigh negligible costs.
Additional control measures				
CM-30	Support vessel in place during Activity to reduce potential for collision or interference with other marine users.	Identifies and communicates with approaching third-party vessels to ensure exclusion (safety) zone is observed, preventing potential interaction or interference.	Additional costs of contracting a support vessel.	**Not Adopted** – Cost outweighs the benefit.
CM-31	Restrictions on volumes of unused IFO and HFO are stored.	Restricting volumes of unused IFO and HFO and limiting storage to tanks that do not have direct exposure to the marine environment minimises the risk	Additional costs associated with removal and disposal of IFO or HFO	**Partially adopted** – benefits of restricting volumes of unused IFO and HFO stored onboard and limiting storage to tanks that do not have

CM Reference	Control measure (CM)	Environmental benefit	Potential cost/issues	Evaluation
		of a spill. Retaining the fuel oil on-board eliminates the need to transfer the fuel onshore as a waste product.	onshore if requirements for onboard are unable to be met.	direct exposure to the marine environment outweighs the potential costs of removal for onshore disposal if these requirements are unable to be met.
CM-32	Limit maximum volume of fuel stored in a single vessel tank.	Reduces the volume of MGO/MDO that can be lost to the marine environment in event of a vessel collision.	Limits the vessels that can be contracted to undertake the Activity, could result in additional bunkering during the Activity if largest volume stored in a single fuel tank is limited to 650 m^3 and the tanks are larger in volume (therefore less tanks in the vessel).	**Adopted** – benefits of ensuring volume is less than 650 m^3 outweighs the potential to not be able to contract a vessel.
CM-33	Require survey vessels to be double hulled.	Reduces the likelihood of a loss of hydrocarbon inventory, minimising potential environmental impact.	Vessels are subject to availability and are required to meet Santos' standards during activities; requirement of a double hull on vessels would limit the number available to Santos; requiring vessels to be refitted to ensure double hulls would also be of high cost.	**Partially Adopted** – Large costs associated with vessel selection. However, it is noted that while not a specific requirement, it is most likely that the survey vessel will have a double hull.
N/A	No diesel bunkering	Reduces the likelihood of a loss of hydrocarbon inventory, minimising potential environmental impact.	Although not expected to occur frequently, the need for operational bunkering may arise during operational activities. Diesel bunkering offshore is considered to be a standard practice, with controls in place and risks well understood by industry.	**Not adopted –** In order to maintain the required level of flexibility, the ability to undertake bunkering of diesel is required. Requirement to return to shore to refuelling would increase duration of the Survey (hence presence in field and associated impacts) and result in additional emissions.
N/A	Manage the timing/location of the Activity to avoid peak marine user periods (e.g. fishing)	Would eliminate potential impacts to other marine users at peak times.	Not considered feasible as marine users could potentially be in the area for a significant portion of the year and the Activity has a short-planned	**Not Adopted** – the Activity will be limited to a 60-day duration and completion prior to January 2022.

CM Reference	Control measure (CM)	Environmental benefit	Potential cost/issues	Evaluation
			duration of 60 days. The area that stakeholders are excluded from is small when compared to the area available to other marine users and there is low fishing Activity in the area as evidenced through historical consultation.	
N/A	Dedicated resources (e.g. dedicated spill response facilities on location) in the event of loss of hydrocarbons to allow rapid response	May allow for quicker response to a spill as resources will be within close proximity.	Large costs associated with mobilising a dedicated resource at the location. Modelling predicts 99% of the hydrocarbon will evaporate and entrain within 3 days under moderate winds. Therefore, dedicated response resources are unlikely to offer a net environmental benefit.	**Not Adopted –** Large cost associated with dedicated resources.

7.1.5 Spill Response Strategies for MDO/MGO Release from Vessel Collision

There are numerous oil spill response strategies available to be implemented in the event of a spill. These are generally strategies which have been implemented in the past or considered good industry practice. **Table 7-8** is the outcome of the first level screening undertaken based on the suitability of the broad response strategies available.

The evaluation of the suitable response strategies was conducted based on the credible spill scenarios identified. Below were the key considerations taken into account for the evaluation:

+ The properties and weathering profile of the spilled oil;
+ The philosophy of the responses;
+ The nature and scale of the credible spill scenario; and
+ The potential safety and environmental aspects, and impacts involved with the selected responses.

Table 7-8: Spill response strategies considered for the mitigation of contact from MDO/MGO release from vessel Collision

Strategy	Description	Evaluation	Adopt/ Reject
Source Control	A vessel collision may result in the release of all or part of a storage tank or fuel tank contents, releasing hydrocarbons to the marine environment. In the event that a vessel fuel tank is ruptured, cargo of the affected tank is to be secured via transfer to another storage area on-board the vessel, transfer to another vessel, or through pumping in water to affected tank to create a water cushion (tank water bottom). Trimming the vessel may also be used to avoid further damage to intact tanks.	Through the implementation of these actions, the volume of hydrocarbons released to the marine environment may be reduced. However, there are several influencing factors that would result in delay or inability to implement controls, potentially resulting in a full discharge of a fuel tank compartment; such as a high sea state, a significantly large rupture, or injuries to personnel.	**Adopt**
Monitor and Evaluate / Surveillance	Operational monitoring is a fundamental aspect of a spill response and used to gain situational awareness of the incident through various surveillance actions. Monitoring is used to assess the nature and scale of the spill, the current and projected movement of the spill, the physical and chemical properties of the spill over time and the actual and potential contact of the spill with sensitive receptors. There are various specific control measures (vessel/aerial surveillance, tracking buoys, operational water quality monitoring, oil spill modelling, remote sensing/satellite imagery) within this response strategy which may be suitable.	The use of various operational monitoring techniques, in combination or individually, will be determined based on the spill distribution as well as other considerations such as access to locations, environmental and metocean conditions. This strategy is vital to ensure that there is sufficient information to gain situational awareness and make informed decisions on response planning and execution. Data from monitor and surveillance activities will be used to inform the Net Environmental Benefit Analysis (NEBA) and used to assist in escalating or de-escalating response strategies as required.	**Adopt**
Chemical Dispersant	Chemical dispersant is applied, either by vessel or aircraft, to break down the hydrocarbons and allow/enhance dispersion into the water column, potentially preventing/reducing shoreline contact and increasing natural rates of biodegradation.	Removes/disperses hydrocarbons from the surface and encourages entrainment into the water column, thereby enhancing biodegradation and dilution. This potentially results in increased volumes of hydrocarbon in the water column, but less on the sea surface. Therefore, there is the potential to prevent/reduce shoreline contact to sensitive receptors and a potential to result in higher entrained hydrocarbon concentrations, which may impact organism in the water column. MDO/MGO is not considered a persistent hydrocarbon and has high natural rates of evaporation and dispersion in the marine environment (99% of the hydrocarbon expected to evaporate or disperse after 3 days under moderate winds). This has been assessed through spill modelling of conservative worst-case scenarios.	**Reject**

Strategy	Description	Evaluation	Adopt/ Reject
		All spill scenarios are short term releases and oil will undergo rapid weathering of those components that dispersants are most effective on. MDO/MGO slicks will break apart into wind rows with low surface thickness (rainbow and metallic sheens) given the very low viscosity of the hydrocarbon. Chemical dispersants have a window of opportunity, after which effectiveness decreases. Modelling indicates that 99% of the hydrocarbon with naturally disperse or evaporate over 72 hours under moderate winds. Therefore, surface dispersant application is unlikely to provide any benefit over natural attrition and evaporation. Dispersant use is not considered to be effective on the spill scenarios given they are not continuous releases and slick characteristics amenable to dispersant operations will unlikely be present by the time dispersant operations are mobilised. This reasoning is consistent with International Tanker Owners Pollution Federation Ltd (ITOPF) guidance (ITOPF 2011) which advises against the use of dispersant on light products such as MDO/MGO given the high natural rates of evaporation/dissipation and rapid spreading.	
Mechanical Dispersion	Physical dispersion is undertaken by running support vessels through the hydrocarbon plume and using the turbulence developed by the propellers or hydroblasting from vessel hydrants to break up the slick. Once dispersed in the water column in the form of smaller droplet sizes, biodegradation processes are enhanced.	MDO/MGO is a light oil that can be easily dispersed in the water column by running vessels through the plume and using the turbulence developed by the propellers to break up the slick. Once dispersed in the water column the smaller droplet sizes enhance the biodegradation process. Caution must be applied during the volatilisation period of the oil due to potential safety and human health issues.	**Adopt**
Containment and Recovery	Containment and recovery of hydrocarbons through the use of offshore boom and skimmers from vessels can prevent oil from reaching sensitive features. This strategy is only effective in calm conditions and may not be an effective use of resources if oil cannot be thickened to a point where worthwhile volumes are collected.	Given the fast spreading nature of MDO/MGO the expected moderate to high sea states of the area causing the slick to break up and disperse, this response is not considered to be effective in reducing the net environmental impacts of a MDO/MGO spill. The ability to contain and recover these spreading oils (i.e. surface sheens) on the sea surface is extremely limited due the very low viscosity of the fuel.	**Reject**

Strategy	Description	Evaluation	Adopt/ Reject
Shoreline Protection and Deflection	Shoreline protection and deflection activities involve the use of booms to: • Protect sensitive receptors; • Deflect spills away from sensitive receptors or shorelines; or • Deflect spills to an area that provides increased opportunity for recovery activities. This strategy is typically not effective in areas experiencing large tidal variations and associated currents.	The effectiveness of this response will be dependent on sea, current, and wind conditions. Deployment is subject to safety concerns of operation in shallow waters and possible grounding issues of vessels. Activities are focused on areas of high protection value in low energy environments based upon real time operational surveillance provided the environmental and metocean conditions are favourable for an effective implementation. Consequently, this strategy may not be applicable across all areas or receptors identified as priority for protection.	**Adopt**
In-Situ Burning	In-situ burning is a technique sometimes used in responding to an oil spill. In-situ burning involves the controlled burning of oil that has spilled at the location of the spill. When conditions are favourable and conducted properly, in-situ burning will reduce the amount of oil on the water.	MDO/MGO disperses and entrains rapidly and is not suitable to be contained by in-situ burning (as described above for containment and recovery). In addition, as the slick thins, its insulating capacity weakens and more heat is lost to the water beneath the slick, eventually resulting in insufficient heat to continue to vaporise the oil and sustain combustion.	**Reject**
Shoreline Clean-Up	During a spill response, clean-up of the oiled shorelines will be implemented using suitable methods, provided it will be beneficial to the environment based on the NEBA performed on the affected areas based on actual site conditions.	Shoreline loading was predicted at Bedout Island, Eighty Mile Beach, and at emergent/intertidal features of Mermaid Reef, Clerke Reef and Imperieuse Reef (Rowley Shoals Marine Park). Contacted shorelines will be assessed for their shoreline clean-up potential. This response has the potential to cause secondary disturbance associated with the clean-up, so applicability of the strategy is based on aerial surveillance reconnaissance, Oiled Shoreline Response Team (OSRT) observations and NEBA in the shoreline clean-up assessment.	**Adopt**
Oiled Wildlife Response (OWR)	Responding to an oiled wildlife incident will involve an attempt to prevent wildlife from becoming oiled and/or the treatment of animals that do become oiled.	The Protection Priorities identified for spill response have include sensitive fauna (e.g. protected birds and turtles) that may be seasonally abundant and undertake key lifecycle processes near shorelines. Mobilisation of experts, trained work forces, facilities and equipment will likely be needed if oil reaches shorelines and nearshore waters. Wildlife response activities may take place at sea, on shorelines and in specialised facilities further inland. Options for wildlife management have to be considered and a strategy determined guided by the Western Australian	**Adopt**

Strategy	Description	Evaluation	Adopt/ Reject
		Oiled Wildlife Response Plan (WAOWRP) and Pilbara Regional Oiled Wildlife Response Plan.	
Scientific Monitoring	This is the main tool for determining the extent, severity and persistence of environmental impacts from an oil spill and allows operators to determine whether their environmental protection outcomes have been met (via scientific monitoring activities). This strategy also evaluates the recovery from the spill.	Scientific monitoring is especially beneficial for the purpose of monitoring entrained and dissolved oil impacts as response strategies are generally targeted to manage the floating oil impacts.	**Adopt**

7.1.6 Detailed Risk Assessment for High Environmental Values

The spill risk assessment approach adopted is based on Santos WA's Oil Spill Risk Assessment and Response Planning Procedure (QE-91-II-20003). The procedure describes the spill risk assessment process as follows:

1. Identify the spatial extent of the EMBA (as defined above by spill modelling and interpolation of the results to account for a spill that could possibly occur anywhere within the Operational Area);
2. Identify areas of high environmental value (HEV) within the EMBA; and
3. Risk assess areas of HEV with a high probability and level of oil contact (Hot Spots).

Santos has predetermined areas of high environmental value (HEV) along the Western Australian coastline by ranking these areas based on:

+ Protected area status – This is used as an indicator of the biodiversity values contained within that area, where a World Heritage Area, Ramsar Wetland and Marine Protected Area will score higher than areas with no protection assigned; and
+ BIAs of LTS – These are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour, such as breeding, feeding, resting or migration. Each one of these within the predefined areas contributes to the score.

Further input to determine areas of HEV included:

+ Sensitivity of habitats to impact from hydrocarbons in accordance with the guidance document Sensitivity Mapping for Oil Spill Response produced by IPIECA, the International Maritime Organisation and International Association of Oil and Gas Producers;
+ Sensitivities of receptors with respect to hydrocarbon-impact pathways;
+ Status of zones within protected areas (i.e., IUCN (1a) and sanctuary zones compared to IUCN (VI) and multiple use zones);
+ Listed species status and predominant habitat (surface versus subsurface); and
+ Social values, i.e., socio-economic and heritage features (e.g., commercial fishing, recreational fishing, amenities, aquaculture).

Tallied scores for each predefined area along the Western Australian coastline were then ranked from 1 to 5, with an assignment of 1 representing areas of the highest environmental value and those with 5 representing the areas of the lowest environmental value.

While the entire EMBA for the MDO/MGO spill is considered in this risk assessment, the assessment is particularly focused on those parts of the EMBA that have:

+ The greatest intrinsic environmental value – i.e., HEV areas ranked 1-3;
+ The highest probability of contact by oil (either floating, entrained or dissolved aromatic) above contact exposure values described in **Section 7.1.2.3**; and
+ The greatest potential concentration or volume of oil arriving at the area.

It is noted that the probability of contact at moderate exposure values are used to identify HEV areas within the EMBA with ecological values and sensitivities, as they represent thresholds above which there is potential for ecological impact (**Table 7-3**). The probability of exposure low exposure values for surface and accumulated hydrocarbons are used to identify HEVs with socio-economic and heritage values.

HEV areas are summarised in **Table 7-9,** including a description of values and a consequence rating for from exposure to hydrocarbons above exposure values. Potential impacts (consequence rating) were determined after considering the receptor values (protected area status, threatened species, BIAs, KEFs, social values including heritage values and concerns raised during stakeholder consultation and the potential impacts to these (**Table 7-6** and **Table 7-7**), from the predicted concentrations/levels of MDO/MGO for each location presented in **Section 7.1.2.5**.

The following HEV areas were identified for detailed assessment in **Table 7-9:**

+ Eighty Mile Beach Marine Park (State Waters – Emergent);
+ Eighty Mile Beach AMP (Submerged);
+ Bedout Island (Emergent);
+ Mermaid Reef AMP (Emergent);
+ Clerke Reef – Rowley Shoals Marine Park;
+ Imperieuse Reef – Rowley Shoals Marine Park; and
+ Rowley Shoals Surrounds.

Additional protected areas have been identified within the overall EMBA. They do not have predicted contact with hydrocarbons above exposure values in the spill modelling but based on the Keraudren interpolated EMBA could be exposed in the event of a spill within the Operational Area at a different location to the two modelled release locations. Additional protected areas are as follows:

- Argo-Rowley Terrace AMP;
- Kimberley AMP;
- Montebello AMP and Montebello Islands State Marine Park;
- Gascoyne AMP;
- Lacepede Islands; and
- Scott Reef.

The values and sensitivities of these protected areas are described in **Section 3.2.2**. With the exception of Argo-Rowley Terrace AMP and Kimberley AMP, these areas are not expected to be contacted by oil above moderate exposure values or surface/accumulated oil above low exposure values based on the modelling presented in **Section 7.1.2.5**. While these areas fall within the wider EMBA for spill response planning (based on the low exposure values for entrained and dissolved hydrocarbons), they are not considered further in this impact assessment in relation to potential for ecological impacts or impacts to socio-economic or heritage receptors. Potential impacts to Argo-Rowley Terrace AMP and Kimberley AMP are assessed in **Table 7-9.**

Table 7-9: Consequence summary for High Environmental Value areas in the EMBA

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
Eighty Mile Beach Marine Park (State Waters) **(Emergent)** NB. Worst case spill modelling results from the southern release location	2	Eighty Mile Beach management plan recognises oil spills as a potential pressure on emergent features: mangroves and saltmarsh, intertidal sand and mudflats (DpaW, 2014). Note that habitats and fauna usually submerged are discussed separately below in 'Eighty Mile Beach AMP (Submerged)'. Contact from floating oil is likely to impact the shoreline and result in accumulated stranded oil at discrete locations. Mangroves and intertidal areas may be impacted by being smothered, although continuous tidal movements will mobilise oil and add to dispersion. Contact from entrained oil may impact shoreline through accumulation, although constant tidal and current motions will re-mobilise oil and create further dilution Contact from floating oil is likely to impact marine fauna by smothering (causing skin/eye irritation and affect ability to thermo-regulate) and oil contact from movement across the shoreline. In addition, ingestion may occur from preening/cleaning body and/or eating oil covered food resulting in internal toxicity. Contact from entrained oil may impact marine fauna by causing skin irritation/toxicity as fauna move through water, or internal toxicity from ingesting oil tainted food. Although constant tidal and current motions will re-mobilise oil and create further dilution and fauna are mobile Oil is unlikely to contact Mandora Salt Marsh, however 'the beach' area consists of sandy beach, mangroves and intertidal mudflats which may be contacted by oil impacting upon the Ramsar values. A spill from the southern release point may result in contact from floating oil, with potential to impact emergent features and result in stranded oil on the shoreline, although tidal movements will mobilise oil and add to dispersion of oil. Modelling results from the southern release location predict a maximum probability of contact above the 10 g/m^2 moderate exposure value (with potential to result in ecological impacts) of 11%. Although, the minimum time to contact is predicted to be 2.3 days, by which time considerable weathering will have occurred (**Section 7.1.2.4**). The maximum probability of shoreline accumulation above the moderate exposure value of 100 g/m^2 is 12%, with a maximum total of 358 tonnes from the southern release location). <u>Habitats</u>	Threatened / Migratory Fauna	C (Moderate)	**C (Moderate)** Due to surface impact and loading to Ramsar wetlands.
			Physical Habitat	B (Minor)	
			Threatened Ecological Communities	N/A	
			Protected Areas	C (Moderate)	
			Socio-economic and Heritage receptors	C (Moderate)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Coral reefs Not identified in emergent area (see Eighty Mile Beach 'AMP (Submerged) below) *Seagrasses* Not identified in emergent area (see Eighty Mile Beach 'AMP (Submerged) below) *Macroalgae* Not identified in emergent area (see Eighty Mile Beach 'AMP (Submerged) below) *Mangroves* Limited stretch along coastline and in Mandora Salt Marsh area. Minor stands 10-20 km close to tidal creeks. *Intertidal mud/sand flats* 225 km intertidal mudflats provide important food source for many of the bird species from the infauna present. Mandora Salt Marsh area contains rare group of wetlands *Sandy Beaches* Sandy shores occupy the landward edge of the intertidal zone (approximately 220 km), provide important turtle nesting habitat and some tourism (see below). *Rocky shorelines* Not identified in emergent area Invertebrates Large number and diversity of invertebrates within the intertidal mudflat areas Oil can reduce invertebrate abundance or alter the intertidal invertebrate community that provides food for non-breeding shorebirds Fish and sharks Not discussed in emergent area, (see Eighty Mile Beach AMP (Submerged) below) Birds Ramsar site			

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		97 wetland bird species, 42 of which are listed under China Australia Migratory Bird Agreement (CAMBA), Japan Australia Migratory Bird Agreement (JAMBA) and Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA) 500,000 birds use the area as a migration terminus annually, key period is Aug-Nov when contact with oil spill could result in impacts at a population level <u>Marine reptiles</u> Flatback turtles nest at scattered locations along shoreline. <u>Marine mammals</u> Not discussed in emergent area, (see Eighty Mile Beach AMP (Submerged) below) <u>Cultural Heritage</u> Indigenous values: wetlands are significant to 3 three local groups, several aboriginal heritage sites present <u>Socio-Economic</u> Tourism activities include camping nearby, nature appreciation, recreational beach fishing and four-wheel driving			
Eighty Mile Beach AMP (Submerged) NB. Worst case spill modelling results from the southern release location	2	Eighty Mile Beach AMP management plan recognises oil spills as potential pressure on submerged features: water and sediment quality, filter feeding communities, macroalgae and seagrasses and coral reef communities. Potential impacts to these receptors are described in **Table 7-6**. Note that habitats and fauna not usually submerged are discussed separately above in 'Eighty Mile Beach (emergent)'. Contact from entrained and dissolved oil may impact submerged corals/seagrasses/macroalgae and filter feeding communities resulting in smothering and/or contact toxic impacts; although constant tidal and current motions will re-mobilise oil and create further dilution. Modelling results from the southern release location predict a maximum probability of contact above the moderate exposure value (which may result in ecological impacts) of 65% for both entrained and dissolved hydrocarbons. There is also a 7.5% probability of exposure to time-integrated dissolved WAF above the moderate exposure value. There is no contact predicted from a spill at the northern release location.	Threatened / Migratory Fauna	C (Moderate)	**C (Moderate)** Due to entrained oil impacts on the AMP values (foraging and habitats).
			Physical Habitat	B (Minor)	
			Threatened Ecological Communities	N/A	
			Protected Areas	C (Moderate)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Physical Habitats *Coral reefs* Subtidal filter feeding communities present, likely provide foraging habitat for flatback turtles High diversity intertidal and subtidal coral reef communities *Seagrasses* Seasonally present but sparsely distributed Dugongs regularly found feeding on seagrass meadows here *Macroalgae* Provide habitat and feeding opportunities for fish, invertebrates and dugong *Mangroves* Not present in submerged area *Intertidal mud/sandflats* Not present in submerged area *Sandy beaches* Not present in submerged area *Rocky shorelines* Not present Marine fauna *Invertebrates* Several invertebrate species targeted by recreational and fisheries Important food source for waterbirds *Fish and sharks* Fish populations dependent on habitat and substrate type Several fish species targeted by recreational and commercial fisheries Sawfish foraging, nursing and pupping; diversity of sharks and rays (including protected species) Diversity of fish species provide recreational and commercial fishing opportunities	Socio-economic and Heritage receptors	C (Moderate)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Birds Migratory seabirds forage in the waters, peak season during Aug-Nov. High diversity of waterbirds including 42 migratory species, waterbirds are nationally and internationally important 500,000 birds use the area as a migration terminus annually, key period is Aug-Nov when contact with oil spill could result in impacts at a population level *Marine reptiles* Flatback turtles forage and inter-nest in offshore waters Green, hawksbill, loggerhead, olive ridley and leatherback may frequent the waters all year round *Marine Mammals* Humpback whale migration pathway though the AMP. Dugongs and other cetaceans inhabit or migrate through the marine park although unlikely to be larger whale species due to water depths <u>Socio-economic</u> Tourism: nature based, fishing and wildlife viewing from vessels. Some vessel-based fishing (mostly shore based recreational fishing in 80 Eighty Mile Beach area) PPA have previously indicated this area is important as a seed stock. Diving for pearl oysters is limited to the water depths < 35m depth contour. <u>Indigenous values</u> The adjacent State Waters Marine Park contains land and sea important to traditional indigenous owners, 4 special purpose zones included in marine park.			
Bedout Island (Emergent)	4	A spill from the southern release point may result in contact from floating oil, with potential to impact sandy beaches resulting in smothering of coral and stranded oil on beaches, although tidal movements will mobilise oil and add to dispersion of oil. Bedout Island includes foraging and nesting areas for marine turtles and feeding/resting/breeding areas for seabirds and migratory shorebirds, potentially impacting habitat.	Threatened / Migratory Fauna	C (Moderate)	**C (Moderate)** Due to potential hydrocarbon impact on the
			Physical Habitat	C (Moderate)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
NB. Worst case spill modelling results from the southern release location		Modelling results from the southern release location predict a maximum probability of contact above the 10 g/m^2 moderate exposure value (with potential to result in ecological impacts) of 2%. Therefore, impacts from surface oil to ecological receptors are unlikely. Furthermore, the minimum time to contact is predicted to be 2.3 days, by which time considerable weathering will have occurred (**Section 7.1.2.4**). The maximum probability of shoreline accumulation above the moderate exposure value of 100 g/m^2 is 4%, with a maximum total of 12 tonnes from the southern release location). <u>Physical Habitats</u> *Coral reefs* Fringing the small island (0.31 km^2) *Seagrasses* None of significance identified *Macroalgae* None of significance identified *Mangroves* None identified.	Threatened Ecological Communities	N/A	migratory shorebirds.
			Protected Areas	N/A	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Intertidal mud/sand flats None identified *Sandy Beaches* Sandy clay on limestone bedrock, heavily vegetated with beach spinifex *Rocky shorelines* Not present in emergent area Fauna Invertebrates None of significance identified Fish Pelagic fishes, stingrays and reef sharks may be present at times Birds Important due to brown booby breeding. Seabird breeding colonies present- island supports over 1,000 nesting pairs of brown boobies (one of the largest colonies in the world). Supports nesting of other birds as well Season for breeding: May to September Marine reptiles Foraging green, hawksbill and loggerhead turtles foraging may be present but not known if nesting site Marine mammals None identified Socio-economic and heritage values - Tourism - Heritage value: two shipwrecks in the surroundings waters	Socio-economic and Heritage receptors	C (Moderate)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
Mermaid Reef AMP NB. Worst case spill modelling results from the northern release location	4	Mermaid Reef AMP management plan recognises oil spills as potential pressure on submerged features: water and sediment quality, coral reef and associated communities. Potential impacts to these receptors are described in **Table 7-6**. A spill from the northern release point may result in contact from floating oil, with potential to impact to intertidal coral habitat resulting in smothering, although tidal movements will mobilise oil and add to dispersion of oil. Modelling results from the northern release location predict a maximum probability of contact above the 10 g/ m^2moderate exposure value (with potential to result in ecological impacts) of 2%. Therefore, impacts from surface oil are unlikely. Furthermore, the minimum time to contact is predicted to be 3.6 days, by which time considerable weathering will have occurred (**Section 7.1.2.4**). The maximum probability of accumulation of hydrocarbons on intertidal features above the moderate exposure value of 100 g/m^2 is 10%, with a maximum total of 152 tonnes from the northern release location). Contact from entrained and dissolved oil may impact submerged coral reef and associated habitat resulting in smothering and/or contact toxic impacts; although constant tidal and current motions will re-mobilise oil and create further dilution. Modelling results from the northern release location predict a maximum probability of contact above the moderate exposure value of 2.5% for entrained and 1.7 for dissolved hydrocarbons. There is no contact predicted for time-integrated dissolved WAF. Impacts from entrained and dissolved oil are therefore considered unlikely.	Threatened / Migratory Fauna	C (Moderate)	**C (Moderate)** Due to potential for impacts on Marine Park values (Corals and associated habitat).
		<u>Physical Habitats</u> *Coral reefs*	Physical Habitat	C (Moderate)	
		Exceptionally rich and diverse intertidal and subtidal reefs. Provide a source of invertebrate and fish recruits for reefs further south and are therefore regionally significant *Seagrasses*	Threatened Ecological Communities	N/A	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Sparse seagrass found within subtidal areas in Rowley Shoals *Macroalgae* Small patches may be present in lagoonal areas *Mangroves* None identified *Intertidal mud/sandflats* None identified	Protected Areas	C (Moderate)	
		Sandy beaches None identified *Rocky shorelines* None identified Marine fauna *Invertebrates*	Socio-economic and Heritage receptors	C (Moderate)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		A number of invertebrate (echinoderms, cnidarians, molluscs and crustaceans) species commonly found at Scott Reef are also found here although in higher densities due to lack of fishing/collection. Diverse molluscan fauna on flats *Fish and sharks* Fish populations similar to those on shelf edge reefs in the Indo-Pacific region but unique in WA waters. Rich diversity of fish (500+ species) *Birds* Wide range of seabirds observed at Rowley Shoals *Marine reptiles* Green and hawksbill turtles are present at the Rowley Shoals. Reefs not known to be regionally significant turtle habitats *Marine Mammals* Northward humpback whale migration pathway adjacent to Rowley Shoals, therefore individuals may be present Variety of toothed and baleen whales likely to be visitors to the area but Rowley shoals are not a key aggregation/calving/mating/foraging area Protected Areas The Rowley Shoals Argo-Rowley Terrace AMP is in place to protect migratory seabirds and endangered loggerhead turtle, sharks, communities and habitats of 220 m-5000m, seafloor features, two KEFs and provides connectivity between Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region. It is an IUCN category zoning of II and VI. Socio-economic and Tourism: nature-based tourism (charter boats, diving, snorkelling) and recreational fishing (although prohibited in certain zones) low usage given distance to mainland Sanctuary zone within marine park Heritage values Indigenous values: none identified Heritage values: none identified			

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
Clerke Reef and Imperieuse Reef -Rowley Shoals Marine Park NB. Worst case spill modelling results from the northern release location	2	Rowley Shoals Marine Park (State Waters) management plan recognises oil spills as potential pressure on water quality (DoEC, 2007). Bedwell Island at Clerke Reef and Cunningham Island on Imperieuse Reef are recognised migratory bird resting areas. Contact from floating oil is likely to impact marine fauna by smothering (causing skin/eye irritation and affect ability to thermo-regulate), oil coating from movement across shorelines and inhalation of oil if surfacing to breathe. In addition, ingestion may occur from preening/cleaning body and/or eating tainted food resulting in internal toxicity. Contact from entrained and dissolved oil may impact marine fauna by causing skin or eye irritation/toxicity as fauna move through water, or internal toxicity from ingesting oil tainted food or breathing oil entrained water (fish). A spill from the northern release point may result in contact from floating oil, with potential to impact emergent coral and sandy beaches resulting in smothering of coral and stranded oil on beaches, although tidal movements will mobilise oil and add to dispersion of oil. Modelling results from the northern release location predict a maximum probability of contact above the 10 g/m^2 moderate exposure value (with potential to result in ecological impacts) of 2.5%. Therefore, impacts from surface oil are unlikely. Furthermore, the minimum time to contact is predicted to be 2.3 days, by which time considerable weathering will have occurred (**Section 7.1.2.4**). The maximum probability of shoreline accumulation above the moderate exposure value of 100 g/m^2 is 10%, with a maximum total of 334 tonnes from the northern release location). Contact from entrained and dissolved oil may impact submerged corals/seagrasses/macroalgae resulting in smothering and/or contact toxic impacts; although constant tidal and current motions will re-mobilise oil and create further dilution. Modelling results from the northern release location predict a maximum probability of contact above the moderate exposure value of 2.5% for both entrained and dissolved. There is no contact predicted for time-integrated dissolved WAF. Impacts from entrained and dissolved oil are therefore considered unlikely. <u>Physical Habitats</u> *Coral reefs* Exceptionally rich and diverse intertidal and subtidal reefs. Provide a source of invertebrate and fish recruits for reefs further south and are therefore regionally significant *Seagrasses*	Threatened / Migratory Fauna	C (Moderate)	**C (Moderate)** Due to potential for impacts on Marine Park values (Corals and seabirds)
			Physical Habitat	C (Moderate)	
			Threatened Ecological Communities	N/A	
			Protected Areas	C (Moderate)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Sparse seagrass found within subtidal areas in Rowley Shoals *Macroalgae* Small patches may be present in lagoonal areas *Mangroves* None identified *Intertidal mud/sandflats* None identified *Sandy beaches* Bedwell Island (Clerke Reef) is a supratidal, unvegetated, sandy cay about 1.3 km long and 2 m high Cunningham Island (Imperieuse Reef) is a supratidal, unvegetated, sandy cay about 3.7 m high *Rocky shorelines* None identified <u>Marine fauna</u>	Socio-economic and Heritage receptors	C (Moderate)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Invertebrates A number of invertebrate (echinoderms, cnidarians, molluscs and crustaceans) species commonly found at Scott Reef are also found here although in higher densities due to lack of fishing/collection. Diverse molluscan fauna on flats *Fish and sharks* Fish populations similar to those on shelf edge reefs in the Indo-Pacific region but unique in WA waters. Rich diversity of fish (500+ species) *Birds* Bedwell island is site of second largest breeding colony of red-tailed tropic birds, an uncommon species in WA Both Bedwell Island and Cunningham Island are known resting sites for migratory birds Wide range of seabirds observed at Rowley Shoals *Marine reptiles* Green and hawksbill turtles are present at the Rowley Shoals. Reefs not known to be regionally significant turtle habitats			

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Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Marine Mammals Northward humpback whale migration pathway adjacent to Rowley Shoals, therefore individuals may be present Variety of toothed and baleen whales likely to be visitors to the area but Rowley shoals are not a key aggregation/calving/mating/foraging area Protected Areas The Rowley Shoals Argo-Rowley Terrace AMP is in place to protect migratory seabirds and endangered loggerhead turtle, sharks, communities and habitats of 220 m-5000m, seafloor features, two KEFs and provides connectivity between Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region. It is an IUCN category zoning of II and VI. Socio-economic and Tourism: nature-based tourism (charter boats, diving, snorkelling) and recreational fishing (although prohibited in certain zones) low usage given distance to mainland Sanctuary zone within marine park Heritage values Indigenous values: none identified Heritage values: none identified			
Rowley Shoals Surrounds	3	See information on **Mermaid Reef, Clerke Reef and Imperieuse Reef** for Rowley Shoals	See information on **Mermaid Reef, Clerke Reef and Imperieuse Reef** for Rowley Shoals	See information on **Mermaid Reef, Clerke Reef and Imperieuse Reef** for Rowley Shoals	See information on **Mermaid Reef, Clerke Reef and Imperieuse Reef** for Rowley Shoals
Argo-Rowley Terrace AMP	3	Argo-Rowley Terrace AMP is not predicted to be contacted by hydrocarbons above any of the exposure values by modelling at the either the southern or northern release location. Due to its proximity to Keraudren Operational Area (23 km) it is included within the EMBA and there is a	Threatened / Migratory Fauna	B (Minor)	**B (Minor)**

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		possibility of exposure. However, given the low probability (<2.5%) of contact at the Rowley Shoals described above by hydrocarbons above moderate thresholds at which ecological impacts may occur, and the minimum time to contact (2.3 days), it is considered unlikely that the values of the Argo-Rowley Terrace AMP would be impacted by a spill. Physical Habitats Seafloor features including aprons and fans, canyons, continental rise, knolls/abyssal hills and the terrace and continental slope; *Coral reefs* None identified *Seagrasses* None identified *Macroalgae* None identified *Mangroves* None identified *Intertidal mud/sandflats* None identified *Sandy beaches* None identified *Rocky shorelines* None identified Marine fauna *Invertebrates* None of significance identified *Fish and sharks* Important habitat and foraging for sharks Provides protection for communities and habitats of the deeper offshore waters of the region	Physical Habitat	B (Minor)	Due to potential for impacts on AMP values
			Threatened Ecological Communities	N/A	
			Protected Areas	B (Minor)	
			Socio-economic and Heritage receptors	B (Minor)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Birds Foraging areas that are important for migratory seabirds *Marine reptiles* Foraging areas that are important for the endangered loggerhead turtle *Marine Mammals* Includes the migratory pathway for pygmy blue whales, therefore individuals may be present Variety of toothed and baleen whales likely to be visitors to the area but the deep waters of the AMP are not a known key aggregation/calving/mating/foraging area <u>Protected Areas</u> The AMP includes Multiple Use Zone (VI), Special Purpose Zone (Trawl) and National Park Zone (II) Two key ecological features: Canyons linking the Argo Abyssal Plain with the Scott Plateau and Mermaid Reef and Commonwealth waters surrounding Rowley Shoals <u>Socio-economic and Tourism</u> Overlap with commercial fisheries including the Northwest Slope Trawl Fishery <u>Heritage values</u> Indigenous values: none identified Heritage values: none identified			
Kimberley AMP	4	Kimberley AMP is predicted to have a very low probability of contact above low exposure values for surface (0.8%) and entrained (2.5%) hydrocarbons from the northern release location. No contact is predicted above moderate exposure values at which ecological impacts may occur from either release location. Given the minimum arrival time of more than 11 days, any hydrocarbons reaching the AMP will be highly weathered. Impacts to the Values of the AMP are therefore not expected. <u>Physical Habitats</u>	Threatened / Migratory Fauna	B (Minor)	**B (Minor)** Due to potential for impacts on AMP values
			Physical Habitat	B (Minor)	
			Threatened Ecological Communities	N/A	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Representation of continental shelf, slope, plateau, pinnacle, terrace, banks and shoals and deep hole/valley seafloor features *Coral reefs* Subtidal filter feeding communities present, likely provide foraging habitat for turtles Intertidal and subtidal coral reef communities *Seagrasses* Seasonally present but sparsely distributed Dugongs regularly found feeding on seagrass meadows here *Macroalgae* Provide habitat and feeding opportunities for fish, invertebrates and dugong *Mangroves* Not present in submerged area *Intertidal mud/sandflats* Not present in submerged area *Sandy beaches* Not present in submerged area *Rocky shorelines* Not present <u>Marine fauna</u> *Invertebrates* None of significance identified *Fish and sharks* Adjacent to important foraging and pupping areas for sawfish *Birds* Foraging areas that are important for migratory seabirds *Marine reptiles*	Protected Areas	B (Minor)	
			Socio-economic and Heritage receptors	B (Minor)	

Hot Spot	HEV Score	Potential Impacts to Values and Sensitivities	Consequence Category	Consequence Ranking	Overall consequence ranking and description
		Important foraging area for marine turtles Adjacent to important nesting sites for green turtles *Marine Mammals* Important foraging areas for dugongs and dolphins Migratory pathway and nursery areas for humpback whales and migratory pathway for pygmy blue whales Protected Areas The AMP includes Multiple Use Zone (VI) and National Park Zone (II) Two key ecological features: the ancient coastline at the 125 m depth contour and the continental slope demersal fish communities Socio-economic and Tourism Commercial tourism, commercial fishing, mining, recreation and traditional use Heritage values Indigenous values: The marine park also holds cultural values of Sea country, valued for indigenous cultural identity, health and well-being Heritage values: none identified			

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7.1.7 Summary of Impact, Consequence and Likelihood Ranking

<table>
<tr><th colspan="2">Description</th></tr>
<tr><td>Receptors</td><td>Marine fauna – plankton, fish and sharks, marine mammals, marine reptiles, seabirds/shorebirds;
Physical Environment / Habitats;
Protected areas; and
Socio-economic and heritage receptors</td></tr>
<tr><td>Consequence</td><td>C- Moderate</td></tr>
<tr><td colspan="2">In the event of a vessel collision, the volume of hydrocarbons released would be a finite amount limited to the maximum credible spill of a full tank inventory release (650 m^3; 1,065 m^3 for conservative model). Given the nature of the MDO/MGO and the distance from most shorelines, dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration.

Habitat modification/degradation/disruption/loss, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (Table 3-7). In addition, the Management Plan for the Eighty Mile Beach Marine Park (State Waters, including Ramsar site) states that DBCA should ensure the water and sediment quality, intertidal sand and mudflat communities, subtidal filter-feeding communities, macroalgal and seagrass communities, coral reef communities, mangrove communities and saltmarshes are not significantly impacted by human activities including oil spills. The potential for impacts to marine fauna is summarised in Table 7-6 and Table 7-7.

In the unlikely event that a vessel collision did occur within the Operational Area, the potential impacts to the environment would be greatest within several kilometres from the spill when the toxic aromatic components of the fuel will be at their highest concentration and when the hydrocarbon is at its thickest on the surface of the receiving waters. The MDO/MGO will also rapidly lose toxicity with time and spread thinner as evaporation continues. The potential sensitive receptors in the surrounding areas of the spill will include fish and sharks, marine mammals, marine reptiles and seabirds at the sea surface, as discussed in Table 7-7. Given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is it expected to be limited to a small number of individuals, with no impacts to regional populations.

Marine habitats may also be impacted as discussed in Table 7-6 and Table 7-7. As per Section 7.1.2, a maximum of 358 tonnes of MDO/MGO may accumulate on the shoreline of Eighty Mile Beach. Lower maximum shoreline loadings were predicted for other shorelines including Port Hedland to Eighty Mile Beach (approximately 22 tonnes, noting the very low (<1 %) contact probability) and Bedout Island (approximately 12 tonnes). Indigenous users may be impacted in the event that a land-based response is required, however consultation will ensure potential impacts are reduced to acceptable levels.

Potential impacts to protected areas identified as areas of High Environmental Value (HEV) within the EMBA, including socio-economic and heritage values, are assessed in detail in Section 7.1.6.

An overall consequence ranking of moderate was assigned to this scenario based on the potential impacts to HEV areas as described in Table 7-9. This is due to the potential for:
- Surface impact and loading to Ramsar wetlands within the Eighty Mile Beach Marine Park (emergent)
- Entrained oil impacts on the AMP values (foraging and habitats) within the Eighty Mile Beach AMP (submerged)
- Hydrocarbon impact on the migratory shorebirds at Bedout Island
- Impact on AMP values of Mermaid Reef (corals and associated habitat)
- Impacts on Marine Park values (corals and seabirds) at Clerke Reef, Imperieuse Reef and Rowley Shoals surrounds in Rowley Shoals State Marine Park
It is noted that potential impacts identified are based on stochastic modelling of 120 spill trajectories at two locations. For any single spill trajectory, impacts would not occur at all locations.</td></tr>
<tr><td>Likelihood</td><td>1 – Rare</td></tr>
<tr><td colspan="2">A hydrocarbon release resulting from a vessel collision is unlikely to have widespread ecological effects given the nature of the hydrocarbons on-board, the finite volumes that could be released, the depth and transient nature of marine fauna in this area.</td></tr>
</table>

Description	
The likelihood of a hydrocarbon release occurring due to a vessel collision is limited given the set of mitigation and management controls in place for this Activity. Consequently, the likelihood of a vessel collision releasing hydrocarbons to the environment that results in a moderate consequence is considered to be **rare**.	
Residual Risk	The residual risk associated with this hazard is Low (C1)

7.1.8 ALARP Evaluation

Vessels are required to undertake the Activity. There are no suitable alternatives to the use and number of vessels to complete the Activity. It is considered that the industry standard and Activity-specific controls to reduce collision risks that have been proposed and the contingencies in place in the event of the hazard occurring reduce the likelihood and potential impacts from a loss of fuel as a result of a vessel collision to ALARP. Alternative and additional controls were considered but not adopted as detailed in **Section 7.1.4.** The proposed control measures are considered appropriate to manage the risk to ALARP.

Spill Response Measures

The state of spill response readiness Santos adopts for operational activities across the NWS is considered commensurate for the spill risk associated with the Activity based on the likelihood of a worst-case spill (Rare) and the level of potential impact associated with worst case spills (Moderate). That is, the spill risk for the Activity fits within the profile covered through existing arrangements.

Pre-deploying existing equipment/ personnel, or adding to existing readiness, in terms of additional capability or administrative planning is considered appropriate where the scale of the spill and the extent/timeframe of environmental impacts cannot be effectively mitigated through existing capacity or when the benefit of adding to readiness outweighs the cost/effort. For the spill risks associated with the current Activity, this is not considered to apply and thus the existing state of readiness is considered to reduce this risk to ALARP.

In terms of spill response activities Santos will implement oil spill response as specified within the OPEP. This includes the use of resources (equipment and personnel) owned by Santos or available through third party providers through contracts, agreements or MoUs. The proposed spill response strategies, refer to **Section 7.3** (Spill Response Operations), consider relevant values and include completion of a NEBA in the event of a spill which includes the relevant values and receptors present in the area, including AMPs. This will limit impacts to the identified AMPs thereby protecting and conserving the ecosystems, habitats and native species, consistent with the park values.

A summary of the ALARP assessment for the level of resourcing required for each of the spill response strategies adopted is provided in **Table 7-10**. This provides the incremental benefit of increasing resourcing levels for each spill response strategy and the associated upfront costs.

From this assessment it is considered that through the resourcing arrangements outlined within the OPEP (including spill response equipment and personnel from internal and external sources including Santos, AMOSC, AMSA, other operators, Oil Spill Response Limited (OSRL), and other national and international suppliers) the spill response strategies and control measures reduce spill risk to ALARP.

Table 7-10: ALARP assessment for the level of resourcing required for the selected response strategies

Strategy	Resourcing	Justification	Environmental benefit of additional resources	Cost of additional resources	ALARP assessment
Aerial surveillance	Helicopter services available through Santos primary contracted supplier (Babcock) based out of Karratha. Ad-hoc contracts through CHC Helicopters. Initial aerial observation using helicopter pilots will occur within 3 hours of notification of the spill. Trained Aerial Observers (7) available from Day-2 of incident following activation (based Perth and Santos facilities).	Given location of spill site, mobilisation of CHC Helicopter from Karratha is considered adequate for surveillance. Endurance not considered a limiting factor at this location. Babcock run to Santos offshore facilities regularly for crew transfers. Mobilisation and refuelling from Exmouth is possible depending upon trajectory of spill. Current arrangements can provide for 2 passes (am and pm) of the spill area per day, this has been exercised as part of major spill exercises. Trained Aerial Observers can mobilise to Karratha/ Exmouth for Day 2 operations. Day 1 surveillance and recording using helicopter pilots considered adequate for initial situational awareness.	Resource not considered limiting. Primary supplier on contract with additional providers available to provide desired overpass frequency. Santos trained observers can be provided on rotation from Day 2.	No additional costs as helicopters through CHC are currently contracted for day to day operations to/from Santos facilities. In the event that additional passes are required due to data gaps the cost of the additional flights will be added to the cost of the response.	There is no value in increasing dedicated overpasses and therefore the arrangements are considered ALARP however opportunistic aerial surveillance can be provided through the shared use of aircraft deployed for other purposes.
Vessel surveillance	Activity vessels, including survey and support vessels. Vessel of opportunity (VOO) from other operators. Additional vessels contracted through Santos vessel providers out of Dampier. Santos has access to AIS live vessel tracking portal	The Survey involves multiple vessels further described in **Section 2**. Should an incident occur, those not involved in the incident can provide surveillance. The Activity area is central on the NWS and offshore from the major marine base of Dampier – additional available vessels out of Dampier can be put on hire through Santos' contracted vessel providers; mobilisation times to site can provide additional contracted vessels relatively quickly. Additional	Based on the likelihood of vessels available on site, given the close proximity of the Activity to central location of the Activity relative to the main marine base of Dampier, dedicated additional vessels for the purpose of oil spill surveillance is not considered required given	The current vessels arrangements are considered to provide the required function. Dedicated vessels on standby for vessel surveillance would cost tens of thousands of dollars per day and are not considered required.	There is no benefit in having additional dedicated surveillance vessels given surveillance can be performed from any vessel and these duties will be shared amongst spill response vessels.

Strategy	Resourcing	Justification	Environmental benefit of additional resources	Cost of additional resources	ALARP assessment
	to establish vessel availability. On-hire vessels supporting Santos' Varanus Island and Ningaloo Vision facilities.	mobilisation from Exmouth can be made through Santos' contracted vessel providers. This strategy is not designed to perform 'whole of spill' coverage which is provided by aerial surveillance (i.e. it is a secondary strategy). On-contract vessels performing duties at VI and Ningaloo Vision will be available as well as vessels of opportunity from other petroleum operators.	the need is met through vessel sharing. Surveillance will also be conducted through a number of complementary strategies (aerial surveillance, oil spill trajectory modelling, tracker buoys).		
Oil spill trajectory and fate modelling	24/7 stand-by spill modelling service provider (RPS). RPS will be contacted immediately (within 2 hours) upon notification of a Level 2 or 3 spill. Spill modelling to be initiated within 24 hours. Upon activation RPS will provide trajectory models within: - 2 hours for OILMAP model for offshore and open ocean - 4 hours for OILMAP operation for nearshore	RPS is to provide at least daily updates to the Incident Management Team (IMT) of trajectory model outputs to inform response planning. More frequent updates can be provided if weather conditions are highly variable or change suddenly. Operational surveillance data (aerial, vessel, tracker buoys) is to be provided to RPS Asia-Pacific Applied Sciences Associates (APASA) to verify and adjust fate predictions of the spill and improve predictive accuracy.	Predictive oil spill modelling will be used to forecast (using real-time data) the trajectory and fate of the spill. Resource is not considered limiting with no environmental benefit from dedicating additional modelling capability.	Santos pay for the provision of the service by RPS. This is considered to provide the required function.	There is no benefit in having additional modelling capability given that RPS have staff based across Australia and can provide 24/7 coverage.
Tracker buoys	Up to 12 Santos tracker buoys (at different Santos facilities), 2 buoys located	Tracker buoys are an additional strategy to aerial surveillance to provide real time verification data	Additional buoys are available through secondary suppliers (e.g. AMOSC, OSRL	Santos has 12 buoys linked to a satellite tracking website designed	The number of buoys immediately available (2 can be deployed form the

Strategy	Resourcing	Justification	Environmental benefit of additional resources	Cost of additional resources	ALARP assessment
	on seismic support vessels, 4 are available on VI and deployment can be expected within 6 hours to track oil heading towards sensitive receptors. Subscription to tracker buoy tracking website. Santos on-hire vessels and VOO for buoy deployment. Subject to weather and vessel availability the tracker buoys can be mobilised within 2 hours upon request from IMT or on-scene commander.	(particularly beneficial at night and in conditions limiting aerial surveillance). 12 x buoys is sufficient to enable timely retrieval and redeployment. Four are available on VI for deployment within 6 hours Vessels for buoy deployment will be Santos on-hire vessels and other operator VOO. Vessels can be shared across this and other tasks (e.g. surveillance).	and AMSA – greater than 20 buoys available) if required. These can be registered on the Santos/JouBeh satellite tracking system within hours. Dedicated vessels are not required given need is met through vessel sharing.	for first strike deployment across its operational facilities. No additional buoys are required to be purchased by Santos Energy given secondary availability through AMSA, AMOSC, OSRL within days. There is no additional upfront cost for accessing these secondary buoys.	seismic support vessels) and the availability of secondary buoys within days is sufficient to cover tracking of oil fronts especially given the spread of oil will be limited within the initial days of the spill. Therefore, no additional requirements and the response is considered ALARP.
Water quality monitoring (Operational and Scientific)	Fluorometers (for hydrocarbon detection) within subsea gliders or towed fluorometers. Conductivity, Temperature, Depth meters (CTDs) probes including fluorometry and dissolved oxygen sensors. Water sampling equipment (e.g. Niskin bottles, jars) Water quality monitoring personnel. Glider Field Engineer for deployment/ recovery.	Santos has field tested deployment of subsea gliders and data transfer using local provider (Blue Ocean monitoring) with access to gliders within Australia and USA. Towed fluorometers area available through contract with OSRL – located in Singapore. CTDs with fluorometers and water sampling equipment available locally and to be arranged through Santos' contracted scientific monitoring provider. Contractual standby arrangements are in place for rapid activation, planning and deployment of operational water quality monitoring personnel.	There are locally available subsea gliders and access to towed fluorometers. Water sampling equipment and CTDs are also available locally. Water sampling equipment is not considered a bottleneck to deployment. Given multiple access avenues to equipment – dedicated equipment (i.e. purchased or standby on-hire equipment) is not considered required. Deployment personnel will initially be provided through Santos's contracted	Santos can access subsea gliders with fluorometers through Blue Ocean Monitoring and towed fluorometers through OSRL. Santos's contracted scientific monitoring provider is on an existing standby footing in Perth with mobilisation time of personnel to site within 72 hr following approval of a monitoring action plan based on the incident specifics. An enhanced standby with vessels,	The existing arrangements are considered sufficient to provide targeted 'first strike' operational water quality monitoring to priority sites as identified through spill modelling and surveillance.

Strategy	Resourcing	Justification	Environmental benefit of additional resources	Cost of additional resources	ALARP assessment
	Dedicated vessels for towed fluorometers, CTDs deployment, water sampling. Vessels of opportunity (vessel sharing) for subsea glider deployment. Oil sample collected using a vessel opportunity and analysed in Perth.	Subsea gliders and towed fluorometers can cover approximately 1 kilometres per hour (km/hr). One fluorometer could cover 24 km/day. CTDs provide discrete 'single point' readings over a depth profile. Water quality sampling at discrete locations. For subsea gliders and towed fluorometers the deployment philosophy is not to 'blindly' patrol the entire spill area. Deployments will be targeted to ground truth spill modelling predictions. That is, the predicted front(s) of entrained oil will be traversed by gliders to verify entrained oil presence. This will be prioritised where fronts are predicted to reach sensitive receptor areas. Similarly, discrete water sampling will target sites positioned to validate modelling predictions.	monitoring provider and subsea glider deployment personnel.	equipment and personnel all prepositioned for immediate deployment would be in order of 10s tens of thousands of dollars per day. Similarly, subsea gliders set-up and prepositioned on standby for immediate deployment would be in 10s tens of thousands of dollars.	
Mechanical dispersion	One seismic vessel and two support vessels are potentially available. VOO from other operators.	Mechanical dispersion may be beneficial depending upon the state of the hydrocarbon, weather conditions and proximity of oil to sensitive receptors. It is a strategy that is therefore dependent upon situational awareness gathered at the time of the incident. This strategy targets discrete patches of oil (typically most suitable for diesel spills) in an opportunistic manner and can be undertaken by	Given there will be the seismic vessel and two support vessels within the Operational Area during the survey operations, availability of vessels to conduct mechanical dispersion will not limit the response. Additional vessels specifically for the purpose	The current vessels arrangements are considered to provide the required function given this strategy is applied opportunistically. Vessels and crew on standby would cost 10s tens of thousands of dollars per day and is not considered required	The strategy is dependent on conditions at time of the spill and can be delivered by vessels co-tasked with other operations. Therefore, the ongoing vessel access arrangements and vessels contracted are considered adequate.

Strategy	Resourcing	Justification	Environmental benefit of additional resources	Cost of additional resources	ALARP assessment
		vessels performing other duties. Dedicated vessels are therefore not considered to be required.	of mechanical dispersion is not considered required, particularly given this strategy can be tasked through vessel sharing.	based on the limited value they would provide.	
Protection and deflection	Shoreline and nearshore boom + ancillary equipment AMOSC (Exmouth, Fremantle and Geelong); AMSA (Fremantle and Dampier) Boom tow-vessels Spill response teams (Santos and AMOSC core group, State Response Team) Tactical response plans in place for the deployment of booms at offshore island locations.	Shoreline and nearshore boom provided by Santos, or through AMOSC or AMSA is available from Mutual aid arrangements through AMOSC also provide access to additional boom from other operators (e.g. Chevron equipment based at Barrow Island). Response exercises deploying boom from VI and Dampier are conducted annually by Santos. Protection priorities along shorelines potentially contacted have been assessed as part of spill response planning.	Boom equipment is not considered limiting. However, the time for deployment may exceed predicted times to shoreline contact, particularly at the Bedout Islands (contact within 2-3 days). This is particularly relevant given that boom deployment locations cannot be confirmed until oil spill fate modelling and aerial/vessel surveillance data has been analysed. Prepositioning or having personnel and equipment at an enhanced standby footing would reduce deployment time. However, pre-deploying boom at sensitive locations creates potential for impacts which weighed against the uncertainty of an oil spill reaching the location are deemed to be unacceptable.	The cost of boom, vessels and personnel on an enhanced standby footing or pre-positioned boom is in the order of tens of thousands of dollars per day and considered to be of limited value based the timeframes needed to undertake oil spill modelling /surveillance activities and a NEBA in order to establish the areas to be protected by boom.	Given there is questionable environmental benefits in having additional resources or pre-positioned resources, the current arrangements are considered ALARP.

Strategy	Resourcing	Justification	Environmental benefit of additional resources	Cost of additional resources	ALARP assessment
Shoreline clean-up	Manual clean-up and flushing equipment (Santos, AMOSC, AMSA, hardware supplies) Staging infrastructure Clean-up team leaders (Santos, AMOSC core group, AMSA) Clean-up labour personnel (labour hire as required) Vessels for transport (Santos contracted vessel providers) Equipment is prepositioned on VI so readily available.	For MDO/MGO spills, given the light/volatile nature of the hydrocarbon and the relatively low concentration/volumes predicted to arrive at shorelines under worst case conditions), intrusive and labour-intensive methods are unlikely to be favoured or required. Existing Santos equipment and that available through AMOSC/AMSA arrangements is considered to be sufficient given stockpile locations at Dampier, Exmouth and VI. Further equipment can be provided through additional Australian stockpile locations.	The main limitation of undertaking a shoreline clean-up response is based around access for plant and personnel to remote offshore island locations (Bedout Island). Provision of additional clean-up resources such as spill kits, sorbents, brooms, shovels, buckets etc. are not considered to provide an environmental benefit unless additional personnel can be mobilised.	During a spill event, the cost of additional resources is not considered the limiting factor; the limiting factor is considered to be numbers of personnel available to undertake shoreline clean-up. Mobilising additional personnel to undertake shoreline clean-up via vessel to remote offshore locations presents increased associated health and safety risks. Personnel mobilised via helicopter is limited to 10 passengers per trip. Once at the locations there is a need to provide adequate facilities.	The level of resources available are considered to be appropriate. The outcome of oil spill modelling/surveillance and a NEBA would be used to identify priorities for protection at specific locations given the time of year e.g. during turtle nesting season, where shoreline clean-up efforts would be directed at nesting beaches. Therefore, the response is considered ALARP.
Waste management	Assorted waste receptacles and trucks Waste personnel – project manager, local responsible personnel and operations personnel. Vessels for waste transport from offshore islands. Dedicated spill equipment container on VI with equipment to establish	Santos' waste service provider for spill response is North West Alliance (NWA). NWA is contracted to provide first strike and ongoing waste storage, transport and disposal requirements commensurate to a worst-case spill across Santos' operations. These resources are commensurate with those required for the worst case from the activities covered in this EP.	NWA has access to sufficient resources for the worst-case waste requirements associated with the Activity; there is no benefit to acquiring additional resources specifically for the Activity. Additional equipment to manage shoreline clean-up waste on offshore islands	Contracted resources are considered greater than required to respond to a worst-case scenario.	Resources are considered to be adequate based on worst case modelled waste requirements.

Strategy	Resourcing	Justification	Environmental benefit of additional resources	Cost of additional resources	ALARP assessment
	waste storage areas during shoreline clean-up (e.g. collapsible bunds/absorbent rolls/drain covers/temporary fencing etc.).		can be accessed and replenished from the mainland during an ongoing response.		
Oiled wildlife response	Oiled wildlife response kits and containers (AMOSC, AMSA, DBCA, DoT) – Darwin, Broome, Exmouth, Karratha, Fremantle, Kensington. OWR personnel Level 2 to 4 as per the WA Oiled Wildlife Response Plan (AMOSC, AMOSC activated OWR contractors, Industry Mutual Aid, DBCA, OSRL activated OWR contractors – "Sea Alarm"). Level of escalation of the OWR is under authority of the DoT incident controller with technical input from the DBCA – Oiled Wildlife Adviser.	The nature of the hydrocarbon released in a worst-case scenario (MDO/MGO) predicts the spatial extent of floating oil above the impact threshold of 10 g/m^2 may extend up to 250 km from the release location. Therefore, widespread physical oiling to wildlife may occur. Additionally, OWR may be undertaken onshore in the event of a spill, the Pilbara Region Oiled Wildlife Response Plan (OWRP) provides contact details for local trade personnel, vets and wildlife specialists that could be employed for manning/maintenance of forward response wildlife response facilities. The equipment and personnel arrangements are consistent with the equipment and personnel requirements as specified in the WA Oiled Wildlife Response Plan and are consistent with the activities covered by this plan. All OWR efforts would be undertaken in consultation with DBCA, and Santos would undertake the response following the outcome of an	Pre-positioning of staging areas and responders has been considered for this spill scenario given worst case timeframe for oil on shorelines may be as soon as 2 days from the occurrence of the release. As Santos has access to OWR kits through third party agreements that can be mobilised in a timely manner, it is not considered to be necessary to increase resources. The available OWR kits are strategically positioned within WA enabling flexibility on locations for staging areas to be established. The ability to increase the OWR effort relies on having adequate numbers of trained personnel available to undertake the response	The cost of personnel (Level 1 responders) on standby is $1,500 per person per day as per existing arrangements through recruiting agencies. This is a guaranteed cost regardless of whether a spill occurs or not. Given that personnel on this level can be arranged within relatively short timeframes there is not considered sufficient environmental value in having dedicated OWR responders on standby. This is further supported by OWR being undertaken in consultation with relevant agencies (e.g. DBCA and DoAWE) which is expected to be more of a limiting factor with regards to time than	Based on the timeframe for oil contact (255inimiz. 2 days) and the nature and thickness of MDO/MGO (worst-case) released, resourcing required for OWR is considered to be within the capacity of Santos and contracted service providers and the response arrangements are considered ALARP.

Santos

Strategy	Resourcing	Justification	Environmental benefit of additional resources	Cost of additional resources	ALARP assessment
		operational NEBA that would direct efforts for maximum effectiveness.	rather than having access to extra OWR kits. Purchasing of an OWR kit by Santos has been discounted as any OWR would be in consultation with DBCA upon completion of a NEBA. The timeframe for this to occur would exceed the time to mobilise an OWR from one of the locations on the WA mainland.	mobilising additional resources.	

7.1.9 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – maximum hydrocarbon spill – MDO/MGO residual risk is ranked Low
Is further information required to support or validate the consequence assessment?	Yes – hydrocarbon spill modelling results were used to determine consequence and risk
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with *International Convention of the Safety of Life at Sea* (SOLAS) 1974, *Navigation Act 2012, MARPOL Annex III-Prevention of Pollution by Harmful Substances,* and relevant recovery plans for threatened species. Management is also consistent with the zoning of the AMPs, in that risks have been reduced to ALARP, e.g. implementation of spill response activities will limit impacts, thereby conserving the marine park values.
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above)

Given the control measures in place to prevent a vessel collision and the low frequency of significant volume spills that occur in the industry, the risk of the event occurring is considered acceptable.

Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan, and in recovery plans for some bird and shark species (**Table 3-7**). Oil spills are also identified as a potential threat to habitats of the Eighty Mile Beach Marine Park (State Waters) in the park's Management Plan. Habitat modification/degradation/disruption, pollution and/or loss of habitat are also identified as threats to sharks, birds, cetaceans and turtles in conservation management and recovery plans. However, the potential hydrocarbon releases as a result of vessel collision are not expected to significantly impact the receiving environment with the implementation of the management controls proposed. Additionally, long term impacts resulting in complete habitat loss or degradation are not considered likely given the controls proposed to prevent releases and therefore the Activity will be conducted in a manner that is considered acceptable.

In accordance with Santos' risk assessment process, the residual risk is considered to be low and is therefore acceptable.

7.2 Minor Hydrocarbon Release

7.2.1 Description of Event

Hydrocarbon release at sea surface	
Event	A minor spill (approximately 37.5 m^3) of MDO/MGO could occur during vessel refuelling resulting in a loss of hydrocarbons to the marine environment at sea surface. Spills of MDO/MGO during refuelling events have the potential to cause impacts to the marine environment through a reduction in water quality and marine fauna exposure. Spills during refuelling can occur through several pathways, including fuel hose breaks, coupling failure or tank overfilling. Spills resulting from overfilling will be contained within the vessel drains and slops tank system. In the event that the refuelling hose is ruptured, the fuel bunkering Activity will cease by turning off the pump; the fuel remaining in the transfer line will escape to the environment as well as fuel released prior to the transfer operation being stopped. The AMSA (2015) *Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities* provides guidance for calculating a maximum credible spill volume for a refuelling spill. The guidance provided by AMSA (2015) for a refuelling spill under continuous supervision is considered appropriate given refuelling will be constantly supervised. The maximum credible spill volume during refuelling is calculated as: transfer rate (150 m^3/ hr) x 15 minutes of flow. The detection time of 15 minutes is seen as conservative but applicable following failure of multiple barriers, followed by manual detection and isolation of the fuel supply. Minor accidental loss of other hydrocarbon-based liquids (e.g. used lubricating oils, cooking oil, and hydraulic oil) to the marine environment could also occur via tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling. Seal oil could potentially leak from the vessel thruster/propeller stern tube directly to sea as a result of leaking seals or mechanical damage. The header tank for stern tube oil is approximately 1 m^3 and is equipped with limit switches in the event of a leak, thus preventing complete loss (the release of <1 m^3 of stern tube oil (non-hydrocarbon based lube oil) event is discussed further in **Section 7.4**).
Extent	Refer to **Section 7.1** for the hydrocarbon characteristics of the MDO/MGO refuelling release. A surface spill of MDO/MGO during refuelling is considered relatively small in comparison to a surface spill of MDO/MGO during a vessel collision. It is therefore assumed that the extent of a hydrocarbon spill during refuelling would remain within the extent of the worst case spill trajectory of MDO/MGO from a vessel collision as detailed in **Section 7.1**.
Duration	MDO/MGO fuel at the sea surface would spread rapidly in the direction of the prevailing wind and surface currents. Evaporation is the dominant process that would to the fate of spilled MDO/MGO from the sea surface during calm conditions while entrainment of droplets within the water column would increasingly contribute to removal of surface oil as wind speed increases.

7.2.2 Nature and Scale of Environmental Impacts

The nature and scale of a 37.5 m^3 MDO/MGO release during refuelling fits well within the expected impact and extent for the MGO/MDO release associated with a vessel collision detailed in **Section 7.1.** Therefore, no further modelling of the 37.5 m^3 is required.

7.2.3 Environmental Performance and Control Measures

Environmental Performance Outcomes relating to this hazard include:

+ EPO-10 – No loss of containment of hydrocarbon to the marine environment.

The control measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

Santos

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM- 34	General chemical management procedures.	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals.	Personnel costs associated with ensuring procedures are in place and implemented during inspections.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweigh the costs.
CM-35	Hazardous chemical management procedures.	Reduces the risk of spills and leaks (discharges) of hazardous chemicals to the sea by controlling the storage, handling and clean up.	Cost associated with permanent or temporary storage areas.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweigh the costs.
CM- 46	MARPOL-compliant fuel oil (MDO/MGO) will be used during the Activity.	Use of MDO/MGO reduces the potential impacts to marine environment in the event of unplanned hydrocarbon spills or leaks during bunkering.	Additional personnel costs of ensuring vessels are using the required fuel.	**Adopted –** benefits of ensuring procedures are followed outweighs the minimal costs of personnel time.
CM- 27	Oil pollution emergency plan (OPEP).	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of implementing response strategies.	**Adopted –** benefits of ensuring procedures are followed and measures implemented and that the vessel is compliant outweighs the costs.
CM- 28	Vessel spill response plans (SOPEP/SMPEP).			
CM- 37	Maritime dangerous goods code.	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDG Code) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	Cost associated with implementation of code/procedure.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweighs the costs.
CM-38	Deck drainage control measures (such as scupper plugs) in areas where chemicals and hydrocarbons are stored and frequently handled.	Reduces potential for hydrocarbon release to the marine environment.	Additional personnel costs of ensuring deck drainage procedures are followed.	**Adopted –** benefits of ensuring vessel is compliant outweighs the minimal costs.
CM- 39	Bulk refuelling transfer procedures.	Prevents probability of unplanned hydrocarbon spills or leaks occurring during	Additional personnel costs of ensuring procedures in place and followed.	**Adopted –** benefits of ensuring procedures are followed

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
		bunkering leading to negative impacts to the marine environment.		outweighs the minimal costs of personnel time.
Additional control measures				
N/A	No bunkering in the Operational Area.	Eliminates the probability of a hydrocarbon spill or leak occurring during bunkering in the Operational Area.	Cost associated with vessel transits and risk transfer to Health and Safety issues with additional trips to port instead. Would significantly increase the schedule to include multiple trips.	**Not Adopted** – Cost outweighs the environmental benefit.
CM- 44	Bunkering drill requirements.	Ensures the controls can be implemented and there is familiarity with the process.	Associated cost with the time spent conducting the drill during mobilisation.	**Adopted –** Benefit of conducting the drill prior to mobilisation outweighs the cost in lost time.

7.2.4 Impact, Consequence and Likelihood Ranking

Description	
Receptors	Marine fauna – plankton, fish and sharks, marine mammals, marine reptiles
Consequence	A – Negligible
In the event of a minor hydrocarbon spill, the quantities would be limited to approximately 37.5 m^3. The small volumes and dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration (i.e. 5 km over 6 hours). The number of receptors present at the Activity location is expected to be limited to a small number of transient individuals. No shoreline receptors are expected to be impacted as the nearest shoreline (Bedout Island) is 65 km from the Operational Area. The susceptibility of marine fauna to hydrocarbons is dependent on hydrocarbon type and exposure duration however given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is considered to be low. As the MDO/MGO is a moderately volatile substance, the impacts to receptors will decline rapidly with time and distance at the sea surface. Rapid dilution would also result in the impacts to receptors declining with time and distance. Deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Approved Conservation Advice (**Table 3-7**). For marine mammals that may be exposed to the more toxic aromatic components of the MDO/MGO, chemical effects are considered unlikely since these species are mobile and therefore will not be exposed for extended durations that would be required to cause any major toxic effects. Although humpback and pygmy blue whales may be exposed, this event is not expected to interfere with their migration Activity. Toxic impacts are not expected to the benthic community due to the water depths of the Operational Area (86 m–94 m). Near the sea surface, fish are able to detect and avoid contact with surface slicks and as a result, fish mortalities rarely occur in open waters from surface spills (Kennish, 1997; Scholz *et al*., 1992). Pelagic fish species are therefore generally not highly susceptible to impacts from hydrocarbon spills. In offshore waters near to the release point, pelagic fish are at risk of exposure to the more toxic aromatic components of the MDO/MGO. Pelagic fish in offshore waters are highly mobile and comprise species such as tunas, sharks and mackerel. Due to their mobility, it is unlikely that pelagic fish would be exposed to toxic components for long periods in this spill scenario. The more toxic components would also rapidly evaporate, and concentrations would significantly diminish with distance from the spill site, limiting the potential area of impact. Adult marine turtles exhibit no avoidance behaviour when they encounter hydrocarbon slicks (Odell and MacMurray 1986). Contact with surface slicks, or entrained hydrocarbons, can therefore result in hydrocarbon adherence to body surfaces (Gagnon and Rawson 2010) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (NOAA 2010). Hydrocarbons in surface waters may also impact turtles when they surface to breathe and inhale toxic aromatic components of the MDO/MGO, resulting in damage to their respiratory systems. Impacts to sea snakes from direct contact with surface hydrocarbons are likely to result in similar physical effects to those recorded for marine turtles (ITOPF 2011). It is unlikely that marine reptiles would be exposed to toxic components for long periods, given the more toxic components of MDO/MGO would rapidly evaporate and concentrations would significantly diminish from the spill site, limiting the potential for impact. Given that a small hydrocarbon spill would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a **negligible** consequence.	
Likelihood	3 – Unlikely
The likelihood of a small hydrocarbon release occurring is limited given the set of management controls in place for this Activity. The likelihood of a refuelling incident with subsequent release to the marine environment is considered to be unlikely.	
Residual Risk	The residual risk associated with this hazard is Low (A3)

7.2.5 ALARP Evaluation

Offshore refuelling is standard industry practice and oil pollution legislation (*Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and MARPOL Annex I) has been developed to safeguard against the risk of a hydrocarbon spill occurring during refuelling. Other hydrocarbon types such as HFO, IFO have specifically not been selected for this Activity (only MDO/MGO will be used in the Operational Area) to ensure that potential environmental impacts are reduced to ALARP. Alternative and additional controls were considered but not adopted as detailed in **Section 7.2.3.** The implementation of these control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

7.2.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – residual risk is ranked Low.
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with *International Convention of the Safety of Life at Sea* (SOLAS) 1974 and *Navigation Act 2012, MARPOL Annex I – Prevention of Pollution from Ships,* and relevant recovery plans (**Table 3-7**).
Are control measures and performance standards consistent with Santos' Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

With the controls in place to prevent refuelling incidents and the minor impacts predicted from a release of MDO/MGO, the risk to the marine environment is considered low.

As described in **Section 3** deteriorating water quality is identified as a potential threat to turtles in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a), and some bird and shark species (**Table 3-7**). Habitat modification/degradation/disruption, pollution and/or loss of habitat are also identified as threats to sharks, birds, cetaceans and turtles in Approved Conservation Advice management and Recovery Plans. However, the volume of MDO/MGO that could occur is not expected to significantly impact the receiving environment and long-term impacts resulting in complete habitat loss or degradation are not considered likely given the controls proposed to prevent releases. The Activity will therefore be conducted in a manner that is considered acceptable.

In accordance with Santos' risk assessment process, the residual risk is considered to be tolerable and therefore acceptable.

7.3 Spill Response Operations

7.3.1 Description of Event

Spill Response Operations	
Aspect	In the event of a hydrocarbon spill, response strategies will be implemented where possible to reduce environmental impacts to ALARP. The selection of strategies will be undertaken through the NEBA process, outlined in Section 6.1 of the OPEP. Spill response will be under the direction of the relevant Control Agency, as defined within the OPEP (Section 2.2). The response strategies and supporting activities deemed appropriate for the worst-case oil spill scenarios identified for the Activity are detailed in **Table 3-5** and **Sections 7** to **13** of the OPEP, and comprise: • Source control; • Operational monitoring;

	• Mechanical dispersion; • Shoreline protection and deflection; • Shoreline clean-up; • Oiled wildlife response; • Scientific monitoring; and • Waste management. While response strategies are intended to reduce the environmental consequences of a hydrocarbon spill, poorly planned and coordinated response activities can result in a lack of, or inadequate, information being available upon which poor decisions can be made, exacerbating or causing further environmental harm. An inadequate level of training and guidance during the implementation of spill response strategies can also result in environmental harm over and above that already caused by the spill. Hydrocarbon response operations will be within offshore and inshore waters using vessels, aircraft, and personnel. Offshore impacts are consistent with vessel and aircraft operations described within this EP for the routine operations. The greatest potential for impacts additional to those described for routine operations are from oiled wildlife response, nearshore protection and deflection and shoreline clean-up operations where disturbance to the environment may occur through intentional response strategy implementation.
Extent	Extent of the hydrocarbon release.
Duration	As required.

7.3.2 Details of the Environmental Impacts and Risks for the Activities

Light emissions	
Spill response activities will involve the use of vessels which are required at a minimum, to display navigational lighting. Vessels may operate in close proximity to shoreline areas during spill response activities. Onshore operations are only expected for the worst-case scenario and only under specific metocean conditions. The onshore response if required is expected to be confined to isolated areas/beaches and a shoreline response will only occur during daylight hours A significant onshore response is not envisaged to clean up these volumes. However, spill response activities may involve onshore operations including the use of vehicles and temporary camps which may require lighting.	
Potential receptors:	Fauna (including Threatened/ Migratory/ Local Fauna) Protected Areas Socio-Economic Receptors
Lighting may cause behavioural changes to fish (including sharks), birds and marine turtles which can have a heightened consequence during key life-cycle activities, for example turtle nesting and hatching. Turtles and birds, which includes threatened and migratory fauna, have been identified as key fauna susceptible to lighting impacts. Refer to **Section 6.3** for further detail on the impacts of light to fish, birds and marine turtles. Spill response activities which require lighting may take place in protected areas in open ocean and shorelines through response strategy implementation. Environmental values and sensitivities potentially impacted by light from response strategy implementation, including BIA's for turtles and birds have been identified in **Section 3.2**. However, given the scale of the response any impacts are expected to be short term, geographically confined and minor. Given that shoreline operations will only be conducted in daytime hours and light impacts would be considered when sighting any shoreline camps. Additionally, light impacts would be considered in the operational NEBA process.	
Noise emissions	
Spill response activities will involve the use of aircraft and vessels which will generate noise both offshore and in proximity to sensitive receptors in coastal areas. Spill response activities will also involve the use of equipment on coastal areas during clean-up of shorelines (e.g. pumps and vehicles), for accessing shoreline areas (e.g. vehicles) and for supporting temporary camps (e.g. diesel generators).	

Potential receptors:	Fauna (including Threatened/ Migratory/ Local Fauna) Protected Areas Socio-Economic Receptors

Underwater noise from the use of vessels may impact marine fauna, such as fish (including commercial species), marine reptiles and marine mammals, in the worst instance causing physical injury to hearing organs, but more likely causing short term behavioural changes, e.g. temporary avoidance of the area, which may impact key life-cycle process (e.g. spawning, breeding, calving). Underwater noise can also mask communication or echolocation used by cetaceans. Refer to **Section 6.2.3** for further detail on the environmental impact of noise attributed to vessel operations.

Cetaceans have been identified as the key concern for vessel noise associated with response strategy implementation, with the humpback and pygmy blue whale migration and distribution BIAs within the spill EMBA. Spill response activities using vessels have the potential to impact fauna in protected areas further described in **Section 7.6**.

Noise and vibration from terrestrial activities on shorelines has the potential to cause behavioural disturbance to coastal fauna including protected seabirds and turtles. Shoreline activities involving the use of noise generating equipment may take place in important nesting areas for turtles and/or roosting/feeding areas for shorebirds.

As a consequence of impacts to fauna (including shorebirds, marine mammals and fish), noise has the potential to impact supported industries such as tourism and commercial fishing.

Atmospheric emissions

The use of fuels to power vessel engines, generators and mobile equipment used during spill response activities will result in emissions of GHG such as CO_2, CH_4 and N_2O, along with non-GHG such as SO_x and NO_x. Emissions will result in localised decrease in air quality.

Potential receptors:	Physical Environment/habitat Fauna (including Threatened/ Migratory/ Local Fauna) Protected Areas

Atmospheric emissions from spill response equipment will be localised and while there is potential for fauna and flora impacts, the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted. Emissions may occur in protected areas, however, the scale of the impact relative to potential oil spill impacts is not considered great.

Operational discharges and waste

Operational discharges include those routine discharges from vessels used during spill response which may include:

- Bilge water;
- Deck drainage;
- Putrescible waste and sewage;
- Cooling water from operation of engines; and
- Desalination plant effluent (brine) and backwash water discharge.

In addition, there are specific spill response discharges and waste creation that may occur, including:

- Cleaning of oily equipment/vessels and vehicles;
- Flushing water for the cleaning of shoreline habitats;
- Sewage/putrescible and municipal waste at camp areas; and
- Creation, storage and transport of oily waste and contaminated organics.

Potential receptors:	Fauna (including Threatened/ Migratory/ Local Fauna) Physical Environment/habitat Protected Areas Socio-Economic Receptors

Operational discharges from vessels may create a localised and temporary reduction in marine water quality. Effects include nutrient enrichment, toxicity, turbidity, temperature and salinity increases, as detailed in **Section 6.5**. Sensitive receptors potentially impacted are likely to be different to those described in **Section 6.5** given vessel use is likely to occur in shallower coastal waters during spill response activities. Discharge could potentially occur adjacent to marine habitats such as corals, seagrass, macroalgae, and in protected areas (i.e. receptors anywhere within the EMBA), which support a more diverse faunal community. Discharges are expected to be very localised and temporary. Cleaning of oil contaminated equipment, vehicles and vessels, has the potential to spread oil from contaminated areas to those areas not impacted by a spill, potentially spreading the impact area and moving oil into a more sensitive environment. Flushing of oil from shoreline habitats is a clean-up technique designed to remove oil from the receptor that has been oiled and remobilise back into the marine environment and result in further dispersion of the oil. The process of flushing has the potential to physically damage shoreline receptors such as mangroves and rocky shoreline communities, increase levels of erosion, and create an additional, and potentially higher, level of impact than if the habitat was left to bio-remediate. Sewage, putrescible and municipal waste will be generated from onshore activities at temporary camps which may include toilet and washing facilities. These wastes have the potential to attract fauna, impact habitats, flora and fauna and reduce the aesthetic value of the environment, which may be within protected areas. The creation, storage and transport of oily waste and contaminated organics has the potential to spread impacts of oil to areas, habitats and fauna not previously contaminated.	
Physical presence and disturbance	
The movement and operation of vessels, including anchoring and operating in the nearshore environment has potential to cause disturbance to the marine environment. Vehicles, personnel and equipment associated with response strategy implementation, have the potential to disturb the physical environment and marine/coastal habitats and fauna, which may include those habitats and fauna within protected areas. Disturbance may also impact cultural values of an area. The movement of vessels could potentially introduce invasive marine species attached as biofouling to nearshore areas, while vehicle and equipment movement could spread non-indigenous flora and fauna. Oiled wildlife response activities may involve deliberate disturbance (hazing), capture, handling, cleaning, rehabilitation and release of wildlife which could lead to additional impacts to wildlife.	
Potential receptors:	Fauna (including Threatened/ Migratory/ Local Fauna) Physical Environment/habitat Protected Areas Socio-Economic Receptors
The use of vessels may disturb benthic habitats in coastal waters including corals, seagrass, macroalgae and mangroves. Impacts to habitats from vessels include damage through the deployment of anchor/chain, nearshore booms and grounding. Vessel use in shallow coastal waters also increases the chance of contact or physical disturbance with marine megafauna such as turtles and dugongs. Booms create a physical barrier on the surface waters that has the potential to injure or entangle passing marine fauna that are either surface breathing or feeding. Vehicles, equipment, personnel used and cleaning activities during shoreline response activities have the potential to damage coastal habitats such as dune vegetation, mangroves and habitats important to threatened and migratory fauna including nests of turtles and birds and bird roosting/feeding areas. Shoreline clean-up may involve the physical removal of substrates that could cause impact to habitats and coastal hydrodynamics and alter erosion/accretion rates. The presence of camp areas, although relatively short-term, may disrupt normal behaviour of coastal species such as shorebirds and turtles, and could potentially interfere with nesting and feeding behaviours. Oiled wildlife response may include the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling such as birds and marine turtles. While oiled wildlife response is aimed at having a net benefit, poor responses can potentially create additional stress and exacerbate impacts from oiling, interfering with life-cycle processes, hampering recovery and in the worst instance increasing levels of mortality. Impacts from invasive marine species released from vessel biofouling include out-competition, predation and interference with other ecosystem processes. The ability for a non-native species to establish is generally mitigated	

in deeper offshore waters where the depth, temperature, light availability and habitat diversity is not generally conducive to supporting reproduction and persistence of the invasive species. However, in shallow coastal areas, such as areas where vessel-based spill response activities may take place, conditions are likely to be more favourable. Impacts from invasive terrestrial species are similar in that the invasive species can out-compete local species (e.g. weeds) and interfere with ecosystem processes. Non-native species may be transported attached to equipment, vehicles and clothing. Such an introduction would be especially detrimental to wilderness areas or protected terrestrial reserves which may have a relatively undisturbed flora and fauna community. The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow on impacts to socio-economic values and industry (e.g. tourism, fisheries).	
Disruption to other users of marine and coastal areas and townships	
Spill response activities may involve the use of vessels, equipment and vehicles, and the establishment of temporary camps, in areas used by the general public or industry. The mobilisation of spill response personnel into an affected area may also place increased demands on local accommodation and other businesses.	
Potential receptors:	Socio-Economic Receptors
The use of vessels in the nearshore and offshore environment and the undertaking of spill response activities at shoreline locations may exclude the general public and industry use of the affected environment. As well as impacting leisure activities of the general public, this may impact on revenue with respect to industries such as tourism and commercial fishing. The mobilisation of personnel to small communities has the potential to affect the local community through demands on local accommodation and business, reducing the availability of services to members of the public.	

7.3.3 Environmental Performance and Control Measures – Spill Response Operations

For EPOs, EPS and Measurement Criteria relating to spill response in the event of a spill during this Activity, refer to Section 16 of the OPEP.

Control measures considered for this Activity are provided below.

Control measure	Environmental benefit	Evaluation
Competent IMT and Oil Spill Responder personnel	Ensures that spill response strategy selection and operational activities consider the potential for additional environmental impacts	**Adopt –** Considered a standard spill response control
Use of competent vessel crew/personnel	Reduces potential for environmental impacts from vessel usage	**Adopt –** Considered a standard spill response control
Spill response activities selected on basis of a NEBA	Provides a systematic and repeatable process for evaluating strategies with net least environmental impact	**Adopt –** Considered a standard spill response control
Noise and atmospheric emissions		
Vessels and aircraft compliant with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003)	Reduces potential for behavioural disturbance to cetaceans	**Adopt –** Considered a standard spill response control (regulatory requirement)
If required under MARPOL, vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate.	Reduces level of air quality impacts	**Adopt –** Considered a standard spill response control (regulatory requirement)
Operational discharges and waste		
Vessels meet applicable MARPOL sewage disposal requirements as appropriate for vessel class	Reduces potential for water quality impacts	**Adopt –** Considered a standard spill response control (regulatory requirement)
Vessels meet applicable MARPOL requirements for oily water (bilge) discharges as appropriate for vessel class	Reduces potential for water quality impacts	**Adopt –** Considered a standard spill response control (regulatory requirement)
Ballast water management plan for international vessels	Improves water quality discharge to marine environment to ALARP Reduces risk of introduced marine species	**Adopt –** Considered a standard spill response control (regulatory requirement)
Compliance with controlled waste, unauthorised discharge and landfill regulations	Ensures correct handling and disposal of oily wastes	**Adopt –** Considered a standard control (regulatory requirement)
Physical presence and disturbance		
Vessels and aircraft compliant with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003)	Reduces potential for behavioural disturbance to cetaceans	**Adopt –** Considered a standard spill response control (regulatory requirement)

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Control measure	Environmental benefit	Evaluation
DPIRD vessel check tool applied to all spill response vessels on basis of the outcome of a NEBA	Reduces risk for introduction of invasive marine species as part of vessel biofouling	**Adopt –** Adopting this control meets industry standards and provides a tool to identify and manage the potential risk
Use of shallow draft vessels for shoreline and nearshore operations	Reduces seabed and shoreline disturbance	**Adopt –** Considered a standard control
OSRT Team Leader assessment/selection of vehicle appropriate to shoreline conditions	Reduces coastal habitat and fauna disturbance	**Adopt –** Considered a standard control
Conduct shoreline/nearshore habitat/bathymetry assessment	Reduces shoreline habitat disturbance	**Adopt –** Considered a standard control
Establish demarcation zones for vehicle and personnel movement considering sensitive vegetation, bird nesting/roosting areas and turtle nesting habitat	Reduces coastal habitat and fauna disturbance	**Adopt –** Considered a standard control
Operational restriction of vehicle and personnel movement to limit erosion and compaction	Reduces coastal habitat erosion and compactions	**Adopt –** Considered a standard control
Prioritise use of existing roads and tracks	Reduces coastal habitat and fauna disturbance	**Adopt –** Considered a standard control
Soil profile assessment prior to earthworks	Reduce habitat disruption and erosion	**Adopt –** Considered a standard control
Pre-cleaning and inspection of equipment (quarantine)	Prevent introduction of invasive species	**Adopt –** Considered a standard control
Use of Heritage Adviser if spill response activities overlap with potential areas of cultural significance	Reduces disturbance to culturally significant sites	**Adopt –** Considered a standard control to be adopted by the relevant Controlling Agency
Adhere to WAOWRP and Pilbara Regional Oiled Wildlife Response Plan (PROWRP)	Oiled wildlife hazing, capture, handling and rehabilitation meet minimum standards as outlined within the WA Oiled Wildlife Response Plan	**Adopt –** Considered a standard control to be adopted by the relevant Controlling Agency

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Control measure	Environmental benefit	Evaluation
Use existing moorings or anchor locations where possible or available	Reduces seabed disturbance from anchoring operations	**Adopt –** Considered a standard control
Boom will be monitored and maintained to ensure trapped fauna are released as early as possible	Reduces fauna disturbance from nearshore protection and deflection activities	**Adopt –** Considered a standard control
Disruption to other users of marine and coastal area and townships		
Stakeholder consultation	Early awareness of spill response activities which reduces potential disruption	**Adopt –** Considered a standard control
Accommodation assessment	Reduces strain on accommodation	**Adopt –** Considered a standard control
Security Management Plan	Reduces potential for security threat causing disruptions in the response activities	**Adopt –** Considered a standard control for large scale deployment in areas with potential security risk
Transport Management Plan	Reduces potential for traffic disruptions	**Adopt –** Considered a standard control for large scale deployment in highly populated areas

7.3.4 Impact and Consequence Ranking

Light emissions	
Potential receptors	Fauna (including Threatened/ Migratory/ Local Fauna): Seabirds, shorebirds and turtles Protected Areas Socio-Economic Receptors.
Consequence ranking	Fauna (including Threatened/ Migratory/ Local Fauna): *A (Negligible)* – Short term behavioural impacts only to small proportion of local population and not during critical lifecycle Activity. No decrease in local population size / area of occupancy of species / loss or disruption of Habitat Critical / disruption to the breeding cycle / introduction of disease. Protected areas: *A (Negligible)* – No or negligible impact on protected area values. No decline of species population within a protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values. Socio-economic receptors*: A (Negligible)* – no or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the Activity.
The receptors considered most sensitive to lighting from vessel and shoreline operations (in event of shoreline clean-up operations) are seabirds and marine turtles, particularly over spring/summer months with respect to marine turtles where emerging hatchlings are sensitive to light spill onto beaches. Following restrictions on night-time operations by spill response vessels, which will demobilise to mooring areas offshore with safety lighting only, impacts from vessels are considered to be *Negligible*. The positioning of temporary camps will be done at the direction of Town of Port Hedland/DoT/ DBCA and following control measures on lighting colour and direction the consequence of shoreline lighting is considered *Negligible*. These species are likely to be values of the protected areas in which they occur (e.g. Eighty Mile Beach), and the impact to the protected area from light is also considered *Negligible.* As a consequence of impacts to fauna, lighting has the potential to impact supported industries such as tourism however as impacts to fauna are considered negligible any indirect impacts on tourism will also be *Negligible*.	
Noise	
Potential receptors	Fauna (including Threatened/ Migratory Fauna): Marine mammals (particularly humpback whales), seabirds and shorebirds Protected Areas Socio-Economic Receptors
Consequence ranking	Fauna (including Threatened/ Migratory/ Local Fauna): *A (Negligible)* – Short term behavioural impacts only to small proportion of local population and not during critical lifecycle Activity. No decrease in local population size / area of occupancy of species / loss or disruption of Habitat Critical / disruption to the breeding cycle / introduction of disease. Protected areas: *A (Negligible)* – No or negligible impact on protected area values. No decline of species population within a protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values. Socio-economic receptors*: A (Negligible)* – no or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the Activity.
Receptors considered most sensitive to vessel noise disturbance are populations of humpback whales and pygmy blue whales during migration season. A temporary behavioural disturbance is expected only with a consequence of *Negligible.* With respect to noise from onshore operations (mobile equipment and vehicles), nesting, roosting or feeding birds are considered to be the most sensitive to noise. The equipment used is not considered to have excessive sound levels and following direction by DoT and DBCA on the location of temporary camp areas, the consequence to birds from noise is expected to be *Negligible*. As a consequence of impacts to fauna, noise has the potential to impact supported industries such as tourism and commercial fishing however as impacts to fauna are considered negligible any indirect impacts on socio-economic receptors will also be *Negligible*.	

Atmospheric emissions	
Potential receptors	Physical environment/habitat: Air quality Fauna (including Threatened/ Migratory Fauna): Seabirds and shorebirds Protected Areas
Consequence ranking	Physical environment/habitat: *A (Negligible) – No or negligible reduction in habitat area/function.* Fauna (including Threatened/ Migratory/ Local Fauna): *A (Negligible)* – Short term behavioural impacts only to small proportion of local population and not during critical lifecycle Activity. No decrease in local population size / area of occupancy of species / loss or disruption of Habitat Critical / disruption to the breeding cycle / introduction of disease. Protected areas: *A (Negligible)* – No or negligible impact on protected area values. No decline of species population within a protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values.
Atmospheric emissions from spill response equipment will be localised and impacts to even the most sensitive fauna, such as birds, are expected to be *Negligible*. Because of the localised and low level of emissions, impacts to protected area values and the physical environment are predicted to be *Negligible.*	
Operational discharges and waste	
Potential receptors	Physical environment/habitat: Coastal vegetation, intertidal and shallow habitats (corals, mangroves, seagrass, macroalgae) Fauna (including Threatened/ Migratory/ Local Fauna): Fish, marine reptiles, marine mammals, seabirds and shorebirds Protected areas Socio-Economic Receptors
Consequence ranking (planned operational discharges)	Physical environment/habitat: *A (Negligible)* – No or negligible reduction in habitat area/function. Fauna (including Threatened/ Migratory/ Local Fauna): *1 (Negligible)* – Short term behavioural impacts only to small proportion of local population and not during critical lifecycle Activity. No decrease in local population size / area of occupancy of species / loss or disruption of Habitat Critical / disruption to the breeding cycle / introduction of disease. Protected areas: *A (Negligible)* – No or negligible impact on protected area values. No decline of species population within a protected area. No or negligible alteration, modification, obscuring or diminishing of protected area values. Socio-economic receptors*: A (Negligible)* – no or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the Activity.
Operational discharges from vessels may create a localised and temporary reduction in marine water quality, which has the potential to impact shallow coastal habitats in particular, however, following the adoption of regulatory requirements for vessel discharges, which prevent discharges close to shorelines, discharges will have a *Negligible* impact to habitats, fauna or protected area values. Furthermore, washing of vessels and equipment will take place only in defined offshore hot zones preventing impacts to shallow coastal habitats. As a consequence of impacts to fauna, operational discharges from vessels has the potential to impact supported industries such as tourism and commercial fishing however as impacts to fauna are considered negligible any indirect impacts on socio-economic receptors will also be *Negligible*. Onshore, the use of flushing water has the potential to damage sensitive shoreline and intertidal habitats, e.g. mangroves, however, low pressure flushing only will be used, preventing further damage to habitats or erosion of sediments. For sensitive habitats the deployment of booms will be considered to retain flushed hydrocarbons, if this presents a net benefit. Following these control measures the use of flushing to clean shorelines and intertidal habitats is seen to have a *Negligible* additional impact to habitats, fauna or protected area values. The cleaning of contaminated vehicles and equipment onshore has the potential to spread oily waste and damage habitats if not contained. Decontamination units will be in use during the spill response thus containing waste and preventing any secondary contamination. The consequence of cleaning discharges is therefore ranked as *Negligible* in terms of impacts to habitats, fauna or protected area values. Sewage, putrescible and municipal waste generated onshore will be stored and disposed of at approved locations.	

Physical presence and disturbance	
Potential receptors	Fauna (including Threatened/ Migratory/ Local Fauna): Nesting and hatching turtles, nesting, roosting and feeding shorebirds/seabirds Protected Areas Physical environment/habitat: coastal vegetation, turtle nesting beaches, shorebird/seabird nesting, roosting and feeding areas, intertidal and shallow habitats (corals, mangroves, seagrass, macroalgae) Socio-Economic Receptors
Consequence ranking (physical presence and disturbance)	Fauna (including Threatened/ Migratory Fauna): *B (Minor)* – Detectable, but insignificant, decrease in local population size. Insignificant reduction in area of occupancy of species. Insignificant loss/disruption of Habitat Critical to survival of a species. Insignificant disruption to the breeding cycle of local population Protected Areas: *B (Minor)* – Detectable but insignificant impact to on one or more of protected areas values. Physical environment/habitat: *B (Minor)* – Detectable but localised and insignificant loss of area/function of habitat. Rapid recovery evident within approximately 1 year (seasonal recovery). Socio-economic receptors*: B (Minor)* – Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local Activity.
The use of vessels and nearshore booms has the potential to disturb benthic habitats including sensitive habitats in coastal waters such as corals, seagrass, macroalgae and mangroves. A review of shoreline and shallow water habitats, and bathymetry, utilising existing moorings and the establishment of demarcated areas for access and anchoring will reduce the level of impact to *Negligible*. The use and movement of vehicles, equipment and personnel during shoreline response activities has the potential to disturb coastal habitats such as dune vegetation, samphire and mangroves, and important habitats of threatened and migratory fauna including nests of turtles and birds and bird roosting areas. Furthermore, clean-up can involve physical removal of substrates that could cause impact habitats, fauna and alter coastal hydrodynamics. As with vessel use, an assessment of appropriate vehicles and equipment to reduce habitat damage, along with the establishment of access routes/demarcation zones, and operational restrictions on equipment/vehicles use will limit sensitive habitat damage and damage to important fauna areas. The establishment of temporary camp areas will be done under direction of Town of Port Hedland, DoT and DBCA with suitable advice sought if access is needed to culturally significant areas. Following these and other control measures the resultant consequence to the physical environment and habitat is assessed as *Minor*, indicating that there may be a detectable reduction in habitat area from response activities (as separate from spill impacts), but recovery will be relatively rapid, once spill response activities cease. As with all spill response activities, this disturbance will only occur if there is a net benefit to accessing and cleaning shoreline areas. The main direct disturbance to fauna would be the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling impacts, such as birds and marine turtles. This would only be done if this intervention were to deliver a net benefit to the species but may result in a *Minor* consequence following compliance with the WA Oiled Wildlife Response Plan and the Pilbara Region Oiled Wildlife Response Plan. These habitats/environments are likely to be values of the protected area they occur in, and the impact to the protected area from physical disturbance is also considered *Minor*. The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow on impacts to socio-economic values and industry (e.g. tourism, fisheries). This impact is considered *Minor*.	
Disruption to other users of marine and coastal areas and townships:	
Potential receptors	Socio-Economic Receptors: Fisheries, Fisheries and Aquaculture, Tourism
Consequence ranking	*B (Minor)* – Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local Activity.

The use of vessels in the nearshore and offshore environment and spill response activities at shoreline locations/close to townships, may exclude general public and industry use. It should be noted that this is distinct from the socio-economic impact of a spill itself which would have a far greater detrimental impact to industry and recreation. Following the application of control measures, it is considered that the additional impact of spill response activities on affected industries would be *Minor*.	
Likelihood	3 – Unlikely
The likelihood of spill response being required is limited given the set of management controls in place for this Activity. The likelihood of spill response being required is considered to be unlikely.	
Residual Risk	The residual risk associated with this hazard is Low

7.3.5 ALARP Evaluation

A NEBA is the primary tool used during spill response to evaluate response strategies with the goal of selecting strategies that results in the least net impact to key environmental sensitivities. The NEBA process will identify and compare net environmental benefits of alternative spill response options. The NEBA will effectively determine whether an environmental benefit will be achieved through implementing a response strategy compared to undertaking no response. NEBA will be undertaken by the relevant Control Agency for the Activity. For those activities under the control of Santos, the IMT Environmental Team Leader will be responsible for reviewing the priority receptors and selected response strategies identified within this EP and coordinating the NEBA for each operational period. This will ensure that at the strategy level, the response operations reduce additional environmental impacts to ALARP.

Spill response activities will be conducted in offshore and coastal waters using vessels and aircraft. The greatest potential for additional impacts from implementing spill response is considered to be to wildlife in offshore waters from oiled wildlife response activities, and shoreline habitats and fauna receptors within shallow waters or on shorelines from nearshore booming and shoreline clean-up activities.

Given the types of activities considered appropriate to responding to a worse-case spill and the scale of operations, standard control measures adopted by Santos for spill response to reduce the level of additional impacts are considered to reduce these impacts to ALARP. This includes working with the relevant Control Agency for spill response and applying the process and standards e.g. for oiled wildlife response as included within the WA Oiled Wildlife Response Plan and Pilbara Regional Oiled Wildlife Response Plan.

Santos considers the actions prescribed in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a) and Approved Conservation Advice for other threatened fauna (**Table 3-7**) relevant to spill responses for the activities to minimise noise and light impacts on marine cetaceans, fish and marine turtles. The proposed Activity will not result in significant impacts on these species and implementation of identified control measures is in line with the relevant Conservation Advice and Recovery Plans. Pollution events (such as hydrocarbon spills) could impact on fauna (as described in **Section 7.1**), and the use of vessels and equipment during the spill response could result in potential impacts as described within this EP. Control measures in place for vessel and helicopter use will reduce potential impacts to marine fauna and these are consistent with current conservation advice. The assessed residual consequence for this impact is minor and cannot be reduced further without disproportionate costs. It is considered therefore that the impact of the activities conducted are ALARP.

7.3.6 Acceptability Evaluation

Is the consequence ranked as A (Negligible) or B (Minor)?	Yes – Maximum consequence is a B (Minor) from planned events and maximum risk is Medium.
Is further information required to support or validate the consequence assessment?	No – Potential impacts and risks are well understood through the information available.
Are control measures and performance standards consistent with industry standards,	Yes – management is consistent with industry standards and regulatory requirements

legal and regulatory requirements, including protected matters?	
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised. During any spill response, a close working relationship with relevant regulatory bodies (e.g. DoT, DBCA, and AMSA) will occur and thus there will be ongoing consultation with relevant stakeholders on the acceptability of response operations. Wildlife response will be conducted in accordance with the WA Oiled Wildlife Response Plan (WA OWRP) and Pilbara Regional Oiled Wildlife Response Plan.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP evaluation above.

7.4 Hazardous and Non-Hazardous Unplanned Discharges – Liquid

7.4.1 Description of Event

Hazardous and non-hazardous (liquid) release to the marine environment	
Event	Hazardous liquids, including miscellaneous chemicals and waste streams (cleaning and cooling agents, stored or spent chemicals and leftover paint materials), are used or stored on board the vessel during the Activity. The main engines and equipment such as pumps, cranes, winches, power packs and generators require MDO/MGO for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the vessels. Small hydrocarbon leaks could occur, and potential impacts are covered under **Section 7.2**, chemical leaks are discussed further in this section. Outside the vessel, the largest credible spill would be a release of <1 m^3 of stern tube oil (non-hydrocarbon-based lube oil) from the vessel thruster/propeller stern tube. Accidental loss of liquid wastes to the marine environment could occur via tank pipework failure or rupture, inadequate bunding and/or storage, insufficient fastening or inadequate handling, poorly maintained lifting equipment, and leading to dropped objects, which may result in impacts to water quality and hence sensitive environmental receptors.
Extent	The maximum volume of hazardous chemical that could be released during routine operations is likely to be small and limited to the volume of individual containers (e.g. drums etc.) stored on-deck. The most credible worst-case spill scenario on-board is considered to be release from an on-deck hydraulic hose (loss of approximately 200 L), however the worst case overall is <1 m^3 of stern tube oil. In the event that the spill is not contained on deck, there would be a release to the marine environment, which would be likely to rapidly disperse and evaporate.
Duration	Instantaneous release during the Activity.

7.4.2 Nature and Scale of Environmental Impacts

Environmentally hazardous chemicals and liquid wastes (hazardous/ non-hazardous liquids) lost to the marine environment from a vessel may lead to contamination of the water column in the vicinity of the vessel.

The potential impacts would be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open ocean (high energy environment that facilitates rapid dispersion and dilution to non-toxic concentrations) (French McCay et al. 2004). This is unlikely to lead to widespread ecological effects.

Woodside (RPS APASA, cited in Woodside 2016) modelled a marine diesel surface spill (volume of 8 m^3) of in the offshore waters of northwest WA. The modelling set an exposure threshold of 10g/m^2, which has previously been used as an approximate lower limit for harmful exposures to birds and marine mammals (NOPSEMA 2019). Results indicated that exposure to surface hydrocarbons above the 10 g/m^2 threshold were limited to the immediate vicinity of the release site, with little potential to extend beyond 1 km. Therefore, it was considered that there was no potential for contact with sensitive receptors above surface threshold concentrations from an 8 m^3 spill of marine diesel within the Operational Area.

The changes to water quality that may result could potentially lead to short-term impacts on marine fauna (e.g. pelagic/benthic fish, epifauna, marine mammals, marine reptiles and seabirds), with chronic impacts not expected due to the short exposure times likely (few hours).

There are no emergent or inter-tidal habitats within the Operational Area that could be impacted by the release of hazardous and non-hazardous liquids. Impacts from the release of hazardous and non-hazardous liquids are unlikely to reach any of the demersal species or benthic habitats at the seabed. Sub-lethal or lethal effects from toxic hazardous/ non-hazardous liquids on marine fauna, is considered unlikely given the expected low concentrations and short exposure times (French McCay et al. 2006).

7.4.3 Environmental Performance and Control Measures

Environmental Performance Outcomes relating to this hazard include:

+ EPO-3 – Discharges to sea meet legislated permissible discharge requirements;
+ EPO-8 – No unplanned objects, emissions or discharges to sea; and
+ The control measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-34	General chemical management procedures.	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals, including requirements of MARPOL Annex III and Marine Orders 94 as appropriate for vessel class.	Personnel costs associated with ensuring procedures are in place and implemented during inspections.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweigh the costs.
CM-35	Hazardous chemical management procedures.	Reduces the risk of spills and leaks (discharges) to the sea by controlling the storage, handling and clean-up of hazardous chemicals.	Cost associated with permanent or temporary storage areas.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweighs the costs.
CM-28	Vessel spill response plans (SOPEP/SMPEP)	Implements response plans to deal with an unplanned release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of implementing response strategies.	**Adopted** – benefits of ensuring procedures are followed and measures implemented and that the vessel is compliant outweighs the costs.
CM-37	Maritime dangerous goods code.	Dangerous goods managed in accordance with IMDG Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction	Cost associated with implementation of code/procedure.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweighs the costs.
CM-41	Equipment maintenance in accordance with Planned Maintenance System (PMS).	Ensures that lifting equipment is maintained and certified, and that lifting procedures are followed reducing probability of dropped objects occurring with the potential to result in hazardous/ non-hazardous liquids release.	Additional personnel costs of ensuring equipment is maintained and certified as appropriate and that procedures in place and followed.	**Adopted** – benefits of ensuring procedures are followed and equipment is compliant outweighs the minimal costs of personnel time.
Additional control measures				

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM- 07	Dropped object prevention and recovery procedure.	Minimises dropped object risk during vessel lifting operations that may cause secondary spill (discharges) resulting in reduction in water quality.	Cost to maintain lifting equipment and implement procedure.	**Adopted –** benefits of ensuring procedures are followed and measures implemented outweighs the costs.

7.4.4 Impact, Consequence and Likelihood Ranking

Description	
Receptors	Marine fauna – Fish, sharks, marine mammals, marine reptiles, seabirds.
Consequence	A – Negligible
In the event of a hazardous/ non-hazardous liquid spill, the worst-case quantity would be limited to <1 m^3 of stern tube oil. The small volumes, dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration. The susceptibility of marine fauna to hazardous/ non-hazardous liquids is dependent on the type and exposure duration. Given that exposures would be limited in extent and duration (French McCay et al. 2006), exposure to marine fauna from this hazard is not expected to result in a fatality. Potential impacts from small volumes (<1 m^3) of hazardous/non-hazardous liquids on water quality would be short-term and localised, due to the nature and behaviour of the hazardous/ non-hazardous liquids. Pelagic fauna present in the immediate vicinity of the spill would most likely be at risk. Deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-7**). However, the potential release of hazardous/ non-hazardous liquids is not expected to significantly impact the receiving environment. Through the management controls proposed to prevent releases, the Activity will be conducted in a manner that is considered acceptable. Given that a small spill (<1m^3) of hazardous/ non-hazardous liquids would not result in a decreased population size at a local or regional scale, it is expected that a spill of this nature would result in a **negligible** consequence.	
Likelihood	2 – Very Unlikely
A small liquid release is unlikely to have widespread ecological effects given the nature of the chemicals on-board, the small volumes that could be released, the water depth, transient nature of marine fauna in this area and the prevention and management procedures in place to clean up a spill. Santos records indicate that although spills and leaks from equipment and machinery (due to split hoses, small leaks, or handling errors) have occurred, most of the spills and leaks reported occurred within bunded areas, were all less than 100 L and cleaned up immediately and therefore did not reach the marine environment. The likelihood of a small hazardous/ non-hazardous liquid release occurring is limited given the mitigation and management controls in place for this Activity. Consequently, the likelihood of releasing hazardous/ non-hazardous liquids to the environment which results in a negligible consequence is considered to be **very unlikely**.	
Residual Risk	The residual risk associated with this hazard is **Low (A2)**

7.4.5 ALARP Evaluation

Hazardous/ non-hazardous liquids are required to operate the vessels and carry out the Activity or may be a resultant waste of the Activity/ vessel operation, so their removal is not viable. No beneficial additional controls were identified to further reduce the risk of this hazard. The management and mitigation controls outlined reduce the risk to a level considered to be ALARP.

7.4.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – maximum hazardous/ non-hazardous liquid release residual risk is ranked Low.
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with *MARPOL Annex III – Prevention of Pollution by Harmful Substances, International Maritime Dangerous Goods Code,* and relevant Recovery Plans and Approved Conservation Advice (**Table 3-7**).

Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

With the controls in place to prevent an accidental release of small volumes (<1m^3) of hazardous/ non-hazardous liquids and the negligible impacts predicted from a release, the risk to the marine environment is considered low and the environmental risk of using and handling the required chemicals is considered acceptable. Preventative and mitigative controls reduce the potential for pollution, deteriorating water quality and/or habitat loss/degradation meaning the Activity will be conducted in a manner consistent with identified recovery plans and advice (**Table 3-7**).

7.5 Hazardous and Non-Hazardous Unplanned Discharges – Solid

7.5.1 Description of Event

Hazardous and non-hazardous (solid) release to the marine environment	
Aspect	Non-hazardous solid wastes (including paper, plastics and packaging) and hazardous solid wastes (such as batteries, fluorescent tubes, medical wastes, and aerosol cans) may be dropped unintentionally to the marine environment, potentially impacting on sensitive receptors. Release of these waste streams may occur as a result of overfull and/or uncovered bins, incorrectly disposed items or spills during transfers of waste. Dropped objects/lost equipment such as a SSS array could also result in seabed disturbance or floating obstacles but this type of equipment will be minimal in size. Other potential dropped objects could include the fenders that are on vessels, should this detach, it will remain buoyant, and potentially be a floating obstacle.
Extent	Localised as all non-buoyant waste material or dropped objects are expected to remain within the Operational Area. Buoyant waste material or dropped objects could potentially move beyond the Operational Area under wave action.
Duration	Temporary (duration of the Activity) or until the solid waste degrades or is retrieved.

7.5.2 Nature and Scale of Environmental Impacts

Non-hazardous solids such as plastics have the potential to smother benthic environments and harm marine fauna through entanglement or ingestion. Marine turtles and seabirds are particularly at risk from entanglement and marine turtles may mistake plastics for food. Once ingested, plastics can damage internal tissues and inhibit physiological processes (Nelms et al 2015), which can both potentially result in fatality. Marine debris has been highlighted as a threat to marine turtles, humpback whales and whale sharks in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a), Conservation Management Plan for the Blue Whale (Recovery Plan) (DotE, 2015), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) and Approved Conservation Advice for *Rhincodon typus* (whale shark). The Recovery Plans and Approved Conservation Advices have specified a number of recovery actions to help combat this threat. Of relevance to this activity is the legislation for the prevention of garbage disposal from vessels, which Santos implements through adherence to MARPOL.

Release of hazardous solids (e.g. wastes such as batteries) may result in the pollution of the immediate receiving environment, which may lead to impacts to marine flora and fauna. Physiological damage, through ingestion or absorption may occur to individual fish, sharks, cetaceans, marine reptiles or seabirds.

The area of potential disturbance due to a non-buoyant dropped object would be restricted to the Operational Area. The seabed within the Operational Area is primarily soft sediments with little epifauna; this habitat type is widely distributed and well represented in the NWS region (RPS, 2019b). The Operational

Area does not overlaps any key ecological features with the closest being the ancient coastline at the 125 m depth contour KEF, which is situated approximately 17 km to the north (RPS, 2019a). Although not expected to be present, damage to hard substrates and associated fauna may occur from a dropped object, however such impact is expected to be restricted to the size of the dropped object with overall impacts assessed as negligible. While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within them (i.e. the epifauna) may occur in the event of a dropped object and depressions may remain on the seabed for some time after removal of the dropped object as it gradually infills over time.

Impacts to socioeconomic receptors may occur if hazardous/ non-hazardous solids cause a safety hazard to other marine users or potentially damage their equipment (e.g. fishing nets).

In the unlikely event of damage to or loss of a SSS towed array (fish), potential environmental effects could be limited to physical impacts on benthic communities arising from the array and associated equipment sinking to the seabed.

7.5.3 Environmental Performance and Control Measures

Environmental Performance Outcomes relating to this hazard include:

+ EPO-7 – No unplanned seabed disturbance; and
+ EPO-8 – No unplanned objects, emissions or discharges to sea or air.

The control measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-42	Waste (garbage) management plan	Reduces probability of waste being discharged to sea, reducing potential impacts to marine fauna. Ensures food waste is discharged in manner that does not pose risk to the environment. Ensures compliance with Marine Orders (94 and 95) and MARPOL (Annex III and V) requirements as appropriate for vessel class.	Personnel cost of vessel audits and inspections, and in recording and reporting waste management.	**Adopted** – benefits of ensuring vessel is compliant outweighs the costs.
CM- 07	Dropped object prevention and recovery procedure.	Impacts to environment are reduced by preventing dropped object and by retrieving dropped objects where possible. Reduce potential for disturbance of seafloor features or limits exposure to the environment.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted** – benefits of ensuring procedures are followed and measures implemented outweighs the costs of personnel time.
CM-41	Equipment maintenance in accordance with PMS.	Ensures that lifting equipment is maintained and certified, and that lifting procedures are followed reducing probability of dropped objects occurring.	Additional personnel costs of ensuring equipment is maintained and certified as appropriate and that procedures in place and followed.	**Adopted** – Benefits of ensuring procedures are followed and equipment is compliant outweighs the minimal costs of personnel time.
CM-43	Equipment deployment/ retrieval procedure.	Reduced potential impacts to the marine environment due to equipment loss or damage.	Personnel costs involved in implementing procedures, maintaining logs / reporting and undertaking training.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweighs the costs of personnel time.
Additional control measures				
N/A	No lifting operations over environmental sensitivities.	Reduce potential for disturbance of seafloor features and associated communities potentially found.	Would require vessels to mobilise out of KEF for resupply. Seismic survey vessel may need to stop acquisition and therefore would lead to costly delays, prolonging the length of the Survey.	**Not Adopted** – Additional costs associated with prolonged survey duration are disproportionate to the minimal environmental benefit given the area potentially impacted in context of the entire KEF.

7.5.4 Impact, Consequence and Likelihood Ranking

Description	
Receptors	Physical environment/ habitat – benthic habitats Marine fauna – fish, sharks, marine mammals, marine reptiles, seabirds. Socio-economic receptors – other marine users (fisheries, shipping, oil and gas operators).
Consequence	A- Negligible
	Physical Environment – benthic habitats In the event of lost equipment/ dropped object, it is expected that it may result in localised damage to the seabed. The extent of the impact is limited to the size of the dropped object and given the size of standard materials transferred, any impact is expected to be very small. Surveys of previous seabed disturbances following rotary borehole sampling drilling activities indicate that recovery of benthic fauna in soft sediment substrates occurs between 6-12 months after the Activity ceases (URS, 2001), suggesting any impacts are short term in duration, and result in a negligible reduction in habitat area/function.
	Marine Fauna- cetaceans, marine turtles, seabirds, sharks and fish. In the event of a hazardous/ non-hazardous solid release, the quantities would be limited. This unplanned release could cause localised impacts to water quality and the benthic environment if the solid can degrade, which may lead to impacts on marine flora and fauna species. Solid wastes have the potential to result in fauna mortality or injury through ingestion or entanglement. Any impacts would be restricted to a small number of individuals in close proximity to the unplanned release. Small volumes of the solid waste stream would be generated during the Activity and with the management measures in place, any accidental loss to the environment would be small in size. Marine debris is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-7**). The controls implemented demonstrate that the Activity will be conducted in a manner that reduces marine debris and therefore potential impacts are reduced to ALARP and of an acceptable level. The limited quantities of accidental hazardous/ non-hazardous solid release associated with this event indicate that, in a worst-case release, fatalities would be limited to individuals and is not expected to result in a decrease of the local population size and the consequence level is therefore, negligible.
	Socio-economic – Interference from a buoyant object In the event of a release of a buoyant object that cannot be recovered, it could present an obstacle to other marine users. Eventually the buoyant object may become non-buoyant and sink to the seabed where it may degrade over time. The time taken for this is dependent on the material released and any impacts to marine fauna and the seabed are described above. This may present a risk to commercial trawling activities and damage their equipment, so fishers may be required to avoid a highly localised area to avoid interaction. Given the likely size of buoyant equipment (i.e. storage drum), it will drift with the currents. It is considered unlikely to present a significant hazard to other marine users and the consequence level is therefore negligible.
Likelihood	2 – Very Unlikely
	A set of control measures and checks have been proposed to ensure that the risks of dropped objects, lost equipment or release of hazardous/ non-hazardous solid waste to the environment has been minimized. The likelihood of transient marine fauna occurring in the Operational Area is limited and given the controls in place, the likelihood of releasing hazardous and non-hazardous solids to the environment resulting in a negligible consequence is considered very unlikely (assumes potential for a single loss of solid waste incident during the Activity).
Residual Risk	The residual risk associated with this hazard is Low (A2)

7.5.5 ALARP Evaluation

Hazardous/ non-hazardous solid waste will be generated during the Activity and managed through the proposed control measures. Equipment loss and dropped objects, which might occur during vessel to vessel transfers in the field will be managed through transfer procedures and equipment management. The control measures proposed are considered sufficient to reduce the risk of hazardous/ non-hazardous solid releases to a level that is ALARP. Additional controls were considered but not adopted as detailed in **Section 7.5.3.** The implementation of these control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

7.5.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – hazardous/ non-hazardous solid release residual risk is ranked Low.
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with MARPOL Annex V. Controls implemented will minimise the potential impacts from the Activity to species identified in relevant Recovery Plans and Approved Conservation Advice (**Table 3-7**) as having the potential to be impacted by marine debris (solid hazardous/ non-hazardous releases).
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

With the controls in place to prevent accidental release of hazardous/ non-hazardous solid waste or a dropped object, and the negligible impacts predicted, the risk to the marine environment is considered low and reduced to a level that is considered acceptable. The Activity undertaken with the controls, will be conducted in a manner that is acceptable under the relevant Recovery Plans and Approved Conservation Advice to prevent accidental release of hazardous/ non-hazardous solid (marine debris) (**Table 3-7**).

7.6 Marine Fauna Interactions

7.6.1 Description of Event

Vessels and/or equipment colliding with marine fauna	
Aspect	There is the potential for vessels, helicopters and/or equipment involved in the Activity to interact with marine fauna (e.g. cetaceans, fish, sharks, marine reptiles and seabirds) including potential strike or collision, which may result in severe injury or mortality.
Extent	Within the Operational Area, in the immediate vicinity of the survey, helicopters and/or support vessel.
Duration	For the duration of the Activity, as described in **Section 2**.

7.6.2 Nature and Scale of Environmental Impacts

Cetaceans are naturally inquisitive marine mammals that are often attracted to vessels underway; for example, dolphins commonly ‘bow ride’ with vessels.

Marine fauna in surface waters that would be most at risk from vessel collision include marine mammals, marine turtles and whale sharks. As summarised in **Section 3.2.3**, the Operational Area overlaps with the whale shark foraging BIA and the pygmy blue whale distribution BIA. However, there are no turtle BIAs within the Operational Area. The worst potential impact from vessel collision would be mortality or serious injury of an individual.

Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously (WDCS, 2006). There has been recorded instances of cetacean deaths as a result of vessel collisions in Australian waters (e.g. a Bryde’s whale in the Bass Strait in 1992) (WDCS, 2006), though the data indicates this is likely to be associated with container ships and fast ferries. Whale and Dolphin Conservation Society (WDCS) (2006) also indicates that some cetacean species, such as humpback whales, can detect and change course in order to avoid a vessel. A recent review of vessel whale strike data identified up to 137 potential strikes in Australian waters from 1840 to 2015 (Peel *et al*. 2018).

Pygmy blue whales may be encountered as the Operational Area is situated within the pygmy blue distribution BIA, however it occupies a tiny fraction of 0.006% (100 km^2/1,733,492 km^2). The National Conservation Values Atlas has identified the pygmy whale migration pathway on the continental shelf edge at depth of 500 to 1,000 m (McCauley & Jenner 2010) much deeper than the water depths of the Operational Area. Migrating individuals are not expected to traverse the Operational Area in large numbers. Breeding areas have not yet been identified; however, it is likely that pygmy blue whales calve in tropical areas of high localised production such as deep offshore waters of the Banda and Molucca seas in Indonesia (Double *et al*. 2012). There are no known breeding areas of significance to pygmy blue whales in waters from Busselton to the Northern Territory border.

The most commonly sighted whale in continental shelf waters of the region is the humpback whale. Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) indicates that humpback whales are one of the most frequently reported whale species involved in vessel strikes worldwide (Laist *et al*., 2001). The increase in vessel numbers (Silber & and Bettridge 2012) is not only a threat to humpback whales in relation to vessel strikes but also in disturbance and displacement from key habitats. Similarly, boat strike is also recognised by the Approved Conservation Advice for whale sharks as one of the threats to their recovery, as well as the Conservation Management Plan (Recovery Plan) for the blue whale (DotE, 2015).

As described in *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**), the humpback whale migrates between calving grounds in the Kimberley region of WA to feeding grounds in Antarctica; with the northbound migration from early June to early August (BHPB, 2005), and the peak of the northbound migration between Exmouth Gulf and the Dampier Archipelago occurring around July, concentrated inshore of the 200 m depth contour (Jenner *et al.*, 2001). The southern migration, which peaks around early September, with pods travelling in shallower waters, typically at 30–100 m and passing to the west of Barrow Island and north of the Montebello islands. However, the Operational Area is not within the humpback whale migration BIA which is situated approximately 20 km to the south.

Whilst the control measures outlined in **Section 6.2** will prevent the Activity occurring in the peak humpback whale migration season, individual humpback and pygmy blue whales may pass through the Operational Area. The reaction of whales to the approach of a vessel is quite variable. Some species remain motionless when in the vicinity of a vessel while others are known to be curious and often approach vessels that have stopped or are slow moving, although they generally do not approach, and sometimes avoid, faster moving ships (Richardson *et al*., 1995).

Given the Operational Area overlaps with whale shark foraging BIA (**Section 3.2.3**), individuals may be encountered during the activities following peak aggregation (May-June) at Ningaloo Reef. However, given the vast distance from the Operational Area to Ningaloo Reef (approximately 550 km), post aggregating individuals are likely to have widely dispersed reducing the expectation of large numbers of whale shark encounters in the Operational Area.

Dugongs are prone to vessel collision since they spend a large proportion of time at the sea surface. However, dugong distribution is correlated with presence of seagrass habitat, which is highly unlikely to occur in the Operational Area due to the water depths and lack of seagrass within the Operational Area (RPS, 2019a). As such, dugong-vessel encounters are expected to be a rare occurrence.

Marine turtle mortality due to boat strike has been identified as an issue in Queensland waters in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a). However, turtles appear to be more vulnerable to boat strike in areas of high urban population where incidents of pleasure crafts are higher. WA turtle populations have not been highlighted as those most affected by boat strike, possibly due to the relatively low human population density of the NWS Pilbara coastline. It is possible that individual flatback turtles may be encountered in the Operational Area. However, given the depth of water, lack of suitable habitat and distance to the shorelines, large numbers of turtle encounters are not expected.

A number of protected species of marine birds have potential habitats or migratory routes in and around the Operational Area (**Section 3.2.3**). BIAs for threatened or migratory bird species. Helicopter flights may be required to support the survey overlap with the Operational Area. Helicopter flights will occur in daylight, thereby enabling visual monitoring to reduce potential interactions with birds. The risk of helicopter strike is not high because helicopter noise is expected to elicit a behavioural response in birds to avoid collision and because of the relatively low speeds at which helicopters would be flying during take-off or landing.

Vessels will be moving at slow speeds in the Operational Area, reducing the likelihood that a collision between the survey vessel and marine fauna will occur, and, should a collision occur, that it would result in serious injury.

7.6.3 Environmental Performance and Control Measures

Environmental Performance Outcomes relating to this hazard include:

+ EPO-9 – No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed marine fauna during activities.

The Control Measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-13	Procedures for interacting with marine fauna	Reduces the risk of physical and behavioural impacts to marine fauna from vessels. If any marine fauna sightings are made during transit vessels can reduce speed, or alter course.	Operational costs to adhere to marine fauna interaction restrictions, such as vessel speed and direction are based on legislated requirements and must be accepted.	**Adopted** – benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos.
Additional control measures				
CM-14	Constant bridge watch on survey vessel.	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost- industry practise	**Adopted** – industry practise, benefits outweigh cost.
N/A	Restrict the timing of activities to operate outside of sensitive marine fauna periods only	Reduce risk of collisions (causing harm) during environmentally sensitive periods listed marine fauna.	Protected Marine Fauna species are present all year round meaning there are no non-sensitive periods to operate in.	**Not Adopted-** Grossly disproportionate to the environmental benefit and would severely limit operations which are required to occur 24 hours a day, 7 days a week.
N/A	No night-time / low visibility operations.	Eliminate / reduce likelihood and consequence of impact.	Lengthens time of survey as operations only occur for approximately 10 hours/day. Increase cost due to increased survey time (more than double cost).	**Not Adopted** – cost outweighs the environmental benefit given the low numbers of marine fauna which may be in the area.
N/A	Dedicated MFO on survey vessel	Improved ability to spot and identify marine fauna at risk of collision (that may cause harm).	Additional cost of contracting a MFO.	**Not adopted-** Risk of animals being countered is too low to justify additional cost of MFO. The cost is disproportionate to the environmental benefit.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Spotter planes / vessels sent ahead to planned night-time Operational Area.	Eliminate / reduce likelihood and consequence of impact.	Cost of specialist aircraft with good downward visibility, or cost of an additional spotter vessel additional MFO's required on aboard aircraft/vessels. Additional risks to environment through use of vessels/airplanes, increased safety risks to personnel on board additional vessels.	**Not Adopted** – based on cost outweighing benefits given negligible consequence.

7.6.4 Impact, Consequence and Likelihood Ranking

Description	
Receptors	Marine fauna – Fish and sharks, cetaceans, marine reptiles
Consequence	A –Negligible
	In the event of a collision with marine fauna, there is the potential for injury or death to an individual. The receptors present in the Operational Area are expected to be limited to a small number of transient individuals. Boat strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Approved Conservation Advice (**Table 3-7**). The information above demonstrates the Activity will be conducted in a manner that reduces potential impacts to ALARP and of an acceptable level. In addition, all vessel strikes will be reported by Santos in the National Ship Strike Database. There is the potential for death or injury of EPBC listed individual species, however as they would represent a small proportion of the local population it is not expected that it would result in a decreased population size over what would usually occur due to natural variation at a local or regional scale. In addition, given the vessels will be moving slowly or remain stationary for extended periods during the Activity. It is expected that a collision with an individual would result in a minor injury only if moving or no injury at all if stationary. Overall, the consequence of a striking an individual marine fauna is not expected to decrease the local population size and therefore is assessed as negligible.
Likelihood	2 – Very Unlikely
	Marine fauna interaction is considered very unlikely given the small Operational Area and short timeframe, slow moving vessels (typically <5 knots), open ocean environment and the ability for fauna to move away. The Australian National Marine Safety Committee (NMSC) reports that during 2009, there was one report of a vessel collision with a marine animal (species not defined) (NMSC, 2010). No known marine fauna aggregation areas occur within the Operational Area and therefore concentrations of milling individuals are unlikely. Consequently, the likelihood of a collision with marine fauna resulting in a minor consequence is considered to be **very unlikely**.
Residual Risk	The residual risk associated with this hazard is Low (A2)

7.6.5 ALARP Evaluation

No alternative options to the use of vessels and towed equipment for the Activity are possible in order to meet the technical objectives of the Activity. If the control measures are adhered to then the risk of marine fauna collisions will be reduced to ALARP.

The assessed residual risk for this impact is low. Additional controls were identified and some have been adopted, as detailed in **Section 7.6.3**. The implementation of these control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

7.6.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – maximum marine fauna collisions residual risk ranking is Low.
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks well understood through the information available.

Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with Part 8 of the EPBC Regulations. Controls implemented will minimise the potential impacts from the Activity to species identified in relevant Recovery Plans and Approved Conservation Advice as having the potential to be impacted by vessel strike.
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

Application of the proposed management and adherence to Commonwealth regulations are in line with relevant actions prescribed in the Recovery Plan and Approved Conservation Advice and reduces the likelihood of vessel interactions with marine fauna. While the potential exists for a collision with marine fauna to occur, it is considered a very unlikely scenario. Vessels will be moving slowly or be stationary for extended periods of time within the Operational Area, thus reducing the likelihood of a fauna strike. In the unlikely event that an impact did occur, it would be highly probable that only a single individual would be contacted. Given the rare likelihood of a collision occurring coupled with the potential impact limited to a single individual the risk is considered acceptable.

7.7 Introduction of Invasive Marine Species

7.7.1 Description of Event

Introduction of Invasive Marine Species	
Aspect	Introduction of invasive marine species (IMS) may occur due to: • Biofouling on vessels and external/internal niches (e.g. sea chests, seawater systems etc) • Biofouling on equipment that is routinely submerged in water (e.g. survey equipment). Once established, IMS have the potential to out-compete indigenous species and affect overall native ecosystem function.
Extent	Localised (seabed and water column near the Operational Area) to widespread, if successfully translocated to new areas via ocean currents or survey equipment transit.
Duration	Temporary (duration of the Activity) to long-term (in the event of successful translocation).

7.7.2 Nature and Scale of Environmental Impacts

IMS are marine plants, animals and algae that have been introduced into a region that is beyond their natural range but have the ability to survive, and possibly thrive (DAFF, 2011). The majority of IMS that are climatically compatible with conditions in NWS waters are found in south-east Asian countries.

Some IMS pose a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (Wells *et al*. 2009). IMS can cause a variety of adverse effects in a receiving environment, including:

+ over-predation of native flora and fauna;
+ out-competing of native flora and fauna for food;
+ human illness through released toxins;
+ depletion of viable fishing areas and aquaculture stock;
+ reduction of coastal aesthetics; and
+ damage to marine and industrial equipment and infrastructure.

Species of concern are those that are not native to the region; are likely to survive and establish in the region and are able to spread by human mediated or natural means. Species of concern vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities.

It is recognised that artificial, disturbed and/or polluted habitats in tropical regions are susceptible to introductions which is why ports are often areas of higher IMS risk (Neil *et al*. 2005).

Following their establishment, eradication of IMS populations is difficult, limiting management options to ongoing control or impact minimisation. Eradication is dependent on the environmental conditions and species. For this reason, increased management requirements have been implemented in recent years by Commonwealth and State regulatory agencies.

Ballast water exchange and biofouling on vessel hulls and other external niche areas, internal niches, and on equipment routinely immersed in water all pose a potential risk of introducing IMS into Australia. The potential biofouling risk presented by the vessels will relate to the length of time that the vessel has already been operating in Australian waters or, if they have been operating outside of Australian waters, the location/s of the operations it has been undertaking, the length of time spent at these location/s, and whether the vessel has undergone hull inspections, cleaning and application of new anti-foulant coating prior to returning to operate in Australia.

7.7.3 Environmental Performance and Control Measures

Environmental Performance Outcomes relating to this hazard include:

+ EPO-2 – No introduction of marine pest species.

The control measures considered for this Activity are shown below; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Section 8.3**.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-44	Invasive Marine Species Management Plan	The risk of introducing IMS is reduced through implementation of IMS risk assessment.	Personnel costs involved in risk assessing vessels in accordance with Invasive Marine Species Management Plan (IMSMP). Costs associated with reducing the vessel risk to 'low' e.g. dry docking, hull cleaning or additional costs due to inspections could lead to potential delays and therefore costs in vessel contracting process due to availability of vessels.	**Adopted** – Minimal personnel costs and potential delays or costs to the Activity are considered outweighed by the benefits of reducing the risk of IMS.
CM-45	Anti-foulant system.	The risk of introducing IMS is reduced due to an anti-foulant systems.	Could lead to potential delays and therefore costs, in vessel contracting process due to availability of vessel with appropriate anti-foulant systems.	**Adopted** – Potential delays or costs to Activity are considered to outweigh the benefits of reducing the risk of IMS.
CM-46	Ballast water management plan.	Reduces the risk of introducing IMS through procedures managing ballast water exchange and identifying high risk ballast water.	Personnel costs in producing and implementing ballast water management plan and in maintaining record books and logs.	**Adopted** – Potential costs are considered outweighed by the benefits of reducing the risk of IMS.
Additional control measures				
N/A	Contract vessels only operating in local state waters to reduce potential for IMS.	Eliminate likelihood of invasive marine species from interstate or international waters.	Appropriate survey vessels required for the Activity are not currently working in Western Australian (or Australian) waters. The survey objectives would not be met if vessel selection was restricted to those operating in only Australian waters.	**Not Adopted** – not feasible to restrict selection of vessels due to availability.
N/A	Mandatory dry docking prior to entering field to clean vessel and/or equipment and remove biofouling.	Eliminate invasive marine species.	Significant cost for this to occur and would lead to scheduling delays.	**Not Adopted** – Costs disproportionately high compared to environmental benefit given other controls in place already reduce the risk. Cost outweighs benefit.
N/A	Mandatory independent IMS survey.	Eliminate invasive marine species.	Cost is high compared to existing risk.	**Not Adopted** – Based on cost outweighing risk.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Pre-mobilisation chemical dosage of ballast water to eliminate IMS.	Would reduce potential for IMS to establish by eliminating individuals present in ballast water.	High cost compared to existing risk; introduction of additional chemical to the marine environment which would likely be toxic to native marine species.	**Not Adopted** – Based on risk to marine environment from release of chemicals and high cost considered disproportionate compared to base case risk.
N/A	Heat treatment of ballast water to eliminate IMS.	Would reduce potential for IMS to establish by eliminating individuals present in ballast water.	High cost compared to existing risk; introduction of water at much higher temperature than surrounding marine environment would likely result in death of native marine species.	**Not Adopted** – based on increased risk to marine environment compared to base case risk.
N/A	Utilise an alternative ballast system to avoid uptake/discharge of water.	Eliminate need for ballast water exchange therefore decreasing risk of introducing IMS through ballast water.	Vessels suitable for the Activity may not have options for alternative ballast therefore would require modification at significant cost.	**Not Adopted** – Cost outweighs benefit.

7.7.4 Impact, Consequence and Likelihood Ranking

Description	
Receptors	Threatened, migratory, and local fauna; Physical environment and habitats; Socio-economic receptors.
Consequence	C – Moderate
	Ballast water is responsible for up to 30% of all IMS incursions into Australian waters, however, research indicates that biofouling (the accumulation of aquatic micro-organisms, algae, plants and animals on vessel hulls and submerged surfaces) has been responsible for more foreign marine introductions than ballast water (DAWR 2017). IMS, if they successfully establish, can out-compete native species for food or space, preying on native species or changing the nature of the environment and can subsequently impact on fisheries or aquaculture. If an IMS is introduced, they have been known to colonise areas outside of the areas they are introduced to. In the event that an IMS is introduced into the Operational Area, given the lack of diversity and extensiveness of similar benthic habitat in the region, there would only be a minor reduction in the physical environment. The overall consequence level was assessed as **moderate**.
Likelihood	1 – Rare
	The pathways for IMS introductions are well known, and consequently standard preventative measures are proposed. The ability for invasive marine species to colonise a habitat is dependent on a number of environmental conditions. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than open water environments where the number of dilutions and the degree of dispersal are high (Paulay *et al*. 2002). Given the deeper water depths (86–94 m), within the Operational Area the likelihood that an IMS would be able to successfully translocate from the Operational Area to surrounding shallower habitats is reduced. With controls in place to reduce the risk of introduction of IMS the likelihood of introducing an IMS is considered **rare**.
Residual Risk	The residual risk associated with this hazard is Low

7.7.5 ALARP Evaluation

The proposed management controls for IMS are considered appropriate to manage the risk of IMS introduction in this case and bring the chance of IMS introduction to ALARP.

Ballast water exchange will be managed in accordance with the IMSMP and legislative requirements, to demonstrate vessels are low risk so that IMS is not introduced into Western Australian waters.

Santos WA has adopted a risk-based approach to managing biofouling given it is not practicable or reasonable to inspect and/or clean every vessel before each voyage. Such an approach is consistent with other petroleum operators on the NWS and is beyond that enforced on the majority of commercial and recreation vessels that regularly transit the same bioregion. International vessels are given the highest priority to prevent the introduction of marine pest species into Australian waters. However, domestic vessels (interstate and locally sourced) are also risk-assessed to reduce the likelihood of spreading marine pest species already established in Australian waters. Through the biofouling risk assessment approach, Santos WA is confident that the *Fish Resources Management Act 1994* and associated regulations prohibiting the introduction of non-endemic fish species will be met.

Additional controls were identified and considered but not adopted as detailed in **Section 7.7.3.** The implementation of these control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. The proposed control measures are considered appropriate to manage the risk to ALARP.

7.7.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – introduction of invasive marine species residual risk ranking is Low.
Is further information required to support or validate the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with *Biosecurity Act* (2015) and National Biofouling Guidance for the Petroleum Industry.
Are control measures and performance standards consistent with the Santos Environmental Management Policy?	Yes – Aligns with the Environmental Management Policy.
Are performance outcomes and standards consistent with stakeholder expectations?	Yes – No concerns raised.
Are control measures and performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP evaluation above).

All vessels and in-sea equipment that are internationally mobilised will meet the requirements of the Santos IMSMP which addresses all applicable State and Commonwealth regulatory requirements. Application of the proposed management and adherence to regulations reduces the likelihood of introducing IMS into the Operational Area. While the potential exists for IMS to be translocated to the area, with the application of rigorous preventative measures and controls, the risk is deemed acceptable in this case.

8. Implementation Strategy

OPGGS€R 2009 Requirements
Regulation 14(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.

P(SL) € Regs 2012 Requirements
Regulation 15(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.

In accordance with Regulation 14(1) of the OPGGS 2009 Regulations, this section provides details on this EP's implementation strategy. The specific measures and arrangements that will be implemented in the event of an oil pollution emergency are detailed in the OPEP.

Ongoing stakeholder management strategies are detailed in **Section 4**.

8.1 Environmental Management System

OPGGS€R 2009 Requirements
Regulation 14(3)
The implementation strategy must contain a description of the environmental management system for the activity, including specific measures to be used to ensure that, for the duration of the activity: a) the environmental impacts and risks of the activity continue to be identified and reduced to a level that is as low as reasonably practicable; and b) control measures detailed in the environment plan are effective in reducing the environmental impacts and risks of the activity to as low as reasonably practicable and an acceptable level; and c) environmental performance outcomes and standards set out in the environment plan are being met.

P(SL) € Regs 2012 Requirements
Regulation 15(3)
The implementation strategy must identify the specific systems, practices and procedures to be used to ensure that: a) The environmental impacts and environmental risks of the petroleum activity are continuously reduced to as low as is reasonably practicable; and b) The environmental performance objectives and environmental performance standards in the environment plan are met.

The Santos WA management system exists to support its moral, professional and legal obligations to undertake work in a manner that does not cause harm to people or the environment. The management system is a framework of policies, standards, processes, procedures, tools and control measures that, when used together by a properly resourced and competent organisation, ensure that:

- A common HSE approach is followed across the organisation;
- HSE is proactively managed and maintained;
- The mandatory requirements of HSE management are implemented and are auditable;
- HSE management performance is measured and corrective actions are taken;
- Opportunities for improvement are recognised and implemented; and

- Workforce commitments are understood and demonstrated.

The implementation strategy is designed to meet the requirements of the EP to ensure that:

- Environmental impacts and risks continue to be identified for the duration of the activity and reduced to ALARP;
- Control measures are effective in reducing environmental impacts and risks to ALARP and acceptable levels;
- Environmental performance outcomes and standards set out in this EP are met; and
- Stakeholder consultation is maintained throughout the activity as appropriate.

8.2 Environmental Management Policy

The Environmental Management Policy (**Figure 1-1**) clearly sets out Santos WA's strategic environmental objectives and the commitment of the management team to continuous environmental performance. This EP has been prepared in accordance with the fundamentals of this policy. By accepting employment with Santos WA, each employee and contractor is made aware that he/she is responsible for the application of this policy.

8.3 Hazard Identification, Risk and Impact Assessment and Controls

Hazards and associated environmental risks and impacts for the proposed activities have been systematically identified and assessed in this EP (refer to **Sections 6** and **7**). The control measures and environmental performance standards that will be implemented to manage the identified risks and impacts, and the environmental performance outcomes that will be achieved, are detailed in **Section** Environmental Performance Outcomes**8.3.1**.

To ensure that environmental risks and impacts remain ALARP and of an acceptable level during the Activity and for the duration of this EP, hazards will continue to be identified, assessed and controlled as described in Operations Management (**Section 8.8**) and Reviews, Audits and Inspections (**Section 8.15**).

Any new, or proposed amendment to a control measure or environmental performance standard or outcome will be managed in accordance with the Management of Change (MoC) procedure (**Section 8.9**).

Oil spill response control measures and environmental performance standards and outcomes are listed in the OPEP.

8.3.1 Environmental Performance Outcomes

To ensure environmental risks and impacts will be of an acceptable level, environmental performance outcomes have been defined and are listed in **Table 8-1**. These outcomes will be achieved by implementing the identified control measures to the defined performance standards.

Table 8-1: Environmental performance outcomes

Reference	Environmental Performance Outcomes
EPO-1	Reduce impacts on other marine users through the provision of information to relevant stakeholders such that they are able to plan for their activities and avoid unexpected interference.
EPO-2	No introduction of marine pest species.
EPO-3	Discharges to sea meet legislated permissible discharge requirements.
EPO-4	Emissions to air meet legislated requirements.
EPO-5	Reduce impacts to air quality from planned emissions associated with the Activity.
EPO-6	Reduce impacts to marine fauna from vessel lighting by reducing lighting to that required by safety and navigational lighting requirements.
EPO-7	No unplanned seabed disturbance.
EPO-8	No unplanned objects, emissions or discharges to sea or air.
EPO-9	No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed marine fauna during activities.
EPO-10	No loss of containment of hydrocarbon to the marine environment.

8.3.2 Control Measures and Performance Standards

OPGGS(E)R 2009 Requirements
Regulation 14(3)
The environment plan must - a) set environmental performance standards for the control measures identified under paragraph (5)(c); b) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured; and c) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

P(SL) (E) Regs 2012 Requirements
Regulation 15(3)
The environment plan must include – a) environmental performance standards — i. that state the performance required of persons, equipment and procedures for the purposes of managing the environmental impacts and environmental risks of the petroleum activity; and ii. against which the performance of the operator in meeting the environmental performance objectives in the environment plan, can be measured; a) measurement criteria for the purposes of determining whether — i. the environmental performance objectives and environmental performance standards in the environment plan have been met; and ii. the implementation strategy in the environment plan has been complied with.

The control measures that will be used to manage identified environmental impacts and risks, and the associated statements of performance required of the control measure (i.e. environmental performance standards) are listed in **Table 8-2.** Criteria outlining how compliance with the control measure, and the expected environmental performance, could be evidenced are also listed. A separate set of performance standards based on the oil spill response operational control measures are included in the OPEP.

In the event of any discrepancies between the control measures listed in **Table 8-2** and the remainder of this EP, the control measures in **Table 8-2** shall prevail.

Table 8-2: Control measures and environmental performance standards for the proposed Activity

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
CM-01	Maritime Notices	A notification will be provided prior to vessel arrival in the Operational Area to AMSA's RCC (minimum two days prior), AHO (minimum four weeks prior) and other relevant Authorities (minimum one week prior), and following vessel departure (within one week), so the maritime industry is aware of petroleum activities.	CM-01-EPS-01	Notice to stakeholders.	EPO-1 EPO-10	6.1, 7.1
CM-02	Stakeholder consultation.	Relevant persons for the Activity identified in **Table 8-3** are provided a commencement notification at least two weeks prior to the Activity commencing and on cessation of the Activity.	CM-02-EPS-02	Stakeholder database.	EPO-1 EPO-10	6.1, 7.1
		All correspondence with external stakeholders is recorded by Santos.	CM-02-EPS-02	Stakeholder database.		
		Santos Consultation Coordinator remains available before, during and after the Activity to ensure stakeholder feedback is evaluated and considered during the operational Activity stages.	CM-02-EPS-03	Consultation Coordinator contact details provided to relevant persons in all correspondence.		
CM-03	Exclusion zone (safety) established to reduce potential for collision or interference with other marine user activities.	A 500 m exclusion zone is defined around the survey vessel during data collection.	CM-03-EPS-01	Notice to Mariners' placed with AHO outlining the exclusion zone and timeframe for the Activity.	EPO-1 EPO-4 EPO-10	6.1, 7.1
CM-04	Avoid others active marine users, where safe to do so.	Vessel dynamic positioning routinely maintained as per manufacture specifications.	CM-04-EPS-01	Vessel PMS schedule and maintenance records.	EPO-1	6.1
		Vessels transiting to and from the Operational Area will avoid commercial vessels that are actively fishing.	CM-04-EPS-02	Vessel Master operating procedure.		
CM-05	Project vessels recreational fishing restrictions.	Survey vessel will be prohibited from recreational fishing within the Operational Area.	CM-06-EPS-01	Incident report.	EPO-1	6.1

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
CM-06	Appropriate Seafarer Competency and Certification	Vessel masters will have qualification and certifications required for their role to demonstrate competence.	CM-07-EPS-01	Training register and personnel CVs.	EPO-3 EPO-4 EPO-8 EPO-10	7.1
CM-07	Dropped object prevention and recovery procedure.	Vessels lifting procedures include the following control measures to reduce the risk of objects entering the marine environment: • Lifting equipment certification and inspection. • Lifting crew competencies. • Preventative maintenance on cranes.	CM-08-EPS-01	Completed inspection checklist.	EPO-3 EPO-8 EPO-10	6.2, 7.1, 7.4, 7.5
		Objects dropped overboard are recovered (where possible) to mitigate the environmental consequences from objects remaining in the marine environment, unless the environmental consequences are negligible, or safety risks are disproportionate to the environmental consequences.	CM-08-EPS-02	Fate of dropped objects detailed in incident documents.		
		Material handling and lifting equipment and remediation equipment maintained in accordance with the PMS.	CM-08-EPS-03	Vessel PMS schedule and maintenance records.		
		Lifting equipment maintained and certified.	CM-08-EPS-04	Lifting equipment certification valid and current.		
CM-08	Standard geotechnical survey data collection procedure implemented.	Equipment will be placed on the seabed only at Santos WA pre-approved locations.	CM-09-EPS-01	Data collection reports.	EPO-3 EPO-8	6.2
CM-09	Vessels use dynamic positioning to maintain location, unless anchoring is required for safety reasons.	Vessels will either be moving or will use dynamic positioning to maintain location, unless anchoring is required for safety reasons.	CM-10-EPS-01	Vessel daily reports.	EPO-3 EPO-8	6.2
CM-10	Consider pre-existing geophysical data in sample target location identification.	Where possible, geophysical investigations will be conducted prior to geotechnical data collections, so to	CM-11-EPS-01	Geophysical and geotechnical data collection reports.	EPO-3	6.2

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
		ensure Santos WA pre-approved geotechnical data collection locations may avoid seabed locations with potential environmental sensitivities (i.e. locations of uneven seabed).			EPO-8	
CM-11	ROV operating procedure.	Where required, ROV operations will be conducted as per approved ROV data collection procedure.	CM-12-EPS-01	ROV operating procedure.	EPO-3 EPO-8	6.2
				ROV dive reports.		
CM-12	Lighting will be used as required for safe navigation and operations.	Minimum lighting required for safe navigation and operations, so to comply with International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and SOLAS/AMSA Marine Orders.	CM-13-EPS-01	Audit report.	EPO-8	6.3
CM-13	Procedures for interacting with marine fauna	Vessels (and where relevant helicopters) comply with Santos Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003) which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 which includes controls for minimising the risk of collision with marine fauna including: all vessels must travel at less than 6 knots within the caution zone of a cetacean (150 m radius for dolphins, 300 m for whales) known to be in the area.	CM-15-EPS-01	Vessel and helicopter contractor procedures align with Part 8 of EPBC Regulations.	EPO-6 EPO-9	6.4, 7.6
			CM-15-EPS-02	Records of breaches of the requirements outlined in Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003), reported via Monthly Recordable Incident Report and Environmental Performance Report.		
				Vessel Statement of conformance.		
		Santos WA will complete a project kick-off meeting with the vessel and helicopter contractor. The meeting will outline the key environmental risks and impacts, Vessel Master/helicopter captain/ crew roles responsibilities and control measures to be complied with for the duration of the	CM-15-EPS-03	Kick off meeting register		

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
		Activity as described in this EP. The contractor is responsible to demonstrate that all the vessel crew are aware of their roles and responsibilities as well as these key environmental risks, impacts and controls prior to commencing the Activity.				
		Any vessel strikes with cetaceans will be reported in the National Ship Strike Database.	CM-15-EPS-04	Conformance checked on receipt of incident report.		
				Induction material and induction attendance/completion records		
CM-14	Constant bridge watch on survey vessel.	At least one person on bridge watch is trained in Marine fauna observation during surveying activities.	CM-18-EPS-01	Training register and/or inductions	EPO-9	6.4, 7.6
CM-15	Constant bridge watch	Competent crew shall maintain constant bridge-watch.	CM-19-EPS-01	Vessel log of times and persons on watch.	EPO-1 EPO-8 EPO-3 EPO-10	6.1, 7.1
				Crew training records and completed vessel statement of conformance.		
		A visual and radar watch will be maintained on the vessel bridge at all times	CM-19-EPS-02	Vessel log of times and persons on watch.		
CM-16	Air pollution prevention certification as per MARPOL Annex VI.	Pursuant to MARPOL Annex VI, vessel will maintain a current IAPP Certificate or equivalent which confirms that measures to prevent ozone-depleting substance (ODS) emissions, and reduce NOx, SOx and incineration emissions during the Activity.	CM-20-EPS-01	Current IAPP certificate or equivalent.	EPO-8 PO-12	6.5
CM-17	Compliance with Marine Order 97: Marine Pollution Prevent – Air Pollution (Division 7).	Vessels will comply with Marine Order 97: Marine Pollution Prevent – Air Pollution (Division 7), specifically: • Fuel use will be measured, recorded and reported • Vessels will use low sulphur fuel (0.5% m/m sulfur content on and after 1 Jan 2020)	CM-21-EPS-02	Bunker notes.	EPO-8	6.5

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
CM-18	All vessel engines to be maintained in accordance with vessel class requirements.	Documented maintenance program is in place for equipment on vessels, that provides a status on the maintenance of equipment.	CM-22-EPS-01	PMS schedule and maintenance records.	EPO-4 EPO-8 EPO-9	6.5
CM-19	Ozone-depleting substances (ODS) handling procedures as per MARPOL Annex VI.	ODS managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air. Includes maintenance of ODS record book, where rechargeable systems containing ODS are recharged or repaired.	CM-23-EPS-01	Completed ODS record book or recording system.	EPO-4 EPO-8 EPO-9	6.5
CM-20	Waste incineration managed in accordance with MARPOL Annex VI and Marine Order 97 as appropriate.	Waste incineration managed in accordance with MARPOL Annex VI.	CM-24-EPS-01	Completed waste record book or recording system.	EPO-7 EPO-9	6.5
CM-21	Sewage treatment system (STP)	Pursuant to MARPOL Annex IV, vessel has a current International Sewage Pollution Prevention (ISPP) Certificate or equivalent which confirms that required measures to reduce impacts from sewage disposal are in place.	CM-25-EPS-01	Current ISPP certificate or equivalent	EPO-3 EPO-8	6.6
		Sewage discharged in accordance with MARPOL Annex IV-Sewage. Whereby discharge of sewage is prohibited except when the ship has in operation an approved sewage treatment plant; is discharging comminuted (or macerated) and disinfected sewage at a distance of more than 3 nm from the nearest land; or is discharging untreated sewage from a holding tank at a prescribed rate and at a distance of more than 12 nm from the nearest land.	CM-25-EPS-02	Completed inspection checklist		
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	CM-25-EPS-03	Maintenance records		
		Specified sewage holding tank will be sized appropriately to contain all vessel generated waste (black, grey water and	CM-25-EPS-04	Written confirmation from vessel contractor of		

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
		putrescible). Vessel number of persons on board (POB) will not exceed STP carrying capacity.		appropriateness of STP capacity / sewage holding tank.		
CM-22	Chemical Selection Process	Chemical products with potential to be released to the sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through OCNS; or have a completed Santos ecotoxicological risk assessment so that only environmentally acceptable products are used.	CM-26-EPS-01	Approved chemical product selection Evaluation	EPO-5 EPO-8	6.7, 6.8, 6.9
			CM-26-EPS-02	Chemical Selection Process Procedure		
CM-23	Oily water treatment system (OWTS)	Oily mixtures only discharged to sea in accordance with MARPOL Annex I.	CM-27-EPS-01	Completed inspection checklist	EPO-3 EPO-5 EPO-8	6.8
				Oil record book.		
		Preventative maintenance on oil filtering equipment completed as scheduled.	CM-27-EPS-02	Maintenance records or evidence of maintenance in operational reports		
		Pursuant to MAPROL Annex I, as relevant to class, vessel will have an International Oil Pollution Prevention (IOPP) Certificate which confirms that required measures to reduce impacts of planned oil discharges are in place.	CM-27-EPS-03	Current IOPP certificate or equivalent		
CM-24	Deck cleaning and product selection	Deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through OCNS; or have a completed Santos ecotoxicological risk assessment so that only environmentally acceptable products are used.	CM-28-EPS-01	Safety data sheet (SDS) and product supplier supplementary data as required	EPO-3 EPO-5 EPO-8	6.8
CM-25	Vessels fitted with AIS systems and radars	Offshore vessels greater than 400 gross tonne will be equipped with an AIS and an automatic radar plotting aid (ARPA).	CM-29-EPS-01	Written confirmation from vessel contractor that the correct equipment is on-board	EPO-10	6.1, 7.1
CM-26	Navigation equipment and procedures	Vessels have undergone an International Marine Contractors Association (IMCA), Common Marine Inspection Audit (CMID)	CM-30-EPS-01	All vessels have a current (<12 months) IMCA or CMID or	EPO-10	6.1, 7.1

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
		or Offshore Vessel Inspection Document (OVID) inspections no greater than 12 months prior to commencing the Activity, to confirm that they meet international HSE and maintenance standards.		OVID certificate prior to mobilisation.		
CM-27	Oil pollution emergency plan (OPEP)	In the event of a hydrocarbon spill to sea, the Santos OPEP requirements are implemented to mitigate environmental impacts.	CM-31-EPS-01	Audit report or vessel daily/weekly records or IMCA CMID or vessel contractor written verification demonstrates compliance.	EPO-10	7.1, 7.2
CM-28	Vessel spill response plans (SOPEP/SMPEP)	Vessels have a current, and implemented, a Shipboard Marine Pollution Emergency Plan (SMPEP) or SOPEP pursuant to MARPOL Annex I, as appropriate for vessel class.	CM-32-EPS-01	Audit report; approved SMPEP/SOPEP; vessel contractor written verification demonstrates compliance.	EPO-10	6.8, 7.1, 7.2, 7.4
		SMPEP/SOPEP spill response exercises conducted not less often than every three months to ensure personnel are prepared.	CM-32-EPS-02	Spill exercise records or evidence of a spill exercise in an operational report		
		Reported spills to deck are cleaned up as per the vessel SOPEP.	CM-32-EPS-03	Incident report details spill clean up		
CM-29	Refuelling and Chemical Transfer Procedure	All vessels that are involved in at sea bunkering or chemical transfer will have appropriate procedure in place to reduce risk of spill to sea.	CM-33-EPS-01	Audit report, incident register; or Vessel Refuelling and Chemical Transfer Procedure	EPO-10	7.1
CM-30	Support vessel in place during Activity to reduce potential for collision or interference with other marine users	Support vessel on standby at all times to monitor the survey vessel exclusion zone, so to identify approaching third-party vessels. During times when the support vessel's radar is not operational, the survey vessel will monitor at all times for	CM-34-EPS-01	Daily vessel report	EPO-10	6.1, 7.1

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
		approaching third-party vessels using an Automatic Identification System.				
CM-31	Restrictions on how small volumes of unused IFO and HFO are stored.	Unused IFO and HFO must be stored in small volumes and not in tanks with direct exposure to the marine environment. If IFO or HFO is proposed to be on board then this will be risk assessed. For the vessel to store IFO or HFO then the risk assessment must conclude that the high cost of removing and disposing of the IFO or HFO onshore is grossly disproportionate to the low risk of a vessel collision and rupture of an in-board fuel tank containing small volumes of the fuel.	CM-35-EPS-01	Bunkering records; audit report or vessel contractor written verification demonstrates compliance.	EPO-10	7.1
CM-32	Limit maximum volume of fuel stored in a single vessel tank	Maximum volume of fuel stored in a single tank of vessels used for the Activity will not exceed 650 m^3 spill model scenario	CM-36-EPS-01	Bunkering records; vessel contractor written verification demonstrates compliance.	EPO-10	7.1
CM-33	Require survey vessels to be double hulled.	All project vessels will be double hulled	CM-37-EPS-01	Audit report or Vessel contractor written verification demonstrates compliance.	EPO-10	7.1
CM-34	General chemical management procedures.	Safety data sheet (SDS) available for all chemicals to aid in the process of hazard identification and chemical management.	CM-38-EPS-01	Completed inspection checklist.	EPO-3 EPO-4 EPO-5 EPO-8 EPO-10	6.8, 7.2, 7.4
		Chemicals managed in accordance with SDS in relation to safe handling and storage, spill-response and emergency procedures, and disposal considerations.	CM-38-EPS-02			
CM-35	Hazardous chemical management procedures.	For hazardous chemicals including hydrocarbons, the following standards apply to reduce the risk of an accidental release to sea: • Storage containers closed when the product is not being used;	CM-39-EPS-01	Completed inspection checklist.	EPO-3 EPO-4 EPO-5 EPO-8 EPO-10	7.2, 7.4

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
		• Storage containers managed in a manner that provides for secondary containment in the event of a spill or leak; • Storage containers labelled with the technical product name as per the SDS; • Spills and leaks to deck, excluding storage bunds and drip trays, immediately cleaned up; • Storage bunds and drip trays do not contain free flowing volumes of liquid; and • Spill response equipment readily available.				
CM-36	MARPOL compliant fuel oil (MDO/MGO) will be used during the Activity.	MARPOL-compliant fuel oil (MDO/MGO) will be used during the Activity.	CM-40-EPS-01	Fuel bunkering records.	EPO-3 EPO-4 EPO-5 EPO-8 EPO-10	7.2
CM-37	Maritime dangerous goods code.	Dangerous goods managed in accordance with IMDG Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	CM-41-EPS-01	Completed Multimodal Dangerous Goods Form. Completed inspection checklist.	EPO-3 EPO-8 EPO-10	7.2, 7.4
CM-38	Deck drainage control measures (such as scupper plugs) in areas where chemicals and hydrocarbons are stored and frequently handled.	Scupper plugs or equivalent deck drainage control measures available where chemicals and hydrocarbons are stored and frequently handled.	CM-42-EPS-01	Weekly environmental inspection checklist.	EPO-3 EPO-8 EPO-10	7.2
CM-39	Bulk refuelling transfer procedures	Bulk fuel transferred in accordance with the vessel contractor procedures to reduce the risk of a release to sea. The procedures will require: • Hose integrity: certified hoses inspected prior to use • Hose floatation: bulk hoses in the water fitted with floatation collars. • Hose connections: hoses used for hydrocarbons fitted with self-sealing (dry-break) connections and self-	CM-43-EPS-01	Completed procedural documents, for example work permits, job safety analysis forms, checklists, etc. Spill details contained in incident documentation.	EPO-3 EPO-4 EPO-8 EPO-15 EPO-10	7.2

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
		sealing break-away connections when two or more hoses are joined together. • Valve alignment: a vessel supervisor checks that all valves are lined up correctly. • Tank venting: air vents for hydrocarbon storage tanks bunded if there is a risk of spill to deck. • Supervision: dedicated hose watch person while pumping bulk fuel. • Communications: constant radio communications between two vessels. • Inventory control: a vessel supervisor monitors tank fill levels. Emergency shutdown: vessel emergency pumping stop tested before each transfer operation.				
CM-40	Bunkering drill requirements.	Bunkering drill undertaken by survey vessel prior to first bunker operations in Operational Area, unless bunkering drill completed within the previous three months in Australian waters.	CM-44-EPS-01	Vessel logs record bunker drill undertaken.	EPO-4 EPO-8 EPO-10	7.2
CM-41	Equipment maintenance in accordance with PMS.	Vessel equipment maintenance records show that there are no outstanding maintenance activities for equipment.	CM-45-EPS-01	PMS register.	EPO-5 EPO-8	7.4, 7.5
CM-42	Waste (garbage) management procedure.	Waste management procedure implemented to reduce the risk of unplanned release of waste to sea. The procedure includes standards for: • Bin types; • Lids and covers; • Waste segregation; and • Bin storage; and • Putrescible waste management.	CM-46-EPS-01	Completed inspection checklist.	EPO-3 EPO-5 EPO-8	6.6, 7.5

CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
		Food waste is disposed in accordance with MARPOL Annex V, including discharge of food waste macerated to less than 25 mm when greater than 3 nm from the nearest land.	CM-46-EPS-02	Completed garbage disposal record book or recording system		
		Vessel's garbage record book maintained to record quantities and types of waste in accordance with MARPOL.	CM-46-EPS-03	Up-to-date Garbage Record Book		
CM-43	Survey equipment deployment / retrieval procedure	Survey equipment undergo regular inspection and planned maintenance system checks for wear and damaged components. These components are replaced on an 'as required' basis.	CM-47-EPS-01	Survey equipment maintenance log	EPO-3 EPO-8	7.5
		Relevant personnel are trained in requirements of the procedures for survey equipment deployment and retrieval.	CM-47-EPS-02	Training records		
CM-44	Invasive Marine Species Management Plan	Vessels to be risk assessed using the DPIRD vessel check tool demonstrating vessel is at 'low risk' of introducing invasive marine species.	CM-48-EPS-01	Completed DPIRD vessel check report demonstrating vessel are low risk.	EPO-2	7.7
		Immersible equipment to be cleaned to 'low risk' of introducing invasive marine species if being deployed to sea during the Activity.	CM-48-EPS-02	Verification that immersible equipment was cleaned to low risk (e.g. photos, inspection reports)		
		Santos will forward the most current Western Australian Prevention List for Introduced Marine Pests to all vessel operators prior to each survey phase to ensure they are aware of potential invasive marine pest species and the reporting requirements	CM-48-EPS-03	Verification that current Western Australian Prevention List has been provided to vessel operators.		
CM-45	Anti-foulant system	Anti-foulant systems are maintained in compliance with International Convention on the Control of Harmful Anti-Fouling Systems on Ships.	CM-49-EPS-01	Current International Anti-Fouling System Certificate.	EPO-2	7.7
CM-46	Ballast water management plan	Pursuant to the *Biosecurity Act 2015* and *Australian Ballast Water Management Requirements 2017*, vessels carrying ballast water and engaged in international voyages shall	CM-51-EPS-01	Administrator-approved ballast water management plan.	EPO-2	7.7

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CM Reference	Control measure	Environmental Performance Standards	EPS Reference	Measurement criteria	EPO Reference	EP Section
		manage ballast water in accordance with a Ballast Water Management Plan so that marine pest species are not introduced. The plan shall include: • Ballast water exchange; • Ballast water management systems; • Sediment management; • Duties of officers and crew; • Coordination with local authorities; and • Record keeping.	CM-51-EPS-02	Completed ballast water record book or log		

8.4 Leadership, Accountability and Responsibility

OPGGS(E)R 2009 Requirements
Regulation 14(4)
The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan including during emergencies or potential emergencies.

P(SL) (E) Regs 2012 Requirements
Regulation 15(4)
The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan.

While Santos WA's Executive Vice President has the overall accountability for the implementation of Santos's WA management system and Environmental Management Policy. Santos's WA Manager for Offshore Developments is responsible for ensuring implementation, management and review of this EP.

Effective implementation of this EP will require collaboration and cooperation amongst Santos and its contractors. This is reflected in **Table 8-3**, which sets out the roles and responsibilities of personnel in relation to the implementation, management and review of the EP.

Table 8-3: Chain of command, key leadership roles and responsibilities

Role	Responsibilities
General Manager, Offshore Developments	• Ensures Santos policies and standards are adhered to and communicated to all employees and contractors; • Promotes HSE as a core value integral with how Santos does its business; • Empowers personnel to 'stop-the-job' due to HSE concerns; • Provides resources for HSE management; • Ensures a high level of HSE performance and drives improvement opportunities; • Ensures emergency response plans are in place; • Maintains communication with company personnel, government agencies and the media; • Approves MoC documents, if acceptable and ALARP.
Company Site Representative	Has responsibility for: • Implementation of EP commitments; • Ensuring personnel competency; • Ensuring compliance with procedures and work instructions; • Site focal point for onshore/offshore communications; • Reporting of all incidents and potential hazards; • Leading site-based incident response; and • Implementation of corrective actions from environmental incidents and audits.
Vessel Master	• Has overall responsibility for: • Implementation and compliance with relevant environmental legislative requirements, EP commitments and operational procedures on the vessel; • Maintaining clear communication with personnel on board; • Communicating hazards and risks to the workforce; • Monitoring daily activities on the vessel to ensure that the relevant environmental legislative requirements, EP commitments and operational procedures are being followed; • Maintaining vessels to all regulatory and class requirements; • Maintaining their vessel in a state of preparedness for emergency response; and • Reporting environmental incidents to Santos and ensuring follow-up actions are carried out.
Santos HSE Manager	• Has overall responsibility for: • Ensuring incident preparedness and response arrangements meet Santos WA and regulatory requirements; • Approving the OPEP; and • Providing ongoing resources to maintain compliance with the OPEP and other Santos WA incident response requirements.

Role	Responsibilities
Santos HSE Coordinator(s)	• Ensures the EP is managed and reviewed: monitors conformance with EPOs and Environmental Performance Standards, and the implementation strategy in the EP; • Prepares, maintains and distributes the environmental compliance register; • Completes regular HSE reports, inspections and audits; • Completes HSE inductions and promotes general awareness; • Collates HSE data and records; • Contributes to HSE incident management and investigations; • Provides operational HSE oversight and advice; • Facilitates the development and implementation of MoC documents; • Provides incident reports, compliance reports and notifications to NOPSEMA; • Ensures stakeholder consultation and communication requirements have been fulfilled; and • Ensures subcontractors are communicated the EP requirements.
HSE Team Lead – Security Emergency Response	• Has overall responsibility for: • Overarching incident and crisis management responsibility; • Managing the CMT and IMT personnel training program; • Reviewing and assessing competencies for CMT, IMT, and field-based IRT members; • Managing the Duty roster system for CMT and IMT personnel; and • Managing the maintenance and readiness of incident response resources and equipment.
Senior Advisor - Oil Spill Response	Has the overall responsibility for: • Providing upfront and ongoing guidance, framework, and direction on preparation of this OPEP; • Developing and maintaining arrangements and contracts for incident response support from 3rd-parties; • Developing and defining objectives, strategies and tactical plans for response preparedness defined in this OPEP and IRP; and • Undertaking assurance activities on arrangements outlined within the OPEP.
All personnel	• Adhere to HSE obligations; • Carry out duties in accordance with defined work systems and procedures; • Report sightings of marine fauna and marine pollution; • Identify HSE improvement opportunities wherever possible; • Report HSE incidents, hazards or non-conformances to supervisors in a timely manner; and • Understand their obligation to ‘stop-the-job’ due to HSE concerns

8.5 Workforce Training and Competency

OPGGS(E)R 2009 Requirements
Regulation 14(5)
The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment plan including during emergencies or potential emergencies, and has the appropriate competencies and training.

P(SL) (E) Regs 2012 Requirements
Regulation 15(5)
The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the petroleum activity is aware of his or her responsibilities in relation to the environment plan and has appropriate competencies and training.

8.5.1 Training and Competency

All members of the workforce on the vessels will complete relevant training and hold qualifications and certificates for their role (e.g. rigging and crane operator certificates, etc.).

Santos and its contractors are individually responsible for ensuring that their personnel are qualified and trained. The systems, procedures and/or responsible persons necessary to ensure that this commitment is met will vary (e.g. online databases, desktop matrix, staff on-boarding processes, training departments, etc.).

Personnel qualification and training records will be sampled before and/or during an Activity. Such checks will be performed during the procurement process, inductions, crew change, and/or operational inspections and audits.

8.5.2 Activity Inductions

All offshore personnel on the vessels will complete an induction that addresses their EP responsibilities. Induction attendance records for all personnel will be maintained. Inductions will include information on:

+ Operating environment (e.g. nearby marine protected areas, KEFs, BIAs, etc.);
+ Regulatory regime (NOPSEMA);
+ Interactions with other marine users;
+ Highest risk activities;
+ EP commitments;
+ Key environmental management requirements; and
+ HSE expectations, including reporting.

8.6 Workforce Involvement and Stakeholder Communication

Daily operational meetings will be held offshore at which HSE will be a standing agenda item. It is a requirement that supervisors attend daily operational meetings and all personnel attend daily toolbox/ pre-shift meetings.

Toolbox meetings will be regularly held offshore to plan jobs and discuss work tasks, including HSE risks and controls.

HSE performance will be monitored and reported during the Activity, and performance metrics (such as the number of environmental incidents) will be regularly communicated to the workforce.

Workforce involvement and environmental awareness will also be promoted by encouraging offshore personnel to report marine fauna sightings and marine pollution (e.g. oil on water).

Ongoing stakeholder management strategies are discussed in **Section 4**.

8.7 Information Management and Document Control

This EP and OPEP, as well as approved MoC documents, are controlled documents and current versions will be available on Santos' intranet. Vessel contractors are also required to maintain current versions of HSE documents on their facilities (i.e. vessels).

EPOs and EPSs will be measured based on the measurement criteria listed in **Table 8-2**. Such records will be maintained for a period of five years from the acceptance date of this EP. Contractors are required to make these records available upon request to Santos.

8.8 Operations Management

Daily reports will be completed by the vessels as a means of monitoring completed and planned activities, and any HSE accidents or incidents.

All personnel are required to adhere to the contractor safety management systems and respective systems of work. Examples include, but are not limited to, preventative maintenance systems and work orders, permits to work, safe work procedures, work instructions, job hazard analysis, job checklists, behavioural observation programs, emergency response and record keeping. Compliance with vessel systems of work will be monitored through work supervision, inspections, audits and after action reviews (**Section 8.15**).

Collectively, these represent a comprehensive and integrated system through which operational control measures (e.g. refuelling) described in this EP will be implemented.

8.9 Management of Change

Proposed changes to this EP and OPEP will be managed in accordance with Santos' *Environment Management of Change Procedure* (EA-91-IQ-10001) – MoC process. The MoC process provides a systematic approach to initiate, assess, document, approve, communicate and implement changes to EPs and OPEPs.

The MoC process considers Regulation 7, 8 and 17 of the OPGGS(E) Regulations and determines if a proposed change can proceed and the manner in which it can proceed. The MoC procedure will determine whether a revision of the EP is required and whether that revision is to be submitted to NOPSEMA. For a change to proceed, the associated environmental impacts and risks must be demonstrated to be acceptable and ALARP. Additional stakeholder consultation may be required depending on the nature and scale of the change. Additional information on the MoC process is provided in **Figure 8-1.**

The MoC procedure also allows for the assessment of new information that may become available post EP acceptance (refer to **Section 8.15**). For example, new management plans or conservation advice. If new information is identified, this is treated as "Change that has an impact on Environment Plan" in **Figure 8-1** and the MoC process is followed accordingly.

Accepted MoCs become part of the in-force EP or OPEP, will be tracked on a register and made available on Santos' intranet. Where appropriate, Santos' environmental compliance register will be updated to ensure changes to control measures or environmental performance standards are communicated to the workforce and implemented. Any MoC will be distributed to the relevant persons, and the most relevant management position (e.g. geophysical manager, vessel masters) will ensure the MoC is communicated and implemented, which may include crew meetings/ briefings/ communications as appropriate for the change.

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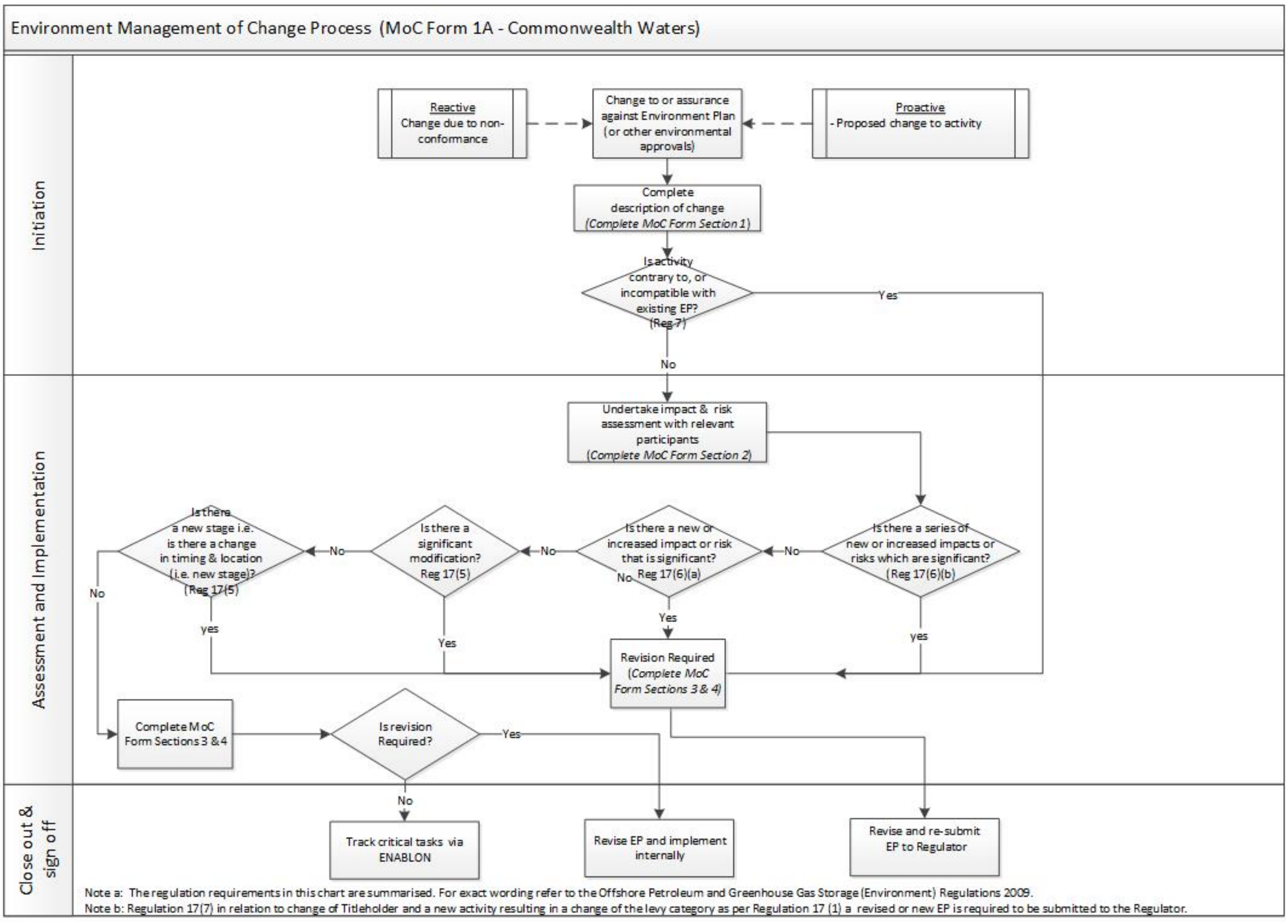

Figure 8-1: Environment Management of Change Process

8.10 Emergency Preparedness and Response

OPGGS(E)R 2009 Requirements
Regulation 14(8)
The implementation strategy must contain an oil pollution emergency plan and provide for the updating of the plan.

P(SL) (E) Regs 2012 Requirements
Regulation 15(10) P(SL)(E)R 2012
The implementation strategy must include an oil spill contingency plan that — a) sets out details of the following — i. preparations to be made for the possibility of an oil spill; ii. emergency response arrangements to be implemented if an oil spill occurs; iii. recovery arrangements to be implemented if an oil spill occurs; and iv. current oil spill trajectory modelling that applies to the petroleum activity; b) requires the operator to conduct tests of the emergency response arrangements set out in the oil spill contingency plan at specified intervals; and c) describes the tests mentioned in paragraph (b).

Vessels are required to have and implement incident response plans, such as an emergency response plan and SMPEP/ SOPEP. Regular incident response drills and exercises (e.g. as defined in emergency response plan, SMPEP/ SOPEP etc.) will be carried out on Activity vessels to refresh the crew in using equipment and implementing incident response procedures.

Santos will implement the *WA-437-P Geotechnical and Geophysical Survey Oil Pollution Emergency Plan* (SO-91-BO-20006.02) in the event of a significant hydrocarbon spill (level 2 or 3). To maintain a state of oil spill preparedness, personnel with OPEP responsibilities will be made aware of their obligations, oil spill response equipment will be maintained, contracts with critical equipment and personnel suppliers will be managed, and agreements will be in place with national regulatory agencies for support in oil spill response. Santos will also implement its oil spill response exercise and training schedule. Further information on oil spill response is provided in the OPEP.

A communications test for the activity is completed prior to commencement of the activities (refer to the OPEP).

8.11 Incident Reporting, Investigation and Follow-up

OPGGS(E)R 2009 Requirements
Regulation 14(2)
The implementation strategy must: a) state when the titleholder will report to the Regulator in relation to the titleholder's environmental b) performance for the activity; and provide that the interval between reports will not be more than 1 year. Note: Regulation 26C requires a titleholder to report on environmental performance in accordance with the timetable set out in the environment plan.
Regulation 14(7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

P(SL) (E) Regs 2012 Requirements
Regulation 17(1)
The environment plan must include the following: c) A list of all incidents that are classified as reportable incidents in relation to the petroleum activity.
Regulation 17(2)
The environment plan must classify an incident as a reportable incident if: a) It could arise from the petroleum activity; and b) It has the potential to cause an environmental impact that is classified, under the environmental risk assessment process described in the environment plan, as moderate or more serious than moderate.

All personnel will be informed through inductions and daily operational meetings of their duty to report HSE incidents and hazards. Reported HSE incidents and hazards will be shared during daily operational meetings, and HSE incidents and hazards will be documented in the incident management systems as appropriate. Significant HSE incidents will be investigated using root cause analysis.

Environmental recordable and reportable environmental incidents will be reported to NOPSEMA, and other regulators as required, in accordance with **Table 8-4.** The incident reporting requirements from **Table 8-4.**

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will be provided to vessels with special attention to the reporting time frames to ensure accurate and timely reporting.

Santos will be responsible for reporting all reportable incidents under Regulation 26 of the OPGGS (E) Regulations within 2 hours. Recordable incidents will also be reported according to the requirements of Regulation 26B of the OPGGS (E) Regulations by Santos no later than 15 days after the end of the calendar month. For the purposes of this Activity, 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 (ranked a C, D or E in the Santos Environmental Consequence Matrix (**Appendix E**)).

Recordable incidents that are a breach of EPO or EPS could include:

+ Uncontrolled release of hydrocarbon or hazardous chemical to the marine environment;
+ Uncontrolled significant release of ODS;
+ Unrecovered container (e.g. 44-gallon drum) of hydrocarbon, chemical or waste to sea;
+ Harm or mortality to marine fauna whether attributable to the vessel or not; and
+ Large oil slick or sheen on the sea surface whether attributable to the vessel or not.

8.12 Regulatory Notifications

In accordance with Regulation 29 and 30, NOPSEMA will be notified at least 10 days before the commencement and within 10 days after finishing each survey phase. As such, multiple commencement and cessation notifications will be submitted over the duration of the EP.

A Regulation 25A end-of-operation of EP notification will be submitted within 12 months of the final Regulation 29(2) notification, unless agreed otherwise with NOPSEMA.

These notification requirements are summarised in **Table 8-4.**

8.13 Monitoring and Recording of Emissions and Discharges

OPGGS(E)R 2009 Requirements
Regulation 10A9(e)
Includes an appropriate implementation strategy and monitoring, recording and reporting arrangements;
Regulation 14(7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

P(SL) (E) Regs 2012 Requirements
Regulation 15(7) (and 34)
The implementation strategy must provide for — a) specified emissions and discharges (whether occurring during normal operations or otherwise) to any air, marine, seabed and sub-seabed environment to be monitored and recorded in a way that — i. is accurate; and ii. can be audited against the environmental performance standards and measurement criteria in the environment plan; and a) the monitoring mentioned in paragraph (a) to be done either continuously or at specified intervals; and b) tests to assess the performance of the monitoring equipment used for the purposes of paragraph (a) to be conducted at specified intervals.

Discharges associated with this Activity will limited to those allowed for under maritime law. Therefore, all discharges will be recorded and controlled in accordance with maritime monitoring and recording requirements. Any non-compliance with discharge requirements will be included in the monthly recordable incident report to NOPSEMA.

8.14 Compliance Reporting

OPGGS(E)R 2009 Requirements
Regulation 14(2)
The implementation strategy must: d) state when the titleholder will report to the Regulator in relation to the titleholder's environmental e) performance for the activity; and provide that the interval between reports will not be more than 1 year. Note: Regulation 26C requires a titleholder to report on environmental performance in accordance with the timetable set out in the environment plan.
Regulation 14(7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

P(SL) (E) Regs 2012 Requirements
Regulation 16
The environment plan must include arrangements for — a) monitoring, and recording information about, the petroleum activity that are sufficient to enable the Minister to determine whether — i. the environmental performance objectives and environmental performance standards in the environment plan have been met; and ii. the implementation strategy in the environment plan has been complied with; and b) reporting to the Minister on the information recorded under paragraph (a) at intervals agreed with the Minister, but not less often than annually.

A detailed environmental performance report will be submitted within three months of submission of Regulation 29(2) end-of-Activity notification to NOPSEMA. This report will meet the requirements of Regulation 26(C).

These compliance reporting requirements are summarised in **Table 8-4**.

8.15 Reviews, Audits and Inspections

OPGGS(E)R 2009 Requirements
Regulation 14(6)
The implementation strategy must provide for sufficient monitoring, recording, audit, management of nonconformance and review of the titleholder's environmental performance and the implementation strategy to ensure that the environmental performance outcomes and standards in the environment plan are being met.

P(SL) (E) Regs 2012 Requirements
Regulation 15(6)
The implementation strategy must provide for the monitoring of, audit of, management of non-compliance with, and review of, the operator's environmental performance and the implementation strategy.

This part of the implementation strategy provides for monitoring, recording, audit, management of non-conformance and review of environmental performance including demonstration that the environmental performance outcomes and standards are being met.

8.15.1 Reviews

This EP includes an assessment of impacts and risks across the entire Operational Area during any time of the year for planned and unplanned events given the nature of the 24/7 operations. It is recognised that the following parameters may change over the validity of the EP:

+ Legislation;
+ Regulator policy and guidance;
+ Businesses conditions, systems, processes and people;
+ Industry practices;
+ Science and technology;
+ Societal and stakeholder expectations;
+ Petroleum industry survey, exploration and development activities;
+ Knowledge about control measure effectiveness and environmental impacts and risks; and
+ Financial assurance requirements.

Through maintenance of up to date knowledge (**Section 8.16**), these changes will be identified. Should a change to the EP be required, then an assessment will be conducted and documented in accordance with Santos' *Environmental Management of Change Procedure* (EA-91-IQ-10001) (**Section 8.9**).

8.15.2 Maintaining Up to Date Knowledge

To ensure that Santos maintains up to date knowledge of the parameters described in **Section 8.16** the following tasks are undertaken:

+ Member of APPEA to ensure that potential changes in legislation, industry practice and other issues that may affect EP implementation are known;
+ Stakeholder, including regulator, management in accordance with **Section 3**;
+ Undertaking annual review of *Values and Sensitivities of the Western Australian Marine Environment* (EA-00-RI-10062, **Appendix B**) which includes completing a new EPBC Act Protected Matters Search; reviewing relevant legislation, government guidance material and conservation management plan updates; and reviewing new published, relevant scientific papers;
+ Undertaking annual spill response exercises to ensure spill response arrangements and capability are adequate;
+ Reviewing the DPIRD Western Australian Prevention List for Introduced Marine Pests prior to each survey phase;
+ Subscription to NOPSEMA's "The Regulator" issued quarterly;
+ Subscriptions to various other regulator updates; and
+ Regular liaison meetings with regulators, including NOPSEMA.

If new information is identified through these processes, this will be treated as "Change that has a potential to impact on Environment Plans" as described in **Figure 8-1**. Should a change to the EP be required, then an assessment will be conducted and documented in accordance with Santos' *Environmental Management of Change Procedure* (EA-91-IQ-10001) (**Section 8.9**).

8.15.3 Audits

Santos audit plans and schedules are reviewed and updated at the beginning of each calendar year and cover all Santos facilities and activities. Santos' audit schedule may be amended to accommodate operational priorities, Activity risk, and personnel availability or should audit demands be high during certain periods (e.g. regulatory audits, contractor audits etc.). Survey phasing conducted under this EP will be considered in the development of the audit schedule.

Audit criteria is typically a selection of control measures and environmental performance standards and outcomes; however, may also include parts of the Activity description or stakeholder consultation and implementation strategies.

Audits may be onshore or offshore, and audit findings may include opportunities for improvement and non-conformances. Audit non-conformances are managed as described in **Section** Non-Conformance Management**8.15.5**. Audit reports will be given a document number and managed as a controlled document.

8.15.4 Inspections

During an Activity, frequent (weekly/monthly) HSE inspections will be conducted to identify hazards, incidents and EP non-conformances. Santos representatives will conduct EP compliance inspections throughout the Activity to ensure compliance against all of the environmental performance outcomes and standards of this EP (**Table 8-1**). Any in-field opportunities for improvement or corrective actions will be discussed during the inspection with the work area supervisor and/or crew. Inspection reports will be distributed to Santos' relevant personnel (e.g. Santos on-board representatives), and HSE Department representatives, for review.

8.15.5 Non-Conformance Management

EP non-conformances will be addressed and resolved by a systematic corrective action process. Non-conformances will be entered into Santos' incident management system. Once entered, corrective actions, time frames and responsible persons (including action owners and event validators) will be assigned. Corrective action 'close out' will be monitored using a management escalation process.

8.16 Continuous Improvement

For this EP, continuous improvement will be achieved as a result of:

+ Improvements identified from the review of Santos HSE key performance indicators (KPIs);
+ Actions arising from Santos HSE improvement plans;
+ Corrective actions and feedback from HSE audits and inspections, incident investigations and after-action reviews;
+ Opportunities for improvement and changes identified during pre-Activity reviews, MoC documents and environmental performance reviews; and
+ Actions taken to address concerns and issues raised during the ongoing stakeholder management process (**Section 4**).

Identified continuous improvement opportunities will be assessed in accordance with Santos' *Environmental Management of Change Procedure* (EA-91-IQ-10001) (refer to **Section 8.9**) to ensure any potential changes to this EP, or OPEP, are managed in accordance with the OPGGS(E) Regulations and in a controlled manner.

Table 8-4: Regulator Activity Notification and Reporting Requirements

Regulation	Requirement	Required Information	Timing	Type	Recipient
Before the Activity					
Regulation 29 & 30 - Notifications	NOPSEMA and DMIRS must be notified that the Activity is to commence.	Complete NOPSEMA's Regulation 29 and 30 Start or End of Activity Notification form for both notifications.	At least 10 days before the Activity commences.	Written	NOPSEMA and DMIRS
N/A	Australian Hydrographic Office (AHO)	Pre-start notification.	At least 21 days before the Activity commences.	Written	AHO
N/A	AMSA JRCC Notification		48 hours (hrs). prior to Activity commencement.	Written	AMSA
Department of Agriculture, Compliance Division	Voluntary biosecurity risk assessment under the Biosecurity Act 2015	To have the biosecurity risk status assessed, offshore vessel contractors must apply to the department at least one month prior to project commencement.	At least one month before the Survey.	Written	DoA
During the Activity					
Regulation 16(c), 26 & 26A – Reportable Incident	NOPSEMA must be notified of any reportable incidents. For the purposes of Regulation 16(c), 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 In the event of an incident impacting on State waters, this will also be reported to DMIRS.	The oral notification must contain: • All material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out; • Any action taken to avoid or mitigate an adverse environmental impact of the reportable incident; and • The corrective action that has been taken, or is proposed to be taken, to sop, control or remedy the reportable incident.	As soon as practicable, and in any case not later than 2 hours after the first occurrence of a reportable incident, <u>or</u> if the incident was not detected at the time of the first occurrence, at the time of becoming aware of the reportable incident.	Oral	NOPSEMA
		A written record of the oral notification must be submitted. The written record is not required to include anything that was not included in the oral notification.	As soon as practicable after the oral notification.	Written	NOPSEMA NOPTA DMIRS National Ship Strike Database

Regulation	Requirement	Required Information	Timing	Type	Recipient
	Any ship strike incident will also be reported to the National Ship Strike database.	A written report must contain: • All material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out; • Any action taken to avoid or mitigate an adverse environmental impact of the reportable incident; • The corrective action that has been taken, or is proposed to be taken, to sop, control or remedy the reportable incident; and • The action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future. Consider reporting using NOPSEMA's Report of an Accident, Dangerous Occurrence or Environmental Incident form: https://www.nopsema.gov.au/assets/Forms/N-03000-FM0831-Report-of-an-Accident-Dangerous-Occurrence-or-Environmental-Incident-Rev-8-Jan-2015-MS-Word-2010.docx Ship strike report: **https://data.marinemammals.gov.au/report/shipstrike**	Must be submitted as soon as practicable, and in any case not later than 3 days after the first occurrence of the reportable incident unless NOPSEMA specifies otherwise. Same report to be submitted to National Offshore Petroleum Titles Administrator (NOPTA) and DMIRS within 7 days after giving the written report to NOPSEMA.	Written	NOPSEMA NOPTA DMIRS
Director of National Parks Reporting	Notification of the event of an oil pollution incident which occurs within a marine park or is likely to impact on a marine park.	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	As soon as practicable.	Oral	Director of National Parks

Regulation	Requirement	Required Information	Timing	Type	Recipient
		• contact details for the response coordinator.			
AMSA Reporting	In consultation AMSA requests notification of reportable vessel incidents under Marine *Safety (Domestic Commercial Vessel) National Law Act 2012, Schedule 1* including: • the loss of a vessel; • a collision with another vessel or an object; • the grounding, sinking, flooding or capsizing of a vessel; • a fire; • a loss of stability that affects the safety of the vessel; • a close quarters situation; • the death or injury, or possible death or injury, of a person on board; and • the loss, or possible loss, of a person from a vessel.	A written report must contain: 1) Incident details (date and time); 2) Location; 3) Type of incident; 4) Incident description; 5) Vessels involved; 6) Persons involved; and 7) Details of assistance rendered/received at incident. Consider reporting using AMSA's Incident Report: http://www.amsa.gov.au/domestic/vessels-operations-surveys/domestic-incident-reporting/	Within 72 hours of the incident.	Written	AMSA
DPIRD Reporting	If marine pests or disease are suspected this must be reported to DPIRD.	Notification of any suspected marine pests or diseases including any organism listed in the Western Australian Prevention List for Introduced Marine Pests and any other non-endemic organism that demonstrates invasive characteristics.	Within 24 hours.	Oral	DPIRD FishWatch
DoAWE Reporting	Any harm or mortality to EPBC Act-listed threatened marine fauna.	Notification of any harm or mortality to an EPBC listed species of marine fauna whether attributable to the Activity or not.	Within 48 hours to compliance@environment.gov.au.	Written	DoAWE
DBCA Reporting	Impacts to marine mammals or	Notification of any incidence of entanglement, boat	Within 48 hours.	Written	DBCA

Regulation	Requirement	Required Information	Timing	Type	Recipient
	turtles in reserves.	collisions and stranding of marine mammals in the reserves' and any incident of turtle mortality and incidents of entanglement.			
Regulation 26B – Recordable Incidents	NOPSEMA must be notified of a breach of an environmental performance outcome or standard, in the EP that applies to the Activity that is not a reportable incident.	Complete NOPSEMA's Recordable Environmental Incident Monthly Report form.	The report must be submitted as soon as practicable after the end of the calendar month, and in any case, not later than 15 days after the end of the calendar month.	Written	NOPSEMA
Regulation 26C Environmental Performance	NOPSEMA must be notified of the environmental performance at the intervals provided for in the EP.	Report must contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP have been met.	A detailed environmental performance report will be submitted within three months of submission of a Regulation 29(2).	Written	NOPSEMA
End of Activity					
Regulation 29 – Notifications	NOPSEMA must be notified that the Activity is completed.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form.	Within 10 days after finishing.	Written	NOPSEMA
Regulation 14 (2) & 26C – Environmental Performance	NOPSEMA must be notified of the environmental performance of the Activity.	Report must contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP have been met.	Environmental performance report submitted within 3 months of the end of the Activity.	Written	NOPSEMA
Regulation 25A Plan ends when titleholder notifies completion and the Regulator accepts the notification.	NOPSEMA must be notified that the Activity has ended, and all EP obligations have been completed.	Notification advising NOPSEMA of end of all activities to which the EP relates and that all obligations have been completed.	Within six months of the final Regulation 29 (2) notification.	Written	NOPSEMA

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APPENDIX A – LEGISLATION

Commonwealth Legislation	Summary	Relevant to Activity?	Administering Authority	Relevant aspects of the Activity	EP Section
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	This Act provides for the preservation and protection from injury or desecration areas and objects that are of significance to Aboriginal people, under which the Minister may make a declaration to protect such areas and objects. The Act also requires the discovery of Aboriginal remains to be reported to the Minister.	Yes	Commonwealth – Department of Environment and Energy	No Activity being undertaken on land or near shore. No known sites of Aboriginal Heritage Significance are within the Operational Area but are present within the EMBA. May be relevant in the event of a hydrocarbon spill requiring shoreline access (e.g. shoreline clean-up)	**Section 7.3**– Spill response operations
Australian Heritage Council Act 2003	This Act identifies areas of heritage value listed on the Register of the National Estate and sets up the Australian Heritage Council and its functions.	No	Australian Heritage Council	There are no national heritage places found on the National Heritage List, within the EMBA. The Dampier Archipelago is the nearest site located approximately 12 km south of the EMBA.	N/A
Australian Maritime Safety Authority Act 1990 (AMSA Act)	This Act specifies that the Australian Maritime Safety Authority's (AMSA) role includes protection of the marine environment from pollution from ships and other environmental damage caused by shipping. AMSA is responsible for administering the Marine Orders in Commonwealth waters. Facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are given effect through AMSA. AMSA is the lead agency for responding to oil spills in the marine environment and is	Yes	AMSA	Vessel movements Marine orders administration Spill control agency	**Section 7.1** – Hydrocarbon spill from a vessel collision

Commonwealth Legislation	Summary	Relevant to Activity?	Administering Authority	Relevant aspects of the Activity	EP Section
	responsible for the Australian National Plan for Maritime Environmental Emergencies (MEE).				
Maritime Powers Act 2013	Protects the heritage values of shipwrecks and relics for shipwrecks over 75 years. It is an offence to interfere with a shipwreck covered by this Act. Available historic shipwreck locations covered by international conventions enacted by this legislation have been identified and assessed (as applicable) within this EP.	No	The Department of Immigration and Border Protection	No planned interaction or interference. Potential impact could be due to a hydrocarbon spill, but the credible spill is to surface, and therefore shipwrecks are highly unlikely to be impacted.	N/A
Biosecurity Act 2015 *Biosecurity Regulations 2016*	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia's native flora and fauna or natural environment. The Commonwealth's powers include powers of entry, seizure, detention and disposal. This Act includes mandatory controls on the use of seawater as ballast in ships and the declaration of sea vessels voyaging out of and into Commonwealth waters. The Regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the quarantine officers.	Yes	Commonwealth – Department of Agriculture and Water Resources	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange	**Section 7.7** Introduction of IMS
Environment Protection and Biodiversity Conservation Act 1999	A new streamlined approach for offshore petroleum and greenhouse gas Activity environmental approvals came into effect on 28 February 2014. The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) is now the sole assessor for offshore petroleum activities in	Yes	Commonwealth – Department of Environment and Energy	Undertaking the Activity involves: • Interaction with marine fauna (MNES which are threatened and migratory species,	**Section 6.3** - Light emissions **Section 6.2** – Noise emissions **Section 6.3** – Planned operational discharges

Commonwealth Legislation	Summary	Relevant to Activity?	Administering Authority	Relevant aspects of the Activity	EP Section
Environment Protection and Biodiversity Conservation Amendment Regulations 2006	Commonwealth waters. Under the new arrangements, environmental protection will be met through NOPSEMA's decision-making processes. Where activities have existing approvals under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), these will continue to apply.			• Light emissions • Underwater noise • Drilling discharges • Vessel movements • Unplanned hydrocarbon/chemical release	**Section 7.1** to **7.5** – for unplanned hydrocarbon and non-hydrocarbon/chemical releases **Section 7.6** Marine fauna collisions
Underwater Cultural Heritage Act 2018	This Act protects shipwrecks, sunken aircraft and other types of underwater heritage (including human remains) that have lain in territorial waters for 75 years or more. The Act replaced the *Historic Shipwreck Act 1976* on 1 July 2019. It also increases penalties applicable to damaged sites.	No	Commonwealth – Department of Environment and Energy	No planned interaction or interference. Potential impact could be due to a hydrocarbon spill, but the credible spill is to surface, and therefore shipwrecks are highly unlikely to be impacted. Multiple shipwrecks (25) and one sunken aircraft identified within EMBA.	**Section 7.1** and **7.2** – for unplanned hydrocarbon spills
National Greenhouse and Energy Reporting Act 2007	Introduces a single national reporting framework for the reporting and dissemination of information about greenhouse gas emissions, greenhouse gas projects and energy use and production of corporations.	Yes	Commonwealth – Department of Environment and Energy And Climate Change Authority	Atmospheric emissions through combustion engine use to operate the survey vessel. To reduce impact of GHG emissions, Santos will comply with MARPOL Annex VI (Marine Orders Part 97: Marine Pollution Prevention – Air Pollution) And require the use of low sulphur fuel	**Section 6.6**– Atmospheric emissions
Maritime Legislation Amendment (Prevention of Air	This Act implements the requirements of MARPOL 73/78 Annex VI for shipping in Commonwealth waters.	Yes	Commonwealth, Department of Infrastructure and Regional Development.	Atmospheric emissions through combustion engine use to operate the survey vessel. To reduce impact of GHG emissions, Santos will comply with MARPOL Annex VI (Marine Orders Part 97:	**Section 6.6**– Atmospheric emissions

Commonwealth Legislation	Summary	Relevant to Activity?	Administering Authority	Relevant aspects of the Activity	EP Section
Pollution from Ships) Act 2007				Marine Pollution Prevention – Air Pollution) And require the use of low sulphur fuel	
Navigation Act 2012	An act regulating navigation and shipping including Safety of Life at Sea (SOLAS). A number of Marine Orders enacted under this Act apply directly to offshore petroleum exploration and production activities: Marine Orders - Part 17: Liquefied gas carriers and chemical tankers Marine Orders - Part 21: Safety of navigation and emergency procedures Marine Orders - Part 30: Prevention of collisions Marine Orders - Part 47: Mobile Offshore Drilling Units Marine Orders - Part 50: Special purpose ships Marine Orders - Part 57: Helicopter Operations Marine Order - Part 59: Off-shore industry vessel operations Marine Orders - Part 60: Floating Offshore facilities	Yes	AMSA (operational) Department of Infrastructure and Regional Development Minister for Infrastructure and Regional Development	Vessel movements	**Section 6.1** – Interaction with other marine users
Offshore Petroleum and Greenhouse Gas Storage Act 2006 Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements specified in the OPGGS Act and associated Regulations. The OPGGS Act contains a broad requirement for titleholders to operate in accordance with "good oil-field practice". Specific environmental provisions relating to work practices essentially require operators to control and prevent the escape of wastes and petroleum.	Yes	NOPSEMA	Undertaking Activity is a Petroleum Activity regulated by NOPSEMA.	**Section 6** and **7**

Commonwealth Legislation	Summary	Relevant to Activity?	Administering Authority	Relevant aspects of the Activity	EP Section
	The Act also requires that activities are carried out in a manner that does not unduly interfere with other rights or interests, including the conservation of the resources of the sea and seabed, such as fishing or shipping. In some cases, where there are particular environmental sensitivities or multiple use issues it may be necessary to apply special conditions to an exploration permit area. The holder of a petroleum title must maintain adequate insurance against expenses or liabilities arising from activities in the title, including expenses relating to clean-up or other remedying of the effects of the escape of petroleum. The OPGGS Environment Regulations provide an objective based regime for the management of environmental performance for Australian offshore petroleum exploration and production activities in areas of Commonwealth jurisdiction. Key objectives of the Environment Regulations include: • to ensure operations are carried out in a way that is consistent with the principles of ecologically sustainable development; • to adopt best practice to achieve agreed environment protection standards in industry operations; and • to encourage industry to continuously improve its environmental performance.				
Ozone Protection and Synthetic Greenhouse Gas	Regulates the manufacture, importation and use of ODS (typically used in fire-fighting equipment	Yes	Commonwealth - Department of	No import, export or manufacture activities of ODS.	**Section 6.6** – Atmospheric emissions

Commonwealth Legislation	Summary	Relevant to Activity?	Administering Authority	Relevant aspects of the Activity	EP Section
Management Act 1989	and refrigerants). Applicable to the handling of any ODS.		Environment and Energy	It is noted that ODS is rarely found on vessels' refrigeration system.	
Protection of the Sea (Powers of Intervention) Act 1981 Protection of the Sea (Powers of Intervention) Regulations 1983	The Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships and provides legal immunity for persons acting under an AMSA direction.	Yes	Commonwealth – Department of Infrastructure and Regional Development (AMSA administers the act and is responsible for ensuring compliance)	Vessel discharges Vessel movements Only relevant to the extent that Santos will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: Marine Orders - Part 91: Marine Pollution Prevention - Oil Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances Marine Orders - Part 95: Marine Pollution Prevention – Garbage Marine Orders - Part 96: Marine Pollution Prevention – Sewage Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems	**Section 6.1** – Interaction with other marine users **Section 6.3** – Planned operational discharges **Section 7.1** to **7.4** – for unplanned hydrocarbon and non-hydrocarbon/chemical spills **Section 7.7** – Introduction of IMS
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 Protection of the Sea (Prevention of Pollution from	This Act relates to the protection of the sea from pollution by oil and other harmful substances discharged from ships. This Act disallows any harmful discharge of sewage, oil and noxious substances into the sea and sets the requirements for a shipboard waste management plan. The following Marine Orders	Yes	Commonwealth – Department of Infrastructure and Regional Development (AMSA administers the	Vessel discharges Vessel movements Santos will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been	**Section 6.1** – Interaction with other marine users **Section 6.3** – Planned operational discharges **Section 7.1** to **7.4** – for unplanned hydrocarbon and

Commonwealth Legislation	Summary	Relevant to Activity?	Administering Authority	Relevant aspects of the Activity	EP Section
Ships) (Orders) Regulations 1994	relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: Marine Orders - Part 91: Marine Pollution Prevention - Oil Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances Marine Orders - Part 94: Marine Pollution Prevention - Harmful Substances in Packaged Forms Marine Orders - Part 95: Marine Pollution Prevention – Garbage Marine Orders - Part 96: Marine Pollution Prevention – Sewage Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems		act and is responsible for ensuring compliance)	put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: Marine Orders - Part 91: Marine Pollution Prevention - Oil Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances Marine Orders - Part 95: Marine Pollution Prevention – Garbage Marine Orders - Part 96: Marine Pollution Prevention – Sewage Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems	non-hydrocarbon/chemical spills **Section 7.7** – Introduction of IMS
Protection of the Sea (Civil Liability of Bunker Oil Pollution Damage) Act 2008	This Act implements the requirements for the International Convention on Civil Liability for Bunker Oil Pollution Damage.	Yes	AMSA	Refuelling of spill response vessels may be undertaken at sea	**Section 7.1**– Hydrocarbon release (vessel collision)
Protection of the Sea (Harmful Antifouling Systems) Act 2006	This Act relates to the protection of the sea from the effects of harmful anti-fouling systems. It prohibits the use of harmful organotins in ant-fouling paints used on ships.	Yes	Commonwealth, Department of Infrastructure and Regional	Vessel movements in Australian Waters. Vessels are required to have biofouling systems in place to prevent introduction of Invasive Marine Species /	**Section 7.7** - Introduction of IMS

Commonwealth Legislation	Summary	Relevant to Activity?	Administering Authority	Relevant aspects of the Activity	EP Section
			Development and AMSA	Harmful Impact on Australian biodiversity	

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
1996 Protocol to The Convention On The Prevention Of Marine Pollution By Dumping Of Wastes And Other Matter, 1972.	Implemented in WA Marine (Sea Dumping) Act and *Environmental Protection (Sea Dumping) Act 1981.*	No	No wastes will be dumped as part of the Activity.	N/A
Agreement Between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and Their Environment 1974 (commonly referred to as the Japan Australia Migratory Bird Agreement or JAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and Japan. Implemented in EPBC Act 1999.	Yes	Relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area and light emissions overlap breeding and foraging BIAs.	**Section 7.1** – Hydrocarbon release (vessel collision) **Section 6.3** – Light Emissions
Agreement Between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and Their Environment 1986 (commonly referred to as the China Australia Migratory Bird Agreement or CAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and China. Implemented in EPBC Act 1999.	Yes	Relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area and light emissions overlap breeding and foraging BIAs.	**Section 7.1** – Hydrocarbon release (vessel collision) **Section 6.3** – Light Emissions
United Nations Convention on Biological Diversity -1992	An international treaty to sustain life on earth.	Yes	Relevant only insofar as the Activity may interact with MNES (threatened and migratory species) protected under the EPBC Act.	**Section 7.1** – Hydrocarbon release (vessel collision) **Section 7.7 –** Introduction of IMS

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC 90)	This convention comprises national arrangements for responding to oil pollution incidents from ships, offshore oil facilities, seaports and oil handling. The convention recognises that in the event of pollution incident, prompt and effective action is essential.	Yes	In the event that worse-case credible spill scenarios may enact a national arrangement for response.	**Section 7.1** – Hydrocarbon release (vessel collision)
Convention on the Conservation of Migratory Species of Wild Animals 1979 (Bonn Convention)	The Bonn Convention aims to improve the status of all threatened migratory species through national action and international agreements between range states of particular groups of species.	Yes	A credible spill scenario may result in impacts to MNES protected migratory species. The Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities is also developed and maintained under the Convention.	**Section 7.1** – Hydrocarbon release (vessel collision) **Section 6.2** – Noise emissions
International Convention for the Prevention of Pollution from Ships 1973/1978 (MARPOL 73/78)	This Convention and Protocol (together known as MARPOL 73/78) build on earlier conventions in the same area. MARPOL is concerned with operational discharges of pollutants from ships. It contains five Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged substances, sewage and garbage. Detailed rules are laid out as to the extent to which (if at all) such substances can be released in different sea areas. The legislation giving effect to MARPOL in Australia is the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, the Navigation Act 2012 and several Parts of Marine Orders made under this legislation.	Yes	Santos will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: • Marine Orders - Part 91: Marine Pollution Prevention - Oil • Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances • Marine Orders - Part 95: Marine Pollution Prevention – Garbage • Marine Orders - Part 96: Marine Pollution Prevention – Sewage • Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution	**Section 7.1** to **7.4** – for unplanned hydrocarbon and non-hydrocarbon/chemical spills **Section 7.7** – Introduction of IMS

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
			• Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems	
International Convention for the Safety of Life at Sea 1974	This convention is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The legislation giving effect to the Safety Convention in Australia is the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, the Navigation Act 2012 and several Parts of Marine Orders made under this legislation.	Yes	Only relevant in so far as SOLAS relates to safety aspects of the Activity, such as navigation aids which reduce potential for vessel collision and hydrocarbon release to the environment (refer to table above for Navigation Act 2012)	**Section 7.1** – Hydrocarbon release (vessel collision)
United Nations Framework Convention on Climate Change (1992)	The objective of the convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. Australia ratified the convention in December 1992, and it came into force on 21 December 1993.	Yes	Only relevant into the extent that to reduce impact of GHG emissions associated with vessel use, Santos will comply with MARPOL Annex VI (Marine Orders Part 97: Marine Pollution Prevention – Air Pollution) And require the use of low sulphur fuel.	**Section 6.6**– Atmospheric emissions

APPENDIX B – VALUES AND SENSITIVITIES OF THE MARINE AND COASTAL ENVIRONMENT

EA-00-RI-10062

Santos

Values and Sensitivities of the Marine and Coastal Environment

PROJECT / FACILITY	All
REVIEW INTERVAL (MONTHS)	12 Months
SAFETY CRITICAL DOCUMENT	NO

Rev	**Owner**	**Reviewer/s** *Managerial/Technical/Site*	**Approver**
	HSE Government Approvals	**HSE**	**Principal Environment Advisor**
6	Nick Phillips	Sonja Mavrick Annette McGovern	Libby Howitt

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Rev	Rev Date	Author / Editor	Amendment
A	13/05/14	Oceanica	Technical review
B	13/05/14	Oceanica	Editorial review
0	30/07/14	EG/GG	Final
1	30/12/14	GG	Updated
2	28/07/2016	Jacobs	Updated
3	28/11/17	Jacobs	Updated
3.1	11/12/2018	Jacobs	Issued for technical review
4	17/12/2018	Jacobs	Issued for use
4.1	09/01/2019	Jacobs	Issued for technical review
5	14/02/2019	Santos	Issued for use
5.1	15/01/2020	CDM Smith	Issued for technical review
6	19/03/2020	CDM Smith	Issued for use

Contents

Figures

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Appendices

1. Introduction

Santos WA Energy Limited (Santos WA) is the titleholder of multiple petroleum titles for exploration, development and operational activities located in marine waters off north-western Western Australia. This document describes the existing environment that may be affected (EMBA) by these petroleum activities and includes details of the relevant values and sensitivities of that environment as required by the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* and State *Western Australian Petroleum (Submerged Lands) (Environment) Regulations 2012.*

The EMBA represents the largest possible spatial extent that could be contacted by the worst-case spill event modelled for Santos activities to date (loss of well control event from drilling an exploration well at Phoenix South). The EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of a worst case oil spill from Santos's activities. The low hydrocarbon exposure values as defined in NOPSEMA's '*Environmental Bulletin – Oil Spill Modelling*' (April 2019), are used as a predictive tool to set the outer boundaries of the EMBA.

This document describes the values and sensitivities of the marine environment based on the modelling results for the low hydrocarbon exposure values for the surface hydrocarbons and the entrained hydrocarbons from a loss of well control event at Phoenix South 2.

This document is informed by a search of the protected matters search tool (PMST) provided by the Department of Agriculture, Water and the Environment (DAWE) (previously the Department of the Environment and Energy (DoEE) (dated 25/11/2019 and provided in **Appendix A**), as well as published scientific literature and studies where applicable. Descriptions of all fauna are provided, with a focus on protected species that are threatened and migratory.

1.1 Geographical Extent

The EMBA, includes the coastal waters and shoreline habitats of Western Australia (WA), encompassing the south of WA and the Northern Territory (NT) border in the north (**Appendix A**). This area largely approximates the Commonwealth North-West Marine Region (NWMR), the South-West Marine Region (SWMR) and the North Marine Region (NMR). Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, there are 14 bioregions that occur within the EMBA. These bioregions are based on fish, benthic habitat and oceanographic data (IMCRA v. 4.0). Where relevant, the physical, biological and social environments within the EMBA are discussed with reference to the IMCRA Provincial Bioregions. The provinces of most relevance (**Figure 1-1**) are:

North-west Marine Region

+ Northwest Shelf Transition;
+ Timor Province;
+ Northwest Transition;
+ Northwest Province;
+ Northwest Shelf Province;
+ Central Western Transition;
+ Central Western Shelf Transition; and
+ Central Western Shelf Province.

South-west Marine Region

+ Central Western Province;
+ Southwest Shelf Transition;

- Southwest Transition; and
- Southwest Shelf Province; and
- Southern Province,

North Marine Region

- Northwest Shelf Transition (as above).

Other IMCRA 4.0 bioregions of interest include: Christmas Island Province.

The international waters of south west Indonesia and Timor-Leste (in part) are also included in the EMBA and described where relevant throughout this document.

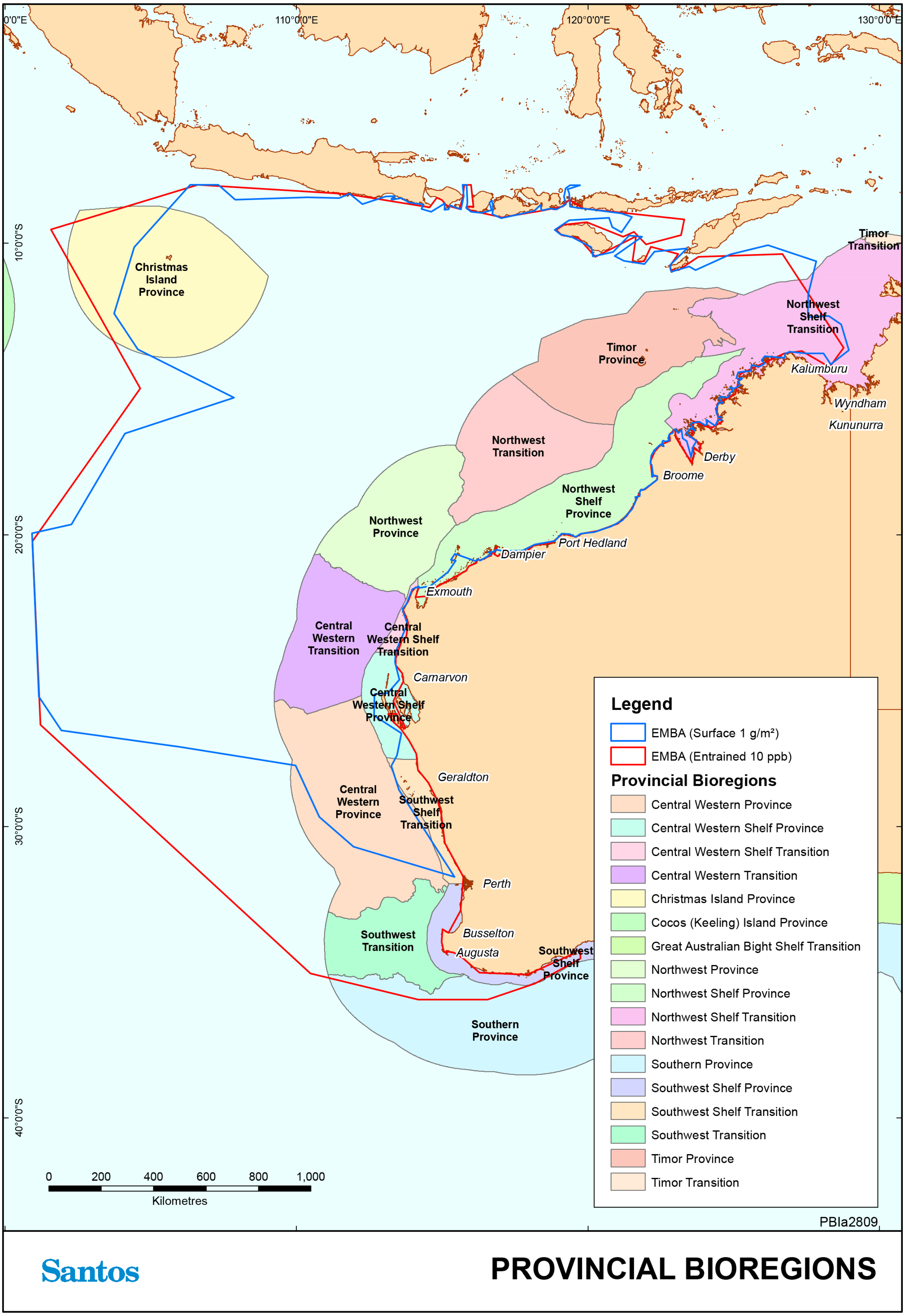

Figure 1-1: EMBA within IMCRA 4.0 Provincial Bioregions

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2. Physical Environment

2.1 Geomorphology

2.1.1 Formation History

Approximately 550–160 million years ago, northern and western parts of Australia formed part of the northern margin of Gondwana. About 300 million years ago, crustal stretching, rifting and breakup initiated development of an extensive basin that became the site for deposition of sediments (Baker *et al*. 2008 in Department of the Environment, Heritage, Water and the Arts (DEWHA) 2008a). Approximately 135 million years ago the continent broke up resulting in the separation of greater India and Australia. Ocean spreading associated with the continental break-up resulted in the creation of the Argo and Cuvier abyssal plains. Subsidence of the rifted margin resulted in the formation of the Exmouth and Scott plateaux and the Rowley Terrace. The narrow shelf south of North West Cape was formed approximately 130 million years ago as a result of the separation of India and seafloor spreading (Baker *et al*. 2008 in DEWHA 2008a).

The South-west region has been relatively stable throughout its recent geological past. This has shaped a continental shelf that has high wave exposure and is punctuated with coastal features such as island groups and fringing coastal reefs providing sheltered habitats for marine communities (2008a).

2.1.2 Present Day Geological Features

The EMBA consists of five major landform features: continental shelf, continental slope, continental rise, Exmouth plateau and abyssal plain. The majority of the area consists of either continental shelf or continental slope (DEWHA 2008a).

Limited surveys have shown that the continental slope in the EMBA comprises diverse geological features such as canyons, plateaux, terraces, ridges, reefs, banks and shoals (DEWHA (2008)) (**Figure 2-1** and **Figure 2-2**). These features are significant in that over half of the total area of banks and shoals across Australia's entire marine jurisdiction occurs in the Commonwealth waters from the South Australian border to the Northern Territory border, as well as 39% of terraces and 56% of deeps, holes and valleys (DEWHA 2008a).

An important characteristic of the EMBA is the significant narrowing of the continental shelf around North West Cape from the broad continental shelf in the north (**Figure 2-3**). For example, in the Joseph Bonaparte Gulf (at the NT boundary), the continental shelf is around 400 km wide, whereas at North West Cape the shelf is only 7 km wide – the narrowest of anywhere on the Australian continental margin (DEWHA 2008a). Shelf width affects oceanography with flow on effects to productivity and ecosystem functioning.

The continental shelf north of Cape Leveque is characterised by a rimmed ramp where the waters over the outer margins of the shelf (approximately 50 to 100 m waters depth) are shallower than the middle portions (up to 150 m water depth). The rim at its outer edge is the site of a number of coral reefs including Ashmore, Cartier, Scott and Seringapatam (DEWHA 2008a).

The Indonesian archipelago lies between the Pacific and Indian oceans, and bridges the continents of Asia and Australia. The archipelago is divided into several shallow shelves and deep-sea basins.

2.1.3 Southwest Shelf Province

The Southwest Shelf Province consists of an area of narrow continental shelf from Rottnest to Point Dempster. For the purposes of this document (EMBA), the northern and western limits of the bioregion are the main focus because it is this portion that falls within the EMBA, which are an extension of the seafloor described in the Southwest Shelf Transition (below). It includes features such as limestone ridges, depressions defining an inshore lagoon and a relatively smooth inner shelf plain that meets the South Bank Ridge on the outer shelf, and islands providing important habitat, such as Rottnest Island. The shelf progressively broadens to form the relatively sheltered waters of Geographe Bay before narrowing once again at Cape Mentelle.

2.1.4 Southwest Shelf Transition

The Southwest Shelf Transition is a nearshore bioregion that covers the area of continental shelf from Perth to Busselton, and extends out to the edge of the shelf. This bioregion consists of a narrow continental shelf, ranging from approximately 40–80 km wide. It includes a series of complex nearshore ridges and depressions that form inshore lagoons, a smooth inner shelf plain, a series of offshore ridges and a steep, narrow outer shelf. The near-shore ridges are formed by eroded limestone reefs and pinnacles that stand 10–20 m above the seafloor. The edge of the inner shelf plain is marked by a series of broken offshore ridges that extend north to the northern limits of the bioregion, where they emerge to support the tropical carbonate reef growth of the Houtman Abrolhos Islands.

2.1.5 Southwest Transition

The Southwest Transition is an offshore deep-water bioregion with a submerged continental fragment as its dominant seafloor feature – the Naturaliste Plateau. The Plateau extends across an area of 90,000 km^2 of which only 29,825 km^2 is within Commonwealth waters. It is located west of Cape Leeuwin and Cape Naturaliste in water depths ranging from 2,000–5,000 m. It is relatively flat with a slight northward dip, and has steep southern and western sides and a more gently sloping northern side. The Plateau is separated from the Australian continent by the Naturaliste Trough and two offshore terraces on the continental slope (average depth 780 m). Submarine canyons incise the northern parts of the slope and parts of the Naturaliste Plateau.

2.1.6 Southern Province

The Southern Province is the largest bioregion within Australia's waters stretching from the shelf break south of Kangaroo Island to the southern edge of the Naturaliste Plateau. The bioregion includes the deepest ocean areas within the Australian Exclusive Economic Zone (approximately 5,900 m maximum water depth) and consists of a long continental slope incised by numerous well-developed submarine canyons. Several key ecological features are present within the EMBA and include the Albany Canyons Group, the Ceduna and Eyre Terraces (covering approximately 147,150 km^2) and the Diamantina Fracture Zone.

2.1.7 Sediments

Terrestrial environments are not a major source of sediment in the area and terrigenous sediments tend to be confined to the inner shelf (generally less than 100 m water depth), particularly in areas adjacent to rivers. Sediments in the area generally become finer with increasing water depth, ranging from sand and gravels on the shelf to mud on the slope and abyssal plain. Joseph Bonaparte Gulf is an exception to this pattern, as sediments with high mud content extend across the inner and mid shelf within the Gulf, graduating to sands and gravels in the Bonaparte Depression.

The distribution and resuspension of sediments on the inner shelf is strongly influenced by the strength of tides across the continental shelf as well as episodic events such as cyclones. Further offshore, on the mid to outer shelf and on the slope itself, sediment movement is primarily influenced by ocean currents and internal tides. Internal tides describe the tidal movement across a slope of water stratified by marked differences in density. Internal tides cause resuspension and net down-slope deposition of sediments on the North West Shelf (DEWHA 2008a).

Surveys conducted over the North West Shelf indicate that similar sediments occur extensively over this geographic region, but with spatial variation in the grain size and origin of the surface sediments.

The ecology of the southwest is also greatly influenced by the lack of river discharge into the Region. The few significant rivers adjacent to the Region flow intermittently and their overall discharge is low. The low discharge of rivers and the generally low rate of biological productivity also results in low turbidity (suspended sediments), making the waters of the Region relatively clear (McLoughlin & Young 1985). Surface sediments in the area are predominantly composed of skeletal remains of marine fauna, with lenses of weathered sands (McLoughlin & Young 1985).

Several geomorphic formations have been associated with Key Ecological Features (DEWHA 2008a) and these are discussed in **Section 10**.

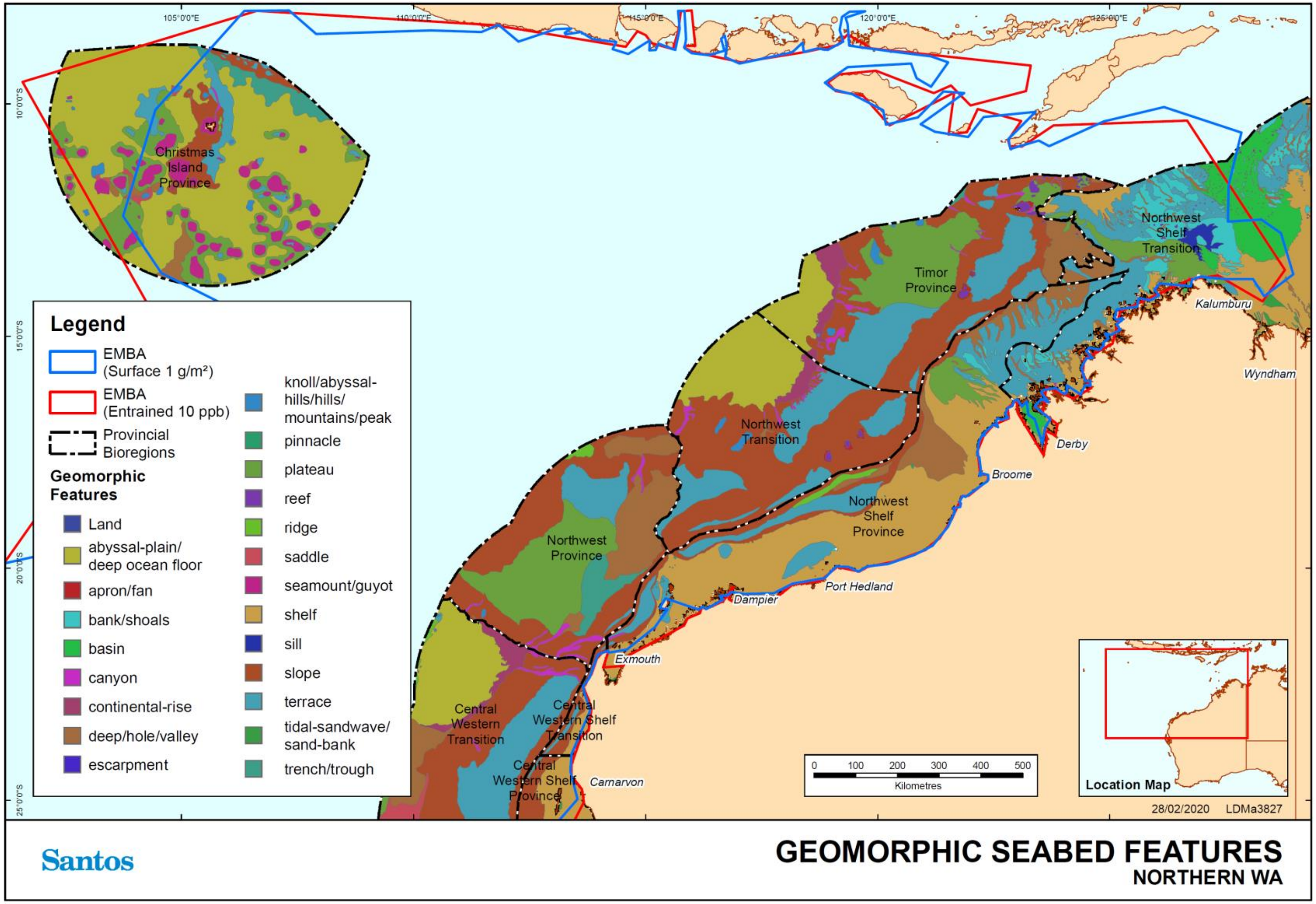


Figure 2-1: Geomorphic/seafloor features of Northern WA

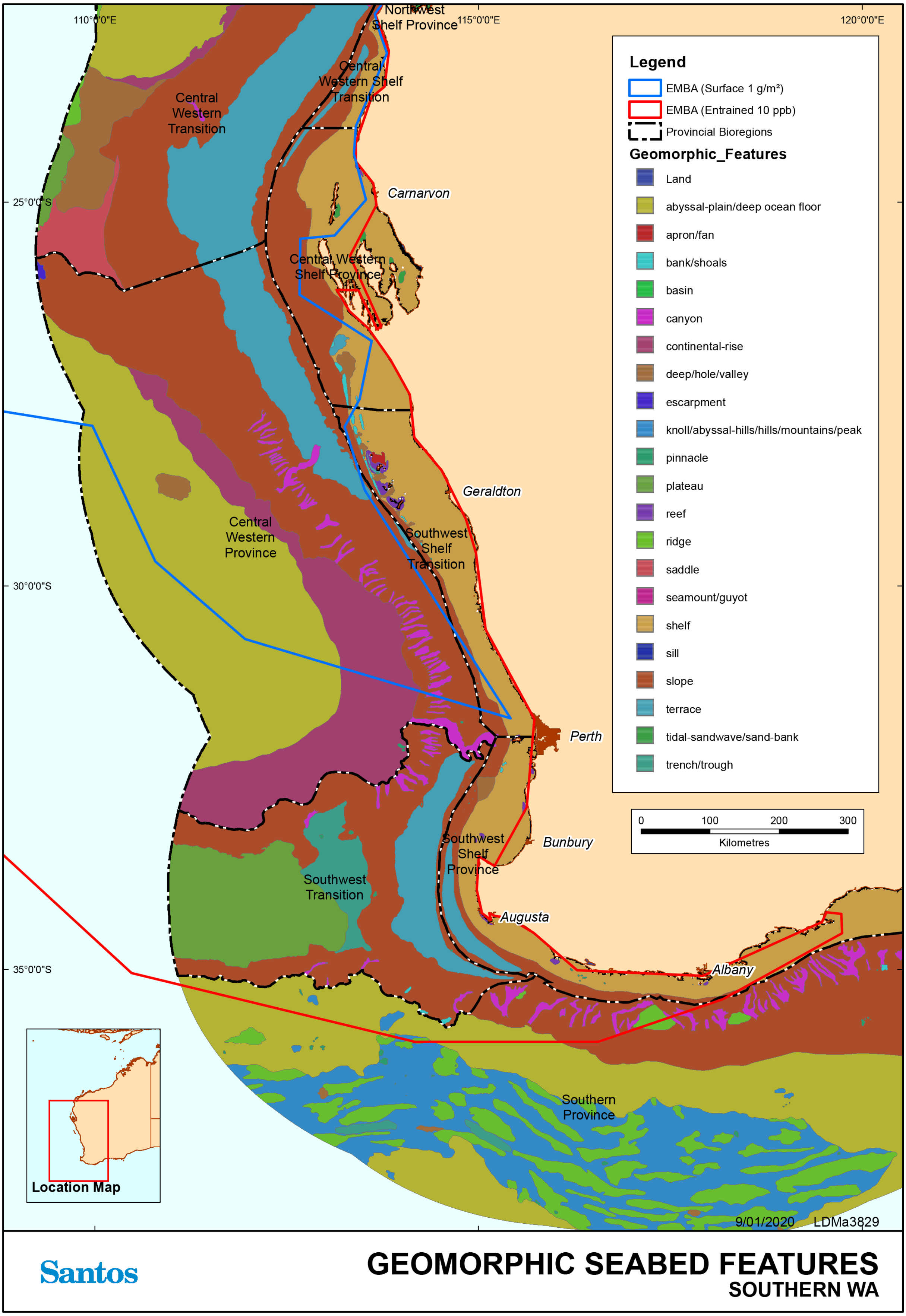


Figure 2-2: Geomorphic/seafloor features of Southern WA

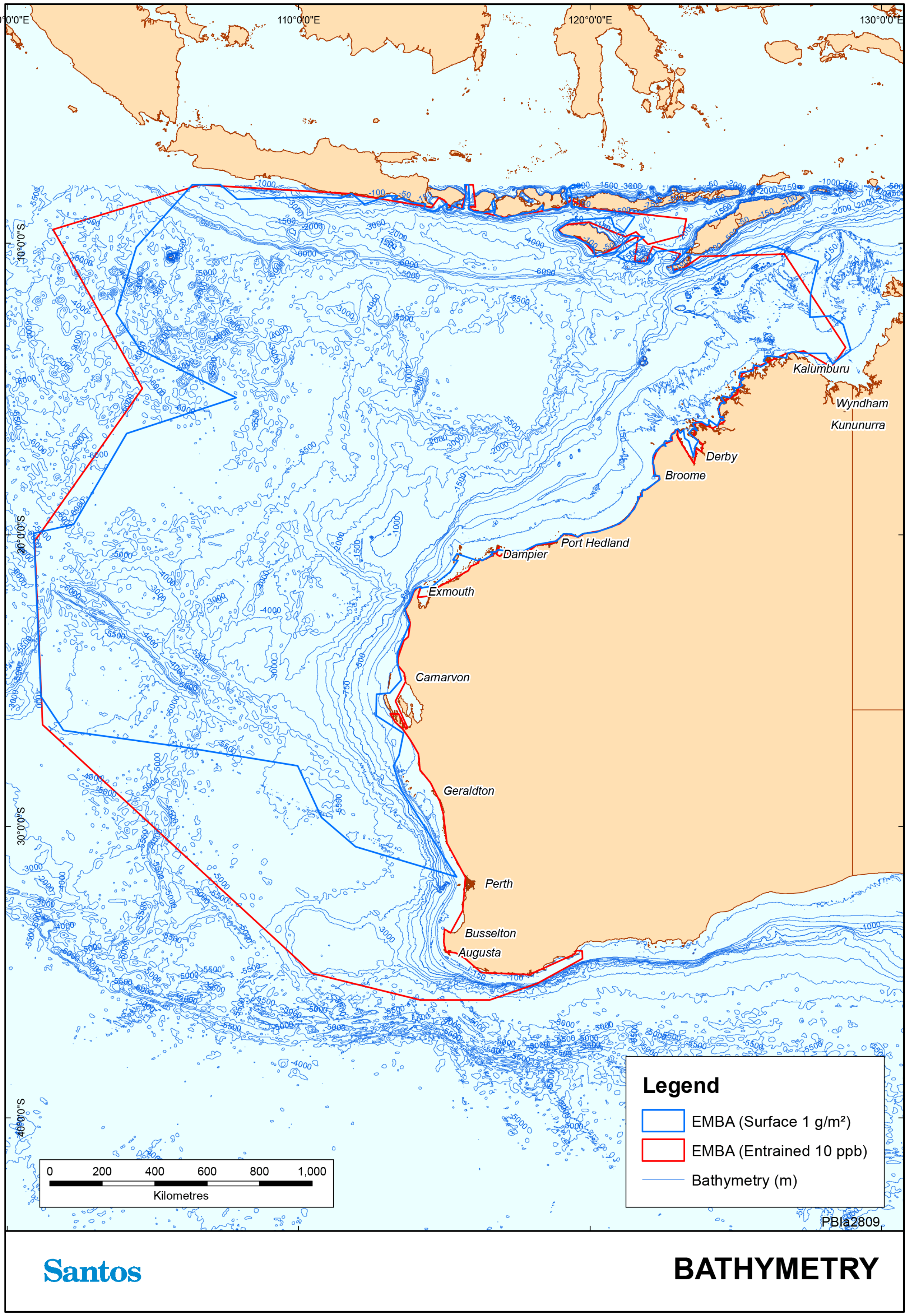


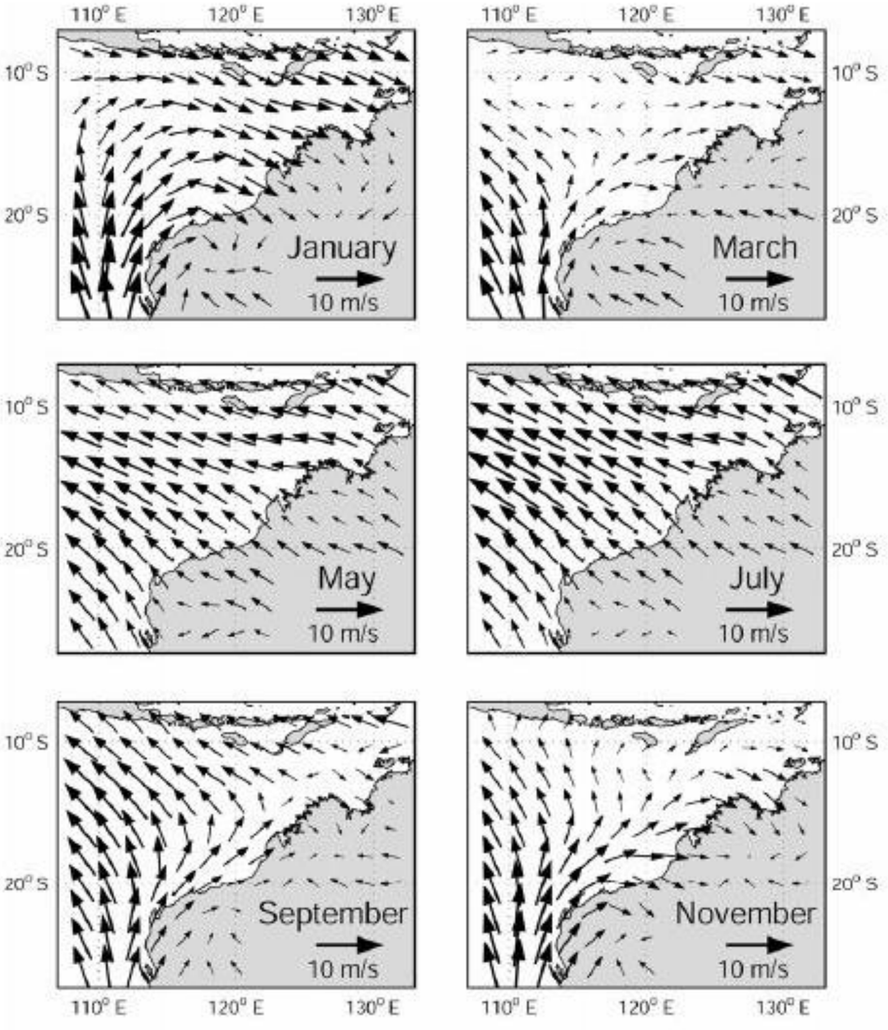
Figure 2-3: Bathymetry of the EMBA

2.2 Climate

Waters in northern Western Australia predominantly lie in the arid tropics, experiencing high summer temperatures and periodic tropical cyclones in summer. Rainfall in the region is low, although intense rainfall may occur during the passage of summer tropical cyclones and thunderstorms (Condie *et al.* 2006). Mean air temperatures range from a minimum of 11°C in winter to a maximum of 36°C in summer (Condie *et al.* 2006). Due to the arid climate, daytime visibility in the area is generally greater than 5 nautical miles (SSE 1991).

The summer and winter seasons fall into the periods September–March and May–July, respectively. Winters are characterised by clear skies, fine weather, predominantly strong east to southeast winds and infrequent rain (calculated from NCEP-NCAR dataset measured from 1982 to1999; Condie *et al.* 2006; **Figure 2-4**).

Summer winds are more variable, with strong south-westerlies dominating. Transitional wind periods, during which either pattern may predominate, can be experienced in April–May and September of each year.



Calculated from NCEP-NCAR dataset measured from 1982 to 1999. Source: Condie *et al*. (2006)

Figure 2-4: Seasonally averaged winds at 10 m above mean sea level

Tropical cyclones generate the most significant storm conditions in the area (SSE 1993). These clockwise-spiralling storms have generated wind speeds 50–120 knots (SSE 1991). Tropical cyclones develop in the eastern Indian Ocean, and the Timor and Arafura Seas during the summer months. Three to four cyclones per year are typical, with the official cyclone season being November through to April (Bureau of Meteorology

(BoM) 2013). In Indonesia, the main variable in climate is not temperature or pressure, but rainfall, which varies greatly by month and place, ranging from 997 millimetres (mm) to 4,927 mm.

Waters in the southwest and southern Western Australia experience a Mediterranean style climate that is characterised by cool, wet winters and hot, dry summers. In winter, wind patterns are characterised by a prevailing westerly wind stream. This enables winter cold fronts and strong westerly winds to regularly penetrate the south-west, with cold fronts crossing the coast every week or so. Apart from the passage of storms, typically lasting one day or less, the weather is otherwise mild in winter with winds variable and relatively weak. In summer, cold fronts rarely penetrate into the south of the state with any strength and hot easterly winds prevail.

2.3 Oceanography

Major drivers of marine ecosystems include ocean currents, tides, waves, temperature and salinity. The dominant offshore sea surface current is the Leeuwin Current (**Figure 2-5**), which carries warm tropical water south along the edge of Western Australia's continental shelf, reaching its peak strength in winter and becoming weaker and more variable in summer (Condie *et al.* 2006). The current is typically located seaward of the shelf break (200 m isobath) and is a narrow, surface current, extending to a depth of 150 m (BHPB 2005, Woodside 2005) and a width of 50–100 km (DEWHA 2008a). The formation of meanders and eddies are also a feature of the Leeuwin Current and a number of eddies occur south of Shark Bay (DEWHA 2008a). The strength of the Leeuwin Current is influenced by seasonal variability in the pressure gradient (DEWHA 2008a). The Holloway Current is the prevailing seasonal current, travelling south-west along the north West Australian coast in winter and north-east in summer (Brewer et al. 2007).

The Indonesian Throughflow is the other important current influencing the upper 200 m of the outer North West Shelf (Woodside 2005). This current brings warm and relatively fresh water to the region from the western Pacific via the Indonesian Archipelago (**Figure 2-5**). Modelling undertaken by Woodside and Commonwealth Scientific and Industrial Research Organisation (CSIRO) Marine and Atmospheric Research indicates that significant east–west flows occur across the North West Shelf to the north of the North West Cape, possibly linking water masses in the area (Woodside 2005, Condie *et al.* 2006).

Currents in the coastal zone and over the inner to mid-shelf are largely driven by tides and winds, whereas offshore, over the continental shelf, slope and rise are influenced by large scale regional circulation (DEWHA 2008a).

The nearshore Ningaloo Current flows northwards opposite to the Leeuwin Current, along the outside of the Ningaloo Reef and across the inner shelf from September to mid-April (BHPB 2005, Woodside 2005). The nearshore Capes Current, which is to the south of the Ningaloo Current, is a seasonal current that appears strongest between Cape Leeuwin and Cape Naturaliste, in the southwest of Western Australia (Pearce and Pattiaratchi 1999). Strong northwards winds between November and March slow the Leeuwin Current and increase the strength of the Capes Current. Localised upwelling is also known to occur in the area (Pearce and Pattiaratchi 1999).

Tides increase in amplitude from south to north, corresponding with the increasing width of the shelf (Holloway 1983). Tides in the area are generally semi-diurnal (i.e. two high tides and two low tides per day) with a spring/neap cycle. The northern area experiences some of the largest tides in the world. In the Kimberley, the daily tidal range is up to 10 m during spring tides and less than 3 m during some neap tides. Mid-shelf tidal currents are predicted to have average speeds of approximately 0.25 knots during neap tides and up to 0.5 knots during spring tides (NSR 1995, WNI 1995).

The wave climate in the northwest is composed of locally-generated wind waves (seas) and swells that are propagated from distant areas (WNI 1995). In summer the seas typically approach from the west and southwest, while in winter the seas typically approach from the south and east. Mean sea wave heights are typically less than 1 m and peak heights of less than 2 m are experienced in all months of the year (WNI 1995).

Indonesian waters, especially the eastern part of the archipelago, play an important role in the global water mass transport system, in which warm water at the surface conveys heat to the deeper cold water in what is known as the great ocean conveyor belt (refer **Figure 2-5**). The eastern archipelago is the only place in the

Pacific Ocean that connects with the Indian Ocean at lower latitudes. The water mass transport from the Pacific to the Indian Ocean through various channels in Indonesia is called Arlindo (Arus Lintas Indonesia), also known as the Indonesian Throughflow (ADB 2014). Surface currents in Indonesian waters are more strongly influenced by circulation from the Pacific Ocean than from the Indian Ocean. The currents are also greatly influenced by the winds of the prevailing monsoon.

Average swell heights are low, around 0.4–0.6 m in all months. The greatest exposure to swells is from the west (SSE 1993). Tropical cyclones have generated significant swell heights of up to 5 m in this area, although the predicted frequency of swells exceeding 2 m is less than 5% (WNI 1996). In the open ocean, sustained winds result in wind-forced currents of approximately 3% of the wind speed (Holloway & Nye 1985).

Tides in the South West Capes area are mixed (i.e. diurnal and semi-diurnal) and generally less than one metre, with a typical daily range of about 0.7 m during spring tides and about 0.5 m during neap tides. Tides of this magnitude produce weak currents compared to wind and wave driven flows (Hill & Ryan 2002 cited in Department of Environment and Conservation (DEC) 2013).

Waters on the continental shelf are usually thermally-stratified, with a marked change in water density at approximately 20 m (SSE 1993). Surface temperatures vary annually, being warmest in March (32°C) and coolest in August (19°C). Vertical gradients are related to the seasonality of sea surface temperatures, and are greatest during the warm-water season (SSE 1991). Near-bottom water temperature on the North West Shelf is approximately 23°C, with no discernible seasonal variation.

Salinity is relatively uniform at 34–35 ppt throughout the water column and across the North West Shelf. Due to the low rainfall there is little freshwater run-off from the adjacent mainland (Blaber *et al*. 1985).

Pronounced shifts in water column characteristics can occur following the passage of tropical cyclones (McKinnon *et al*. 2003). Changes in water temperature and salinity characteristics can result from changes in local heating and evaporation following the southward movement of warmer water due to southward-moving cyclones, and can have flow-on effects to primary and secondary productivity (McKinnon *et al*. 2003).

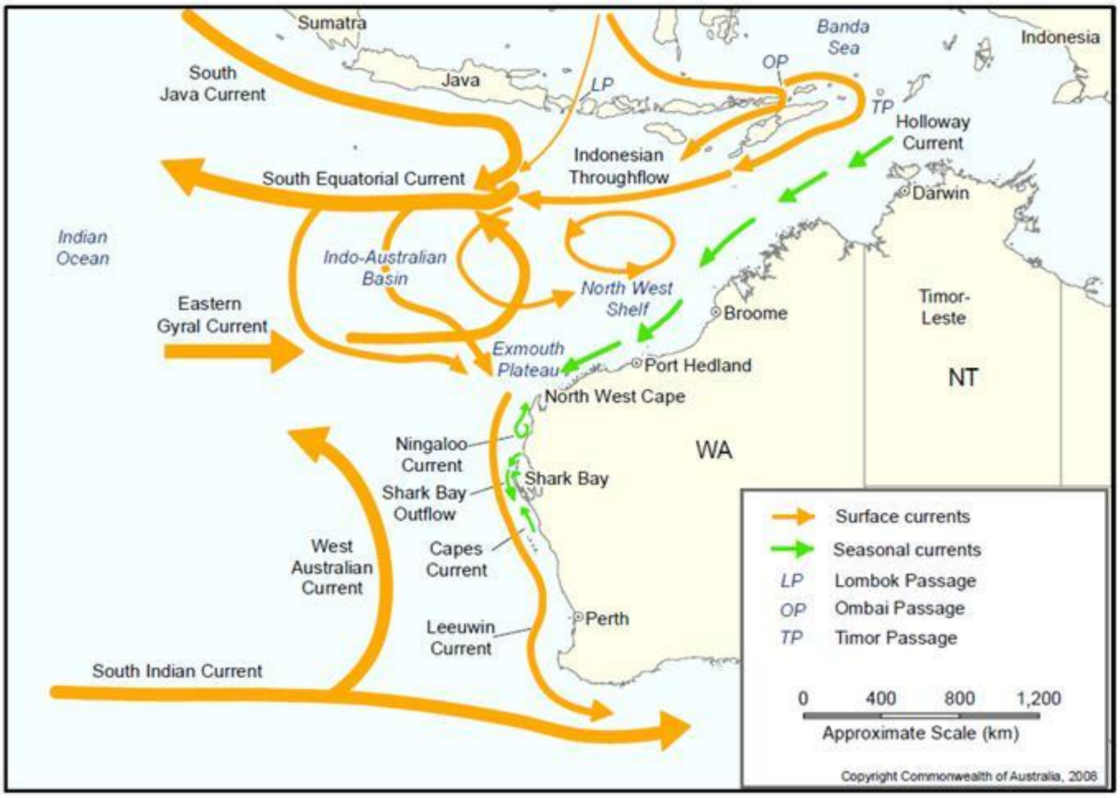


Figure 2-5: Surface currents in WA

Source: DEWHA (2008b)

3. Benthic and Pelagic Habitats

Benthic habitats are defined as those subtidal habitats lying below the lowest astronomical tide (LAT). The benthic habitats within waters in the EMBA lie at depths ranging from LAT down to more than 6,000 m at Argo and Cuvier abyssal plains (DEWHA 2008a, 2008b).

Benthic habitats are partially driven by light availability. Primary producers (photosynthetic corals, seagrasses and macroalgae) are limited to the photic zone, whereas benthic invertebrates including filter feeding communities may be found in deeper waters. The depth of the photic zone varies spatially and temporally and is predominantly dependent on the volumes of suspended material in the water column. The photic zone in the offshore Pilbara is approximately 70 m whereas in oceanic waters in the northwest and coastal waters of the southwest the photic zone may extend to 120 m (DEWHA 2008b).

The following section broadly categorises benthic habitats as four biological communities; coral, seagrasses, macroalgae and non-coral benthic invertebrates. These communities are discussed in terms of the 14 IMCRA v. 4.0 bioregions. Some broad scale benthic habitat mapping exists for the Northwest and Central Western Shelf Provinces and this is shown in **Figure 3-1**.

3.1 Coral Reefs

Corals are both primary producers and filter feeders and thus play a role in the provision of food to marine fauna and in nutrient recycling to support ecosystem functioning (Conservation and Land Management (CALM) & Marine Parks and Reserves Authority (MPRA) 2005a).

Corals create settlement substrate and shelter for marine flora and fauna. Studies have shown that declines in the abundance, or even marked changes in species composition of corals, has a marked impact on the biodiversity and productivity of coral reef habitats (Pratchett *et al*. 2008). As part of the reef building process, scleractinian corals are also important for protection of coastlines through accumulation and cementation of sediments and dissipation of wave energy (CALM & MPRA 2005a).

The waters in the EMBA contain extensive coral communities. Coral reefs in the area fall into two general groups: the fringing reefs around coastal islands and the mainland shore; and large platform reefs, banks and shelf-edge atolls offshore (Woodside 2011). The distribution of corals in area is governed by the availability of hard substrate for attachment and light availability.

Coral reefs are dynamic environments that regularly undergo cycles of disturbance and recovery. Depending on how frequent and severe the disturbances are, recovery can take a few years or more than a decade. Disturbances can include bleaching, cyclones and disease outbreaks (Australian Institute of Marine Science (AIMS) 2011).

Corals in the northwest and central provinces have experienced bleaching events and subsequent recovery. Bleaching is the process where symbiotic algae are expelled from the coral tissue, often leading to the death of the colony. Causes of bleaching include high temperatures (Scott Reef; 1998), anoxic conditions (Bill's Bay; 2008) or smothering (Waples & Hollander 2008, Gilmour et al. 2013). Coral susceptibility to bleaching and their ability to recover is an important consideration in the context of potential anthropogenic impacts.

Four bioregions (Northwest Province, Northwest Transition, Central Western Province and Central Western Shelf Transition) lie in deep waters below the photic zone. Two bioregions (Southwest Transition and Southwest Shelf Province) occur in waters that are too cold to support tropical coral reefs species. Photosynthetic corals are not present in either of these locations and hence these bioregions are not discussed further.

3.1.1 Southwest Shelf Transition

The coral reefs of the Houtman Abrolhos Islands are the most southern extensive coral community along the west coast. Smaller localised pockets do occur as far south as Rottnest Island and even extend to Cape Naturaliste in the Southwest Shelf Province. The reefs around the Abrolhos Islands comprise 211 known species of corals and all but two of the coral species are tropical (Department of Fisheries (DoF) 2012). The greatest diversity and density of corals is found on the reef slopes, shallow reef perimeters and lagoon patch reefs in the more sheltered northern and eastern sides of each of the three limestone platforms that support the island groups (DoF 2012).

3.1.2 Central Western Shelf Province

The Central Western Shelf Province occurs on the continental shelf between Coral Bay and Busselton and is generally flat with depths ranging from 0–100 m. The province includes Shark Bay and Bernier, Dorre and Dirk Hartog Islands.

Studies at Shark Bay recorded 80 species of coral (Marsh 1990). The study determined that salinity and seasonal temperature gradients restrict the distribution of corals to areas that have normal salinity in the western half of the Bay, a few species occur in the metahaline waters but none in the hyper saline areas (Marsh 1990). The eastern shores of Bernier, Dorre and Dirk Hartog Islands provide the most favourable habitats for coral growth due to shelter, and water with relatively small salinity and temperature fluctuations. Some sections of these islands support prolific coral growth (up to 100% cover) both in the sheltered leeward and exposed areas. This bioregion is a transitional zone between the predominantly tropical flora and fauna of the north and temperate flora and fauna further south (CALM & NPNCA 1996).

3.1.3 Central Western Shelf Transition

A significant proportion of this bioregion is covered by the Ningaloo Reef. The Ningaloo Reef is unique in that it is the largest fringing reef in Australia and is the only large reef found on the western side of a continent in the southern hemisphere.

A 300 km section of the coast, from Red Bluff to North West Cape and extending to Bundegi in Exmouth Gulf, is included in the Ningaloo Marine Park. Ningaloo Reef supports variable lagoonal, intertidal and subtidal coral communities along its length. Ningaloo Reef is characterised by a high diversity of hard corals with at least 217 species representing 54 genera of hermatypic (reef building) corals recorded to date (Veron & Marsh 1988). The most diverse coral communities are found in the shallow relatively clear water, high energy environment of the fringing barrier reef and low energy lagoonal areas to the west of North West Cape (CALM & MPRA 2005a).

Coral diversity reduces with increasing depth, and corals are uncommon at depths greater than 40 m (Waples & Hollander 2008). At depths between 20 and 30 m hard corals have been found to be more dominant in the northern areas of the Ningaloo Marine Park, whereas in southern areas other sessile invertebrates such as sponges, as more prevalent (Waples & Hollander 2008).

3.1.4 Northwest Transition

This bioregion lies mostly over the continental slope and the abyssal plain in deep waters that preclude photosynthetic coral growth (DEWHA 2008a). However, in contrast with the surrounding area, the Rowley Shoals are three distinct reef systems (Mermaid, Clerke and Imperieuse Reefs) approximately 30–40 km apart that rise vertically to the surface from depths of between 500 and 700 m. The marine reef fauna of the Rowley Shoals is considered to be exceptionally rich and diverse, including species typical of the oceanic coral reef communities of the Indo-West Pacific. As many of these species are not found in the inshore tropical waters of northern Australia, such populations are of regional significance (DEWHA 2008a).

A 1993 survey at Mermaid Reef recorded 214 species of scleractinian corals (Done *et al*. 1994). The survey found that coral assemblages of the Rowley Shoals are broadly comparable to those found on the reefs of the outer Great Barrier Reef and in the Coral Sea. While the coral fauna is similar to Scott Reef, it differs considerably from that of north-western Australia (Veron 1986). Veron (1986) notes that the clear water of the Rowley Shoals allows coral communities to exist over a great range of depths, while the strong wave action on the outer coral slopes and the wide tidal range result in distinct patterns of zonation.

3.1.5 Northwest Shelf Province

This province contains numerous small coastal islands in addition to larger archipelago and offshore island groups. Many of these features are surrounded by shallow waters with small barrier and fringing reefs that support coral communities. Key areas recognised for coral communities in this bioregion are discussed below.

The Dampier Archipelago supports coral reefs in shallow waters near islands and submerged pinnacles. The most significant coral reefs have formed along the seaward slopes of Delambre Island, Hamersley Shoal, Sailfish Reef, Kendrew Island and north-west Enderby Island (CALM & MPRA 2005). Field trips in the Dampier Archipelago between 1972 and 1998 recorded 229 species of corals from 57 genera (Griffith 2004). Surveys of the Dampier Port and inner Mermaid Sound recorded approximately 120 coral species from 43 genera (Blakeway & Radford 2005) with coral reefs dominated by acroporids and pocilloporids. The greatest coral cover (up to 70%) was recorded in the eastern half of the archipelago (Wells *et al*. 2003).

The Montebello, Lowendal and Barrow Islands include 315 islands associated with extensive coral reefs, the most significant of which occur in the sheltered waters on the eastern side of the islands. Examples of these significant reefs include Dugong Reef, Batman Reef and reefs along the Lowendal Shelf (DEC & MPRA 2007a). Dominant corals include acroporids and poritids, with greater than 70% cover recorded for some areas (Chevron 2010). Subtidal coral reef communities around the islands are highly diverse, with at least 150 species of hard corals recorded from fringing and patch coral reef areas (DEC & MPRA 2007a).

Coral distribution near the mainland is restricted by lack of light due to natural turbidity. Corals may exist as sparse coral colonies in some locations, rather than extensive coral communities. Within Exmouth Gulf, coral communities are less common but are present on fringing reefs surrounding islands, as solitary corals distributed across areas of hard substrate, or on larger isolated patch reefs.

An epibenthic dredge survey of nearshore areas north of Broome identified 14 species of hard corals from six families (Keesing *et al*. 2011). Limited coral surveys conducted at Broome (15 species) and the Lacepede Islands (ten species) (Veron & Marsh 1988) suggest the species diversity in this locality may be low. However, low species diversity observed during the dredge survey may reflect the limited sampling frequency, limited depth range (11–23 m) or inadequate sampling in habitats considered favourable for the proliferation of hard corals (hard substrate). In contrast, other surveys of nearshore locations in the region have recorded much higher levels of species diversity. Veron and Marsh (1988) stated that 102 species of hard corals have been recorded from the Kimberley coast and nearshore reefs and Cairns (1998) recorded 87 species of azooxanthellate hard coral species from north-western Australian waters.

3.1.6 Timor Province

Although water depths in this province are generally deep (200 m to almost 6,000 m) there are several reefs and islands that are regarded as biodiversity hotspots (DEWHA 2008a).

Ashmore Reef, Cartier Island, Hibernia, Scott and Seringapatam Reefs are areas of enhanced local biological productivity, within an area of relatively unproductive waters. Ashmore Reef National Nature Reserve supports one of the greatest number of coral species of any reef off the West Australian coast, with 255 species of reef-building corals in 56 genera (Veron 1993). Taxonomic revisions and additional surveys have resulted in a net increase in species numbers to 275 (Griffith 1997, Ceccarelli *et al*. 2011). Species are typical of the Indo-pacific region and none are unique or considered endemic. However, 41 species (15% of the total hard coral species at the site) are listed as vulnerable on the IUCN Red List (IUCN 2019). In 1998, hard coral covered an area of around 717 ha at Ashmore Reef. The majority of hard corals occur in the deep lagoon (265 ha) and shallow reef top (315 ha) with small areas in the shallow lagoons, and reef edge/slope habitats (Skewes *et al*. 1999a). The soft, non-reef building corals are less well studied at Ashmore Reef than the hard corals (Hale & Butcher 2013). In 1986, 39 soft coral taxa were recorded within the Ashmore Reef, including the vulnerable blue coral (*Heliopora coerulea*) which was moderately common on the reef flats (Marsh 1993). In 1998, the total cover of soft coral at Ashmore Reef was 323 ha and *Sarcophyton* spp. was the dominant taxa covering around 19 ha in total (Skewes *et al*. 1999b, Hale & Butcher 2013).

The species composition of all the hard coral reefs in the bioregion is very similar and reflects strong links with Indo-West Pacific fauna, largely as a result of the dispersal of coral spawn via regional currents. The reefs and islands in this bioregion are thought to be important biological stepping-stones between centres of biodiversity in the Indo–Pacific and reef ecosystems further south (DEWHA 2008a).

Seringapatam Reef is a regionally important scleractinian coral reef as it has a high biodiversity, which is comparable to Ningaloo Reef. Results from the Western Australian Museum (WAM) survey in 2006 noted 159 species of scleractinian corals with a hard coral cover of approximately 16% (WAM 2009). The dominant benthic habitats of the reef were observed to include hard and soft corals (Heyward et al. 2013 cited in ConocoPhillips 2018).

Scott Reef consists of two reefs, North Scott Reef and South Scott Reef, which are separated by a deep (400–700 m) channel. North Scott Reef is an annular reef which encloses a lagoon that is connected to the ocean. South Scott Reef is a crescent-shaped reef which forms an arc and partially encloses another lagoon. Light penetration at Scott reef is high due to low turbidity. Light penetration depths to the deeper part of South Reef Lagoon are in excess of 50m with corals able to survive at depths of up to 70 m (Woodside Energy Limited *et al.* 2010).

Hibernia Reef consists of an approximately oval-shaped reef, with large areas of the reef becoming exposed at low tide. Hibernia Reef is also characterised by a deep central lagoon and drying sand flats.

There are a number of shoals and banks in the NMR and NWMR. Relatively few studies have been undertaken of these features with the majority of the understanding derived from the Big Bank Shoals study (Heyward *et al*. 1997), PTTEP surveys initiated in response to the Montara incident (Heyward *et al*. 2010; Heyward *et al.* 2011) and ConocoPhillips baseline surveys undertaken to support the Barossa Area Development (Heyward *et al.* 2017). The PTTEP surveys completed at Ashmore, Cartier and Seringapatam Reefs were undertaken during a coral bleaching disturbance likely to be attributed to regional thermal stress indicated by both *in situ* and satellite based data for the region. The condition of the reefs communities was consistent with previous surveys within the area and did not indicate any disturbance from the Montara incident (Heyward *et al*. 2010; Heyward *et al.* 2012).

In general, the submerged features are characterised by abrupt bathymetry, rising steeply from the surrounding outer continental shelf at depths of 100 m–200 m. The shoals and banks tend to flatten at depths of 40-50 m, with horizontal plateau areas of several square kilometres generally present at 20-30 m depths (Heyward *et al*. 2010). The shoals and banks support a diverse and varied range of benthic communities, including algae, reef-building soft corals, hard corals and filter-feeders (Heyward *et al.* 1997, Heyward *et al.* 2012). The plateau areas were dominated by benthic primary producer habitat, with interspersed areas of sand and rubble patches (Heyward *et al*. 2012).

3.1.7 Northwest Shelf Transition

Coral communities of the Northwest Shelf Transition have historically not been well studied. However, based on the scale of reef development and the diversity of coral species recorded through limited surveys, it is highly likely that further surveys will demonstrate that the Kimberley contains a coral reef province of global significance (Masini *et al*. 2009).

Coral reefs in the province include fringing reefs around coastal islands and some mainland shores. Development of coral communities in inshore areas is limited due to persistent high turbidity. Known examples of coral reefs in the bioregion are given below, however further mapping is required.

Benthic habitat surveys at Adele and Long Islands in 2009 and 2010 revealed extensive development of hard and soft coral communities (Richards *et al*. 2013). Scleractinian coral communities at Adele Island were diverse, supporting 176 species in intertidal and subtidal areas up to 14 m depth. At Long Island approximately 200 species of scleractinian corals were recorded in intertidal and subtidal areas. These surveys also identified two significant and unique habitats; a zone of mixed corallith and rhodolith habitat at Adele Island and an Organ Pipe Coral habitat zone with unusually high benthic cover at Long Island (Richards *et al*. 2013).

Studies by DBCA and the LNG industry indicate that fringing and emergent coral reefs are well developed in the Heyward island group, around islands in the Bonaparte Archipelago, and off mainland shores of Cape Voltaire and Cape Bougainville. Surveys by INPEX of Maret, Bethier and Montalivet islands, which were largely restricted to the intertidal zone, have recorded 280 species of coral from at least 55 genera, making the Kimberley Bioregion the most coral-diverse area in WA (INPEX 2008).

Montgomery Reef has been identified as a key feature in the area. Montgomery Reef is a huge submerged rock platform covering approximately 400 km^2. Corals occur in the subtidal area around Montgomery Reef, and in the many rock pools on the platform where there is shaded from the sun by algae or rock ledges

(DEWHA 2008a). A survey of benthic habitats at Montgomery Reef was conducted in 2009 by AIMS but a literature search found no published results from this survey (AIMS 2014).

Browse Island is surrounded by a minor fringing coral reef. Assemblages at Browse Island are characteristic of coral platform reefs throughout the Indo-West Pacific region, particularly Cartier Island. Coral diversity was greatest on the reef faces and shallow lagoons but these areas were of very limited extent (URS 2010a).

Hard corals have been recorded at Echuca Shoals but the community was low in both species richness and abundance (URS 2010a). The presence of occasional large outcrops suggests that larger coral structures have occurred previously and may still occur elsewhere on the shoal (RPS Environmental 2008).

3.1.8 International Waters

Important areas outside of the IMCRA bioregions include:

Christmas Island

Fringing coral reefs around Christmas Island are relatively simple with 88 coral species previously identified which are identified to support and over 600 fish species (Director of National Parks 2012).

Indonesia (west)

Indonesia has an estimated 75,000 km^2 coral reef ecosystem distributed throughout the archipelago (Tomascik et al. 1997 cited in Hutumo & Moosa 2005). Fringing reefs are the most common reef types with scleractinian corals as being the most dominant and important group. 452 species of hermatypic scleractinian coral were collected from Indonesian waters by Tomascik et al. (1997 cited in Hutumo & Moosa 2005), a study presented by Suharsono (2004 cited in Hutumo & Moosa 2005), indicated that 590 species of scleractinian corals exist in Indonesian waters. Acropora, Montipora and Porites are the most important reef building corals in Indonesia.

The Lesser Sunda Ecoregion encompasses the chain of islands and surrounding waters from Bali, Indonesia to Timor-Leste. This region contains suitable habitat for corals on shallow water substrates formed by limestone and lava flows and is thought to contain more than 500 species of scleractinian reef-building corals (DeVantier *et al.* 2008). Coral species composition is influenced by regional and local scale seasonal upwellings that typically occur from April to May each year on the southern side of the islands. The ecoregion is considered important for coral endemism, particularly the areas of Bali-Lombok, Komodo and East Flores. Fringing coral reefs tend to be less developed on the southern, more exposed shorelines (Wilson *et al.* 2011).

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

3.2 Seagrasses

Seagrasses are biologically important for four reasons:

1. As sources of primary production;
2. As habitat for juvenile and adult fauna such as invertebrates and fish;
3. As a food resource; and
4. For their ability to attenuate water movement and trap sediment (Masini *et al*. 2009).

Twenty-five species of seagrass have been recorded in WA, the highest diversity in the world (Masini *et al*. 2009). Waters extending from Busselton to the NT border support predominantly tropical species although temperate species are also found, particularly between Busselton and Exmouth (Walker 1987). One species, *Cymodocea angustata*, is endemic to WA (Department of Parks and Wildlife (DPAW) 2013).

The main seagrasses of the region are small, ephemeral species that grow on soft sediments and have a seed bank in the surficial sediments that allows them to recover quickly from disturbance (Walker 1989). Small, ephemeral species of seagrass tend to form mixed associations with macroalgae (CALM & MPRA 2005, DEC & MPRA 2007a, BHPBIO 2011) and usually covers less than 5% of the substrate (BHPBIO 2011, van Keulen & Langdon 2011).

Areas occupied by seagrass vary markedly both seasonally and interannually and it is not clear why some areas of suitable substrate will support seagrass in one year but not the next. It appears that recruitment to what may otherwise be suitable substrate is haphazard, lending weight to the descriptions of these seagrass communities as ephemeral (CALM & MPRA 2005, DEC & MPRA 2007a).

Two bioregions (Northwest Province and Central Western Transition) lie entirely in deep waters below the photic zone. Seagrasses are not present hence these bioregions are not discussed further.

3.2.1 Southwest Shelf Province

Geographe Bay is a large relatively sheltered area with that supports extensive beds of tropical and temperate seagrass that have a high diversity of species and endemism (DEWHA 2008a). They are thought to account for about 80% of benthic primary production in the area. These seagrass beds provide important nursery habitat for many shelf species that use the shallow seagrass habitat as nursery grounds for several years before moving out over the shelf to their adult feeding grounds along the shelf break.

The Geographe Bay seagrass meadows are among the most extensive temperate seagrass communities on the west coast (MPRSWG 1994 cited in DEC 2013), and include 10 species from five genera (*Amphibolis, Posidonia, Halophila, Heterozostera* and *Thalassodendron*). Geographe Bay is dominated by stands of the narrowleaf tape-weed (*Posidonia sinuosa*) that covers approximately 70% of Geographe Bay. It has smaller areas of *Posidonia angustifolia*, *Amphibolis griffithii*, *A. antarctica* and minor species, which have irregular distributions both spatially and temporally (Lord 1995 cited in DEC 2013). *Thalassodendron pachyrhizum*, *Posidonia* spp. and *Amphibolis* spp. are also found in depths of between 27 and 45 m (Walker *et al*. 1994 cited in DEC 2013).

3.2.2 Southwest Shelf Transition

Species diversity of seagrasses in this bioregion is the highest in the world, with 14 species occurring (DEWHA 2008a). In total, 10 seagrass species have been recorded at the Abrolhos ranging from small, delicate species to larger, more robust types that grow in large meadows (DoF 2012). Small paddle-weeds grow in protected lagoon areas or deep waters between the islands, such as Goss Passage and the larger species may be found growing on reef as well as in sandy areas (DoF 2012). *Thalassodendron pachyrhizum*, which is encountered growing on the exposed reef crest area, has been recorded at a number of the island groups. There are also two species of wire-weed (*Amphibolis* species), endemic to southern Australia, found at the Abrolhos (DoF 2012). The most abundant seagrass is *Amphibolis antarctica*, while *Amphibolis griffithii* appears to be restricted to bays such as Turtle Bay in the Wallabi Group.

The larger ribbon-weeds (*Posidonia* species) grow in sheltered bays and lagoons where the sand cover is deeper and more stable (e.g. Turtle Bay, the Gap, East Wallabi Island, the lagoon on the west side of West Wallabi Islands and around North Island) (DoF 2012).

Nine species of seagrass are found in the Perth region, including at Rottnest Island where *Amphibolis* thrives in clear waters overlying limestone rock (Amalfi 2006). Seagrasses are a major component of the ecosystem on the Rottnest Shelf, thriving in waters ranging in depth from intertidal to 45m (Amalfi 2006). All of the seagrass species identified with the exception of *Syringodium isoetifolium* and *H. ovalis* are endemic to temperate areas of southern Australia (Amalfi 2006). At Rocky Bay, on the north side of the island where it is protected from big swells and strong south to south-westerly winds, a mix of dense seagrass meadow consisting of *Amphibolis* and *Posidonia* thrive. The meadows around Rottnest Island serve as nurseries for juveniles of many fish species, and are home to species such as the cobbler and long-headed flathead (Amalfi 2006).

3.2.3 Central Western Shelf Province

Shark Bay contains the largest reported seagrass meadows in the world (approximately 4,000 km^2), as well as some of the most species-rich seagrass assemblages (Walker *et al.* 1989). Twelve species of seagrass are found in the Bay with the dominant species being *Amphibolis antarctica*. Seagrass is a fundamental component of biological processes in Shark Bay; it has modified the physical, chemical and biological characteristics of the Bay and provides food, habitat and nursery grounds for many species (CALM & National Parks and Nature Conservation Authority (NPNCA) 1996).

An inshore survey of benthic habitats near Busselton recorded dense coverage of *Amphibolis* spp. on limestone pavement. *Halophila* spp., *Heterozostera* spp. and *Syringodium isoetifolium* were recorded on sandy substrates (DoF 2007).

3.2.4 Central Western Shelf Transition

Nine species of seagrasses have been found throughout Ningaloo Reef (van Keulen & Langdon 2011). Some delineation of temperate and tropical species exists; however, several species were found throughout the Ningaloo Reef. Halophila ovalis was the most commonly found seagrass at Ningaloo and was generally found growing in sandy patches between coral bomboras. *Amphibolis antarctica* is a large meadow forming species that has been found growing in large clumps in Bateman Bay, north of Coral Bay (van Keulen & Langdon 2011).

3.2.5 Northwest Transition

The Rowley Shoals provide the only suitable shallow substrate for seagrasses in this predominantly deep bioregion. Sparse seagrass is found within subtidal coral reef communities of the Rowley Shoals but is not a major habitat type. Two species of seagrass, *Thalassia hemprichii* and *Halophila ovalis*, have been recorded at Mermaid Reef (Huisman *et al*. 2009). Earlier studies at Mermaid and Imperieuse Reef recorded the above two species and a third species; *Thalassodendron ciliatum* (Walker & Prince 1987).

3.2.6 Northwest Shelf Province

In the Northwest Shelf Province, seagrasses are present but sparsely distributed to depths of approximately 30 m (LEC & Astron 1993, URS 2009, CALM 2005a). The abundance and distribution of tropical (and subtropical) seagrass species can vary greatly due to seasonal changes in water quality (turbidity, light penetration) and conditions (wave action, temperature), with biomass tending to peak in summer (Lanyon & March 1995).

Studies between Quondong and Coulomb Points north of Broome identified seagrass communities of *Halophila* spp. patchily distributed across large areas, from the lower intertidal and out to a depth of approximately 20 m (DEC 2008, Fry *et al*. 2008). Similarly, *Halophila decipiens* was the only seagrass collected from epibenthic dredge studies at five localities near Broome from Gourdon Bay to Packer Island (Keesing *et al.* 2011).

Roebuck Bay is located south of Broome and includes large areas of intertidal mudflats. Extensive seagrass meadows occur in the northern regions of Roebuck Bay and are dominated by *Halophila ovalis* and *Halodule uninervis*. *Halophila minor* and *Halodule pinifolia* have also been reported at this location (Prince 1986, Walker & Prince 1987, Seagrass-Watch 2019).

In the Dampier Archipelago seagrass occurs in the larger bays and sheltered flats of the area (CALM & MPRA 2005). Six species of seagrass, including three Halophila species, have been recorded on the subtidal soft sediment habitats (CALM & MPRA 2005). Seagrasses do not form extensive meadows within the proposed reserves, but rather form interspersed seagrass/macroalgal beds. The largest areas of seagrass are found between Keast and Legendre islands, and between West Intercourse Island and Cape Preston (CALM & MPRA 2005).

Surveys near Onslow found that *Halophila* spp. were the most widespread of the seagrasses in that region. Seagrasses were found to be generally sparsely distributed (<10% cover), occurring in small patches within larger areas of suitable substrate. Small areas of higher (>50%) seagrass cover occurred in shallow clear water areas but were not common (URS 2009, URS 2010b, Chevron 2010).

Similarly, in the Montebello/Barrow Islands Marine Conservation Reserves, seagrasses appear not to form extensive meadows but are sparsely interspersed between macroalgae. Seven seagrass species have been recorded in the Reserves (DEC & MPRA 2007a) with *Halophila* spp. the most common seagrass species on shallow soft substrates and sand veneers. Distributions of these species extend from the intertidal zone to approximately 15m water depth (DEC & MPRA 2007a). Surveys to the northwest and southeast of Barrow Island from 2002 to 2004 did not identify any significant seagrass meadows but confirmed the presence of sparse coverage of *Halophila* and *Halodule* spp. in shallow areas east of Barrow Island (RPS BBG 2005).

A significant meadow of large seagrasses at Mary Anne Reef east of Onslow was identified almost 30 years ago and its presence today is unconfirmed. The meadow was several hundred hectares of *Cymodocea angustata* at 30–50% cover, occurring primarily at a depth of 2–3 m (Walker & Prince 1987).

3.2.7 Timor Province

Seagrass has been reported on the reef flats of offshore reefs of this bioregion (Whiting 1999, Hale & Butcher 2013). Five species of seagrass were reported at Ashmore Reef with *Thalassia hemprichii* being the dominant species (Pike & Leach 1997, Skewes *et al*. 1999b, Brown & Skewes 2005). The total area of seagrass at Ashmore Reef in 1999 was estimated to be 470 ha (Skewes *et al*. 1999b). However, much of this was very sparse cover and there were only 220 ha of seagrass with a greater than 10% cover (Brown & Skewes 2005). Seagrass grew in a sparse, patchy distribution across the sand flats, but had a higher coverage on the reef flat area, where it extended to within 100 m of the reef crest. The area of greatest cover and diversity was in the west and south-west areas of the reef on the inner reef flat (Brown & Skewes 2005). These seagrass meadows support a small but significant population of dugongs estimated at around 100 individuals comprising all age classes from calves to adults (Hale & Butcher 2005).

Similarly, Scott Reef supports five species of seagrass (URS 2006), with *Thalassia hemprichii* most abundant (Skewes *et al*. 1999a, URS 2006). The area of seagrass at Scott Reef is significantly less than that recorded for Ashmore Reef (approximately 100 ha) (Woodside 2011). The highly energetic environment and significant tidal exposure of Scott Reef restricts the area of habitats potentially suitable for seagrass establishment to a small proportion of the total area, resulting in low abundance (Skewes *et al*. 1999a, URS 2006).

Seringapatam Reef was found to have a seagrass cover of 2 ha out of 5,519 ha (0.04%) composed of *Thalassia hemprichii* and *Halophila ovalis* in approximately equal quantities (Skewes *et al*. 1999a). This finding contrasts with a more recent survey where only one species of seagrass (*Halophila decipiens*) was recorded at Seringapatam (Huisman *et al*. 2009).

Skewes *et al*. (1999a) did not observe any seagrass communities at Hibernia Reef.

3.2.8 Northwest Shelf Transition

Extensive and diverse intertidal seagrass meadows are known from islands in the southern Kimberley, particularly in the Sunday Island One Arm Point area (Walker 1995, Walker & Prince 1987). Ten species of seagrasses have been recorded at One Arm Point, with the majority of meadows low to moderate in abundance and dominated by *Thalassia hemprichii* with *Halophila ovalis*, *Halodule uninervis* and *Enhalus acoroides* (Seagrass-Watch 2019).

While some seagrasses have been collected from intertidal sites in the central and north Kimberley (Walker *et al*. 1996, Walker 1997), these areas were not found to be species rich and did not support extensive seagrass meadows like those found in the southern Kimberley.

Subtidal seagrass meadows in the Northwest Shelf Transition are not well mapped, although dugongs are known to feed on seagrass communities in coastal waters of the Joseph Bonaparte Gulf (DEWHA 2008a).

3.2.9 International Waters

Important areas outside of the IMCRA bioregions include:

Indonesia (west)

Within Indonesian waters, the lower intertidal and upper subtidal zones are considered important areas for the growth of seagrass (Hutumo and Moosa 2005). Pioneering vegetation in the intertidal zone is dominated by *Halophila ovalis* and *Halodule pinifolia* while *Thalassodendron ciliatum* dominate the lower subtidal zones. Wide areas of the Indonesian coastal waters are covered by dense beds of seagrass.

Seagrass habitats are widely distributed across the Lesser Sunda Ecoregion. Preliminary data from the United Nations Environment Program's (UNEP) World Conservation Monitoring Centre (WCMC) has identified the following areas as potential areas of importance for seagrass, many of which are outside the EMBA (DeVantier *et al.* 2008):

- North-west Bali;
- South-west and west Lombok;
- North-east Sumbawa;
- Komodo Islands;
- Savu; and
- South coast of Timor-Leste.

The Kepulauan Seribu National Park is also known for its rich diversity of seagrasses (refer to **Section 9.8**).

3.3 Macroalgae

Macroalgae are important contributors to primary production and nutrient cycling in the region, providing food and habitat for vertebrate and invertebrate fauna. Macroalgae are also recognised for their role in spatial subsidies; the movement of nutrients or energy between neighbouring habitats. Spatial subsidies involving macroalgae include the movement of wrack from macroalgal beds to bare substrates and shorelines (Orr 2004).

Macroalgae are primarily associated with hard substrates. They occur in moderate to high cover on exposed hard substrates, but typically have lower cover on hard substrates that are covered with a veneer of sediment (SKM 2009, BHPBIO 2011). Macroalgae exhibit very high seasonal and interannual variation in biomass (Heyward *et al*. 2006) and distribution, abundance and biodiversity (Rio Tinto 2009, BHPBIO 2011). The distribution of hard substrates therefore indicates areas that may support macroalgal communities, although abundance and diversity may fluctuate annually.

Macroalgae are susceptible to disturbance from factors such as sedimentation, scouring and turbidity but the marked seasonality in biomass, abundance, diversity and distribution suggests macroalgae are likely to be resilient to acute, short-term disturbance acting at local scales. Macroalgae may be more susceptible to impacts acting over longer time scales (years) and at certain times of the year, where recruitment at a regional scale could be affected. Indirect impacts affecting the numbers, distribution and community structure of herbivorous fish can also be expected to have impacts (either positive or negative) on macroalgal habitats (Vergès *et al*. 2011).

Two bioregions (Northwest Province and Central Western Transition) lie entirely in deep waters below the photic zone. Benthic macroalgae are not present hence these bioregions are not discussed further.

3.3.1 Southwest Shelf Province

Species diversity of macroalgae is very high. The south coast of the bioregion is characterised by a relatively higher diversity of temperate macro-algal species compared with the Southwest Shelf Transition. These colonise the exposed rocky shorelines and rocky reefs (DEWHA 2008a).

3.3.2 Southwest Shelf Transition

The Houtman Abrolhos have known species of benthic algae with macroalgae communities considered important in supporting a diversity of marine life.

More than 340 species of macroalgae (including 54 species of green algae, 71 species of brown algae, and 222 species of red algae) have been recorded from rock platforms around Rottnest Island (Amalfi 2006).

3.3.3 Central Western Shelf Province

Although seagrasses are the most visually dominant organisms found in Shark Bay (Walker *et al*. 1989) macroalgae are also a significant component within the system, with 161 taxa of benthic macroalgae reported from the location (Kendrick *et al*. 1990). The seagrass meadows host a large number of epiphytic algal species (Harlin *et al*. 1985, Kendrick *et al*. 1990), which numerically dominate the algal flora of the area. Eighty algal species were epiphytic on the seagrass *Amphibolis antarctica*, and of these, over half have been reported both as epiphytes and benthic algae. Benthic macroalgae can be found in growing on occasional subtidal rock (limestone–sandstone) platforms and extensive sand flats that occur throughout Shark Bay, and as drift within seagrass meadows (Kendrick *et al*. 1990).

The benthic algae of Shark Bay are not predominantly temperate as is the case with the seagrasses (Walker *et al*. 1989) and seagrass epiphytes (Kendrick *et al*. 1990). The majority of taxa are either of tropical or cosmopolitan distribution. Their local distribution within Shark Bay is correlated with salinity, with benthic algal species richness lower in areas of high salinity (Kendrick *et al*. 1990).

Limestone platforms occur along the bioregion's coastline and high energy environments are likely to be dominated by large brown algae including *Ecklonia radiata* and *Sargassum* spp. with articulated coralline algae making up the understorey. More diverse algae assemblages may be observed in sheltered locations such as potholes and ledges (DoF 2007).

3.3.4 Central Western Shelf Transition

Macroalgal beds along the Ningaloo coastline are generally found on the shallow limestone lagoonal platforms and occupy about 2,200 ha of the Ningaloo Marine Park and Muiron Islands Marine Management Area (CALM & MPRA 2005a). Macroalgal communities within the area have been broadly described (Bancroft & Davidson 2000). The dominant genera are the brown algae *Sargassum*, *Padina*, *Dictyota* and *Hydroclathrus* spp. (McCook et al. 1995).

3.3.5 Northwest Transition

Although macroalgae is present at the Rowley Shoals, it is not recognised as a key habitat component in the Mermaid Reef Marine National Nature Reserve Plan of Management (EA 2000) or the Rowley Shoals Marine Park Management Plan (DEC & MPRA 2007b).

There is nothing to suggest that the algal flora of the Rowley Shoals is unique within the Indo-Pacific (Huisman *et al*. 2009). A study of macroalgae at 16 locations at Mermaid Reef recorded over 100 species (Huisman *et al*. 2009). The algal flora recorded at the Rowley Shoals represents a small portion of the highly diverse Indo-Pacific flora. The majority of species that were recorded at Mermaid Reef had been previously recorded from mainland north-western Australia or from Indonesia (Huisman *et al*. 2009).

3.3.6 Northwest Shelf Province

Macroalgae are diverse and widespread throughout the Northwest Shelf Province. They are restricted to depths where sufficient light penetrates to the substrate and therefore tend to be most common in shallow subtidal waters down to approximately 20 m depth.

In the nearshore regions of the Pilbara, macroalgae are often a dominant component of the mosaic of benthic organisms found on hard substrates in shallow water. In these shallow waters, regular disturbance to reef habitats from seasonal changes in sedimentation/ erosion patterns and the less frequent impacts of cyclones and storms through sedimentation and scouring may substantially alter the distribution and composition of the benthic communities associated with reefs, including macroalgal habitats (BHPBIO 2011).

Macroalgae dominate shallow (<10 m) submerged limestone reefs and also grow on stable rubble and boulder surfaces in the Dampier Archipelago (CALM & MPRA 2005). Huisman and Borowitzka (2003) reported approximately 200 species of macroalgae from the Dampier Archipelago. Low relief limestone reefs that are dominated by macroalgae, account for 17% (approximately 35,460 ha) of the marine habitats within the proposed Marine Management Area (CALM 2005a).

Epibenthic dredge surveys along the coastline north of Broome identified 43 species of algae from 22 families (Keesing *et al*. 2011). The lower species diversity collected by this study is attributed to the method of collection and limited depth range (11–23 m) (Keesing *et al*. 2011).

Macroalgae occur around the numerous small offshore islands within this bioregion (including Thevenard Island, Airlie Island and Serrurier Island) associated with limestone pavement and protected areas of soft sediments. Dominant species are consistent with those described for the Dampier Archipelago (Woodside 2011).

In the shallow offshore waters of the Pilbara region, macroalgae are the dominant benthic habitat on hard substrates in both the Montebello and Barrow Islands Marine Parks and are the main primary producers (DEC & MPRA 2007a, Chevron 2010). Shallow water habitats outside these marine parks are also likely to support substantial areas of macroalgal habitat wherever conditions are suitable.

Macroalgae occupy approximately 40% of the benthic habitat area in the Montebello/ Lowendal/ Barrow Island region (CALM 2005b). At least 132 macroalgal taxa occur around Barrow Island, with most thought to be widely distributed in the tropical Indo-Pacific region (Chevron 2005).

Macroalgae monitoring around the Lowendal and Montebello Islands since 1996 (The Ecology Lab 1997, IRCE 2002 2003 2004 2006 2007, URS 2009) has found macroalgal cover and biomass to be naturally spatially and temporally variable. *Sargassum* spp. represented 70% of the macroalgal assemblage in 2009, compared to 96% in 2002 (URS 2009). Sargassum spp. cover as a percentage of total macroalgae cover was significantly lower in 2009 than in previous years, primarily due to an increase in filamentous algae at a number of sites (URS 2009).

3.3.7 Timor Province

Macroalgae at Ashmore Reef are estimated to cover over 2,000 ha, mostly on the reef slope and crest areas (Hale & Butcher 2013). The algal community is dominated by turf and coralline algae, with fleshy macroalgae comprising typically less than 10% of total algal cover (Skewes *et al*. 1999b).

Surveys at Scott and Seringapatam Reefs recorded over 100 species of marine algae (Huisman *et al*. 2009). The marine algal community was similar between reefs and also similar to the Rowley Shoals. Algae found at these offshore atolls forms a small subset of the Indo-Pacific algal flora, with virtually all of the species identified thus far having been previously collected from north-western Australia or from localities further north. Although further research is necessary, at present there is nothing to suggest that the macroalgae communities of these offshore atolls are unique within the Indo-Pacific (Huisman *et al*. 2009).

3.3.8 Northwest Shelf Transition

There is a lack of information regarding the marine benthic flora of north-west Western Australia and no comprehensive marine flora list exists for the region (Huisman 2004). However, about 70 algae species were collected during a survey of intertidal reefs on the central Kimberley coast in 1997 (Walker 1997).

Tropical macroalgae species are typically associated with areas of hard substrate and various types of macroalgae occur on rock platforms intermingled with coral and sponge. Abundance and biomass typically exhibit strong seasonal trends (Heyward *et al*. 2006).

The diversity and abundance of algae in the Kimberley is probably linked to the region's extreme tidal exposure and highly turbid waters, reducing light penetration and resulting in deposition of fine sediments (Walker 1997). However, the role of algae appears crucial to the growth of reefs in the highly turbid waters of the Kimberley coast and islands (Brooke 1997). *Sargassum* spp. and coralline algae may be dominant (DPAW 2013).

3.3.9 International Waters

No information on macroalgae in international waters has been identified other than for Timor-Leste waters.

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

3.4 Non-Coral Benthic Invertebrates

The offshore marine environment from Busselton to the Northern Territory border is overwhelmingly dominated by soft sediment seabeds; sandy and muddy substrates, occasionally interspersed with hard substrates covered with sand veneers, and rarely, exposed hard substrate. In shallow waters, non-coral benthic invertebrates may form part of the mosaic of benthic organisms found on hard substrates, alongside macrophytes and coral colonies. As light reduces with water depth, non-coral benthic invertebrates are the dominant community, albeit at low densities.

Non coral benthic invertebrates feed by filtering small particles from seawater, typically by passing the water over a specialised filtering structure. Examples of filter feeders are sponges, soft and whip corals and sea squirts.

3.4.1 Southwest Transition

There is little available information on benthic biological communities of this bioregion however deep sea crabs, such as the champagne crab and crystal crab are known to inhabit the seafloor of the slope (DEWHA 2008b).

3.4.2 Southern Province

There is little information available on the benthic biological communities within the bioregion, however it is described as a unique region of deep-sea habitats that includes the Diamantina Fracture Zone Key Ecological Feature. The Diamantina Fracture Zone is described as structurally complex deep water environment of seamounts and numerous closely spaced troughs and ridges, which represents a unique region of deep-sea habitats including 26 endemic species of demersal fish (DSEWPaC) 2012b).

3.4.3 Central Western Province

The understanding of marine life in this bioregion is mostly confined to the demersal fish on the continental slope. The exception to this is the Perth Canyon which, although poorly understood, is known to have unique seafloor features with ecological properties of regional significance.

3.4.4 Western Shelf Province

The Central Western Shelf Province occurs on the continental shelf in water depths from 0 to 100 m. Biological communities of the shelf are likely to include a sparse invertebrate assemblage of sea cucumbers, urchins, crabs and polychaetes on sand substrates. Hard substrates are likely to contain sessile invertebrates such as sponges and gorgonians. The biological communities of this bioregion share many similarities with the adjoining temperate region (DEWHA 2008a).

Stromatolites occur in Shark Bay. Although they are a microbial colony (prokaryote), and not an invertebrate (eukaryote), they are described here as a unique benthic biological community. Stromatolites are rock-like structures built by cyanobacteria. Shark Bay's stromatolites are 2,000 to 3,000 years old and are similar to life forms found on Earth up to 3.5 billion years ago. Until about 500 million years ago, stromatolites were the only macroscopic evidence of life on the planet; hence they provide a unique insight into early life forms and evolution. The stromatolites are located in the hypersaline environment of Hamelin Pool and are one of the reasons for the area's World Heritage Listing (DPAW 2009).

3.4.5 Central Western Transition

The Central Western Transition extends from the shelf break to the continental slope with some parts of the bioregion occurring on the abyssal plain. Water depths range from 80 m to almost 6,000 m. Sediments are dominated by muds and sands that decrease in grain size with increasing depth. The present level of understanding of the marine environment in this bioregion is generally poor. The harder substrate of the slope in waters of 200–2,000 m deep is likely to support populations of epibenthic fauna including bryozoans and sponges. These support larger infauna and benthic animals such as crabs, cephalopods, echinoderms and other filter feeding epibenthic organisms. In the deeper waters of the abyss, the benthic communities are likely to be sparse (DEWHA 2008a).

3.4.6 Central Western Shelf Transition

The Central Western Shelf Transition is located entirely on the continental shelf and is comprised mainly of sandy sediments in depths between 0 and 80 m (DEWHA 2008a).

Some sponge species and filter-feeding communities found in deeper waters offshore from the Ningaloo Reef appear to be significantly different to those of the Dampier Archipelago and Abrolhos Islands, indicating that the Commonwealth waters have some areas of potentially high and unique sponge biodiversity (Rees *et al*. 2004).

3.4.7 Northwest Province

The Northwest Province is located entirely on the continental slope in water depths of predominantly between 1,000–3,000 m and is comprised of muddy sediments. Despite the present poor knowledge of the benthic communities on the Exmouth Plateau, information on sediments in the bioregion indicates that benthic communities are likely to include filter feeders and epifauna. Soft-bottom environments are likely to support patchy distributions of mobile epibenthos, such as sea cucumbers, ophiuroids, echinoderms, polychaetes and sea pens.

3.4.8 Northwest Transition

The Northwest Transition is located from the shelf break (200 m water depth) over the continental slope to depths of more than 1,000 m at the Argo Abyssal Plain. Benthic habitat mapping surveys and epibenthic sampling conducted by CSIRO at the continental slope (approximately 400 m water depth) showed that all survey sites predominantly comprised soft muddy sediment, which was often riffled. Gravel, boulders and small outcrops were occasionally recorded. Epifaunal abundance was similar all sites, with epifauna limited to sparsely distributed isolated individuals. Epifauna included isolated scattered sessile crinoids, anemones, glass sponges and seapens. Occasional non-sessile fauna included urchins, prawns and other decapods, holothurians and sea stars. Modelling indicated a 1 km long beam trawl across the continental shelf (approximately 400 m water depth) would be expected to yield sparse (<20 individuals) and low diversity (<10 species) of epibenthic fauna (≥1 cm body size) (Williams *et al*. 2010). Deeper on the continental slope at approximately 700 m and approximately 1,000 m, habitats were similar to those observed at 400 m (Williams *et al*. 2010).

Although soft sediment habitat may appear monotonous and featureless, there is likely to be some marked differences in terms of ecological functioning and faunal composition between shelf and deep-sea areas, with the 200 m isobath widely believed to represent a key boundary (Wilson 2013, Brewer *et al*. 2007, Gage & Tyler 1992). Beyond the 200 m isobath, deep-sea benthic communities rely exclusively on the settling of organic detritus from the overlying water column as a food source. The spatial and temporal distribution of benthic fauna depends on factors such as sediment characteristics, depth and season (Wilson 2013).

Due to contrasting depths, the Rowley Shoals supports a diverse marine invertebrate community including a number of endemic species. Invertebrate species (excluding corals) at the Rowley Shoals include sponges, cnidarians (jellyfish, anemones), worms, bryozoans (sea mosses), crustaceans (crabs, lobsters, etc.), molluscs (cuttlefish, baler shells, giant clams, etc.), echinoderms (starfish, sea urchins) and sea squirts (DEC & MPRA 2007b).

3.4.9 Northwest Shelf Province

This bioregion is located primarily on the continental shelf in water depths from 0 to 200 m (DEWHA 2008a). The sandy substrates on the shelf within this bioregion are thought to support low density benthic communities of bryozoans, molluscs and echinoids (DEWHA 2008a). Sponge communities are also sparsely distributed on the shelf, but are found only in areas of hard substrate. The region between Dampier and Port Hedland has been described as a hotspot for sponge biodiversity (Hooper & Ekins 2004).

Epibenthic dredge surveys in nearshore areas around Broome covered 1,350 m^2 of seabed in depths between 11 and 23 m. The survey recorded 357 taxa comprising 52 sponges, 30 ascidians, 10 hydroids, 52 cnidarians (not including scleractinian corals), 69 crustaceans, 73 molluscs and 71 echinoderms. The most important species on soft bottom habitats in terms of biomass was the heart urchin *(Breynia desorii)*, whilst sponges were the dominant fauna by biomass on hard bottom habitats. The biomass of other filter feeders, especially ascidians, soft corals, gorgonians was also high, indicating the importance of these groups in characterising hard bottom habitats.

In 2007, CSIRO conducted extensive benthic habitat mapping surveys and epibenthic fauna (living on the surface and ≥1 cm body size) sampling in deep waters (100–1,000 m) spanning thirteen sites between Barrow Island and Ashmore Reef running along the continental shelf and across the continental slope of the North West Shelf (Williams *et al*. 2010). At the continental shelf margin (approximately 100 m water depth) Williams *et al*. (2010) reported that similar benthic habitats occurred at each survey site across the breadth of the North

West Shelf. Benthic habitats at this depth comprised a mix of riffled muddy sand (sometimes as a veneer over rocky subcrops) together with gravel to pebble-sized rubble, cobbles, boulders and some rock outcrops. Typical epifauna found at these depths included scattered isolated hydroids, sea fans and soft corals and often small sponges. Other fauna observed at some of the sites included scattered isolated sea whips, crinoids, sea pens, urchins and anemones. Epibenthic fauna along the continental shelf margin were quantified as sparse and low diversity (Williams *et al*. 2010). Modelling indicated that a trawl sample of 1 km length would generally be expected to yield approximately 80 individuals represented by 15 species (Williams *et al*. 2010) in 100 m depth waters.

At the shelf edge (approximately 200 m water depth), two sites were surveyed. Both sites were similar to the continental shelf margin, except the northern site mainly comprised coarse material. Epifauna observed at the northern site was similar at 200 m as at 100 m. At the southern site, epifauna included sparse and scattered individual soft corals, anemones, glass sponges and stalked crinoids (Williams *et al.* 2010). Modelling indicated epibenthic fauna were sparse and had low diversity, numbering approximately 20–40 individuals in a 1 km long trawl sample represented by approximately 5–10 species (Williams *et al*. 2010).

Baseline studies undertaken in nearshore areas of the Pilbara (SKM 2009, Rio Tinto 2009, BHPBIO 2011) and offshore areas around Barrow Island (Chevron 2010) have shown that filter feeder communities are a dominant component of benthic habitats in depths >10 m where reduced light appears to inhibit extensive development of hard corals and macroalgae. The pavement habitats between Barrow Island and the mainland are covered by a sediment veneer that appears to periodically move, exposing areas of pavement reef. Sessile benthic organisms that require hard substrates for attachment, such as gorgonians, are frequently seen emerging through a shallow veneer of sand. This type of substrate (sediment veneer) with sparse filter feeder communities is common throughout this area (SKM 2009, Rio Tinto 2009, BHPBIO 2011).

3.4.10 Timor Province

The Timor Province is located on the continental slope and abyssal plain and water depths range from 200 m to almost 6,000 m. Benthic studies in this bioregion are scarce, however data from the North West Slope Trawl Fishery suggests that muddy sediments in the Timor Province support significant populations of crustaceans (Brewer *et al*. 2007). Additionally, research into the demersal fish communities of the continental slope has identified the Timor Province as an important bioregion. This is due to the presence of a number of endemic fish species, and two distinct demersal community types associated with the upper slope (water depths of 225–500 m) and mid-slope (water depths of 750–1,000 m) (Last *et al*. 2005). The current understanding of the relationship between demersal fish communities and benthic environments on the continental slope is rudimentary (DEWHA 2008a).

Over 130 species of sponges have been recorded at the Ashmore Reef National Nature Reserve (Russell & Hanley 1993).

Studies of Seringapatam Reef have observed the dominant benthic habitats to include filter feeders, such as sponges, gorgonians, hydroids and seapens (Heyward et al. 2013 cited in ConocoPhillips 2018).

3.4.11 Northwest Shelf Transition

The Northwest Shelf Transition is located on the continental shelf with a small area extending onto the continental slope, with water depths ranging from 0–330 m. Nearshore areas may support significant filter feeding communities but these have not yet been described (Masini *et al*. 2009).

Pipeline route surveys north of the Kimberley in water depths from 10–250 m recorded a seabed largely devoid of hard substrate, with only sparse epibenthic fauna noted on the predominantly sandy substrate. Occasional epibenthic fauna (featherstars, gorgonians, bryozoans, sea urchins, hydroids and sponges) were recorded in areas where rocky substrate or outcrops were present (URS 2010a).

In contrast, benthic surveys at Echuca Shoals identified broad areas of hard substrate with substantial epibenthic fauna. The shallow shoal areas were dominated by a flat ‘reef’ platform with crinoids, sea whips, soft corals and low densities of hard corals. With increasing depth (25–80 m) soft corals and sponges became increasingly dominant. At greater depths (80–100 m) the density of epibenthic fauna decreased substantially with sea whips and sea fans became dominant (URS 2010a).

3.4.12 International Waters

No information on non-coral benthic invertebrates in international waters has been identified other than for Timor-Leste waters.

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

3.5 Plankton

Plankton abundance and distribution is patchy, dynamic and strongly linked to localised and seasonal productivity (Evans *et al.* 2016). Fluctuations in abundance and distribution occur both vertically and horizontally in response to tidal cycles, seasonal variation (light, water temperature and chemistry, currents and nutrients) and cyclonic events. As a key indicator for ecosystem health and change, Plankton distribution and abundance has been measured for over a century in Australia (Richardson *et al.* 2015). The compilation of this data has been made publicly available through the Australian Ocean Data Network (Australian Ocean Data Network 2017) and has been used in the Australia State of the Environment 2016 report (Jackson *et al.* 2017) to nationally assess marine ecosystem health. According to their findings, warming ocean temperatures has extended the distribution of tropical phytoplankton species (which have a lower productivity), further south resulting in a decline in primary productivity in oceanic waters north of 35°C, especially the North West Shelf (Evans *et al.* 2016). Trends of primary productivity across Australia are however variable with the South West of Australia experiencing an increase in productivity and northern Australia experiencing no change between 2002-2016 (Evans *et al.* 2016).

Within the EMBA, peak primary productivity varies on a local and regional scale. For example, peak phytoplankton biomass in waters surrounding Broome has been observed in May with a high variability recorded in August, whereas recorded phytoplankton biomass in waters surrounding Geographe Bay has been found to peak during winter and is localised close to the coast (Bloundeau-Patissier *et al.* 2011). In general, these peaks are linked to mass coral spawning events, peaks in zooplankton and fish larvae abundance and periodic upwelling. Regional upwelling is most common close to the coast and where surface waters diverge. Despite the suppression of major upwelling along the WA coast by the Leeuwin Current, known key upwelling regions include the Ningaloo region (Hanson & McKinnon 2009) and Cape Mentelle (Pattiaratchi 2007). It is also expected that a high abundance of plankton will occur within areas of localised upwelling in the EMBA where the seabed disrupts the current flow.

In waters surrounding Indonesia, seasonal peaks in phytoplankton biomass is linked to monsoon related changes in wind. When the winds reverse direction (offshore vs. onshore), nutrient concentrations decrease/increase because of the suppression/enhancement of upwelling (National Aeronautics and Space Administration (NASA) 2017). Annual variability of phytoplankton productivity in waters surrounding Indonesia is heavily influenced by the El Niño-Southern Oscillation climate pattern (NASA 2017). For example, phytoplankton productivity around Indonesia increases during El Niño events.

Santos

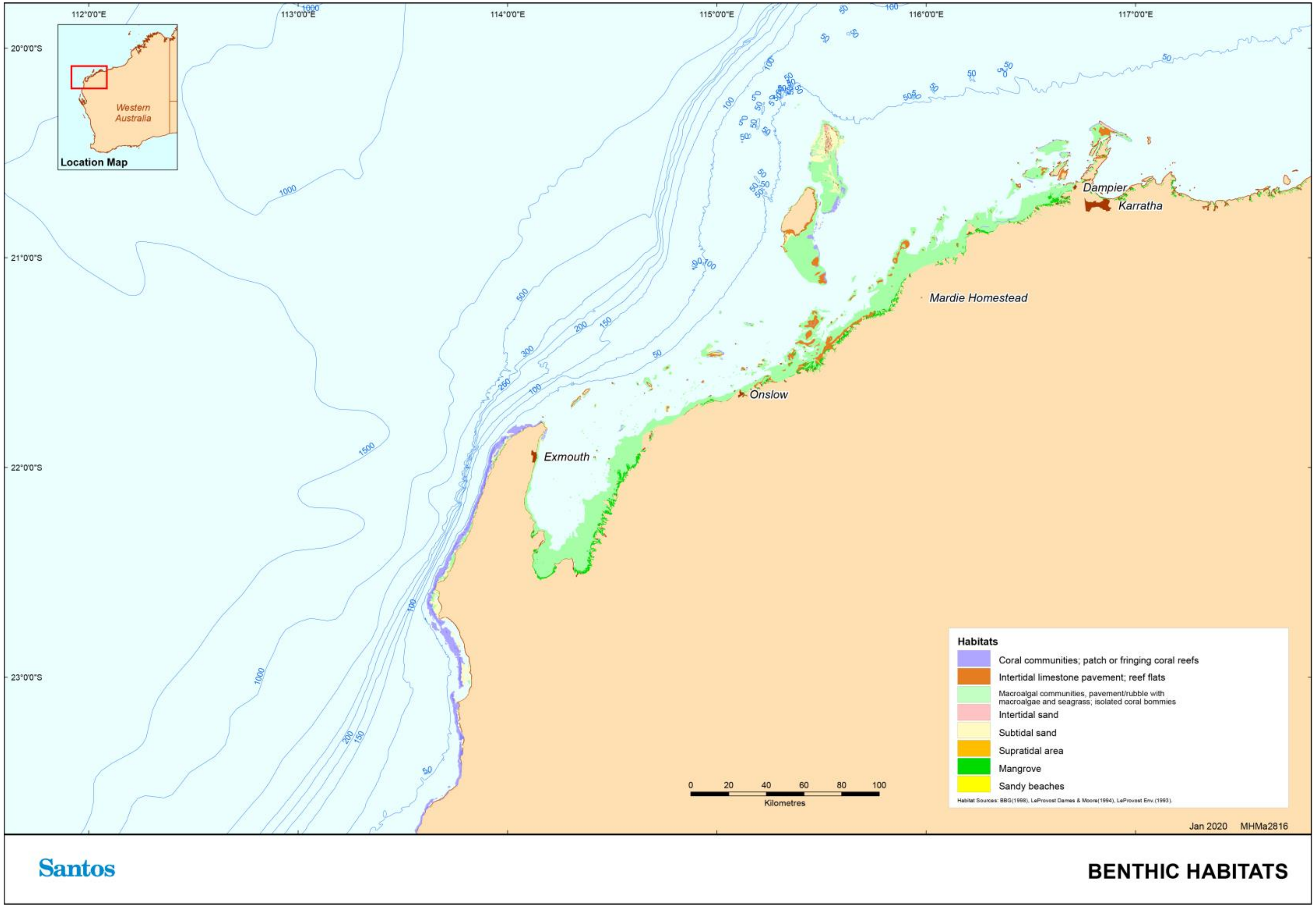


Figure 3-1: Benthic habitats from Coral Bay to Dampier

4. Shoreline Habitats

Shoreline habitats are defined as those habitats that are adjacent to the water along the mainland and of islands that occur above the LAT and most often in the intertidal zone.

The following section broadly categorises shoreline habitats as the following biological communities; mangroves, intertidal mud/sand banks, beaches, and rocky shores. These communities are discussed in **Sections 4.1- 4.5**, in terms of the 14 IMCRA v. 4.0 bioregions where relevant and where information is available.

Figure 3-1 broadly illustrate these habitats within the Northwest Shelf Province and Central Western Shelf Transition.

4.1 Mangroves

Mangroves commonly occur in sheltered coastal areas in tropical and sub-tropical latitudes (Kathiresan and Bingham 2001). Up to eight species of mangroves are found further north in the Central Western Shelf Transition region, but at most locations the dominant mangrove (in terms of area of intertidal zone occupied) is *Avicennia marina*, with the stilt rooted mangrove *Rhizophora stylosa* often occurring as thin zones of dense thickets within the broad zone of *A. marina*. Mangroves are found wherever suitable conditions are present including wave dominated settings of deltas, beach/dune coasts, limestone barrier islands and ria/archipelago shores (Semeniuk 1993). Mangrove plants have evolved to adapt to fluctuating salinity, tidal inundation and fine, anaerobic, hydrogen sulfide rich sediment (Duke *et al.* 1998).

Mangroves are important primary producers and have a number of ecological and economic values. For example, they play a key role in reducing coastal erosion by stabilising sediment with their complex root systems (Kathiresan and Bingham 2001). They are also recognised for their capacity to help protect coastal areas from the damaging effects of erosion during storms and storm surge. Mangroves are also important in the filtration of run-off from the land which helps maintain water clarity for coral reefs which are often found offshore in tropical locations (National Oceanic and Atmospheric Administration (NOAA) 2010). The intricate matrix of fine roots within the soil also binds sediments together.

Mangroves play an important role in connecting the terrestrial and marine environments (Alongi 2009). Numerous studies (e.g. Nagelkerken *et al.* 2000, Alongi 2002, Alongi 2009, Kathiresan and Bingham 2001) have shown mangroves to be highly productive and an important breeding and nursery areas for juvenile fish and crustaceans, including commercially important species (Kenyon *et al*. 2004). They also provide habitat for many juvenile reef fish species.

Mangroves also play an important ecosystem role in nutrient cycling and carbon fixing (NOAA 2010). The trees absorb carbon dioxide from the atmosphere and the organic matter such as fallen leaves forms nutrient rich sediments creating a peat layer that stores organic carbon (Alongi 2009, Ayukai 1998).

The muddy sediments that occur in mangrove forests are home to a variety of epibenthic, infaunal and meiofaunal invertebrates (Kathiresan and Bingham 2001). Crustaceans known to inhabit the mud in mangrove systems include fiddler crabs, mud crabs, shrimps and barnacles. Within the water channels of the estuary, various finfish are found from the smaller fish such as gobies and mudskippers (which are restricted to life in the mangroves) through to larger fish such as barramundi (*Lates calcarifer*) and the mangrove jack (*Lutjanus argentimaculatus).* Mangroves and their associated invertebrate-rich mudflats are also an important habitat for migratory shorebirds from the northern hemisphere, as well as some avifauna that are restricted to mangroves as their sole habitat (Garnet and Crowley 2000).

The two key State regulatory documents relevant to the protection and management of mangroves in WA are:

- EPA (2001) Guidance Statement for Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline. Guidance Statement No. 1; and
- EPA (2016) Technical Guidance – Protection of Benthic Communities and Habitats.

4.1.1 Central Western Shelf Province

Shark Bay (in the Central Western Shelf Province) supports the southern-most area of substantial mangrove habitat in Western Australia (Rule *et al*. 2012). The mangroves of Shark Bay comprise only one species, the white mangrove *Avicennia marina*, and these trees occur around the coastline in widely dispersed and often isolated stands of varying size.

4.1.2 Central Western Shelf Transition

The regional mangroves from Exmouth to Broome (within the Central Western Shelf Transition and southern part of the Northwest Shelf Province) represent Australia's only 'tropical-arid' mangroves. The most significant stand of mangroves in the Central Western Shelf Transition is Mangrove Bay on the western side of the Cape Range Peninsula in the Ningaloo Marine Park. This small area of mangrove (37 ha) represents the largest area of mangrove habitat within the Ningaloo Marine Park and is considered extremely important from a biodiversity conservation perspective (CALM 2005).

4.1.3 Northwest Shelf Province

In the Pilbara region, the coast is a complex of deltas, limestone barrier islands and lagoons, with a variable suite of substrates. As a result, mangroves in this region form relatively diverse fringing stands, albeit often stunted in stature but at times quite extensive in area. The mangroves along the Pilbara coastline are the largest single unit of relatively undisturbed tropical arid zone habitats in the world. The area has nine mangrove taxa and a total of 632 km^2 mangroves (MangroveWatch 2014). As with most arid zone mangroves, Pilbara mangroves are characterised by open woodlands and shrublands that are of relatively lower productivity than the mangrove communities of the wet tropics because of the extreme water and salinity stresses that affect the intertidal zone in the Pilbara (EPA 2001). Significant stands of mangroves in the Pilbara include:

- Exmouth Gulf: mangrove assemblages within the Bay of Rest on the western shore of the Gulf and the extensive mangrove system on the eastern shore of the Gulf that extends as a series of tidal flats and creek channels from Giralia Bay to Yanrey Flats (Astron 2014). These areas of mangrove are also designated as 'regionally significant' by the EPA (2001). The importance of these mangroves to the Exmouth Prawn Fishery is discussed in Kangas et al. (2006);
- Mainland coast and nearshore islands: mangrove assemblages at Ashburton River Delta, Coolgra Point, Robe River Delta, Yardie Landing, Yammadery Island and the Mangrove Islands are all designated as 'regionally significant' by the WA EPA (2001) and the EPA will give these mangrove formations the highest degree of protection with respect to geographical distribution, biodiversity, productivity and ecological function; and
- Montebello, Barrow and Lowendal Islands: mangrove assemblages all lay within designated reserves. The mangrove communities of the Montebello Islands are considered globally unique as they occur in lagoons of offshore islands (DEC 2007). Mangrove stands identified on Varanus Island occur on the west coast in discrete patches within the tidal and supratidal zones, at South Mangrove Beach and a small embayment (Astron 2016). Mangrove stands on Varanus Island have been identified as healthy, with similar stands also identified as present on Bridled Island to the north of Varanus Island (Astron 2016).

The mangroves of the Kimberley are particularly diverse and relatively untouched. They occupy a variety of coastal settings including rocky shores, beaches and tidal flats (Cresswell and Semeniuk 2011). They belong to the Indo-Malaysian group of Old World Mangroves centred in the Indian-Pacific area (Cresswell and Semeniuk 2011). Of the eighteen species of mangrove plants known to Australia all are represented in the Kimberley including *Avicennia marina, Aegialitis annulata, Aegiceras corniculatum, Rhizophora stylosa, Ceriops tagal, Osbornia octodonta, Bruguiera exaristata, Camptostemon schultzii, Excoecaria agallocha, Sonneratia alba,* and *Xylocarpus australasicus* (Pendretti and Paling, 2001; Waples, 2007). Of these, ten occur only in the Kimberley (Waples 2007). *Rhizophora stylosa* and *Avicennia marina* are the most common mangrove species along the WA Coast.

Mangroves line much of the coastal area within the western Kimberley (and within the proposed Horizontal Falls Marine Park area). They are known to line the shore in the upper reaches of Talbot Bay and to fringe many of the islands of the Buccaneer Archipelago. There are large stands in the southern section of Dugong Bay. Kingfisher Islands has been noted to exhibit extensive mangroves where 10 species of mangrove have been recorded (Wilson 2013). Mangroves line the shores of the southern coast of Collier Bay and large tracts are found in Walcott Inlet and Secure Bay (Duke *et al.* 2010). The mangroves on the eastern side of the inlet extend about 30 km inland (Gueho 2007, Pendretti and Paling 2001, Zell 2007). Further along the coast mangroves have been identified lining much of the shores of Doubtful Bay. Mangroves are also known to line the shores of the Sale River and have been identified in George Water. For detailed maps of mangrove distribution refer to Pendretti and Paling (2001).

4.1.4 Northwest Shelf Transition

Mangroves are also a prominent feature of the North Kimberley. Fringing mangroves have developed around the edge of Prince Frederick Harbour and to the east of Cape Voltaire extending along the shores of Walmesly Bay and Port Warrender (Zell 2007). This region is humid and *Xylocarpus granatum* is localised here (Cresswell and Semeniuk 2011). The rocky coastline between Cape Pond and Cape Voltaire does not lend itself to mangrove development; instead coastal woodland grows on the shores above high water mark. Mangroves are interspersed with rocky outcrops and beaches around much of the Admiralty Gulf, Vansittart Bay and Napier Broome Bay (with extensive stands around the Drysdale estuary). Cape Londonderry marks the westerly limit of *Scyphiphora hydrophylacea* (Duke *et al.* 2010).

Between Cape Londonderry and Cape Dussejour mangrove communities are sparse, and limited to a few small stands in the bays as this part of the coastline is dominated by high relief rocky shores which are exposed to the prevailing easterly winds (Wilson 1994). Extensive mangroves do however line the shores of the islands and rivers in the Cambridge Gulf, where 12 mangrove species have been recorded (Wilson 2013). The mangroves of the Ord River are notable in terms of their structural complexity and diversity. Fourteen species of mangrove have been recorded in the boundaries (Pedretti and Paling 2001). The mangroves of the Cambridge Gulf are important for saltwater crocodiles and mangrove bird communities. A unique type of flycatcher which is an intermediate between *Microcea flavigater* and *Microeca tormenti* has been identified in the mangroves of the Cambridge Gulf (Johnstone 1984). Additionally, the area is important for maintaining stocks of the commercially exploited species of the Red-Legged Banana Prawns (*Penaeus indicus)* (Kenyon *et al.* 2004).

4.1.5 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.1.6 International Waters

Subawa's south coast in Indonesia is thought to contain the most significant stand of mangroves in the Lesser Sunda Ecoregion (DeVantier 2008). Other significant stands have been mapped at the following locations (DeVantier 2008):

+ North-west and south east Bali;
+ North coast of Nusa Lembongan;
+ North-east and east Sumba;
+ South-west, north-west, north and east Flores and Maumere;
+ Komodo Island, and nearby islands; and
+ South west, south, central and north Timor-Leste.

Several Indonesian National Parks, including Karimunjawa National Park, Kepulauan Seribu National Park, Meru Betiri National Park, Bali Barat National Park and Komodo National Park contain mangrove forest (refer to **Section 9.8**).

4.2 Intertidal Mud/Sand Flats

Intertidal mudflats form when fine sediment carried by rivers and the ocean is deposited in a low energy environment. Tidal mudflats are highly productive components of shelf ecosystems responsible for recycling organic matter and nutrients through microbial activity. This microbial activity helps stabilise organic fluxes by reducing seasonal variation in primary productivity which ensures a more constant food supply (Robertson 1988). Intertidal sand and mudflats support a wide range of benthic infauna and epifauna which graze on microscopic algae and microbenthos, such as bivalves, molluscs, polycheate worms and crustaceans (Zell 2007).

The high abundance of invertebrates found in intertidal sand and mudflats provides an important food source for finfish and shellfish which swim over the area at high tide. Mudflats have also been shown to be significant nursery areas for flatfish. During low tide, these intertidal areas are also important foraging areas for indigenous and migratory shorebirds. Mudflats also play a vital role in protecting shorelines from erosion (Wade and Hickey 2008).

4.2.1 Central Western Shelf Province

Shark Bay in the Central Western Shelf Province has an protected intertidal ecological community 'Subtropical and Temperate Coastal Saltmarsh', as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is the northerly limit for this community and there is a transition zone for many saltmarsh species (CALM 1996). The EPBC 'Listed Advice' (DSEWPaC 2013a) reports that sediments associated with these communities generally consist of poorly-sorted anoxic sandy silts and clays, and may have salinity levels that are much higher than seawater due to evaporation. The drainage characteristics of coastal soils, along with tidal patterns and elevation, can strongly influence the distribution of flora and fauna within the Coastal Saltmarsh ecological community (DSEWPaC 2013a).

4.2.2 Northwest Shelf Province

Within Northwest Shelf Province both Roebuck Bay and Eighty Mile beach are areas with significant intertidal mudflats that are used by birds in spring and summer including species listed as threatened under the *Biodiversity Conservation Act 2016* (BC Act) or EPBC Act, or listed on the IUCN Red List of Threatened Species (IUCN 2019). Intertidal mudflats are also an important feature of the Kimberley coast forming in many bays and inlets of the region (Waples 2007). The sediments that dominate these flats are generally of terrigenous origin (Wilson 2013).

The mudflats of the Kimberley coast have been shown to be important for migratory birds of the East Asian-Australasian Flyway, which is estimated to support more than five million migratory shorebirds (Barter 2002, Bennelongia Pty Ltd 2010, Wade and Hickey 2008). The migratory birds visit the mudflats of the Kimberley coast to feed on benthic organisms prior to embarking on a 10,000–15,000 km migration to their breeding grounds in the Artic (Wade and Hickey 2008).

4.2.3 Northwest Shelf Transition

Extensive mud flats are located in Collier Bay, where the highest tidal range in Australia is found. (Wilson 2013, Zell 2007). A study by (Duke *et al*. 2010, Masini *et al*. 2009) also identified fringing mudflats around Walcott Inlet, and Doubtful Bay. The tidal mudflats of Walcott Inlet are up to 5 km wide and support a rich intertidal invertebrate community (Gibson and Wellbelove 2010). These invertebrate communities in turn also support large numbers of waterbirds (Wilson 1994).

Extensive intertidal mudflats occur in Prince Frederick Harbour and are generally backed by mangroves. The mudskipper is known to feed on these mudflats at low tide. Intertidal flats are also a feature of the estuary of the Mitchell River. The mudflats of Port Warrender are known to support 20 shorebird species and tern species and it is likely the other mudflats in the region also support high numbers of birds. The ecological significance of the wetlands of the Mitchell River has been recognised in *A Directory of Important Wetlands in Australia*. Mud and sand flats are also known to surround much of Deep Bay and Napier Broome Bay.

Intertidal sand and mudflats are a common feature of the East Kimberley. Large sand bars are present on the river mouths of the King George River, Berkeley River and Lyne River and intertidal mudflats are extensive along the edges of the Cambridge Gulf. The estuary is wide and very shallow in some sections, and the silt and clay is continually picked up and redeposited by strong tidal currents (Robson *et al.* 2008). The tidal flats of the Ord River in the Cambridge Gulf have been listed as a wetland of international importance for the conservation of waterbirds under the Ramsar convention. The area supports a variety of fauna including shorebirds and mudskippers. Tidal mudflats are also extensive along the coast between the Cambridge Gulf and the WA-NT Border.

4.2.4 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.2.5 International Waters

Although no specific areas of intertidal mud or sand flats have been identified for international waters, the southern coasts of the islands that make up the Lesser Sunda Ecoregion of Indonesia and Timor-Leste do contain numerous estuarine habitats. These estuaries are likely to contain intertidal and tidal sand and mud flats that support a range of benthic invertebrate species that in turn attract other species such as birds and fish. Such estuaries in the Lesser Sunda Ecoregion are typically mangrove lined. Within the Lesser Sunda Ecoregion, the following areas are recognised as containing estuarine habitat (Wilson et al. 2011):

+ Lombok;
+ Sumba;
+ Central south and central north coasts of Sumbawa;
+ North-east coast of Flores; and
+ South-west coast of Timor-Leste.

The Irebere Estuary, located on the south-eastern coast, Tilomar located on the southern coast and Nino Konis Santana located on the eastern coast of Timor-Leste has been recognised as an Important Bird Area (Birdlife International 2018).

Several National Parks in the Ecoregion also contain estuarine habitats (likely to include intertidal sand and mud flats), including Karimunjawa National Park (refer to **Section 9.8**).

4.3 Intertidal Platforms

Intertidal platforms are areas of hard bedrock and/or limestone with or without a sediment veneer of varying thickness. These platforms can vary from low to high relief and provide a habitat for a diverse range of intertidal organisms (Morton and Britton in Jones 2004, SKM 2009, 2011, Hanley and Morrison 2012) and some species of shore birds (Garnet and Crowley 2000). They are common within each of the coastal bioregions within the EMBA.

4.3.1 Southwest Shelf Province and Southwest Shelf Transition

Intertidal platforms within the Northwest and Southwest bioregions support a mosaic of fauna and flora that typically exhibits strong variability in percent cover, community composition, abundance and diversity both between and within reefs at varying spatial and temporal scales (SKM 2009, 2011). Reef platforms typically exhibit zonation of fauna and flora from upper to lower levels on the intertidal zone, with increasing diversity, abundance and biomass lower in the intertidal (Morton and Britton in Jones 2004, SKM 2009, 2010, 2011, Hanley and Morrison 2012).

On the south coast of the Southwest Shelf Province, the coastal geomorphology changes from the predominant limestone reefs to eroded Precambrian rocks. Intertidal platforms are also common along the Southwest Shelf Transition. Shark Bay in the Central Western Shelf Province has a high diversity of intertidal marine habitats as a result of the diversity of benthic substrate, salinity and the broad geographical features which influence depth, water movement and turbidity (CALM 1996, DSEWPaC 2013b). This includes extensive, limestone platforms (as well as sand flats, mud flats, salt marsh and mangroves and beaches (CALM 1996).

4.3.2 Central Western Shelf Province and Transition

Limestone pavements extend out from the beach into subtidal zones, e.g. along the Ningaloo Coast and North West Cape; and higher relief platforms (>0.5 m off high water mark) are also present at a number of headlands along the North West Cape.

4.3.3 Northwest Shelf Province and Northwest Shelf Transition

Large tidal regimes are likely to be the defining environmental factor influencing the distribution of intertidal flora and fauna in the Northwest Shelf Province and Northwest Shelf Transition. The intertidal area of the Kimberley has an extreme tidal range (hypertidal) which creates unique environmental conditions and habitats not seen else anywhere else in the world. As a remote area many of the habitats are untouched and they are recognised as having significant conservation value (DPaW 2013). DPaW (2013) reports that as a result of the monsoonal influxes of freshwater and land-derived nutrients distinctive tropical marine ecosystems have occurred.

4.3.4 International Waters

While no significant areas of intertidal platforms have been identified in international waters, the high energy southern coastlines of the islands of the Lesser Sunda Ecoregion of Indonesia (and also including Timor-Leste) are likely to have areas of exposed pavements consisting of limestone and remnant lava flows (Wilson *et al*. 2011).

4.4 Sandy Beaches

Sandy beaches are those areas within the intertidal zone where unconsolidated sediment has been deposited (and eroded) by wave and tidal action. Sandy beaches can vary from low to high energy zones; the energy experienced influences the beach profile due to varying rates of erosion and accretion. Sandy beaches are found across the EMBA and vary in length, width and gradient. They are interspersed among areas of hard substrate (e.g. sandstone) that form intertidal platforms and rocky outcrops. There is a wide range of variation in sediment type, composition, and grain size along the EMBA.

Sandy beaches provide habitat to a variety of burrowing invertebrates and subsequently provide foraging grounds for shorebirds (Garnet and Crowley 2000). The number of species and densities of benthic macroinvertebrates that occur in the sand are typically inversely correlated with sediment grain-size and exposure to wave action, and positively correlated with sedimentary organic content and the amount of detached and attached macrophytes (Wildsmith *et al.* 2005). However, the distributions of these faunas among habitats will also reflect differences in the suite of environmental variables that characterize those habitats (Wildsmith *et al.* 2005).

Sandy habitats are important for both resident and migratory seabirds and shorebirds (refer **Section 8**). While sand flats and beaches generally support fewer species and numbers of birds than mudflats of similar size; some species such as the beach thick knee (*Esacus giganteus*) a crab eater, are commonly associated with sandy beaches (Garnet and Crowley 2000). Sandy beaches can also provide an important habitat for turtle nesting and breeding (see marine turtles **Section 6.1**).

Sandy beaches also provide important nesting habitat for the six species of marine turtles that nest within WA (refer **Section 6.1**).

4.4.1 Southwest Shelf Province

The hooded plover (*Thinornis rubricollis*) is a shorebird found on several beaches within the South West capes. Hooded plovers live on sandy surf beaches and prefer beaches backed by dunes rather than cliffs (DEC 2013). In addition to this, beaches in the South West province provide a variety of socio economic values including tourism, commercial and recreational fishing, and support other recreational activities.

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4.4.2 Southwest Shelf Transition

Sandy beaches throughout the Abrolhos host breeding populations of the Australian sea lion. The Abrolhos represent the northernmost breeding population of Australian sea lions. The current population at the Abrolhos is estimated to be approximately 90 individuals (DoF 2012).

In addition to this, beaches in the South West province provide a variety of socio-economic values including tourism, commercial and recreational fishing, and support of other recreational activities.

4.4.3 Northwest Shelf Province

Eighty Mile Beach Marine Park is one of the Australia's largest uninterrupted sandy beaches (stretching 220 km) and is an important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DEC 2012a). It is also a listed Ramsar wetland (see **Section 9** on Protected Areas).

4.4.4 Northwest Shelf Transition

Sand habitat within the Camden Marine Park is mainly associated with shorelines and inlets on both mainland and island shores. Some beach deposits on islands in the Kimberley are composed of skeletal carbonate sand, while they may also consist of sediments from inland areas carried to the sea by rivers and gullies (DPaW 2013). The sediment coarseness of the sand may vary, and may also be littered with dead shell, rock and/or coral material. Sea cucumbers that ingest sand and filter out microscopic food are often common in this habitat DPaW 2013).

Generally, in this region, sand habitat is adjacent to either dense mangrove stands or rocky cliffs (DPaW 2013). Beaches can be highly influenced by tide and weather conditions. Those that overlie rock are likely to shift and be ephemeral in nature.

4.4.5 International Waters

No significant areas of sandy beaches in international waters have been identified. However, the southern coastlines of the islands of the Lesser Sunda Ecoregion of Indonesia and Timor-Leste are known to contain sandy beaches consisting of soft black sand, formed by volcanic activity. Within this region, a number of National Parks are considered important sites for turtle nesting beaches, including the Meru Betiri National Park (refer to **Section 9.8**).

4.5 Rocky Shorelines

Rocky shorelines are found across the EMBA and are often indicative of high energy areas (wave action) where sand deposition is limited or restricted (perhaps seasonally or during a cyclone). They are formed from limestone pavement extending out from the beach into subtidal zones, for example along the Ningaloo Coast and North West Cape; higher relief platforms (>0.5 m off high water mark) are also present at a number of headlands along the North West Cape. This habitat is also widespread heading south towards Perth.

Rocky shores can include pebble/ cobble, boulders, and rocky limestone cliffs (often at the landward edge of reef platforms). Rocky outcrops typically consist of hard bedrock, but some of the coastline has characteristic limestone karsted cliffs with an undercut notch. Rocky shorelines can vary from habitats where there is bedrock protruding from soft sediments to cliff like structures that form headlands. Rocky shorelines are an important foraging area for seabirds and habitat for invertebrates found in the intertidal splash zone (Morton and Britton cited in Jones 2004). For example, oyster catchers and ruddy turnstones feed along beaches and rocky shorelines (see seabirds in **Section 8.2.2**).

4.5.1 International Waters

The Lesser Sunda Ecoregion contains numerous rocky shores, particularly on the exposed southern coastlines of the islands that make up the ecoregion. Areas of rocky shores include the following (DeVantier 2008):

+ The Bukit Peninsula and Nusa Penida areas of Bali;
+ South Lombok;

- South-east Sumbawa;
- Nusa Tengara;
- Sumba; and
- Timor-Leste, including Roti Island, Fatu and Atapupu.

5. Fish and Sharks

Fish distributions in the EMBA are discussed with respect to the IMCRA Provincial Bioregions which were defined using CSIRO's 1996 regionalisation of demersal fish on the continental shelf to the shelf break, and their 2005 regionalisation of demersal fish on the continental slope to approximately 1,200 m depth (DEH 2006). The EPBC species listed as threatened and migratory found in the EMBA, according to the Protected Matters search (**Appendix A**), are shown in **Table 5-5-1** along with their WA conservation listing (as applicable) and discussed in **Section 5.2** below.

The following WA conservation codes apply to WA conservation significant fauna:

+ Threatened Species (listed under BC Act):
  - Critically Endangered
  - Endangered
  - Vulnerable
+ Specially protected species (listed under BC Act):
  - Migratory
  - Species of special conservation interest (conservation dependant fauna)
  - Other specially protected species
+ Priority species (non-statutory state based administrative process):
  - Priority 1, 2 and 3: poorly-known species – possible threatened species that do not meet survey criteria or are otherwise data deficient. Ranked in order of priority. In urgent need of further survey.
  - Priority 4: species that are adequately known, are either: rare but not threatened; meet criteria for near threatened; or delisted as threatened species within last five years for reasons other than taxonomy. Requiring regular monitoring.

A detailed account of commercial and recreational fisheries that operate in the region is provided in in the Commercial Fisheries **Section 14.7** and detailed in *The State of the Fisheries Report* 2017/2018 (Gaughan *et al.*, 2019).

Table 5-5-1: EPBC listed fish and shark species in the EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Blind gudgeon (*Milyeringa veritas)*	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - No BIA defined
Balstons pygmy perch (*Nannatherina balstoni*)	Vulnerable	Vulnerable	-	Species or species habitat likely to occur within area.	None - No BIA defined

[1] The Wildlife Conservation (Specially Protected Fauna) Notice 2018 has been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the BC Act.

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Blind cave eel (*Ophisternon candidum)*	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - No BIA defined
Black-stripe minnow (*Galaxiella nigrostriatal*)	Endangered	Endangered	-	Species or species habitat known to occur within area.	None - No BIA defined
Grey nurse shark (*Carcharias taurus*)	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - BIA not found in EMBA
Great white shark (*Carcharodon carcharias*)	Vulnerable & Migratory	Vulnerable	-	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to **Table 5-3**
Whale shark (*Rhincodon typus*)	Vulnerable & Migratory	Specially protected (species otherwise in need of special protection)	-	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to **Table 5-3**
Northern river shark (*Glyphis garricki)*	Endangered		Priority 1	Breeding likely to occur within the area.	None - BIA not found in EMBA
Dwarf sawfish (*Pristis clavata)*	Vulnerable & Migratory		Priority 1	Breeding known to occur within area.	Yes – Refer to **Table 5-3**
Freshwater sawfish (*Pristis pristis)*	Vulnerable & Migratory		Priority 3	Species or species habitat known to occur within area.	Yes – Refer to **Table 5-3**
Narrow sawfish (*Anoxypristis cuspidate)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Green sawfish (*Pristis zijsron)*	Vulnerable & Migratory	Vulnerable	-	Breeding known to occur within area.	Yes – Refer to **Table 5-3**
Shortfin mako *(Isurus oxyrinchus)*	Migratory	-	-	Species or species habitat likely to occur within area .	None - No BIA defined
Longfin mako *(Isurus paucus)*	Migratory	-	-	Species or species habitat likely to occur within area.	None - No BIA defined
Reef manta ray *(Manta alfredi)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined

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Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Giant manta ray *(Manta birostris)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Porbeagle *(Lamna nasus)*	Migratory	-	-	Species or species habitat may occur within area.	None - No BIA defined

In addition a review of conservation dependent species[2] identified five species of fish / sharks that may occur in the EMBA:

- Orange roughy (*Hoplostethus atlanticus*);
- Southern blue fin tuna (*Thunnus maccoyii*);
- Southern dogfish (*Centrophorus zeehaani*);
- School shark (*Galeorhinus galeus*); and
- Scalloped hammerhead (*Sphyrna lewini*).

5.1 Regional Surveys

Within the EMBA a number of important geographical areas for fish exist, including Ningaloo Marine Park, Montebellos/Barrow Island Marine Park, Abrolhos Australian Marine Park and the Rowley Shoals.

5.1.1 Southwest Shelf Province

At least 150 species have been identified within the capes region as being reef-associated (Hutchins 1994 cited in DEC 2013). Of these, 77% are warm temperate species, 18% are subtropical species and 5% are tropical (DEC 2013).

The most abundant finfish species across the region identified during surveys were the Maori wrasse (*Opthalmolepis lineolatus*), red banded wrasse (*Pseudolabrus biserialis*), McCulloch scalyfin (*Parma mccullochi*), and western king wrasse (*Coris auricularis*). The yellow headed hulafish (*Trachinops noarlungae*), black headed puller (*Chromis klunzingeri*), rough bullseye and common bullseye (*Pempheris multiradiata* and *P. klunzingeri*) were also common at Eagle Bay and Geographe Bay (Westera *et al.* 2007 cited in DEC 2013).

5.1.2 Southwest Shelf Transition

A total of 389 finfish species have been recorded at the Abrolhos (DoF 2012). The Abrolhos and their surrounding coral and limestone reef systems consist of a combination of abundant temperate macroalgae with coral reefs, supporting substantial populations of large species such as baldchin groper and coral trout. Some of the species occurring in the Abrolhos are dependent on larvae carried southward by the Leeuwin Current from areas further north, such as Shark Bay or Ningaloo Reef. Similarly, populations of some of the species occurring at Rottnest Island are dependent on larvae generated from breeding populations at the Abrolhos (DoF 2012).

More than 20 species of sharks have been identified at the Abrolhos (DoF 2012). These sharks include:

- Port Jackson sharks (*Heterodontus portusjacksoni*);

[2] Conservation dependent species are listed species under the EPBC Act and are considered as part of the Commonwealth marine area.

- Tiger shark (*Galeocerdo cuvier*);
- Whaler sharks (*Carcharhinus brachyurus*); and
- Wobbegongs (*Orectolobus maculatus*).

Abrolhos waters are considered to be an important food source for sharks, due to the resident fish populations. Various species of rays have been recorded at the Abrolhos. These include the manta ray and the white spotted eagle ray (DoF 2012).

5.1.3 Central Western Province

The Perth Canyon appears to be an important ecological feature attracting krill and fish aggregations that in turn attract larger species such as predatory fish and pygmy blue whales (DSEWPaC 2012). Demersal slope fish assemblages in this bioregion are characterised by high species diversity. Scientists have described 480 species of demersal fish that inhabit the slope of this bioregion and 31 of these are considered endemic to the bioregion. Demersal fish on the slope in this bioregion in particular have high species diversity compared with other more intensively sampled oceanic regions of the world. Below 400 m water depth demersal fish communities are characterised by a diverse assemblage where relatively small, benthic species (grenadiers, dogfish and cucumber fish) dominate.

5.1.4 Central Western Shelf Province

The Central Western Shelf Province is located near Shark Bay and is the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay, 83% are tropical species with 11% warm temperate and 6% cool temperate species (CALM 1996).

5.1.5 Central Western Shelf Transition

Ningaloo is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that provides habitat for many fish species. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). Ningaloo Reef is a well known biodiversity hotspot, supported by the direct link between the reef and the ancient reef systems found closer to the equator by the Leeuwin Current (Kemps 2010). Approximately 500 species of fish have been reported to inhabit the reef (Kemps 2010). The Piercam project from inception in 2005 to 2013, identified 165 fish species from 50 families at the Point Murat Navy Pier alone, located within the Ningaloo Marine Park (Whisson & Hoschke 2013).

Seasonal aggregations of whale sharks occur at Ningaloo each year (CALM 2005). There is limited data available on species diversity and distribution of sharks in the Ningaloo area as chondrichthyan biodiversity for the area has not been specifically recorded. Despite this, it is possible that the Ningaloo Reef Marine Park contains the largest and most diverse collection of sharks on the Australian coastline (Stevens *et al.* 2009). It was estimated in 2009 by Last and Stevens (cited in Stevens *et al.* 2009), that there are likely to be 118 species of chondrichthyan fishes occurring in the park. Of these species, 59 are shark species predicted to be found at depths of less than 200 m (Stevens *et al.* 2009).

The lagoon at Ningaloo Reef appears to provide a juvenile habitat and nursery area for shark species such as the grey nurse shark (*C. Taurus*), black-tipped reef shark (*Carcharhinus melanopterus*) and other reef sharks (Carcharhinidiae) (Stevens *et al.* 2009). A study conducted on the distribution and abundance of elasmobranches in the Ningaloo Marine Park, in 2009, tracked the movements of six key shark species. Species such as *Galeocerdo cuvier* (tiger shark) and *Sphyrna mokarran* (great hammerhead) were found to remain for brief time periods in the park, in contrast to other species found to re-visit the Ningaloo area (Stevens *et al.* 2009). Several species of sharks within Ningaloo have been identified as key indicator species for the health of the system (Stevens *et al.* 2009).

Barrow Island includes Biggada Reef, an ecologically significant fringing reef, and the Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops; providing fish habitat (DEC 2007a). Within the Barrow/Montebello region, at least 380 fish species have been recorded (de Lestang & Jankowski 2017). Most species exhibit wide distributions, with local species composition closely resembling that of the Dampier Archipelgao. Coral habitats support the most diverse fish community in this region, comprising, among others, many species of damselfish (*Pomacentridae*), parrotfish (*Scaridae*), snappers (*Lutijanidae*) and groupers (*Serranidae*) (de Lestang & Jankowski 2017). The region's macroalgal habitats are considered important nursery areas for a diverse range of fish species, such as emperor (*Lethrinidae*), threadfin bream (*Nemipteridae*), tuskfish (*Labridae*) and trevally (*Carangidae*) (de Lestang & Jankowski 2017).

Ramsar wetlands within the area (e.g. Eighty Mile Beach and Ashmore Reef National Nature Reserve) can also provide important habitat for fish (see **Section 9.2**).

5.1.6 Central Western Transition

The biological communities of the Central Western Transition are thought to be distinctive owing to the proximity of deep oceans areas to the continental slope and shelf, resulting in close interaction between pelagic species of the Cuvier Abyssal Plain and those of the slope and shelf (DEWHA 2008a).

The present level of understanding of the marine environment in this bioregion is generally poor. The diversity of fish and cephalopod species changes with depth, generally decreasing species numbers with increasing depth. The demersal slope fish bioregionalisation identified some endemism in communities in this bioregion (Last *et al*. 2005), however, it is lower than other areas of the North-west Marine Region (DEWHA 2008a).

Bentho-pelagic fish, such as deep-water snappers (e.g. *Paracaesio* spp, and *Eletis* spp.), hatchetfish (*Argyropelecus* spp.), dragonfish (*Melacosteus* spp.), viperfish (*Chauliodus* spp.) and a number of eels species migrate between the benthic and pelagic systems, forming an important link between these systems (DEWHA 2008a).

Transient fish species through the Central Western Transition bioregion include southern bluefin tuna (migrating to and from spawning grounds), broadbill swordfish (*Xiphius gladius*), bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*) and striped marlin (*Tetrapturus audax*). Pelagic sharks also range across the bioregion following schools of pelagic fish (DEWHA 2008a).

5.1.7 Northwest Shelf Province and Northwest Province

The demersal zone of the North West Shelf (which includes the Northwest Province and Northwest Shelf Province) hosts a diverse assemblage of fish of tropical Indo-west Pacific affinity, with up to 1,400 species known to occur, with a great proportion of these occurring in shallow coastal waters (Allen *et al*. 1988). Last *et al*. (2005) and Fox and Beckley (2005) described the North-west Province as being characterised by a high level of endemism and species diversity. Certain areas of increased biological activity (e.g. Glomar Shoals) attract demersal fish species such as Rankin cod, red emperor, crimson snapper and spangled emperor that are exploited by commercial trawl and trap fisheries (Sainsbury *et al*. 1992, Fletcher and Santoro 2013).

The shallow waters (<30 m) of the Dampier Archipelago, in the Northwest Shelf Province, support a characteristic and rich fish fauna of 650 species from a variety of habitats including coral and rocky reefs, mangroves, sand and silty bottoms and sponge gardens (Hutchins 2003 & 2004). The majority of these species are found over hard substrate, but significant numbers are also found from soft bottom and mangrove areas. The outer islands of the Archipelago are inhabited predominantly by coral reef fishes whereas inner areas close to the mainland are occupied by mangrove and silty-bottom dwellers. The inter-island passages have a relatively rich soft bottom fauna. EPBC Act protected fish species within the Dampier Archipelago include the dwarf sawfish (*Pristis clavata*), freshwater sawfish (*Pristis pristis*) and narrow sawfish (*Anoxypristis cuspidate*).

The fish fauna of the archipelago is less diverse than the islands of the West Pilbara to the south, but are closely related to the fauna at the offshore Montebello Islands (Hutchins 2004). The fish fauna of Barrow/ Lowendal/ Montebello Islands are widespread throughout the Indo-west Pacific region.

Within the southern portion of the Northwest and Northwest Shelf Province, small pelagic fish (e.g. lantern fishes) comprise a third of the total fish biomass (Bulman 2006) and inhabit a range of marine environments, including inshore and continental shelf waters. These small pelagic fish play an important ecological role, not only for this particular area but for the entire NWMR. They feed on pelagic phytoplankton and zooplankton and provide a food source for a wide variety of predators such as marine mammals, sharks, large pelagic fish and seabirds, thus providing a vital link between many of the region's trophic systems (Mackie *et al*. 2007).

Pelagic fish in the Northwest and Northwest Shelf Province include tuna, mackerel, herring, pilchard and sardine, and game fish such as marlin and sailfish (BBG 1994, Brewer *et al*. 2007), some of which are targeted by both commercial and recreational fishers. In particular, adult and juvenile southern bluefin tuna are thought to migrate through the North West Shelf on their way to and from spawning grounds in the north-eastern Indian Ocean. However, the timing of these migrations and the use of regional currents to assist their migration is still unclear. The oceanic waters of the North West Shelf are also believed to provide important spawning and nursery grounds for a number of large pelagic fish species. **Table 5-2** provides a summary of the key fish species and likely timing of their spawning in the region (DoF correspondence).

5.1.8 Northwest Shelf Transition

Creek systems, mangroves and rivers, and ocean beaches within this region provide habitat for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin and cods (Fletcher and Santoro 2013). The offshore atolls and the continental shelf waters in the Northwest Shelf Transition are also geographically important for fish species. They support species of recreational and commercial interest, including saddle-tail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish (Gaughan et al. 2019).

The Rowley Shoals within the Northwest Shelf Transition comprise three oceanic reef systems approximately 30–40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant (DEC 2007b). See **Section 11** on State Marine Parks and Nature Reserves for further details on important geographical areas for fish.

5.1.9 Northwest Transition

The Northwest Transition bioregion may support sparse populations of bentho-pelagic fish and cephalopods in low densities. Pelagic fish species likely to be present include grenadiers and hatchetfish (*Argyropelecus* spp.) as well as transient populations of highly mobile pelagic fish. Adult and juvenile southern bluefin tuna are through to migrate through this bioregion on their way to and from spawning grounds in the north-eastern Indian Ocean (DEWHA 2008a).

The slope habitat of this bioregion is associated with important populations of demersal fish species and supports the second richest demersal fish assemblage nationally (Last *et al*. 2005). Over 508 fish species have been identified on the slope in this area and 64 of these species are endemic. The high diversity and endemism of the demersal fish fauna indicates important interactions between physical processes and trophic structures in this bioregion. For more information on the slope habitat for fish and sharks, refer to **Section 10.1.18**.

The Rowley Shoals within the Northwest Transition comprise three oceanic reef systems approximately 30–40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant (DEC 2007b).

5.1.10 Timor Province

The diversity of demersal fish assemblages on the continental slope in the Timor Province (as well as the Northwest Transition and the Northwest Province) is high compared to elsewhere along the Australian continental slope (DSEWPaC 2012). Elements of the Timor Province are not well known, due to limited survey data in the northern limits of the region. The province is geographically extensive and includes 418 fish species, 64 of which are endemic to the region (Last *et al.* 2009). Key indicator species include *Bembrops nelsoni*, *Bythaelurus* sp., *Halicmetus* sp., *Malthopsis* spp, *Neobythites australiensis*, *Nobythites bimaculatus*, *Neobythites macrops*, *Neobythites soelae*, *Parapterygotrigla* sp., *Physiculus roseus* (Last *et al.* 2005).

Scott and Seringapatam Reefs are regionally important for the diversity of their fauna, including 558 fish species (Department of the Environment (DoE) 2014). Scott Reef has enormous habitat diversity and is considered a hot spot for fish, with five endemic species (DoE 2014). Scott Reef has biogeographic significance due to the presence of species which are at or close to the limits of their geographic ranges, including fish known previously only from Indonesian waters such as cardinalfish, azure damselfish (*Chrysoptera hemicyanea*), comb-tooth blenny (*Escnius schroederi*) and several Gobiids (DoE 2014).

Santos

The diversity of fish at Ashmore Reef is also higher than other comparable reefs in the bioregion with over 760 species recorded (Russell *et al.* 2005, Kospartov *et al.* 2006. The majority of fish species are shallow water, benthic taxa that typically inhabit depths down to 100 m and are widely distributed throughout the Indo-West Pacific (Russell *et al.* 2005). The most species rich groups are gobies (*Gobiidae*), damselfishes (*Pomacentridae*), wrasses (*Labridae*), cardinal fishes (*Apogonidae*), moray eels (*Muraenidae*), butterflyfishes (*Chaetodontidae*), and rockcods and groupers (*Serranidae*) (Allen 1989, Russell *et al*. 2005).

5.1.11 Christmas Island Province

The Christmas Island Province is in deep, offshore waters (2,200 m – 6,000 m depth range). These waters provide habitat for pelagic finfish species including tuna (*Thunnus* sp.) and wahoo (*Acanthocybium solandri*), and some demersal species such as ruby snapper (*Etelis carbunculus*).

Table 5-2: Spawning and aggregation times of key commercially caught fish species within the North West Shelf

Species		Month											
Species Common Name	**Species Latin Name**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Blacktip shark	*Carcharhinus tilstoni* and *C. limbatus*												
Goldband snapper	*Pristipomoides multidens*												
Rankin cod	*Epinephelus multinotatus*												
Red emperor	*Lutjanus sebae*												
Sandbar shark	*Carcharhinus plumbeus*												
Spanish mackerel	*Scomberomorus commerson*												
Pink snapper	*Pagrus auratus*												
Baldchin groper	*Choerodon rubescens*												
Crystal (snow) crab	*Chaceon spp.*												
King George whiting	*Sillaginodes punctate*												
Spangled emperor	*Lethrinus nebulosus*												
Pearl oyster	*Pinctada maxima*												
Blue-spotted emperor	*Charaxes cithaeron*												
Dusky whaler	*Carcharhinus obscurus*	May occur throughout the year											
Whiskery shark	*Furgaleus macki*												
Gummy shark	*Mustelus antarcticus*	Peak pupping periods unknown											
Fish	other species	Timing of spawning activity varies between species											

5.2 Fish Species

Four species of fish listed as threatened under the EPBC Act (**Table 5-5-1**) were identified in the Protected Matters search (**Appendix A**):

- Balston's pygmy perch (*Nannatherina balstoni*);
- Black-stripe minnow (*Galaxiella nigrostriata*);

- Blind gudgeon (*Milyeringa veritas*); and
- Blind cave eel (*Ophisternon candidum*).

In addition the Barrow cave gudgeon *(Milyeringa justitia*) has been identified as relevant threatened species under the BC Act. This species is not listed under the EPBC Act.

5.2.1 Blind Gudgeon, Balston's Pygmy Perch and Blind Cave Eel

Both the blind gudgeon (*Milyeringa veritas*) and blind cave eel (*Ophisternon candidum*) are known to occur on the Cape Range Peninsula (in the Central Western Shelf Transition) (Humphreys and Feinberg 1995), and a related species of the genus Milyeringa, the Barrow cave gudgeon *(Milyeringa justitia*) has also been noted at Barrow Island (Humphreys 1999). The Barrow cave gudgeon is listed as Vulnerable under the WA BC Act. They have been recorded in waters ranging from fresh to seawater at depths of up to 33 m in caves and 50 m in wells and bores. Both species are restricted to either caves or groundwater (Humphreys and Blyth 1994) and are the only two vertebrate animals known from Australia for this (DoE 2014a).

The Balston's pygmy perch distribution ranges from Moore River (75 km north of Perth) at the northern extent to Two Peoples Bay near Albany. This freshwater species is typically associated with shallow waters near riparian vegetation and is considered to have low salinity tolerance, making it unlikely to occur in estuarine conditions (DoEE, 2016).

5.2.2 Black-stripe minnow

The black-stripe minnow inhabits coastal wetlands of south-west WA between Augusta and Albany. During summer when ephemeral pools dry out, individuals burrow into the moist soil below to aestivate until the rains return in autumn (Bray and Gomon 2017).

5.2.3 Syngnathids

The EPBC Protected Matters search also identified 72 'listed marine species of fish which are largely from the family Syngnathidae (**Appendix A**). Syngnathids are a group of bony fishes that include seahorses, pipefishes, pipehorses and sea dragons, although taxonomic uncertainty still surrounds a number of these (DEWHA 2012a). Knowledge about the distribution, abundance and ecology of syngnathids is limited.

5.3 Sharks, Rays and Sawfishes

The diversity of marine environments in the waters within the NWMR has led to a rich fauna of cartilaginous fish (sharks and rays). Of the approximately 500 shark species found worldwide, 19% (94) are found in the region (DEWHA 2008a). The EPBC Act Protected Matters search (**Appendix A**) identified four species of shark, and three species of sawfishes listed as threatened within the search area between south west WA and NT border (**Table 5-5-1**), including:

- Grey nurse shark (*Carcharias taurus*);
- Great white shark (*Carcharodon carcharias*);
- Northern river shark (*Glyphis garricki*);
- Whale shark (*Rhincodon typus*);
- Dwarf sawfish (*Pristis clavata*);
- Freshwater sawfish (*Pristis pristis*); and
- Green sawfish (*Pristis zijsron*).

In addition, the narrow sawfish (*Anoxypristis cuspidate*), two species of ray, the reef manta ray (*Manta alfredi*) and giant manta ray (*Manta birostris*), the porbeagle (*Lamna nasus*) and the longfin (*Isurus paucus*) and shortfin (*Isurus oxyrinchus*) mako sharks are listed as migratory within the search area (**Table 5-5-1).**

The Biologically Important Areas (BIAs) for relevant species detailed above are illustrated in **Figure 5-1, Figure 5-2** and **Figure 5-3**.

5.3.1 Grey Nurse Shark

The grey nurse shark (*Carcharias taurus*) is listed as vulnerable under the EPBC Act and the BC Act, and may be found within the EMBA. In Australia, the grey nurse shark is now restricted to two populations, one on the east coast from southern Queensland to southern NSW and the other is predominantly found around the southwest coast of WA, but has been recorded on the North West Shelf (DEWHA 2012b, Pogonoski *et al*. 2002). It is believed that the east and west coast populations do not interact and ongoing research will probably confirm that the populations are genetically different (Last and Stevens 2009).

While it is thought that grey nurse sharks have a high degree of site fidelity, some studies (McCauley 2004) suggest that grey nurse sharks move between different habitats and localities, exhibiting some migratory characteristics. In certain areas grey nurse sharks are vulnerable to localised pressure due to high endemism. The status of the west coast population is poorly understood although they are reported to remain widely distributed along the WA coast and are still regularly encountered, albeit with low and indeterminate frequency (Chidlow *et al*. 2006).

Grey nurse sharks are often observed hovering motionless just above the seabed, in or near deep sandy-bottomed gutters or rocky caves, and in the vicinity of inshore rocky reefs and islands (Pollard *et al*. 1996). The species has been recorded at varying depths, but is generally found between 15–40 m (Otway & Parker 2000). Grey nurse sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 m on the continental shelf (Pollard *et al*. 1996). Grey nurse sharks feed primarily on a variety of teleost and elasmobranch fishes and some cephalopods (Gelsleichter *et al*. 1999, Smale 2005).

No grey nurse shark BIAs were identified in the EMBA.

5.3.2 Great White Shark

The great white shark (*Carcharodon carcharias*) is listed as vulnerable and migratory under the EPBC Act and is listed as vulnerable under the BC Act. In Australia, great white sharks have been recorded from central Queensland around the south coast to northwest WA, but may occur further north on both coasts (Last and Stevens 2009). There are no known aggregation sites for white sharks in the North-west marine region, but the species has been recorded in North West Shelf waters during humpback migrations (DEWHA 2012b). They are widely but not evenly distributed in Australian waters and are considered uncommon to rare compared to most other large sharks (CITES 2004).

Study into great white shark populations is difficult (Cailliet 1996) given the uncertainty about their movements, emigration, immigration and difficulty in estimating the rates of natural or fishing mortality.

Great white sharks can be found from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas (Pogonoski *et al*. 2002). They also make open ocean excursions and can cross ocean basins (for instance from South Africa to the western coast of Australia and from the eastern coast of Australia to New Zealand). Great white sharks are often found in regions with high prey density, such as pinniped colonies (DEWHA 2009). The relevant great white shark BIAs in the EMBA are detailed in **Table 5-3** and is shown on **Figure 5-1** (DoEE 2019b).

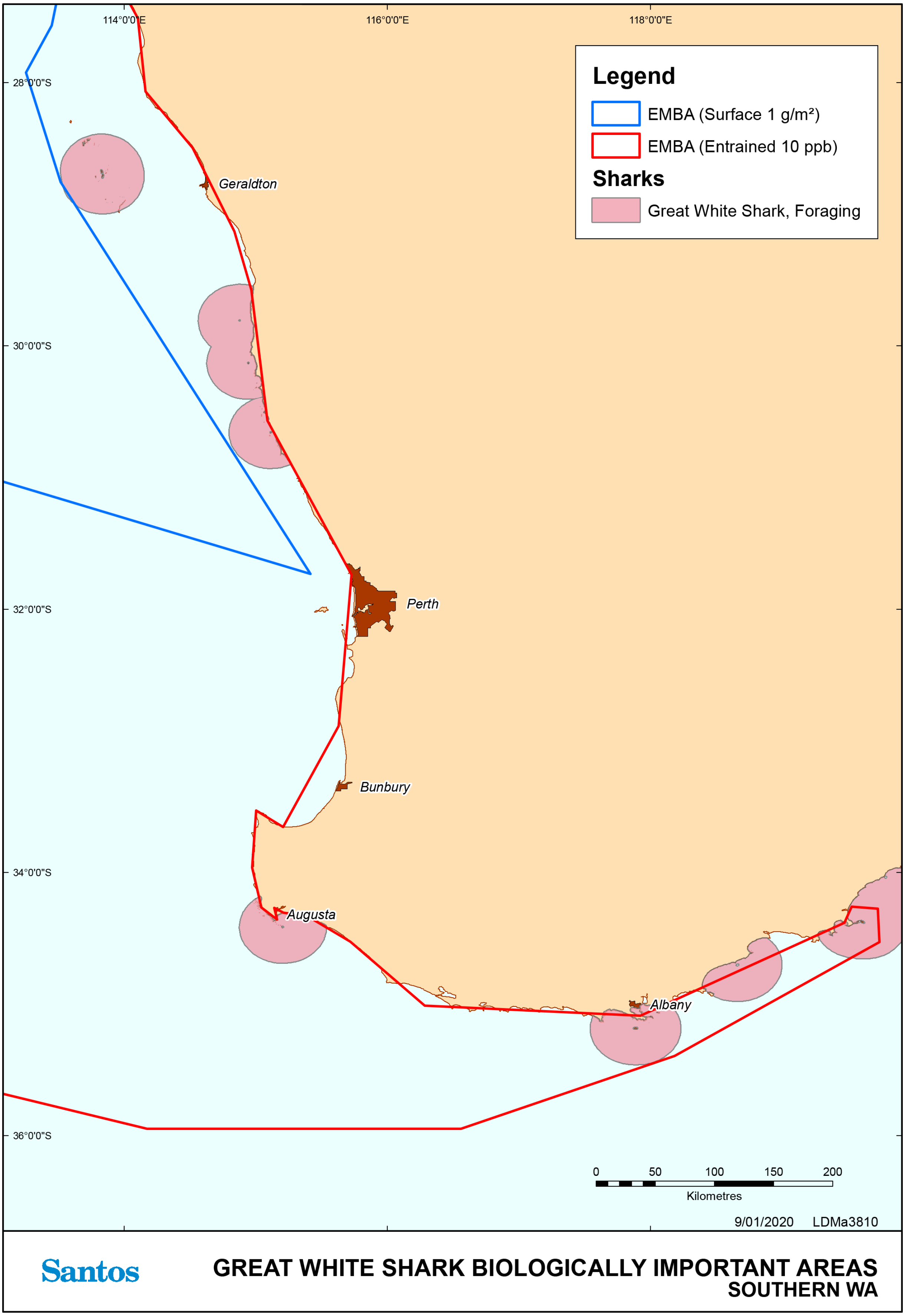

Figure 5-1: Biologically important area – great white shark

5.3.3 Northern River Shark

The northern river shark (*Glyphis garricki*) is listed as endangered under the EPBC Act and is one of the rarest species of shark in the world. Adults only recorded in marine habitats, whereas neonates, juveniles and subadults recorded in freshwater, estuarine and marine environments. It is also listed as a Priority 1 conservation species in WA.

The associated recovery plan (Sawfish and River Sharks Multispecies Recovery Plan, Commonwealth of Australia 2015) identifies adults and juveniles are being known in WA marine waters north of Derby. Pupping and juvenile sharks are identified as known to occur in Cambridge Gulf and pupping is also identified as likely to occur in King Sound. Under the associated recovery plan all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

5.3.4 Whale Shark

The whale shark (*Rhincodon typus*) is listed as vulnerable and migratory under the EPBC Act and is also listed as a specially protected species under the BC Act as a species of special conservation interest (conservation dependent fauna). The species is also classified as vulnerable on the World Conservation Union's Red List of Threatened Species (Norman 2005) and are protected under the WA *Conservation and Land Management Act 1984* and WA *Fish Resources Management Act 1994*.

The whale shark is the largest of all fish (>18 m; Borrell *et al*. 2011; Chen *et al*. 1997, Compagno 2001) and is a migratory species with worldwide geographical ranges between 30º N and 35º S (Last and Stevens 2009). There is a general lack of knowledge on many aspects of whale shark biology, including definitive migration patterns. The species is oceanic but often forms aggregations in coastal waters at sites throughout the tropics. Typically, these aggregations are seasonal and often coincide with specific productivity events that are a focus of feeding for the animals. For example, whale sharks aggregate to feed on dense swarms of copepods in Baja California (Clark and Nelson 1997), fish spawn off Belize (Heyman *et al*. 2001) and red crab larvae at Christmas Island (Meekan *et al*. 2009).

One of the best known aggregation sites for whale sharks occurs along the central and NW coast of Western Australia from March to July and is focused at Ningaloo Reef, within the Exmouth region. The small size and general absence of female whale sharks from Ningaloo Reef suggests that the region may be important for feeding rather than breeding (Norman and Stevens 2007). The timing of this aggregation coincides with a pulse in seasonal productivity that results in large abundances of tropical krill on which these filter feeding sharks feed (Meekan *et al*. 2006, Jarman and Wilson 2004). At Ningaloo Reef, whale sharks are often found swimming close to the reef front, within a few kilometres of the shore and in water of less than 50 m deep. A tourist industry based on snorkelling with the sharks in this area has developed over the last 15 years and is now estimated to be worth over $4 million annually to the local economy of the Ningaloo region.

Estimates of the size of the population participating in the Ningaloo aggregation are between 300 and 500 individuals (Meekan *et al*. 2006), but research indicates that the Ningaloo population of whale sharks is declining (Bradshaw *et al*. 2007).

Whale sharks are known to be highly migratory with migrations of 13,000 km being recorded (Eckert and Stewart 2001). Research on the migration patterns of whale sharks in the western Indian Ocean, and isolated and infrequent observations of individuals, indicate that a small number of the Western Australian population migrate through the North West Shelf. Wilson *et al*. (2006) tagged 19 whale sharks in 2003 and 2004, with long term movements patterns successfully recorded from six individuals. All travelled northeast into the Indian Ocean after departing Ningaloo Reef, with one tracked to Ashmore Reef and another to Scott Reef. Whale sharks are occasionally observed from Santos WA's offshore oil and gas facilities on the North West Shelf (Harriet Alpha and Stag platforms). In general, migration along the northern WA coastline broadly follows the 200 m isobath and typically occurs between July and November (DoE 2015).

A biologically important area for whale sharks is located in northern WA, offshore of the Pilbara and Kimberley coastline, and broadly follows the 200 m isobath The relevant whale shark BIAs in the EMBA are detailed in **Table 5-3** and is shown on **Figure 5-2**.

DBCA has a wildlife management program to manage whale shark interactions in reserves - *Whale shark management with particular reference to Ningaloo Marine Park, Wildlife Management Program no. 57 (2013).*

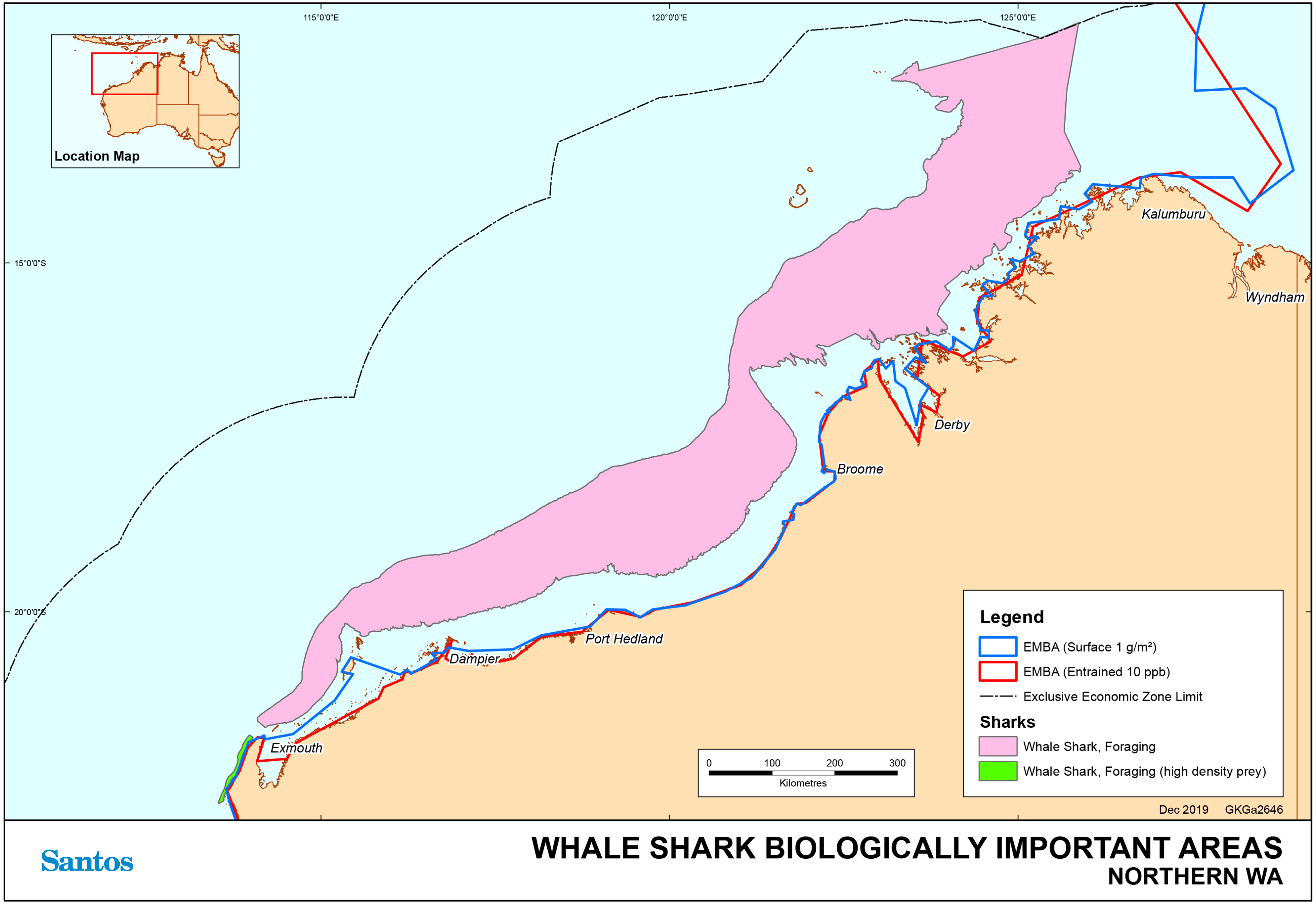

Figure 5-2: Biologically important area – whale shark

5.3.5 Dwarf Sawfish

The dwarf sawfish (*Pristis clavata*) is listed as vulnerable under the EPBC Act and thought to be restricted to Australia (DoE 2014b). It is also listed as a Priority 1 conservation species in WA. The Australian distribution of the dwarf sawfish is considered to extend across northern Australia and along the Kimberley and Pilbara coasts (Last and Stevens 2009, Stevens *et al*. 2005). However, the majority of records of dwarf sawfish in WA have come from shallow estuarine waters of the Kimberley region which are believed to be nursery (pupping) areas, with immature juveniles remaining in these areas up until three years of age (Thorburn *et al*. 2004). Adults are known to seasonally migrate back into inshore waters (Peverell 2007); although it is unclear how far offshore the adults travel as captures in offshore surveys are very uncommon. The species' range is restricted to brackish and salt water (Thorburn *et al*. 2007).

The recovery plan identifies pupping as known to occur in the King Sound, the Cambridge Gulf and 80 Mile Beach, with pupping likely to occur identified at a number of locations along the Pilbara and Kimberly Plan (Commonwealth of Australia, 2015). Under the associated recovery plan all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

The relevant sawfish BIAs in the EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

5.3.6 Freshwater and Green Sawfish

The freshwater sawfish (*Pristis pristis)* and green sawfish (*Pristis zijsron)* are both listed as Vulnerable under the EPBC Act. The freshwater sawfish is listed as a Priority 1 conservation species in WA, while the green sawfish is listed as Vulnerable under the BC Act.

Both species are wider-ranging than the dwarf sawfish and are also found in the Indo-west Pacific (DoE 2014c, DoE 2014d). Important areas for sawfishes include King Sound, and the Fitzroy, Durack, Robinson and Ord rivers for the freshwater sawfish; and Cape Keraudren for the green sawfish (Stevens *et al*. 2008, Thorburn *et al*. 2007, 2008).

Sawfishes generally inhabit inshore coastal, estuarine and riverine environments. The freshwater sawfish has been recorded in north-west Australia from rivers (including isolated water holes), estuaries and marine environments (Stevens *et al*. 2005). Newborns and juveniles primarily occur in the freshwater reaches of rivers and in estuaries, while most adult freshwater sawfish have been recorded in marine and estuarine environments (Peverell 2005, Thorburn *et al*. 2007). It is believed that mature freshwater sawfish enter less saline waters during the wet season to give birth (Peverell 2005) and freshwater river reaches play an important role as nursery areas (DoE 2014c).

The green sawfish has predominantly been recorded in inshore coastal areas, including estuaries and river mouths with a soft substrate, although there have been records of sawfish offshore in depths up to 70 m (Stevens *et al*. 2005). This species does not occupy freshwater habitats (DoE 2014d).

Short-term tracking has shown that green sawfish appear to have limited movements that are tidally influenced, and they are likely to occupy a restricted range of only a few square kilometres within the coastal fringe, with a strong association with mangroves and adjacent mudflats (Stevens et al. 2008). Sawfishes feed close to the benthos on a variety of teleost fishes and benthic invertebrates, including cephalopods, crustaceans and molluscs (Compagno & Last 1999, Last & Stevens 2009, Pogonoski *et al*. 2002, Thorburn *et al*. 2007, 2008).

Baseline surveys undertaken for Chevron's Wheatstone project identified green sawfish habitat and nursery area for juveniles within the north-eastern lagoon of the Ashburton Delta and in Hooley Creek near Onslow. Distribution of sawfish in these creeks is spatially and seasonally variable due to changing tidal and environmental conditions. However, they typically return to inshore waters to breed and pup during the wet season (i.e. January) (Chevron 2011).

The relevant sawfish BIAs in the EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

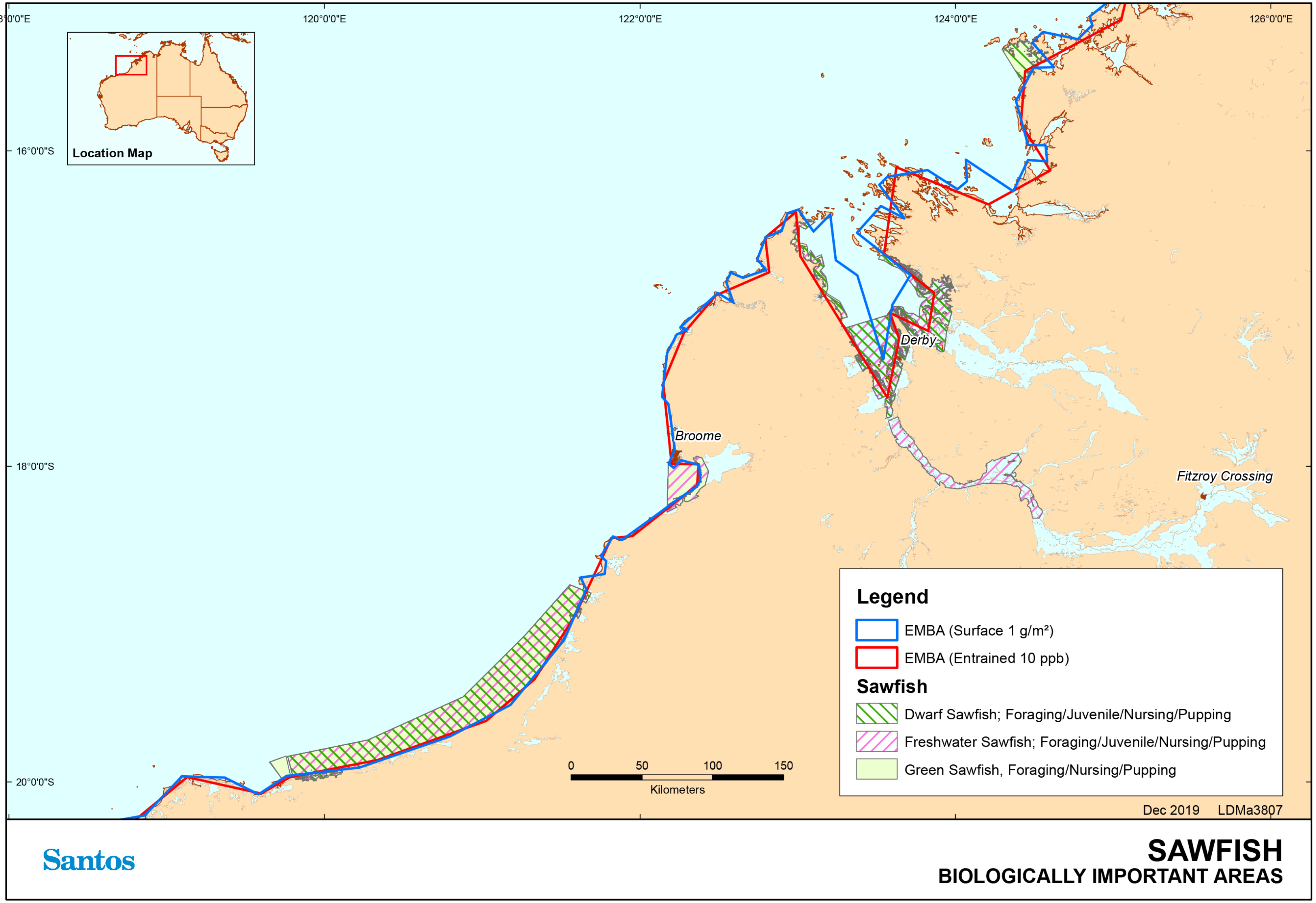

Figure 5-3: Biologically important areas – sawfish

5.3.7 Narrow Sawfish

The narrow sawfish (*Anoxypristis cuspidate*) is listed as Migratory under the EPBC Act. It is a marine or marginal (brackish water) species found from inshore waters to a depth of 40 m (Compagno *et al.* 2006). Though details of its ecology are not precisely known, it probably spends most of its time on or near the bottom in shallow coastal waters and estuaries. A study showed the narrow sawfish to be the most abundant amongst the sawfish sampled in the Gulf of Carpentaria (Peverell, 2005) which holds some consistency with the offshore distribution of the species as shown by a study of Northern Prawn Fishery by-catch. Peverell (2005) also used catch data of offshore surface net fisheries to conclude that narrow sawfish also inhabit the mid-water column and can thus be described as a benthopelagic animal. The narrow sawfish is known to form aggregations of mature females during the months of October to November. Its Australian distribution is unclear though it is most common in the Gulf of Carpentaria with southward ranges extending to Broad Sound in Queensland and the Pilbara Coast (circa 116°E), Western Australia (Last & Stevens 2009).

5.3.8 Giant Manta Ray / Reef Manta Ray

The giant manta ray appears to be a seasonal visitor to coastal or offshore sites. Giant manta rays are often seen aggregating in large numbers to feed, mate, or clean. Sightings of these giant rays are often seasonal or sporadic but in a few locations their presence is a more common occurrence. This species is not regularly encountered in large numbers and, unlike some other rays do not often appear in large schools (>30 individuals) when feeding. Overall, they are encountered with far less frequency than the smaller manta species, despite having a larger distribution across the globe (IUCN 2019).

The giant manta ray occurs in tropical, sub-tropical and temperate waters of the Atlantic, Pacific and Indian Oceans. They are commonly sighted along productive coastlines with regular upwelling, oceanic island groups and particularly offshore pinnacles and seamounts. The giant manta ray is commonly encountered on shallow reefs while being cleaned or is sighted feeding at the surface inshore and offshore. It is also occasionally observed in sandy bottom areas and seagrass beds (IUCN 2019).

The reef manta ray has a circumtropical and sub-tropical distribution, existing in the Pacific, Atlantic and Indian Oceans. Within this broad range, however, actual populations appear to be sparsely distributed and highly fragmented. This is likely due to the specific resource and habitat needs of this species.

Overall population size is unknown, but subpopulations appear, in most cases, to be small (about 100–2,000 individuals). A proportion of the individuals in some populations undertake significant coastal migrations (IUCN 2019). Since the species is migratory it is possible that individuals may be encountered in the operational area, however, given that they generally do not aggregate in large groups, high numbers are not expected to be encountered during the activities.

5.3.9 Shortfin Mako and Longfin Mako Sharks

The shortfin mako and longfin mako sharks are listed as migratory under the EPBC Act. The longfin mako is widely distributed but rarely encountered oceanic shark that ranges from Geraldton around the north coast to at least Port Stephens in New South Wales (DSEWPaC 2012). The shortfin mako is an oceanic and pelagic species, although they are occasionally seen inshore. They are found throughout temperate seas but are rarely found in waters colder than 16°C.

5.3.10 Porbeagle (Mackerel Shark)

The porbeagle (mackerel shark) (*Lamna nasus*) are listed as Migratory under the EPBC Act. The porbeagle is wide-ranging, typically occurring in oceanic waters off the continental shelf, although they occasionally enter coastal waters (Francis *et al*. 2002 cited in DoE 2014e). The porbeagle is known to undertake seasonal migrations, although the timing and details of these migratory movements are not well understood (Saunders *et al.* 2011 cited in DoE 2014e).

5.4 Biologically Important Areas / Critical Habitat – Fish

BIAs are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration**.** BIAs are identified by DAWE, however, they have no legal status, but are designed to assist decision making under the EPBC Act. They are not designed to identify protected areas, but may inform such processes. **Table 5-3** below provides an overview of BIAs in the EMBA for fish.

The DAWE may make recovery plans for threatened fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, and summary of relevant recovery plans is listed in **Section 13.2**. BIAs may overlap these sites, but may be identified for other purposes. DAWE state that the criteria used to identify 'habitat critical to the survival of the species' are more complex than those used it identify BIA. Specifically, the Sawfish and River Sharks Multispecies Recovery Plan (DoEE 2015) cites that *"all areas where aggregations of individuals have been recorded displaying biologically important behaviour such as breeding, foraging, resting or migrating, are considered critical to the survival of the species unless population survey data suggests otherwise"*.

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Table 5-3: Biologically important areas - fish

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Great white shark	*Carcharodon carcharias*	Foraging – associated with pinniped colonies in the mid-west and south west and waters off Bremer Bay	Waters off pinniped colonies throughout the South-west Marine Region Waters off Bremer Bay
Whale shark	*Rhincodon typus*	Foraging (high density prey) – Ningaloo Reef Foraging – Wider Ningaloo Region	Ningaloo Marine Park and adjacent Commonwealth waters Northward from Ningaloo along 200 m isobath
Dwarf sawfish	*Pristis clavata*	Foraging – Eighty Mile Beach, King Sound, Camden Sound Nursing - Eighty Mile Beach, King Sound, Fitzroy River and May Robinson River Pupping – Eighty Mile Beach, King Sound, Fitzroy River and May Robinson River Juvenile – King Sound, Fitzroy River and May Robinson River	Eighty Mile Beach Camden Sound - eastern shore Fitzroy River Mouth, May and Robinson River - tidal tributaries King Sound (inshore waters)
Freshwater sawfish	*Pristis pristis*	Nursing – King Sound Foraging – King Sound, Roebuck Bay, Eighty Mile Beach Pupping – Roebuck Bay, Eighty Mile Beach Juvenile – Roebuck Bay	Eighty Mile Beach King Sound - tidal tributaries Roebuck Bay
Green sawfish	*Pristis zijsron*	Pupping – Cape Keraudren, Eighty Mile Beach, Roebuck Bay, Willie Creek, Cape Leveque	Eighty Mile Beach Camden Sound Cape Keraudren

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Species	Scientific name	Aggregation area and use	Specific geographic locations for species
		Foraging - Cape Keraudren, Roebuck Bay, Cape Leveque, Camden Sound Nursing - Cape Keraudren, Eighty Mile Beach, Ashburton River and Hooley Creek near Onslow	Cape Leveque Roebuck Bay Willie Creek Ashburton River Hooley Creek

6. Marine Reptiles

Thirty-three species of listed marine reptiles under the Commonwealth *EPBC Act 1999* are known to occur in Australian waters in the EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DoEE 2019) showed that some listed reptile species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining reptile species identified in the Protected Matters search (**Appendix A**), eight are listed as threatened and seven are listed as migratory. These species are show in **Table 6-1** along with their WA conservation listing (as applicable)[3]. BIAs within the EMBA area discussed in **Table 6-3**.

Table 6-1: EPBC listed marine reptile species in the EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Green turtle (*Chelonia mydas*)	Vulnerable Migratory	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Flatback turtle (*Natator depressus*)	Vulnerable Migratory	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable Migratory	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Loggerhead turtle (*Caretta caretta*)	Endangered Migratory	Endangered	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered Migratory	Endangered	-	Foraging feeding or related behaviour known to occur within area	Yes – refer to **Table 6-3**
Leatherback turtle (*Dermochelys coriacea*)	Endangered Migratory	Vulnerable	-	Foraging feeding or related behaviour known to occur within area	Yes – refer to **Table 6-3**
Short-nosed seasnake (*Aipysurus apraefrontalis*)	Critically Endangered	Critically Endangered	-	Species or species habitat known to	None - No BIA defined

[3] An overview of WA fauna conservation codes is provided in **Section 5** (fish and sharks).

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
				occur within area	
Leaf-scaled seasnake (*Aipysurus foliosquama*)	Critically Endangered	Critically Endangered	-	Species or species habitat known to occur within area	None - No BIA defined

6.1 Marine Turtles

Six species of marine turtle occur in, use the waters, and nest on sandy beaches in WA. These are the green turtle (*Chelonia mydas*), flatback turtle (*Natator depressus*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), Olive Ridley turtle (*Lepidochelys olivacea)* and leatherback turtle (*Dermochelys coriacea*) (**Table 6-1**).

These six species are listed on the EPBC Act List of Threatened Species as either ‘endangered’ or ‘vulnerable’ and all six species are also listed as ‘migratory’. They are also listed as threatened species under the BC Act.

A summary of the different habitat types used during the various life stages of marine turtle species identified in the EMBA is given in **Table 6-2.**

Table 6-2: Summary of habitat types for the life stages of the six marine turtle species in the EMBA (DSEWPaC, 2012b)

Life Stage		Green turtle	Flatback turtle	Hawksbill turtle	Loggerhead turtle	Olive ridley turtle	Leatherback turtle
Post-hatchling		Open ocean pelagic habitats (poorly studied for Australian populations)	Coastal waters (poorly studied for Australian populations)	Open ocean pelagic habitats (poorly studied for Australian populations)	Pelagic (poorly studied for Australian populations)	Pelagic (poorly studied for Australian populations)	Pelagic (no data for Australian populations)
Adult	Mating	Offshore from nesting beaches.	Currently unknown for North West Shelf region.	Offshore from nesting beaches.	Little is known for North West Shelf region but expected to occur either en-route or adjacent to nesting beaches.	Not recorded within North West Shelf region.	Not recorded within North West Shelf region.
	Nesting	Typically, high energy, steeply sloped beaches with deep sand and deep water approach.	Typically, low-energy beaches that are narrow with a low to moderate slope. Beach approach obstructed by broad intertidal mud or limestone platforms.	Typically beaches close to nearshore coral reefs and sediment comprised of coarse sand and coral rubble.	Poorly studied for North West Shelf region by generally prefer high energy, relatively narrow, steeply sloped, coarse-grained beaches.	Not recorded within North West Shelf region.	Not recorded within North West Shelf region.
	Internesting	Shallow coastal waters within several kms of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Shallow nearshore waters within 5-60 km of nesting beach. Inter-nesting buffers of 40-60 km identified around all nesting habitats.	Shallow coastal waters within several kilometres of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Shallow coastal waters within several kilometres of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Not recorded within North West Shelf region. Inter-nesting buffers of 20 km identified around all nesting habitats.	Not recorded within North West Shelf region.
	Foraging	Neritic habitats associated with seagrass and algae, and mangrove habitats.	Turbid, shallow inshore waters, subtidal, soft-bottomed habitats of the continental shelf.	Subtidal and intertidal coral and rocky reef habitats of the continental shelf.	Subtidal and intertidal coral and rocky reefs, seagrass and deeper soft-bottomed habitats of the continental shelf.	Many feed within continental shelf waters, however it is not known if others are pelagic, as with the east Pacific population.	Mostly pelagic but will forage close to shore and over continental shelf in temperate waters.

6.1.1 Loggerhead Turtle

The loggerhead turtle (*Caretta caretta*) has a worldwide distribution, living and breeding in subtropical to tropical locations (Limpus 2008b). Breeding aggregations in Australia occur on both the east coast (Queensland and NSW) and the west. The annual nesting population in Western Australia is thought to be 3,000 females annually (Baldwin *et al*. 2003), and this is considered to support the third largest population in the world (Limpus 2008b). Loggerhead turtles have one genetic breeding stock within Western Australia (Commonwealth of Australia 2017a).

The WA distribution of sandy beach nesting areas extends from Shark Bay to the southern area of the North West Shelf, with occasional late summer nesting crawls recorded as far north as Barrow and Varanus Island and the Lowendal and Rosemary Islands (DSEWPaC 2012d). Major nesting locations include the Muiron Islands, the Ningaloo Coast south to Carnarvon and the islands around Shark Bay, which includes Dirk Hartog Island, one of the principal nesting and inter-nesting sites in WA (Limpus 2008). The Recovery Plan for Marine Turtles in Australia (2017) identifies the Muiron Islands (as a principal rookery), and all waters within a 20 km radius as habitat critical to the survival of loggerhead turtles (Commonwealth of Australia 2017a).

Estimates of up to 5,000 female loggerhead turtles have been predicted within the Ningaloo Marine Park and Muiron Islands Marine Management Area (Waayers 2010). Earlier surveys found higher proportions of nesting loggerheads in the southern areas of the reserves (CALM 2005a). Aerial surveys conducted in 2000 and 2001 in the Exmouth region recorded only 12 sightings in Commonwealth waters and these turtles were most likely loggerheads (BHP 2005). In a survey commissioned by Santos WA around the islands in the Exmouth Region, loggerhead turtles were recorded nesting on Flat Island north of the Exmouth Gulf which was the first time they had been recorded in that location (Astron 2014).

Loggerhead nesting and breeding occurs from November to March, with a peak in late December/early January (Limpus 2008b). However, there is variability each year as illustrated in a study by Santos WA (Astron 2014) around the islands in the Exmouth Region where higher numbers of nesting turtles were recorded in October 2013 than in the subsequent January 2014 surveys.

Foraging areas are widespread for loggerhead turtle populations and migrations from nesting to feeding grounds can stretch thousands of kilometres, including feeding grounds as far north as the Java Sea of Indonesia for the WA population (Limpus 2008b). Shark Bay has been identified as an important foraging habitat for loggerhead turtles (Commonwealth of Australia 2017a). Loggerhead turtles are carnivorous and feed primarily on benthic invertebrates from depths of up to approximately 50 m to near shore tidal areas including areas of rocky and coral reef, muddy bays, sand flats, estuaries and seagrass meadows (Limpus 2008b).

Figure 6-1 illustrates the BIAs and habitat critical (draft) for loggerhead turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

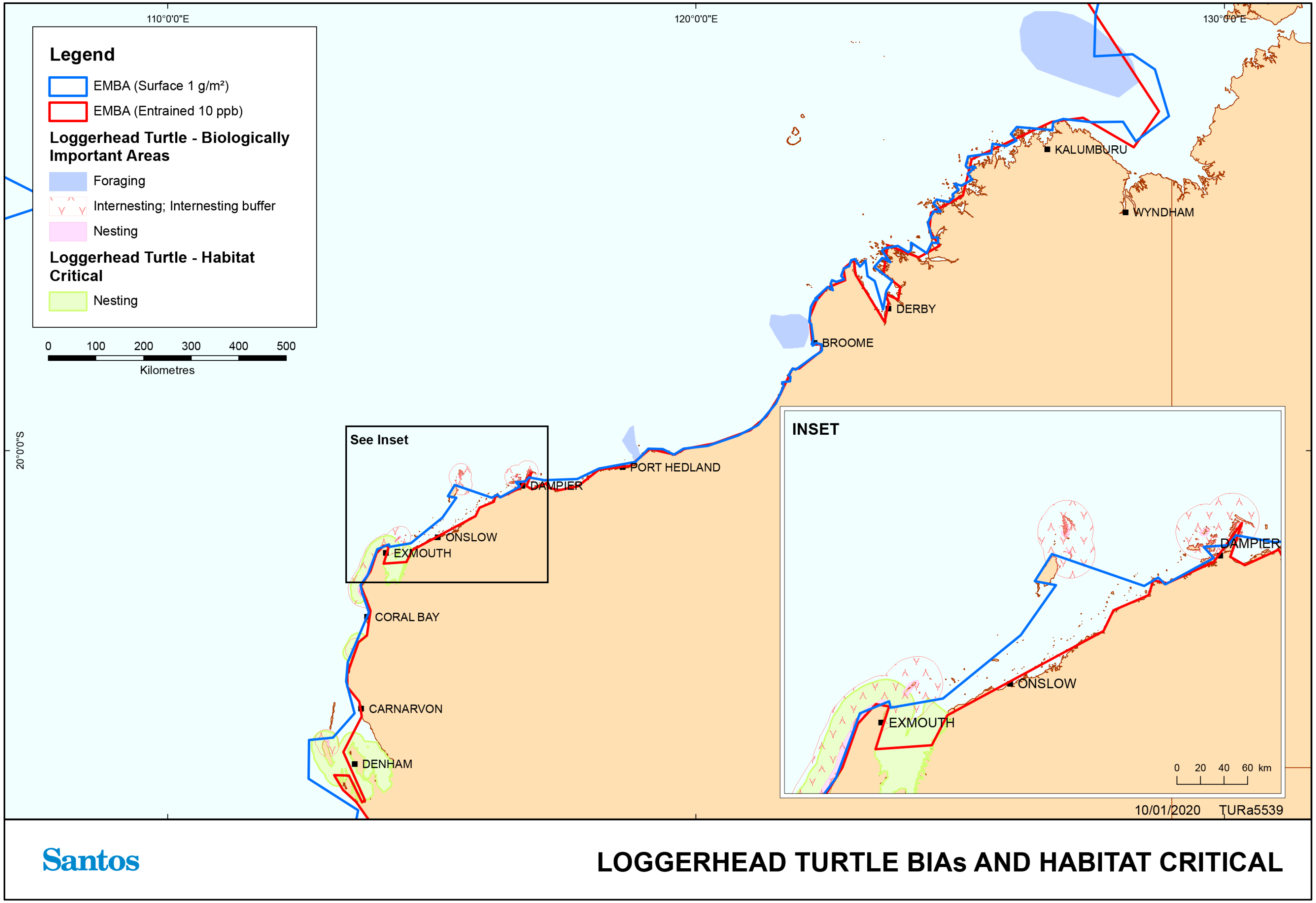

Figure 6-1: Biologically Important Areas and Habitat Critical – Loggerhead Turtle

6.1.2 Green Turtle

Australian population of green turtles is estimated to be approximately 70,000 and is divided into seven genetically distinct breeding aggregations. The species is widespread and abundant in WA waters with an estimated 20,000 individuals occurring, arguably the largest population in the Indian Ocean (Limpus 2008a). There are three distinct breeding stocks in WA waters which include: the North west Shelf stock, the Scott-Browse stock and the Ashmore Stock (Commonwealth of Australia 2017a).

The North west Shelf population is one of the largest in the world and the most significant rookery is the western side of Barrow Island (Prince 1994, Limpus 2008a). Other principal rookeries include the Lacepede Islands, Montebello Islands, Dampier Archipelago, Browse Island and North West Cape (Prince 1994, Limpus 2008a, DSEWPaC 2012b). See **Table 6-3** for a complete list.

Surveys by Waayers (2010) within the Ningaloo Marine Park and Muiron Islands Marine Management Area estimated up to 7,500 female green turtles used these areas. In 2014, Santos WA commissioned a survey of the islands in the Exmouth Region which found that North and South Muiron Islands were significant nesting sites for green turtles with over 100 green turtles nesting overnight on one beach at North Muiron Island (Astron 2014). The green turtle is also known to breed in large numbers in the dunes above the extensive beaches found on Serrurier Island, with counts indicating the island supports the second largest rookery in the Pilbara (Oliver 1990).

Lower density green turtle nesting has also been recorded on Jurabi coast, Thevenard Island, Lowendal Islands and in Exmouth Gulf (Limpus 2008a). Only low numbers of green turtles have been observed nesting on Varanus Island, as well as Airlie Island (Pendoley Environmental 2011). From monitoring undertaken in 2016/17 by Santos WA on Varanus Island; three green turtles were observed to nest over a four week tagging effort (Astron 2017).

Green turtle nesting abundance and timing fluctuates significantly from year to year depending on environmental variables, locality and food availability (Pendoley Environmental 2011). Nesting of green turtles has been recorded from August to March on Serrurier Island (Woodside 2002), from December to March along coast adjacent to Ningaloo (CALM 2005a) and from October to February on Varanus Island (Pendoley Environmental 2011). On Barrow Island, mating aggregations may commence from October with peak nesting from December to January, with hatchlings emerging through summer and early autumn. However, nesting on Barrow Island has been recorded all year round (Chevron 2005 and 2008, Pendoley 2005). Nesting on the Scott Reef-Sandy Islet and Browse Island has been observed all year round with peaks between December and January (Commonwealth of Australia 2017a). The re-nesting period for female green turtles is approximately five years (Hamann *et al*. 2002).

Green turtles spend the first five to ten years of their life drifting on ocean currents, before moving to reside in shallower benthic habitats, including tropical coral and rocky reefs and seagrass beds. Green turtles have been known to migrate more than 2,600 km between feeding and breeding grounds (Limpus 2008a).

Green turtles are omnivores, mainly feeding in shallow benthic habitats on seagrass and/ or algae, but are also known to feed on sponges, jellyfish and mangroves (Limpus 2008a). Green turtles are unlikely to forage or dwell within deeper offshore waters due to the water depths; however, they may occasionally migrate through it.

Figure 6-2 illustrates the BIAs and habitat critical (draft) for green turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

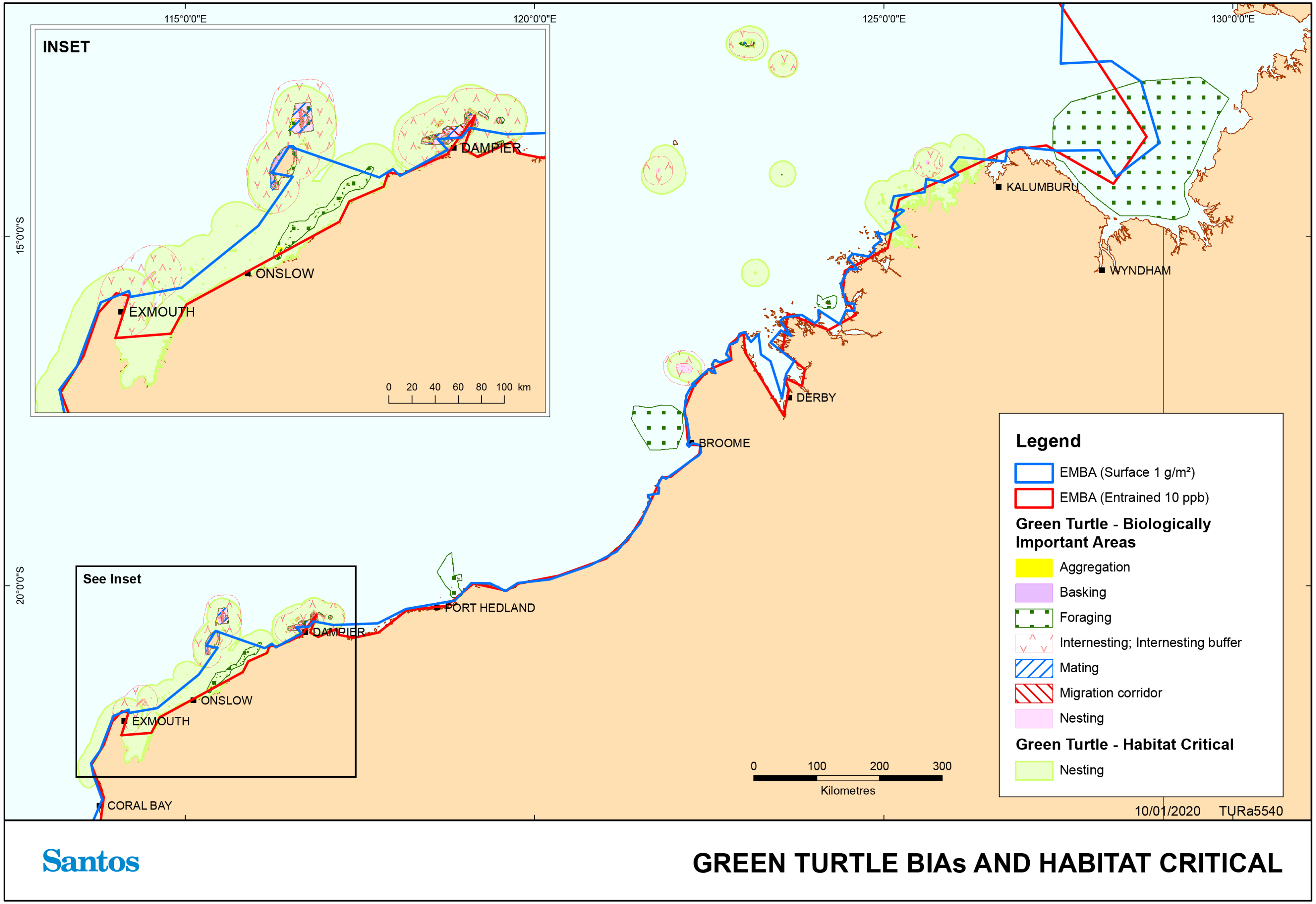

Figure 6-2: Biologically Important Areas and Habitat Critical – Green Turtle

6.1.3 Hawksbill Turtle

Hawksbill turtles (*Eretmochelys imbricata*) have a global distribution throughout tropical and sub-tropical marine waters. The Western Australian stock is concentrated on the North West Shelf (Dampier Archipelago) (Limpus 2009a), and is considered to be one of the largest hawksbill populations remaining in the world. The estimated number of nesting hawksbill turtles in WA waters is between 2,000 and 4,500 individuals (Morris 2004).

In WA, their nesting range is relatively small and extends from the Muiron Islands to the Dampier Archipelago, a distance of approximately 400 km. The most significant breeding areas, that support hundreds of nesting females annually, are around sandy beaches within the Dampier Archipelago, Montebello Islands, Lowendal Islands and Barrow Island (Pendoley 2005, Limpus, 2009a).

The largest known nesting area for the North West Shelf population is the sandy shoreline of Rosemary Island, within the Dampier Archipelago, particularly on the north-western side of the Island. It is believed that the Rosemary Island rookery may support up to 1,000 nesting females annually (Limpus 2009). Low density nesting is also known from Barrow Island, Airlie Island, Muiron Islands and North West Cape/ Ningaloo coast (Cape Range) (Limpus 2009a). Nesting hawksbills have also been found on NE Regnard Island and SW Regnard Island, confirming the Regnard Islands as hawksbill rookeries (Pendoley Environmental 2009).

The hawksbill turtle nesting population within the Exmouth region is also considered important as the populations in Western Australia represent the largest remaining population in the Indian Ocean (CALM 2005). The best estimate of numbers within the Ningaloo Marine Park and Muiron Islands Marine Management Area is between 20–700 individuals (Waayers 2010).

A snapshot survey of Varanus Island and the Lowendal Islands conducted for Santos WA during October 2012 found the five most frequented beaches by hawksbills, based on the track counts, were Beacon Island (*n*=43), Parakeelya (*n*=41), Kaia (*n*=40), Rose (*n*=30) and Pipeline (*n*=28). Results of the October 2012 three-day track census program showed that Beacon Island also hosted the highest daily number of overnight emergences by hawksbills and is therefore an important nesting beach for hawksbill turtles (Pendoley Environmental 2013).

On Varanus Island, hawksbill turtle nesting activity is predominantly distributed on the island's east coast, including Pipeline, Harriet, and Andersons beaches (Pendoley Environmental 2019). Individual hawksbill turtles appear to show a strong fidelity to these beaches, often returning to the same beach to nest within the season (Pendoley Environmental 2019). Between 1986 and 2019, a total of 571 individual hawksbill turtles were tagged on Varanus Island.

Nesting is reported to occur between October and February in WA (Commonwealth of Australia 2017a). Hawksbill turtles have been observed breeding on the North West Shelf between July and March with peak nesting activity around the Lowendal Islands between October and December (Limpus 2009a).

Female hawksbills skip annual breeding opportunities (Kendall & Bjorkland 2001), presumably due to high energy demands of breeding (Chaloupka & Prince 2012).

Individuals may migrate up to 2,400 km between their nesting and foraging grounds (DSWEPaC 2012a). Satellite tracking of nesting turtles on Varanus Island (32 km) and Rosemary Island has shown adult turtles to feed between 50 and 450 km from their nesting beaches (DSWEPaC 2012a).

Adults tend to forage in tropical tidal and sub-tidal coral and rocky reef habitat where they feed on an omnivorous diet of sponges, algae, jelly fish and cephalopods (DSWEPaC 2012a). Hawksbill turtles are unlikely to spend significant time within offshore waters as it is too deep to act as a feeding ground. However, it is likely they may migrate through those areas.

Figure 6-3 illustrates the BIAs and habitat critical (draft) for hawksbill and olive ridley turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

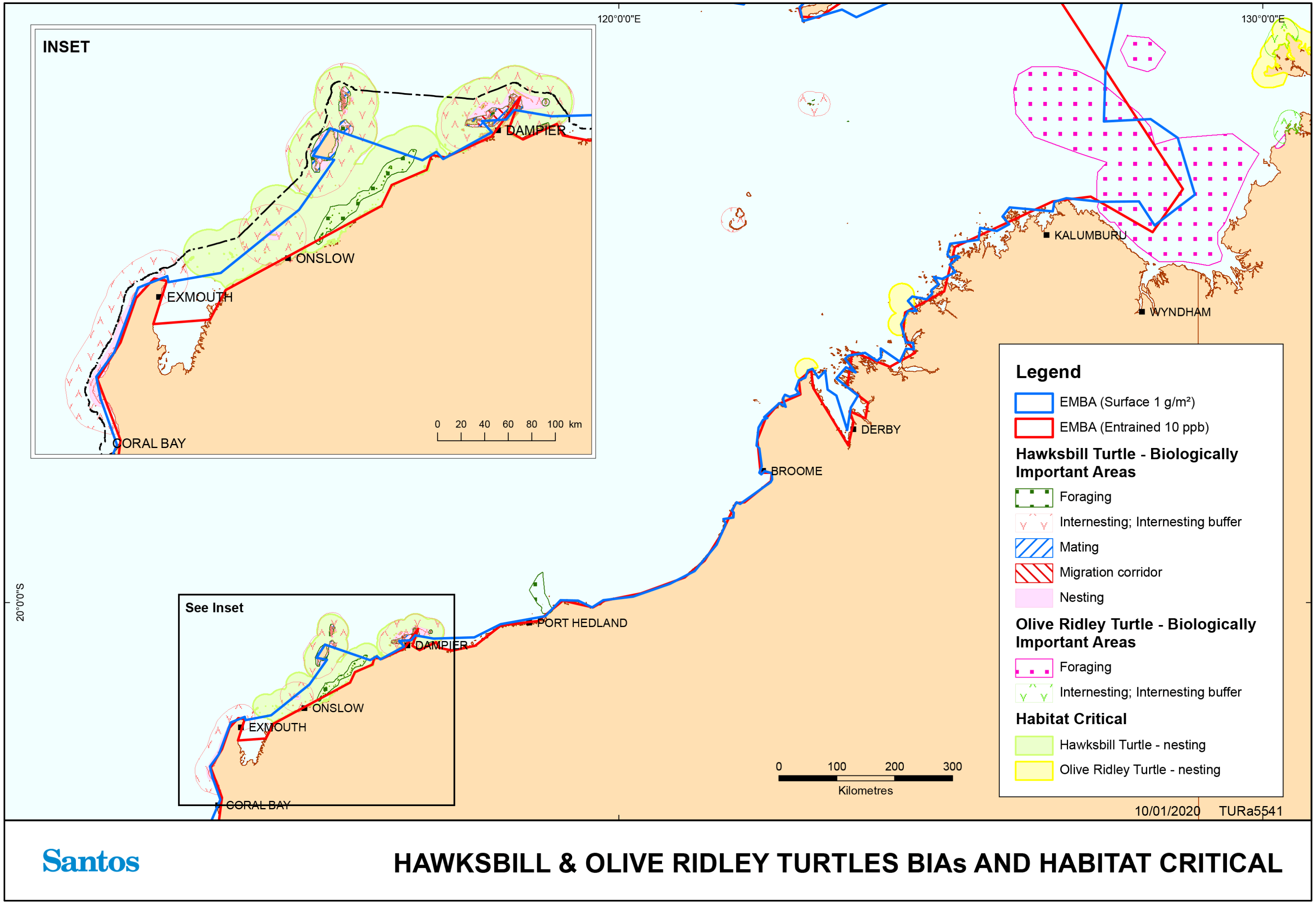

Figure 6-3: Biologically Important Areas and Habitat Critical – Hawksbill and Olive Ridley Turtle

6.1.4 Flatback Turtle

The flatback turtle (*Natator depressus*) has an Australasian distribution, with all recorded nesting beaches occurring within tropical to sub-tropical Australian waters. One third of the total breeding for the species occurs in Western Australia (WA) (Limpus, 2007). The management of the flatback turtle in Australia is broken up into five stocks currently described around Australia; eastern Queensland, Arafura Sea, Cape Domett, South-west Kimberley and Pilbara stocks (Commonwealth of Australia 2017).. The Pilbara stock nests throughout the North West Shelf and is characterised by summer nesting (October to March), and the northern stock at Cape Domett which breeds mainly in winter (July to September) (Commonwealth of Australia 2017a). The South-west Kimberley stock is also characterised by summer nesting.

The southern WA nesting population of flatback turtles occurs from Exmouth to the Lacepede Islands off the Kimberley coast (DSEWPaC 2012c). On the North West Shelf, significant rookeries are centred on Barrow Island especially the east coast beaches (DSEWPaC 2012b).

Montebello Islands, Thevenard Island, Varanus Island, the Lowendal Islands, King Sound and Dampier Archipelago are also significant rookeries (Pendoley 2005, Limpus 2007, Pendoley Environmental 2011). Nesting is also widespread along the mainland beaches from Mundabullangana on the Pilbara coast north, including Cemetery Beach near Port Hedland, Eighty Mile Beach and to Broome (Limpus 2007, DSEWPaC 2012b).

Long term monitoring of flatback turtles nesting in the Port Hedland area, specifically at Cemetery Beach and Pretty Pool Beach, was undertaken between 2004 and 2014. Monitoring results indicated the main nesting season of flatback turtles in the area was between mid-October and January, which is consistent with other rookeries in the Pilbara region including Barrow Island, Mundabullangana, Karratha and Onslow (Waayers and Stubbs 2016). The onset of the nesting season appears to be relatively consistent each year and is thought to be associated with the southern movement of warmer sea surface temperatures along the northern WA coast.

There have been occasional records of nesting by flatback turtles on the Jurabi Coast and Muiron Islands (CALM 2005). During turtle surveys for Santos, WA flatback turtle nesting was recorded on Bessieres Islands (Astron 2014), Serrurier, Flat, Table and Round Island in previous surveys (Pendoley Environmental 2009). Flatback turtle tracks have been seen on Forty Mile beach and evidence of flatback nesting was recorded on the same beach the next day (Pendoley Environmental 2009).Previously the status of the flatback population(s) was undetermined and although not well quantified, it was estimated to be many thousands of females (Limpus 2007). However, Pendoley *et al*. (2014) reported both Barrow Island and Mundabullangana flatback turtles as substantial reproductive populations with 4,000 and 3,500 turtles tagged at each location between 2006/2006 and 2010/2011. Cemetery beach at Port Hedland had approximately 350 turtles were tagged over two seasons of monitoring (2009/2010 and 2011/12).

Satellite tracking of adult (female) flatback turtles shows they use a variety of inshore and offshore marine areas off the east and west coasts of Barrow Island. Females inter-nest close to their nesting beaches, typically in 0–10 m of water (Chevron 2008). However, flatback turtles also travel approximately 70 km and inter-nest in shallow nearshore water off the adjacent mainland coast, before returning to Barrow Island to lay another clutch of eggs. The average inter-nesting period is 13–16 days.

From long-term tagging studies on Varanus Island and Pendoley's observations, it appears that the nesting season for flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March. Flatbacks have been observed to nest on Varanus Island between November and February (Chevron 2008, Pendoley Environmental 2011 & 2013). Population monitoring of flatback turtles on Varanus Island, calculated from 16 seasons, indicates a mean population estimate of 226 (+/- 97). Modelled Flatback turtle populations have shown a slight decline from 2008/09 to 2016/17, which is considered to be part of fluctuations in the natural cycle (Astron 2017). Flatback turtles tend to nest on all beaches on Varanus Island (Astron 2017). Flatback hatching and emergence success is noted as higher compared to that reported for other Western Australian rookeries (Pendoley et al. 2014; cited Astron 2017).

Unlike other sea turtles, the flatback turtle lacks a wide oceanic dispersal phase and adults tend to be found in soft sediment habitats within the continental shelf of northern Australia (DSEWPaC 2012b). Little information is known on the diets of flatback turtles (DSEWPaC 2012b), however, they are believed to forage on primarily soft-bodied invertebrates (Commonwealth of Australia 2017a).

Figure 6-4 illustrates the BIAs and habitat critical (draft) for flatback turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

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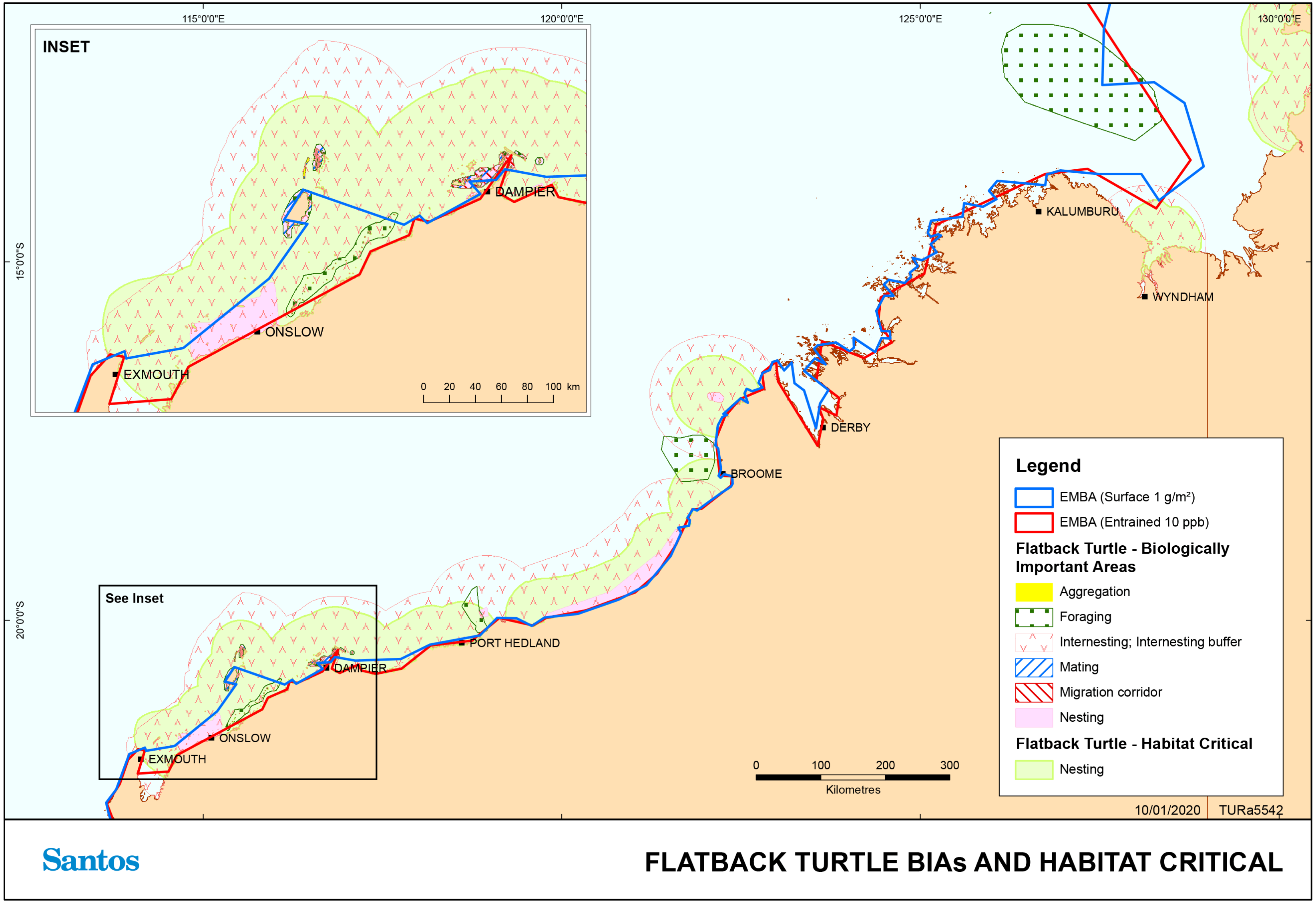

Figure 6-4: Biologically Important Areas and Habitat Critical – Flatback Turtle

6.1.5 Leatherback Turtle

The leatherback turtle *(Dermochelys coriacea*) has the widest distribution of any marine turtle, and can be found from tropical to temperate waters throughout the world (Márquez 1990). There are no major leatherback turtle centres of nesting activity that have been recorded in Australia, although scattered isolated nesting (one to three nests per annum) occurs in southern Queensland and the Northern Territory (Limpus and McLachlin 1994).

There have been several records of leatherback turtles off the coast of WA, but no confirmed nesting sites (Limpus 2009c). Turtle observations have mainly occurred south of the North West Shelf area and in open waters (>200 m deep) (Limpus 2009c). Due to the lack of nesting sites around Australian coastal waters, it is presumed that Leatherback turtles observed in Australian waters are migrating from neighbouring countries to utilise feeding grounds in Australia (Limpus 2009c).

The leatherback turtle will feed at all levels of the water column and is carnivorous feeding mainly on pelagic, soft-bodied marine organisms such as jellyfish, which occur in greatest concentrations in areas of upwelling or convergence (DSEWPaC 2012d). The leatherback turtle is a highly pelagic species with adults only going ashore to breed.

No leatherback turtle BIAs or habitat critical (draft) are found within the EMBA.

6.1.6 Olive Ridley Turtles

Olive ridley turtles (*Lepidochelys olivacea*) are the least common turtle species encountered with habitat critical nesting occurring near Vulcan Island, Darcy Island, Prior Point and Llanggi and Cape Leveque (Commonwealth of Australia 2017). This species forages within the shallow benthic habitats of northern Western Australia and is thought to feed primarily on gastropods and small crabs within the benthic, soft-bottomed communities of the continental shelf (Limpus 2009). Olive Ridley turtles forage as far south as the Dampier Archipelago-Montebello Islands.

BIAs for this endangered species are known to occur in the vicinity of Joseph Bonaparte Depression (DSEWPaC 2012b, Commonwealth of Australia 2017a). See **Figure 6-3** for identified olive ridley turtle BIAs and critical habitats (draft) within the EMBA (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

6.2 Seasnakes

Storr *et al*. (1986) estimate nine genera and 22 species of sea snakes occur in WA waters, with 25 listed marine seasnake species being recorded in the search area **Appendix A**. Little is known of the distribution of individual species, population sizes or aspects of their ecology. Sea snakes are essentially tropical in distribution, and habitats reflect influences of factors such as water depth, nature of seabed, turbidity and season (Heatwole and Cogger 1993). Seasnakes are widespread throughout waters of the North West Shelf in offshore and nearshore habitats. They can be highly mobile and cover large distances or they may be restricted to relatively shallow waters and some species must return to land to eat and rest. In the north-west region of Western Australia, no BIAs have been designated for seasnakes. However, both Ashmore Reef and Cartier Island are characterised for both a high density and high diversity of seasnakes (DSEWPaC 2012b).

Two species of seasnakes listed as threatened under the EPBC Act were identified in the Protected Matters search within the EMBA (**Appendix A**):

+ Short-nosed seasnake (*Aipysurus apraefrontalis*); and
+ Leaf-scaled seasnake (*Aipysurus foliosquama*).

6.2.1 Short-nosed Seasnake

The short-nosed seasnake (*Aipysurus apraefrontalis*) is listed as critically endangered under the EPBC Act and the BC Act. It is a fully aquatic, small snake and is endemic to WA. It has been recorded from Exmouth Gulf, WA to the reefs of the Sahul Shelf, in the eastern Indian Ocean. This species is believed to show strong site fidelity to shallow coral reef habitats in less than 10 m of water, with most specimens having been collected from Ashmore and Hibernia reefs (Minton & Heatwole 1975, Guinea and Whiting 2005).

The species prefers the reef flats or shallow waters along the outer reef edge in water depths to 10 m (McCosker 1975, Cogger 2000). The species has been observed during daylight hours, resting beneath small coral overhangs or coral heads in 1–2 m of water (McCosker 1975). Guinea and Whiting (2005) reported that very few short-nosed seasnakes moved even as far as 50 m away from the reef flat and are therefore unlikely to be expected in high numbers in offshore, deeper waters.

6.2.2 Leaf-scaled Seasnake

The leaf-scaled seasnake *(Aipysurus foliosquama)* is listed as critically endangered under the EPBC Act and the BC Act. It occurs in shallow water (less than 10 m in depth), in the protected parts of the reef flat, adjacent to living coral and on coral substrates (DoE 2014). The species is found only on the reefs of the Sahul Shelf in WA, especially on Ashmore and Hibernia Reefs (Minton and Heatwole 1975). The leaf-scaled seasnake forages by searching in fish burrows on the reef flat (DoE 2014).

6.3 Crocodiles

The salt-water crocodile (*Crocodylus porosus*) is a migratory species under the EPBC Act and is also listed as a specially protected species (Other specially protected fauna) under the BC Act. In WA, the species is found in most major river systems of the Kimberley, including the Ord, Patrick, Forrest, Durack, King, Pentecost, Prince Regent, Lawley, Mitchell, Hunter, Roe and Glenelg Rivers. The largest populations occur in the rivers draining into the Cambridge Gulf and the Prince Regent River and Roe River systems. There have also been isolated records in rivers of the Pilbara region, around Derby near Broome and as far south as Carnarvon on the mid-west coast (DEC 2009a).

6.4 Biologically Important Areas/Habitat Critical – Marine Reptiles

Table 6-3 provides an overview of BIAs in the EMBA for marine reptiles, as identified by the DAWE (Commonwealth) and critical habitats identified in associated recovery plans. The DAWE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[4].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of habitat critical - habitat 'critical to the survival of the threatened species. To date no habitat critical in WA has been listed under either Act.

[4] Further background information on BIA and identification of critical habitat in recovery plans is provided in **Section 5.4**.

Table 6-3: Biologically important areas/critical habitats and geographic locations - reptiles

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
Loggerhead turtle	*Caretta caretta*	Nesting, migration, foraging and internesting – Islands and coastline of the Kimberley region and islands of the North West Shelf, Ningaloo coast and Jurabi coast	Cohen Island De Grey River to Bedout Island Dirk Hartog Island Gnarloo Bay James Price Point Lowendal Island Montebello Island Muiron Island Ningaloo Coast and Jurabi coast Rosemary Island Western Joseph Bonaparte Depression	Exmouth and Ningaloo coast Gnaraloo Bay and beaches Shark bay, all coastal and island beaches out the to the northern tip of Dirk Hartog Island
Green turtle	*Chelonia mydas*	Nesting, migration foraging, aggregation, mating, basking and internesting – Offshore islands in the Browse Basin, North West Shelf and Kimberley/Pilbara coastlines Mating/nesting – Dampier Archipelago Basking – Middle Island	Ashmore Reef Barrow Island Browse Island Cartier Island Cassini Island Coral reef habitat west of the Montebello group. Extends the entire length of Montebellos Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Island Delambre Island Dixon Island Greens - inshore tidal and shallow subtidal areas around Barrow Island Hawksbills - shallow water coral reef and artificial reef (pipeline) habitat James Price Point Joseph Bonaparte Gulf Lacepede Island Legendre Island, Huay Island Middle Is. West Coast Barrow Island West Coast and North Coast Montebello Island - Hermite Island, NW Island, Trimouille Island Montebello Islands Montgomery Reef	Mainland east of Mary island to mainland adjacent to Murrara Island including all offshore islands Ashmore Reef and Cartier Reef Browse Island Scott Reef Adele Island Lacepede Island Dampier Archipelago Barrrow Island Montebello Islands Serrier Island and Thevenard Island Exmouth Gulf and Ningaloo Coast

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
			North and South Muiron Island North Turtle Island North West Cape Scott Reef Scott Reef - Sandy Islet Seringapatam Reef String of islands between Cape Preston and Onslow, inshore of Barrow Is	
Hawksbill turtle	*Eretmochelys imbricata*	Nesting, migration, mating, foraging and internesting – Offshore islands in the Browse Basin, North West Shelf and Kimberley/Pilbara coastlines Mating/nesting/internesting – Lowendal group, Montebello Islands	Ah chong and South East Island Ashmore Reef Barrow Island Cartier Island Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Is Delambre Island Delambre Island (and other Dampier Archipelago Islands) Dixon Island Greens - inshore tidal and shallow subtidal areas around Barrow Island Hawksbills - shallow water coral reef and artificial reef (pipeline) habitat Lowendal Island Group Montebello Island - Hermite Island, NW Island, Trimouille Island Montebello Island, Trimoulle and NW islands Ningaloo coast and Jurabi coast Rosemary Island Scott Reef String of islands between Cape Preston and Onslow, inshore of Barrow Island Thevenard Island Varanus Island	Cape Preston to mouth of Exmouth Gulf (including Montebello Islands and Lowendal Islands) Dampier Archipelago (including Delambre Island and Rosemary Island)
Flatback turtle	*Natator depressus*	Nesting, migration, mating, aggregation, foraging, internesting – Islands of the North West Shelf and the Pilbara/Kimberley coastlines	Eighty Mile beach Barrow Island Cape Domett Cape Thouin/ Mundabullangana/Cowrie Beach	Cape Domett and Lacrosse Island Lacepede Islands Eighty Mile beach Cemetary beach Eco Beach

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
		Mating, nesting – Barrow Island	Coral reef habitat west of the montebello group. Extends the entire length of Montebellos Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Is Delambre Island Dixon Island Holothuria Zone (Northern Kimberley, Holothuria Banks) Intercourse Island James Price Point Lacepede Island Legendre Island, Huay Is Montebello Island - Hermite Island, NW Island, Trimouille Island North Turtle Island Port Hedland, Cemetery Beach Port Hedland, Paradise Beach Port Hedland, Pretty Pool String of islands between Cape Preston and Onslow, inshore of Barrow Is The main nesting beach at Cape Domett is a 1.9-km-long north-west-facing sandy beach on the east of the Cambridge Gulf, East Kimberley, Western Australia (14 48.10S, 128 24.50E), located approximately 80 km north-north-east of the nearest town, Wyndham. Thevenard Island - South coast West of Cape Lambert Western Joseph Bonaparte Depression	Mundabullangana Beach Dampier Archipelago Barrow Island, Montebello Island, coastal islands from Cape Preston to Locker Island
Leatherback turtle	*Dermochelys coriacea*	None within EMBA	None within EMBA	None within EMBA
Olive ridley turtle	*Lepidochelys olivacea*	Foraging, migration – Joseph Bonaparte Gulf – Kimberley region	Western Joseph Bonaparte Depression	Cape Leveque Prior Point and Llanggi Darcy Island Vulcan Island

7. Marine Mammals

Forty-four species of listed marine mammals are known to occur in Australian waters in the EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DoEE 2019a) showed that some listed mammal species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining listed species, five are listed as threatened and migratory, one is listed as threatened and ten are listed as migratory under the Commonwealth EPBC Act (BIAs for marine mammals are discussed in **Table 7-3**). These species are shown in **Table 7-1** along with their conservation listing under the WA BC Act (as applicable).

The section below gives further details on marine mammal species listed as threatened and migratory and a summary is presented in **Table 7-2**. Identified BIAs are presented in **Table 7-3**.

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Table 7-1: Marine mammals listed as threatened or migratory under the EPBC Act

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Other WA Conservation Code		
Sei whale *(Balaenoptera borealis)*	Vulnerable Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Blue whale *(Balaenoptera musculus)*	Endangered Migratory	Endangered	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 7-3**
Fin whale *(Balaenoptera physalus)*	Vulnerable Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Southern right whale *(Eubalaena australis)*	Endangered Migratory	Vulnerable	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Humpback whale *(Megaptera novaeangliae)*	Vulnerable Migratory	Specially Protected (special conservation interest)	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Sperm whale *(Physeter macrocephalus)*	Migratory	Vulnerable	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 7-3**
Antarctic minke whale *(Balaenoptera bonaerensis)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Bryde's whale *(Balaenoptera edeni)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Pygmy right whale *(Caperea marginate)*	Migratory	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Other WA Conservation Code		
Killer whale *(Orcinus orca)*	Migratory	-	-	Species or species habitat may occur within area	None - No BIA defined
Indo-Pacific humpback dolphin (*Sousa chinensis)*	Migratory	-	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Spotted bottlenose dolphin (Arafura/ Timor Sea Populations) *(Tursiops aduncus)*	Migratory	-	-	Species or species habitat likely to occur within area	Yes – Refer to **Table 7-3**
Irrawaddy dolphin (Australian snubfin dolphin) *(Orcaella heinsohni)*	Migratory	-	P4	Species or species habitat known to occur within area	Yes – Refer to **Table 7-3**
Dusky dolphin (*Lagenorhynchus obscurus)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Australian sea lion (*Neophoca cinérea)*	Vulnerable	Vulnerable	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Dugong (*Dugong dugon)*	Migratory	Specially protected (species otherwise in need of special protection)	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**

In addition, the New Zealand fur-seal *(Arctocephalus forsteri)*, has been identified as a species of relevance to the EMBA. The New-Zealand fur seal is listed as a protected species under WA BC Act, but not listed as threatened under the EPBC Act.

7.1 Threatened and Migratory Species

7.1.1 Sei Whale

Sei whales have a worldwide, oceanic distribution, ranging from polar to tropical waters. Sei whales tend to be found further offshore than other species of large whales (Bannister *et al*. 1996).

Sei whales move between Australian waters and Antarctic feeding areas however they are only infrequently recorded in Australian waters (Bannister *et al*. 1996) and their movements and distribution in Australian waters is not well known (DoEE 2019a). There are no known mating or calving areas in Australian waters (Parker 1978 in DoEE 2019a). The National Conservation Values Atlas currently record no BIAs for this species (DoEE 2019b). Surveys of the Bonney Upwelling (outside of the EMBA) between 2000 and 2003 recorded sightings of sei whales feeding during summer and autumn, indicating that this is potentially an important feeding ground (DoEE 2019b).

7.1.2 Blue Whale

Two sub-species of blue whale are recorded in Australian waters; the southern (or true) blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*Balaenoptera musculus brevicauda*). Southern blue whales are believed to occur in waters south of 60°S and pygmy blue whales occur in waters north of 55°S (i.e. not in the Antarctic) (DEWHA 2008a). By this definition all blue whales in waters from Busselton to the NT border are assumed to be pygmy blue whales, and are discussed below.

Pygmy blue whales have a southern hemisphere distribution, migrating from tropical water breeding grounds in winter to temperate and polar water feeding grounds in summer (Bannister *et al*. 1996, Double *et al*. 2014). The WA migration path takes pygmy blue whales down the WA coast to coastal upwelling areas along southern Australia (Gill 2002) and south at least as far as the Antarctic convergence zone (Gedamke *et al*. 2007).

Tagging surveys have shown pygmy blue whales migrating northward relatively near to the Australian coastline (100 km) until reaching North West Cape after which they travelled offshore (240 km) to Indonesia. Passive acoustic data documented pygmy blue whales migrating along the Western Australian shelf break (Woodside 2012). Tagging data collected by Gales *et al.* (2010) has provided the first definitive link between the blue whales that feed off the Perth Canyon and those that occur around Indonesia. This is movement is concordant with the proposed 'Tasmania to Indonesia' population described by Branch *et al.* (2007).

The northern migration passes the Perth Canyon from January to May and north bound animals have been detected off Exmouth and the Montebello Islands between April and August (Double *et al*. 2012a, McCauley & Jenner 2010). During the southern migration, pygmy blue whales pass south of the Montebello Islands and Exmouth from October to the end of January, peaking in late November to early December (Double *et al*. 2012b). Generally, they appear to travel as individuals or in small groups based on acoustic data. For example, analysis of pygmy blue whale calls from noise loggers deployed around Scott Reef (2006 to 2009) for the Woodside Browse project showed that 78% of the calls were from lone whales, 18% were from two whales and 4% were from three or more whales (McCauley 2011; Woodside 2014).

Pygmy blue whales appear to feed regularly along their migration route (i.e. at least once per week or more frequently) and are likely to have multiple food caches along their migratory route (e.g. Rowley Shoals and Ningaloo Reef) (ConocoPhillips 2018).

Recognised feeding areas of significance to this species, located within the EMBA include Ningaloo Reef and Perth Canyon (DEWHA 2010a). The Ningaloo Reef area has the capacity to offer feeding opportunities to pygmy blue whales through unique biophysical conditions able to support large

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biomasses of marine species (Double *et al*. 2014). Surface lunge feeding of pygmy blue whales has been observed at North West Cape and Ningaloo Reef in June (C. Jenner & M-N Jenner, unpublished data, 2001 in Double *et al*. 2014). A biologically important foraging area encompasses Seringapatam Reef, Scott Reef and the open waters to the west of these features (DoE 2015a; DoEE 2019c. These steep gradient features tend to stimulate upwelling and, therefore increased productivity (seasonally variable) (ConocoPhillips 2018). Hence, they provide a favourable foraging area.

Breeding areas have not yet been identified, however, it is likely that pygmy blue whales calve in tropical areas of high localised production such as deep offshore waters of the Banda and Molucca Seas in Indonesia (Double *et al*. 2014, DoEE 2019b). There are no known breeding areas of significance to blue whales in waters from Busselton to the Northern Territory border.

The BIAs for blue whale and pygmy blue whale are detailed in **Table 7-3** and depicted in **Figure 7-1** and **Figure 7-2.**

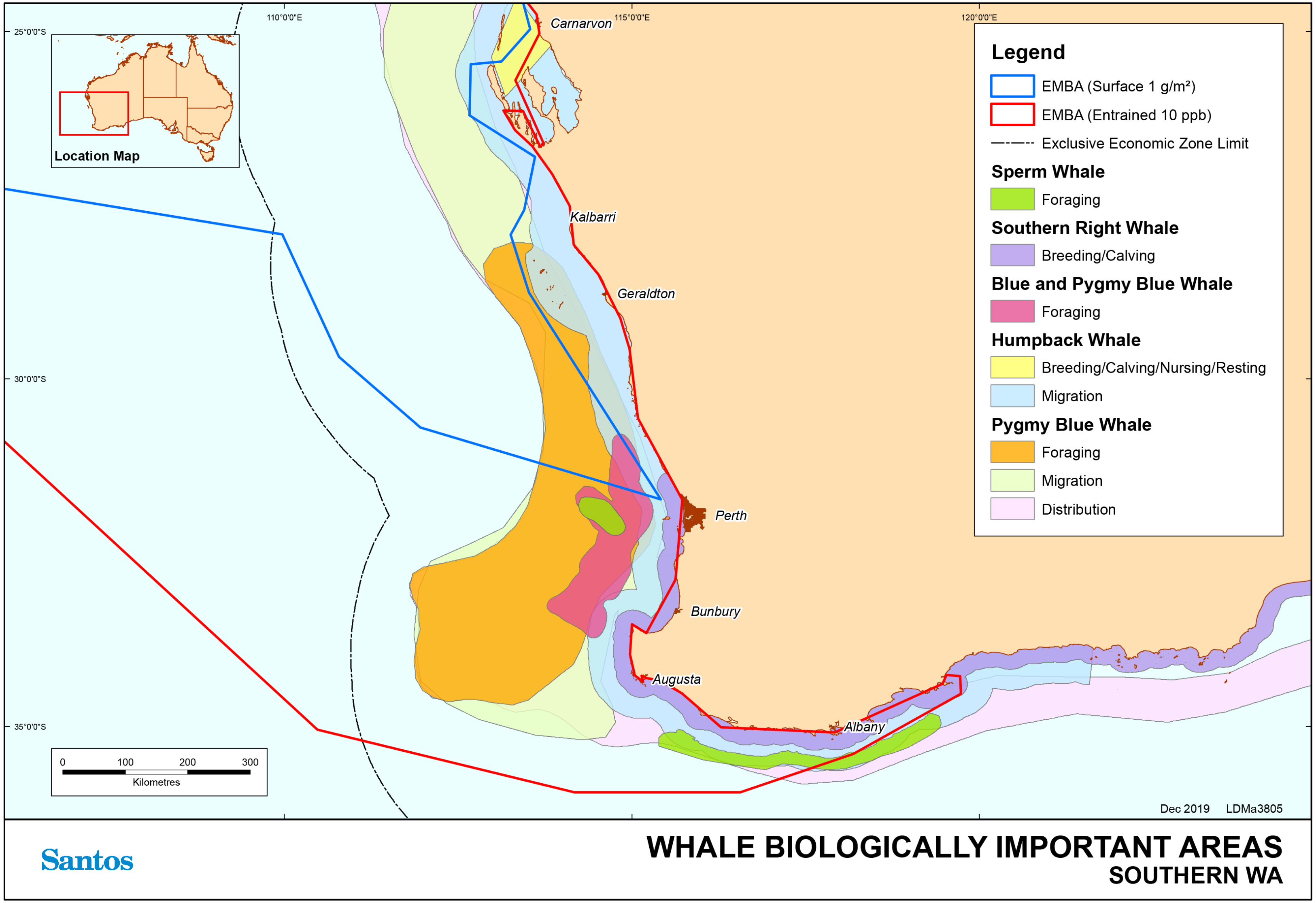

Figure 7-1: Biologically important areas – whales – Southern WA

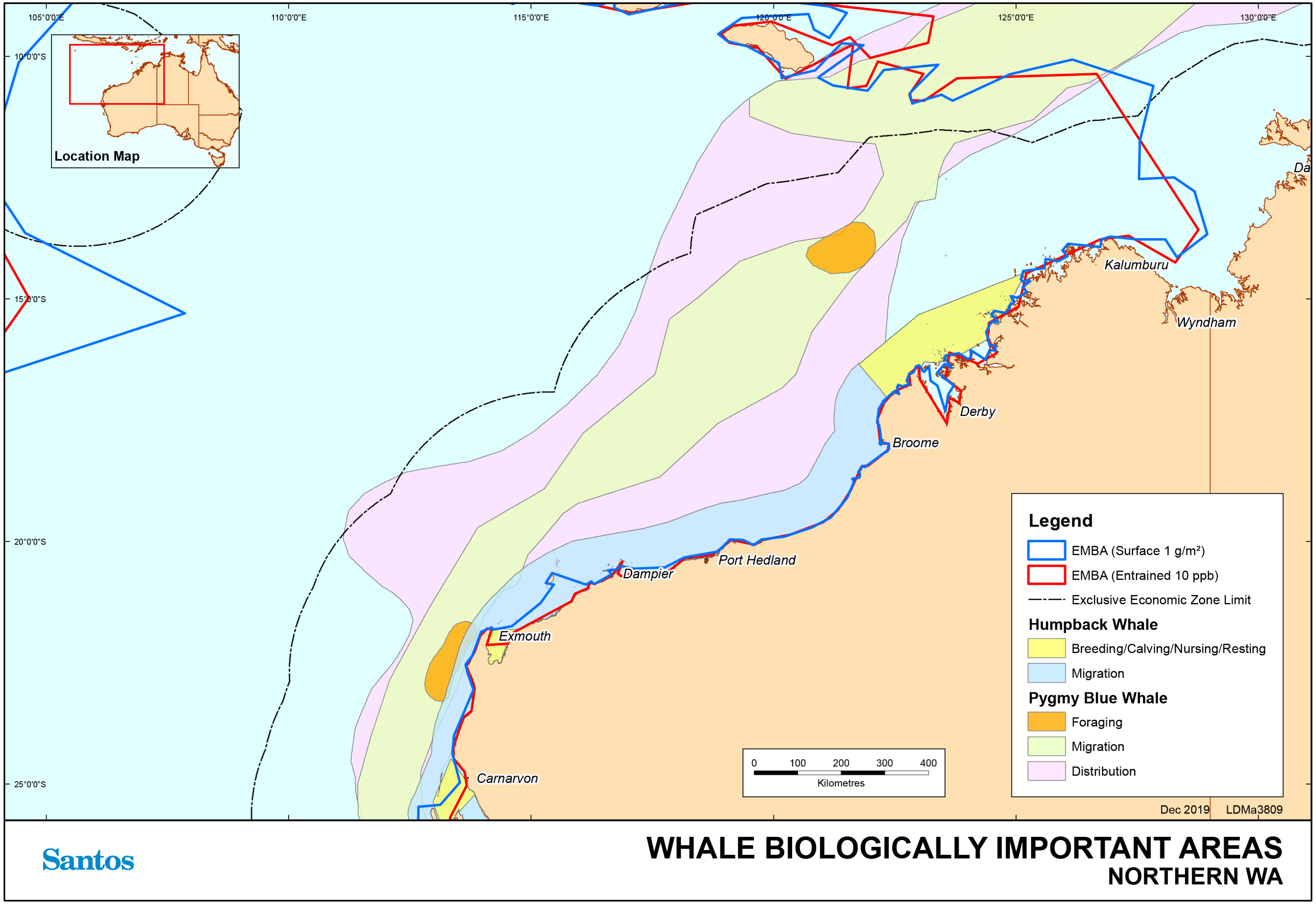

Figure 7-2: Biologically important areas – whales – Northern WA

7.1.3 Fin Whale

Fin whales have a worldwide distribution generally in deeper waters, with oceanic migrations between warm water breeding grounds and cold water feeding grounds.

The fin whale distribution in Australia is not clear due to the sparsity of sightings. Information is known primarily from stranding events and whaling records. According to the Species Profile and Threats database (DoEE 2019a); fin whales are thought to be present from Exmouth, along the southern coastline, to southern Queensland.

Migration paths are uncertain but are not thought to follow Australian coastlines (Bannister *et al*. 1996). There is insufficient data to prescribe migration times for fin whales. During summer and autumn this species has been recorded acoustically at the Rottnest Trench.

There are no known mating or calving areas in Australian waters (DoEE 2019a) and no BIAs for the fin whale are currently identified by the National Conservation Values Atlas (DoEE 2019b).

7.1.4 Southern Right Whale

The southern right whale is present in the southern hemisphere between approximately 30° and 60°S. The species feeds in the Southern Ocean in summer, moving close to shore in winter.

In Australian waters, southern right whales range from Perth, along the southern coastline, to Sydney. Sightings have been recorded as far north as Exmouth although these are rare (Bannister *et al*. 1996).

BIAs including calving and aggregation areas are recorded for this species along the southern coastline of Australia (DoEE 2019b). Details on the BIA for southern right whale are provided in **Table 7-3** and depicted in **Figure 7-1**.

7.1.5 Humpback Whale

Humpback whales have a worldwide distribution, migrating along coastal waters from polar feeding grounds to subtropical breeding grounds. Geographic populations are distinct and at least six southern hemisphere populations are thought to exist based on Antarctic feeding distribution and the location of breeding grounds on either side of each continent (Bannister *et al*. 1996). The population of humpback whales migrating along the WA coastline was recently estimated to be greater than 33,000 whales and likely increasing at exceptionally high growth rates between 10–12% (Hedley *et al*. 2011, Salgado Kent *et al*. 2012).

The west coast Australian humpback whale population migrates from Southern Polar Ocean ‘summer’ feeding grounds to their northern tropical ‘winter’ calving/ breeding grounds in coastal waters of the Kimberley. The northern migration tends to follow deeper waters of the continental shelf, whilst the southward migration concentrates whales closer to the mainland (Jenner *et al*. 2001). Recent satellite tagging of southbound humpback whales indicate that whales generally migrated close to the coastline, within a few tens of kilometres of shore and in a corridor frequently less than 100 km (Double *et al*. 2010). Aerial surveys and noise logger recordings undertaken for Chevron’s Wheatstone Project indicated that the main distribution of humpback whales were sighted at an average distance of 50 km from the mainland during the northern migration and 35 km during the southbound migration (RPS 2010a).

The precise timing of the migration varies between years by up to six weeks, influenced by water temperature, sea ice distribution, predation risk, prey abundance and the location of feeding grounds (DEWR 2007).

Peak northward migration across the North West Shelf is identified as from late July to early August, and peak southward migration from late August to early September (DoEE 2015c). Data collected between 1995 and 1997 by the Centre for Whale Research indicates that the period for peak northern migration into the calving grounds in the Kimberley is mid to late July. The peak for southern migration is in the first half of September (Jenner *et al.* 2001). Actual timing of annual migration may vary by as much as three weeks from year to year due to food availability in the Antarctic (DMP 2003).

Satellite tagging data collected for migrating northbound humpback whales identified a consistent narrow inshore distribution, unlike the southward migration. There was little evidence that the whales tended to venture further from shore and into deeper water at any point on their northward migration. Whales were seen with calves off the North West Cape outside the 'calving grounds; of Lacepede Islands to Camden Sound. This indicates some potential for this area being used as a 'calving site' as well as a migratory corridor. Consequently, the region from the Lacepede Islands to Camden Sound should not be seen as the exclusive 'calving ground' for this population (Double *et al.* 2012b).

Details on the BIA for humpback whales are provided in **Table 7-3** and depicted in **Figure 7-1** and **Figure 7-2**.

7.1.6 Sperm Whale

Sperm whales typically occur in WA along the southern coastline between Cape Leeuwin and Esperance (Bannister *et al.* 1996). Sperm whales are distributed worldwide in deep waters (greater than 200 m) off continental shelves and sometimes near shelf edges, averaging 20 to 30 nautical miles offshore (Bannister *et al.* 1996). The sperm whale is known to migrate northwards in winter and southwards in summer, however, detailed information on the distribution of sperm whales is not available for the timing of migrations. Sperm whales have been recorded in deep water off the North West Cape on the west coast of Western Australia (RPS 2010b), and appear to occasionally venture into shallower waters in other areas (RPS 2010b). Details on the BIA for sperm whales are provided in **Table 7-3** and are shown in **Figure 7-1.**

7.1.7 Antarctic Minke Whale

The Antarctic minke whale is distributed throughout the Southern Hemisphere from 55°S to the Antarctic ice edge during the austral summer and has been recorded in all Australian States (Bannister et al. 1996; Perrin & Brownell 2002). Detailed information on timing and location of migrations and breeding grounds on the west coast of Australia is largely unknown. However, it is believed that the Antarctic minke whale migrates up the WA coast to approximately 20°S during Australian winter to feed and possibly breed (Bannister *et al.* 1996).

7.1.8 Bryde's Whale

The Bryde's whale is found all year round in tropic and temperate waters (Kato 2002). Two forms are recognised: inshore and offshore Bryde's whales. It appears that the inshore form is restricted to the 200 m depth isobar whilst the offshore form is found in deeper waters of 500-1,000 m (DoEE 2019c). Both forms are expected to be found in zones of upwelling where they feed on shrimp like crustaceans (Bannister *et al.* 1996). Little is known about the population abundance of Bryde's whale, the location of exact breeding and calving grounds and large-scale migration patterns (DoEE 2019c). It is however, suggested that the offshore form migrates seasonally, heading towards warmer tropical waters during the winter.

7.1.9 Pygmy Right Whale

The pygmy right whale is considered the most elusive baleen whale and as a result very little is known about the whale's distribution in Australian waters. Records of the pygmy right whale in Australian waters are distributed between 32°S and 47°S and are restricted in the west by the Leeuwin current (Kemper 2002). It is possible that the pygmy right whale will be encountered in the southern extent of the EMBA, particularly in coastal areas of upwelling (Kemper 2002).

7.1.10 Killer Whale

The killer whale has a widespread global distribution and has been recorded in waters of all Australian states/territories (Bannister *et al.* 1996). Whilst more commonly found in cold, deeper waters, killer whales have been observed along the continental slope, shelf and shallow coastal areas of WA. Killer whales are known to make seasonal movements and are most likely to follow the migratory routes of their prey.

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7.1.11 Indo-Pacific Humpback Dolphin

The Indo-pacific humpback dolphin is typically found in water less than 20 m deep, but has been recorded in waters up to 40 m deep. This species is generally found in association with river mouths, mangroves, tidal channels and inshore reefs (DoEE 2016a). This species of dolphin is known to have resident groups that forage, feed, breed and calve in the state waters of Roebuck Bay, Dampier Peninsula, King Sound north, Talbot Bay, Anjo Peninsula, Vansittart Bay, Napier Broome Bay and Deception Bay (DoEE 2016a).

The Indo-Pacific humpback dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3**.

7.1.12 Spotted Bottlenose Dolphin (Indo-Pacific bottlenose dolphin)

The spotted bottlenose dolphin (*Tursiops aduncus*) (Arafura / Timor Sea populations) is generally considered to be a warm water subspecies of the spotted bottlenose dolphin, occurring in shallow (often <10 m deep) inshore waters (Bannister et al., 1996; Hale et al., 2000). The known distribution of the spotted bottlenose dolphin extends from Shark Bay north to the western edge of the Gulf of Carpentaria in Australia (DoEE 2016b). The spotted bottlenose dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3**.

7.1.13 Irrawaddy Dolphin (Australian Snubfin Dolphin)

The Irrawaddy dolphin, also known as the snubfin dolphin (*Orcaella heinsohni*) is known to occur within the waters off northern Australia, extending north from Broome in Western Australia to the Brisbane River in Queensland (DoEE 2016c). Surveys have indicated that the species is typically found in protected shallow nearshore waters, generally less than 20 m deep, adjacent to river and creek mouths close to seagrass beds (DoEE 2016c). The snubfin dolphin was not recorded during any of the aerial surveys undertaken along the Dampier Peninsula coastline in the vicinity of James Price Point but were observed in Roebuck Bay from vessels on several occasions (RPS, 2010b). Based on the extensive survey effort and amenable conditions within the James Price Point coastal area during the survey, it is concluded that this species is seldom found outside of shallow and sheltered bays and inlets (DSD 2010). The Irrawaddy dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3.**

7.1.14 Dusky Dolphin

The dusky dolphin’s distribution is strongly linked to colder waters. In Australia, the dusky dolphin has been sighted in southern Australia from WA to Tasmania. It is presumed to be primarily an inshore species but has been known to move further offshore, possibly due to its desire for colder waters (Gill *et al.* 2000). Dusky dolphins are expected to be limited in their distribution along the WA coastline due to the presence of the southward-flowing warm water of the Leeuwin Current.

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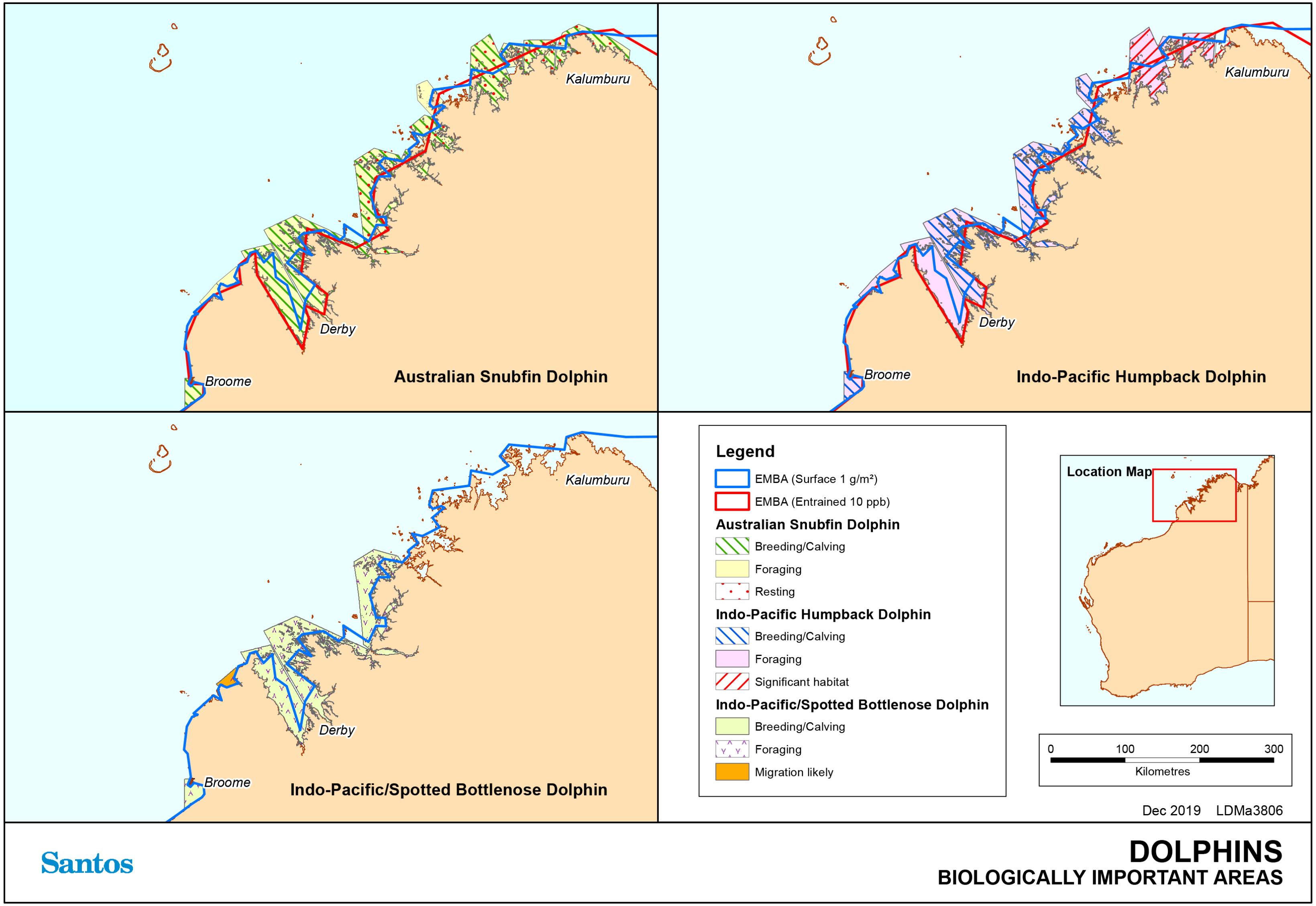

Figure 7-3: Biologically important areas – dolphins

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7.1.15 Australian Sea Lion

The Australian sea lion is endemic to Australia. Breeding colonies are found only in South Australian and Western Australian waters. There are currently 76 known Australian sea lion pupping locations along the coast and offshore islands between the Houtman Abrolhos Islands in Western Australia to the Pages Islands in South Australia (DSEWPaC 2013c). The species has also been recorded at Shark Bay (DoE 2014a).

BIAs for foraging, haul-out and breeding sites identified by the National Conservation Values Atlas are located south of the waters from Busselton to the NT border (DoEE 2019b). Male Australian sea lions have been recorded foraging in areas up to 60 km away from their birth colonies, with potentially larger dispersal ranges up to 180 km (Hamer *et al*. 2011). However, female Australian sea lions have restricted home ranges, with high rates of natal site fidelity and limited gene flow with other regions (Campbell 2005). The Australian sea lion BIA in the EMBA is outlined in **Table 7-3** and is depicted in **Figure 7-4.**

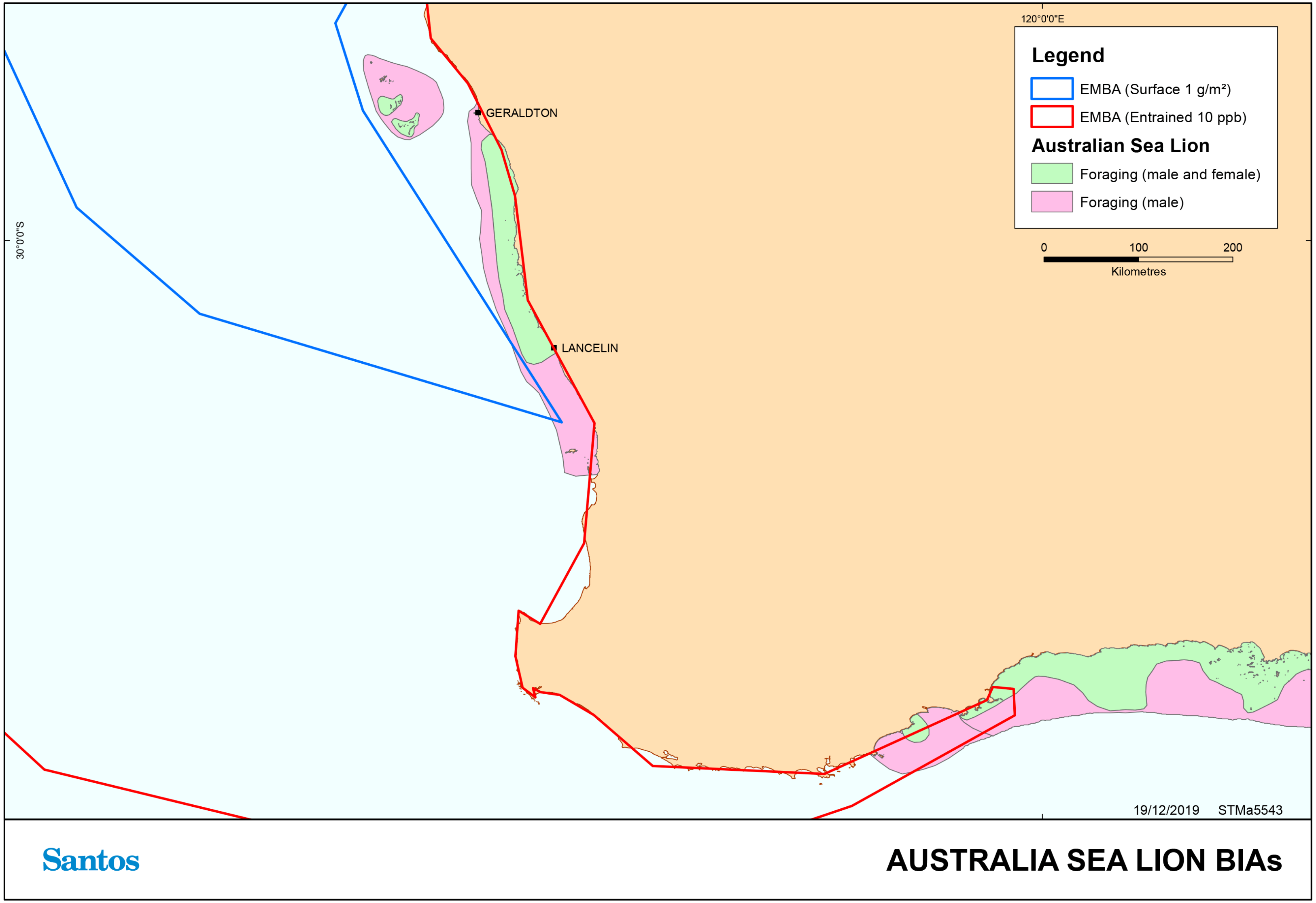

Figure 7-4: Biologically important areas – Australian sea lion

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7.1.16 Dugongs

Dugongs (*Dugong dugon*) are large herbivorous marine mammals (up to 3 metres) that feed off seagrass and generally inhabit coastal areas. Key populations along the WA coast are principally located at: Shark Bay (the largest resident population in Australia), Ningaloo Marine Park and Exmouth Gulf, the Pilbara coast and offshore areas including Montebello/Barrow/Lowendal Islands, and further north at Eighty Mile Beach and off the Kimberley Coast, particularly Roebuck Bay and Dampier Peninsula (Marsh *et al*. 2002; DSEWPaC 2012). Populations are also present at Ashmore Reef. Dugong distribution and movement is based on the abundance, size and species of seagrass meadow. Dugongs can migrate hundreds of kilometres between seagrass habitat. The dugong BIAs in the EMBA are detailed in **Table 7-3** and shown in **Figure 7-5**.

7.1.17 New Zealand fur-seal

The New Zealand fur-seal (also known as the long-nosed fur seal) (*Arctocephalus forsteri*) is a specially protected species (Other Specially Protected) under the BC Act. The New Zealand fur seal is found in Ngari Capes Marine Park (two colonies) (and along other parts of Australia's southern coast).[5]

[5] Identified as a relevant species through review of *Biodiversity Conservation Act 2016* listed species for marine species without an EBPC Act listing.

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Figure 7-5: Biologically important areas – dugongs

Table 7-2: Summary of information for marine mammals listed as threatened under the EPBC Act

Aspect	Sei whale	Blue and pygmy blue whales	Fin whale	Southern right whale	Humpback whale	Australian sea lion
Species expected in area	Unknown	Yes	Unknown	Unlikely, southern distribution	Yes	Unlikely, southern distribution
Migration depth (m)	Unknown, prefers offshore waters	500-1,000	Unknown	n/a	Up to 100	n/a
Migration seasonality	Unknown	Apr to Aug (north), Oct to Jan (south)	Unknown	n/a	Jun to Nov	n/a

7.2 Biologically Important Areas / Critical Habitat – Marine Mammals

Table 7-3 below provides an overview of BIAs in the EMBA for marine mammals

The DAWE may also make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[6].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Table 7-3: Biologically important areas – marine mammals

Species	Scientific name	Aggregation area and use	BIAs within EMBA
Blue and pygmy blue whales	*Balaenoptera musculus*	Migration – along the continental shelf edge off the WA coastline, extending offshore near Scott Reef and into Indonesian waters Foraging – along Ningaloo reef, around Scott Reef, around the Perth canyon	Blue and pygmy blue whale - Head of the Perth Canyon Outer continental shelf from Cape Naturaliste to south of Jurien Bay Outer Perth Canyon Head of the Perth Canyon Pygmy blue whale - Augusta to Derby. Tend to pass along the shelf edge at depths of 500 m to 1000 m; appear close to coast in the Exmouth-Montebello Islands area on southern migration. From Mandurah to south of Cape Naturaliste, seaward to the 50 m depth contour Indonesia- Banda Sea Ningaloo Perth Canyon

[6] Further background information on BIA and identification of critical habitat in recovery plans is provided in **Section 5.4**.

Species	Scientific name	Aggregation area and use	BIAs within EMBA
			Scott Reef
Southern right whale	*Eubalena australis*	Breeding/calving – along the south west and southern coastline of WA/SA	Bunbury area, WA Camac Island/Fremantle, WA Coast Cape Naturaliste to Cape Leeuwin Coast Perth region to Cape Naturaliste Geographe Bay, WA Perth to Kangaroo Island
Humpback whale	*Megaptera novaeangliae*	Breeding/calving/nursing/resting – Kimberley/Coastal North Lacepede Island, Campden Sound, Exmouth Gulf, Shark Bay Migration - northern migration deeper waters of the continental shelf, southward migration – along the WA mainland	Cape Leeuwin to Houtman Abrolhos Cape Naturaliste Cape Naturaliste to Cape Leeuwin Exmouth Gulf Flinders Bay Geographe Bay Houtman Abrolhos Islands Kimberley/Coastal North Lacepede Island, Camden Sound North of Houtman Abrolhos Shark Bay The migration corridor extends from the coast to out to approximately 100 km offshore in the Kimberley region extending south to North West Cape. From North West Cape to south of shark Bay the migration corridor is reduced to approximately 50 km. West coast - Lancelin to Kalbarri West coast- Bunbury to Lancelin including Rottnest Island
Sperm whale	*Physeter macrocephalus*	Foraging - west end of Perth Canyon and Albany Canyons	Western end of Perth canyon Albany Canyons - Immediately south of the continental shelf edge extending over the continental slope
Indo-Pacific humpback dolphin	*Sousa chinensis*	Breeding, calving, foraging – Kimberley coastal waters and islands Significant habitat – unknown behavior – Admiralty Gulf & Parry Harbour and Bougainville Peninsula Significant habitat - Vansittart Bay, Anjo Peninsula	Admiralty Gulf & Parry Harbour Bougainville Peninsula Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) Carnot & Beagle bay King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Maret and Biggee Island Pender bay Port Nelson, York Sound, Prince Frederick Harbour Prince Regent River Roebuck Bay

Species	Scientific name	Aggregation area and use	BIAs within EMBA
			Vansittart Bay, Anjo Peninsula Willie Creek
Indo-Pacific/spotted bottlenose dolphin	*Tursiops aduncus*	Breeding, calving, foraging – Kimberley coastal waters and islands Migration – Pender Bay	Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Pender bay Roebuck Bay
Irrawaddy dolphin (Australian snubfin dolphin)	*Orcella heinsohni*	Breeding, calving, foraging, resting– Kimberley coastal waters and islands	Admiralty Gulf and Parry Harbour Bougainville Peninsula Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) Cape Londonderry and King George River Carnot and Beagle bay King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Maret and Biggee Island Ord River Pender bay Port Nelson, York Sound, Prince Frederick Harbour Prince Regent River Roebuck Bay Vansittart Bay, Anjo Peninsula Willie Creek
Australian sea lion	*Neophoca cinerea*	Foraging – male and female – Houtman Abrolhos Island, mid-west coast (more restricted spatial extent than males) Foraging – males Houtman Abrolhos Island, mid-west coast down to Perth Breeding – Buller Island, North Fisherman Island, Beagle Island, Albrolhos Island Haul Out Sites – North Cervantes Island, Sandland Island, Albrolhos Island	Houtman Abrolhos Islands Mid-west coast, includes Beagle Island, Fisherman Island, Jurien Bay, Cervantes and Buller Colonies From Recherche Archipelago to Doubtful Islands – Key colonies, Kimberly island, Glenny and Wickham Island. Haul-Off rock
Dugong	*Dugong dugon*	Foraging –Dampier Peninsula, Roebuck Bay, Shark Bay, Exmouth and Ningaloo coastline Migration – Roebuck Bay and North East Peron Peninsula, Shark Bay	Ashmore Reef - Far West Ashmore Reef - South (located on sea reef side only, not interior) Between Peron Peninsula and Faure Island, Shark Bay Dirk Hartog Island, Shark Bay

Santos

Species	Scientific name	Aggregation area and use	BIAs within EMBA
		Breeding/calving/nursing – Exmouth and the Ningaloo coastline	East of Faure Island, Shark Bay Exmouth Gulf Kimberley coast, Dampier Peninsula Middle Island, Kimberley coast North East Peron Peninsula, Shark Bay North of Faure Island, Shark Bay Pilbara and Kimberley coast near Dampier Peninsula Pilbara and Kimberley coast near James Price Point Roebuck Bay, Broome South Passage, Shark Bay Useless Loop, Shark Bay

8. Birds

Marine waters and coastal habitats in the EMBA contain key habitats that are important to birds, including offshore islands, sandy beaches, tidal flats, mangroves and coastal and pelagic waters. These habitats support a variety of birds which utilise the area in different ways and at different times of the year (DSEWPaC 2012a). Birds can be broadly grouped according to their preferred foraging habitat as coastal/ terrestrial birds, seabirds and shorebirds.

Coastal or terrestrial species inhabit the offshore islands and coastal areas of the mainland throughout the year. These species are either primarily terrestrial, or they may forage in coastal waters. Resident coastal and terrestrial species include osprey (*Pandion cristatus*), white-bellied sea eagle (*Haliaeetus leucogaster*), silver gull (*Larus novaehollandiae*) and eastern reef egret (*Egreta sacra*) (DEWHA 2008a).

Seabirds include those species whose primary habitat and food source is derived from pelagic waters. These species spend the majority of their lives at sea, ranging over large distances to forage over the open ocean. Seabirds present in the area include terns, noddies, petrels, shearwaters, tropicbirds, frigatebirds boobies and albatrosses (DEWHA 2008a).

Shorebirds, including waders, inhabit the intertidal zone and adjacent areas. Some shorebird species, including oystercatchers are resident (Surman & Nicholson 2013). Other shorebirds are migratory and include species that utilise the East Asian–Australasian Flyway, a migratory pathway for millions of migratory shorebirds that travel from Northern Hemisphere breeding grounds to Southern Hemisphere resting and foraging areas. Shorebirds that regularly migrate through the area include the *Scolopacidae* (curlews, sandpipers etc.) and *Charadriidae* (plovers and lapwings) families.

Surveys in the area by Santos WA and other agencies have built a picture of diverse avifauna. A summary of research is discussed below, followed by information on threatened and migratory birds. Wetlands of international importance are discussed in **Section 9.2**.

8.1 Regional Surveys

8.1.1 Abrolhos Islands

The Abrolhos Islands are one of the most significant seabird nesting areas in the eastern Indian Ocean with over two million birds breed on the islands and small rocky atolls in the Abrolhos (DoF 2012). The mixture of species is unique, as subtropical and tropical species, and littoral and oceanic foragers, share the breeding islands. A total of 95 bird species have been recorded as residents or visitors to the Abrolhos Islands. Of these 35 species are known to breed at the Abrolhos (DoF, 2012):

+ Common noddy (rookery – Pelseart Island): The Abrolhos supports 80 per cent of the Australian breeding population of the common noddy (*Anous stolidus*) with up to 250,000 common noddies breed at Pelsaert Island. These birds lay their eggs in spring, but the actual month can vary, depending on their food supply and the weather conditions existing in offshore waters (DoF 2012);
+ Caspian tern (rookeries – Leo Island, West Wallabi Island and Pelsaert Island): Unlike other more social terns, Caspian terns (*Hydroprogne caspia*) are usually solitary nesters. There are less than 150 of these breeding at the Abrolhos, across 22 islands (DoF 2012);
+ Wedge-tailed shearwaters (rookeries): The Abrolhos are the most important breeding sites in Australia for the wedge tailed shearwater (Ardenna pacifica), with between 500,000 and a million of these birds breeding there every year, predominantly on West Wallabi Island. The wedge-tailed shearwater breeding colonies at the Abrolhos are the largest in Australia (DoF 2012);
+ Bridled tern (rookeries – Gun Island, Leo Island, Pelsaert Island, Little North Island, Fisherman Islands, Beagle Islands and Penguin Island): Bridled terns (*Onychoprion anaethetus*) breed on 90 islands throughout the Abrolhos. These birds fly north for the winter, through Indonesia to waters around the Phillippines. There are approximately 4,000 bridled terns who return to the Abrolhos around October every

year to lay their eggs. Bridled terns nest on more islands in the Abrolhos than any other bird species (DoF, 2012);

+ Osprey (nesting area – Pelseart Island): Up to 100 eastern ospreys (Pandion cristatus) nest at a number of sites throughout all three island groups at the Abrolhos, including nesting platforms made from converted rock lobster pots and stacked fishing equipment on jetties (DoF 2012);
+ White-bellied sea eagle (nesting area – West Wallabi Island): At the Abrolhos, there are up to 50 breeding white-breasted sea eagles (Haliaeetus leucogaster), spread across all three island groups (DoF 2012);
+ Australian lesser noddy (feeding area and rookeries Morley Island, Wooded Island and Pelseart Island): In Australia the Australian lesser noddy is only known to breed in this area and is known to forage between the islands and the continental shelf edge; and
+ Other areas rookeries identified for both the wedge-tailed shearwater and bridled tern within the south west area include Lancelin Island, Rottnest Island and Safety Bay.

8.1.2 North West Cape

Avifauna surveys of the North West Cape have recorded 144 bird species, one third of which are seabirds and shorebirds (resident and migratory) (May *et al*. 1983). Approximately 33 species of seabirds and shorebirds are found in the Ningaloo Marine Park with the main breeding areas at Mangrove Bay, Mangrove Point, Point Maud, the Mildura wreck site and Fraser Island (CALM & MPRA 2005a).

8.1.3 Muiron Islands and Exmouth Gulf Islands

Muiron Islands and Exmouth Gulf Islands are generally lacking in published bird observations data. Early indications from surveys commissioned by Santos WA in 2013/14 indicate that South and North Muiron Islands are regionally significant in terms of wedge-tailed shearwater (*Puffinus pacificus*) nesting, whilst Bessiers and Fly islands are also significant (Surman pers comm. 2013). Nine coastal/terrestrial species and 21 shorebirds were identified on the Muiron and Exmouth Gulf Islands during the first of these surveys and seven bird species were recorded nesting (Surman 2013).

8.1.4 Dampier Archipelago/Cape Preston Region

The Dampier Archipelago/Cape Preston region is a nesting area for at least 16 species of seabirds. Many of the islands and rocks in the area are known breeding grounds for birds, including wedge-tailed shearwaters (*Puffinus pacificus*), Caspian terns (*Sterna caspia*), bridled terns (*Sterna anaethetus*) and roseate terns (*Sterna dougallii*). Small islands and islets such as Goodwyn Island, Keast Island and Nelson Rocks provide important undisturbed nesting and refuge sites and Keast Island provides one of the few nesting sites for pelicans in WA (CALM & MPRA 2005).

8.1.5 Barrow Island and Lowendal Island Group

Barrow Island and surrounding islands have a diverse avifauna comprising at least 110 species, including 11 resident land birds, eight resident seabirds, 17 seabirds, 22 species of migratory waders, six resident shorebirds and 43 irregular visitors (Surman 2003). The avifauna of Barrow Island is thus poor in terms of land birds and waterfowl compared to mainland areas of the Pilbara, but rich in migratory waders and seabirds. Compared to other nearby offshore islands, Barrow Island has substantially more migratory waders but fewer breeding seabirds (Surman 2003).

The Lowendal Island Group has a diverse avifauna comprising 89 recorded species (Dinara Pty Ltd. 1991, Burbidge *et al*. 2000). Six species of resident land birds and six species of raptors have been recorded at the Lowendal Islands (Surman & Nicholson 2012). Up to fourteen seabird species have been observed at any one time during annual surveys of the Lowendal Islands between 2004 and 2012. Surveys at the Montebello Islands have recorded 70 bird species. This includes 12 species of seabirds and 14 species of migratory shorebirds (Burbidge *et al*. 2000).

8.1.6 Varanus, Airlie, Serrurier, Bridled, Abutilon, Beacon and Parakeelya Islands

Wedge-tailed shearwaters have been identified to nest on Varanus, Airlie, Serrurier and Bridled Islands (Astron 2017a). Breeding participation on the islands appears to be largely influenced by pre-breeding oceanographic conditions (Astron 2017a). Monitoring in 2016/17 was undertaken by Santos WA and demonstrated the colony sizes for wedgetailed shearwaters to be within or above previously reported ranges (Astron 2017a). This is informed though monitoring that has been undertaken under the Integrated Shearwater Monitoring Program (ISMP), established in 1994.

In 2016/17, areas of potential wedge-tailed shearwater nesting habitat were recorded on Varanus Island (5.53 ha) and Airlie Island (12.47 ha) and surrounding islands of Bridled (2.94 ha), Serrurier (130.89 ha), Abutilon (2.02 ha) and Parakeelya (1.66 ha) (Astron 2017a). The number of wedge-tailed shearwater breeding pairs was also estimated for each of Varanus (1,492 +/- 702), Airlie (600 +/- 124), Bridled (1,039 +/- 342), Serrurier (23,240 +/- 4,341), Abutilon (317 +/- 210) and Parakeelya (172 +/- 138) islands (Astron 2017a).

Other seabird species utilising Abutilon, Beacon, Bridled and Parakeelya islands for nesting include bridled terns, silver gulls, crested terns and lesser crested terns. Monitoring for these seabirds in 2016/17 was also completed by Santos WA, with monitoring results concluded to support previous trends for all species. Bridled terns mainly utilise Abutilon, Bridled and Parakeelya islands for breeding, with smaller numbers noted on Beacon and Varanus Islands. The bridled terns have not been recorded on Airlie Island and only in very small numbers on Varanus Island (Astron 2017b).

Silver gull numbers appear to be growing across the region (2010/2011). However, reasons for this are unknown but considered possibly to be due to greater prey availability or immigration from the mainland (Astron 2017b). Silver gulls have been found to utilise Bridled, Parakeelya, Abutilon and Beacon islands longer term for breeding. Silver gulls have not been identified to nest on Varanus island and were only recorded nesting on Airlie island for the first time in 2016/17 since monitoring commencement in 2004/05 (Astron 2017b).

The crested tern and lesser crested tern are noted as nomadic breeders that appear to use a consistent subset of islands for breeding. In 2016/17, Beacon Island was the favourable nesting site for the crested tern and lesser crested tern (Astron 2017b). Surveys in the vicinity of Port Hedland (Bennelongia 2011) recorded 23 species of migratory shorebird between 2002 and 2011. Terrestrial/coastal and seabird species were not targeted. A total of 4,248 migratory shorebirds of 18 species were observed during the field survey in April 2011.

8.2 Threatened Species

A Protected Matters search of the EMBA identified 55 bird species (**Appendix A**) listed under the EPBC Act as threatened.

An examination of the species profile and threats database (DoEE 2019a) and The Action Plan for Australian Birds (Garnet 2011) showed that some listed bird species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial or southern distributions. Hence, these species are not discussed further.

EPBC Act threatened species expected to occur in the area are listed in **Table 8-1** along with their WA conservation status (as applicable), and discussed below. There are an additional 44 migratory species listed under the EPBC Act, with these detailed in **Section 8.3** (**Table 8-3**). BIAs for birds are detailed in **Table 8-6** and depicted in **Figure 8-1** and **Figure 8-2**.

Table 8-1: Birds listed as threatened under the EPBC Act

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Shorebirds					
Red knot (*Calidris canutus*)	Endangered	Endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Curlew sandpiper (*Calidris ferruginea*)	Critically endangered	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Great knot (*Calidris tenuirostris*)	Critically endangered	Critically endangered	-	Roosting known to occur within area	None - No BIA defined
Greater sand plover (*Charadrius leschenaultia*)	Vulnerable	Specially protected (migratory)	-	Roosting known to occur within area	None - No BIA defined
Lesser sand plover (*Charadrius mongolus*)	Endangered	Endangered	-	Roosting known to occur within area	None - No BIA defined
Western Alaskan bar-tailed godwit (*Limosa lapponica baueri*)	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area	None - No BIA defined
Northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri*)	Critically endangered	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Eastern curlew (*Numenius madagascariensis*)	Critically endangered	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Australasian bittern (*Botaurus poiciloptilus*)	Endangered	Endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Australian painted snipe (*Rostratula australis*)	Endangered	Endangered	-	Species or species habitat may occur within area	None - No BIA defined
Seabirds					
Australian lesser noddy (*Anous tenuirostris melanops*)	Vulnerable	Endangered	-	Breeding known to occur within area	Yes – refer to **Table 8-6**

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Fairy piron (southern) (*Pachyptila tutur subantarctica)*	Vulnerable	-	-	Species or species habitat known to occur within area	None - No BIA defined
Southern royal albatross (*Diomedea epomophora)*	Vulnerable, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Northern royal albatross (*Diomedea sanfordi)*	Endangered, Mirgratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Amsterdam albatross (*Diomedea amsterdamensis*)	Endangered, Migratory	Critically endangered	-	Species or species habitat may occur within area	None - No BIA defined
Antipodean albatross (*Diomedea antipodensis)*	Vulnerable	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Sooty Albatross (*Phoebetria fusca)*	Vulnerable, Migratory	Endangered	-	Species or species habitat may occur within area	None - No BIA defined
Tristan albatross (*Diomedea dabbenea)*	Endangered, Migratory	Critically endangered	-	Species or species habitat may occur within area	None - No BIA defined
Wandering albatross (*Diomedea exulans)*	Vulnerable, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
Christmas island frigatebird (*Fregata andrewsi)*	Endangered, Migratory	Specially protected (migratory)	-	Foraging, feeding or related behaviour known to occur within area	None - No BIA defined
Southern giant petrel (*Macronectes giganteus)*	Endangered, Migratory	Specially protected (migratory)	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Northern giant petrel (*Macronectes halli)*	Vulnerable, Migratory	Specially protected (migratory)	-	Species or species habitat	None - BIA not found in EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
				may occur within area	
Abbott's booby (*Papasula abbotti)*	Endangered	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Soft-plumaged petrel (*Pterodroma mollis)*	Vulnerable	-	-	Foraging, feeding or related behaviour known to occur within area	Yes – refer to **Table 8-6**
Blue Petrel (*Halobaena caerulea)*	Vulnerable	-	-	Species or species habitat may occur within area	None - No BIA defined
Australian fairy tern (*Sternula nereis)*	Vulnerable	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 8-6**
Indian yellow-nosed albatross (*Thalassarche carteri)*	Vulnerable, Migratory	Endangered	-	Foraging, feeding or related behaviour may occur within area	Yes – refer to **Table 8-6**
Shy albatross (*Thalassarche cauta)*	Vulnerable, Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
White-capped albatross (*Thalassarche cauta steadi)*	Vulnerable, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
Black-browed albatross (*Thalassarche melanophris)*	Vulnerable, Vulnerable	Endangered	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Campbell albatross (*Thalassarche impavida)*	Vulnerable, Migratory	Vulnerable	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Christmas Island white-tailed tropicbird (*Phaethon lepturus fulvus)*	Endangered	-	-	Species or species habitat may occur within area	None - No BIA defined

8.2.1 Shorebirds

Red Knot (New Siberian Islands and north-eastern Siberia)

The red knot is a migratory shorebird and the species includes five subspecies, including two found in Australia, *Calidris canutus piersmai* and *Calidris canutus rogersi*. The red knot breeds in Siberia and spends the non-breeding season in Australia and New Zealand. During the non-breeding season the species spends the majority of its time on tidal mudflats or sandflats where they feed on intertidal invertebrates, especially shellfish (Garnet *et al.* 2011).

Curlew Sandpiper

This species is a migratory shorebird that breeds in north Siberia and spends the non-breeding season from western Africa to Australia (Bamford *et al.* 2008). The curlew sandpiper occurs around coastal Australia and preferred habitats include coastal brackish lagoons, tidal mud and sand flats, estuaries, saltmarshes and less often inland. Their diet is mainly comprised of polychaete worms, molluscs and crustaceans (Higgins & Davies 1996 in Garnet *et al.* 2011).

Great Knot

The great knot is a migratory shorebird with a global distribution, breeding in north-east Siberia and spending the non-breeding season along coasts from Arabia to Australia. Non-breeding birds migrate to inlets, bays, harbours, estuaries and lagoons with large intertidal mud and sand flats where they feed on bivalves, gastropods, crustaceans and other invertebrates (Higgins & Davies 1996 in Garnet *et al.* 2011).

Greater Sand Plover and Lesser Sand Plover

The greater sand plover and lesser sand plover are congeners that breed in China, Mongolia and Russia. The greater sand plover spends the non-breeding season along coasts from Japan through southeast Asia to Australasia, while the lesser sand plover spends the non-breeding season along coasts from Taiwan to Australasia (Banford *et al*. 2008). Non-breeding birds occur along all Australian coasts, especially in the north for the greater sand plover (DoEE 2019a) and in the east for the lesser sand plover (DoEE 2019a).

Non-breeding birds forage on beaches, salt-marshes, coastal bays and estuaries, and feed on marine invertebrates including molluscs, worms, crustaceans and insects (Marchant & Higgins 1993 in Garnet *et al*. 2011).

Bar-tailed Godwit (Western Alaskan and Northern Siberian Subspecies)

Two subspecies of the bar-tailed godwit exist, as determined by their breeding locations in Siberia and Alaska (Bamford *et al*. 2008). Non-breeding birds migrate to the coasts of Australia. The western Alaskan subspecies occurs especially on the north and east coasts of Australia whilst the northern Siberian subspecies occurs especially along the coasts of north Western Australia (DoEE 2019b).

Non breeding birds are found on muddy coastlines, estuaries, inlets, mangrove-fringed lagoons and sheltered bays, feeding on annelids, bivalves and crustaceans (Higgins and Davies 1996 in Garnet *et al*. 2011).

Eastern Curlew

The eastern curlew is a migratory shorebird that breeds in Siberia, Kamchatka and Mongolia and migrates to coastal East Asia and Australia. The South Korean Yellow Sea is an important staging post for this species. Non breeding birds occur around coastal Australia, are more common in the north and have disappeared or become much rarer at many sites along the south coast (Garnet 2011).

Non breeding birds are present at estuaries, mangroves, saltmarshes and intertidal flats, particularly those with extensive seagrass (Zosteraceae), where they feed on marine invertebrates, especially crabs and small molluscs (Higgins & Davies 1996 in Garnet 2011).

Australian Painted Snipe

The Australian painted snipe has been recorded at wetlands in all states of Australia (DoE 2014g). The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or canegrass or sometimes tea-tree (*Melaleuca*). The Australian painted snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (DoE 2014g).

Australasian Bittern

The Australasian bittern is found in coastal and sub-coastal areas of south-eastern and south-western mainland Australia and the eastern marshes of Tasmania (Birdlife Australia 2017). The specie lives predominantly in reedbeds and other water vegetation. Feeding on other small animals, insects, snails and spiders the bittern forages at night. Breeding occurs during summer from October to January.

8.2.2 Seabirds

Australian Lesser Noddy

This species is usually found only around its breeding islands in the Houtman Abrolhos Islands in Western Australia (Storr *et al*. 1986). The Australian lesser noddy occupies coral-limestone islands that are densely fringed with white mangrove *Avicennia marina*, and it occasionally occurs on shingle or sandy beaches (Higgins & Davies 1996 in DoEE 2019a). This species is thought to be sedentary or resident, staying near to its breeding islands in the non-breeding season. It may leave nesting islands for short periods during the non-breeding season, and probably forages widely (Higgins & Davies 1996 in DoEE 2019a).

Breeding apparently occurs only on Morley, Wooded and Pelsaert Islands at the Houtman Abrolhos Islands (Higgins and Davies 1996 in DoE 2014b). Mangrove stands support approximately 68,000 breeding pairs spread over the three islands (Surman & Nicholson 2006). Breeding may also occur on Ashmore Reef (Stokes & Hinchey 1990). The breeding season extends from mid-August to early April (Higgins & Davies 1996 in DoE 2014b).

The National Conservation Values Atlas identifies BIAs for this species in the area of the Houtman Abrolhos islands (**Table 8-6**). The Species Group Report Card – Seabirds (DSEWPaC 2012b) states that the entire Australian population of this species breeds in the South-west Marine Region, south of Busselton.

Albatrosses

A Protected Matters search of the waters in the EMBA (**Appendix A**) identified several albatross species that may occur in the area, comprising of the southern royal albatross, northern royal albatross, Amsterdam albatross, Antipodean albatross, Tristan albatross, sooty albatross, wandering albatross, Indian yellow-nosed albatross, shy albatross, white-capped albatross, black-browed albatross and Campbell albatross. All these species predominantly occur in subantarctic to subtropical waters and breed on islands in the southern oceans (DoEE 2019a).

The National Conservation Values Atlas (DoEE 2019b) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) do not identify any BIAs for these species in the area from Busselton to the Northern Territory border. However, a BIA for the Indian yellow-nosed albatross is identified for foraging north to Shark bay and extending east into Bass Strait.

Christmas Island Frigatebird

The Christmas Island frigatebird is a very large seabird. Breeding colonies of the Christmas Island frigatebird is currently confined to Christmas Island in the Indian Ocean (DoE 2014c). No breeding colonies have ever been found away from Christmas Island.

Southern Giant Petrel

The southern giant petrel is a highly migratory bird with a large natural range. This species occurs from Antarctic to subtropical waters and breeds on the Antarctic continent, peninsular and islands and on subantarctic islands and South America. Breeding occurs annually between August and March (DoEE 2019a).

The National Conservation Values Atlas (DoEE 2019b) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) do not identify any BIAs for this species in the area from Busselton to the NT border.

Northern Giant Petrel

The northern giant petrel occupies the Antarctic Polar Front. In summer, it occurs predominantly in sub-Antarctic to Antarctic waters, usually between 40 and 64° The northern giant-petrel breeds on sub-Antarctic islands. Its breeding range extends into the Antarctic zone at South Georgia. It nests in coastal areas where vegetation or broken terrain offers shelter, on sea-facing slopes, headlands, in the lee of banks, under or against vegetation clumps, below cliffs or overhanging rocks, or in hollows. On Campbell Island, it nests on the edge of the coastal plateau. Tussock-grass is widespread at many breeding sites. Its nests are built in secluded, coastal sites, sheltered by heavy vegetation. On Antipodes Island, it nests under *Senecio antipoda* (DoE 2014d).

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species in the area spanning SW WA to the Northern Territory border.

Soft-Plumaged Petrel

The soft-plumaged petrel is generally found over temperate and subantarctic waters in the South Atlantic, Southern Indian and western South Pacific Oceans. The species breeds colonially on islands in the southern oceans. Breeding occurs from August to May (Marchant & Higgins 1990 in DoEE 2019a).

A BIA for this species is identified for foraging in seas north to 21°30’S off WA.

Blue Petrel

The blue petrel is marine species of the Sub Antarctic and Antarctic seas. In summer, it occurs mainly over waters of -2 to 2° C in surface temperature, but it also ranges south to the edge of the pack-ice and north to approximately 30° south, or further north over cool currents (DoE 2014e). In the Antarctic, it generally avoids the pack-ice, and only occasionally approaches the edge of the ice. Given the location of the EMBA, this species is unlikely to occur.

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species in the area spanning SW WA to the NT border.

Abbott’s Booby

Currently, Abbott's booby is only known to breed on Christmas Island and to forage in the waters surrounding the island (DoE 2014f). Within Christmas Island, most nests are found in the tall plateau forest on the central and western areas of the island, and in the upper terrace forest of the northern coast.

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species in the area spanning SW WA to the NT border.

Australian Fairy Tern

The Australian fairy tern is distributed in a large geographic range between Australia, New Zealand and New Caledonia. Three subspecies have been identified, one of which is found in Australia. The Australian fairy tern occurs along the coasts of Victoria, Tasmania, South Australia and WA; occurring as far north as the Dampier Archipelago (DoEE 2019a). The subspecies has been found in embayments of a variety of habitats including offshore, estuarine or lacustrine islands, wetlands and mainland coastline (Higgins & Davies 1996 in DoE 2014b, Lindsey 1986).

Australian fairy terns nest on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The Australian fairy tern breeds from August to February depending on the location of the breeding colony (Higgins & Davies 1996 in DoEE 2019a). They generally nest in small colonies of up to 100 birds, although larger colonies of more than 1400 pairs have been reported in Western Australia (Hill *et al*. 1988).

The National Conservation Values Atlas (DoEE 2019b) identifies the vicinity of the lower north-west coast (north to Dampier Archipelago) and west coast (south to Peel inlet) as BIAs for foraging. Biologically important breeding areas were also identified scattered along the coast between Shark Bay and the Pilbara (**Table 8-6**).

Christmas Island White-tailed Tropicbird

The Christmas Island white-tailed tropicbird is endemic to Christmas Island and leaves the island to forage in the warm waters of the Indian Ocean (Garnett 2011). The white-tailed tropicbird roots at sea; only incubating or brooding adults remain on nests on the island at night (Stokes 1988).

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species within the EMBA.

Fairy Piron (southern)

The fairy piron is distributed off the cold-water coasts of Antarctica and southern Australia and New Zealand. The southern subspecies is known to breed on Macquarie Island, Langdon Point, Davis Point and Bishop and Clerk islands (Garnett & Crowley 2000). It is estimated that the population of the fairy piron (southern) is a little over 50 pairs (Brothers 1984).

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species within the EMBA.

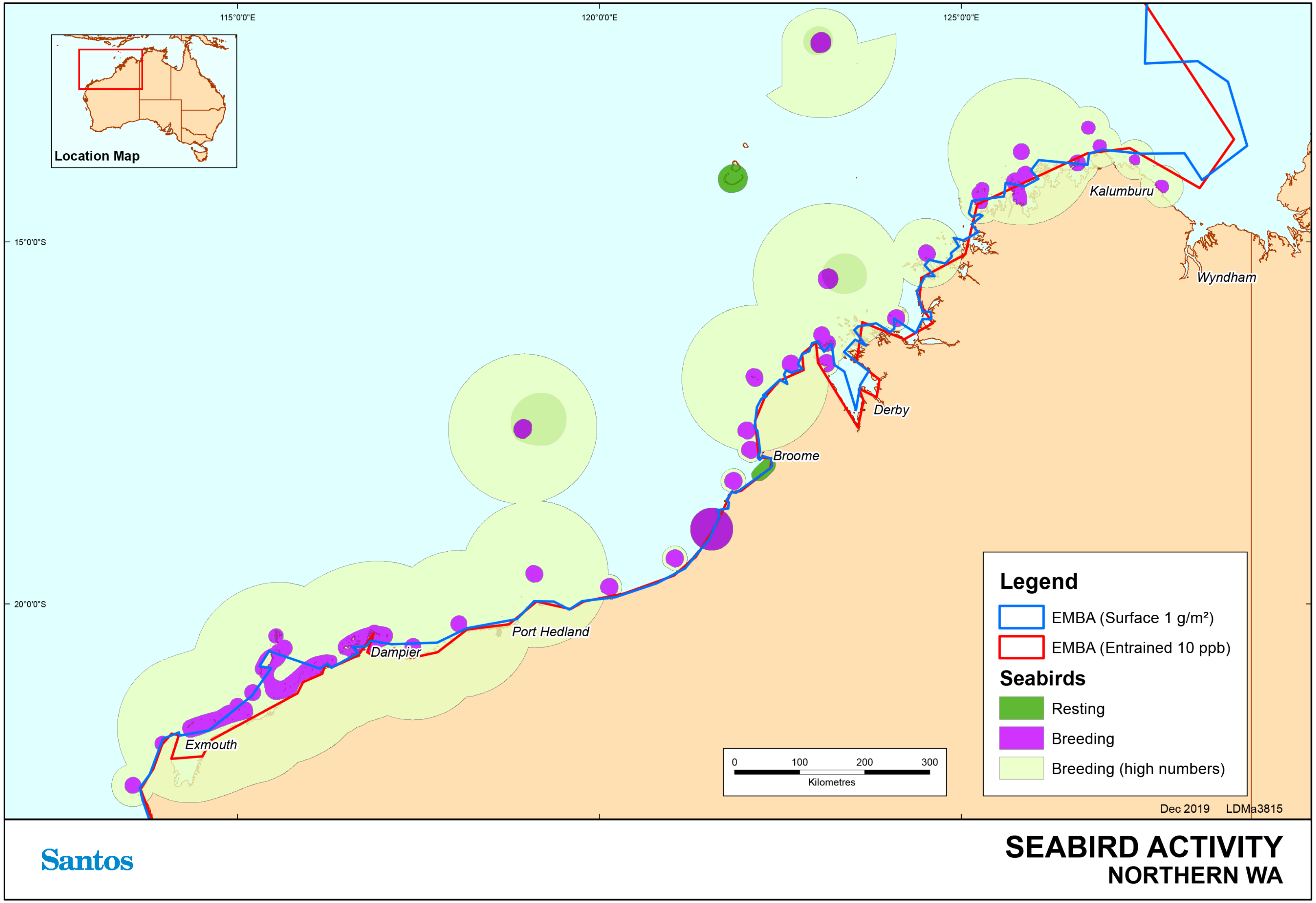

Figure 8-1: Biological important areas – birds – Northern WA

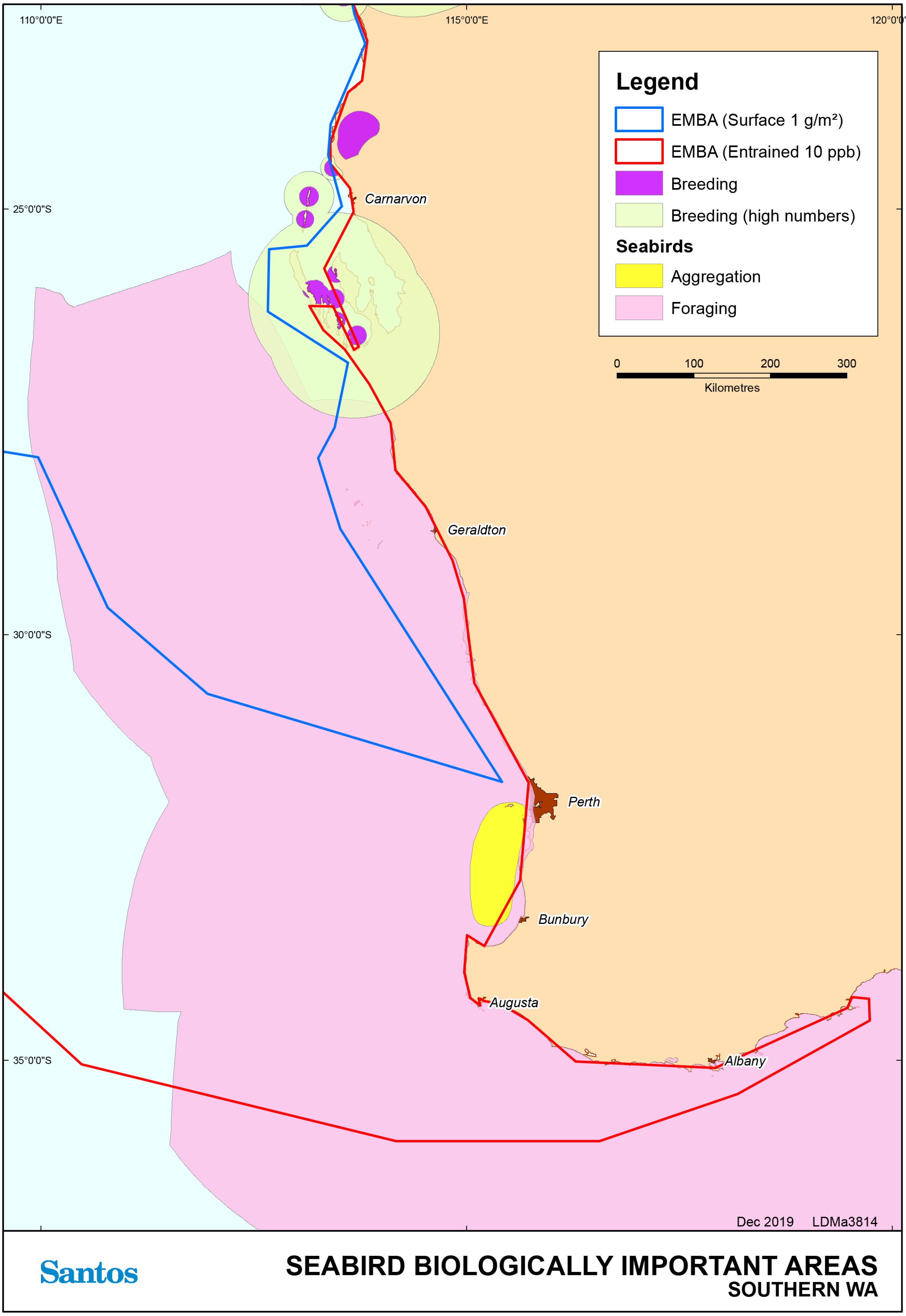

Figure 8-2: Biologically important areas – birds – Southern WA

Table 8-2: Summary of information for birds listed as threatened under the EPBC Act that may be in the EMBA

Species	Species Expected in EMBA	Breeding in the Area /Seasonality	Foraging
Shorebirds			
Red knot	Yes	No	Intertidal invertebrates
Curlew sandpiper	Yes	No	Polychaete worms, molluscs and crustaceans taken from shorelines
Great knot	Yes	No	Bivalves, gastropods, crustaceans and other invertebrates taken from shorelines
Greater sand plover/lesser sand plover	Yes	No	Marine invertebrates taken from shorelines
Bar-tailed godwit	Yes	No	Annelids, bivalves and crustaceans taken from shorelines
Eastern curlew	Yes	No	Marine invertebrates associated with seagrass
Australasian bittern	Yes	No	Other small animals, insects, snails and spiders
Australian painted snipe	Yes	No	Seeds and small invertebrates
Western Alaskan bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects
Northern Siberian bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects and some plant material
Seabirds			
Australian lesser noddy	May forage from Kalbarri to Shark Bay	No	Small fish taken from marine and coastal waters (DoE 2014b)
Amsterdam albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Antipodean albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Black-browed albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Campbell albatross	Low densities	No	Cephalopods, fish, salps, jellyfish and crustaceans taken from marine and coastal waters.
Indian yellow-nosed albatross	Low densities	No	Cephalopods, and fish taken from marine and coastal waters.
Northern royal albatross	Low densities	No	Cephalopods, fish, salps and crustaceans taken from marine and coastal waters.
Shy albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Sooty Albatross	Low densities	No	Cephalopods, fish, crustaceans, siphonophores and penguin carrion taken from marine waters.

Species	Species Expected in EMBA	Breeding in the Area /Seasonality	Foraging
Southern royal albatross	Low densities	No	Cephalopods, and fish taken from marine and coastal waters.
Tristan albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine waters.
Wandering albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
White-capped albatross	Low densities	No	Cephalopods and fish taken from marine and coastal waters.
Southern & Northern giant petrel	Low densities	No	Scavenges penguin, seal and whale carcasses. Hunts live birds, penguin chicks' cephalopods and krill. Marine and coastal waters (DoE 2014b)
Soft-plumaged petrel	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters (DoE 2014b)
Australian fairy tern	Yes	Yes Aug to Feb	Bait fish taken from coastal waters
Fairy piron (southern)	Very low densities	No	Small pelagic crustaceans, small fish and squid
Christmas Island frigatebird	Low densities	No	Planktonic crustaceans, fish and squid
Abbott's booby	Low densities	No	Fish and squid
Blue petrel	Low densities	No	Crustaceans, small fish and squid
Christmas Island white-tailed tropicbird	Very low densities	No	Squid and flying fish

8.3 Migratory Species

The EPBC PMST search identified 44 species listed as migratory that may occur within the EMBA. These species are listed in **Table 8-3**. All of the species are also listed as migratory under the BC Act, with the exception of the flesh-footed shearwater. Those species that are listed as both migratory and threatened under the EPBC Act are outlined in **Table 8-1** and are not repeated within **Table 8-3**.

Table 8-3: Summary of migratory birds that may occur within the EMBA

Species	Common Name	Likelihood of occurrence in EMBA
Limnodromus semipalmatus	Asian dowitcher	Roosting known to occur within area
Limosa lapponica	Bar-tailed godwit	Species or species habitat known to occur within area
Limosa limosa	Black-tailed godwit	Roosting known to occur within area
Onychoprion anaethetus	Bridled tern	Breeding known to occur within area
Limicola falcinellus	Broad-billed sandpiper	Roosting known to occur within area
Sula leucogaster	Brown booby	Breeding known to occur within area
Hydroprogne caspia	Caspian tern	Breeding known to occur within area

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Species	Common Name	Likelihood of occurrence in EMBA
Tringa nebularia	Common Greenshank	Species or species habitat known to occur within area
Anous stolidus	Common noddy	Breeding known to occur within area
Tringa totanus	Common redshank	Roosting known to occur within area
Actitis hypoleucos	Common sandpiper	Species or species habitat known to occur within area
Thalasseus bergii	Crested tern	Breeding known to occur within area
Charadrius bicinctus	Double-banded plover	Roosting known to occur within area
Ardenna carneipes	Flesh-footed shearwater	Breeding known to occur within area
Apus pacificus	Fork-tailed swift	Species or species habitat likely to occur within area
Fregata minor	Greater frigatebird	Breeding known to occur within area
Pluvialis squatarola	Grey plover	Roosting known to occur within area
Tringa brevipes	Grey-tailed tattler	Roosting known to occur within area
Fregata ariel	Lesser frigatebird	Breeding known to occur within area
Tringa stagnatilis	Little greenshank	Roosting known to occur within area
Sternula albifrons	Little tern	Breeding known to occur within area
Calidris subminuta	Long-toed stint	Species or species habitat known to occur within area
Sula dactylatra	Masked booby	Breeding known to occur within area
Charadrius veredus	Oriental plover	Roosting known to occur within area
Glareola maldivarum	Oriental pratincole	Roosting known to occur within area
Pandion haliaetus	Osprey	Breeding known to occur within area
Pluvialis fulva	Pacific golden plover	Roosting known to occur within area
Calidris melanotos	Pectoral sandpiper	Species or species habitat known to occur within area
Sula sula	Red-footed booby	Breeding known to occur within area
Phalaropus lobatus	Red-necked phalarope	Roosting known to occur within area
Calidris ruficollis	Red-necked stint	Roosting known to occur within area
Phaethon rubricauda	Red-tailed tropicbird	Breeding known to occur within area
Sterna dougallii	Roseate tern	Breeding known to occur within area
Arenaria interpres	Ruddy turnstone	Roosting known to occur within area
Philomachus pugnax	Ruff (reeve)	Roosting known to occur within area
Calidris alba	Sanderling	Roosting known to occur within area
Calidris acuminata	Sharp-tailed sandpiper	Roosting known to occur within area
Ardenna grisea	Sooty shearwater	Species or species habitat may occur within area
Calonectris leucomelas	Streaked shearwater	Species or species habitat known to occur within area
Calonectris leucomelas	Streaked shearwater	Species or species habitat known to occur within area
Xenus cinereus	Terek sandpiper	Roosting known to occur within area
Ardenna pacifica	Wedge-tailed shearwater	Breeding known to occur within area
Numenius phaeopus	Whimbrel	Roosting known to occur within area

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Species	Common Name	Likelihood of occurrence in EMBA
Phaethon lepturus	White-tailed tropicbird	Breeding known to occur within area
Tringa glareola	Wood sandpiper	Roosting known to occur within area

Australia is signatory to three international treaties with China, Japan and the Republic of Korea to safeguard migratory bird species, predominantly shorebirds. To facilitate observance of the three agreements, 36 species of migratory shorebirds have been listed as specially protected under both the Commonwealth EPBC Act and the WA BC Act.

Three internationally recognised areas that support shorebird migrations are protected as wetlands of international importance; Ashmore Reef, Eighty-mile Beach and Roebuck Bay. These wetlands are discussed further in **Section 9.2**.

The EPBC Act Policy Statement 3.21 sets out criteria for determining the significance of sites to migratory shorebirds based on the number of migratory species and the proportion of a species population that is supported by the site (Commonwealth of Australia 2017b). Site significance can be difficult to assess, particularly for ephemeral inland wetlands. These areas may be used rarely, depending weather conditions, but still provide important habitat for migratory shorebird species.

Migratory shorebirds require a particular conservation approach due to their migration patterns that take them across international boundaries (Bamford *et al*. 2008). These species and their habitats are sensitive to threats due to their high site fidelity, tendency to aggregate, high energy demands and the need for habitat networks containing both roosting and foraging sites (Commonwealth of Australia 2017b). Migratory shorebirds are known to use networks of connected sites (also known as site complexes). They move within these networks depending on the time of day, availability of resources and environmental conditions at the site (Commonwealth of Australia 2017b).

The types of habitat used by migratory shorebirds in Australia vary across the species identified in the PMST search. Migratory shorebirds use both coastal and inland habitats that most commonly include:

+ Coastal habitats: coastal wetlands, estuaries, mudflats, rocky inlets, reefs and sandy beaches, sometimes supporting mangroves; and
+ Inland habitats: inland wetlands, floodplains and grassland areas, often with ephemeral water sources (Commonwealth of Australia 2017b).

Feeding guilds provide an explanation for much of the shorebird distribution pattern in the north Western Australia. For example, Rogers (1999) classified shorebirds (and others) in Roebuck Bay as belonging to seven guilds on the basis of prey choice and foraging method. In order of abundance; these are summarised in **Table 8-4**.

Table 8-4: Feeding guilds based on prey choice and foraging method (Rogers 1999) adapted from DEC (2003) and Bennelongia (2008)

Feeding habitat	Feeding guild	Species
Sea edge	Tactile hunters of macrobenthos	Great knot, red knot, bar-tailed godwit, black-tailed godwit, Asian dowitcher
Along sandy sea edges or near tidal creeks	Tactile hunters of microbenthos	Curlew sandpiper, red-necked stint, broad-billed sandpiper, marsh sandpiper, sharp-tailed sandpiper
Reefs or mangrove fringes	Visual hunters of slow surface-dwelling prey	Common sandpiper, sooty oystercatcher, pied oystercatcher, silver gull, ruddy turnstone

Feeding habitat	Feeding guild	Species
Sandier western parts of Roebuck Bay, often near-shore	Visual hunters of small fast prey	Grey plover, red-capped plover, greater sand plover, lesser sand plover, grey-tailed tattler, terek sandpiper
Soft mudflats in north-east Roebuck Bay	Visual hunters of fast large prey	Eastern curlew, whimbrel, greenshank, striated heron and black-necked stork
Soft mudflats in north-east Roebuck Bay	Kleptoparasites	Gull-billed tern (robs large crabs from whimbrels)
Creek-lines in eastern Roebuck Bay	Pelagic hunters of nekton (animals of the pelagic zone) and neuston (animals that live on the surface film)	Black-winged stilt, red-necked avocet, reef egret, little egret, great white egret, white-faced heron, royal spoonbill

The Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015) provides a framework to guide the conservation of migratory shorebirds and their habitat in Australia and, in recognition of their migratory habits, outlines national activities to support their appreciation and conservation throughout the East Asian-Australasian Flyway.

The following migratory shorebird species are subject to the Wildlife Conservation Plan for Migratory Shorebirds 2015.

Table 8-5: Birds subject to the Wildlife Conservation Plan for Migratory Shorebirds 2015

Migratory species	DoEE SPRAT information on distribution within the area of interest
Asian dowitcher	The Asian dowitcher is a regular visitor to the north-west between Port Hedland and Broome. Elsewhere they are sporadic and rare. In the NT, the Asian dowitcher is found in Darwin and Arnhem Land. In WA, the species has been recorded at Albany, Lake McLarty, Lake McLeod, north-east Pilbara and the south-west Kimberley division. It has also been recorded at the Port Hedland Saltworks, Roebuck Bay, Ashmore Reed and Eighty Mile Beach.
Bar-tailed godwit	The bar-tailed godwit has been recorded in the coastal areas of all Australian states. In WA, it is widespread around the coast, from Eyre to Derby, with a few scattered records elsewhere in the Kimberley.
Black-tailed godwit	The black-tailed godwit is found in all states and territories of Australia, however, it prefers coastal regions and the largest populations are found on the north coast between Darwin and Weipa. The population that inhabitats Roebuck Bay is approximately 7,374 (>1% of the species total population).
Broad-billed sandpiper	In WA, few records occur in the south-west, but the broad-billed sandpiper may be regular in small numbers at scattered locations, from Warden Lake Nature Reserve and Coramup Creek to Guraga Lake Nature Reserve and Hurstview Lake. Individuals mostly occur on the coasts of the Pilbara and Kimberley between Onslow and Broome, but are also recorded north to the mouth of Lawley River, and inland at Lake Daley.
Common greenshank	The common greenshank occurs around most of the coast from Cape Arid in the south to Carnarvon in the north-west. In the Kimberley region, it is recorded in the south-west and the north-east, with isolated records from the Bonaparte Archipelago. WA has three sites of international importance for the common greenshank which include: + Eighty Mile Beach (2,240 individuals); + Wilson Inlet (568 individuals); and + Roebuck Bay (560 individuals).
Common redshank	In Western Australia (WA), the species is vagrant to the south-west with records at Peel Inlet, Coodanup, the Gascoyne region, Coral Bay and Carnarvon.
Common sandpiper	WA distribution includes:

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ Roebuck Bay; and + Nuytsland Nature Reserve.
Double-banded plover	The double-banded plover can be found in both coastal and inland areas. There are no nationally significant sites within WA.
Fork-tailed swift	In WA, there are sparsely scattered records of the fork-tailed swift along the south coast, ranging from near the Eyre Bird Observatory and west to Denmark. They are widespread in coastal and subcoastal areas between Augusta and Carnarvon, including some on nearshore and offshore islands. They are scattered along the coast from south-west Pilbara to the north and east Kimberley region, near Wyndham. There are sparsely scattered inland records, especially in the Wheatbelt, from Lake Annean and Wittenoom. They are found in the north and north-west Gascoyne Region, north through much of the Pilbara Region, and the south and east Kimberley (Higgins 1999).
Great knot	The great knot has been recorded around the entirety of the Australian coast, with a few scattered records inland. The greatest numbers are found in northern Australia; where the species is common on the coasts of the Pilbara and Kimberley, from the Dampier Archipelago to the Northern Territory border. Important sites for great knot in Western Australia include: + Eighty Mile Beach (169,044 individuals); and + Roebuck Bay (22,600 individuals).
Greater sand plover	In Australia, the greater sand plover occurs in coastal areas in all states, though the greatest numbers occur in northern Australia, especially the north-west. In northern Australia, the species is especially widespread between North West Cape and Roebuck Bay in Western Australia and are sparsely scattered records from the largely inaccessible area between Roebuck Bay and Darwin. Internationally important sites within Western Australia include: + Eighty Mile Beach (64,548 individuals); + Roebuck Bay (26,900 individuals); and + Ashmore Reef (1,196 individuals).
Grey plover	In Australia, the grey plover has been recorded in all states, where it is found along the coasts and are recorded frequently between Albany and the northern Kimberley coast. Internationally important sites include: + Eighty Mile Beach (1,650 individuals); + Roebuck Bay (1,300 individuals); + Peel Inlet (600 individuals); and + Nuytsland Nature Reserve (409 individuals).
Grey-tailed tattler	There are a few scattered records for the species along the south coast near the Eyre Bird Observatory, Point Malcolm, Rossiter Bay, Shark Lake Nature Reserve and surrounding swampland. It is found in the south-west between Augusta and Cervantes. The grey-tailed tattler is widespread from Houtman Abrolhos and the mainland adjacent to the Kimberley Division. It has also been recorded inland at Lake Argyle and on islands off the coast.
Lesser sand plover	Within Australia, the lesser sand-plover is widespread in coastal regions, and has been recorded in all states. It mainly occurs in northern and eastern Australia, in south-eastern parts of the Gulf of Carpentaria, western Cape York Peninsula and islands in Torres Strait, and along the entire east coast, though it occasionally also occurs inland. In Western Australia the following are important sites: + Eighty Mile Beach (1,575 individuals); + Roebuck Bay (1,057 individuals); + Broome (745 individuals); and

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ Port Hedland Saltworks (668 individuals).
Little greenshank	The marsh sandpiper is found on coastal and inland wetlands throughout Australia found mainly on the coast in Western Australia. National sites of importance within Western Australia include: + Port Hedland Saltworks (500 individuals); + Peel inlet (276 individuals); and + Eighty Mile Beach (140 individuals).
Long-toed stint	In Western Australia the species is found mainly along the coast, with a few scattered inland records. On the south coast the Long-toed Stint is found from Esperance to Albany and inland to Lake Cassencarry and Dumbleyung. On the south-west coast the species is known from the Vasse River estuary, Guraga Lake and the Namming Nature Reserve. The species has occasionally been recorded in the Gascoyne Region, around Lake Wooleen, Meeberrie Station and McNeill Claypan. It is widespread around the Pilbara region and the Kimberley Division between Karratha and Wyndham-Kununurra. Inland records include Lake Brown, Hannan Lake, Lake Biolet, Newman Sewage Farm and Lake Gregory.
Oriental plover	Internationally important marine sites: + Eighty Mile Beach (approximately 60,000 birds); and + Roebuck Bay (Approximately 8500 birds).
Oriental pratincole	Internationally important site: + Eighty Mile Beach (2.88 million birds). The species occurs at numerous and widespread sites in northern Australia, especially near the Pilbara and Kimberley coasts of northern WA.
Pacific golden plover	In Western Australia, the species is seldom recorded along the southern or south-western coasts but is more widespread along the Pilbara and Kimberley coasts between North-West Cape. Internationally important sites include Eighty Mile Beach with 440 individuals.
Pectoral sandpiper	In Australasia, the pectoral sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire.
Red knot	The red knot large numbers are regularly recorded in north-west Australia, with 80 Mile Beach and Roebuck Bay being particular strongholds.
Red-necked phalarope	The red-necked phalarope is a regular at the Port Hedland Saltworks and Rottnest Island, Western Australia. The species is also found at the ICI Saltworks in South Australia.
Red-necked stint	The red-necked stint has been recorded in all coastal regions, and found inland in all states when conditions are suitable. The red-necked stint probably travels in flocks and has been observed to feed in dense flocks. The Australian population was estimated at 353,000. Internationally important sites include: + Eighty Mile Beach (60,000 individuals); + Port Hedland Salt Works (23,000 individuals); + Roebuck Bay (19,800 individuals); + Wilson Inlet (15,252 individuals) + Alfred Cove Nature Reserve (10,000 individuals); + Lake Macleod (8,312 individuals); and

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ Peel Inlet (8,063 individuals).
Ruddy turnstone	The ruddy turnstone is widespread within Australia during its non-breeding period of the year. Australian sites of international importance include: + Eighty Mile Beach (3,480 individuals); + Ashmore Reef (2,230 individuals); + Roebuck Bay (2,060 individuals); + Barrow Island (1,733 individuals); and + Lacepede Islands (1,050 individuals).
Ruff (reeve)	In Western Australia the species has been recorded at the lower King River and it is mostly found in the south-west region of the state. It has been sighted at the Vasse River estuary, north to Namming Lake and Lake McLarty. It has been periodically recorded at Port Hedland, Kununurra and the Argyle Diamond Mine. There are unconfirmed reports at Curlewis Camp, Millstream Chichester, Broome and Roebuck Bay.
Sanderling	They occur on most of the coast from Eyre to Derby, and also around Wyndham. They are more often recorded on the south and southwest coasts, north to around southern Shark Bay, with more sparsely scattered records further north in Gascoyne and Pilbara Regions and the Kimberley Division. Important sites include: + Eighty Mile Beach (2,230 individuals); + Ashmore Reef (1,132 individuals); and + Roebuck Bay (1,510 individuals).
Sharp-tailed sandpiper	They are widespread from Cape Arid to Carnarvon, around coastal and subcoastal plains of Pilbara Region to south-west and east Kimberley Division (Higgins & Davies 1996).
Streaked shearwater	Exmouth Gulf to the north.
Terek sandpiper	In Western Australia (WA), the terek sandpiper is rarely seen on the south coast: occasionally around Eyre and several records around Albany. On Swan River plain, it has been recorded between Bunbury and the mouth of the Moore River. The species is widespread in the Pilbara region and Kimberley Division, from Dampier to Wyndham, with occasional records around Shark Bay. Internationally important sites include: + Eighty Mile Beach (8,000 individuals); and + Roebuck Bay (1,840 individuals).
Whimbrel	It is common and widespread from Carnarvon to the north-east Kimberley Division, Western Australia. It is occasionally seen on the south coast of Western Australia and has occasionally been recorded in south-west Western Australia and further north to Shark Bay.
Wood sandpiper	The wood sandpiper has its largest numbers recorded in north-west Australia, with all areas of national importance located in Western-Australia: + Parry Floodplain (Wyndham) (355 individuals) + Camballin (185 individuals) + Lake Argyle (90 individuals) + Shark Bay area, (80 individuals) + Vasse-Wonnerup estuary (61 individuals) + Lake McLarty (64 individuals); and + Kogolup Lakes (60 Individuals)

Shorebird migration patterns are seasonal and vary according to species (DSEWPaC 2012). Generally, shorebirds migrate to northern Australia in August to November. Many birds remain in northern Australia but others disperse southwards (Bennelongia 2011). Migratory shorebird numbers on northern beaches peak in November then again in March as the majority of birds begin their return to the northern hemisphere between March and May. Most migratory shorebirds do not breed in Australia and juvenile birds may spend several years in Australia before reaching maturity and returning north to breed (DEWHA 2009).

8.4 Biologically Important Areas / Habitat Critical – Birds

Table 8-6 below provides an overview of BIAs in the EMBA for birds. The DAWE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[7].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Table 8-6: Biologically important areas - birds

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Australian fairy tern	*Sternula nereis*	Foraging – Kimberley, Pilbara and Gascoyne coasts and islands	Found in the vicinity of lower north-west coast (north to Dampier Archipelago), west coast (south to Peel Inlet) and south coast (from Flinders Bay east to Israelite Bay), including islands (as far offshore as Trimouille Island and Houtman Abrolhos. Pilbara and Gascoyne coasts and islands
Australian lesser noddy	*Anous tenuirorstris melanops*	Foraging - Houtman Abrolhos Islands	Houtman Abrolhos Islands
Bridled tern	*Sterna anaethetus*	Foraging - West coast of Western Australia and around to Recherche Archipelago	West coast of WA and around to Recherche Archipelago including offshore waters
Brown Booby	*Sula leucogaster*	Breeding, foraging - Kimberley and northern Pilbara coasts and islands also Ashmore Reef.	Kimberley and northern Pilbara coasts and islands also Ashmore Reef.
Caspian tern	*Sterna caspia*	Foraging - mainly islands (as far offshore as Adele, Bedout, Trimouille and the Houtman Abrolhos)	In WA found on most coasts, mainly islands (as far offshore as Adele, Bedout, Trimouille and the Houtman Abrolhos) and at Lake Argyle, Lake Gregory and Lake MacLeod; accidental elsewhere in the interior.
Common noddy	*Anous stolidus*	Foraging	Around Houtman Abrolhos Around Lancelin Island
Flesh footed shearwater	*Ardenna carneipes*	Foraging, aggregation (pre-migration) - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Foraging from Cape Naturaliste to Eyre, 1-150 km offshore. Pre-departure zone in some years from Rottnest Island to Bunbury.

[7] Further background information on BIA and identification of critical habitat in recovery plans is provided in Section 5.4.

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Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Greater frigatebird	*Fregata minor*	Breeding, foraging - Kimberley and Ashmore Reef	Kimberley and Ashmore Reef
Great-winged petrel	*Pterodroma macroptera*	Foraging - Offshore south of Shark Bay	Offshore south of Shark Bay, extending around south-west corner of WA and east past Kangaroo Island
Indian Yellow-nosed Albatross	*Thalassarche carteri*	Foraging - south-west marine region, north to Shark Bay and extending east into Bass Strait	Throughout offshore waters of south-west marine region, north to Shark Bay and extending east into Bass Strait
Lesser crested tern	*Sterna bengalensis*	Breeding, foraging - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef
Lesser frigatebird	*Fregata ariel*	Breeding, foraging – Kimberley and Pilbara coasts and islands also Ashmore Reef.	Kimberley and Pilbara coasts and islands also Ashmore Reef.
Little penguin	*Eudyptula minor*	Foraging - Perth to Bunbury	Perth to Bunbury
Little shearwater	*Puffinus assimilis*	Foraging - From Kalbarri to Eucla	From Kalbarri to Eucla including offshore waters
Little tern	*Sternula albifrons*	Breeding, foraging, resting - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef Resting - Roebuck Bay	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef Roebuck Bay Ramsar site
Pacific gull	*Larus pacificus*	Foraging –west coast and islands	West coast and islands from Point Quobba (24º30'S) south to Wedge Island (formerly south to Warnbro Sound and at Cape Naturaliste); casual further north (Point Cloates and Lake MacLeod).
Red-footed Booby	*Sula sula*	Breeding, foraging - north west Kimberley and Ashmore reef	North west Kimberley and Ashmore reef
Roseate tern	*Sterna dougallii*	Breeding, foraging – Islands and coastline in the Kimberley, Pilbara and Gascoyne regions Resting – Eighty Mile Beach	Eighty Mile Beach (northern end) Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef Low Rocks and Stern Island in Admiralty Gulf North-east and North-west Twin Islets near the mouth of King sound North-western and west coasts and islands from Sir Graham Moore Is (13º50'S), south to Mandurah (32º32'S) and as far offshore as Ashmore Reef, Bedout Island and the Houtman Abrolhos.
Soft plumage petrel	*Pterodroma mollis*	Foraging - seas north to 21º30'S	In WA found in seas north to 21º30'S.

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Sooty tern	*Sterna fuscata*	Foraging – Timor sea	Timor Sea S to 14º30, off northwest coast from Lacepede I SW to 117ºE including Abrolhos, Fisherman & Lancelin Is, accidental on lower west coast to Hamelin Bay. Breeding visitor (late Aug - early May) Abrolhos & Lancelin Is; casual winter (Nov - Apr) to Fisherman
Wedge-tailed shearwater	*Ardenna pacifica*	Breeding, foraging – west coast from Ashmore Reef to Carnac I. Kimberley, Pilbara, Gascoyne coasts, Ashmore reef	Breeding (in hundreds of thousands) off west coast from Ashmore Reef (12º15'S) to Carnac Island (32º07'S), and ranging in western seas between 12º00'S and 33º20'S. Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef
White-faced storm petrel	*Pelagodroma marina*	Foraging (in high numbers) - Offshore areas of the south-west marine region and into the adjacent south-east marine region and the north-west marine region to north of Shark Bay	Offshore areas of the south-west marine region and into the adjacent south-east marine region and the north-west marine region to north of Shark Bay
White-tailed tropic bird	*Phaethon lepturus*	Breeding, foraging - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef

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9. Protected Areas

A number of areas in the EMBA are protected under state and federal legislation. Protected areas include World Heritage Areas, Wetlands of International Importance (Ramsar), Wetlands of National Importance, National and Commonwealth Heritage Places, and terrestrial conservation reserves (National Parks, Nature Reserves and Conservation Parks) that bound marine waters. These areas are listed in **Table 9-1**, and shown in **Figure 9-1**, **Figure 9-2** and **Figure 9-3**, and discussed below. Other protected areas include Key Ecological Features (discussed in **Section 10**) and State and Commonwealth Marine Parks/Reserves (discussed in **Section 11** and **Section 12**). A Protected Matters search of the EMBA (**Appendix A**) identified several protected areas which were deemed to be irrelevant to Santos WA's petroleum activities due to their terrestrial location (e.g. Forrestdale and Thomsons Lakes – Ramsar wetland).

The Register of the National Estate (RNE) provides a listing of more than 13,000 natural, historic and indigenous sites of significance. However, in 2012 all references to the RNE were removed from the EPBC Act and the *Australian Heritage Council Act 2003*.The RNE is now maintained on a non-statutory basis as a publicly available archive and educational resource. A protected matters search of the area from the South Australian border to the NT border listed 197 places on the RNE, although it is recognised that not all indigenous sites may be listed (**Appendix A**). The RNE places are not discussed further here but are listed in **Appendix A**.

Table 9-1: Summary of protected areas in waters within the EMBA

Area type	Title
World Heritage Area	Shark Bay
	The Ningaloo Coast
Wetland of International Importance (Ramsar)	Eighty Mile Beach
	Roebuck Bay
	Ashmore Reef National Nature Reserve
	Becher Point
	Peel-Yalgorup System
	Vasse-Wonnerup System
	Hosnies Spring
	The Dales
Wetlands of National Importance	Ashmore Reef
	Mermaid Reef
	Vasse-Wonnerup Wetland System
National Heritage Place	HMAS Sydney II and HSK Kormoran Shipwreck Sites
	Batavia Shipwreck Site and Survivor Camps Area 1629- Houtman Abrolhos
	The West Kimberley
	The Ningaloo Coast
	Shark Bay
	Dirk Hartog Landing Site 1616 - Cape Inscription Area
	Dampier Archipelago (including Burrup Peninsula)
	Fitzgerald River National Park
	Lesueur National Park

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Area type	Title
Commonwealth Heritage Place	HMAS Sydney II and HSK Kormoral Shipwreck Sites
	Ningaloo Marine Area - Commonwealth Waters
	Mermaid Reef - Rowley Shoals
	Ashmore Reef National Nature Reserve
	Scott Reef and Surrounds – Commonwealth Area
	Garden Island
	Christmas Island Natural Areas
	Yampi Defence Area
	Learnmonth Air Weapons Range Facility
	Lancelin Defence Training Area
Threatened Ecological Communities	Monsoon Vine Thickets on the ridge on the coastal sand dunes of Dampier Peninsula
	Roebuck Bay mudflats
	Subtropical and Temperate Coastal Saltmarsh
Terrestrial Conservation Reserves e.g. national parks, nature reserves, and conservation parks.	Numerous bounding marine waters – refer to **Section 9.6.**

9.1 World Heritage Areas

There are two World Heritage Areas located in marine waters of WA, both of which occur in the waters from the South Australian border to the NT border: the Ningaloo Coast and Shark Bay (DEC 2012).

9.1.1 Shark Bay

Shark Bay was included on the World Heritage List in 1991 and is one of the few properties inscribed for all four outstanding natural universal values:

+ An outstanding example representing the major stages in the earth's evolutionary history;
+ An outstanding example representing significant ongoing ecological and biological processes;
+ An example of superlative natural phenomena; and
+ Containing important and significant habitats for in situ conservation of biological diversity.

Since 1997, an agreement established the joint management of the Shark Bay WHA by the Australian Commonwealth government and the Western Australian state government, with the operational responsibility by the Western Australian agencies (DEWHA 2008a). This agreement also created a Community Consultative Committee and a Scientific Advisory Committee, both of which provide advice as required. The entire WHA encompasses islands and peninsulas, with an area of approximately 2.2 million hectares (70% of which is marine waters), and includes the following areas (UNESCO 2020):

+ Hamelin Pool Marine Nature Reserve;
+ Francois Peron National Park;
+ Shell Beach Conservation Park;
+ Monkey Mia Reserve;

+ Monkey Mia Conservation Park;
+ Zuytdorp Nature Reserve;
+ Bernier, Dorre and Koks Islands Nature Reserves;
+ Dirk Hartog Island National Park; and
+ Various pastoral leases.

The marine environment of the Shark Bay World Heritage Area is protected as a State Marine Reserve and is discussed further in **Section 11.1.3**.

9.1.2 The Ningaloo Coast

The Ningaloo Coast was included on the World Heritage List in 2011 and was inscribed for outstanding natural universal values as follows:

+ An example of superlative natural phenomena and areas of exceptional natural beauty and aesthetic importance;
+ outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features; and
+ the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The Ningaloo Coast WHA includes (DEWHA 2010b):

+ Ningaloo Marine Park (Commonwealth waters);
+ Ningaloo Marine Park (Western Australia state waters);
+ Muiron Island Marine Management Area (including the Muiron Islands);
+ Jurabi Coastal Park;
+ Bundegi Coastal Park;
+ Cape Range National Park; and
+ Learmonth Air Weapons Range.

The Ningaloo Coast World Heritage Area (including the Muiron Islands) is managed under a plan that is consistent with the World Heritage Convention and Australia's World Heritage management principles. World Heritage Management principles are set out in regulations and cover matters relevant to the preparation of management plans, the environmental assessment of actions that may affect the property and community consultation processes.

The Australian World Heritage management principles are outlined under Schedule 5 of the EPBC regulations (2000). The objective is to ensure that any likely impact of an action on the World Heritage values of the property should be considered. Any action should be consistent with the protection, conservation, presentation or transmission to future generations of the World Heritage values of the property.

The marine environment of the Ningaloo Coast World Heritage Area is protected as a State Marine Park, a Commonwealth Marine Park, and is discussed further in **Section 11.1.4** and **Section 12.3.4**, respectively.

9.2 Wetlands of International Importance (Ramsar)

There are nine wetlands of international importance (Ramsar wetlands) in waters from the South Australian border to the NT border; all were listed in 1990 with the exception of Becher Point which was listed in 2001 and The Dales which was listed in 2002. The Ashmore Reef National Nature Reserve (listed in 2002) is also a Commonwealth Marine Park and is discussed further in **Section 12.3.12.**

9.2.1 Eighty Mile Beach

The Eighty Mile Beach Ramsar site comprises a 220 km beach between Port Hedland and Broome with extensive intertidal mudflats and Mandora Salt Marsh, located 40 km east (Hale & Butcher 2009) totalling 175,487 ha. Eighty Mile Beach is characterised by extensive mudflats supporting an abundance of macroinvertebrates which provide food for large numbers of shorebirds.

Eighty Mile Beach is one of the most important sites for migratory shorebirds in the East Asian Australasian Flyway, with 42 migratory shorebird species recorded at this location. It is estimated that 500,000 shorebirds use Eighty Mile Beach as a migration terminus annually (Hale and Butcher 2009), and more than 472,000 migratory waders have been counted on the mudflats during the September to November period. The location of Eighty Mile Beach makes it a primary staging area for many migratory shorebirds on their way to and from Alaska and eastern Siberia (Hale & Butcher 2009). Although many birds move further on their journey, others remain at the site for the non-breeding period.

Eighty-mile Beach supports more than one per cent of the flyway population (or one per cent of the Australian population for resident species) of 21 waterbirds, including 17 migratory species and four Australian residents. It is one of the most important sites in the world for the migration of Great Knot.

Eighty Mile Beach also supports a high diversity and abundance of wetland birds. A total of 97 wetland bird species have been recorded within the beach portion of the Ramsar site (Hale & Butcher 2009). This includes 42 species that are listed under international migratory agreements CAMBA (38), JAMBA (38) and ROKAMBA (32) as well as an additional 22 Australian species that are listed under the EPBC Act. In addition, there is a single record for Nordmann's Greenshank (*Tringa guttifer*) from the beach, which is listed as endangered under the IUCN Red List (IUCN 2019).

The Mandora Salt Marsh area contains an important and rare group of wetlands (Lake Walyarta and East Lake), including raised peat bogs, a series of small permanent mound springs and the most inland occurrence of mangroves in WA (Hale & Butcher 2009). A small number of tidal creeks dissect the beach, including Salt Creek which is fed partly from groundwater and has permanent surface water. The Mandora Salt Marsh lakes fill predominantly from rainfall and runoff in the wet season then dry back to clay beds. The mound springs likely come from water deep within the Broome sandstone aquifer rising through fractures in the rock, and resulting in permanent mostly freshwater surface water. Flatback turtles (*Natator depressus*), listed as vulnerable under the EPBC Act, regularly nest at scattered locations along Eighty Mile Beach.

Eighty Mile Beach is used for beach based recreation, including four-wheel driving, motorcycling, fishing and shell collecting. Mandora Salt Marsh is mainly used for cattle grazing. The site is traditionally part of Karajarri Country in the north, Nyangumarta Country in the south and Ngarla Country in the southern end of Eighty Mile Beach. The site has artefacts such as middens, pinka (large baler shells used to scoop and carry water for drinking), wilura (used for sharpening spear heads), axes, and flakes, and kurtanyanu and jungari (grinding stones).

9.2.2 Roebuck Bay

The Roebuck Bay Ramsar site is located at Roebuck Bay near Broome in northern WA totalling 34,119 ha. Roebuck Bay has a large tidal range which exposes around 160 km^2 of mudflat, covering most of the Ramsar site (DoE 2014c). Waters more than 6 m deep at low tide are excluded from the site (Bennelongia 2009). The eastern edge of the site is made up of microscale linear tidal creeks (DoE 2014c).

The intertidal mud and sand flats support a high abundance of bottom dwelling invertebrates (between 300—500 benthic invertebrate species), which are a key food source for waterbirds (Bennelongia 2009). The site is one of the most important migration stop-over areas for shorebirds in Australia and globally. For many shorebirds, Roebuck Bay is the first Australian landfall they reach on the East Asian Australasian Flyway. The total numbers of waders using the site each year is estimated at over 300,000 (DoE 2014c). The northern beaches and Bush Point provide important high tide roost sites.

The site receives tidal seawater as well as fresh surface and groundwater, and the balance between the two influences the residual groundwater salinity and the distribution of plants and animals (DoE 2014c). Mangrove swamps line the eastern and southern edges of the site, and extend up into the linear tidal creeks (DoE 2014c). They are important nursery areas for marine fishes and crustaceans, particularly prawns.

Extensive seagrass beds occur in the bay, providing an important feeding ground for dugongs and loggerhead and green turtles (Bennelongia 2009). Flatback turtles nest in small numbers, while marine fish (including sawfish) regularly breed in the tidal creeks and mangroves. Dolphins also regularly use the site (DoE 2014c).

The site is used for recreational or tourism activities such as fishing, crabbing, sightseeing and bird watching. Broome Bird Observatory, a small reserve at the northern end of the site, engages in shorebird research and public education.

Roebuck Bay lies in the traditional estate of Indigenous people belonging to both Jukun and Yawuru groups. The site was an important area for seasonal meetings, exchanging gifts, arranging marriages and settling disputes. Numerous shellfish middens, marking former camping places, can still be seen along coastal cliffs and dunes. Indigenous people continue to make extensive use of Roebuck Bay's natural resources for activities such as gathering shellfish, fishing and hunting.

9.2.3 Ashmore Reef National Nature Reserve

In addition to being listed as a National Nature Reserve, Ashmore Reef has been designated a Ramsar Wetland of International Importance due to the importance of the islands in providing a resting place for migratory shorebirds and supporting large breeding colonies of seabirds (Hale and Butcher, 2013). The reserve provides a staging point for many migratory wading birds from October to November and March to April as part of the migration between Australia and the northern hemisphere (Commonwealth of Australia, 2002). Migratory shorebirds use the reserve’s islands and sand cays as feeding and resting areas during their migration.

Ashmore is the largest of the atolls in the Timor Province bioregion. The three islands within the site are also the only vegetated islands in the bioregion. Each of the wetland types present are in near natural condition and the site has the largest seagrass coverage in the bioregion. The reserve supports 64 species of internationally and nationally threatened species. This includes 41 species of hard reef forming coral, eight fish, six reptiles (including endangered and critically endangered sea turtles and seasnakes), five sea cucumbers, two giant clams, one soft coral and the dugong.

Ashmore Reef plays a primary role in the maintenance of biodiversity in reef systems in the region. The Reserve supports 275 species of reef building coral, 13 species of sea cucumbers, and high numbers of mollusc species. There are over 760 fish species, 13 species of sea snake, 99 species of decapod crustacean and 47 species of waterbird listed as migratory under international treaties. It supports breeding of 20 species of waterbirds including the brown booby, lesser frigatebird, crested tern, bridled tern, sooty tern and common noddy. The Ramsar site is also important for feeding for green turtles, hawksbill turtle and loggerhead turtle and critical nesting and inter-nesting habitats for green and hawksbill turtles.

Ashmore Reef regularly supports more than 20,000 waterbirds and has been known to support more than 65,000 waterbirds. 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.

9.2.4 Becher Point

The Becher Point Wetlands Ramsar site is a system of about sixty small wetlands located near Rockingham in south-west Western Australia and covers 677 ha. The wetlands are made up of chains of small, linear ovoid or irregular shaped basins arranged in five groups, each roughly parallel to the coast and separated by sand ridges (DoE 2014l). The wetlands are an example of shrub swamps and seasonal marshes that have formed in an extensive sequence of inter-dunal depressions that have arisen from seaward advancement of the coastline over recent millennia.

The wetlands in the site are shallow and fill seasonally. Rainfall in winter and spring recharges the groundwater, which rise up to waterlog the wetland basins. The wetlands then dry out again for summer to autumn. When flooded the wetlands are mainly freshwater (DoE 2014l).

The wetlands support sedgelands, herblands, grasslands, open-shrublands and low open-forests. The sedgelands that occur within the linear wetland depressions of the Ramsar site are a nationally listed threatened ecological community. At least four species of amphibians and 21 species of reptiles have been recorded within the wetlands, as well as the Southern Brown Bandicoot (DoE 2014l).

9.2.5 Peel-Yalgorup System

The Peel-Yalgorup System located adjacent to the city of Mandurah in Western Australia, is a large and diverse system of shallow estuaries, coastal saline lakes and freshwater marshes. The site includes the Peel Inlet, Harvey Estuary, Lake McLarty, Lake Mealup and ten Yalgorup National Park wetlands and covers an area of 26, 530 ha (DoE 2014m). Lake Clifton, which is part of the wetlands is one of the few locations in the word where thrombolites occur in inland, hyposaline waters. Thrombalites are underwater rock-like structures that are formed by the activities of microbial communities.

The Peel-Yalgorup System Ramsar site is the most important area for waterbirds in south-western Australia, supporting in excess of 20,000 waterbirds annually (DoE 2014m). It also supports a wide variety of invertebrates and estuarine and marine fish.

9.2.6 Vasse-Wonnerup System

The Vasse-Wonnerup System Ramsar wetland is situated in the Perth Basin, south-western Western Australia and covers an area of 1,115 ha. It is an extensive, shallow, nutrient-enriched wetland system of highly varied salinities. The site is located on a narrow, flat plain separated from the ocean by a narrow system of low dunes. The system is comprised of two former estuaries – the Vasse and Wonnerup lagoons (DoE 2014n).

The system supports tens of thousands of resident and migrant waterbirds of a wide variety of species. More than 33,000 waterbirds have been counted at the Vasse-Wonnerup System and more than 80 species have been recorded in the System including Red-necked Avocets and Black-winged Stilts, Wood Sandpiper, Sharp tailed Sandpiper, Long-toed Stint, Curlew Sandpiper and Common Greenshank (DoE 2014n).

9.2.7 Hosnies Spring

The Hosnies Spring Ramsar site is located on Christmas Island and is a small area of shallow freshwater streams and seepages, 20–45 metres above sea-level on the shore terrace of the east coast of the island covering an area of approximately 199 ha. The site includes surrounding terrestrial areas with rainforest grading to coastal scrub, and includes an area of shoreline and coral reef (DoEE 2019).

The Hosnies Spring Ramsar site supports a unique wetland of Christmas Island with the mangrove forest present at the site unique within the bioregion and possibly worldwide. The two species of mangroves that make up the stand, which normally grow intertidally, grow to a height of 24–37 m above sea level that have been estimated to have persisted for 120,000 years. Additionally, the site is important to blue crabs which rely on the freshwater provided by the spring and as a likely migratory route for the endemic red crab during breeding migrations (DoEE 2019).

9.2.8 The Dales

The Dales Ramsar site is located on Christmas Island and is comprised of a near-pristine system of seven watercourses collectively known as The Dales and covers an area of 585 ha. The Dales includes permanent and perennial streams, permanent springs, and include the majority of surface water on the Island. Most rainfall on Christmas Island filters down through the soil and limestone, and surface runoff only occurs after heavy rain. The Dales contain numerous wetland types including surface and karst features, and inland and coastal wetlands (DoEE 2019a).

The Dales support a number of unique ecological and geomorphic features including anchialine cave communities, surface karst including the unique stepped tufa deposits at Hugh's waterfall, a stand of Tahitian chestnuts, a large number of endemic terrestrial species and a significant number of seabirds including Abbott's booby, red-footed booby and the brown booby, all of which breed at the site, and provide essential habitat for the Christmas Island frigatebird (DoEE 2019a).

9.3 Wetlands of National Importance

9.3.1 Ashmore Reef

See the Ashmore Reef National Nature Reserve (**Section 9.2.3**) and Ashmore Reef Marine Park (**Section 12.3.12**).

9.3.2 Mermaid Reef

See the Mermaid Reef Marine Park (**Section 12.3.9**).

9.3.3 Vasse-Wonnerup Wetland System

See the Vasse-Wonnerup Wetland System (**Section 9.2.6**).

9.3.4 "The Dales", Christmas Island

See The Dales Ramsar site (**Section 9.2.8**).

9.3.5 Eighty Mile Beach System

See Eighty Mile Beach Ramsar site (**Section 9.2.1**).

9.3.6 Exmouth Gulf East

The Exmouth Gulf East wetlands are located in the eastern section of Exmouth Gulf from Giralia Bay to Urala Creek Locker Point. The wetland comprises of numerous tidal creeks, indentations and islands of dry land, mudflats, saline coastal flats and extensive mangroves (DAWE 2020a).

The site is one of the major population centres for dugongs in WA and its seagrass beds and extensive mangroves provide nursery and feeding areas for marine fishes and crustaceans in the Gulf. In addition there are at least 29 species of birds which utilise the wetland, including 16 migratory shorebirds and several terns (DAWE 2020a).

9.3.7 Hosine's Spring, Christmas Island

See Hosine's Spring Ramsar site (**Section 9.2.7**).

9.3.8 Hutt Lagoon System

The Hutt Lagoon System wetlands (3,000 ha) are located within the Geraldton Sandplains and comprises of Hutt Lagoon and the lakes and marshes immediately north-west and south-east of the lagoon, notably Utcha Swamp. The system is a coastal brine lake which runs parallel to the coast (DAWE 2020b).

Hutt Lagoon is a migratory stop-over for migratory waders, however numbers using the area vary greatly between years and are likely to be lower when northern and inland waterbodies are extensively flooded. Breeding shorebirds include the Australasian grebe (*Tachybaptus novaehollandiae*), grey teal (*Anas gibberifrons*) and eurasian coot (*Fulica atra*) at Utcha Swamp (DAWE 2020b).

9.3.9 Lake Macleod

The Lake Macleod wetland (150,000 ha) is located in the Carnarvon bioregion and includes distinct "inner wetlands" (sinkholes, channels, lakes, marshes) in the west and "floodout marshes" at river mouths in the north-east. The wetland also includes a lake bed that is infrequently inundated. The lake lies parallel to the Indian Ocean, north of the Gascoyne River and located 30 km away from Shark Bay East wetland(DAWE 2020c).

The Lake Macleod is a major migration stop-over and drought refuge area for shorebirds; it is one of the most important non-tidal stop-over sites in Australia. It also supports Australia's largest inland community of mangroves and associated fauna. Fifty-eight species have been identified within the wetland with 29 being shorebirds and eight gulls and terns, with seven species found breeding (DAWE 2020c).

9.3.10 Lake Thetis

The Lake Thetis wetland (7 ha) is located in the Swan bioregion and comprises of seasonal marshes that form in interdunal areas to the south of the lake. Lake Thetis is distinguished by the presence of both a variety of benthic microbial communities (mats) and stromatolites. No threatened species or migratory species have been observed to utilise this wetland (DAWE 2020d).

9.3.11 Learmonth Air Weapons Range – Saline Coastal Flats

The Learmonth Air Weapons Range – Saline Coastal Flats wetland (300 ha) represents typical saline coastal flats subject to inundation and ponding. The vegetation typically has a low species richness, but its floristic composition and structure is highly distinctive and supports habitat specific fauna (DAWE 2020e).

Species composition of the wetland has little information however it is likely to possess a relatively diverse community (DAWE 2020e).

9.3.12 Leslie (Port Hedland) Saltfields System

The Leslie (Port Hedland) Saltfields System (13,000 ha) comprises a large saltfield, fringing coastal flats, tidal creeks and mudflats between the saltfields and the Indian Ocean.

The wetland is likely a major migration stop-over area for shorebirds in the East Asia-Australasia Flyway. It is possibly the most important stop-over site in the Flyway for the broad-billed sandpiper (*Limicola falcinellus*) and an important site for oriental plover (*Charadrius veredus*). It is also likely to be the most important site in Australia for Asian dowitcher (*Limnodromus semipalmatus*) and red-necked phalarope (*Phalaropus lobatus*) (DAWE 2020f).

9.3.13 Prince Regent River System

The site comprises of the entire Prince Regent River system and large areas of mangrove on either side of the river mouth in Saint George Basin (14,300 ha). The site is a tropical estuary and river system incised in a plateau, and is characterised by mangrove-fringed embayments (DAWE 2020g).

The site comprises of a diverse assemblage of flora and fauna, and includes mangroves, riverine vegetation, waterbirds, frogs, reptiles and fish. The site includes some of the most suitable and extensive breeding habitat for the saltwater crocodile in WA, well developed river banks with thick stands of reed and grasses (DAWE 2020g).

9.3.14 Roebuck Bay

See Roebuck Bay Ramsar site (**Section 9.2.2**).

9.3.15 Rottnest Island Lakes

The Rottnest Island Lakes wetland site comprises of a cluster of 18 lakes and swamps on the north-east part of Rottnest Island (180 ha). The site is a breeding area for Australian shelduck (*Tadorna tadornoides*) and major breeding area for fairy tern (*Sterna nereis*). The lakes are also a major migration stop-over area for shorebirds in south-western Australia and provide a significant drought refuge area for shorebirds, notably the banded stilt (*Cladorhynchus leucocephalus*) (DAWE 2020h).

9.3.16 Shark Bay East

The Shark Bay East wetland site extends along 250 km of coastline in the east arm of Shark Bay, from the mouth of the Gascoyne River (Carnarvon) south to latitude 26 S. The site comprises tidal wetlands and marine waters that are less than 6 m deep at low tide (up to approximately 10 km from shore). The wetland is a large, shallow marine embayment that support extensive seagrass beds and substantial areas of intertidal mud/sand-flats and mangrove swamp (DAWE 2020i).

The mangroves, algae and seagrasses present at the side are important for both dugongs and green turtles. A total of 69 species have been identified within the wetland including the threatened little tern (*Sterna albifrons*) and 33 shorebirds. A total of six species have been identified to be breeding within the wetland (Australian pelican, great egret, little egret, unidentified cormorants and striated herons). The site is also a stop-over for 24 species of migratory shorebirds (DAWE 2020i).

9.3.17 Cape Leeuwin System

The Cape Leeuwin System site is a small coastal valley, approximately 20 ha in size. Seepage from a series of freshwater springs feed an elongate swamp on the floor of the valley and moistens areas of the limestone and granite coastline to the west (DAWE 2020j). The site has been identified as the habitat for the largest known population of the rare aquatic gastropod mollusc; the Cape Leeuwin freshwater snail (*Austroassiminea letha* (Sr)) (DAWE 2020j).

9.3.18 Doggerup Creek System

The Doggerup Creek System site (2,500 ha) supports extensive flats subject to inundation in the north and east of its catchment. The sites includes lakes (e.g. Doggerup, Samuel and Florence Lakes) and many small unnamed swamps. The site is an example of an `acid peat flat' with small permanent lakes and river (DAWE 2020k).

The wetland plant communities include 32 species at Doggerup Lake, 19 at Lake Samuel and 35 at Lake Florence. The site is a major habitat for two aestivating inland fishes, *Galaxiella nigrostriata* and *Lepidogalaxias salamandroides*, that are endemic to the far south coast of WA. No threatened species have been identified within the site and it is not considered to be an important wetland for migratory shorebirds (DAWE 2020k).

9.3.19 Cape Range Subterranean Waterways

The Cape Range Subterranean Waterways wetland site comprises of the subterranean waterways, sinkholes, general groundwater and artificial wells of the coastal plain and foothills of Cape Range north of a line between Norwegian Bay, at the foot of the peninsula on the west coast, and the Bay of Rest in Exmouth Gulf (DAWE 2020l).

The site is one of the only examples of subterranean karst wetland system (apart from Barrow Island) in arid north-western Australia. Two threatened species have been identified within the wetland and include the blind cave eel and the blind gudgeon (DAWE 2020l).

9.3.20 Yalgorup System

See Peel-Yalgorup System Ramsar site (**Section 9.2.5**).

9.4 National Heritage Places

Natural, historic and indigenous places that are of outstanding heritage value to the Australian nation are recorded as National Heritage Places. Eleven National Heritage Places are found in waters from the South Australian border to the NT border, with nine od these occurring within the EMBA. Shark Bay and The Ningaloo Coast are listed as both World Heritage Areas and National Heritage Places, and are discussed in **Section 9.1**.

9.4.1 HMAS Sydney II and HSK Kormoran Shipwreck Sites

The naval battle fought in 1941 between the Australian warship HMAS Sydney II and the German commerce raider HSK Kormoran off the Western Australian coast during World War **II** was a defining event in Australia's cultural history. The loss of HMAS Sydney II, along with its entire crew of 645 following the battle with HSK Kormoran, remains Australia's worst naval disaster (DoE 2014d).

The shipwreck sites are comprised of two areas located approximately 290 km west-southwest of Carnarvon. The shipwrecks of the HMAS Sydney II and HSK Kormoran are located on the seabed approximately 22 km apart (DoE 2014d).

9.4.2 Batavia Shipwreck site and Survivor Camps Area 1629 - Houtman Abrolhos

The Batavia was included on the National Heritage List in 2006. This shipwreck is the oldest of the known Verenigde Oost-Indische Compagnie (VOC) wrecks on the WA coast and has a unique place in Australian shipwrecks. Because of its relatively undisturbed nature the archaeological investigation of the wreck itself has revealed a range of objects of considerable value to the artefact specialist and historian. The recovered sections of the hull of the Batavia that have been reconstructed in the Western Australian Maritime Museum and provides information on 17th century Dutch ship building techniques, while the remains of the cargo carried by the vessel have provided economic, and social evidence of the operation of the Dutch port at Batavia (now Jakarta) in the early 17th century (DoE 2014d).

9.4.3 The West Kimberley

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 (DoE 2014d). Of these values, the most relevant to the marine environment is Roebuck Bay as a migratory hub for shorebirds. These values are discussed in **Section 9.2.2**. The area is characterised by a diversity of landscapes and biological richness found in its cliffs, headlands, sandy beaches, rivers, waterfalls and islands.

9.4.4 The Ningaloo Coast

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.4.5 Shark Bay

See Shark Bay World Heritage Area (**Section 9.1.1**).

9.4.6 Dirk Hartog Landing Site 1616 - Cape Inscription Area

Cape Inscription is the site of the oldest known landings of Europeans on the Western Australian coastline (from Dirk Hartog of the Dutch East India Company's ship the Eendracht in October 1616), and is associated with a series of landings and surveys by notable explorers over a 250-year period (DoEE 2019b). The landing site forms part of the Dirk Hartog Island, and is about 1,110 ha located 100 km south west of Carnarvon (DoEE 2019b).

9.4.7 Dampier Archipelago (including Burrup Peninsula)

The Dampier Archipelago (including the Burrup Peninsula) contains one of the densest concentrations of rock engravings in Australia, with some sites containing thousands or tens of thousands of images. At a national level it has an exceptionally diverse and dynamic range of schematised human figures, and provides an unusual and outstanding visual record of the Aboriginal responses to the rise of sea levels at the end of the last Ice Age (DoEE 2019c).

The site is about 36,860 ha at Dampier and comprises of nine distinct areas of the Burrup Peninsula Areas and part of the following surrounding islands: West Intercourse Island, West Mid Intercourse Island, Enderby Island, Goodwin Island, West Lewis Island and East Lewis Island, Rosemary Island, Brigadier Island, Miller Rocks, Lady Nora Island and Elphick Nob, Malus Islands, Angel Island, Gidley Island, Cohen Island, Keast Island and Collier Rocks, Tozer Island, Dolphin Island, and Unnamed Island (DoEE 2019c).

9.4.8 Fitzgerald River National Park

The Fitzgerald River National Park contains an exceptional concentration of plant species richness and endemism. At an international level it is recognised as a biodiversity hotspot of south western Australia and at a national level it has an exceptional endemism and diversity for plant species. The diversity is considered high due to a wide range of landforms, geology and soil types that supports a diverse community of shrublands and heath, often dominated by eucalypt mallee species (DoEE 2019d).

The national park is approximately 297,244 ha located between Bremer Bay and Hopetoun in the south west of Western Australia. The park contains extensive marine plain sediments deeply incised by several rivers, creating valleys and tablelands. The park's coastline is diverse, consisting of long beaches, quartzite cliffs, extensive sand drifts and inlets. Along the Hamersley and Fitzgerald River valleys are spongolite cliffs that were formed more than 36 million years ago (Eocene period) and consist of sea sponge fossils (DoEE 2019d)

9.4.9 Lesueur National Park

The Lesueur National Park contains an exceptional concentration of plant species richness and endemism. At an international level it is recognised as a biodiversity hotspot of south western Australia and at a national level it has an exceptional endemism and diversity for plant species. The diversity is considered high due to a wide range of landforms, geology and soil types that supports a diverse community of shrublands and heath (DoEE 2019e).

The national park is approximately 27,235 ha located near the towns of Green Head and Jurien Bay. Coastal areas consist of recent (Holocene) sand deposits and mobile dunes extending inland for approximately two kilometres. The dunes are bordered by a series of mainly saline lakes with some freshwater springs and swamps on the eastern margins. Further inland are older (Quaternary) dune systems that have been compacted in places to form limestone. The park supports approximately 122 birds, including a diverse range of honeyeaters, fairy wrens and thornbills (DoEE 2019e).

9.5 Commonwealth Heritage Places

The Commonwealth Heritage Places List comprises natural, indigenous and historic heritage places which are either entirely within a Commonwealth area, or outside the Australian jurisdiction and owned or leased by the Commonwealth or a Commonwealth Authority. Nine natural Commonwealth Heritage Places are found in or adjacent to the EMBA. Three of these places (Ashmore Reef, Mermaid Reef and the Ningaloo Marine Area – Commonwealth Waters) are found in Marine Parks and are discussed further in **Section 12**. The HMAS Sydney II and HSK Kormoran Shipwreck Sites is listed under both National and Commonwealth Heritage Lists and discussed in **Section 9.4.1**.

9.5.1 Scott Reef and Surrounds – Commonwealth Area

Scott Reef is a large, emergent shelf atoll located on the edge of the broad continental shelf, about 300 km from mainland north-western Australia. The listing comprises the areas of Scott Reef that are within Commonwealth waters to the 50 m BSL bathymetric contour. This includes North Reef, an annular reef, 16.3 km long and 14.4 km wide; and parts of the lagoon of South Reef, a crescent shaped reef 17 km across (DoE 2014d).

The place is regionally significant both because of its high representation of species not found in coastal waters off Western Australia and for the unusual nature of its fauna which has affinities with the oceanic reef habitats of the Indo-West Pacific as well as the reefs of the Indonesian region (DoE 2014d).

9.5.2 Mermaid Reef – Rowley Shoals

See the Mermaid Reef Marine Park (**Section 12.3.9**).

9.5.3 Ningaloo Marine Area – Commonwealth Waters

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.5.4 Ashmore Reef National Nature Reserve

See the Ashmore Reef Marine Park (**Section 12.3.12**).

9.5.5 Garden Island

Garden Island is located to the south of Perth, 5 km northwest of Rockingham. It was registered in 2004 based on various fauna, geological, European and Aboriginal heritage and vegetation values. It was the original first site occupied by Governors Stirling's Party in 1829, with prior use by Aborigines and the French (being called Ile de Buache by the French in 1801). The island is virtually free from widespread feral animal colonisation, providing important habitat for various species that have reduced on the mainland. The island provides breeding habitat for bridled tern (*Sterna anaethetus*), rainbow bee-eaters (*Merops ornatus*) and osprey (*Pandion haliaetus*), which nest on the rocks surrounding the island. Important feeding habitat for the Sanderling (*Calidris alba*) is provided by sandy beaches on the west coast of the island.

The island provides nesting habitat on beaches for the breeding migrant fairy tern (*Sterna nereis*), which requires undisturbed nesting periods. The mature relatively undisturbed heath, scrub and low forest communities unburnt since the 1920's in the northern section of the island are especially important as a reference site for natural history. The least disturbed examples of calcaronite reef structures dune and tamate landscapes in the metropolitan region are present on the western side of the island (DoEE 2016b).

9.5.6 Christmas Island Natural Areas

Christmas Island is located is approximately 1,500 km from Exmouth and is approximately 2,200 ha above Low Water and 3,600 ha below Low Water in the Indian Ocean. The island is an uplifted coral atoll with its characteristic steep series of rainforest-covered terraces and sheer limestone cliffs. It was registered in 2004 based on various fauna, vegetation, geological and cultural heritage values. The evolutionary significance of Christmas Island is demonstrated both by its high level of endemism and by its unique assemblage of plant and animal species. The island hosts seventeen endemic plant species and rich endemic fauna includes three mammal species, ten bird species, five reptile species, one crab species, two insects, three marine fish species and several marine sponge species (DoEE 2019f).

The rainforests of Christmas Island are biogeographically significant; species have evolved from being either shoreline forest or early rainforest succession species to those that fill a tall climax rainforest role. The Island contains unique plant communities of high conservation and scientific interest including a variety of elevated and relict cycad and back-mangrove communities of international significance (DoEE 2019f).

The island is also one of the world's most significant seabird islands, both for the variety and numbers of sea-birds, with over 100 species of bird having been recorded, including eight species that breed on the island. The island rainforest provides significant habitat for two endemics the nationally endangered Abbott's booby and the nationally vulnerable Christmas Island frigate bird (DoEE 2019f).

The fringing simple reefs and adjacent waters of Christmas Island support provides habitat for two nationally vulnerable species of turtle, the green and hawksbill which nest on two of the Island's beaches and two nationally vulnerable shark species (DoEE 2019f).

9.5.7 Yampi Defence Area

The Yampi Defence Area is located at the confluence of the Dampierland, Central and Northern Kimberley biogeographic regions and has a diverse range of ecosystems of landforms, soils and vegetation representative of the transition from the sandstone plateaux of the wetter north-west Kimberley, to the broad plains and pindan scrub of the drier south-west Kimberley (DoEE 2019g).

The diversity of landforms in the place and the resultant high concentration of small refugial habitats support a regionally rich vertebrate fauna. The bird fauna is significant as it represents a suite of species which are at or near the southern edge of their range in the semi-humid zone of the Kimberley. The place is also an important zone of overlap between many northern and southern species and sub-species. The vertebrate fauna shows its closest similarity to those recorded from the wetter areas of the west Kimberley that lie further to the north. The place supports several fauna and flora species that are listed as specially protected, threatened or having priority status in Western Australia in addition to four fauna species that are nationally vulnerable and one nationally endangered (DoEE 2019g).

9.5.8 Learmonth Air Weapons Range Facility

The Learmonth Air Weapons Range Facility is located 30 km south west of Learmonth within Cape Range and Adjacent Coastal Plain, which is listed on the Register of the National Estate. As the Learmonth Air Weapons Range Facility is located within Cape Range it is of considerable importance of showing he sea level and landform changes for the past 1.8 million years (DoEE 2019h).

The area is important to a number of cave fauna of Cape Range and is considered of exceptional biogeographical importance. It hosts a high number of endemic aquatic stygofauna with ecosystems found within this area are considered rare within Western Australia and are considered to be of considerable scientific interest. The area also supports several species of terrestrial fauna that are isolated populations, populations at the extent of their range and a number of fauna and flora species that are endemic to southern WA and restricted to sandy coastal habitats along the western coast (DoEE 2019h).

9.5.9 Lancelin Defence Training Area

The Lancelin Defence Training Area is located approximately 11 k north of Lancelin township situated on the Swan Coastal Plain and consists of three main land systems that include Quindalup and Spearwood Dune Systems (together making up the Coastal Belt), and the Bassendean Dunes (DoEE 2019i).

The area supports a high diversity of vegetation types, flora species, fauna habitat types and a high diversity of terrestrial fauna.

9.6 Coastal Terrestrial Conservations Reserves – bound by marine waters

Conservation reserves are created under the Land Administration Act 1997, and once reserved and set aside for conservation purposes are regulated under the *Conservation and Land Management Act (CALM) 1984*. Most conservation reserves in WA are vested in (owned) by the WA Conservation and Parks Commission, an independent statutory body established by the CALM Act 1984, and most are managed by the Department of Biodiversity, Conservation and Attractions – Parks and Wildlife Service.

In WA there are three main types of terrestrial conservation reserves with legislative protection:

+ Nature reserves – established for wildlife and landscape conservation; scientific study; and preservation of features of archaeological, historic or scientific interest;
+ National parks – as above but also to be used for enjoyment by the public. Have national or international significance; and
+ Conservation parks – as above but have local or regional significance.

Nature reserves can have an extra classification applied to them and become ‘A class’ reserves, which generally require an Act of Parliament to alter.

There are numerous terrestrial conservation reserves located adjacent to the coast in the EMBA. The oceanward boundary of the reserves varies. In some cases, the reserves extend to the low water mark, i.e. including the inter-tidal zone (particularly applicable to older gazetted reserves and terrestrial reserves not surrounded by a marine reserve). While in other cases, the terrestrial reserves extend to the high-water mark e.g. Lowendal Islands Nature Reserve (particularly applicable to terrestrial reserves adjacent to more recently gazetted marine parks). In other cases, the seaward boundary of the reserves is not defined. Management plans also contain the caveat for further consideration of the most appropriate tenure for intertidal areas and management arrangements.

Further information on coastal terrestrial reserves is provided below in **Section 9.6.1** (national parks) and **Section 9.6.2** (nature reserves and conservations parks).

9.6.1 Coastal National Parks

Protected coastal national parks managed under the CALM Act 1984 in the EMBA are listed in **Table 9-2**. The table also includes: any applicable management plan; whether the park includes the inter-tidal area; and the name of any adjacent state marine reserve. All National Parks are WA Class A reserves and IUCN Class 2.

Table 9-2: Coastal National Parks – coastal boundary in relation to inter-tidal zone

National Park	IBRA bioregion[8]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Reserves of Northern WA (see Figure 9-4)				
Lawley River	Northern Kimberley	-	No [9]	Kimberley Marine Park
Mitchell River		-		
Prince Regent		-		
Reserves of North-West WA (see Figure 9-5)				
Murujuga	Pilbara	Murujuga National Park management plan 78 (DEC 2013)	Yes [10]	-
Cape Range	Carnarvon	Cape Range National Park Management Plan (DEC 2010a)	No	Ningaloo Marine Park
Reserves of Southern WA – (see Figure 9-6)				
Francois Peron	Carnarvon	Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan (2012)	No	Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve
Dirk Hartog	Yalgoo		Yes – intertidal zone on western side of Dirk Hartog is included (as no marine park on western side of island)	
Kalbarri	Geraldton Sandplains	Kalbarri National Park Management Plan (DPAW 2015)	Yes [10]	-
Namburg	Geraldton Sandplains	Namburg National Park Management Plan (1998)	Yes	-
Yalgorup	Swan Coastal Plain	Yalgorup National Park Management Plan (CALM 1995)	Yes [10]	-
Leeuwin - Naturaliste	Warren	Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan (DPAW 2015)	No	Ngari Capes Marine Park

[8] IBRA classifies Australia's landscapes into large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (DoEE 2012).

National Park	IBRA bioregion[8]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Torndirrup	Warren	Albany coast draft management plan 2016 (DPaW 2016b)	Yes[10]	
Walpole-Nornalup	Warren	Walpole Wilderness and Adjacent Parks and Reserves Management Plan (DEC 2008) Walpole and Nornalup Inlets Marine Park Management Plan No 62 (DEC 2009b)	Yes[10]	Walpole and Nornalup Inlets Marine Park
Waychinicup	Southern Jarrah Forest and Fitzgerald	Albany coast draft management plan 2016 (DPAW 2016)	Yes[10]	
West Cape Howe	Warren	Albany coast draft management plan 2016 (DPaW 2016)	Yes[10]	
D'Entrecasteaux	Warren	Shannon and D'Entrecasteaux National Parks Management Plan No. 71 (DEC 2012b)	Yes[10]	
Fitzgerald River	Fitzgerald	Fitzgerald River National Park Management Plan 1991 – 2001 No. 15 (CALM 1991)	Yes[10]	

9.6.2 Coastal Nature Reserves and Conservation Parks

Protected coastal nature reserves and conservation parks managed under the CALM Act 1984 in the EMBA are listed in **Table 9-3** and shown in **Figure 9-4**, **Figure 9-5** and **Figure 9-6** for the north, north-west and south of WA respectively. The table also includes: reserve class; IUCN classification; any applicable management plan; whether the reserve includes the inter-tidal area; and the name of any adjacent state marine reserve (may also describe inter-tidal areas values).

The CALM Act does not require management plans to be in place for conservation reserves at all time, instead they are required to be made as is reasonably practicable regarding resources. This means some conservation reserves do not have a management plan, or do not have a recent management plan.

Table 9-3: Nature Reserves (NR) and Conservation Parks (CP) in EMBA

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Reserves of Northern WA (see Figure 9-4)					
Ord River NR	-	1a	-		North Kimberley Marine Park
Pelican Island NR	-	1a			
Lesueur Island NR	A	1a			

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Low Rocks NR	A	1a		No [9]	
Browse Island NR	A	1a	-	Yes [10]	-
Scott Reef NR	-	1a	-	Yes [10]	-
Adele Island NR	A	1a	-	Yes [10]	-
Tanner Island NR	A	1a	-	Yes [10]	-
Lacepede Islands NR		1a	-	Yes [10]	-
Coulomb Point NR	A	1a	-	Yes [10]	-
Yawaru Birragun CP; Yawuru Northern Intertidal Area	- & A	2 & 6	Yawaru Birragun Conservation Park Management Plan (DPaW 2016). *Yawuru Intertidal Area management plan is not yet available*.	Yes	-
Jinmarnkur CP	C	-	Parks and reserves of the south-west Kimberley and north-west Pilbara Draft Management Plan (DPAW 2016). *Covers 80 Mile Beach coastal reserves*.	No	Eighty Mile Beach Marine Park
Jinmarnkur Kulja NR	A	-			
Kujungurru Warrarn NR	A	1a			
Kujungurru Warrarn CP	C	-			
Unnamed	A	-			
Jarrkunpungu NR	A				
Bedout Island NR	A	1a	-	Yes [10]	-
North Turtle Island NR	A	1a	-	Yes [10]	-
Reserves of North-West WA (see Figure 9-5)					
Unnamed (Dampier Archipelago) NR	A	1a	Dampier Achipelago Management Plan (CALM 1990). *Covers 25 of the islands*	Yes	-
Swan Island NR	A	1a	-	Yes[10]	Kimberly Marine Park
Unnamed NR		1a	-	Yes [10]	-
North Sandy Island NR	A	1a	-	Yes [10]	-
Montebello Islands CP	A	2	-	Partially [11]	Montebello Islands Marine Park
Lowendal Island NR		1a	-	No	

[9] Inferred as adjacent marine park boundary is the high water mark and dual tenure cannot exist.

[10] Conservatively inferred as no adjacent Marine Park.

[11] Reserve R42197 includes the inter-tidal zone and reserve R42196 does not.

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Barrow Island NR	A	1a	Barrow Island Group Nature Reserves (DPAW 2015)	Yes	Barrow Island Marine Management Area and Marine Park. Lowendal Island NR only partially bounded
Boodie, Double and Middle Islands NR	-	1a		Yes	
Great Sandy Island NR	B	1a	-	Yes	Barrow Island Marine Management Area
Weld Island NR	-	1a	-	Yes [10]	-
Little Rocky Island NR	A	1a	-	Yes [10]	-
Airlie Island NR	-	1a	-	Yes [10]	-
Thevenard Island Nature	-	1a	-	Yes [10]	-
Bessieres Island NR	A	1a	-	Yes [10]	-
Serrurier Island NR	-	1a	-	Yes [10]	-
Round Island NR	-	1a	-	Yes [10]	-
Locker Island NR	A	1a	-	Yes [10]	-
Rocky Island NR	-	1a	-	Yes [10]	-
Gnandaroo Island NR	A	1a	-	Yes [10]	-
Victor Island NR	-	1a	-	Yes [10]	-
Y Island NR	-	1a	-	Yes [10]	-
Tent Island NR	-	1a	-	Yes [10]	-
Burnside and Simpson Island NR	-	1a	-	Yes [10]	-
Whalebone Island NR		1a	-	Yes [10]	-
Whitmore, Roberts, Doole Islands & Sandalwood Landing NR	-	1a	-	Yes [10]	-
Muiron Islands NR	-	1a	Jarabi and Bundegi Coastal Parks and Muiron Islands (CALM 1999)	No [9]	Muiron Islands Marine Management Area
OneTree Point NR	A	1a	-	Yes [10]	
Reserves of Southern WA – (see Figure 9-6)					
Koks Island NR	A	1a	Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan (DPAW 2012) -	Yes [10]	-
Bernier and Dorre Islands NR	A	4			
Shell Beach CP	-	3		No	Shark Bay Marine Park
Freycinet, Double Islands etc NR	A	1a			Shark Bay Marine Park

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Zuytdorp NR	-	1a		Yes [10]	-
Beekeepers NR	-	1a	-	Yes [10]	-
Beagle Islands NR	A	1a	Turquoise Coast Nature Reserve Management Plan (CALM 2004). *Covers chain of approximately 40 protected islands lying between Lancelin and Dongara.*	Yes	-
Lipfert, Milligan, etc Islands NR	A	1a			-
Fisherman Islands NR	A	1a			Jurien Bay Marine Park: extends from Greenhead south to Wedge Island
Sandland Islands NR	A	1a			
Boullanger, Whitlock, Favourite, Tern and Osprey Islands NR	A	1a			
Escape Island NR	A	1a			
Essex Rocks NR	A	1a			
Outer Rocks NR	A	1a			
Ronsard Rocks NR	A	1a			
Cervantes Islands NR	A	1a			
Buller, Whittell and Green Islands NR	A	1a			
Wedge Island NR	A	1a			
Lancelin and Edwards Islands NR	A	1a			-
Southern Beekeepers NR	-	1a	Namburg National Park Management Plan (CALM 1998)	No	-
Wanagarren NR	-	1a		Yes	
Nilgen NR	-	1a		Yes	
Unnamed CP (R 49994) west of Wilbinga	-	2		Yes [10]	-
Unnamed CR (R 42469) at Woodman Point	-	-	Woodman Park Regional Park Management Plan (DEC 2010b)	No	-
Unnamed CP at Woodman Point (R 49220)	-	2		No	-
Carnac Island NR	A	1a	Carnac Island Nature Reserve Management Plan (CALM 2003)	Yes	-
Penguin Island CP	A	3	Shoalwater Islands Management Plan (CALM 2002)	No	Shoalwater Islands Marine Park
Shoalwater Islands NR	A	1a		Yes	
Port Kennedy Scientific Park	A	1a	Rockingham Lakes Regional Park (DEC 2015)	No	-

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Leschenault Peninsula CP	A	2	Leschenault Peninsula Management Plan (CALM 1998)	Yes	-
Sugar Loaf Rock NR	A	1a	Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan (DPAW 2015)	Yes	Ngari Capes Marine Park
Hamelin Island NR	A	1a		Yes	
Seal Island NR	A	1a		Yes	
St Alouarn Island NR	A	1a		Yes	
Flinders Bay NR	A	1a		Yes	
Quagering NR	A	1a		Yes[10]	-
Doubtful Islands NR	A	1a		Yes	Bremer Marine Park
Quarram NR	A	1a		Yes	South-west corner Marine Park
Chatham Island NR	A	1a		Yes	
Two Peoples Bay NR	A	4	Albany coast draft management plan 2016 (DPAW 2016b)	Yes[10]	-
Breaksea Island NR	A	1a		Yes[10]	-
Bald Island NR	A	1a		Yes[10]	-
Eclipse Island NR	A	1a		Yes[10]	-
Michaelmas Island NR	A	1a		Yes[10]	-
Glasse Island NR	A	1a		Yes[10]	-
Arpenteur NR	-	1a		No	-

Further information is provided below in relation to Varanus Island and Airlie Island Nature Reserves. Santos WA's Varanus Island Processing Hub and Airlie Island (operations ceased) co-exist with the reserves.

Lowendal Islands Nature Reserve - Varanus Island

Varanus Island is part of the Lowendal Islands group, a Nature Reserve (Class C). The Lowendal Islands comprise more than 40 limestone islands, islets and rocky stacks. There is not currently a DBCA Management Plan covering the Lowendal Islands Nature Reserve. Varanus Island is the largest island in the Lowendal Islands and is approximately 2.5 km long and 600m wide at its widest point. Its highest point is approximately 30m above sea level.

Described ecological conservation values of marine relevance include: Wedge-tailed Shearwater nesting (see Section **8.1.6**); Loggerhead and Hawksbill Turtle nesting (see Section 6.1.1 and Section **6.1.3**), Flatback Turtle nesting (Section 6.1.4). The Lowendal Islands are described as particularly important for tern breeding (DEC 2002), further information on terns is provided in **Section 8.2.1**.

Airlie Island Nature Reserve

Airlie Island Nature Reserve is an ungazetted 'C' class nature (Reserve identifier: 40323, Crown Lease 1901/100) located on Airlie Island. Airlie Island is a small sand cay (26 Ha) located 35 km NNE of Onslow. It is part of the Pilbara Inshore Islands chain. A management plan for the nature reserves of the Pilbara Inshore Islands is currently under development (DBCA 2019) i.e. there is not currently a DBCA Management Plan covering Airlie Island Nature Reserve.

Described ecological conservation values of marine relevance include: a wedge-tailed shearwater nesting (see **Section 8.1.6**); silver gull nesting (see **Section 8.1.6**) and low levels of green turtle and hawksbill turtle nesting (see **Section 6.1.2** and **6.1.3**).

9.7 Threatened Ecological Communities

An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat. Ecological communities are listed under the EPBC Act as threatened if the community is at risk of extinction.

Similarly, ecological communities can be listed under the WA BC Act as threatened if facing a risk of becoming a collapsed ecological community. To date no ecological communities are listed as threatened under the WA Act, however several ecological communities are currently endorsed by the WA Minister of Environment as Threatened Ecological Communities (TECs) through the previous non-statutory process.

TECs of relevance (likely to exist in marine water inter-tidal areas) in the EMBA are listed in **Table 9-1** and further described below.

Table 9-4: Relevant TEC in the marine EMBA

Species	Conservation Status		
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Otherwise endorsed by the WA Minister for Environment
Monsoon Vine Thicket on the Ridge on the Coastal Sand Dunes of Dampier	Endangered	-	Vulnerable
Roebuck Bay mudflats	-	-	Vulnerable
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	-	-

9.7.1 Monsoon Vine Thicket on the Ridge on the Coastal Sand Dunes of Dampier

Monsoon vine thicket occurs as semi - deciduous and evergreen vine thicket communities on and behind landward slopes of coastal sand dunes on the Dampier Peninsula in the Kimberley Region. This community is closely associated with coastal dunes elsewhere on the Dampier Peninsula and is listed as Endangered under the EPBC Act (Government of Western Australia 2010; DoEE 2016b). The community is also endorsed by the WA Minister for Environment as a threatened ecological community (non-statutory process).

9.7.2 Roebuck Bay Mudflats

Roebuck Bay mudflats (Kimberley region) have been endorsed by the WA Minister for Environment as a threatened ecological community (non-statutory process). The TEC is not listed under the EPBC Act.

Roebuck Bay mudflats (Kimberley region) are described as a ‘species rich faunal community of the intertidal mudflats of Roebuck Bay’ in the Kimberley region. Classed as Vulnerable (B). Roebuck Bay is a tropical marine embayment with extensive, biologically diverse, intertidal mudflats.

Roebuck Bay is protected as a designated Ramsar Wetland of International Importance (**Section 9.2.2**) and Marine Park (see **Sections 11.1.17** and **12.3.10**).

9.7.3 Subtropical and Temperate Coastal Saltmarsh

Subtropical and Temperate Coastal Saltmarsh occurs within the subtropical and temperate climatic zones and is present in coastal areas under regular or intermittent tidal influences and occurs over six State jurisdictions (Queensland, New South Wales, Victoria, Tasmania and WA). In WA it occurs from the south coast up to the southern part of Shark Bay. The community is made up of mainly salt tolerant vegetation which include halophytes as well as a number of non-vascular plant species. The community is listed as vulnerable under the EPBC Act (DoE 2014k).

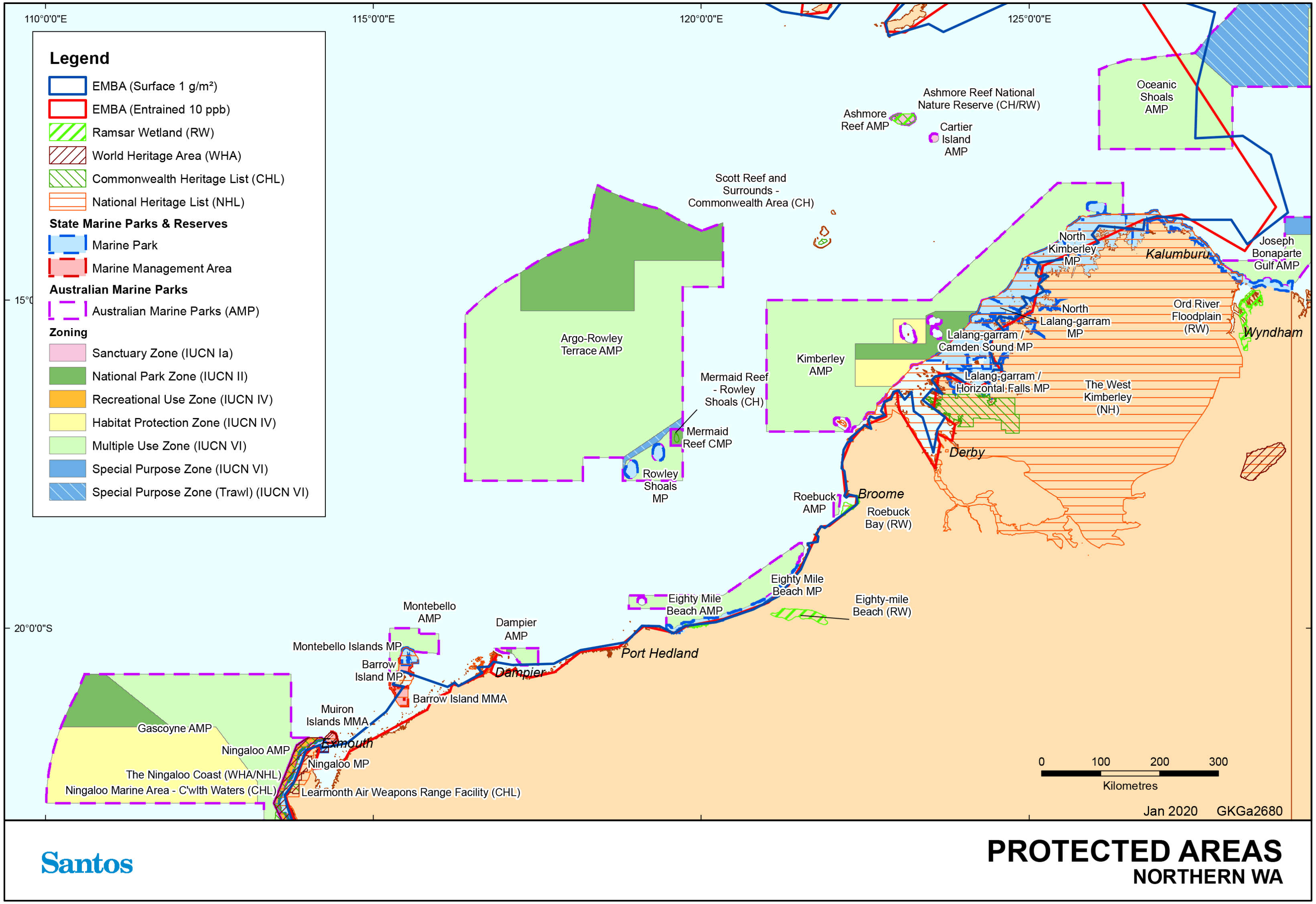

Figure 9-1: Protected areas in Northern WA

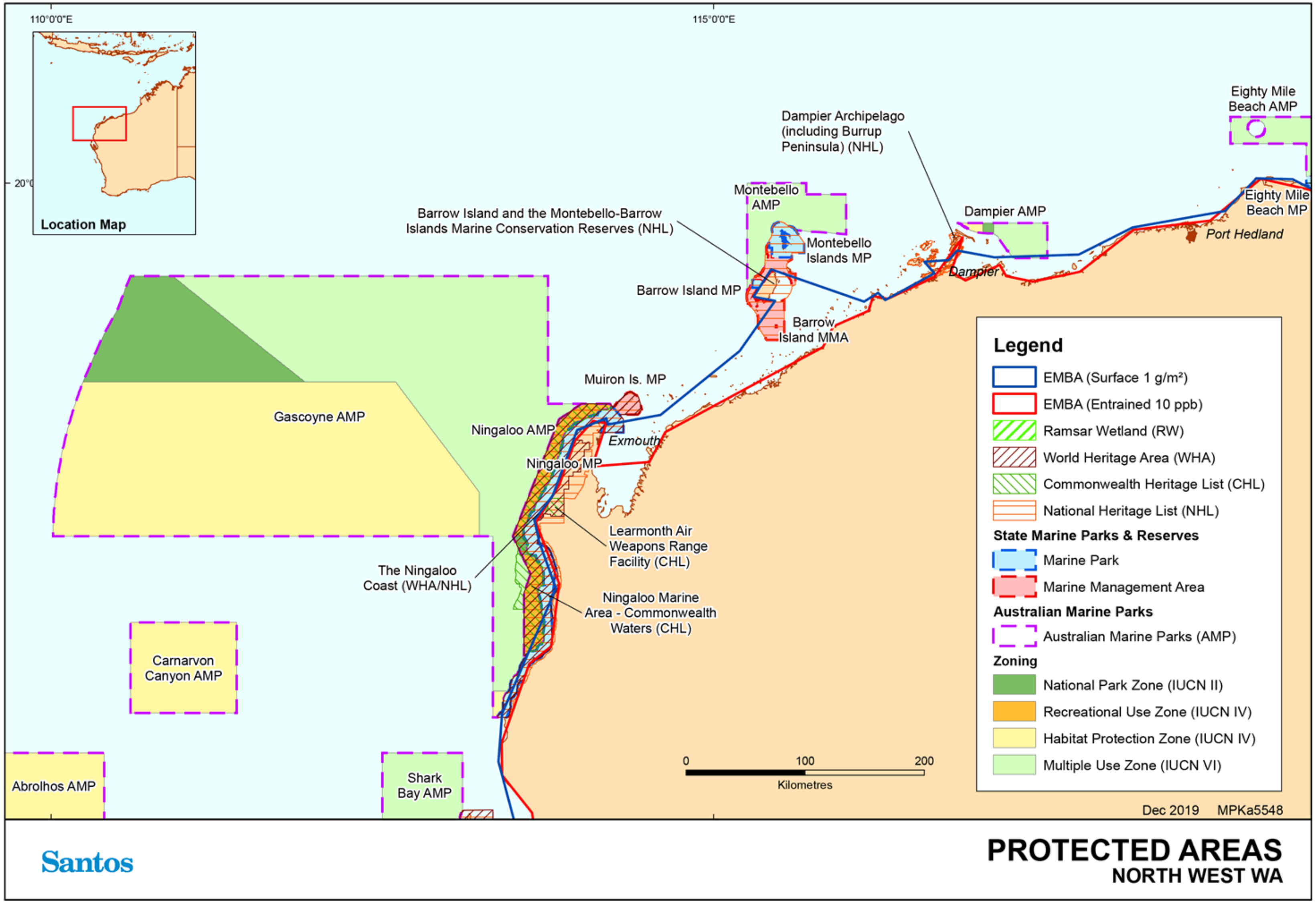

Figure 9-2: Protected areas in North-West WA

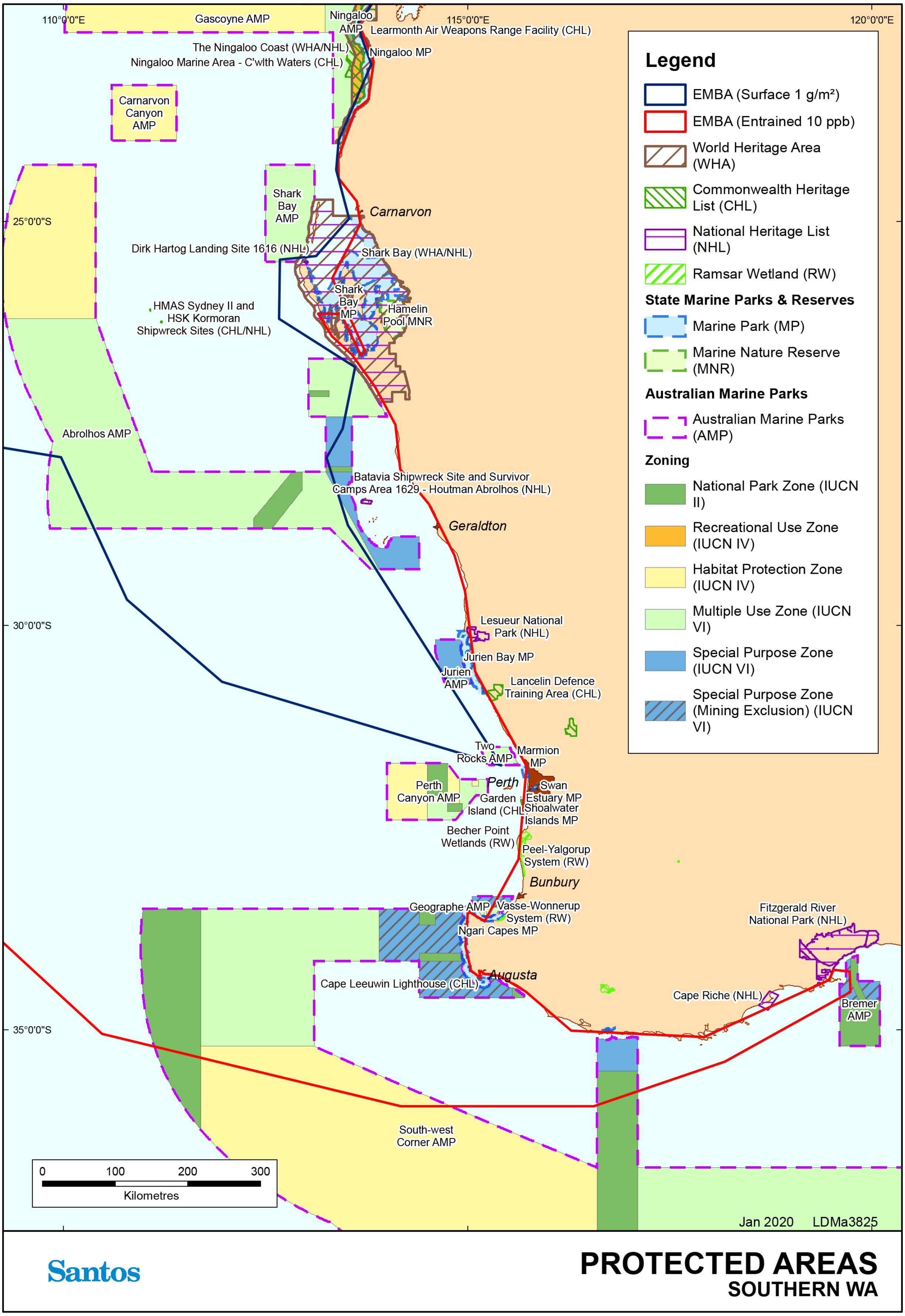

Figure 9-3: Protected areas in Southern WA

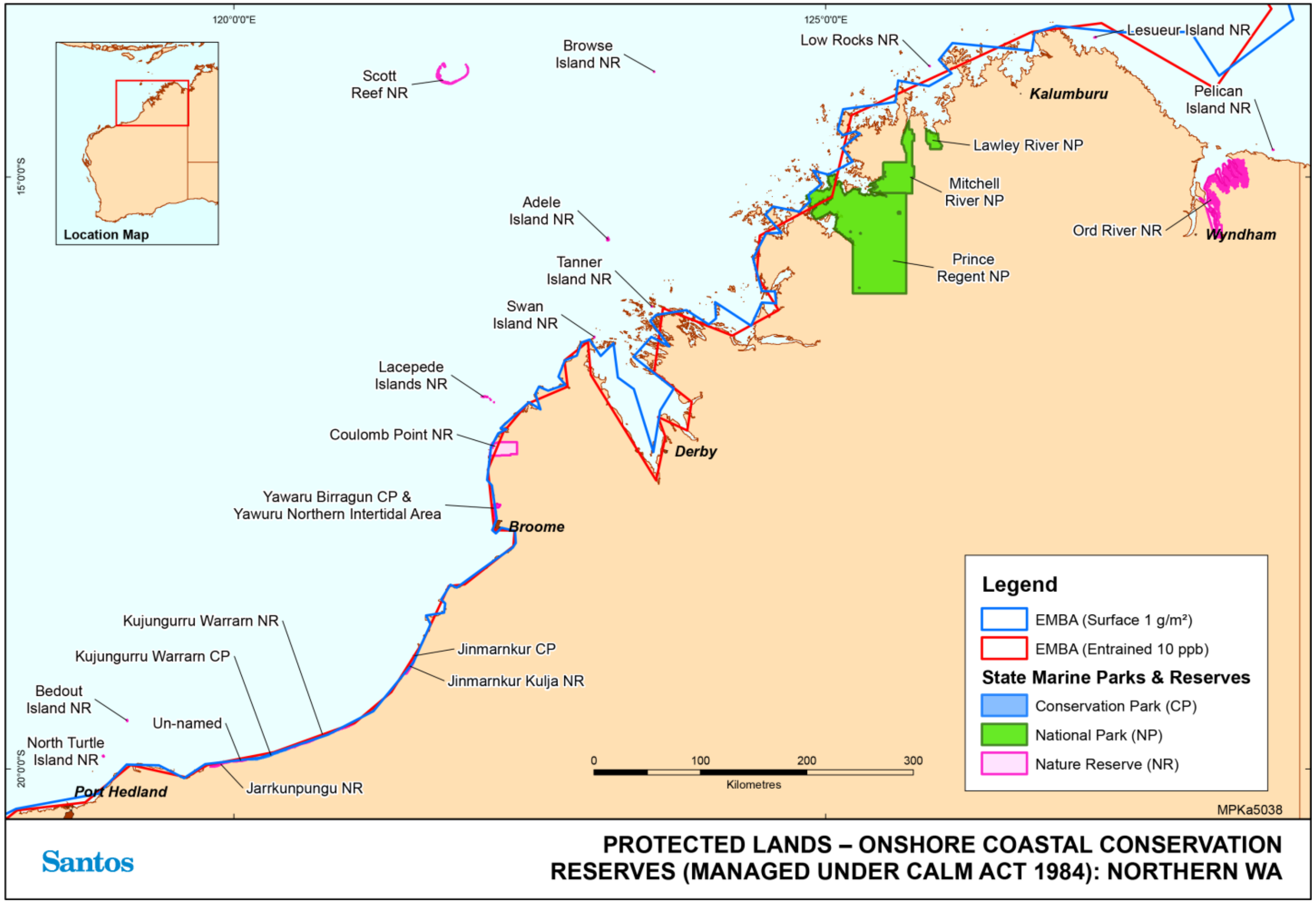

Figure 9-4: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in northern WA[12]

[12] Yawaru Minyirr Buru Conservation Reserve (adjacent to Roebuck Bay) not shown as exact spatial extent unavailable, however the adjacent inter-tidal waters are managed under adjacent Roebuck Bay Marine Park (described in **Section 11.1.17**).

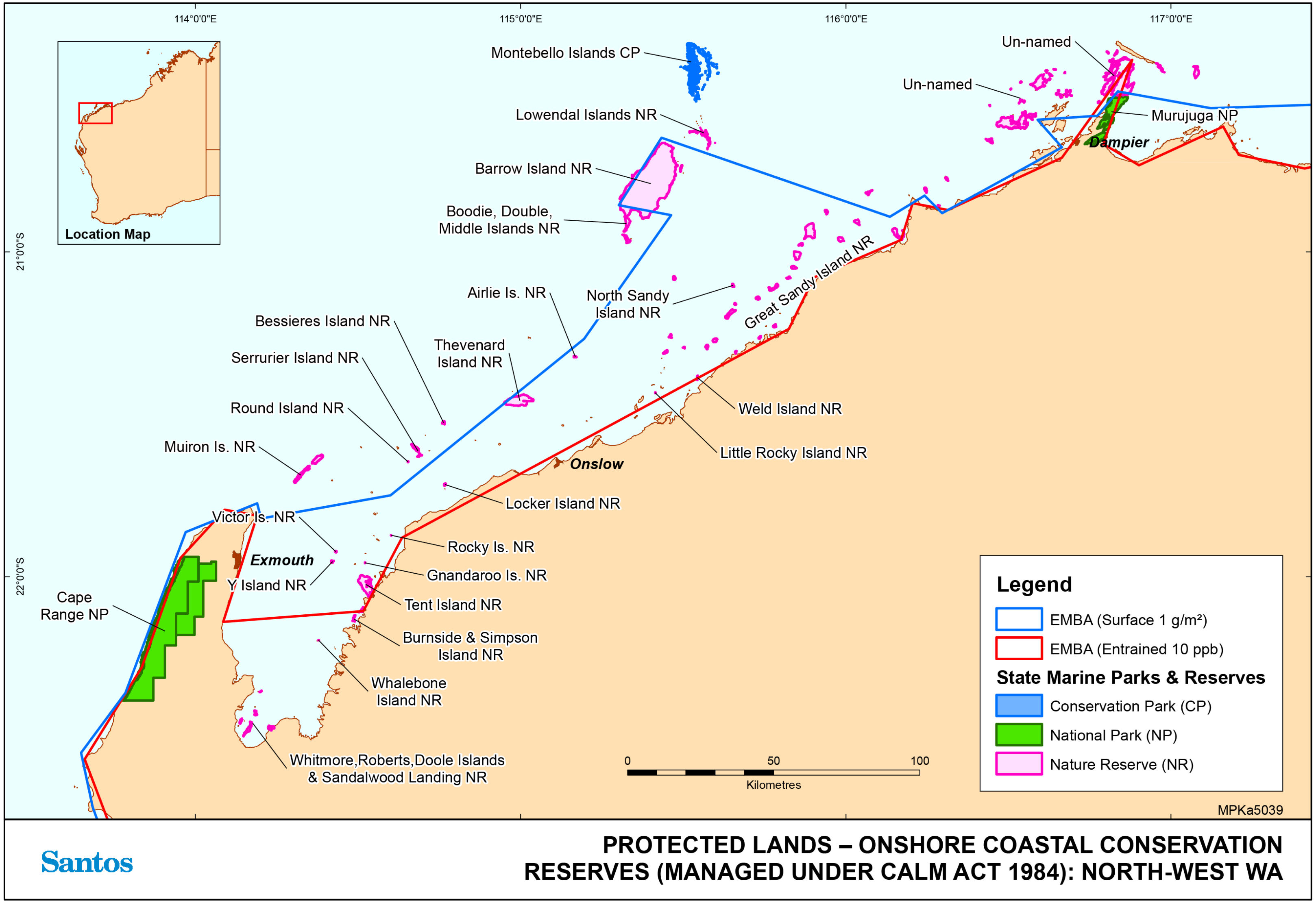

Figure 9-5: **Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in North-West WA**

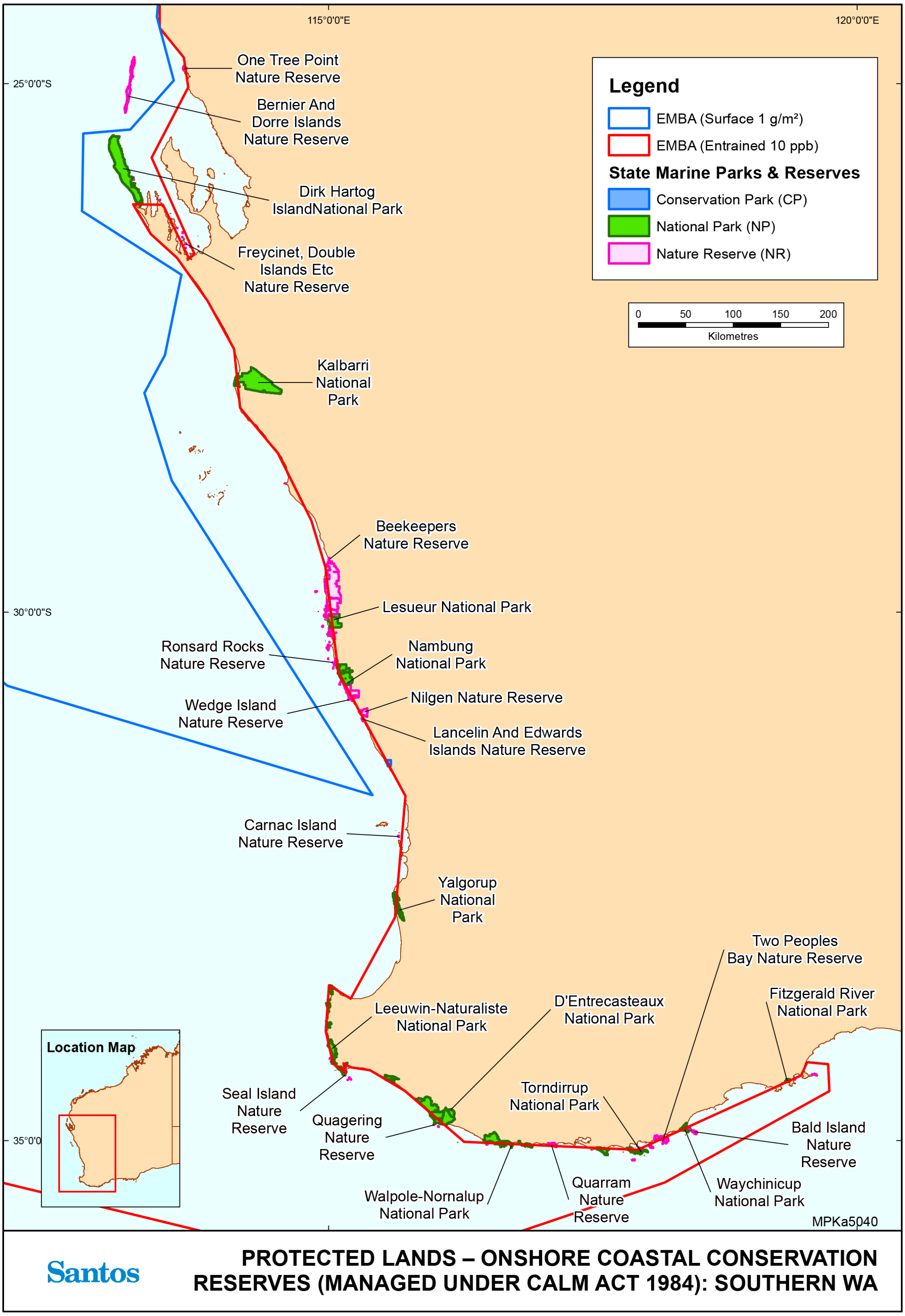

Figure 9-6: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in Southern WA[13]

13 Rottnest Islands Conservation Park Conservation Park is not shown (managed under Rottnest Island Authority Act 1987).

9.8 International Protected Areas

There are 53 National Parks in Indonesia, six are World Heritage Sites, nine are part of the World Network of Biosphere Reserves and five are wetlands of international importance under the Ramsar convention. A total of nine parks are largely marine (ADB 2014). Of these protected areas only the Laut Sawu Marine National Park (including the Tirosa Batek Marine Area and the Sumba Strait Marine Area) intersects with the EMBA.

The Laut Sawu Marine National Park located within the Lesser Sunda Ecoregion in the Savu Sea and covers a reported 35,211 km^2 (Protected Planet 2017). It was established in 2009 and has an IUCN Category II status (Protected Planet 2017). The marine park area is a known migration route for several cetacean species, including the blue whale and sperm whale. Other cetacean species such as pygmy killer whales, melon-head whale, short-finned pilot whales and numerous dolphin species (including Risso's dolphin, Fraser's dolphin, common dolphin, bottlenose dolphin and spinner dolphin) are known to frequent the marine park area. Several species of marine turtle, including the green turtle, hawksbill turtle and leatherback turtle have also been recorded in the marine park area.

The marine park area covers a range of habitats and species diversity, including:

+ 532 corals species which include 11 endemic and sub endemic species;
+ 350 reef fish species;
+ fifteen mangrove species are recorded that represented 9 families of mangrove;
+ ten seagrass species;
+ deep-water habitats such as seamounts, deep-water canyons, straits (migratory corridors);
+ large persistent pelagic habitats;
+ main migratory corridors and habitats for 14 whale species, seven dolphin's species, and dugong; and
+ habitats for five sea turtle species (green, leatherback, olive ridley, loggerhead, and flatback) as well as for large marine fauna such as sharks, napoleon, parrotfish and groupers (Savu Sea National Marine Conservation Area undated).

10. Key Ecological Features

10.1 Introduction

Key ecological features (KEFs) are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity. KEFs meet one or more of the following criteria (DSEWPaC 2012a):

+ A species, group of species or a community with a regionally important ecological role;
+ A species, group of species or a community that is nationally or regionally important for biodiversity;
+ An area or habitat that is nationally or regionally important for:
    - Enhanced or high biological productivity;
    - Aggregations of marine life; or
    - Biodiversity and/or endemism
+ A unique seafloor feature with ecological properties of regional significance.

Twenty five key ecological features of the Commonwealth waters in the EMBA (covering the NMR, the NWMR and the SWMR) have been identified in the protected matters search (**Figure 10-1** and **Figure 10-2**) and are discussed in this section.

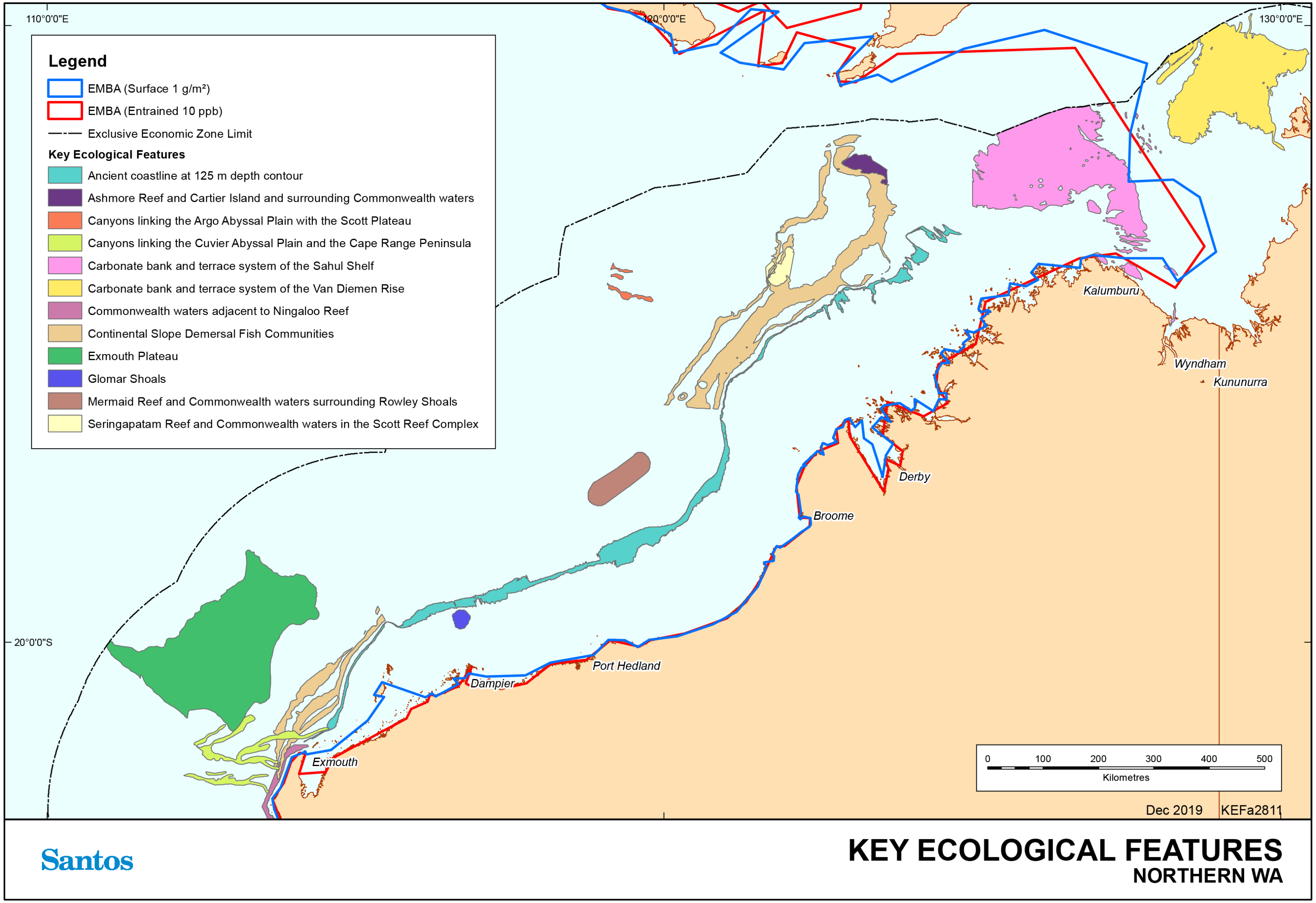

Figure 10-1: Key ecological features of Northern WA

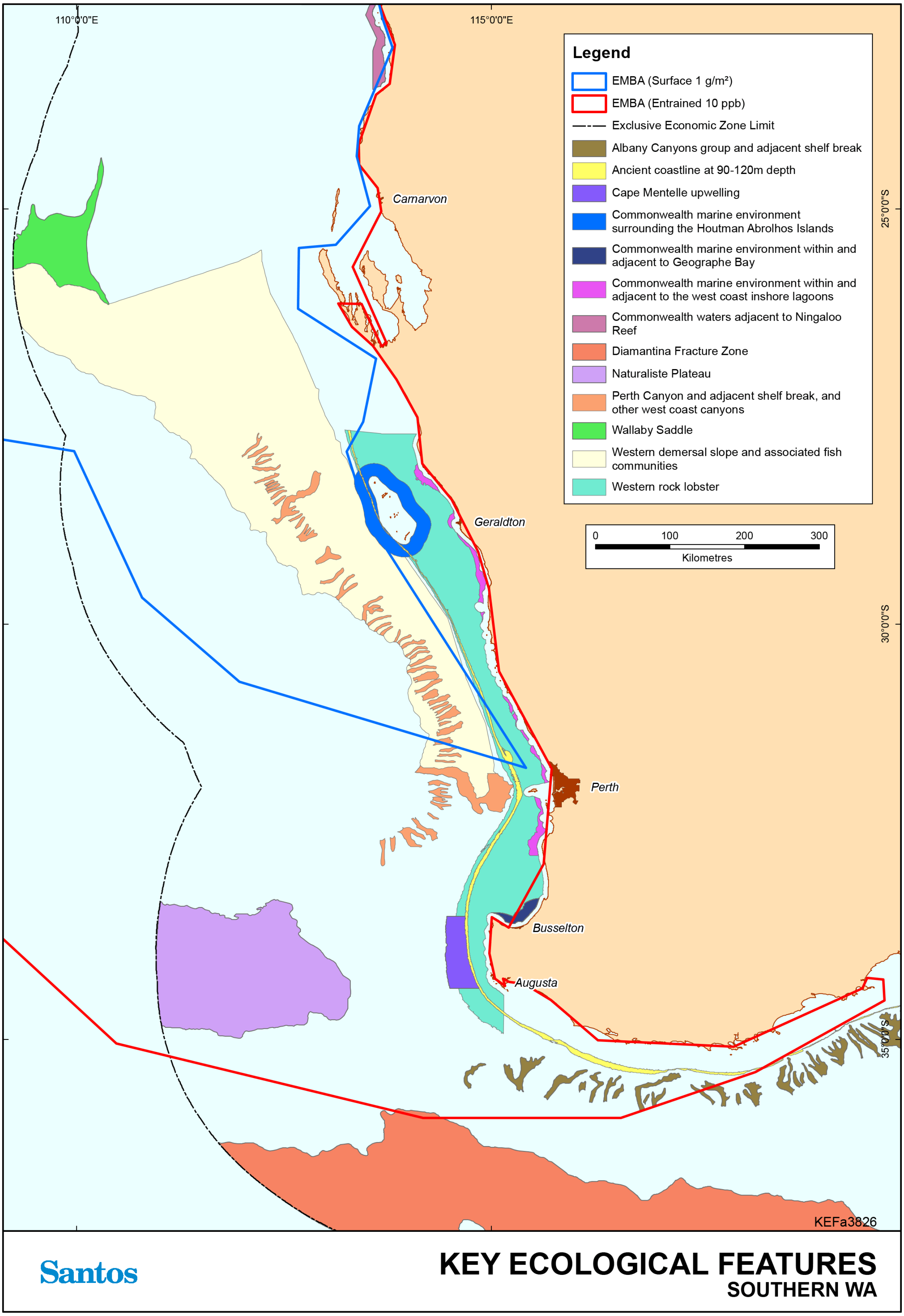

Figure 10-2: Key ecological features of Southern WA

10.1.1 Commonwealth Marine Environment Surrounding the Houtman Abrolhos Islands (and Adjacent Shelf Break)

The Commonwealth marine environment surrounding the Houtman Abrolhos Islands (and adjacent shelf break) is defined as a KEF for its high levels of biodiversity and endemism in benthic and pelagic habitats. The Houtman Abrolhos Islands and surrounding reefs support a unique mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The reefs are composed of 184 known species of corals that support about 400 known species of demersal fish, 492 known species of molluscs, 110 known species of sponges, 172 known species of echinoderms and 234 known species of benthic algae (DEWHA 2008b). The Houtman Abrolhos Islands are the largest seabird breeding station in the eastern Indian Ocean (DSEWPaC 2012a). They support more than one million pairs of breeding seabirds. The Houtman Abrolhos Islands and surround waters are also BIAs for Australian sea lions for foraging and breeding (DEWHA 2010b).

10.1.2 Perth Canyon and Adjacent Shelf Break, and other West-Coast Canyons

The Perth Canyon is defined as a KEF for its high biological productivity and aggregations of marine life and unique seafloor features with ecological properties of regional significance. The Perth Canyon is the largest known undersea canyon in Australian waters. In the Perth Canyon, interactions between the Leeuwin Current and the Canyon topography induce clockwise-rotating eddies that transport nutrients upwards in the water column from greater depths (DoEE 2019a). Due to the Canyon's depth and Leeuwin Current's barrier effect, this remains a subsurface upwelling which supports ecological complexity that is typically absent from canyon systems in other areas (Pattiaratchi 2007). This nutrient-rich cold-water habitat attracts feeding aggregations of deep-diving mammals, such as pygmy blue whales and large predatory fish that feed on aggregations of small fish, krill and squid (DSEWPaC 2012a). The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs (DoEE 2017a).

10.1.3 Commonwealth Marine Environment within and adjacent to the West-Coast Inshore Lagoons

This key ecological feature is composed by a chain of inshore lagoons of limestone reef (as deep as 30 m) extending along the Western Australian coast from south of Mandurah to Kalbarri. The mix of sheltered and exposed seabeds form a complex mosaic of habitats. The lagoons are dominated by seagrass and epiphytic algae (Dambacher et al. 2009). Although macroalgae (principally Ecklonia spp.) and seagrass appear to be the primary source of production, scientists suggest that groundwater enrichment may supplement the supply of nutrients to the lagoons. The lagoons are associated with high biodiversity and endemism, containing a mix of tropical, subtropical and temperate flora and fauna.

The inshore lagoons are important areas for the recruitment of the commercially and recreationally important western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, abalone and many other reef species. The area includes breeding and nursery aggregations for many temperate and tropical marine species (Goldberg & Collings 2006 in McClatchie et al. 2006). Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon.

10.1.4 Commonwealth Marine Environment within and Adjacent to Geographe Bay

The Commonwealth marine environment within and adjacent to Geographe Bay is defined as a KEF for its high productivity and aggregations of marine life and high levels of biodiversity and endemism. Geographe Bay is known for its extensive beds of tropical and temperate seagrass that account for about 80 % of benthic primary production in the area (DEH 2006). This habitat supports a diversity of species, many of them not found anywhere else (DSEWPaC 2012a). The bay provides important nursery habitat for many species, including juvenile dusky whaler sharks. It is also an important resting area for migrating for humpback whales (McCauley *et al.* 2000).

10.1.5 Cape Mentelle Upwelling

The Cape Mentelle upwelling is defined as a KEF for its high productivity and aggregation soft marine life. The Cape Mentelle upwelling draws relatively nutrient-rich water from the base of the Leeuwin Current, up the continental slope and onto the inner continental shelf, where it results in phytoplankton blooms at the surface. The phytoplankton blooms provide the basis for an extended food chain characterised by feeding aggregations of small pelagic fish, larger predatory fish, seabirds, dolphins and sharks (DSEWPaC 2012a). The Cape Mentelle upwelling has a disproportionate influence on the overall-nutrient poor nature of the region's water.

10.1.6 Naturaliste Plateau

The Naturaliste Plateau is defined as a KEF for its unique seafloor feature with ecological properties of regional significance. The Naturaliste Plateau is Australia's deepest temperate marginal plateau and occurs an area where numerous water bodies and currents converge. It is also the only seafloor feature in the region that interacts with the subtropical convergence front (DoEE 2019b). Although there is very little known about the marine life of the plateau, it is speculated that the combination of its structural complexity, mixed water dynamics and relative isolation indicate that it supports deep-water communities with high species diversity and endemism (DEWHA 2008b; DSEWPaC 2012a). The Plateau acts as an underwater 'biogeographical island' on the edge of the abyssal plain, providing habitat for fauna unique to these depths (Richardson et al. 2005). The Plateau is also within a deep eddy field that is thought to be associated with high productivity and aggregations of marine life (Pattiaratchi 2007). Proximity to the nearby subtropical convergence front is thought to have a significant influence on the biodiversity of the Plateau (DEWHA 2008b).

10.1.7 Western Demersal Slope and associated Fish Communities

The Western Demersal Slope and associated Fish Communities, also known as the Demersal Slope and associated Fish Communities of the Central Western Province, is defined as a key ecological community for its high levels of biodiversity and endemism. The western demersal slope provides important habitat for demersal fish communities, with a high level of diversity and endemism. A diverse assemblage of demersal fish species below a depth of 400 m is dominated by relatively small benthic species such as grenadiers, dogfish and cucumber fish. Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the sea floor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits (DSEWPaC 2012a). Scientists have described 480 species of demersal fish that inhabit the slope, and 31 of these are considered endemic (DoEE 2019a).

10.1.8 Western Rock Lobster

The Western Rock Lobster KEF is defined due to its presumed ecological role on the West Coast Continental Shelf. This species is the dominant large benthic invertebrate in the region. The lobster plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western rock lobsters are an important part of the food web on the inner shelf, particularly as juveniles as they are preyed upon by octopus, cuttlefish, baldchin groper, dhufish, pink snapper, wirrah cod and breaksea cod (DEWHA 2008b, DSEWPaC 2012a). The high biomass of western rock lobsters and their vulnerability to predation suggest that they are an important trophic pathway for a range of inshore species that prey upon juvenile lobsters (DEWHA 2008b).

10.1.9 Wallaby Saddle

The Wallaby Saddle is defined as a KEF for its high productivity and aggregations of marine life. The Wallaby Saddle is an abyssal geomorphic feature located on the upper continental slope at a depth of 4,000–4,700 m (DSEWPaC 2012a). The feature connects the north-west margin of the Wallaby Plateau with the margin of the Carnarvon Terrace (Falkner *et al*. 2009 in DSEWPaC 2012a). The Wallaby Saddle is situated within the Indian Ocean water mass and is thus differentiated from systems to the north that are dominated by transitional fronts or the Indonesian Throughflow (DSEWPaC 2012a). Little is known about the Wallaby Saddle; however, the area is considered one of enhanced productivity and low habitat diversity (Brewer *et al*. 2007). The Wallaby Saddle is associated with historical aggregations of sperm whales (DEWHA 2008c).

10.1.10 Commonwealth Waters Adjacent to Ningaloo Reef

The Commonwealth Waters adjacent to Ningaloo Reef KEF is defined for high productivity and aggregations of marine life. The Ningaloo Reef extends almost 300 km along the Cape Range Peninsula to the Red Bluff and is globally significant as the only extensive coral reef in the world that fringes the west coast of a continent. Commonwealth waters adjacent to the reef are thought to support the rich aggregations of marine species at Ningaloo Reef through upwellings associated with canyons on the adjacent continental slope and interactions between the Ningaloo and Leeuwin currents (Brewer *et al*. 2007, DEWHA 2008d, DSEWPaC 2012a). The narrow continental shelf (10 km at its narrowest) means that the nutrients channelled to the surface via canyons are immediately available to reef species. Terrestrial nutrient input is low, hence this deep-water source is a major source of nutrients for Ningaloo Reef and therefore very important in maintaining this system (DEWHA 2008c).

The reef is known to support an extremely abundant array of marine species including over 200 species of coral and more than 460 species of reef fish, as well as molluscs, crustaceans and other reef plants and animals (DEWHA 2008c). Marine turtles, dugongs and dolphins frequently visit the reef lagoon. The Commonwealth waters around Ningaloo include areas of potentially high and unique sponge biodiversity (DEWHA 2008c). Upwellings on the seaward side support aggregations such as whale sharks and manta rays (these waters are the main known aggregation area for whale sharks in Australian waters). Humpback whales are seasonal visitors to the outer reef edge and seasnakes, sharks, large predatory fish and seabirds also utilise the reef and surrounding waters.

The Ningaloo Marine Park includes this Key Ecological Feature and is discussed in **Section 12.3.4**.

10.1.11 Canyons Linking the Cuvier Abyssal Plain with the Cape Range Peninsula

The Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula are defined as a KEF as they are unique seafloor features with ecological properties of regional significance.

Cape Range Peninsula and the Cuvier Abyssal Plain are linked by canyons, the largest of which are the Cape Range Canyon and Cloates Canyon. These two canyons are located along the southerly edge of Exmouth Plateau adjacent to Ningaloo Reef and are unique due to their close proximity to the North West Cape (DSEWPaC 2012a). The Leeuwin Current interacts with the heads of the canyons to produce eddies resulting in delivery of higher nutrient, cool waters from the Antarctic intermediate water mass to the shelf (Brewer *et al*. 2007). Strong internal tides also create upwelling at the canyon heads (Brewer *et al*. 2007). Thus the canyons, the Exmouth Plateau and the Commonwealth waters adjacent to Ningaloo Reef interact to create the conditions for enhanced productivity seen in this region (Sleeman *et al*. 2007 in DSEWPaC 2012a). The canyons are also repositories for particulate matter deposited from the shelf and sides of the canyons and serve as conduits for organic matter between the surface, shelf and abyssal plains (DSEWPaC 2012a).

The soft bottom habitats within the canyons themselves are likely to support important assemblages of epibenthic species. Biological productivity at the head of Cape Range Canyon in particular, is known to support species aggregations, including whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds. The canyons are thought to be significant contributors to the biodiversity of the adjacent Ningaloo Reef, as they channel deep water nutrients up to the reef, stimulating primary productivity (DEWHA 2008c).

10.1.12 Exmouth Plateau

The Exmouth Plateau is defined as a KEF as it is a unique seafloor feature with ecological properties of regional significance. The Exmouth Plateau covers an area of 49,310 km^2 and is located approximately 150 km northwest of Exmouth. The plateau ranges in water depths from 800 to 4,000 m (Heap & Harris 2008 in DSEWPaC 2012a). The plateau’s surface is rough and undulating at 800–1,000 m depth. The northern margin is steep and intersected by large canyons (e.g. Montebello and Swan canyons) with relief greater than 50 m. The western margin is moderately steep and smooth and the southern margin is gently sloping and virtually free of canyons (Falkner *et al*. 2009 in DSEWPaC 2012a).

The Exmouth Plateau is a regionally and nationally unique tropical deep sea plateau. It that may serve an important ecological role by acting as a topographic obstacle that modifies the flow of deep waters that generate internal tides, causing upwelling of deeper water nutrients closer to the surface (Brewer *et al.* 2007). Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna. Whaling records from the 19th century suggest that the Exmouth Plateau may have supported large populations of sperm whales (Bannister *et al*. 2007). Fauna in the pelagic waters above the plateau are likely to include small pelagic species and nekton (Brewer *et al.* 2007).

10.1.13 Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals

Mermaid Reef and Commonwealth waters surrounding Rowley Shoals is defined as a KEF for its enhanced productivity and high species richness. The Rowley Shoals are a group of three atoll reefs—Clerke, Imperieuse and Mermaid reefs—located about 300 km north-west of Broome. Mermaid Reef lies 29 km north of Clerke and Imperieuse reefs and is totally submerged at high tide. Mermaid Reef and 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). Rowley shoals contain 214 coral species and approximately 530 species of fishes (Gilmour et al. 2007), 264 species of molluscs and 82 species of echinoderms (Done et al. 1994; Gilmour et al. 2007). Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Done et al. 1994).

Mermaid Reef falls under Commonwealth jurisdiction and forms the Mermaid Reef Commonwealth Marine Park. Clerke and Imperieuse reefs constitute the Rowley Shoals Marine Park, which falls under Western Australian Government jurisdiction (EA 2000). The Rowley Shoals are discussed with the Commonwealth and State Marine Park (**Sections 11.1.9** and **12.3.9**).

10.1.14 Glomar Shoals

The Glomar Shoals are a submerged feature situated at a depth of 33–77 m, approximately 150 km north of Dampier on the Rowley Shelf (Falkner *et al*. 2009 in DSEWPaC 2012a). They consist of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells (McLoughlin & Young 1985 in DSEWPaC 2012a). The area's higher concentrations of coarse material compared to surrounding areas are indicative of a high energy environment subject to strong seafloor currents (Falkner *et al*. 2009 in DSEWPaC 2012a).

Biological communities found at the Glomar Shoals have not been comprehensively studied, however the shoals are known to be an important area for a number of commercial and recreational fish species such as rankin cod, brown striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish. Catch rates at the Glomar Shoals are high, indicating that the area is a region of high productivity (Falkner *et al*. 2009, Fletcher & Santoro 2009 in DSEWPaC 2012a). It is unclear if the removal of non-target species due to the commercial fishing over the shoals is having an impact on its value (DSEWPaC 2012a).

The Glomar Shoals are regionally important for their potentially high biological diversity and localised productivity. Biological data specific to the Glomar Shoals is limited, however the fish of the shoals are probably a subset of reef-dependent species and anecdotal evidence suggests they are particularly abundant (DSEWPaC 2012a).

10.1.15 Ancient Coastline at 125 m Depth Contour

The shelf of the North-west Marine Region contains several terraces and steps which reflect changes in sea level that occurred over the last 100,000 years. The most prominent of these features occurs at a depth of 125m as an escarpment along the North West Shelf and Sahul Shelf (DSEWPaC 2012a). Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher biological diversity. Little detailed knowledge is available, but the hard substrate of the escarpment is likely to support sponges, crinoids, molluscs, echinoderms (DSEWPaC 2012a). It is understood that changes in topography at these depths are critical points for the generation of internal waves (Holloway *et al.* 2001 cited in DEWHA 2008c), playing a minor role in aiding localised upwelling or at least regional mixing associated with the seasonal changes in currents and winds. It is also believed that this prominent floor feature could be important as a migratory pathway for cetaceans and pelagic species such as the whale shark and humpback whale, as they move north and south between feeding and breeding grounds (DEWHA 2008c).

Parts of the ancient coastline are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column providing a relatively nutrient-rich environment for species present on the escarpment (DSEWPaC 2012a). This enhanced productivity could potentially be attracting baitfish, which in turn provide food for the migratory species. The pressures of potential concern on the biodiversity value of this feature generally include ocean acidification as a result of climate change (DoEE 2019a).

10.1.16 Ancient Coastline at 90-120 m Depth

This coastline is found in the South-west Marine Region and contains several terraces and steps reflecting a gradual increase in sea level across the shelf that occurred during the Holocene. Some of these features create escarpments of distinct elevation, creating topographic complexity through the exposure of rocky substrates. The most prominent of these occurs close to the middle of the continental shelf off the Great Australian Bight at a depth of 90-120 m, which provides a complex habitat for a number of species (DSEWPaC 2012c). The area has important conservation value due to its potential for high productivity, biodiversity and aggregations of marine life. Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment of exposed hard substrates, where it is dominated by sponge communities of significant biodiversity and structural complexity (DSEWPaC 2012c). These sponge communities have been recorded to contain sponges up to one metre across, which implies that some of the sponges in this region are likely to be many decades old (DSEWPC 2012c). It has been suggested that in certain places, the area may support some demersal fish species, travelling to the upper continental slope from across the continental shelf. The transportation of fine grained sediments off shelf occurs as a physical process down to depths of approximately 120 m, and influence the benthic invertebrate communities of the Great Australian Bight (DSEWPaC 2012c). Both species richness and biomass in the area, has been associated as declining with increasing depth and percentage of fines in sediment (Ward *et al.* 2006 cited in DSEWPaC 2012c).

10.1.17 Canyons Linking the Argo Abyssal Plain with Scott Plateau

The Scott Plateau connects with the Argo Abyssal Plain via a series of canyons, the largest of which are the Bowers and Oates canyons (DSEWPaC 2012a). The canyons are believed to be up to 50 million years old and excavated during the evolution of the region through sediment and water movements (DEWHA 2008d). The canyons cut deeply into the south-west margin of the Scott Plateau and act as conduits for transport of sediments from an approximate depth of 2,000–3,000 m to depths of more than 5,500 m (DSEWPaC 2012a). The water masses at these depths are deep Indian Ocean water on the Scott Plateau and Antarctic bottom water on the Argo Abyssal Plain. Both water masses are cold, dense and nutrient-rich (Lyne *et al*. 2006 in DSEWPaC 2012a). The high productivity of the region is believed to be led by topographically induced water movements through the canyons and the action of internal waves in these canyons as well as around islands and reefs. The canyons are therefore thought to be linked to small and periodic upwellings that enhance this biological productivity (DEWHA 2008d).

The Canyons linking the Argo Abyssal Plain and Scott Plateau are likely to be important features due to their historical association with sperm whale aggregations (DSEWPaC 2012a). Historical records of whaling in the Timor region indicate that the number of sperm whales was high in the region in the past. Though current numbers are unknown, it is possible that they congregate around the canyon heads adjacent to the Scott Plateau, encouraged by the high biological productivity, supporting stocks of their prey (DEWHA 2008d). There is anecdotal evidence that supports the idea that the Scott Plateau itself may be a breeding ground for sperm and beaked whales. It is also likely that important demersal communities occur in the canyons, as they do in the Scott Plateau supported by the localised upwelling, which in turn attract larger predatory fish, sharks and cetaceans (DEWHA 2008d).

10.1.18 Continental Slope Demersal Fish Communities

The Australian Continental Slope provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Specifically, the continental slope between North West Cape and the Montebello Trough is the most diverse slope bioregion in Australia with more than 500 fish species, 76 of which are endemic (Last *et al*. 2005 in DSEWPaC 2012).

The Continental Slope consists of two distinct community types, associated with the upper and mid slope, 225 – 500 m and 750 – 1000 m respectively. The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope (DSEWPaC 2012). The bacteria and fauna that is present in the system on the Continental Slope are the basis for the food web for demersal fish and higher order consumers in the system. Further information of this system has been poorly researched, though it has been suggested that it is a detritus-based system, where infauna and epifauna become prey for a range of teleost fish, molluscs and crustaceans (Brewer *et al.* 2007). The higher order consumers supported by this system are likely to be carnivorous fish, deep water sharks, large squid and toothed whales (Brewer *et al.* 2007). The pelagic production is known to be phytoplankton based, with hotspots located around oceanic reefs and islands (Brewer *et al.* 2007).

It is believed that the loss of the benthic habitat along this continental shelf region would likely lead to a decline in the species diversity and endemism that this feature is associated with (DoEE 2019a). The endemism of the region is not supported by large data sets and is scarce. It is consequently not well understood what interactions exist between the physical processes and trophic structures that lead to this high diversity of fish and the suggested presence of endemic species in the region (DoEE 2019a).

10.1.19 Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex

Scott and Seringapatam reefs are part of a series of submerged reef platforms that rise steeply from the sea floor between the 300–700 m contours on the north-west continental slope and lie in the Timor Province (Falkner et al. 2009). Scott Reef consists of two separate reef formations, North Reef and South Reef. The total area of the key ecological feature is approximately 2,418 km². As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region.

Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life including humpback whales on their northerly migration, Bryde's whales, pygmy blue whales, Antarctic minke whales, dwarf minke whales, minke whales, dwarf sperm whales and spinner dolphins (Jenner et al. 2008; Woodside 2009). Whale sharks and several species of sea snakes have also been recorded in this area (Donovan et al. 2008). Green and hawksbill turtles nest during the summer months on Sandy Islet on South Scott Reef. These species also internest and forage in the surrounding waters (Guinea 2006). 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). Corals and fish at Scott Reef have higher species diversity than the Rowley Shoals (Done et al. 1994).

Scott Reef is listed as Commonwealth Heritage Places and is discussed in **Section 9.5.1**.

10.1.20 Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters

Ashmore Reef and Cartier Island are situated on the shallow upper slope of the Sahul Shelf, north of Scott and Seringapatam reefs. Rising from a depth of more than 100 m, the reef platform is at the edge of the North West Shelf and covers an area of 239 km². Ashmore Reef Commonwealth Marine Reserve encloses an area of about 583 km² of seabed (EA 2002). Cartier Island lays about 350 km off Australia's Kimberley coast, 115 km south of the Indonesian island of Roti and 45 km south-east of Ashmore Reef Commonwealth Marine Reserve. Cartier Island Commonwealth Marine Reserve covers 167 km² (EA 2002). Species at Ashmore Reef and Cartier Island include more than 225 reef-building corals, 433 molluscs, 286 crustaceans, 192 echinoderms, and the most diverse variety of fish of any region in Western Australia with 709 species (EA 2002).

Sandy beaches provide important habitat for nesting green and hawksbill turtles throughout the year. Seagrass present at Ashmore Reef provides critical breeding (April–May) and foraging (throughout the year) habitat for a genetically distinct population of dugong with their range probably extending to other submerged shoals within the area (Brown & Skewes 2005; Whiting 1999). The emergent habitat at Ashmore also provides important nesting sites for seabirds, many of which are migratory. Ashmore's islands are regarded as supporting some of the most important seabird rookeries on the North West Shelf seasonally supporting up to 50,000 seabirds (26 species) and up to 2,000 waders (30 species, representing almost 70% of wader species that regularly migrate to Australia) (Milton 2005). Large colonies of sooty terns, crested terns, bridled terns and common noddies breed on the east and middle islands. Smaller breeding colonies of little egrets, eastern reef egrets, black noddies and possibly lesser noddies also occur. Migratory wading birds include eastern curlews, ruddy turnstones, whimbrels, bar-tailed godwits, common sandpipers, Mongolian plovers, red-necked stints and tattlers, during October–November and March–April as part of the migration between Australia and the Northern Hemisphere (Milton 2005).

10.1.21 Carbonate Bank and Terrace System of the Sahul Shelf

The Carbonate Banks and Terrace System of the Sahul Shelf are located in the western Joseph Bonaparte Gulf and to the north of Cape Bougainville and Cape Londonderry. The banks consist of a hard substrate and flat tops at depths of 150–300 m. Each bank occupies an area generally less than 10 km^2 and is separated from the next bank by narrow sinuous channels with depths up to 150 m. The origin of the banks is uncertain, though the area contains predictably high levels of productivity, in comparison to the generally low productivity of the region (DSEWPaC 2012).

The banks are foraging areas for loggerhead, olive ridley and flatback turtles and provide habitat for humpback whales, and green and freshwater sawfish (Donovan *et al*. 2008 in DSEWPaC 2012). The hard substrate of the banks is thought to support diverse organisms including sessile benthic invertebrates such as sponges, soft and hard corals, gorgonians, bryozoans, ascidians and associated reef fish and elasmobranchs (Brewer *et al*. 2007). Cetaceans, green and fresh sawfish are also likely to occur in the area, as well as possibly the Australian snubfin dolphin, a migratory species occurring mostly on the northern extent of the Sahul Shelf (DSEWPaC 2012).

According to DSEWPaC (2012) the carbonate banks and terrace system of the Sahul Shelf are regionally important because of their role in enhancing productivity relative to their surrounds. Little is known about the banks, terraces and associated channels but they are believed to be areas of enhanced productivity and biodiversity due to the upwellings of cold nutrient-rich water at the heads of the channels and the availability of hard substrate (Brewer *et al*. 2007).

10.1.22 Pinnacles of the Bonaparte Basin

The limestone Pinnacles of the Bonaparte Basin are located in the mid-outer shelf of the western Joseph Bonaparte Gulf and comprise of 61% of the limestone pinnacles in the Northwest Marine Region and 8% of the total limestone pinnacles found within the Australian Exclusive Economic Zone (Baker *et al.* 2008). The pinnacles range from water depths of 30 to 80 m providing hard substrate in a relatively sparse soft sediment habitat for sessile species. The pinnacles are thought to be remnants of the calcareous shelf and coastal features from previous low sea level stands, and have been recorded to be up to 50 m in height and range from 50 to 100 km long (Baker *et al.* 2008, Heyward *et al.* 1997).

Diverse communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species such as snappers, emperors and groupers have been recorded (Brewer *et al.* 2007, Nichol *et al.* 2013). Foraging and general use has been recorded within the pinnacles by marine turtles and the area has also been suggested to be used by freshwater and green sawfish as well as humpback whales (Donovan *et al.* 2008). The pinnacles have been recognised as a sponge biodiversity hotspot which has recorded greater diversity and communities than that of the surrounding seafloor (NERP MBH 2014).

According to DSEWPaC (2012) the Pinnacles of the Bonaparte Basin are regionally important because of its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats. The hard substrate of the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required.

10.1.23 Diamantina Fracture Zone

The Diamantina Fracture Zone is located south of the Naturaliste Plateau covering a range of more than 100,00 km^2 in water depths greater than 3,000 m. The ridge, troughs and seamounts that form the fracture zone have been recorded to have a relief up to 4,000 m which has resulted in highly variable environmental conditions (Stow 2006, Richardson *et al.* 2005). The Diamantina Fracture Zone encompasses the deepest known points in Australia's exclusive economic zone, reaching depths of more than 6,000 metres.

Limited information is available for the Diamantina Fracture Zone, however it is likely that due to the highly variable environmental conditions within the distinctive community structures and unique habitats have the potential to form. The presence of seamounts and ridges has the potential to increase local primary and secondary productivity, which may in turn promote phytoplankton growth. Increased phytoplankton has been recorded to increase the diversity and abundance of marine life (e.g. whales, dolphins, fish and benthic species) (Rowden *et al.* 2010). The area is expected to sustain similar habitats to that of and around the Tasmanian Seamounts due to similar depths in the South-east Marine Region (Richardson et al. 2005).

According to DSEWPaC (2012) the Diamantina Fracture Zone is regionally important because of to enhance productivity and assist with dispersal and migration of species across the region and wider abyssal plain (Wilson & Kaufman 1987, in Richardson *et al.* 2005). While research on the Diamantina Fracture Zone is limited, its size, physical complexity and isolation indicate that it is likely to support deepwater communities characterised by high species diversity and endemism.

10.1.24 Demersal Slope and Associated Fish Communities of the Central Western Province)

The demersal slope and associated fish communities of the Central Western Province is located on the edge of the shelf to the limit of the exclusive economic zone from Perth to the northern boundary of the SWMR. The area supports a diverse demersal fish species assemblage of relatively small benthic species (e.g. grenadier, dogfish and cucumber fish) at depths greater than 400 m. Fish species within this area have adapted physically to feed on the seafloor and do not appear to migrate vertically to feed (Williams *et al.* 2001).

According to DSEWPaC (2012), the demersal slope and associated fish communities of the Central Western Province are recognised as a KEF for their high levels of biodiversity and endemism. A total of 480 fish species have been described that inhabit the slope of this bioregion with 31 considered to be endemic to the bioregion. Demersal fish communities within the area have recorded higher diversity when compared to other oceanic regions which have been more intensively sampled. The increased diversity within the area has been attributed to the overlap of ancient and extensive Indo-west Pacific and temperate Australasian fauna (Williams et al. 2001).

10.1.25 Albany Canyons Group and Adjacent Shelf Break

The Albany Canyons group and adjacent shelf break is located along a 700 km extent ranging from Cape Leeuwin to the east of Esperance and consists of 32 deep canyons which cut into the continental slope. Sonar surveys have indicated that individual canyons can extent up to 90 km long at water depths of 2,000 m. The canyons can start at the uppermost continental slope and reach the lowermost slope and extend onto the abyssal plain (Exon *et al.* 2005).

Due to close spacing of the numerous canyons, a wide range of depth dependent benthic habitats are connected increasing the habitat heterogeneity along the south western Australian continental margin. Offshore transport increases the sediment load and organic material is received from productive shelf waters. The closely spaced canyons have the potential to allow increased amounts of organic matter to reach the abyssal plain which may increase biodiversity in comparison to other areas within the south west Marine Region. (Richardson e*t al.* 2005).

According to DSEWPaC (2012), the Albany Canyons group and adjacent shelf break is regionally important and recognised as a key ecological feature for its high productivity, aggregations of marine life, and as a unique seafloor feature with ecological properties of regional significance (Pattiaratchi 2007). Both benthic and demersal habitats within the feature are of conservation value. The canyons are known to be a feeding area for the sperm whale (Bannister *et al.* 1996) and sites of orange roughy aggregations (Caton & McLoughlin 2004).

11. State Marine Conservation Reserves

11.1 Introduction

Marine parks and reserves have been progressively established in Western Australia since 1987. The Conservation and Parks Commission (CPC) is the vesting authority for marine parks and reserves under the provisions of the *Conservation and Land Management Act 1984*. Parks and Wildlife, within the Department of Biodiversity, Conservation and Attractions (DBCA), is responsible for day to day management of the parks.

There are three categories of state marine conservation reserves: marine parks; marine management areas; and marine nature reserves.

Marine parks are created to protect natural features and aesthetic values while allowing recreational and commercial uses that do not compromise conservation values. There are currently 18 marine parks within the EMBA (refer **Figure 9-1**, **Figure 9-2** and **Figure 9-3**).

Marine parks are multiple-use reserves that cater for a wide range of activities. Within marine parks there may be four types of management zones: recreation zones: general use zones; no-take areas known as sanctuary zones; and special purpose zones.

Each marine park has a 'management plan' that contains strategies to protect the high value assets in the park, as well as permitted activities tables. These tables provide explicit regulatory management.

Sanctuary zones are 'no-take' areas created primarily for conservation and scientific research and are designed to protect a particular significant ecosystem or habitat. Low-impact tourism may be permitted, but no recreational or commercial fishing, aquaculture, pearling, petroleum drilling or production is allowed.

Marine management areas provide an integrated management structure over areas that have high conservation value and intensive multiple-use. There are two marine management areas within the EMBA (described below).

There is currently only one state marine nature reserve: Hamelin Pool Nature Reserve part of the Shark Bay World Heritage Area (**Section 9.1.1**)

11.1.1 Ngari Capes Marine Park

The Ngari Capes Marine Park is gazetted as a Class A Marine Park. The park is located off the southwest coast of Western Australia, approximately 250 km south of Perth, covering approximately 123,790 ha. The seaward boundary of the marine park is congruent with the seaward limit of Western Australian waters (three nautical miles from the territorial baseline). The north-eastern boundary in Geographe Bay is located near the intersection of the Shire of Busselton boundary with the coastline. The Shire of Busselton–Shire of Capel boundary is approximately 30 m north-east of the marine park boundary, while the south-eastern boundary in Flinders Bay is located at 115˚17'00" E. The marine park consists of four areas that are representative of the Leeuwin–Naturaliste marine bioregion: Geographe Bay; Cape Naturaliste to Cape Mentelle coast; the Cape Mentelle to Cape Leeuwin coast; and Flinders Bay. These areas show distinct differences in geomorphology, oceanography, habitats and flora and fauna.

The Ngari Capes Marine Park was identified as one of the most diverse temperate marine environments in Australia. Warm, tropical waters of the Leeuwin Current mix with the cool waters of the Capes Current, resulting in high finfish diversity, including tropical and temperate species (see fish in **Section 5.1.1**) and internationally significant seagrass diversity with seagrasses occurring at depths greater than 40 m (see seagrasses in **Section 3.2**). The marine park also surrounds a number of islands that are important seabird nesting habitat and pinniped haul-outs (places where seals and sea lions leave the water and come onto land), including Hamelin Island, Sugarloaf Rock and the Saint Alouarn Islands which include Flinders Island, Seal Island and Square Rock (DEC 2013). These islands are vested with the Conservation Commission as nature reserve and are managed by DBCA for the purpose of conservation. The marine park is also adjacent to the Leeuwin Naturaliste National Park which extends to the high water mark (DEC 2013).

The Ngari Capes marine park was also created for its high social values. The unique geographical location of this region exposes it to large, uninterrupted ocean swells and results in the South West capes area being recognised as one of the world's premier surfing regions. Many activities occurring in the region are marine based, including commercial and recreational fishing, swimming, surfing, diving, snorkelling, boating, and marine nature-based tourism.

11.1.2 Jurien Bay Marine Park

The Jurien Bay Marine Park is a Class A marine park located on the central west coast of Western Australia about 200 km north of Perth and covers an area of 82,375 ha (CALM 2005b). Its western boundary is the seaward limit of Western Australian coastal waters. Its northern boundary is the northern point of Dynamite Bay at Green Head (30° 4' 7.9" South), and its southern boundary is located just south of Wedge (30° 50' 20" South) and is contiguous with the southern boundary of the Wanagarren Nature Reserve.

Jurien Bay Marine Park is considered to be broadly representative of the Central West Coast limestone reef system, which is a major marine ecosystem within this bioregion. The marine biota of the area consists of an unusual mix of tropical and temperate species as well as many endemic species (Larkum & Hartog, 1989). The Marine Park is dominated by five major marine habitat types: seagrass meadows; bare or sparsely vegetated mobile sand; shoreline and offshore intertidal reef platforms; subtidal limestone reefs; and reef pavement (CALM 2005b). Marine wildlife includes 14 species of cetaceans, a variety of sea and shorebirds which nest on the islands and the Australian sea lion (North Fisherman Island to the north of Jurien Bay is one of the main breeding sites for sea lions in the Central West Coast region and it is believed this breeding population is genetically distinct from the southern coast population – Gales et al. 1992). Commercial fishing for western rock lobster as well commercial wetlining, abalone, shark netting, beach seining for mullet and collecting of specimen shells and aquarium fish are carried out within the marine park.

11.1.3 Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve

The Shark Bay Marine Reserves comprise the Shark Bay Marine Park and the Hamelin Pool Marine Nature Reserve. The Shark Bay Marine Park was gazetted on 30 November 1990 as A Class Marine Park Reserve No. 7 and vested in the National Park and Nature Conservation Authority (NPNCA) under the CALM Act. The marine park encompasses an area of 748,725 ha (CALM 1996).

The Bay is located near the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay, 83% are tropical species with 11% warm temperate and 6% cool temperate species. Similarly, of the 218 species of bivalves recorded in Shark Bay, 75% have a tropical range and 10% a southern Australian range, with 15% being endemic to the west coast (CALM 1996).

Key features of Shark Bay Marine Park include (CALM 1996, DSEWPaC 2013b):

+ 12 species of seagrass making it one of the most diverse seagrass assemblages in the world;
+ Seagrass that covers over 4,000 km2 of the bay. The 1,030 km2 Wooramel Seagrass Bank is the largest structure of its type in the world;
+ An estimated population of about 11,000 dugongs, one of the largest populations in the world;
+ Humpback and southern right whales use the bay as a migratory staging post;
+ Bottlenose dolphins occur in the bay, and green turtle and loggerhead turtle nest on the beaches;
+ Large numbers of sharks including whaler, tiger shark and hammerhead are present as well as an abundant population of rays, including the manta ray;
+ Hamelin Pool in Shark Bay contains the most diverse and abundant examples of stromatolite forms in the world, representative of life-forms which lived some 3,500 million years ago; and
+ Shark Bay Marine Park does not cover Bernier and Dorre Islands and only coastal waters inshore of Dirk Hartog Island (east of eastern shoreline).

Shark Bay was included on the World Heritage List in 1991 primarily on the basis of three natural features: vast seagrass beds; dugong population; and stromatolites (microbial colonies that form hard, dome-shaped deposits and are among the oldest forms of life on Earth) (DSEWPaC 2013b; see **Section 9.1**).

There is no zoning within the Hamelin Pool Marine Nature Reserve. This area is a 'look but don't take' area managed solely for the conservation of globally outstanding marine life. Hamelin Pool is one of only two known places in the world with living examples of marine stromatolites (DEC 2010). The shores of Hamelin Pool are also important for the formation of extensive marine algal mats formed by microbial algae. If damaged, the mats and stromatolites can take many hundreds of years to recover (DEC 2010).

11.1.4 Ningaloo Marine Park

The Ningaloo Marine Park was declared in May 1987 under the National Parks and Wildlife Conservation Act 1975 (Commonwealth). The Ningaloo Coast, incorporating both key marine and terrestrial values was later granted World Heritage Status in June 2011. In November 2012, the Ningaloo Marine Park (Commonwealth Waters) was renamed to be incorporated in the North-west Commonwealth Marine Reserves Network. The park covers an area of 263,343 km^2, including both State and Commonwealth waters, extending 25 km offshore.

The park protects a large portion of Ningaloo Reef, which stretches over 300 km from North West Cape south to Red Bluff. It is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that varies in width from 200 m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). The Ningaloo Marine Park forms the backbone of the nature-based tourism industry, and recreational activities in the Exmouth region. Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

The reef is composed of partially dissected basement platform of Pleistocene marine or Aeolian sediments or tertiary limestone, covered by a thin layer of living or dead coral or macroalgae. Key features that characterise the Ningaloo Reef include (CALM 2005):

+ Over 217 species of coral (representing 54 genera);
+ Over 600 species of mollusc (clams, oysters, octopus, cuttlefish, snails);
+ Over 460 species of fish;
+ Ninety-seven species of echinoderms (sea stars, sea urchins, sea cucumbers);
+ Habitat for numerous threatened species, including whales, dugong, whale sharks and turtles; and
+ Habitat for over 25 species of migratory wading birds listed in CAMBA and JAMBA.

11.1.5 Muiron Islands Marine Management Area

The Ningaloo Marine Park Management Plan (CALM 2005) created a MMA for the Muiron Islands, immediately adjacent to the northern end of the Park. This is managed as an integrated area together with the Ningaloo Marine Park, but its status as a MMA means that some activities, including oil and gas exploration, are still permitted under a strict environmental assessment process involving DMIRS.

The Muiron Islands, located 15 km northeast of the North West Cape comprise the North and South Muiron Islands and cover an area of 1,400 ha (AHC 2006). They are low limestone islands (maximum height of 18 m above sea level (ASL)) with some areas of sandy beaches, macroalgae and seagrass beds in the shallow waters (particularly on the eastern sides) and coral reef up to depths of 5m, which surrounds both sides of South Muiron Island and the eastern side of North Muiron Island. The Muiron Islands MMA was WA's first MMA, gazetted in November 2004. It covers an area of 28,616 ha and occurs entirely within state waters (CALM 2005).

11.1.6 Barrow Island Marine Park

The Barrow Island Marine Park covers 4,169 ha, all of which is zoned as sanctuary zone (the Western Barrow Island Sanctuary Zone) (DEC 2007). It includes Biggada Reef, an ecologically significant fringing reef, and Turtle Bay, an important turtle aggregation and breeding area (DEC 2007). Representative areas of seagrass, macroalgal and deep water habitat are also represented within the marine park (DEC 2007). Passive recreational activities (such as snorkelling, diving and boating) are permitted but extractive activities such as fishing and hunting are not.

11.1.7 Barrow Island Marine Management Area

The Barrow Island Marine Management Area (MMA) is the largest reserve within the Montebello/Barrow Islands marine conservation reserves, covering 114,693 ha (DEC 2007). The MMA includes most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park, with the exclusion of the port areas of Barrow Island and Varanus Island.

The MMA is not zoned apart from one specific management zone: the Bandicoot Bay Conservation Area. This conservation area is on the southern coast of Barrow Island and has been created to protect benthic fauna and seabirds. It includes the largest intertidal sand/mudflat community in the reserves, is known to be high in invertebrate diversity and is an important feeding area for migratory birds.

As for the other reserves in the Montebello/Barrow Islands marine conservation reserves, the Barrow Island MMA includes significant breeding and nesting areas for marine turtles and the waters support a diversity of tropical marine fauna, important coral reefs and unique mangrove communities (DEC 2007). Green, hawksbill and flatback turtles regularly use the island's beaches for breeding, and loggerhead turtles are also occasionally sighted.

11.1.8 Montebello Islands Marine Park

Montebello/Barrow/Lowendal Islands are part of a shallow submarine ridge, which extends north from the mainland near Onslow. The ridge contains extensive areas of intertidal and shallow subtidal limestone pavement surrounding the numerous, mostly small islands which are found in the region. The seabed is generally less than 5 m deep and consists of sand veneered limestone pavement with patches of fringing coral reef (DEC 2007).

The island chain lies entirely within WA State waters, with the State-Commonwealth boundary extending out to encompass the islands and waters 3 nm west of Barrow Island and north of the Montebello Islands. These islands are protected within as marine conservation reserves: Montebello Islands Marine Park, Barrow Islands Marine Park and Barrow Island Marine Management Area.

The Montebello Islands Marine Park (58,331 ha), consists of two sanctuary zones, two recreation zones, one special purpose zone for benthic protection, eleven special purpose zones for pearling and general use zones.

The Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops; rocky shore accounts for 81% of shoreline habitat (DEC 2007a).

The ecological and conservation values of the Montebello and Barrow Islands Marine Conservation Reserve (MCR) include important habitats including corals reefs and bommies, mangroves, seagrass and macroalgae meadows, rocky shorelines and hard substrate, intertidal sand and mudflat communities. These habitats provide protection, food and habitat for a large diversity of species, including dugongs, turtles, whales, other protected cetaceans and birds as well as sea snakes and fish. The area is considered to have a high biodiversity. The islands also provide feeding and resting areas for migrating shorebirds and seabird nesting areas.

Socio-economic values of the Montebello and Barrow Islands MCR include hydrocarbon exploration and production, pearling, nature-based tourism, commercial and recreational fishing, water sports, European history and maritime heritage and scientific research (DEC 2007)

Special purpose zones for pearling are established for the existing leaseholder to allow pearling to be the priority use of these areas (DEC 2007a). Commercial fishing includes a trap fishery for reef fishes, mainly in water depths of 30–100 m, and wet lining for reef fish and mackerel. Fish trawling also occurs in the waters near to the Montebello Islands. A tourist houseboat operates out of Claret Bay, at the southern end of Hermite Island, during the winter months. The Montebello Islands are becoming more frequently used by recreational boaters for camping, fishing and diving activities.

11.1.9 Rowley Shoals Marine Park

The Rowley Shoals (including the Commonwealth-managed Mermaid Reef Marine National Nature Reserve) are located approximately 300 km west-northwest of Broome, lying between 17°07'S, 119°36'E and 17°35'S, 118°56'E and encompassing approximately 87,674 ha (DEC 2007b).

The Rowley Shoals is ecologically significant in that the reefs form part of a series of important ecological "stepping stones" for a range of reef biota originating in Indonesian/west Pacific waters. Their position off the north-west Australian coast, an area of few offshore reef systems, provides an important upstream source for recruitment to reefs further south (DEC 2007b). Marine wildlife includes 184 species of corals, primarily Indo-West Pacific species, indicating the strong affinity of the Rowley Shoals communities with Indonesia. In terms of other species, at least 264 species of molluscs, 82 species of echinoderms and 389 species of finfish were also identified (DEC 2007b). The faunal assemblages of the Rowley Shoals Marine Park are regionally significant as they contain large numbers of species not found in the more turbid coastal environments of tropical Western Australia (DEC 2007b). There is a relatively low level of recreational and commercial activity, mostly atribuated to the remoteness of the Shoals with access difficult from both Indonesia and mainland Australia (DEC 2007b).

11.1.10 Lalang-garram/Camden Sound Marine Parks

The Lalang-garram/Camden Sound Marine Park was created on 19 June 2012 under Section 13 of the Conservation and Land Management Act 1984 (CALM Act). It is a multiple zone marine park that includes; Sanctuary, Special Purpose, and General Use zones (DPaW 2013). The marine park falls within the west Kimberley, which was recently added to the Australian National Heritage List because of its natural, indigenous and historic values to the nation.

The marine park is located about 150 km north of Derby (or 300 km north of Broome) and lies within the traditional country of three Aboriginal native title groups. The Dambimangari people's determination overlies the majority of the marine park. A section of the Wunambal Gaambera people's Uunguu determination includes a small portion of St George Basin, while a small section of the Mayala people's claim (native title not determined at the time of writing of Management Plan) overlies the southwest corner of the marine park (DPaW 2013).

The marine park covers an area of approximately 705,000 ha. It recognises and provides special management arrangements for this area of the Kimberley, which is a principal calving habitat of the humpback whale (*Megaptera novaeangliae*) population that migrates annually along Western Australia's coast. The marine park also conserves a range of species listed as having special conservation status 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 shoals, and the extensive mangrove forests and marine life of the St George Basin and Prince Regent River (DPaW 2013).

11.1.11 Marmion Marine Park

Marmion Marine Park was Western Australia's first marine park, declared in 1987 and is a multi-use reserve (CALM 2002). Marmion Marine Park is located offshore from Perth's northern suburbs, between Trigg Island and Burns Beach.

Habitats in the area include intertidal reef platforms, coastal sand beaches, a high limestone reef about 1 km from shore, Little Island and the Three Mile Reef system. Of note are complex assemblages of sea floor communities, including seagrass meadows, algal limestone pavement communities and crevice animal associations (CALM 2002).

The marine park provides an important habitat for marine mammals, such as sea lions, dolphins and whales. The island nature reserves within Marmion Marine Park provide an important habitat for several species of seabirds and haul-out areas for Australian sea lions, especially at Little Island and Burns Rocks (CALM 2002).

11.1.12 Swan Estuary Marine Park

The Swan Estuary Marine Park (A Class marine reserve number 4) was gazetted on 25 May 1990. The Swan Estuary Marine Park and Adjacent Nature Reserves Management Plan 1999-2009 was gazetted 7 April 2000 (CALM 1999).

The Swan Estuary Marine Park encompasses Alfred Cove, 200 ha adjacent to the suburbs of Attadale and Applecross; Pelican Point, a 45 ha area in Crawley; and Milyu, 95 ha adjacent to the Como foreshore (CALM 1999). All three localities are within 20 minutes of the Perth CBD.

These areas encompass mudflats, seagrass beds and intertidal vegetation such as sedges and saltmarsh, which provide many different habitats for a host of animals. The most important of these, due to their international significance, are the migratory wading birds. They come from as far afield as Asia, Mongolia and Siberia. About 33 of these species are protected, including the red-necked stint (CALM 1999).

11.1.13 Shoalwater Islands Marine Park

The Shoalwater Islands Marine Park is located within the Perth metropolitan area, adjacent to the city of Rockingham and was gazetted in 1990 (DEC 2007). There are three sanctuary zones, two special purpose zones and a large general use zone in the park.

The Shoalwater Island region is dominated by beach and rocky shore shoreline habitats. The many jagged edged islands and rocky islets of the marine park provide important roosting and nesting areas for numerous bird species. The marine park has some of the healthiest seagrass meadows in the Perth metropolitan area, consisting of long lived species such as *Posidonia* spp. and *Amphibolis* spp. Seagrass meadows provide an important habitat and nursery area for a large number of marine species such as fish, rock lobsters, worms, shellfish, crustaceans, fish sharks and rays (DEC 2007).

The habitats of the marine park are important for the feeding, resting and breeding of little penguins and other sea and shore birds. Penguin Island which is found within the marine park has the largest breeding colony of little penguin on the west coast of Australia (DEC 2007). The bottlenose dolphin is the most common marine mammal, and Australian sea lions are commonly seen throughout the park.

11.1.14 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park, located between Port Hedland and Broome, was gazetted on 29 January 2013. It covers an area of approximately 200,000 ha stretching for some 220 km from Cape Missiessy to Cape Keraudren, and includes sanctuary, recreation, general use and special purpose zones. The park is managed under the Eighty Mile Beach Marine Park Management Plan 2014-20124 (DPaW, 2014).

The listed ecological values of the Eighty Mile Beach Marine Park include the high sediment and water quality, the juxtaposition of the beach, coastal topography and seabed and the diverse and ecologically important habitats and marine/coastal flora and fauna. The listed habitat values of the marine park are as follows:

+ The intertidal sand and mudflat communities supporting a high abundance and diversity of invertebrate life and providing a valuable food source for shorebirds (including migratory species) and other fauna;
+ The diverse subtidal filter-feeding communities;
+ Macroalgal and seagrass communities providing habitat and feeding opportunities for fish, invertebrates and dugongs;
+ High diversity intertidal and subtidal coral reef communities; and
+ Mangrove communities and adjacent saltmarshes provide nutrients to the surrounding waters and habitat for fish and invertebrates.

The listed marine and coastal fauna values are as follows:

- A high diversity and abundance of nationally and internationally important shorebirds and waders (including migratory species) are found in the marine park;
- Flatback turtles are endemic to northern Australia and nest at Eighty Mile Beach;
- Dugongs and several whale and dolphin species inhabit or migrate through the marine park;
- A highly diverse marine invertebrate fauna provides an important food source for a variety of animals, including birds, fish and turtles, along with recreational and commercial fishing opportunities;
- A diversity of fish species provides recreational and commercial fishing opportunities; and
- A diversity of sharks and rays, including several protected species, are found in the park.

In addition to these natural values, the marine park contains land and sea important to traditional Indigenous owners through identity and place, family networks, spiritual practice and resource gathering. The marine park also has a history of European activity including exploration, pastoralism and commercial fishing (e.g. the pearl oyster fishery). The park contains a historical WWII plane wreck (*Dornier Do-24 X-36*) and shipwrecks (two pearl luggers). The marine park provides tourism opportunity and recreational value through its remoteness, diversity and abundance of habitats and marine fauna and the pristine nature of the marine and coastal environment.

The marine park contains vast intertidal sand and mudflats that extend up to 4 km wide at low tide and provide a rich source of food for many species. Eighty Mile Beach Marine Park is one of the world's most important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DPaW 2014) (see **Section 9.2.1**).

11.1.15 Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Parks

The Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Parks were established in 2016 under the State Government's *Kimberley Science and Conservation Strategy* and are jointly managed by Dambimangari Traditional Owners and the Department of Parks and Wildlife (DPaW 2016). The marine parks fall within the west Kimberly region, included in the Australian National Heritage List for its nationally significant natural, indigenous and historic values (DoEE 2019c).

The Lalang-garram/ Horizontal Falls Marine Park extends from Talbot Bay (*Ganbadba*) in the west to Walcott Inlet (*Iledda*) and Glenelg River (*Molor Moloiyn*) in the east and covers approximately 353,000 ha (DPaW 2016). The marine park protects the internationally recognised Horizontal Falls and is important for the region's tourism. The North Lalang-garram Marine Park lies between the Lalang-garram / Camden Sound and North Kimberley Marine Parks and covers approximately 110,000 ha (DPaW 2016).

The area's large tidal range results in extensive intertidal areas with diverse ecosystems such as fringing coral reefs, mangroves and mudflat communities. Subtidal habitats and communities common to the marine parks include filter feeding communities of sponges and hard and soft corals. These intertidal and subtidal habitats provide critical foraging and nursery areas for dugong, marine turtles, estuarine crocodiles, snubfin and Indo-Pacific humpback dolphins, several species of sawfish and migratory seabirds. The marine parks are also a principal calving habitat for humpback whales (DPaW 2016).

11.1.16 North Kimberley Marine Park

The North Kimberley Marine Park was established in December 2016 as a Class A marine park under the CPC (DPaW 2016a). The marine park comprises four separate management areas including, Uunguu, Balanggarra, Miriuwung Gajerrong, and Wilinggin. It is a multiple zone marine park that includes: eight sanctuary zones, nine special purpose zones (recreation and conservation), two special use zone (cultural heritage), and general use areas (DPaW 2016a). The marine park is managed in accordance with the provisions of the CALM Act with joint management between the Department of Parks and Wildlife and Traditional Owners of the area.

The area within the marine park is recognised for its Aboriginal cultural and heritage values, natural values including coral reefs, marine turtle species, dugongs, seagrass and macroalgal communities, mangroves and saltmarshes, finfish, and water and sediment quality, as well as for its social values (i.e. recreation, tourism and community values) and commercial values and resource use (e.g. commercial fishing). The marine park lies within the Indian Ocean and Timor Sea of Western Australia's Kimberley region, covering an area of approximately 1,845,000 hectares (DPaW 2016a). The south-western boundary is approximately 270 km northeast of Derby.

11.1.17 Yawuru Nagulagun/ Roebuck Bay Marine Park

The Yawuru Nagulagun/Roebuck Bay Marine Park was approved by the State Minister for Environment in October 2016 and declared as a Class A reserve over the subtidal and intertidal areas of Roebuck Bay (excluding the Kimberley Ports Authority waters), (DBCA, 2017a). The Marine Park is managed with a joint management framework between Parks and Wildlife and Yawuru Registered Native Title Body Corporation (RNTBC). The intent is to manage the areas from the offshore waters around Roebuck and Broome, collectively referred to as the Yawuru conservation estate, as one ecological system (DPaW 2016b). The development of the joint management plan is in accordance with the Conservation and Land Management Act 1984 (Yawuru Organisation 2017) as well as contributes to the State Governments commitment under the Kimberly Science and Conservation Strategy, released in June 2011.

The Yawuru people have lived along the foreshores of Roebuck Bay for thousands of years, the Bay is part of the Yawuru traditional estate (DPaW 2016b). Roebuck Bay is an internationally significant Ramsar wetland, declared in 1990, and an important feeding ground for many species of migratory shorebirds. It hosts possibly the greatest diversity of shorebird species at any site across the globe (DBCA 2017b). The Bay has some of the most productive tropical intertidal flats in the world, and is consequently an important ground for Yawuru fishing, hunting and gathering of sea food. The Bay hosts communities of seagrass and macroalgae, providing food for protected species such as the dugong and flatback turtle. Marine mammals also pass through the waters of the Bay such as the Australian snubfin dolphin and the humpback dolphin, the humpback whale can also be found during annual migration (DPaW 2016b).

12. Australian Marine Parks

12.1 Introduction

In agreement with the States and NT governments, the Australian Commonwealth government was committed to establish Commonwealth marine parks as a component of the National Representative System of Marine Protected Areas (DoE 2014) (See **Figure 9-1, Figure** 9-2 and **Figure 9-3**). In November 2012, the Commonwealth Marine Reserves Network was proclaimed with the purpose of protecting the biological diversity and sustainable use of the marine environment (Director of National Parks 2012a). Commonwealth Marine Reserves were renamed as Australian Marine Parks in October 2017. Six marine regions are included in the Australian Marine Parks Network, including the Coral Sea, the South-west, the Temperate East, the South-east the North and the North-west. The South-east network 10-year Management Plan came into effect on 1 July 2013. The remaining networks 10-year Management Plans were approved and came into effect on 1 July 2018.

The new management plans establish the management and zoning of the designated marine parks. The marine park networks pertinent to the EMBA include:

- The South-West Marine Parks Network;
- The North-West Marine Parks Network; and
- The North Marine Parks Network.

The South-West Marine Parks Network comprises 14 marine parks. Six of these occur in West Australian waters in the EMBA, including:

- Abrolhos Commonwealth Marine Park;
- Jurien Marine Park;
- Two Rocks Marine Park;
- Perth Canyon Marine Park;
- Geographe Marine Park;
- South-west Corner Marine Park; and
- Bremer Marine Park

The North-West Marine Parks Network comprises 13 marine parks which all occur in West Australian waters pertinent to the EMBA:

- Carnarvon Canyon Marine Park;
- Shark Bay Marine Park;
- Gascoyne Marine Park;
- Ningaloo Marine Park;
- Montebello Marine Park;
- Dampier Marine Park;
- Eighty Mile Beach Marine Park;
- Argo-Rowley Terrace Marine Park;
- Mermaid Reef Marine Park;
- Roebuck Marine Park;

- Kimberley Marine Park;
- Ashmore Reef Marine Park; and
- Cartier Island Marine Park.

The Northern Marine Parks Network comprises eight marine parks. However, only the Oceanic Shoals Marine Park extends across the boundary with the North-West Marine Parks Network, into the EMBA.

The sizes of these marine parks range from 300—152,000 km^2, and the water depths within the marine parks vary from approximately 15—1,500 m deep. The EPBC Act requires that each management plan assign an International Union for the Conservation of Nature (IUCN) category to each marine park. Additionally, the Act also allows for the management plan to divide a marine park into zones and to assign a category to each zone, which may differ from the overall category of the marine park. Zoning takes into account the purposes for which the marine parks were declared, the objectives of the relevant management plans, the values of the marine park and requirements of the EPBC Act and EPBC Regulations.

Five types of zone are represented within the North Marine Parks Network. However, it is only the Multiple Use Zone (IUCN Category VI) of the Oceanic Shoals Marine Park which extends into the EMBA.

The North-West Marine Parks Network includes six different types of zoning:

- Sanctuary Zone (IUCN Category Ia);
- National Park Zone (IUCN Category II);
- Recreational Use Zone (IUCN Category IV);
- Habitat Protection Zone (IUCN Category IV);
- Multiple Use Zone (IUCN Category VI); and
- Special Purpose Zone (Trawl) (VI).

The South-west Marin Parks Network includes six different types of zoning:

- National Park Zone (IUCN Category II);
- Habitat Protection Zone (IUCN Category IV);
- Multiple Use Zone (IUCN Category VI);
- Special Purpose Zone (Mining Exclusion) (IUCN Category VI);
- Special Purpose Zone (IUCN Category VI); and
- Special Purpose Zone (Trawl) (IUCN Category VI).

A summary of the South-West and North-West Marine Parks Networks is provided in **Table 12-1**.

12.2 South-West Marine Parks Network

The South-West Commonwealth Marine Parks Network is aligned to the South-West Marine Region. The network covers 508,371 km^2 and includes 14 marine parks (Director of National Parks, 2018a). Broad values of the South-west Australian Marine Parks include:

- Natural values;
- Cultural values;
- Heritage values; and
- Socio-economic values.

Further detail on each of the relevant marine parks those that fall within the EMBA is provided below.

12.2.1 Abrolhos Marine Park

The Abrolhos Marine Park (including zones within the EMBA: Marine National Park Zone – IUCN Category II-2,548 km^2; Habitat Protection Zone – IUCN Category VI-23,239 km^2; Multiple Use Zone – IUCN Category VI-56,545 km^2; Special Purpose Zone – IUCN Category VI-5,729 km^2) covers and area of approximately 88,060 km^2 and protects the following conservation values (Director of National Parks, 2018a):

- Important foraging areas for the:
  - Threatened Australian lesser noddy;
  - Northernmost breeding colony of the threatened Australian sea lion;
  - Great white sharks; and
  - Migratory common noddy, wedge-tailed shearwater, bridled tern, Caspian tern and roseate tern.
- Important migration habitat for the protected humpback whale and pygmy blue whales;
- The second largest canyon on the west coast, the Houtman Canyon;
- Examples of the northernmost ecosystems of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion);
- Examples of the deeper ecosystems of the Abrolhos Islands meso-scale bioregion;
- Examples of the shallower, southernmost ecosystems of the Central Western Shelf Province provincial bioregion including the Zuytdorp meso-scale bioregion;
- Examples of the deeper ecosystems of the Central Western Transition provincial bioregion;
- Examples of diversity of seafloor features including: southern most banks and shoals of the North-west region; deep holes and valleys; slope habitats; terrace and shelf environments; and
- Seven KEFs.

The Abrolhos Marine Park is adjacent to the Shark Bay World Heritage Property. The marine park does not contain any Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains 11 known shipwrecks listed under the *Underwater Culture Heritage Act 2018* . Commercial tourism, fishing, recreation and mining are important supported socio-economic activities in the park.

12.2.2 Jurien Marine Park

The Jurien Marine Park (including zones within the EMBA): Marine National Park Zone -IUCN Category II – 31 km^2 Special Purpose Zone -IUCN Category VI – 1,820 km^2) covers and area of approximately 1,851 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Threatened Australian sea lion;
  - Threatened white shark; and
  - Migratory roseate tern, bridled tern, wedge-tailed shearwater, and common noddy.
- Important migration habitat for the protected humpback whale;
- Examples of the ecosystems of two provincial bioregions: the central part of the South-west Shelf Transition (which includes the Central West Coast meso-scale bioregion) and small parts of the Central Western Province;
- Three KEFs; and
- Heritage values represented by the SS Cambewarra and Oleander historic shipwreck.

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The Jurien Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, recreation and mining are important supported socio-economic activities in the park.

12.2.3 Two Rocks Marine Park

The Two Rocks Marine Park (including zones within the EMBA): Multiple Use Zone - IUCN Category VI – 867 km^2; Marine National Park Zone - IUCN Category II – 15 km^2) covers an area of approximately 882 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Threatened Australian sea lion; and
  - Migratory roseate tern, bridled tern, Caspian tern, wedge-tailed shearwater, and common noddy.
+ Important migratory areas for protected humpback whales and pygmy blue whales;
+ Seasonal calving habitat for the threatened southern right whale;
+ Examples of the ecosystem of the southernmost parts of the South-west Shelf Transition (including the Central West Coast meso-scale bioregion); and
+ Three KEFs.

The Two Rocks Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, recreation and scientific research are important supported socio-economic activities in the park.

12.2.4 Perth Canyon Marine Park

Perth Canyon Marine Park (including zones within the EMBA): Marine National Park Zone – IUCN Category II – 1,241 km^2; Habitat Protection Zone – IUCN Category IV –4,352 km^2; Multiple Use Zone – IUCN Category VI – 1,816 km^2) covers an area of approximately 7,409 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Globally important seasonal feeding aggregation for the threatened blue whale;
+ Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Migratory sperm whale; and
  - Migratory wedge-tailed shearwater.
+ Important migratory areas for protected humpback whales and blue whales;
+ Seasonal calving habitat for the threatened southern right whale;
+ Examples of the ecosystems of the southernmost parts of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion), and the northernmost parts of the South-west Transition and Southwest Shelf Province (including the Leeuwin-Naturaliste meso-scale bioregion); and
+ Four KEFs.

The Perth Canyon Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, shipping, recreation and defence training are important supported socio-economic activities in the park.

12.2.5 Geographe Marine Park

Geographe Marine Park (including zones within the EMBA): Marine National Park Zone - IUCN Category II – 15 km^2; Special Purpose Zone - IUCN VI – 650 km^2; Multiple Use Zone - IUCN Category VI – 291 km^2; Habitat Protection Zone (IV) 21 km^2) covers an area of approximately 977 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Important foraging areas for the:
  - Threatened soft-plumaged petrel; and
  - Migratory wedge-tailed shearwater.
- Important pre-migration aggregation area for the migratory flesh-footed shearwater;
- Important migratory habitat for the protected humpback whale and blue whale;
- Seasonal calving habitat for the threatened southern right whale.
- Seasonal calving habitat for the threatened southern right whale.
- Representation of the South-west Shelf Province on the continental shelf as well as the Leeuwin-Naturaliste meso-scale bioregion;
- Two KEFs; and
- Representation of the seagrass habitats of the Geographe Bay key ecological feature, which in this location extend the furthest into Commonwealth waters.

The Geographe Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains eight known shipwrecks listed under the *Underwater Culture Heritage Act 2018.* Commercial tourism, fishing and recreation are important supported socio-economic activities in the park.

12.2.6 South-west Corner Marine Park

The South-west Corner Marine Park (including zones within the EMBA: Marine National Park Zone - IUCN II – 54,841 km^2; Multiple Use Zone - IUCN VI –106,602 km^2; Special Purpose Zone (Mining exclusion) - IUCN VI – 9,550 km^2, Special Purpose Zone – IUCN VI – 5753 km^2; Habitat Protection Zone - IUCN IV – 95,088 km2) covers an area of approximately 271,833 km2 within the EMBA and protects the following conservation values (Director of National Parks 2018a):

- Important migratory area for protected humpback whales and blue whales;
- Important foraging areas for the:
  - Threatened white shark;
  - Threatened Australian sea lion;
  - Threatened Indian Yellow-nosed albatross and soft-plumaged petrel;
  - Sperm whale;
  - Migratory flesh-footed shearwater, short-tailed shearwater and Caspian tern; and
  - Seasonal calving habitat for the threatened southern right whale.
- Representation of three provincial bioregions (the South-west Transition and Southern Province in the off-shelf area, and the South-west Shelf Province on the continental shelf) and two meso-scale bioregions (southern end of the Leeuwin-Naturaliste meso-scale bioregion and western and central parts of the Western Australia South Coast meso-scale bioregion);
- Representation of the Donnelly Banks, east of Augusta, characterised by higher productivity and including nursery habitats; and

- Six KEFs.

The South-west Corner Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains ten known shipwrecks listed under the *Underwater Culture Heritage Act 2018* . Commercial tourism, fishing, shipping and recreation are important supported socio-economic activities in the park.

12.2.7 Bremer Marine Park

The Bremer Marine Park: National Park Zone – IUCN II – 3,172 km^2; Special Purpose Zone (Mining exclusion) - IUCN VI – 1,300 km^2, which covers an area of approximately 4,472 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Contains habitats, species and ecological communities associated with two bioregions: Southern Province and South-west Shelf Province;
- Two key ecological features (Albany Canyon group and adjacent shelf break and ancient coastline between 90 m and 120 m depth);
- Important foraging areas for:
- Threatened white shark;
- Threatened Australian sea lion;
- Threatened Indian Yellow-nosed albatross, Fairy tern and soft-plumaged petrel; and
- Migratory flesh-footed shearwater, short-tailed shearwater, Bridled tern and Caspian tern.
- Important migratory pathway for humpback whales;
- Significant calving habitat for the threatened southern right whale; and
- Important aggregation area for killer whales

The marine park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, shipping and recreation are important supported socio-economic activities in the park.

12.3 North-West Marine Park Network

The North-West Marine Parks Network is aligned to the North-west Marine Region. The network covers 335, 341 km^2 and includes 13 marine parks (Director of National Parks, 2018b). Broad values of the North-west Commonwealth Marine Reserves Network include:

- Natural values;
- Cultural values;
- Heritage values; and
- Socio-economic values.

Further detail on each of the relevant marine parks within the EMBA is provided below.

12.3.1 Carnarvon Canyon Marine Park

The Carnarvon Canyon Marine Park (Habitat Protection Zone – IUCN Category IV) covers an area of approximately 6,177 km^2 and protects the following conservation values (Director of National Parks 2018b):

- The Carnarvon Canyon a single channel canyon with seabed features that include slope, continental rise and deep holes and valleys;

+ The Carnarvon Canyon ranges in depth from 1500 m to over 5,000 m, thereby providing habitat diversity for benthic and demersal species; and
+ Central Western Transition provincial bioregion ecosystem examples are found here, which are characteristic of the biogeographic faunal transition between tropical and temperate species.

There is limited information about species' use of this Marine Park (Director of National Parks 2018b). The marine park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018b). Commercial fishing, tourism, shipping and mining are important supported socio-economic activities in the marine park.

12.3.2 Shark Bay Marine Park

The Shark Bay Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 7,443 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging areas adjacent to important breeding areas for several species of migratory seabirds;
+ Part of the migratory pathway of protected humpback whales;
+ Internesting habitat for marine turtles;
+ Waters that are adjacent to the largest nesting area for loggerhead turtles in Australia;
+ Marine park and adjacent coastal areas important for shallow-water snapper;
+ Protection to shelf and slope habitats as well as a terrace feature;
+ Examples of the shallower ecosystems of the Central Western Shelf Province and Central Western Transition provincial bioregions including the Zuytdorp meso-scale bioregion; and
+ Connectivity between the inshore waters of the Shark Bay World Heritage Area and the deeper waters of the area.

Whilst no listed international, Commonwealth or National Heritage places are within the marine park, the park is adjacent to Shark Bay World Heritage Area (Director of National Parks 2018b). Commercial tourism, fishing, mining and recreation are important socio-economic values of the park.

12.3.3 Gascoyne Marine Park

The Gascoyne Marine Park (Multiple Use Zone – IUCN Category VI-33,652 km^2; Habitat Protection Zone – IUCN Category IV-38,982 km^2; Marine National Park Zone – IUCN Category II-9,132 km^2) covers an area of approximately 81,766 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important foraging areas for: migratory seabirds threatened and migratory hawksbills and flatback turtles; and vulnerable and migratory whale shark;
+ A continuous connectivity corridor from shallow depths around 15 m out to deep offshore waters on the abyssal plain at over 5,000 m in depth;
+ Seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise. It also provides protection for sponge gardens in the south of the reserve adjacent to Western Australian coastal waters;
+ Ecosystems examples from the Central Western Shelf Transition, the Central Western Transition and the Northwest province provincial bioregions as well as the Ningaloo meso-scale bioregion;
+ Four KEFs for the region:
  - Canyons on the slope between the Cuvier Abyssal Plain and the Cape Range Peninsula (enhanced productivity, aggregations of marine life and unique sea-floor feature);
  - Exmouth Plateau (unique sea-floor feature associated with internal wave generation);

  - Continental slope demersal fish communities (high species diversity and endemism – the most diverse slope bioregion in Australia with over 500 species found with over 64 of those species occurring nowhere else); and
  - Commonwealth waters adjacent to Ningaloo Reef.
+ The canyons in this reserve are believed to be associated with the movement of nutrients from deep water over the Cuvier Abyssal Plain onto the slope where mixing with overlying water layers occurs at the canyon heads. These canyon heads, including that of Cloates Canyon, are sites of species aggregation and are thought to play a significant role in maintaining the ecosystems and biodiversity associated with the adjacent Ningaloo Reef; and
+ The reserve therefore provides connectivity between the inshore waters of the existing Ningaloo Commonwealth marine park and the deeper waters of the area.

The park is also adjacent to World Heritage listings associated with the Ningaloo Coast. Commercial tourism, commercial fishing, mining and recreation are important socio-economic values of the park (Director of National Parks 2018b).

12.3.4 Ningaloo Marine Park

Ningaloo Marine Park stretches approximately 300 km along the west coast of the Cape Range Peninsula and is adjacent to the Western Australian Ningaloo Marine Park and Gascoyne Marine Park (Director of National Parks, 2018b). Ningaloo Reef is the longest fringing barrier reef in Australia forming a discontinuous barrier that encloses a lagoon that varies in width from 200 m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). It is the only example in the world of extensive fringing coral reef on the west coast of a continent.

The Ningaloo Marine Park (Recreational Use Zone – IUCN Category II) covers an area of approximately 2,435 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important habitat (foraging areas) for vulnerable and migratory whale sharks;
+ Areas used for foraging by marine turtles adjacent to important internesting sites;
+ Part of the migratory pathway of the protected humpback whale;
+ Foraging and migratory pathway for pygmy blue whales;
+ Breeding, calving, foraging and nursing habitat for dugong;
+ Shallow shelf environments which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
+ Seafloor habitats and communities of the Central Western Shelf Transition;
+ Three KEFs; and
+ The Ningaloo Coast World Heritage Property, the Ningaloo Coast National Heritage listing and Ningaloo Marine Area Commonwealth Heritage Listing.

Commercial tourism and recreation are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.5 Montebello Marine Park

The Montebello Marine Park is located offshore of Barrow Island and 80 km west of Dampier extending from the Western Australian state water boundary, and is adjacent to the Western Australian Barrow Island and Montebello Islands Marine Parks. The Montebello Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 3,413 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging areas for migratory seabirds that are adjacent to important breeding areas;

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+ Areas used by vulnerable and migratory whale sharks for foraging;
+ Foraging areas marine turtles which are adjacent to important nesting sites;
+ Section of the north and south bound migratory pathway of the humpback whale;
+ Shallow shelf environments with depths ranging from 15–150 m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
+ Seafloor habitats and communities of the Northwest Shelf Province provincial bioregions as well as the Pilbara (offshore) meso-scale bioregion; and
+ One KEF for the region is the ancient Coastline (a unique seafloor feature that provides areas of enhanced biological productivity).

Commercial tourism, commercial fishing, mining and recreation are important socio-economic values for the park.

12.3.6 Dampier Marine Park

The Dampier Marine Park (Marine National Park Zone – IUCN Category I-73 km^2; Habitat Protection Zone – IUCN Category IV-104 km^2; Multiple Purpose Zone – IUCN Category VI-1,074 km^2) covers an area of approximately 1,252 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging areas for migratory seabirds that are adjacent to important breeding grounds;
+ Important foraging areas for marine turtles adjacent to significant nesting sites;
+ Part of the migratory pathway of the protected humpback whale;
+ Protection for offshore shelf habitats and shallow shelf habitats adjacent to the Dampier Archipelago; and
+ Communities and seafloor habitats of the Northwest Shelf Province provincial bioregion as well as the Pilbara (nearshore) and Pilbara (offshore) meso-scale bioregions are included.

Port activities, commercial fishing and recreation are important activities in the marine park (Director of National Parks 2018b). No heritage listings apply to the marine park.

12.3.7 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park (Multiple Use Zone – IUCN Category VI) is adjacent to the Western Australia Eighty Mile Beach Marine Park, 74 km north-east of Port Hedland and covers an area of approximately 10,785 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Breeding, foraging and resting habitat for seabirds (one of the world's most important feeding grounds for migratory shorebirds and waders and is listed under the Ramsar Convention);
+ Internesting and nesting habitat for marine turtles (it supports a significant nesting population of flatback turtles, which are endemic to northern Australia);
+ Foraging, nursing and pupping habitat for sawfish;
+ Migratory pathway for humpback whales;
+ Coastal waters provide critical habitat for several shark and ray species at varying life stages;
+ The Nyangumarta, Karajarri and Ngarla people's sea country extends into Eighty Mile Beach Marine Park. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities; and
+ Three known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*: Lorna Doone (wrecked in 1923), Nellie (wrecked in 1908), and Tifera (wrecked in 1923).

Tourism, commercial fishing, pearling and recreation are important activities in the Marine Park (Director of National Parks 2018b).

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12.3.8 Argo-Rowley Terrace Marine Park

The Argo-Rowley Marine Park is located approximately 270 km north-west of Broome, Western Australia, and extends to the limit of Australia's exclusive economic zone. The Marine Park (Multiple Use Zone – IUCN Category VI-108,812 km^2; Marine National Park Zone – IUCN Category II-36,050 km^2; Special Purpose Zone – IUCN Category VI-1,141 km^2) covers an area of approximately 146,003 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging areas that are important for migratory seabirds as well as the endangered loggerhead turtle;
+ Important habitat and foraging for sharks;
+ Migratory pathway for pygmy blue whales (Director of National Parks 2018b);
+ Protection for communities and habitats of the deeper offshore waters (220 m to over 5,000 m) of the region;
+ Seafloor features including aprons and fans, canyons, continental rise, knolls/abyssal hills and the terrace and continental slope;
+ Communities and seafloor habitats of the Northwest Transition and Timor Province provincial bioregions;
+ Connectivity between the existing Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region;
+ Two KEFs in the reserve include:
  - The canyons linking the Argo Abyssal Plain with the Scott Plateau (unique seafloor feature with enhanced productivity and feeding aggregations of species); and
  - Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals (an area of high biodiversity with enhanced productivity and feeding and breeding aggregations).

No heritage listings apply to this marine park (Director of National Parks 2018b). Commercial fishing, mining and recreation are important socio-economic values for the park.

12.3.9 Mermaid Reef Marine Park

The Mermaid Reef Marine Park (Multiple Use Zone – IUCN Category VI) lays approximately 280 km north-west of Broome, Western Australia, adjacent to the Argo–Rowley Terrace Marine Park and approximately 13 km from the Western Australian Rowley Shoals Marine Park. It covers an area of 540 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Mermaid Reef and Commonwealth waters surrounding Rowley Shoals are valued for its high productivity, aggregations of marine life and high species richness;
+ Mermaid Reef, Clerke Reef and Imperieuse Reef are biodiversity hotspot and key topographic feature of the Argo Abyssal Plain;
+ Rowley Shoals present some of the best geological examples of shelf atolls in Australian waters, and are ecologically significant in that they are considered ecological steppingstones for reef species originating in Indonesian/Western Pacific waters, are one of a few offshore reef systems on the north-west shelf, and may also provide an upstream source for recruitment to reefs further south;
+ Breeding habitat for seabirds;
+ Migratory pathway for the pygmy blue whale; and
+ One known shipwreck listed under the *Underwater Cultural Heritage Act 2018*: Lively (wrecked in 1810).

Tourism, recreation, and scientific research are important activities in the Marine Park (Director of National Parks 2018b).

12.3.10 Roebuck Marine Park

The Roebuck Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 304 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging habitat area for migratory seabirds adjacent to important breeding areas;
+ Foraging area adjacent to important nesting sites for flatback turtles;
+ Parts of the migratory pathway of the protected humpback whale;
+ Habitat adjacent to important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish;
+ Foraging and calving areas for Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins;
+ Foraging habitat for dugong;
+ Protection for shallow shelf habitats ranging in depth from 15–70 m;
+ Ecosystems example of the Northwest Shelf Province provincial bioregion and the Canning meso-scale bioregion; and
+ Sea country valued for indigenous cultural identity, health and well-being for the Yawuru people (Director of National Parks 2018b).

No heritage listings apply to the marine park. Commercial tourism, fishing, pearling and recreation are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.11 Kimberley Marine Park

The Kimberley Marine Park (Multiple Use Zone – IUCN Category VI) is located approximately 100 km north of Broome, Western Australia, and extends from the Western Australian state water boundary north from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville. It is adjacent to the Western Australian Lalanggarram / Camden Sound Marine Park and the North Kimberley Marine Park. It covers an area of 74,469 km^2, and protects the following conservation values (Director of National Parks 2018b):

+ Northwest Shelf Province;
  - Diverse benthic and pelagic fish communities
  - Ancient coastline thought to be an important seafloor feature
  - Migratory pathway for humpback whales
+ Northwest Shelf Transition;
  - High levels of species diversity
  - Endemism occur among demersal fish communities on the continental slope
+ Timor Province;
  - 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)
  - 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;
  - breeding and foraging habitat for seabirds;

- Internesting and nesting habitat for marine turtles;
- Breeding, calving and foraging habitat for inshore dolphins;
- Calving, migratory pathway and nursing habitat for humpback whales;
- Migratory pathway for pygmy blue whales;
- Foraging habitat for dugong and whale sharks;
- The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people's sea country extends into the Kimberley Marine Park. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities; and
- More than 40 known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*.

Tourism, commercial fishing, mining, recreation, including fishing, and traditional use are important activities in the Marine Park (Director of National Parks 2018b).

12.3.12 Ashmore Reef Marine Park

The Ashmore Reef Marine Park (Sanctuary Zone – IUCN Category Ia; Recreational Use Zone – IUCN Category II) covers an area of approximately 583 km^2 (Director of National Parks 2018b). It forms part of the North-west Park Network. As the only oceanic reef in the north-east Indian Ocean with vegetated islands (East, Middle and West Islands), Ashmore is also the largest of three emergent, oceanic reefs in the region (DSEWPaC 2012). Both the Ashmore and Cartier Islands fall under the legal memorandum of understanding between Indonesia and Australia, as both areas are located within Australia's external territory (DSEWPaC 2012).

Ashmore Reef Marine Park is located on Australia's North West Shelf in the Indian Ocean, about 450 nautical miles (840 km) west of Darwin and 330 nautical miles (610 km) north of Broome. The reserve covers 583 km^2 and includes two extensive lagoons, shifting sand flats and cays, seagrass meadows, a large reef flat covering an area of 239 km^2. Within the reserve are three small islands known as East, Middle and West Islands (DoE, 2002).

Ashmore was designated a Ramsar Wetland of International Importance in 2003 due to the importance of its islands providing a resting place for migratory shorebirds and supporting large seabird breeding colonies.

The proclaimed marine park will protect the following conservation values (DoE 2014):

+ Ecosystems, habitats and communities associated with; the North West Shelf; Timor Province; and emergent oceanic reefs;
+ The island and reef habitats:
  - Contains critical nesting and internesting habitat for green turtles (including one of three genetically distinct breeding populations in the North-west Marine Region). Low level nesting activity by loggerhead turtles has also been recorded;
  - Large and significant feeding populations of green, hawksbill and loggerhead turtles occur around the reefs (it is estimated that approximately 11,000 marine turtles feed in the area throughout the year);
  - Supports a small dugong population of less than 50 individuals that breed and feed around the reef. This population is thought to be genetically distinct from other Australian populations;
  - Migratory pathway for pygmy blue whales (Director of National Parks 2018b);
  - Support some of the most important seabird rookeries on the North West Shelf including colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns;
  - Is an important staging points/feeding areas for many migratory seabirds; and
  - Is internationally significant for its abundance and diversity of sea snakes.

- Two KEFs:
- Ashmore Reef and Cartier Island and surrounding Commonwealth waters; and
- Continental slope demersal fish communities (Director of National Parks 2018b);
- Cultural and heritage sites, including;
- Ashmore lagoon as a rest/staging area for traditional Indonesian fishers
- Indonesian artefacts; and
- Grave sites.
- Commonwealth heritage listing – Ashmore Reef

Ashmore Reef and nearby islands and reefs are associated with benthic communities consisting predominantly of sand and coral rubble, with noteworthy hard coral, soft coral, algae and seagrasses (Heyward *et al.* 2012; Skewes et al., 1999a, 1999b). The reefs host similar benthic communities, with areas of relatively high live coral cover, although episodes of coral bleaching have been recorded (Heyward *et al.* 2012). Benthic organisms that depend on photosynthesis such as seagrasses, macroalgae and zooxanthellate corals are typically restricted to shallower waters around the reefs, although in the clear tropical waters may be found at considerable depths. Given the shallowest sampling location is greater than 60 m, and that most sampling locations are greater than 100 m deep, diverse benthic communities driven by primary producers such as seagrasses, algae and zooxanthellate corals are not expected to occur at the sampling locations. Data collected in the vicinity of Ashmore Reef indicates that corals are likely to spawn during March and April (Heyward *et al.* 2010).

Soft sediments are widespread in the region, with sediment infauna communities in the region dominated by polychaetes and crustaceans. These taxa accounted for over 80% of benthic infauna sampled, both in terms of numbers of species and individual organisms (Smith *et al.* 1997).

Commercial tourism, recreation and scientific research are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.13 Cartier Island Marine Park

The Cartier Island Marine Park (Sanctuary Zone – IUCN Category Ia) is located approximately 45 km south-east of Ashmore Reef Marine Park and 610 km north of Broome, Western Australia. Both Marine Parks are in Australia's External Territory of Ashmore and Cartier Islands and are also within an area subject to a Memorandum of Understanding (MoU) between Indonesia and Australia, known as the MoU Box. The Marine Park covers an area of 172 km² and protects the following conservation values (Director of National Parks 2018b):

- Ashmore Reef and Cartier Island and surrounding Commonwealth waters;
- Areas of enhanced productivity in an otherwise low-nutrient environment;
- Regional importance for feeding and breeding aggregations of birds and marine life;
- Continental slope demersal fish communities;
- Area of high diversity in demersal fish assemblages;
- Area of high diversity and abundance of hard and soft corals, gorgonians (sea fans), sponges and a range of encrusting organisms;
- Breeding and foraging habitat for seabirds;
- Internesting, nesting and foraging habitat for marine turtles;
- Foraging habitat for whale sharks;
- Internationally significant for its abundance and diversity of sea snakes;

- One known shipwreck listed under the *Underwater Cultural Heritage Act 2018*: the Ann Millicent (wrecked in 1888).

Scientific research is an important activity in the Marine Park (Director of National Parks 2018b).

12.4 North Marine Park Network

The North Park Network is aligned to the North Marine Region. The network covers 157,480 km^2 (Director of National Parks 2018c). Broad values of the North Network include:

- Natural values;
- Cultural values;
- Heritage values; and
- Socio-economic values.

Further detail on the applicable Oceanic Shoals Marine Park is provided below.

12.4.1 Oceanic Shoals Marine Park

The Oceanic Shoals Marine Park (zones within EMBA: Multiple Use Zone - IUCN Category VI- 32,488 km^2; Special Purpose Zone – IUCN VI-24,443 km^2) covers an area of approximately 56,931 km^2 within the EMBA.

The marine park protects the following conservation values (DoE 2014):

- Important resting area for turtles between egg laying (internesting area) for the threatened flatback turtle and olive ridley turtle;
- Important foraging area for the threatened loggerhead turtle and olive ridley turtle;
- Examples of the ecosystems of two provincial bioregions: the Northwest Shelf Transition Province (which includes the Bonaparte, Oceanic Shoals, and Tiwi meso-scale bioregions) and the Timor Transition Province;
- KEFs represented in the park are (Director of National Parks 2018c):
  - Carbonate bank and terrace system of the Van Diemen Rise (unique sea-floor feature);
  - Carbonate banks and terrace system of the Sahul Shelf (unique sea-floor feature);
  - Pinnacles of the Bonaparte Basin (enhanced productivity, unique sea-floor feature); and
  - Shelf break and slope of the Arafura Shelf (unique sea-floor feature).

No heritage listings apply to the marine park. Commercial fishing and mining are important socio-economic values for the park (Director of National Parks 2018c).

A spatial predictive benthic habitat model of the Oceanic Shoals Marine Park has been developed by AIMS, as part of the Australian National Environmental Science Programme, to determine the spatial heterogeneity of the benthic environment and key classes of organisms within the reserve. The benthic habitat model maps the 10 broad classes of benthic organisms; alcyons, gorgonians, soft corals, hard corals, halimeda, macroalgae, seagrass, filterers (e.g. sponges), burrowers (e.g. sea urchins) and no biota detected (Radford and Puotinen 2016).

Table 12-1 Summary of marine network values, pressures, management programs and actions applicable to the EMBA

Marine network	Values	Pressures	Management programs and actions
SOUTH WEST	+ Nine bioregions + Key ecological features + EPBC listed species + Biologically important areas + Sea country indigenous values + Historic shipwrecks + Adjacent to Shark Bay World Heritage Area + Shipping and port activities + Commercial fishing + Marine tourism	+ Climate change + Hydrological changes from coastal development and agriculture (increase sediment loads and pollutants) + Illegal/unregulated/unreported fishing + Bycatch of non-target species + Habitat modification from mining + Human presence + Invasive species + Marine pollution	+ Communication, education and awareness programs + Promote suitable tourism experience + Facilitate partnerships between tourism operators and Indigenous operators + Indigenous engagement program + Marine monitoring programs + Park management via assessments / authorisation program for marine park activities + Marine park management and development of suitable infrastructure + Compliance planning and surveillance

Marine network	Values	Pressures	Management programs and actions
NORTH WEST	+ Eight bioregions + Key ecological features + EPBC listed species + Biologically important areas + Sea country indigenous values + Native title determinations + Traditional Indonesian fishers + World Heritage Properties (Ningaloo Coast, Shark Bay) + Ashmore Reef Marine Park and Eighty-Mile Beach Ramsar sites + Shipping and port activities + Commercial fishing, pearling, aquaculture + Marine tourism + Scientific research	+ Climate change + Hydrological changes from coastal development and agriculture (increase sediment loads and pollutants) + Illegal/unregulated/unreported fishing + Bycatch of non-target species + Habitat modification from mining + Human presence + Invasive species + Marine pollution	+ Communication, education and awareness programs + Promote suitable tourism experience + Facilitate partnerships between tourism operators and Indigenous operators + Indigenous engagement program + Marine monitoring programs + Park management via assessments / authorisation program for marine park activities + Marine park management and development of suitable infrastructure + Compliance planning and surveillance

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Marine network	Values	Pressures	Management programs and actions
NORTH	+ One bioregion + Key ecological features + EPBC listed species + Biologically important areas + Historic shipwrecks	+ Climate change + Hydrological changes reliance upon the large number of estuaries and waterways that feed into the Gulf of Carpentaria and the waters adjacent to the Northern Territory coastline + Illegal/unregulated/unreported fishing + Bycatch of non-target species + Physical Habitat modification + Marine pollution	+ Communication, education and awareness programs + Promote suitable tourism experience + Facilitate partnerships between tourism operators and Indigenous operators + Indigenous engagement program + Marine monitoring programs + Park management via assessments / authorisation program for marine park activities + Marine park management and development of suitable infrastructure + Compliance planning and surveillance

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13. Conservation Management Plans

In order to protect, maintain and enhance recovery of certain threatened species and ecological communities the DAWE may prepare conservation management plans in the form of Conservation Advice or Recovery Plans.

13.1 Conservation Advice

When a native species or ecological community is listed as threatened under the EPBC Act, conservation advice is developed to assist its recovery. Conservation advice provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of a newly listed species or ecological community.

13.2 Recovery Plans

The Australian Government Minister for the Environment may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth EPBC Act. Recovery plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long-term survival in the wild of a threatened species or ecological community.

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Table 13-1: Summary of EPBC Act recovery plans applicable to the EMBA

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
Bird	Australian lesser noddy	Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (2015)	Habitat modification by pied cormorants (Houtman Abrolhos)
			Catastrophic destruction of habitat by cyclones
	Migratory species within the EMBA: + Asian dowitcher; + Bar-tailed godwit; + Black-tailed godwit; + Broad-billed sandpiper; + Common greenshank; + Common redshank; + Common sandpiper; + Double-banded plover; + Fork-tailed swift; + Grey plover; + Grey-tailed tattler; + Long-toed stint; + Little greenshank + Oriental plover; + Oriental pratincole; + Pacific golden plover; + Pectoral sandpiper; + Red-necked phalarope; + Red-necked stint;	Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and degradation
			Pollution and Contaminants
			Invasive species
			Anthropogenic disturbance
			Climate change and variability
			Overharvesting of shorebird prey
			Fisheries bycatch
			Direct mortality (hunting)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	+ Ruddy turnstone; + Ruff (reeve); + Sanderling; + Sharp-tailed sandpiper; + Streaked shearwater; + Terek sandpiper; + Whimbrel; and + Wood sandpiper.		
	Christmas Island frigatebird	Approved Conservation Advice for *Fregata andrewsi* (Christmas Island frigatebird) (2016)	Habitat loss, disturbance and modifications (terrestrial related)
			Fishing
			Invasive species
			Fire
			Climate change
	Australasian bittern	Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (2011)	Reduction in extent and quality of habitat due to the diversion of water away from wetlands
			Drainage of swamps
			Loss or alteration of wetland habitats due to clearing for urban and agricultural development
			Peat mining
			Predation by introduced vertebrate pests such as foxes and cats
			Reduced water quality as a result of increasing salinity, siltation and pollution
			Overgrazing by livestock
			Detrimental fire regimes
	Red knot		Habitat loss and habitat degradation

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Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice for *Calidris canutus* (Red knot) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (2015)	Ongoing human disturbance
			Habitat loss and degradation from pollution
			Changes to the water regime
			Invasive plants
	Great knot	Approved Conservation Advice for *Calidris tenuirostriss* (Great knot) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015).	Habitat loss and habitat degradation
			Pollution/contaminants
			Disturbance
			Diseases
			Direct mortality (hunting)
			Climate change impacts
	Greater sand plover	Approved Conservation Advice for *Charadrius leschenaultii* (Greater sand plover) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and habitat degradation
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Climate change impacts

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Lesser sand plover	Approved Conservation Advice for *Charadrius mongolus* (Lesser sand plover) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and habitat degradation
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Climate change impacts
	Antipodean albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Amsterdam albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing

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Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Tristan albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Southern royal albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Wandering albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Northern royal albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest

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Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Blue petrel	Approved Conservation Advice for *Halobaena caerulea* (blue petrel) (2015)	Habitat loss, disturbance and modification
			Predation
	Western Alaskan bar-tailed godwit	Wildlife Conservation Plan for Migratory Shorebirds (2015) Approved Conservation Advice for *Limosa lapponica baueri* (Bar-tailed godwit (western Alaskan)) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Northern Siberian bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian)) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Southern giant petrel		Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Northern giant petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Eastern curlew	Approved Conservation Advice *for Numenius madagascariensis* (eastern curlew) (2015)	Ongoing human disturbance
			Habitat loss and degradation from pollution
			Changes to the water regime

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Invasive plants
	Fairy prion (southern)	Approved Conservation Advice for *Pachyptila turtur subantarctica* (fairy prion (southern)) (2015)	Competition with blue petrels
			Soil erosion
			Fire
	Abbott's booby	Approved Conservation Advice for *Papasula abbotti* (Abbott's booby) (2015)	Clearance of about a third of the former nesting rainforest habitat
			Crazy ants
	Christmas Island white-tailed tropicbird	Conservation Advice for *Phaethon lepturus fulvus* white-tailed tropicbird (Christmas Island) (2014)	Introduced predators on Christmas Island
			Crazy ants
	Sooty albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Soft-plumaged petrel	Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (2015)	Accidental introduction of predators (relevant only to Maatsuyker Island, located offshore of Tasmania)
	Australian painted snipe		Loss and degradation of wetlands, through drainage and the diversion of water for agriculture and reservoirs

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Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Commonwealth Conservation Advice on *Rostratula australis* (Australian painted snipe) (2013)	Grazing and associated trampling of wetland vegetation/nests, nutrient enrichment and disturbance to substrate by livestock
			Climate change
			Predation by feral animals
			Introduction of weeds
	Australian fairy tern	Commonwealth Conservation Advice on *Sternula nereis nereis* (fairy tern) (2011)	Predation by introduced mammals and native birds
			Disturbance by humans, dogs and vehicles
			Increasing salinity in waters adjacent to Fairy Tern colonies
			Irregular water management
			Weed encroachment
			Oil spills, particularly in Victoria (potential threat)
	Indian yellow-nosed albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Shy albatross		Incidental catch resulting from fishing operations

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Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	White-capped albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Campbell albatross		Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Black-browed albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
Mammals	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Habitat degradation including pollution (increasing port expansion and coastal development)
			Pollution (persistent toxic pollutants)
			Vessel strike
			Prey depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Blue whale	Blue Whale Conservation Management Plan 2015 - 2025 (2015)	Whaling
			Climate Variability and Change
			Noise Interference
			Habitat Modification
			Vessel Disturbance
			Overharvesting of prey
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance
			Habitat degradation including coastal development, port expansion and aquaculture
			Pollution (persistent toxic pollutants)
			Fisheries catch, entanglement and bycatch
			Vessel strike
			Resource depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Southern right whale	Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012)	Entanglement
			Vessel disturbance
			Whaling

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Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Climate variability and change
			Noise interference
			Habitat modification
			Overharvesting of prey
	Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)	Whaling
			Climate and Oceanographic Variability and Change
			Overharvesting of Prey
			Noise Interference
			Habitat degradation including coastal development and port expansion
			Entanglement
			Vessel disturbance and strike
	Australian sea-lion	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (2013)	Fishery bycatch (primary threat)
			Entanglement in marine debris (primary threat)
			Marine aquaculture
			Habitat degradation
			Human disturbance
			Direct killing (primary threat)
			Disease
			Pollution and oil spills
			Noise
			Competition and prey depletion
			Climate change

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Taxa	Common name	Recovery Plan / Conservation Advice	Threats
Reptiles	Short-nosed seasnake	Approved Conservation Advice on *Aipysurus apraefrontalis* (Short-nosed seasnake) (2011)	Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)
			Oil and gas exploration
			Incidental catch and death in commercial prawn trawling fisheries
	Leaf-scaled seasnake	Approved Conservation Advice on *Aipysurus foliosquama* (Leaf-scaled seasnake) (2011)	Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)
			Oil and gas exploration
			Incidental catch and death in commercial prawn trawling fisheries (north-west marine area)
			Unsustainable and illegal fishing practices (currently the most significant threat in the Ashmore region)
	Loggerhead turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Loggerhead turtle – WA genetic stock	Fisheries bycatch – international (moderate), domestic (high)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (high), chronic (low)
			Marine debris – entanglement and ingestion (moderate; unknown)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (moderate), within Australia's jurisdiction (low)
			Light pollution (moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Fisheries bycatch – international (moderate), domestic (high)
			Cumulative impacts of threats
	Green turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Green turtle – NWS genetic stock (NWS), Scott-Browse genetic stock (ScBr), Ashmore genetic stock (AR)	Fisheries bycatch – international (moderate), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation NWS – moderate, AR –high; unknown, ScBr – moderate; unknown)
			Habitat modification – infrastructure/coastal development (NWS – moderate, AR – low, ScBr – high), dredging/trawling (NWS – moderate, AR – low, ScBr – low)
			Chemical and terrestrial discharge – acute (NWS, AR, ScBr –high), chronic (NWS – moderate, AR – high, ScBr – high)
			Marine debris – entanglement (NWS – moderate, AR – very high, ScBr – moderate; unknown) and ingestion (NWS – low; unknown, AR – moderate, ScBr – moderate)
			Climate change and variability (NWS – moderate, AR – very high, ScBr – high)
			International take – outside Australia's jurisdiction (moderate; unknown for NWS and ScBr), within Australia's jurisdiction (moderate; unknown for NWS and ScBr)
			Light pollution (NWS – high, AR – moderate, ScBr – moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (NWS – moderate; unknown, AR – low, ScBr – moderate), chronic (NWS – moderate; unknown, AR – low, ScBr – moderate; unknown)
			Recreational activities
			Diseases and pathogens (low; unknown for AR and ScBr)
			Cumulative impacts of threats
	Leatherback turtle	Approved Conservation Advice on *Dermochelys coriacea* (2008)	Incidental capture in commercial fisheries
			Harvest of eggs and meat
			Ingestion of marine debris
			Boat strike

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Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Predation on eggs by wild dogs, pigs and monitor lizards
			Degradation of foraging areas
			Changes to breeding sites
		Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Fisheries bycatch – international (high), domestic (high)
			Indigenous take (low)
			Terrestrial predation (moderate; unknown)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (low)
			Chemical and terrestrial discharge – acute (low), chronic (low; unknown)
			Marine debris – entanglement (moderate) and ingestion (high)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (high), within Australia's jurisdiction (low)
			Light pollution (low)
			Vessel disturbance (moderate)
			Noise interference – acute (low; unknown), chronic (low; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Fisheries bycatch – international (high), domestic (high)
			Cumulative impacts of threats
	Hawksbill Turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Hawksbill turtle – WA genetic stock	Fisheries bycatch – international (moderate), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation (moderate)

Santos

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (moderate), chronic (moderate)
			Marine debris – entanglement (moderate) and ingestion (low; unknown)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (very high), within Australia's jurisdiction (moderate)
			Light pollution (high)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
	Olive ridley turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Olive ridley turtle – Northern Territory genetic stock	Fisheries bycatch – international (moderate), domestic (high)
			Indigenous take (moderate)
			Terrestrial predation (moderate; unknown)
			Habitat modification – infrastructure/coastal development (low), dredging/trawling (low)
			Chemical and terrestrial discharge – acute (high), chronic (moderate)
			Marine debris – entanglement (very high) and ingestion (moderate; unknown)
			Climate change and variability (very high)
			International take – outside Australia's jurisdiction (moderate), within Australia's jurisdiction (moderate)
			Light pollution (moderate)
			Vessel disturbance (moderate)

Santos

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Noise interference – acute (low), chronic (low; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
	Flatback turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Flatback turtle – Pilbara coast genetic stock (Pil), South-west Kimberley coast genetic stock (swKim) and Cape Domett (CD)	Fisheries bycatch – international (low), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (Pil – high, swKim – moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (high), chronic (moderate)
			Marine debris – entanglement (moderate) and ingestion (low)
			Climate change and variability (Pil – high, swKim – moderate)
			International take – outside Australia's jurisdiction (low), within Australia's jurisdiction (low)
			Light pollution (Pil – high, swKim – moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (Pil – low, swKim – moderate)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
Sharks and fish	Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (2014)	Mortality due to incidental capture by commercial and recreational fisheries
			Mortality die to shark control programs
			Ecotourism

Santos

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Public aquarium trade
			Pollution and disease
			Ecosystem effects - habitat modification and climate change
	Great white shark	Recovery plan for the White Shark (*Carcharodon carcharias*) (2013)	Mortality related to being caught accidentally (bycatch) or illegally (targeted) by commercial and recreational fisheries, including issues of post release mortality
			Mortality related to shark control activities such as beach meshing or drumlining (east coast population)
			Illegal trade in white shark products
			Ecosystem effects as a result of habitat modification and climate change
			Ecotourism
	Northern river shark	Approved Conservation Advice for *Glyphis garricki* (northern river shark) (2014)	Commercial fishing activities
			Recreational fishing
			Indigenous fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation and modification
			Marine debris
			Collection of animals for display in public aquaria (no known occurrences to date)
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Dwarf sawfish	Approved Conservation Advice on *Pristis clavata* (dwarf sawfish) (2009)	Being caught as bycatch in commercial and recreational net fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation due to increasing human development

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Freshwater sawfish	Approved Conservation Advice for *Pristis pristis* (largetooth sawfish) (2014)	Commercial fishing activities
			Recreational fishing
			Indigenous fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation and modification
			Marine debris
			Collection of animals for display in public aquaria
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Green sawfish	Approved Conservation Advice for *Pristis zijsron* (green sawfish) (2008)	Capture as bycatch and byproduct in gillnet and trawl fisheries
			Illegal capture for fins and rostra
			Habitat degradation through coastal development
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015)	Intentional and unintentional mortality from fishing outside of Australian waters
			Boat strike from large vessels
			Habitat disruption from mineral exploration, production and transportation
			Disturbance from domestic tourism operations
			Marine debris

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Climate change
	Blind gudgeon	Approved Conservation Advice for *Milyeringa veritas* (blind gudgeon) (2008)	Habitat degradation and modification associated with sedimentation from mining/construction, canal development, water abstraction, point source pollution from sewage, landfill, dumping and mining; and diffuse pollution from urban development/ petroleum infrastructure
	Blind cave eel	Approved Conservation Advice for *Ophisternon candidum* (blind cave eel) (2008)	Habitat degradation and modification associated with sedimentation from mining/construction, canal development, water abstraction, point source pollution from sewage, landfill, dumping and mining; and diffuse pollution from urban development
	Balston's pygmy perch	Approved Conservation Advice for *Nannatherina balstoni* (Balston's pygmy perch) (2008)	Habitat degradation and modification associated with flow and increased salinisation, siltation and eutrophication that occur through changes to flow regimes (regulation and abstraction), road maintenance, mineral sand exploration and mining, ground water extraction and agricultural and forestry practices in the uppermost catchment
	Black-stripe minnow	Approved Conservation Advice for *Galaxiella nigrostriatal* (Black-striped minnow) (2018)	Climate change – increased air and water temperatures, decreased rainfall, increased evaporation, lowering groundwater table.
			Invasive species (*Gambusia holbrooki*), aggressive interactions and competition

14. Social, Economic and Cultural Features

14.1 Industry

In 2018/19, Western Australia's petroleum industry was worth $38.4 billion per annum. The petroleum sector accounted for 26% of the total value of WA's mineral and petroleum sales in 2018/19, with 20 per cent of all mineral and petroleum sales coming from Liquefied Natural Gas (LNG). Currently Western Australia has four operating LNG projects; the North West Shelf, Gorgon, Pluto and Wheatstone. There are also a number of Floating Production and Storage Offtake (FPSO) facilities in the Timor Sea and North West Shelf, as denoted on **Figure 14-1** to **Figure 14-3**. Offshore development is focussed in the Carnarvon Basin, Browse Basin and on the North West Shelf (DMP 2014). There are also domestic gas plants on Varanus Island in the North West Shelf, Devil Creek Onshore Gas Plant and Macedon Gas Plant in the Pilbara region and an oil facility near Dongara called Cliff Head. There are several exploration and production permits and leases throughout WA and Commonwealth waters in the EMBA. Existing petroleum infrastructure, permits and licences are shown in **Figure 14-1** to **Figure 14-3**.

14.2 Other Infrastructure

The Jasuraus submarine communication cable links Australia with Indonesia. The cable was installed as a link from Australia to provide telephone services connection to the world in 1995-1996. Travelling north out of Port Hedland for approximately 210 km the cable then heads north-west toward Jakarta, Indonesia. The cable runs up through Permit Areas WA-435-P and WA437-P. Its capacity and major role was overtaken in 2000 by other subsea cables out of Australia. However, Telstra continues to manage the cable as it remains an emergency backup link out of Australia. The cable includes two submerged repeaters in the wider region.

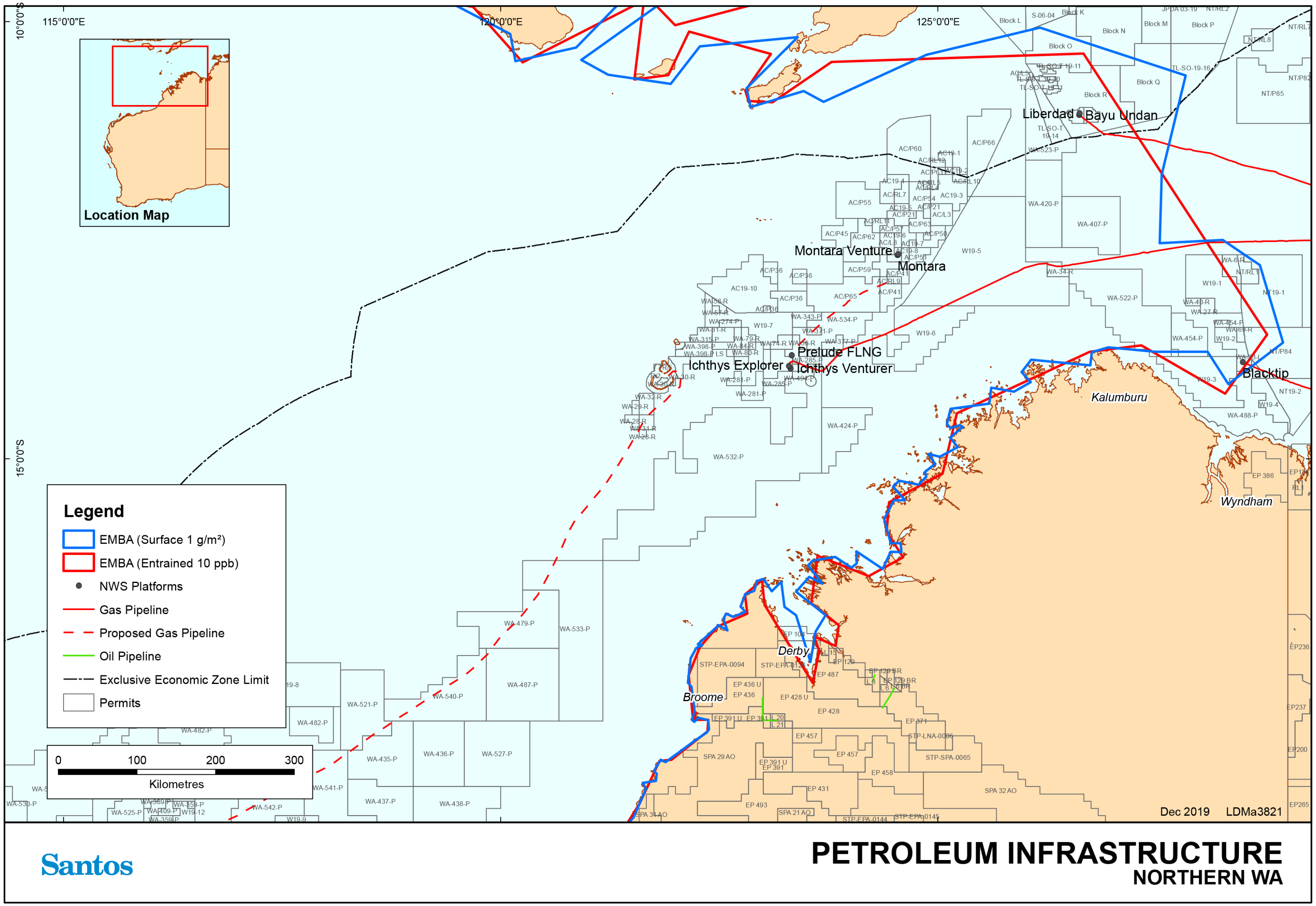

Figure 14-1: Existing petroleum infrastructure, permits and licences – Northern WA

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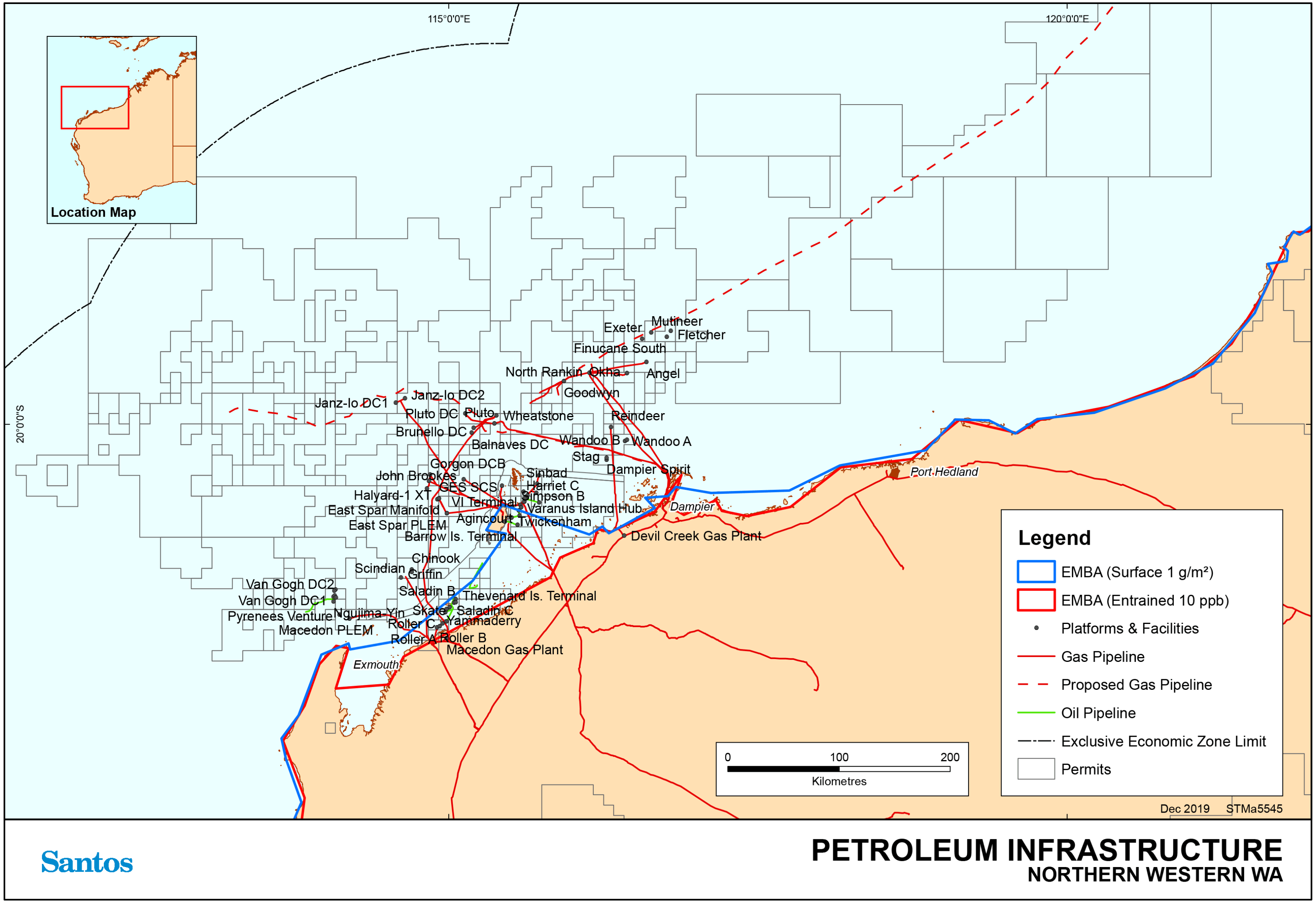

Figure 14-2: Existing petroleum infrastructure, permits and licences – Northern Western Australia

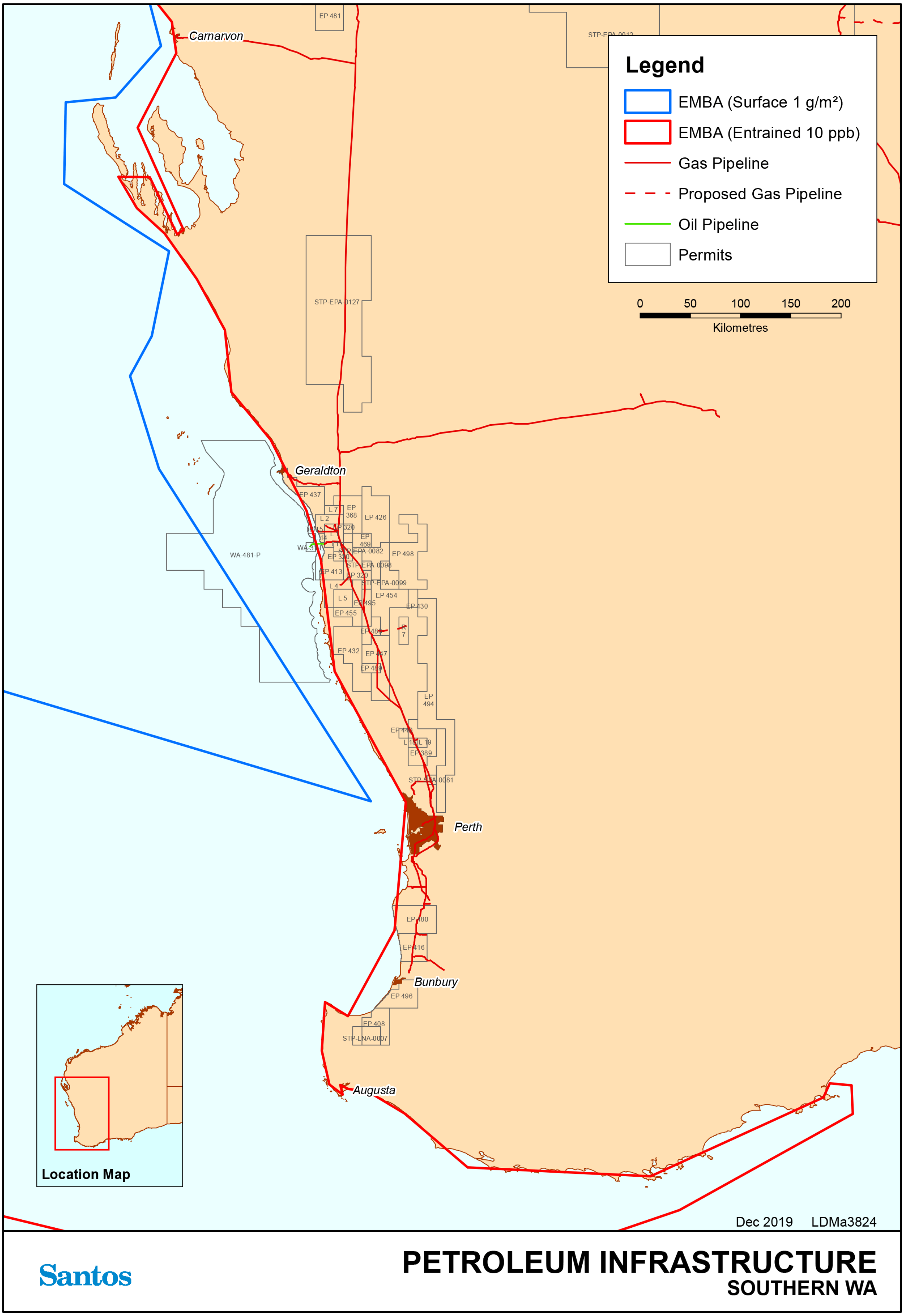

Figure 14-3: Existing petroleum infrastructure, permits and licences –Southern WA

14.3 Shipping

The Western Australian coastline supports twelve ports including the major ports of Dampier, Port Hedland and Broome which are operated by their respective port authorities. Large cargo vessels move through the region to and from Fremantle, transiting along coastline. Commercial shipping also moves to and from marine terminals associated with the oil and gas industry (see **Section 14.1**). Other large ports include Geraldton, Busselton, Albany and Esperance. Closer proximity shipping also includes construction vessels/barges/dredges, domestic support vessels, and offshore survey vessels.

The Australian Maritime Safety Authority (AMSA) has established a network of shipping fairways off the north-west coast of Australia to manage traffic patterns (AMSA 2013). The Shipping Fairways are designed to keep shipping traffic away from offshore infrastructure and aims to reduce the risk of collision (AMSA 2013).

Use of the fairways is strongly recommended but not mandatory. The International Regulations for *Preventing Collisions at Sea 1972* apply to all vessels navigating within or outside the shipping fairways. The use of these fairways does not give vessels any special right of way (AMSA 2012).

Under the *Commonwealth Navigation Act 2012*, certain vessels operating in Australian waters are required to report their location on a daily basis to the Rescue Coordination Centre (RCC) in Canberra. This Australian Ship Reporting System (AUSREP) is an integral part of the Australian Maritime Search and Rescue system and is operated by AMSA through the RCC. Vessels recorded in waters in the EMBA through the AUSREP system in 2019 are shown in **Figure 14-4**.

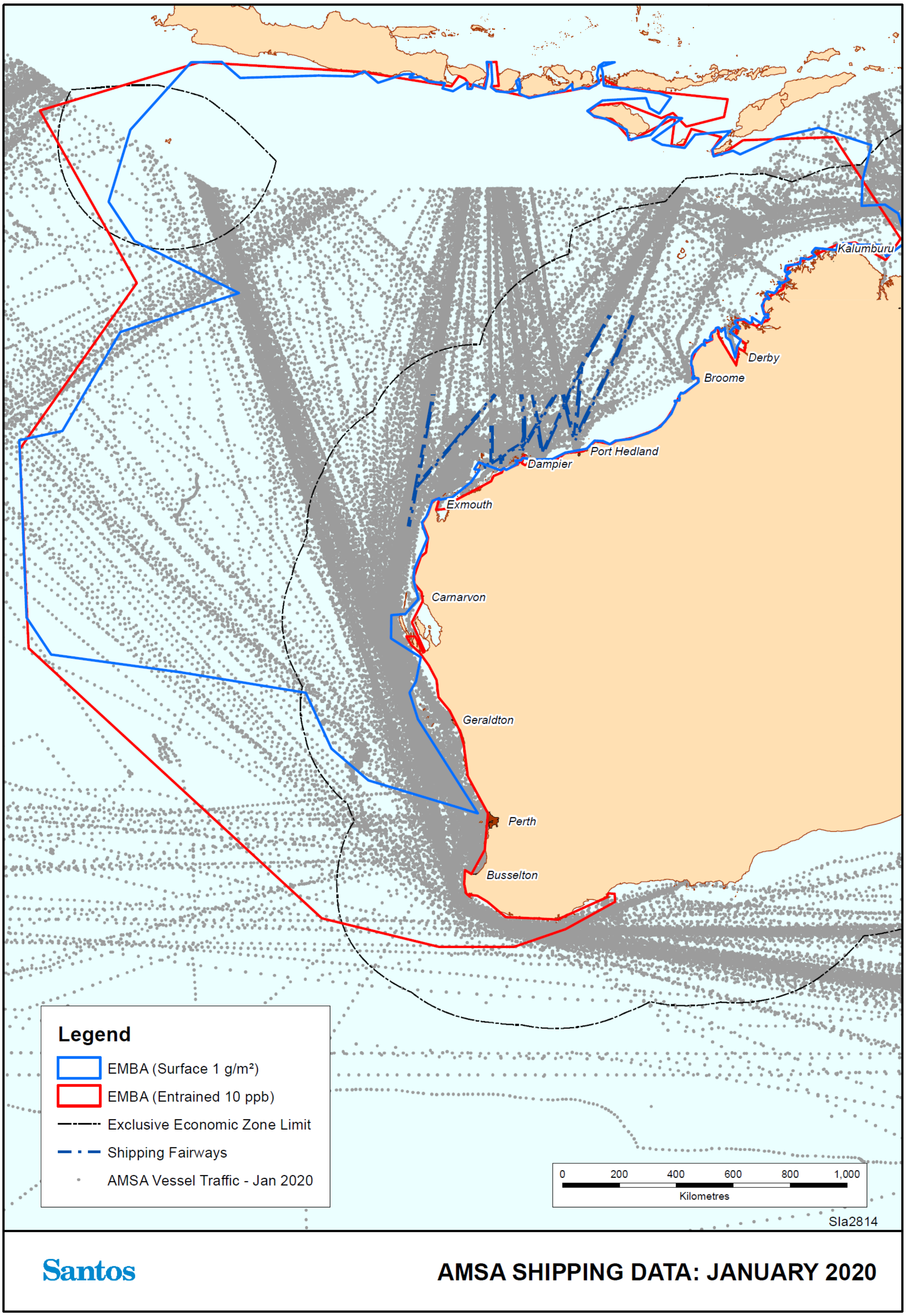

Figure 14-4: AMSA ship locations and shipping routes

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14.4 Defence Activities

Key defence bases and facilities are illustrated in **Figure** 14-5.

The Naval Communication Station Harold E. Holt is located on the northwest coast of Australia, 6 km north of Exmouth. The town of Exmouth was built at the same time as the communications station to provide support to the base and to house dependent families of US Navy personnel (Shire of Exmouth 2018, DoE 2014).

The station provides very low frequency radio transmission to US Navy and Royal Australian Navy ships and submarines in the western Pacific Ocean and eastern Indian Ocean. With a transmission power of 1 megawatt, it is the most powerful transmission station in the southern hemisphere (Shire of Exmouth 2018, DoE 2014).

Two Royal Australian Airforce (RAAF) bases are located in the northwest of WA; Learmonth RAAF Base, near Exmouth and Curtin RAAF Base near Derby (RAAF 2014).

Designated military exercise areas occur over waters and airspace of the north west of WA and may be activated following the required notifications.

Additional defence activities that occur within the EMBA include:

- Broome training depot;
- Exmouth admin and high frequency transmitting;
- Exmouth Very Low Frequency transmitting station;
- Geraldton training depot “A” Company 16th Battalion;
- HMAS Stirling-Rockingham;
- HMAS Stirling-Garden Island;
- Karratha training depot;
- Learmonth – air weapons range;
- Learmonth radar site – Vlaming Head Exmouth; and
- Yampi Sound training area.

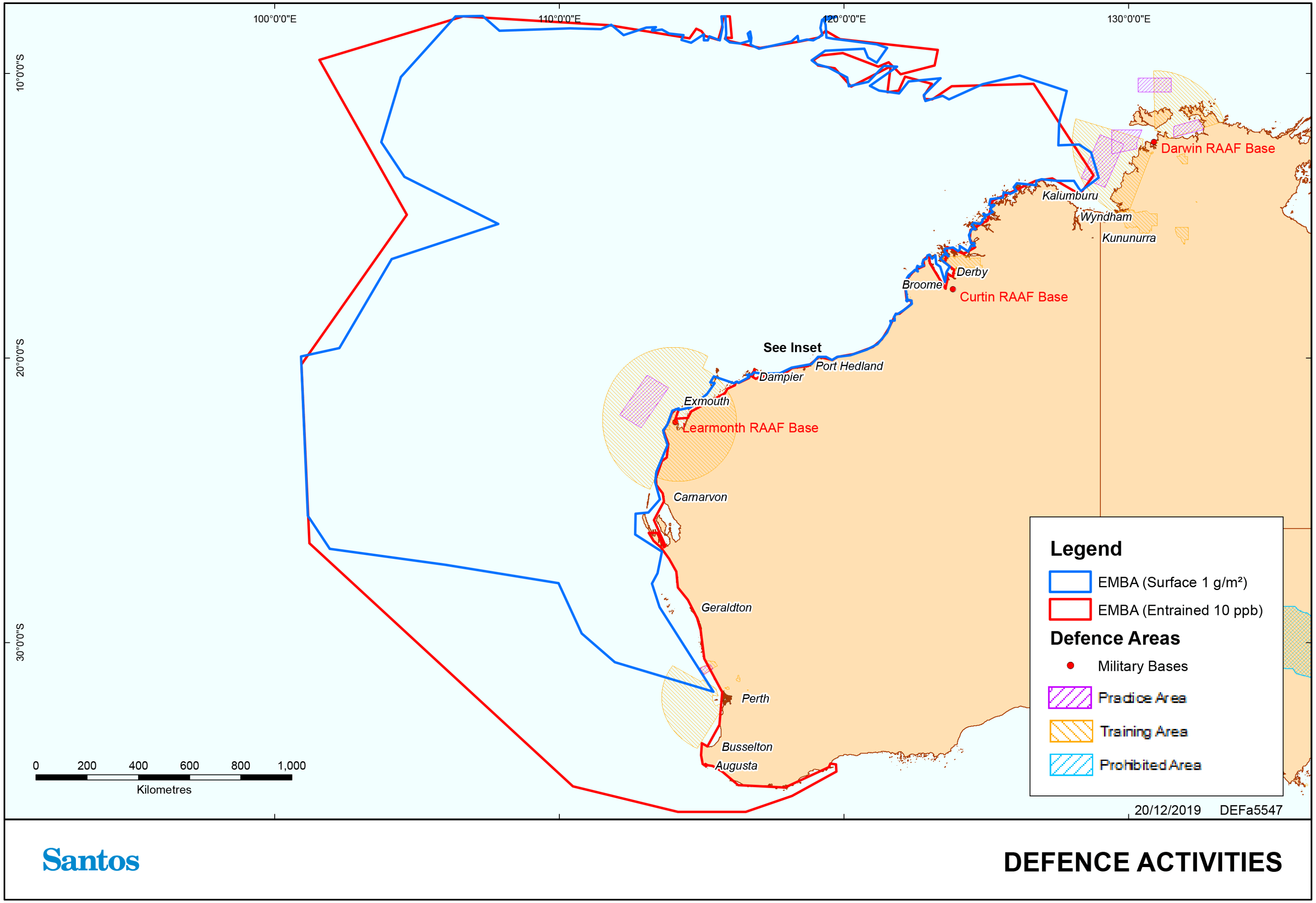

Figure 14-5: Defence activities in WA

14.5 Tourism

The Kimberley, Pilbara and Gascoyne regions are popular visitor destination for Australian and international tourists. Tourism is concentrated in the vicinity of population centres including Broome, Dampier, Exmouth, Coral Bay and Shark Bay.

Marine and coastal use is also clustered around major population centres along the WA coastline including Perth, Bunbury, Geraldton, Margaret River, Jurien Bay, August and Albany.

Tourism contributes to local economies in terms of both income and employment and tourists include local, interstate and international visitors. Popular water-based activities include fishing, swimming, snorkelling/ diving, surfing/windsurfing/kiting and boating, while popular land based activities include bushwalking, camping, bird watching and four-wheel driving.

Seasonal nature-based tourism such as humpback whale watching, whale shark encounters and tours of turtle hatching mainly occurring around Ningaloo Reef, Cape Range National Park, Broome and Perth (Tourism Western Australia 2014). Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

14.6 Cultural Heritage

Four places of cultural significance are protected as National Heritage Places in the waters from Busselton to the NT border. The Dampier Archipelago (including Burrup Peninsula), Batavia Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos, Dirk Hartog Landing Site 1616 – Cape Inscription area and the HMAS Sydney II and HSK Kormoran Shipwreck Site are discussed in **Section 9**. Additional Commonwealth Heritage Places denoted for their historic value in the EMBA are listed in **Appendix A**.

14.6.1 Indigenous Heritage

Indigenous people have a strong ongoing association with the area that extends from the beginning of human settlement in Australia some 50,000 years ago. The close, long standing relationship between Aboriginal peoples and the coastal and marine environments of the area is evident in indigenous culture today, in addition to archaeological sites such as the Burrup Peninsula. The Indigenous peoples of the northwest continue to rely on coastal and marine environments and resources for their cultural identity, health and wellbeing, as well as their domestic and commercial economies (DEWHA 2008a). With the EMBA, Barrow Island, Montebello Islands, Exmouth, Ningaloo Reef, Kimberly Coast, Eighty Mile Beach, Roebuck Bay, Dampier Peninsula and the South West and the adjacent foreshores have a long history of occupancy by Indigenous communities. Areas that are covered by registered native title claims are likely to practice indigenous fishing techniques at various sections of the WA coastline; most notably in the Kimberley coastal region and islands.

Marine resource use by Indigenous people is generally restricted to coastal waters. Fishing, hunting and the maintenance of maritime cultures and heritage through ritual, stories and traditional knowledge continue as important uses of the nearshore region and adjacent areas. However, while direct use by Aboriginal people deeper offshore waters is limited, many groups continue to have a direct cultural interest in decisions affecting the management of these waters. The cultural connections Aboriginal people maintain with the sea may be affected, for example, by offshore fisheries and industries. In addition, some Indigenous people are involved in commercial activities such as fishing and marine tourism, so have an interest in how these industries are managed in offshore waters with respect to their cultural heritage and commercial interests (DEWHA 2008a).

14.6.2 Maritime Heritage

Details of recorded shipwreck sites are available on the Australian National Shipwreck Database are managed by the DAWE although precise locations of the wrecks are sometimes unknown. A search of the Australian National Shipwreck Database in the EMBA identified 942 shipwrecks. Key shipwrecks in the North West Marine Region are listed in **Table 14-1** and shown in **Figure 14-6** to **Figure 14-9**, in addition to the Ann Millicent (DEWHA 2008a). Under the Commonwealth *Underwater Culture Heritage Act 2018* all shipwrecks older than

75 years are protected, while those dated pre-1900 are protected by WA law under the *Maritime Archaeology Act 1973*. Within the EMBA, there are 697 shipwrecks in excess of 75 years old.

Table 14-1: Shipwrecks

Name	Description	Location
Ann Millicent	Iron hulled barque, wrecked c. 1888	Cartier Island
Crown of England	1,847 t sailing ship, wrecked c. 1912	Wreck Point, Depuch Island
Eddystone	2,040 t brigantine rigged iron steamship	Cossack Roads, Depuch Island Passage
Perentie	Barge	Barrow Island
Fin	Early iron whaler	Frazer Island, Point Cloates
Karrakatta	1,271 t, schooner rigged, coastal steamship	King Sound, 140 km north-northwest of Derby
Manfred	587 t barque	3 km north west of West Island in the Lacepede Islands
Perth	499 t, iron coastal steamship	Ningaloo Reef
Rowley Shoals unconfirmed wreck	Armed whaler of 200–250 t, possibly the Lively, wrecked c 1800	Mermaid Reef
Zvir	Iron steamer	Frazer Island, Point Cloates
Browse Island (East) unconfirmed wreck	Late nineteenth century iron sailing vessel of approximately 1,000 t	Browse Island
Fairy Queen	115 t Singapore built brigantine	Point Murat, North West Cape
Gudrun	Iron frames and fastenings	Cape Peron Flats in Shark Bay
SS Sunbeam	Iron hulled, single screw steamer	Middle Osborne Island, Admiralty Gulf
Trial	English East Indiaman of about 500 t, wrecked c 1622	Trial (or Tryal) Rocks, 20 km northwest of the Montebello Islands
Zuytdorp	Seventeenth century Dutch East Indiaman	Zuytdorp Cliffs, 75 km north of Kalbarri

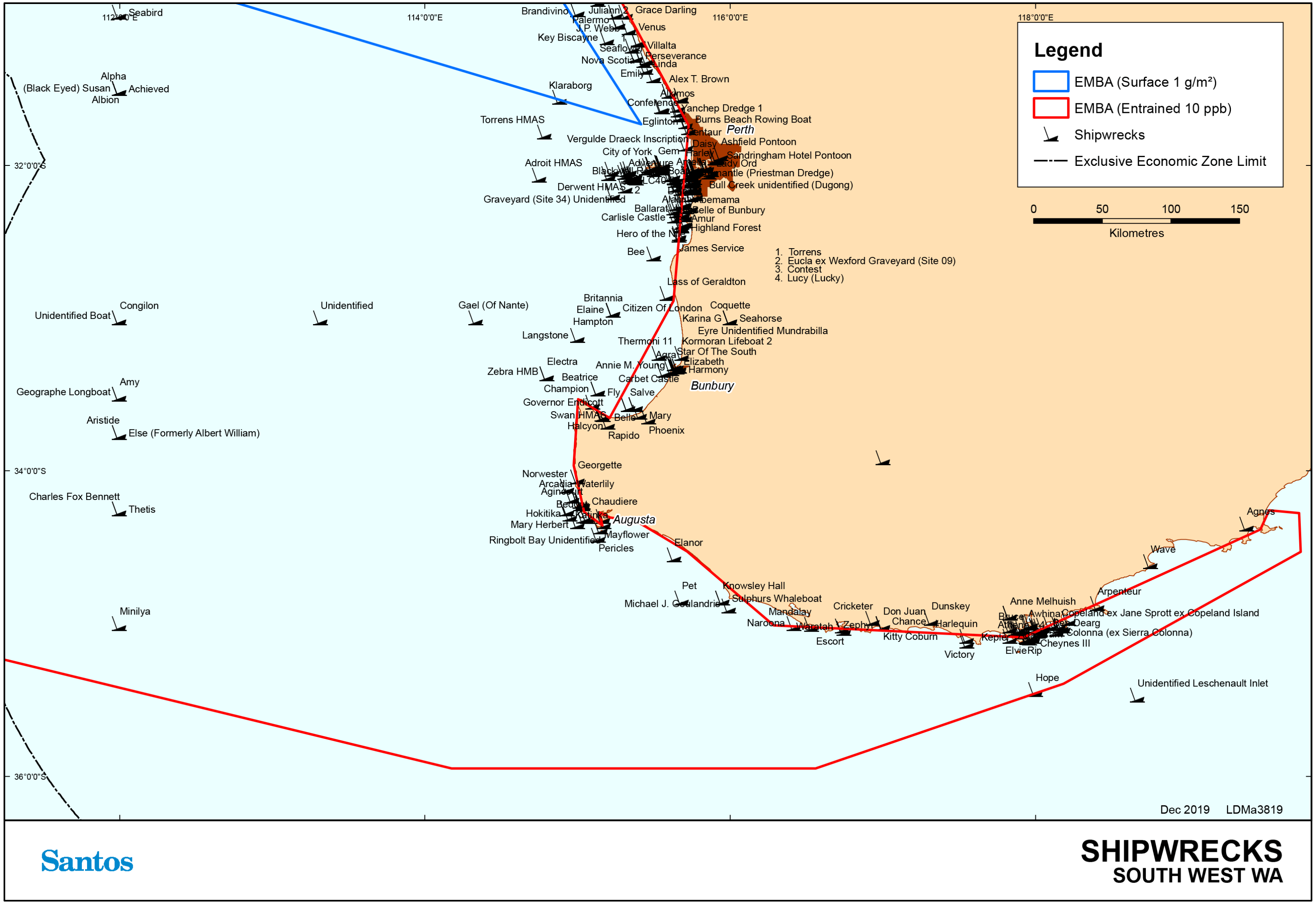

Figure 14-6: Shipwrecks – South West WA

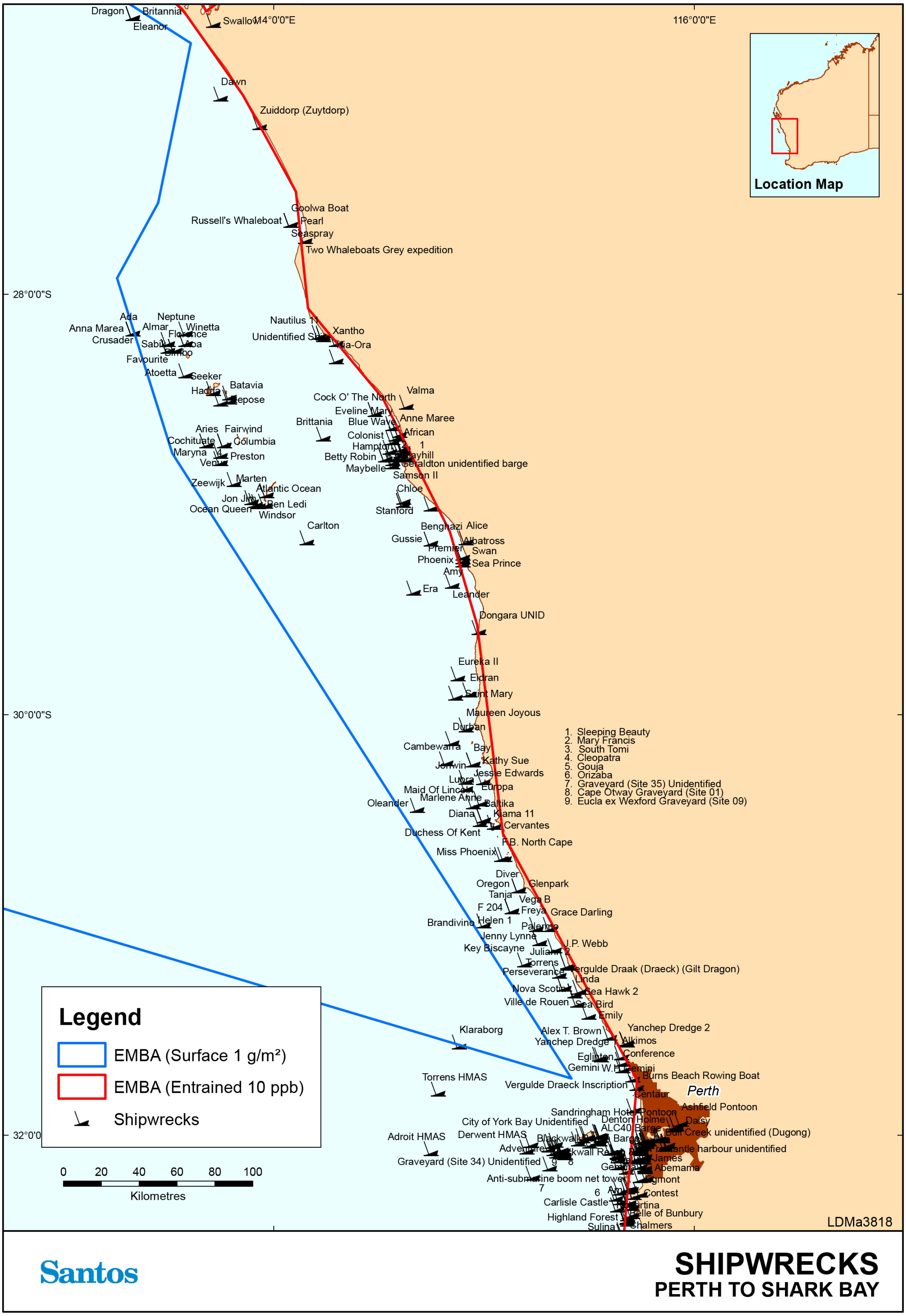

Figure 14-7: Shipwrecks – Perth – Shark Bay

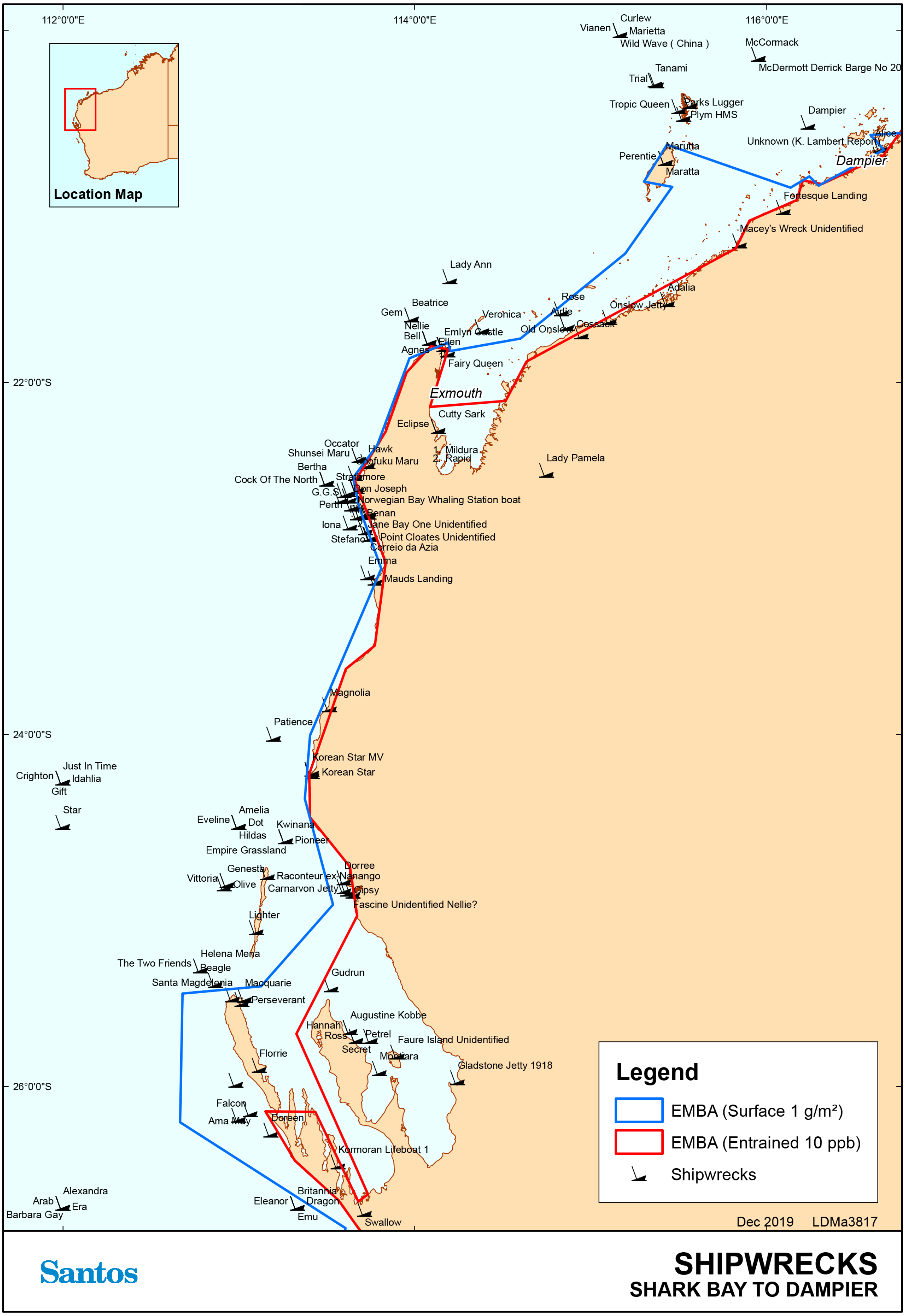

Figure 14-8: Shipwrecks – Shark Bay – Dampier

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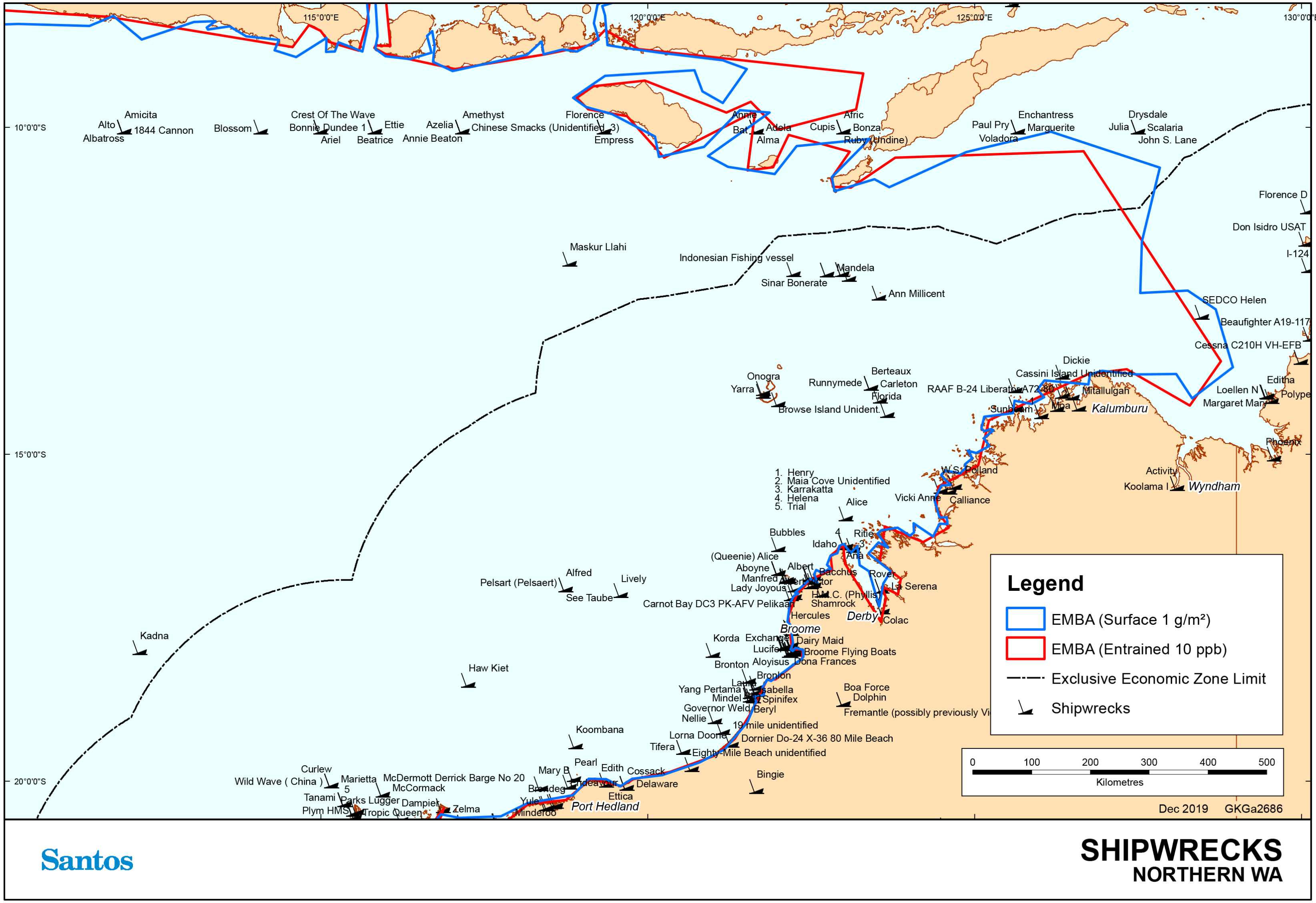

Figure 14-9: Shipwrecks – Northern WA

14.7 Commercial Fisheries

A valuable and diverse commercial fishing industry is supported by both the offshore and coastal waters in the North Coast, Gascoyne, West Coast and South Coast Bioregions between the WA and NT and South Australian borders. The major fisheries in this area target tropical finfish, large pelagic fish species, crustaceans (prawns and scampi), Western Rock Lobster and pearl oysters (Fletcher and Santoro 2013). A number of smaller fisheries also exist in this area including the octopus and beche-de-mer fisheries.

14.7.1 State Fisheries

State fisheries are managed by the WA Department of Primary Industries and Regional Development (DPIRD) (formerly Department of Fisheries (DoF)) with specific management plans, regulations and a variety of subsidiary regulatory instruments under the *Fish Resources Management Act 1994* (WA). The information on State managed fisheries has been derived from '*The State of the Fisheries'* Report 2017/2018 (Gaughan *et al.* 2019) and direct consultation with DPIRD. Santos WA consults regularly with State fisheries relevant to activity operational areas, mainly by distribution of an Annual Consultation Update by post.

State commercial fisheries that exist between Kalbarri (WA) and the NT border are shown in **Figure** 14-10. A summary of all commercial fisheries in the area is also summarised **Table 14-2**. These are:

North Coast Bioregion

- Onslow Prawn Managed Fishery (OPMF);
- Nickol Bay Prawn Managed Fishery (NBPMF) – referred to as Nickol Bay Prawn Limited Entry Fishery in **Figure** 14-10;
- Broome Prawn Managed Fishery (BPMF);
- Kimberley Prawn Managed Fishery (KPMF);
- Kimberley Gillnet & Barramundi Managed Fishery (KGBF);
- Northern Demersal Scalefish Managed Fishery (NDSF);
- Kimberley Developing Mud Crab Fishery – not shown in **Figure** 14-10;
- Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF);
- Pilbara Trap Managed Fishery (PTMF);
- Pilbara Line Fishery;
- Western Australian Sea Cucumber Fishery (referred to as Beche-de-mer Fishery in **Figure** 14-10);
- Mackerel Managed Fishery (Area 1 – Kimberley and Area 2 – Pilbara);
- Western Australian Pearl Oyster Fishery – referred to as Pearl Oyster Managed Fishery in **Figure** 14-10;
- Northern Shark Fisheries (closed, not shown in **Figure** 14-10) including:
    - Western Australian North Coast Shark Fishery - not shown in **Figure** 14-10; and
    - Joint Authority Northern Shark Fishery - not shown in **Figure** 14-10;
    - North Coast Trochus Fishery – not shown in **Figure** 14-10; and
    - Pilbara Developing Crab Fishery – not shown in **Figure** 14-10.

Gascoyne Bioregion

- Exmouth Gulf Prawn Managed Fishery;
- Gascoyne Demersal Scalefish Managed Fishery;

- Shark Bay Scallop Managed Fishery – referred to as Shark Bay Scallop Limited Entry Fishery on **Figure** 14-10;
- Shark Bay Prawn Managed Fishery – referred to as Shark Bay Prawn Limited Entry Fishery on **Figure** 14-10;
- Shark Bay Crab Interim Managed Fishery; and
- Mackerel Fishery (Area 3 – Gascoyne/West Coast).

West Coast Bioregion

- Roe's Abalone – not shown in **Figure** 14-10;
- Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWRMF) (Closed) – referred to as Abrolhos Islands and Mid-West Trawl Limited Entry Fishery in **Figure** 14-10;
- West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF);
- South West Trawl Managed Fishery – referred to as South West Trawl Limited Entry Fishery in **Figure** 14-10;
- Mandurah to Bunbury Developing Crab Fishery – not shown in **Figure** 14-10;
- Cockburn Sound Crab Managed Fishery – not shown in **Figure** 14-10**;**
- Cockburn Sound Line and Pot Managed Fishery – not shown in **Figure** 14-10;
- Cockburn Sound Mussel Managed Fishery – not shown in **Figure** 14-10;
- Warnbro Sound Crab Managed Fishery (closed) – not shown in **Figure** 14-10;
- West Coast Nearshore and Estuarine Finfish Fisheries, including:
- Cockburn Sound Fish Net Managed Fishery – not shown in **Figure** 14-10;
- West Coast Beach Baited Managed Fishery – not shown in **Figure** 14-10;
- South West Beach Seine Fishery – not shown in **Figure** 14-10; and
- West Coast Estuarine Managed Fishery – not shown in **Figure** 14-10;
- Temperate Demersal Gillnet and Demersal Longline Fisheries, including:
    - West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (West Coast Bioregion) – not shown in **Figure** 14-10;
- West Coast Deep Sea Crab (Interim) Managed Fishery – referred to as West Coast Deep Sea Crustacean Managed Fishery in **Figure** 14-10;
- West Coast Nearshore Net Managed Fishery – not shown in **Figure** 14-10;
- Octopus Interim Managed Fishery – not shown in **Figure** 14-10;
- West Coast Rock Lobster Managed Fishery; and
- West Coast Purse Seine Fishery – not shown in **Figure** 14-10.

South Coast Bioregion

- Greenlip/Brownlip Abalone Fishery – not shown in **Figure** 14-10;
- South Coast Deep-Sea Crab Fishery – not shown in **Figure** 14-10;
- South Coast Open Access Netting Fishery – not shown in **Figure** 14-10; and

- South West Coast Beach Net – not shown in **Figure** 14-10.
- South Coast Salmon Managed Fishery (forms part of the South Coast Nearshore and Estuarine Finfish Fishery);
- South West Coast Salmon Managed Fishery;
- Temperate Demersal Gillnet and Demersal Longline Fisheries including:
    - Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (South Coast Bioregion)
    - South West Trawl Managed Fishery (SWTMF) – referred to as South West Trawl Limited Entry Fishery in **Figure** 14-10; and
    - Windy Harbour/Augusta Rock Lobster Managed Fishery – not shown in **Figure** 14-10.

Whole of State Fisheries

- Marine Aquarium Fish Managed Fishery (MAFMF);
- Specimen Shell Managed Fishery; and
- Hermit Crab Fishery (HCF) – not shown in **Figure** 14-10.

Some of the fisheries listed above will be more susceptible to impacts than others, particularly fisheries without the ability to escape impacts. For example, above average water temperatures over the last three years will have had an impact on prawn fisheries in Exmouth and scallops and blue swimmer crabs in Shark Bay which have been significantly affected by the initial heat wave event of 2010/11 (Caputi *et al*. 2014).

14.7.2 Commonwealth Fisheries

Commonwealth fisheries are those within the 200 nautical mile Australian Fishing Zone (AFZ) managed by Australian Fisheries Management Authority (AFMA) and are, on the high seas, and, in some cases, by agreement with the States and Territory, to the low water mark. Information on Commonwealth managed fisheries has been derived from '*Fishery Status'* Report 2019 (Department of Agriculture 2019)

Commonwealth fisheries who have permits to operate in the EMBA include:

- North West Slope Trawl (NWST);
- Northern Prawn Fishery (NPF);
- Southern Bluefin Tuna Fishery (SBFTF);
- Western Tuna and Billfish Fishery (WTBF) (including Southern Tuna and Billfish Fishery shown in **Figure** 14-11**)**;
- Small Pelagic Fishery (SPF);
- Southern and Eastern Scalefish and Shark Fishery (SESSF) – not shown in **Figure** 14-11;
- Skipjack Tuna Fishery (STF) (referred to as Western Skipjack Tuna Fishery in **Figure** 14-11); and
- Western Deepwater Trawl (WDTF) (referred to as Western Deepwater Trawl Fishery in **Figure** 14-11).

Commonwealth commercial fisheries between Kalbarri (WA) and the NT Border are shown in **Figure** 14-11 and summarised in **Table 14-2**.

14.7.3 Indonesian Commercial and Subsistence Fishing

Within the northern and north-western extent of the EMBA is a defined area where a Memorandum of Understanding (MoU) exists between the Australian and Indonesian Governments. The Agreement between the Government of Australia and the Government of the Republic of Indonesia Relating to Cooperation in

Fisheries (1992 Fisheries Cooperation Agreement) provides the framework for fisheries and marine cooperation between Australia and Indonesia, and facilitates information exchange on research, management and technological developments, complementary management of shared stocks, training and technical exchanges, aquaculture development, trade promotion and cooperation to deter illegal fishing.

Cooperation under the Agreement today takes place under the auspices of the Working Group on Marine Affairs and Fisheries. Established in 2001, the Working Group on Marine Affairs and Fisheries is the primary bilateral forum to enhance collaboration across the spectrum of marine and fisheries issues relevant to the areas of the Arafura and Timor seas. The Working Group brings together the fisheries, environment and scientific research portfolios and agencies from both countries.

The MoU Box (shown on **Figure** 14-10 and **Figure** 14-11) is an area of Australian water in the Timor Sea where Indonesian traditional fishers, using traditional fishing methods only, are permitted to operate. Officially it is known as the Australia-Indonesia Memorandum of Understanding regarding the Operations of Indonesian Traditional Fishermen in Areas of the Australian Fishing Zone and Continental Shelf – 1974.

As part of negotiations to delineate seabed boundaries, Australia and Indonesia entered into the MoU which recognises the rights of access for traditional Indonesian fishers in shared waters to the north of Australia. This access was granted in recognition of the long history of traditional Indonesian fishing in the area. The MoU provides Australia with a tool to manage access to its waters while for Indonesia, it enables Indonesian traditional fishers to continue their customary practices and target species such as trepang, trochus, abalone and sponges. Guidelines under the MoU were agreed in 1989 in order to clarify access boundaries for traditional fishers and take into account the declaration of the 200 nautical mile fishing zones. Because of its approximate shape the MoU area became known as the MoU Box.

Between 2006 and 2008, a series of surveys were undertaken to understand the traditional practice of Indonesian fishers that journey to Scott Reef within the MoU boundary (ERM 2008, 2009). The majority of perahu (vessels) that travel to Scott Reef originate from the islands of Rote (near West Timor) and Tonduk and Raas (in East Java). Some crew from the Rote perahus are recruited from the region of Alor (one of the Lesser Sundas chain, located north of East Timor and east of Bali). In 2007, an estimated 800 fishers (approximately 80 vessels) travelled from these home islands to Scott Reef, mainly to collect trepang. Similar vessel numbers sailed to Scott Reef in 2008.

Journeys to Scott Reef are generally restricted to drier months when wind speeds and directions are more desirable. Most Indonesian fishers travel to Scott Reef during July to October, although a few Rotenese make the journey to Scott Reef in the early season between April and June. Other fishers plan to go after Aidil Fitri, a religious holiday widely celebrated on Tonduk Island that celebrates the end of Ramadan.

The fishers focus their activities in and around the shallow water lagoons of Scott Reef primarily targeting trepang; and opportunistically gather trochus shells. They also catch fish largely for subsistence purposes although the average fish catch per lete-lete (traditional Indonesian fishing vessel) in 2008 increased to commercial volumes. Although deeper waters are more plentiful in trepang, deep diving is generally not undertaken by the fishers due to the MoU stipulation on the exclusive use of traditional equipment only (Woodside Energy Limited 2011).

14.8 Aquaculture

14.8.1 North Coast Bioregion

Aquaculture development in this region is dominated by the production of pearls from the species *Pinctada maxima.* A large number of pearl oysters for seeding is obtained from wild stocks and supplemented by hatchery-produced oysters with major hatcheries operating at Broome and the Dampier Peninsular. Pearl farm sites are located mainly along the Kimberley coast, particularly in the Buccaneer Archipelago, in Roebuck Bay and at the Montebello Islands. Developing marine aquaculture initiatives in this region include growing trochus and barramundi. Marine production of barramundi is focussed in Cone Bay fishing (Fletcher and Santoro 2015).

The Pearl Oyster Fishery of Western Australia operates in shallow coastal waters (DoF 2006). All the leases are within the 35m diving depth. Through consultation the Pearl Producer's Association (PPA) have raised concern that spawning stock is found to the 100 m depth contour. However, this is not supported in the study by Condie *et al* (2006) who modelled oyster larva transport in the Eighty Mile Beach region and found that while some larvae travelled more than 60 km, most were transported less than 30 km. The model results suggest that spawning in the Eighty Mile Beach region is concentrated around the 8 to 15m depth range, with potential smaller contributions from the northeast. These spawning events are likely to lead to successful recruitment locally and alongshore to the southwest.

They also feed larvae into neighbouring shallow coastal environments (through tidal oscillations) and deeper waters to the west (>20 m). However, spat abundances seem to be low in these areas, suggesting that recruitment is strongly limited by habitat availability and possibly high mortality rates in shallow water. High local abundances of broodstock and spat observed occasionally in deeper water (<30 m) seem to be supported by intermittent larval transport from inshore populations. Spawning in this area seems to contribute little to recruitment in the inshore populations.

Further aquaculture operations are expected in the region with recent funding supporting the establishment of an aquaculture zone (Gaughan *et al.* 2019).

14.8.2 Gascoyne Coast Bioregion

Hatchery production of oysters is the core of the pearling industry in the Gascoyne region. Hatcheries in Carnarvon and Exmouth supply spat to pearl farms in the north-west and several hatcheries supply juveniles to the black-lip pearl oyster to developing black pearl farms in the region. Pearl production is carried out on a small scale in Shark Bay and Exmouth Gulf. The local aquiculture sector is also focussing on the production of aquarium species.

14.8.3 West Coast Bioregion

The principal aquaculture development activities in this region are the production of blue mussels (*Mytilus galloprovincialis*) and marine algae (*Dunaliella salina*) and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands. The main mussel farming area is in southern Cockburn Sound, where conditions are sheltered and the nutrient and planktonic food levels are sufficient to promote good growth rates fishing (Fletcher and Santoro 2015).

Currently, the Department of Fisheries is seeking to secure strategic environmental approvals for a Mid-West Aquaculture Development Zone (Gaughan *et al*. 2019).

14.8.4 South West Bioregion

The predominant aquaculture activity undertaken in this region is the production of mussels and oysters from Oyster Harbour at Albany. This activity is restricted to this area where there are sufficient nutrient levels related to terrestrial run-off to provide the planktonic food necessary to promote growth of filter-feeding bivalves fishing (Fletcher and Santoro 2015). The high-energy environment and limited protected deep waters limits other forms of aquaculture.

14.8.5 Indonesian Aquaculture

An analysis by WorldFish has indicated that aquaculture will overtake capture fisheries as the major source of fish in Indonesia before 2030 (Phillips *et al.* 2015). By volume, Indonesian aquatic production is dominated by seaweeds, but by value, domestically consumed species such tilapia and milkfish, together with export-orientated commodities such as shrimp and tuna, are of greater importance (Phillips *et al*. 2015).

Carrageenan seaweed farming based primarily on the cultivation of *Kappaphycus* and *Eucheuma* species has grown significantly in Indonesia. Due to the simple farming techniques required, low requirements of capital and material inputs, and short production cycles it has become a favourable livelihood for smallholder farmers and fishers (Valderrama *et al*. 2013). Indonesia's coastline provides ideal conditions for fish farming in "brackish waters". Aquaculture in Indonesia is predominantly used for seaweed production, whilst offshore fish cultivation remains relatively undeveloped (Global Business Guide 2014).

14.9 Recreational Fisheries

14.9.1 North Coast Bioregion

The North Coast Bioregion (Pilbara/Kimberley) runs from the Ashburton River to the Western Australia/Northern Territory border (WAFIC 2016). The oceanography of this region includes waters of Pacific Ocean origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian throughflow and Holloway currents which flow seasonally and interact with Indian ocean waters. Recreational fishing is experiencing a significant growth in this region, with a distinct seasonal peak in winter when the local population increases by significant numbers of metropolitan and inter-state tourists. This has been added to by the increased recreational fishing by those involved in the construction or operation of major developments in this region. Owing to the high tidal range, much of the angling activity is boat-based with beach fishing limited to periods of flood tides and high water. Numerous creek systems, mangroves, rivers and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including saddletail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, mackerels and billfish (WAFIC 2016).

14.9.2 Gascoyne Coast Bioregion

The Gascoyne Coast Bioregion extends from just north of Kalbarri to the Ashburton River, south of Onslow. The marine environment of this region represents a transition between the fully tropical waters of the north-west shelf of the north coast region and the temperate waters of the west coast region. This region has been identified as one of the 18 world 'hotspots' in terms of tropical reef endemism and the second most divers marine environment in the world in terms of tropical reef species. This region is a focal point for winter recreational fishing and is a key component of many tourist visits. Angling activities include beach and cliff fishing (e.g. Steep Point and Quobba), embayment and shallow-water boat angling (e.g. Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g. off Ningaloo). The predominant target species include the tropical species such as emperors, tropical snappers, groupers, mackerels, trevallies and other game fish. Temperate species at the northern end of their ranges such as pink snapper, tailor and whiting also provide significant catches, particularly in Shark Bay (WAFIC 2016).

14.9.3 West Coast Bioregion

The marine environment of the West Coast Bioregion which lies between Kalbarri and Augusta is predominantly a temperate oceanic zone, but it is heavily influenced by the Leeuwin current, which transports warm tropical water southward along the edge of the continental shelf. This region contains the state's major population centres and is the most heavily used bioregion for recreational fishing (Fletcher and Santoro 2015). The range of recreational fishing opportunities includes estuarine fishing, beach fishing and boat fishing either in embayments or offshore for demersal and pelagic game species often around the islands and out to the continental shelf (WAFIC 2016).

14.9.4 South West Bioregion

The South West Bioregion includes the water from Augusta to Eucla on the Western Australia/South Australia border. The continental shelf waters of this region are generally temperate but low in nutrients due to the seasonal presence of the tail of the tropical Leeuwin current and limited terrestrial run-off. As much of the south coast is remote or difficult to access, recreational beach and boat fishing tends to be concentrated around the main population and holiday centres. The major target species for beach and rock anglers are salmon, herring, whiting and trevally, while boat anglers target pink snapper, queen snapper, Bight redfish, a number of shark species, salmon fish and King George whiting. Another component of the recreational fishery is dinghy and shoreline fishing off estuaries and rivers where the main angling targets are black bream and whiting. Recreational netting primarily targeting mullet also occurs in these estuaries (WAFIC 2016).

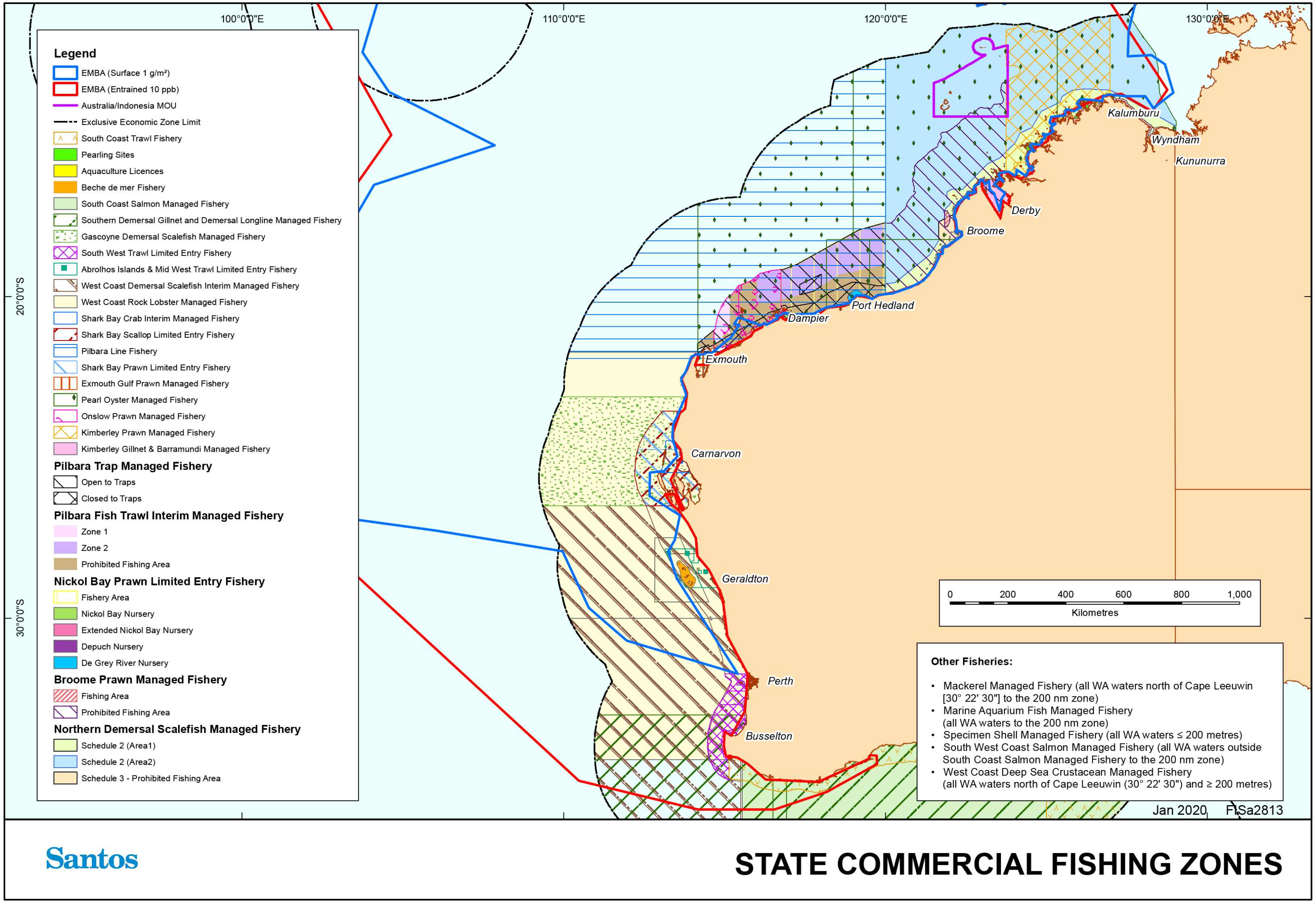

Figure 14-10: State commercial fishing zones

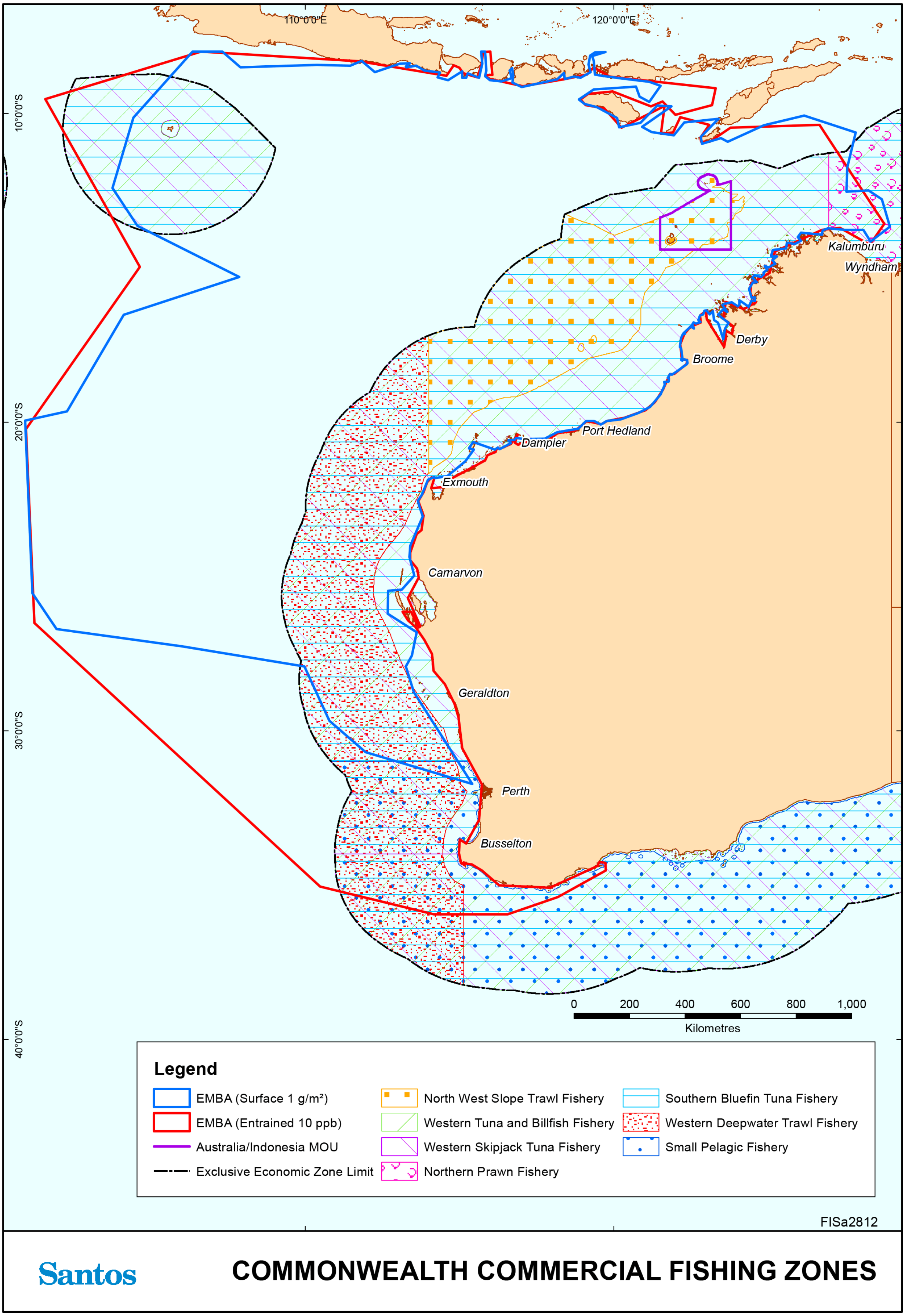

Figure 14-11: Commonwealth commercial fishing zones

Table 14-2: Commercial fisheries with permits to operate within the EMBA

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
State Managed Fisheries				
Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWTMF)	Saucer scallops (*Ylistrum balloti*), with a small component targeting the western king prawn (*Penaeus latisulcatus*)	2017/2018: 651 tonnes	Operates using low opening otter trawl systems.	All the waters of the Indian Ocean adjacent to Western Australia between 27°51´ south latitude and 29°03´ south latitude on the landward side of the 200 m isobath'.
Broome Prawn Managed Fishery (BPMF)	Western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species).	Extremely low fishing effort occurred as only a single boat undertook trial fishing to investigate whether catch rates were sufficient for commercial fishing. This resulted in negligible landings of western king prawns with no byproduct recorded.	Otter trawl	The BPMF operates in a designated trawl zone off Broome. The boundaries of the BPMF 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'. The actual trawl area is contained within a delineated small area north west of Broome.
Cockburn Sound Mussel Managed Fishery	Blue mussels (*Mytilus edulis*)	2015: Unspecified	Agriculture	Main mussel farming occurs in southern Cockburn Sound.
Cockburn Sound Crab Managed Fishery	Blue Swimmer (*Portunus armatus)* Blue swimmer crab (*Portunus armartus)*	2017/2018: 5: closed to commercial and recreational fishing since April 2014	Drop nets, scoop nets, diving	Encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island and back to John Point on the mainland.
Cockburn Sound Line and Pot Managed Fishery	Southern garfish (*Hyporhamphus melanochir*), Australian herring (*Arripis geogianus*)	2017/2018: 257 tonnes	Line (fish) Shelter and trigger pots (octopus)	Encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island and back to John Point on the mainland.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Exmouth Gulf Prawn Managed Fishery	Western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*).	2017/2018: 713 tonnes	Low opening otter trawls.	Sheltered waters of Exmouth Gulf Essentially the western half of the Exmouth Gulf (eastern part is a nursery ground). The Muiron Islands and Point Murat provide the western boundary; Serrurier Island provides the northern limit
Gascoyne Demersal Scalefish Managed Fishery (GDSMF)	Targets pink snapper (*Pagrus auratus*) and goldband snapper (*Pristipomoides multidens*). Other demersal species caught include the rosy snapper (*P. filamentosus*), ruby snapper (*Etelis carbunculus*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, including spangled emperor*, Lethrinus nebulosus*, and redthroat emperor, *L. miniatus*), cods (Epinephelidae, including Rankin cod, *Epinephelus multinotatus* and goldspotted rockcod, *E. coioides*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicas*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).	2017/2018: Snapper: 133 tonnes Other demersals: 144 tonnes	Mechanised handlines	The GDSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°07'30"S and 26°30'S. Vessels are not permitted to fish in inner Shark Bay.
Abalone Managed Fishery	Greenlip abalone (*Haliotis laevigata*) Brownlip abalone (*H. conicopora)*	2017/2018: 98 tonnes	Dive fishery The principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) or SCUBA using an abalone 'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.	Shallow coastal waters off the south-west and south coasts of Western Australia Covers all Western Australian coastal waters, which are divided into eight management areas. Commercial fishing for greenlip/brownlip abalone is managed in three separate areas.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Hermit Crab Fishery (HCF)	Australian land hermit crab (*Coenobita variabilis*)	2017/2018: 58,643 (lowest reported in the last 10 years (2008-2017; catch range 58,643-118,203).	Land based hand collection typically using four-wheel drives to access remote beaches	Operates in Western Australian waters north of the Exmouth Gulf (22°30'S)
Kimberley Developing Mud Crab Managed Fishery	Mud crab (*Scylla serrata*)	2017/2018: 60 tonnes (also includes catch data from Pilbara Developmental crab fishery)	Mud Crab traps	This fishery operates between Broome and Cambridge Gulf. Three commercial operators are permitted to fish from King Sound to the Northern Territory border, with closed areas around communities and fishing camps. One Aboriginal Corporation is permitted to fish in King Sound, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier peninsula, north of Broome. Notices issued under the *Fish Resources Management Act 1994* prohibit all commercial fishing for mud crabs in Roebuck Bay and an area of King Sound near Derby.
Kimberley Gillnet and Barramundi Managed Fishery (KGBF)	Barramundi *(Lates calcarifer),* King threadfin *(Polydactylus macrochir),* Blue threadfin *(Eleutheronema tetradactylum)*	2017/2018: 79.9 tonnes	Gill net in inshore waters	Nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129ºE) to the top end of Eighty Mile Beach, south of Broome (19ºS). The waters of the KGBF are defined as 'all Western Australian waters north of 19° south latitude and west of 129° east longitude and within three nautical miles of the high water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47´ south latitude.
Kimberley Prawn Managed Fishery (KPMF)	Banana prawns (*Penaeus merguiensis*) Tiger prawns (*Penaeus esculentus*)	2017/2018: 269 tonnes	Otter trawl	The KPMF operates off the north of the state between Koolan Island and Cape Londonderry.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	Endeavour prawns (*Metapenaeus endeavouri*) Western king prawns (*Penaeus latisulcatus*)			The boundaries of the KPMF are 'all Western Australian waters of the Indian Ocean lying east of 123°45´ east longitude and west of 126°58´ east longitude'. It abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF).
Mandurah to Bunbury Developing Crab Fishery	Blue swimmer crab (*Portunus armartus)*	2017/2018: 5.2 tonnes	Drop nets, scoop nets, diving	Fishery extends from south of the Shoalwater Islands Marine Park (32°22'40''S) to Point McKenna near Bunbury (33°16'S) and offshore to 115°30'E. The fishery is divided into two zones with crab fishing historically being permitted within Area 1, Comet Bay between 32°22''40''S and 32°30'S, and Area 2, Cape Bouvard to the southern boundary of the fishery. In 2015 crab fishing within Area 2 ceased.
Marine Aquarium Fish Managed Fishery (MAFMF)	Over 250 target species of finfish. (228 species caught in 2012). Fishermen can also take coral, live rock, algae, seagrass and invertebrates. The main fish species landed in 2012 were scribbled angelfish (*Chaetodontoplus duboulayi*) and green chromis (*Chromis cinerascens*) The main coral species landed in 2012 were the coral like anemones of the Corallimorpharia.	2017/2018: Total catch of 150,544 fishes, 21.9 t of coral, live rock & living sand and 322 L of marine plants.	Hand harvest while diving or wading. Hand held nets	Dive based fishery operating all year throughout WA waters, but restricted by diving depths. The MAFMF is able to operate in all State waters (between the Northern Territory border and South Australian border). The fishery is typically more active in waters south of Broome with higher levels of effort around the Capes region, Perth, Geraldton, Exmouth and Dampier. Operators in the MAFMF are also permitted to take coral, live rock, algae, seagrass and invertebrates under the Prohibition on Fishing (Coral, 'Live Rock' and Algae) Order 2007 and by way of Ministerial Exemption (Gaughan & Santoro, 2018).

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Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Nickol Bay Prawn Managed Fishery (NBPMF)	Primarily targets banana prawns (*Penaeus merguiensis*)	2017/2018: 227 tonnes	Otter trawl	Operates along the western part of the North-West Shelf in coastal shallow waters The boundaries of the NBPMF are 'all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120° east longitude on the landward side of the 200 m isobath'. The NBPMF incorporates the Nickol Bay, Extended Nickol Bay, Depuch and De Grey size managed fish grounds (State of the Fisheries 2014-15).
North Coast Trochus Fishery	Trochus (*Tectus niloticus*)	2017/2018: Unspecified	Harvested by with handheld levers or chisels	Indigenous fishery operating within King Sound
Northern Demersal Scalefish Managed Fishery (NDSF)	Red emperor (*Lutjanus sebae*) Goldband snapper (*Pristipomoides multidens*)	2017/2018:1317 tonnes (total) Goldband snapper (not including other jobfish): 473 tonnes Red emperor: 34 – 47 tonnes	The permitted means of operation within the fishery include handline, dropline and fish traps, but since 2002 it has essentially been a trap-based fishery which uses gear time access and spatial zones as the primary management measures (State of the Fisheries 2014-15).	The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the northwest coast of Western Australia in the waters east of 120° E longitude. These waters extend out to the edge of the Australian Fishing Zone (200 nautical miles). The Fishery consists of three zones; Zone A is an inshore area, Zone B comprises the area with most historical fishing activity and Zone C is an offshore deep slope developmental area. The fishery is further divided into two fishing areas; an inshore sector and an offshore sector. The inshore waters in the vicinity of Broome are closed to commercial fishing.
WA North Coast Shark Fisheries	Sandbar (*Carcharhinus plumbeus)*, hammer head (*Sphyrnidae*), blacktip (*Carcharhinus melanopterus*) and lemmon sharks (*Negaprion brevirostris*).	2017/2018: closed since 2008/2009	Gill net, longline	Comprised of the State-managed WA North Coast Shark Fishery in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery in the eastern Kimberley.

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Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Octopus Interim Managed Fishery	*Octopus cf. tetricus*, with occasional bycatch of *O. ornatus* and *O. cyanea* in the northern parts of the fishery, and *O.maorum* in the southern and deeper sectors.	2017/2018: Commercial: 257 tonnes Recreational: 1 tonne	Line and pots Trawl and trap (land Octopus as byproduct)	Fishery in development phase. Four main categories in WA waters. Octopus are primarily caught in the Developing Octopus Interim Managed Fishery (largest fishery) are limited to the boundaries of the developmental fishery, which is an area bounded by the Kalbarri Cliffs (26°30'S) in the north and Esperance in the south. Passive and by-product harvests of octopus occur in both the Cockburn Sound (Line and Pot) Managed Fishery and the West Coast Rock Lobster Managed Fishery.
Onslow Prawn Managed Fishery (OPMF)	Western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.)	2017/2018: Negligible (Minimal fishing occurred in 2017)	Otter trawl	Operates along the western part of the North-West Shelf with most prawning activities concentrated in the shallower water off the mainland. The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200 m depth isobath'.
Pilbara Developmental Crab Fishery	Blue Swimmer (*Portunus armatus)* Mud Crab (*Scylla* spp)	2017/2018: 60 tonnes (total number includes Kimberley Developing Mud Crab Fishery)	Variety of gear but mostly commercial crab pots (Hourglass traps used in inshore waters from Onslow through to Port Hedland with most commercial and activity occurring in and around Nickol Bay) Recreational fishers use drop nets or scoop nets, with diving for crabs becoming increasingly popular	The majority of the commercially and recreationally-fished stocks are concentrated in the coastal embayments and estuaries between Geographe Bay in the south west and Nickol Bay in the north. Crabbing activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around Nickol Bay.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and frypan Moses' snapper (*Argyrops Lutjanusspinifer russelli*).	2017/2018: 1,780 tonnes	Demersal trawl	The Pilbara Fish Trawl (Interim) Managed Fishery is situated in the Pilbara region in the north west of Australia. It occupies the waters north of latitude 21°35'S and between longitudes 114°9'36"E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath. The Fishery consists of two zones; Zone 1 in the south west of the Fishery (which is closed to trawling) and Zone 2 in the North, which consists of six management areas.
Pilbara Trap Managed Fishery (PTMF)	Blue-spot emperor (*Lethrinus hutchinsi*), Red snapper (*Lutjanus erythropterus*), Goldband snapper (*Pristipomoides multidens*), Scarlet perch (*Lutjanus malabaricus*), Red emperor (*Lutjanus sebae*), Spangled emperor (*Lethrinus nebulosus*), Rankin cod (*Epinephelus multinotatus*)	2017/2018: 400–600 tonnes	Use of rectangular traps with single opening and 50 mm x 70 mm rectangular mesh panels. Trap fishing normally targets areas around rocky outcrops and reefs	Permitted to operate within waters bounded by a line commencing at the intersection of 21°56´ S latitude and the high water mark on the western side of the North West Cape.
Pilbara Line Managed Fishery	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*),	2017/2018: 50–115 tonnes	Line	The Pilbara Trap Managed Fishery lies north of latitude 21°44´ S and between longitudes 114°9´36´´ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and frypan snapper (*Argyrops spinifer*), Ruby snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus)*			
Roe's Abalone	Western Australian Roe's abalone (*Haliotis roei*)	2017/2018: Commercial: 49 tonnes Recreational: 23 tonnes	Dive and wade fishery. The commercial fishery harvest method is a single diver working off a 'hookah' (surface-supplied breathing apparatus) using an abalone 'iron' to prise the shellfish off rocks. Abalone divers operate from small fishery vessels (generally less than 9 metres in length).	Operating in shallow coastal waters along WA's western and southern coasts from Shark Bay to the SA border. Divided into 8 management areas. Commercial fishing for Roe's abalone is managed in 6 separate regions from the South Australian border to Busselton Jetty – Areas 1, 2, 5, 6, 7 and 8. Area 8 of the fishery was not fished in 2013.
Shark Bay Crab Interim Managed Fishery	Blue swimmer crab (*Portunus armatus*)	2017/2018: 443 tonnes total Crab: 153 tonnes	Trawl and trap	Waters of Shark Bay north of Cape Inscription, to Bernier and Dorre Islands and Quobba Point. In addition, two fishers with long-standing histories of trapping crabs in Shark Bay are permitted to fish in the waters of Shark Bay south of Cape Inscription.
Shark Bay Prawn Managed Fishery	Western king prawn (*Penaeus latisulcatus*), brown tiger prawn (*Penaeus esculentus*), Variety of smaller prawn species including endeavour prawns (*Metapenaeus* spp.) and coral prawns (various species).	2017/2018: 1,608 tonnes	Low opening otter trawls	The boundaries of the Shark Bay Prawn Managed Fishery are located in and near the waters of Shark Bay

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Shark Bay Scallop Managed Fishery	Saucer Scallop (*Ylistrum balloti*)	2017/2018: 1,632 tonnes	Low opening otter trawls	The boundaries of the Shark Bay Scallop Managed Fishery are located in and near the waters of Shark Bay
South Coast Open Access Netting Fishery	Insufficient information	Insufficient information	Insufficient information	Bunbury to the South Australian Border
Specimen Shell Managed Fishery (SSF)	Shells (cowries, cones) The Specimen Shell Managed Fishery (SSF) is based on the collection of individual shells for the purposes of display, collection, cataloguing, classification and sale. Just under 200 (196) different Specimen Shell species were collected in 2012, using a variety of methods.	2017/2018: 7,806 shells	Hand harvest while diving or wading along coastal beaches below the high water mark An exemption method being employed by the fishery is using a remote controlled underwater vehicle at depths between 60 and 300 m.	Dive based fishery operating all year throughout WA waters, but restricted by diving depths. The fishing area includes all Western Australian waters between the high water mark and the 200 m isobath. While the fishery covers the entire WA coastline, there is some concentration of effort in areas adjacent to population centres such as Broome, Karratha, Exmouth, Shark Bay, metropolitan Perth, Mandurah, the Capes area and Albany.
South Coast Salmon Managed Fishery	WA salmon (*Arripis truttaceus*)	2017: 50 tonnes	Beach seine net, rod and line	Licensees operate from 18 designated beaches within the South Coast Bioregion, many of which have huts that are referred to as salmon camps.
South West Coast Salmon Managed Fishery	WA salmon (*Arripis truttaceus*)	Insufficient information	Insufficient information	Insufficient information
South West Coast Beach Net	Insufficient information	Insufficient information	Insufficient information	Insufficient information
South West Trawl Managed Fishery (SWTMF)	Saucer scallops (*Ylistrum balloti*)	2017/2018: 460 t meat weight (2,301 t whole weight)	Otter trawls	Waters between 31°34’27’’S and 115°8’8’’E where it intersects with the high water mark at Cape Leeuwin and on the landward side of the 200 m isobath.

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Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Temperate Demersal Gillnet and Demersal Longline Fisheries (TDGDLF)	Gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and sandbar shark (*Carcharhinus plumbeus*).	2017/2018: 2016-17Sharks and rays: 936 tonnes Scalefish: 133 tonnes	Demersal gillnets and power-hauled reels (to target sharks) Demersal longline	The Temperate Demersal Gillnet and Demersal Longline fisheries consists of Zone 1 of the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery. The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF) spans the waters from 33° S latitude to the WA/SA border and comprises three management zones Zone 1 extends southwards from 33° S to 116° 30' E longitude off the south coast. Zone 2 extends from 116°30' E to the WA/SA border (129° E). A small number of Zone 3 units permit fishing throughout Zone 1 and eastwards to 116° 55'40" E. The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) technically extends northwards from 33° S latitude to 26° S longitude. However, the use of shark fishing gear has been prohibited north of 26° 30' S (Steep Point) since 1993. Demersal gillnet and longline fishing inside the 250 metre depth contour has been prohibited off the Metropolitan coast (between latitudes 31° S and 33° S) since November 2007.
Warnbro Sound Crab Managed Fishery	Blue Swimmer (*Portunus armatus)* Blue swimmer crab (*Portunus armartus)*	2017/2018: closed to commercial and recreational fishing	Drop nets, scoop nets, diving	Includes Warnbro sound and adjacent water, extending from Becher Point to John Point.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
West Coast Deep Sea Crustacean (Interim) Managed Fishery	Crystal (Snow) crabs (*Chaceon albus*), Giant (King) crabs (*Pseudocarcinus gigas*) and Champagne (Spiny) crabs (*Hypothalassia acerba*).	2017/2018: 164.4 tonnes	Baited pots operated in a longline formation in the shelf edge waters (>150 m)	North of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150 m isobath out to the extent of the AFZ, mostly in 500 to 800 m of water.
West Coast Demersal Scalefish (Interim) Managed Fishery	West Coast Inshore Demersals: West Australian Dhufish (*Glaucosoma hebraicum*), Pink snapper (*Pagrus auratus*) with other species captured including Redthroat Emperor (*Lethrinus miniatus*), Bight Redfish (*Centroberyx gerrardi*) and Baldchin Groper (*Choerodon rubescens*). West Coast Offshore Demersals: Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneios*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.	2017/2018: 248 tonnes	Handline and drop line	The WCDSIMF encompasses the waters of the Indian Ocean just south of Shark Bay (at 26°30'S) to just east of Augusta (at 115°30'E) and extends seaward to the 200 nm boundary of the Australian Fishing Zone (AFZ). The commercial fishery is divided into five management areas comprising four inshore areas and one offshore area. The inshore areas, i.e. Kalbarri, Mid-West, Metropolitan and South-West, extend outwards to the 250 m depth contour, while the Offshore Area extends the entire length of the fishery from the 250 m depth contour to the boundary of the AFZ.
West Coast Estuarine Managed Fishery	Blue swimmer crab (*Portunus armartus)*	2017/2018: 353 tonnes (blue swimmer crab) commercial and 58-77 tonnes recreational	Drop nets, scoop nets, diving (crabs)	Includes the waters of the Swan and Canning Rivers (Area 1), the waters of the Peel Inlet and Harvey Estuary, together with the Murray Serpentine, Harvey and Dandalup Rivers (Area 2) and waters of the Hardy Inlet (Area 3). Of these areas only Areas 1-2 are permitted for crab fishing.
West Coast Nearshore and Estuarine Finfish Fisheries	Nearshore: whitebait (*Hyperlophus vittatus*), western Australian salmon (*Arripis truttaceus*), Australian herring (*Arripis georgianus*), southern school whiting (*Sillago bassensis*), yellowfin	2017/2018: 353 tonnes	Haul, beach seine and gill netting (commercial). Line fishing (recreational)	Five commercial fisheries target nearshore and/or estuarine finfish in the West Coast Bioregion. Nearshore: Cockburn Sound Fish Net Managed Fishery operating within in

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	whiting (*Sillago schomburgkii*), yelloweye mullet (*Aldrichetta forsteri*), tailor (*Pomatomus saltarix*), southern garfish (*Hyporhamphus melanochir*), silver trevally (*Pseudocaranx georgianus*) and King George whtiting (*Sillaginodes punctate*). Estuarine*:* sea mullet (*Mugil cephalus*), estuary cobbler (*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).			Cockburn sound, South West Coast Salmon Managed Fishery operating on various beaches south of the Perth Metropolitan area, West Coast Beach Bait Managed Fishery operating on beaches spanning from Moore River to Tim's Thicket and the South West Beach Seine Fishery operating on various beaches from Tim's Thicket southwards to Port Geographe Bay Marina. Estuarine*:* West Coast Estuarine Managed Fishery operating in the Swan/Canning and Peel Harvey estuaries, and in the Hardy Inlet
West Coast Nearshore Net Managed Fishery	Southern garfish (Hyporhamphus melanochir), Australian herring (Arripis georgianus),	Insufficient information	Insufficient information	Insufficient information
West Coast Purse Seine Fishery	Scaly mackerel (*Sardinella lemuru*), pilchard (*S. sagax*), Australian anchovy (*Engraulis australis*), yellowtail scad (*Trachurus novaezelandiae*) and maray (*Etrumeus teres*).	2017/2018: 1,095 tonnes	Purse seine gear	Waters between Ningaloo and Cape Leeuwin including three separate zones: Northern Development (22°00'S to 31°00'S), Perth Metropolitan (31°00'S to 33°00'S) and Southern Development Zone (33°00'S to Cape Leeuwin).
West Coast Rock Lobster Managed Fishery (WCRLMF)	Western rock lobster (*Panulirus cygnus*)	2016: 272 – 400 tonnes (346-481 tonnes based on updated average weight)	Baited traps (pots). Pots and diving (recreational catch)	The fishery is situated along the west coast of Australia between Latitudes 21°44´ to 34°24´ S. The fishery is managed in three zones: Zone A – Abrolhos Islands, north of latitude 30° S excluding the Abrolhos Islands (Zone B) and south of latitude 30° S (Zone C).
West Coast Demersal Gillnet and Demersal Longline (WCDGDLF)*	Gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and sandbar shark (*C. plumbeus*)	2016/2018: 936 tonnes of sharks and rays	Demersal gillnets and demersal longline (not widely used)	Operates between 26° and 33° S.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Mackerel Fishery	Spanish mackerel *(Scomberomorus commerson)*, grey mackerel *(S.semifasciatus)*, with other species from the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium* also contributing to commercial catches.	2016: Commercial: The commercial catch of spanish mackerel was 276 tonnes in 2016 (Gaughan & Santoro, 2018)	Trolling or handline Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands. Jig fishing is also used to capture grey mackerel *(S.semifasciatus)*	The Fishery extends from the West Coast Bioregion to the WA/NT border, to the 200 nautical mile AFZ with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts of the Northern Bioregion. Restricted to coastal and shallower waters. Catches are reported separately for three Areas: Area 1 - Kimberley (121º E to WA/NT border); Area 2 -Pilbara (114º E to 121º E); Area 3 - Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S).
Western Australian Pearl Oyster Managed Fishery	Indo- Pacific silver-lipped pearl oyster (*Pinctada maxima*).	2018: 468,573 shells	Drift diving restricted to shallow diveable depths. The collection of pearl oysters for the Pearl Oyster Managed Fishery is restricted to shallow diving depths below 35 m. Divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legalised oysters by hand as they are seen.	The fishery is separated into four zones: Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30'E. There are five licensees in this zone. No fishing in this zone since 2008 Pearl Oyster Zone 2: East of Cape Thouin (118°20´ E) and south of latitude 18°14´ S. The 9 licensees in this zone also have full access to Zone 3. This zone is the mainstay of the fishery. Pearl Oyster Zone 3: West of longitude 125°20´ E and north of latitude 18°14´ S. The 2 licensees in this zone also have partial access to Zone 2. Pearl Oyster Zone 4: East of longitude 125°20´ E to the Western Australia/Northern Territory border. Although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				economically viable. However, pearl farming does occur.
Western Australian Sea Cucumber Fishery (formerly known as Beche-de-mer)	Sandfish (*Holothuria scabra*) and deepwater redfish (*Actinopyga echinites*).	2016: 93 tonnes	Hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading.	The Western Australian Sea Cucumber Fishery is permitted to operate throughout WA waters with the exception of a number of specific closures around the Dampier Archipelago, Cape Keraudren, Cape Preston and Cape Lambert, the Rowley Shoals and the Abrolhos Islands. The fishery is primarily based in the northern half of the State, from Exmouth Gulf to the Northern Territory border.
Commonwealth Managed Fisheries				
North West Slope Trawl	Scampi (crayfish): velvet scampi (*Metanephrops velutinus*) and boschmai scampi (*Metanephrops boschmai*). Deepwater prawns (penaeid and carid): pink prawn (*Parapenaeus longirostris*), red prawn (*Aristaeomorpha foliacea*), striped prawn (*Aristeus virilis*), giant scarlet prawn (*Aristaeopsis edwardsiana*), red carid prawn (*Heterocarpus woodmasoni*) and white carid prawn (*Heterocarpus sibogae*). Snapper.	2017-18: 79.7 total tonnes.	Demersal crustacean trawl seaward of the 200 m isobath.	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ).
Western Skipjack Tuna Fishery	Skipjack tuna (*Katsuwonus pelamis*)	2017-18: None in either zones	Purse seine	The Skipjack Tuna Fishery is split into two sectors; east and west. The Western Skipjack Tuna Fishery is located in all Australia waters west of 142° 30’ 00°E, out to 200 nm from the coast.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				There has been no fishing effort in the Skipjack Tuna Fishery since the 2008-09 season, and in that season activity concentrated off South Australia (Department of Agriculture 2019).
Small Pelagic Fishery	Australian sardine (*Sardinops sagax*), blue mackerel (*Scomber australasicus*), jack mackerel (*Trachurus declivis*) and redbait (*Emmelichthys nitidus*).	2018-19: 9,424 tonnes	Purse-seine and midwater trawling	Extends from Queensland to southern Western Australia.
Southern Bluefin Tuna Fishery	Southern bluefin tuna (*Thunnus maccoyii*).	2017-18: 6,159 tonnes	Purse seine vessels primarily in Great Australian Bight all year round and longline off southern NSW in winter. Around 98% of Australia's SBT quota is taken by 5–10 purse seine vessels fishing for 13–25 kg southern bluefin tuna.	Fishery includes all waters of Australia, out to 200 nm from the coast. No current effort on the North West Shelf, fishing activity is concentrated in the Great Australian Bight and off South-east Australia (Department of Agriculture 2019).
Western Deepwater Trawl Fishery	A diverse range of species are caught, ranging from tropical and ruby snappers on the shelf edge to orange roughy (*Hoplostethus atlanticus*), oreo dories and bugs (*Ibacus* spp.) in the deeper temperate waters.	2017-18: 101.9 tonnes	Demersal fish trawl seaward of the 200 m isobath.	Its northernmost point is from the boundary of the AFZ to longitude 114° E, and its southernmost point is from the boundary of the AFZ to longitude 115°08' E. Deep water off WA, from the 200 m isobath to the edge of the AFZ.
Western Tuna and Billfish Fishery	Broadbill swordfish (*Xiphias gladius*), albacore tuna (*Thunnus alalunga*), striped marlin (*Kajikia audax*), bigeye tuna (*T. obesus*) and yellowfin tuna (*T. albacares*).	2018: 278 tonnes	Pelagic, longline, minor line and purse seine.	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. In recent years, fishing effort has concentrated off south-west

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				Western Australia and South Australia with no current effort on the North West Shelf (Department of Agriculture 2019).

Source: Apache (2008); Australian Fisheries Management Authority (2011); Department of Fisheries (2013), Stakeholder consultation.

[1]Sources for catch data: Department of Agriculture 2019; Gaughan *et al*, 2019; DPIRD 2018.

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Appendix A: EPBC Act Protected Matters Report

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

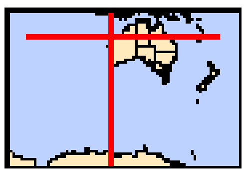
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

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: 25/11/19 14:53:11

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:	2
National Heritage Places:	9
Wetlands of International Importance:	7
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	199
Listed Migratory Species:	108

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:	9
Commonwealth Heritage Places:	24
Listed Marine Species:	216
Whales and Other Cetaceans:	44
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Australian Marine Parks:	45

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	140
Regional Forest Agreements:	1
Invasive Species:	64
Nationally Important Wetlands:	19
Key Ecological Features (Marine)	24

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Fitzgerald River National Park	WA	Listed place
Lesueur National Park	WA	Listed place
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place
The West Kimberley	WA	Listed place
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place
Historic		
Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos	WA	Listed place
Dirk Hartog Landing Site 1616 - Cape Inscription Area	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Ashmore reef national nature reserve	Within Ramsar site
Becher point wetlands	Within 10km of Ramsar
Eighty-mile beach	Within Ramsar site
Hosnies spring	Within Ramsar site
Peel-yalgorup system	Within Ramsar site
Roebuck bay	Within Ramsar site
The dales	Within Ramsar site

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
Extended Continental Shelf

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
North-west
South-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
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes	Endangered	Community likely to

Names	Status	Type of Presence
of Dampier Peninsula		occur within area
Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)	Critically Endangered	Community known to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Accipiter hiogaster natalis		
Christmas Island Goshawk [82408]	Endangered	Species or species habitat known to occur within area
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Atrichornis clamosus		
Noisy Scrub-bird, Tjimiluk [654]	Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	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 tenuirostris		
Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus banksii naso		
Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii		
Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Breeding known to occur within area
Calyptorhynchus latirostris		
Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Cereopsis novaehollandiae grisea		
Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
Chalcophaps indica natalis		
Christmas Island Emerald Dove, Emerald Dove (Christmas Island) [67030]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Dasyornis longirostris		
Western Bristlebird [515]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur

Names	Status	Type of Presence
		within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to 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
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren [26004]	Vulnerable	Species or species habitat likely to occur within area

Names	Status	Type of Presence
Ninox natalis Christmas Island Hawk-Owl, Christmas Boobook [66671]	Vulnerable	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
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Pezoporus flaviventris Western Ground Parrot, Kyloring [84650]	Critically Endangered	Species or species habitat likely to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat known to occur within area
Psophodes nigrogularis nigrogularis Western Heath Western Whipbird [64449]	Endangered	Species or species habitat known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta cauta Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Turdus poliocephalus erythropleurus Christmas Island Thrush [67122]	Endangered	Species or species habitat likely to occur

Names	Status	Type of Presence
		within area
Turnix varius scintillans Painted Button-quail (Houtman Abrolhos) [82451]	Vulnerable	Species or species habitat likely to occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Galaxiella nigrostriata Blackstriped Dwarf Galaxias, Black-stripe Minnow [88677]	Endangered	Species or species habitat known to occur within area
Milyeringa veritas Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Nannatherina balstoni Balston's Pygmy Perch [66698]	Vulnerable	Species or species habitat known to occur within area
Ophisternon candidum Blind Cave Eel [66678]	Vulnerable	Species or species habitat known to occur within area
Insects		
Hesperocolletes douglasi Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
Trioza barrettae Banksia brownii plant louse [87805]	Endangered	Species or species habitat known to 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	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Bettongia lesueur lesueur Burrowing Bettong (Shark Bay), Boodie [66659]	Vulnerable	Species or species habitat known to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat likely to occur within area
Crocidura trichura Christmas Island Shrew [86568]	Critically Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area

Names	Status	Type of Presence
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon auratus auratus Golden Bandicoot (mainland) [66665]	Vulnerable	Species or species habitat likely to occur within area
Isoodon auratus barrowensis Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Lagorchestes hirsutus bernieri Rufous Hare-wallaby (Bernier Island) [66662]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus dorreae Rufous Hare-wallaby (Dorre Island) [66663]	Vulnerable	Species or species habitat known to occur within area
Lagostrophus fasciatus fasciatus Banded Hare-wallaby, Merrnine, Marnine, Munning [66664]	Vulnerable	Species or species habitat known to occur within area
Leporillus conditor Wopilkara, Greater Stick-nest Rat [137]	Vulnerable	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesembriomys gouldii gouldii Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known to occur within area
Osphranter robustus isabellinus Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat known to occur within area
Perameles bougainville bougainville Western Barred Bandicoot (Shark Bay) [66631]	Endangered	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

Names	Status	Type of Presence
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Phascogale calura Red-tailed Phascogale, Red-tailed Wambenger, Kenngoor [316]	Vulnerable	Species or species habitat may 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
Pipistrellus murrayi Christmas Island Pipistrelle [64383]	Critically Endangered	Species or species habitat known to occur within area
Potorous gilbertii Gilbert's Potoroo, Ngilkat [66642]	Critically Endangered	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Breeding known to occur within area
Pseudomys fieldi Shark Bay Mouse, Djoongari, Alice Springs Mouse [113]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys shortridgei Heath Mouse, Dayang, Heath Rat [77]	Endangered	Species or species habitat may occur within area
Pteropus natalis Christmas Island Flying-fox, Christmas Island Fruit-bat [87611]	Critically Endangered	Roosting known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known 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
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
Other		
Idiosoma nigrum Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat may occur within area
Kumonga exleyi Cape Range Remipede [86875]	Vulnerable	Species or species habitat likely to occur within area
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
Adenanthos dobagii Fitzgerald Woollybush [21253]	Endangered	Species or species habitat likely to occur within area
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area

Names	Status	Type of Presence
Androcalva bivillosa Straggling Androcalva [87807]	Critically Endangered	Species or species habitat may occur within area
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Banksia brownii Brown's Banksia, Feather-leaved Banksia [8277]	Endangered	Species or species habitat known to occur within area
Banksia nivea subsp. uliginosa Swamp Honeypot [82766]	Endangered	Species or species habitat likely to occur within area
Banksia pseudoplumosa False Plumed-Banksia [82760]	Endangered	Species or species habitat may occur within area
Banksia squarrosa subsp. argillacea Whicher Range Dryandra [82769]	Vulnerable	Species or species habitat may occur within area
Banksia verticillata Granite Banksia, Albany Banksia, River Banksia [8333]	Vulnerable	Species or species habitat likely to occur within area
Beyeria lepidopetala Small-petalled Beyeria, Short-petalled Beyeria [18362]	Endangered	Species or species habitat likely to occur within area
Boronia clavata Bremer Boronia [5538]	Endangered	Species or species habitat likely to occur within area
Caladenia barbarella Small Dragon Orchid, Common Dragon Orchid [68686]	Endangered	Species or species habitat may occur within area
Caladenia bryceana subsp. cracens Northern Dwarf Spider-orchid [64556]	Vulnerable	Species or species habitat known to occur within area
Caladenia busselliana Bussell's Spider-orchid [24369]	Endangered	Species or species habitat likely to occur within area
Caladenia caesarea subsp. maritima Cape Spider-orchid [64856]	Endangered	Species or species habitat known to occur within area
Caladenia elegans Elegant Spider-orchid [56775]	Endangered	Species or species habitat likely to occur within area
Caladenia excelsa Giant Spider-orchid [56717]	Endangered	Species or species habitat likely to occur within area
Caladenia granitora [65292]	Endangered	Species or species habitat known to occur within area
Caladenia hoffmanii Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat known to occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area

Names	Status	Type of Presence
Caladenia lodgeana Lodge's Spider-orchid [68664]	Critically Endangered	Species or species habitat known to occur within area
Caladenia procera Carbunup King Spider Orchid [68679]	Critically Endangered	Species or species habitat may occur within area
Caladenia viridescens Dunsborough Spider-orchid [56776]	Endangered	Species or species habitat known to occur within area
Calectasia cyanea Blue Tinsel Lily [7669]	Critically Endangered	Species or species habitat known to occur within area
Chamelaucium sp. S coastal plain (R.D.Royce 4872) Royce's Waxflower [87814]	Vulnerable	Species or species habitat may occur within area
Chordifex abortivus Manypeaks Rush [64868]	Endangered	Species or species habitat known to occur within area
Chorizema varium Limestone Pea [16981]	Endangered	Species or species habitat known to occur within area
Conostylis micrantha Small-flowered Conostylis [17635]	Endangered	Species or species habitat may occur within area
Conostylis misera Grass Conostylis [21320]	Endangered	Species or species habitat may occur within area
Darwinia oxylepis Gillam's Bell [13188]	Endangered	Species or species habitat may occur within area
Darwinia wittwerorum Wittwer's Mountain Bell [15626]	Endangered	Species or species habitat may occur within area
Daviesia obovata Paddle-leaf Daviesia [17311]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat known to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Drummondita ericoides Morseby Range Drummondita [9193]	Endangered	Species or species habitat known to occur within area

Names	Status	Type of Presence
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus cuprea Mallee Box [56773]	Endangered	Species or species habitat may occur within area
Eucalyptus x phylacis Meelup Mallee [87817]	Endangered	Species or species habitat known to occur within area
Gastrolobium papilio Butterfly-leaved Gastrolobium [78415]	Endangered	Species or species habitat may occur within area
Grevillea batrachioides Mt Lesueur Grevillea [21735]	Endangered	Species or species habitat may occur within area
Grevillea brachystylis subsp. australis [55525]	Vulnerable	Species or species habitat may occur within area
Grevillea humifusa Spreading Grevillea [61182]	Endangered	Species or species habitat may occur within area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat likely to occur within area
Isopogon uncinatus Albany Cone Bush, Hook-leaf Isopogon [20871]	Endangered	Species or species habitat known to occur within area
Kennedia glabrata Northcliffe Kennedia [16452]	Vulnerable	Species or species habitat likely to occur within area
Kennedia lateritia Augusta Kennedia [45985]	Endangered	Species or species habitat likely to occur within area
Keraudrenia exastia Fringed Keraudrenia [66301]	Critically Endangered	Species or species habitat known to occur within area
Lambertia echinata subsp. occidentalis Western Prickly Honeysuckle [64528]	Endangered	Species or species habitat may occur within area
Lambertia orbifolia Roundleaf Honeysuckle [15725]	Endangered	Species or species habitat likely to occur within area
Lechenaultia chlorantha Kalbarri Leschenaultia [16763]	Vulnerable	Species or species habitat likely to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Leptomeria dielsiana Diels' Currant Bush [5146]	Vulnerable	Species or species habitat known to occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area

Names	Status	Type of Presence
Marianthus paralius [83925]	Endangered	Species or species habitat known to occur within area
Pityrodia augustensis Mt Augustus Foxglove [4962]	Vulnerable	Species or species habitat likely to occur within area
Pneumatopteris truncata fern [68812]	Critically Endangered	Species or species habitat known to occur within area
Reedia spathacea Reedia [2995]	Critically Endangered	Species or species habitat likely to occur within area
Sphenotoma drummondii Mountain Paper-heath [21160]	Endangered	Species or species habitat likely to occur within area
Stachystemon nematophorus Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat known to occur within area
Tectaria devexa [14767]	Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may occur within area
Verticordia apecta Hay River Featherflower, Scruffy Verticordia [65545]	Critically Endangered	Species or species habitat may occur within area
Verticordia plumosa var. vassensis Vasse Featherflower [55804]	Endangered	Species or species habitat may occur within area
Wurmbea calcicola Naturaliste Nancy [64691]	Endangered	Species or species habitat known to occur within area
Wurmbea tubulosa Long-flowered Nancy [12739]	Endangered	Species or species habitat known to 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	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Cryptoblepharus egeriae Christmas Island Blue-tailed Skink, Blue-tailed Snake-eyed Skink [1526]	Critically Endangered	Species or species habitat likely to occur within area
Ctenotus lancelini Lancelin Island Skink [1482]	Vulnerable	Species or species habitat known to occur within area
Ctenotus zastictus Hamelin Ctenotus [25570]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Cyrtodactylus sadleiri Christmas Island Giant Gecko [86865]	Endangered	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat known to occur within area
Emoia nativitatis Christmas Island Forest Skink, Christmas Island Whiptail-skink [1400]	Critically Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lepidodactylus listeri Christmas Island Gecko, Lister's Gecko [1711]	Critically Endangered	Species or species habitat known to occur within area
Lerista nevinae Nevin's Slider [85296]	Endangered	Species or species habitat known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area
Liopholis pulchra longicauda Jurien Bay Skink, Jurien Bay Rock-skink [83162]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Ramphotyphlops exocoeti Christmas Island Blind Snake, Christmas Island Pink Blind Snake [1262]	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
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

Name	Status	Type of Presence
		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 carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Breeding known to occur within area
Ardenna grisea		
Sooty Shearwater [82651]		Species or species habitat may 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
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena		
Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata andrewsi		
Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding 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
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli		
Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
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
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely 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
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		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	Foraging, feeding or related behaviour known to occur within area

Names	Threatened	Type of Presence
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding 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	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding 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
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known 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 known 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 habitat may occur within

Names	Threatened	Type of Presence
		area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known 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
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 known to 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
Rhipidura rufifrons Rufous Fantail [592]		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]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur

Names	Threatened	Type of Presence
		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]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting 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]		Roosting 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 minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area

Name	Threatened	Type of Presence
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting 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 Land - Christmas Island National Park
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion
Defence - GREENOUGH RIFLE RANGE
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND
Defence - LANCELIN TRAINING AREA
Defence - LEARMONTH - AIR WEAPONS RANGE
Defence - YAMPI SOUND TRAINING AREA

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ashmore Reef National Nature Reserve	EXT	Listed place
Christmas Island Natural Areas	EXT	Listed place
Garden Island	WA	Listed place
Lancelin Defence Training Area	WA	Listed place
Learmonth Air Weapons Range Facility	WA	Listed place
Mermaid Reef - Rowley Shoals	WA	Listed place
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place
Yampi Defence Area	WA	Listed place
Historic		
Administrators House Precinct	EXT	Listed place
Bungalow 702	EXT	Listed place
Cape Leeuwin Lighthouse	WA	Listed place
Cliff Point Historic Site	WA	Listed place
Drumsite Industrial Area	EXT	Listed place
Geraldton Drill Hall Complex	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Industrial and Administrative Group	EXT	Listed place

Names	State	Status
J Gun Battery	WA	Listed place
Malay Kampong Group	EXT	Listed place
Malay Kampong Precinct	EXT	Listed place
Phosphate Hill Historic Area	EXT	Listed place
Poon Saan Group	EXT	Listed place
Settlement Christmas Island	EXT	Listed place
South Point Settlement Remains	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
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting 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]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding 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
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area

Names	Threatened	Type of Presence
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting 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]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may 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

Names	Threatened	Type of Presence
		within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		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 known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding likely to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Breeding known to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Puffinus huttoni Hutton's Shearwater [1025]		Foraging, feeding or related behaviour known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur

Names	Threatened	Type of Presence
		within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
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]		Roosting 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
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
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 galei Gale's Pipefish [66191]		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 habitat may occur within area
Choeroichthys sculptus Sculptured Pipefish [66197]		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 haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area

Names	Threatened	Type of Presence
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
Cosmocampus maxweberi Maxweber's Pipefish [66209]		Species or species habitat may occur within area
Doryrhamphus baldwini Redstripe Pipefish [66718]		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 macrorhynchus Whiskered Pipefish, Ornate Pipefish [66222]		Species or species habitat may occur within area
Halicampus mataafae Samoan Pipefish [66223]		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

Names	Threatened	Type of Presence
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippichthys spicifer Belly-barred Pipefish, Banded Freshwater Pipefish [66232]		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 breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		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 subelongatus West Australian Seahorse [66722]		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
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area

Names	Threatened	Type of Presence
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		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
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		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

Names	Threatened	Type of Presence
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Breeding known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known 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 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 pooleorum Shark Bay Seasnake [66061]		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	Breeding known to occur

Name	Threatened	Type of Presence
		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	Foraging, feeding or related behaviour known 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	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Seasnake [1101]		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 inornatus Plain Seasnake [1107]		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

Name	Threatened	Type of Presence
		habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known 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 acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		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	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		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
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to 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
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area

Names	Status	Type of Presence
Hyperoodon planifrons Southern Bottlenose Whale [71]		Species or species 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
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may 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
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		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]		Foraging, feeding or

Names	Status	Type of Presence
		related behaviour known to 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
Tasmacetus shepherdi Shepherd's Beaked Whale, Tasman Beaked Whale [55]		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 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

Commonwealth ReservesTerrestrial [Resource Information]

Name	State	Type
Christmas Island	EXT	National Park (Commonwealth)

Australian Marine Parks [Resource Information]

Name	Label
Abrolhos	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	National Park Zone (IUCN II)
Abrolhos	Special Purpose Zone (IUCN VI)
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)
Bremer	National Park Zone (IUCN II)
Bremer	Special Purpose Zone (Mining
Carnarvon Canyon	Habitat Protection Zone (IUCN IV)
Cartier Island	Sanctuary Zone (IUCN Ia)
Dampier	Habitat Protection Zone (IUCN IV)
Dampier	Multiple Use Zone (IUCN VI)
Dampier	National Park Zone (IUCN II)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)

Names	Label
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Geographe	Habitat Protection Zone (IUCN IV)
Geographe	Multiple Use Zone (IUCN VI)
Geographe	Special Purpose Zone (Mining
Jurien	National Park Zone (IUCN II)
Jurien	Special Purpose 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)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Perth Canyon	Habitat Protection Zone (IUCN IV)
Perth Canyon	Multiple Use Zone (IUCN VI)
Perth Canyon	National Park Zone (IUCN II)
Roebuck	Multiple Use Zone (IUCN VI)
Shark Bay	Multiple Use Zone (IUCN VI)
South-west Corner	Habitat Protection Zone (IUCN IV)
South-west Corner	Multiple Use Zone (IUCN VI)
South-west Corner	National Park Zone (IUCN II)
South-west Corner	Special Purpose Zone (IUCN VI)
South-west Corner	Special Purpose Zone (Mining
Two Rocks	Multiple Use Zone (IUCN VI)
Two Rocks	National Park Zone (IUCN II)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Adele Island	WA
Airlie Island	WA
Arpenteur	WA
Bald Island	WA
Bardi Jawi	WA
Barrow Island	WA
Bedout Island	WA
Beekeepers	WA
Bernier And Dorre Islands	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	WA
Breaksea Island	WA
Browse Island	WA
Burnside And Simpson Island	WA
Cape Range	WA
Carnac Island	WA
Chatham Island	WA
Coulomb Point	WA
D'Entrecasteaux	WA
Dambimangari	WA
Dambimangari	WA
Dirk Hartog Island	WA
Doubtful Islands	WA
Eclipse Island	WA
Escape Island	WA
Fitzgerald River	WA
Flinders Bay	WA
Freycinet, Double Islands etc	WA
Glasse Island	WA
Gnandaroo Island	WA
Hamelin Island	WA
Jarrkunpungu	WA

Names	State
Jinmarnkur	WA
Jinmarnkur Kulja	WA
Jurabi Coastal Park	WA
Kalbarri	WA
Karajarri	WA
Koks Island	WA
Kujungurru Warrarn	WA
Lacepede Islands	WA
Lancelin And Edwards Islands	WA
Leeuwin-Naturaliste	WA
Lesueur	WA
Little Rocky Island	WA
Locker Island	WA
Low Rocks	WA
Lowendal Islands	WA
Michaelmas Island	WA
Montebello Islands	WA
Mount Manypeaks	WA
Muiron Islands	WA
Murujuga	WA
NTWA Bushland covenant (0005)	WA
NTWA Bushland covenant (0013)	WA
NTWA Bushland covenant (0090)	WA
Nambung	WA
Nilgen	WA
North Sandy Island	WA
North Turtle Island	WA
Nyangumarta Warrarn	WA
One Tree Point	WA
Prince Regent	WA
Quagering	WA
Quarram	WA
Rottnest Island	WA
Round Island	WA
Scott	WA
Seal Island (WA25645)	WA
Seal Island (WA32199)	WA
Serrurier Island	WA
Southern Beekeepers	WA
St Alouarn Island	WA
Sugar Loaf Rock	WA
Swan Island	WA
Tamala Pastoral Lease (Part)	WA
Tanner Island	WA
Tent Island	WA
Torndirrup	WA
Two Peoples Bay	WA
Unnamed WA11883	WA
Unnamed WA11962	WA
Unnamed WA15185	WA
Unnamed WA26400	WA
Unnamed WA28968	WA
Unnamed WA32478	WA
Unnamed WA33799	WA
Unnamed WA34039	WA
Unnamed WA36907	WA
Unnamed WA36909	WA
Unnamed WA36910	WA
Unnamed WA36913	WA
Unnamed WA36915	WA
Unnamed WA37168	WA
Unnamed WA37338	WA
Unnamed WA37383	WA
Unnamed WA37500	WA
Unnamed WA40322	WA
Unnamed WA40828	WA

Name	State
Unnamed WA40877	WA
Unnamed WA41080	WA
Unnamed WA41775	WA
Unnamed WA42030	WA
Unnamed WA44665	WA
Unnamed WA44667	WA
Unnamed WA44669	WA
Unnamed WA44672	WA
Unnamed WA44673	WA
Unnamed WA44676	WA
Unnamed WA44682	WA
Unnamed WA44685	WA
Unnamed WA44688	WA
Unnamed WA44690	WA
Unnamed WA44709	WA
Unnamed WA46982	WA
Unnamed WA46983	WA
Unnamed WA46984	WA
Unnamed WA48205	WA
Unnamed WA48858	WA
Unnamed WA48968	WA
Unnamed WA49994	WA
Unnamed WA51105	WA
Unnamed WA51162	WA
Unnamed WA51617	WA
Unnamed WA51932	WA
Unnamed WA53015	WA
Utcha Well	WA
Uunguu	WA
Victor Island	WA
Walpole-Nornalup	WA
Wanagarren	WA
Waychinicup	WA
Wedge Island	WA
Weld Island	WA
West Cape Howe	WA
Y Island	WA
Yalgorup	WA
Yampi	WA
Yawuru	WA
Zuytdorp	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

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		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area

Names	Status	Type of Presence
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Gallus gallus Red Junglefowl, Domestic Fowl [917]		Species or species habitat likely to occur within area
Lonchura oryzivora Java Sparrow [59586]		Species or species habitat likely to occur within area
Meleagris gallopavo Wild Turkey [64380]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pavo cristatus Indian Peafowl, Peacock [919]		Species or species habitat likely to occur within area
Phasianus colchicus Common Pheasant [920]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
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
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur

Name	Status	Type of Presence 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
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		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 norvegicus Brown Rat, Norway Rat [83]		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
Sus scrofa Pig [6]		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		
Andropogon gayanus Gamba Grass [66895]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus declinatus Bridal Veil, Bridal Veil Creeper, Pale Berry Asparagus Fern, Asparagus Fern, South African Creeper [66908]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur

Names	Status	Type of Presence
		within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Cylindropuntia spp. Prickly Pears [85131]		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
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may 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 likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur

Names	Status	Type of Presence
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		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
Lycodon aulicus Wolf Snake, Common Wolf Snake, Asian Wolf Snake [83178]		Species or species habitat likely to occur within area
Lygosoma bowringii Christmas Island Grass-skink [1312]		Species or species habitat likely to occur within area
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
"The Dales", Christmas Island	EXT
Ashmore Reef	EXT
Cape Leeuwin System	WA
Cape Range Subterranean Waterways	WA
Doggerup Creek System	WA
Eighty Mile Beach System	WA
Exmouth Gulf East	WA
Hosine's Spring, Christmas Island	EXT
Hutt Lagoon System	WA
Lake MacLeod	WA
Lake Thetis	WA
Learmonth Air Weapons Range - Saline Coastal Flats	WA
Leslie (Port Hedland) Saltfields System	WA
Mermaid Reef	EXT
Prince Regent River System	WA
Roebuck Bay	WA
Rottnest Island Lakes	WA
Shark Bay East	WA
Yalgorup Lakes System	WA

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
Canyons linking the Cuvier Abyssal Plain and the	North-west
Carbonate bank and terrace system of the Sahul	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	North-west
Mermaid Reef and Commonwealth waters	North-west

Names	Region
Pinnacles of the Bonaparte Basin	North-west
Seringapatam Reef and Commonwealth waters in	North-west
Wallaby Saddle	North-west
Albany Canyons group and adjacent shelf break	South-west
Ancient coastline at 90-120m depth	South-west
Cape Mentelle upwelling	South-west
Commonwealth marine environment surrounding	South-west
Commonwealth marine environment within and	South-west
Commonwealth marine environment within and	South-west
Diamantina Fracture Zone	South-west
Naturaliste Plateau	South-west
Perth Canyon and adjacent shelf break, and other	South-west
Western demersal slope and associated fish	South-west
Western rock lobster	South-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

-9.177999538 123.2974515,-9.72765503 123.1868066,-10.0392856 121.9949108,-9.610169143 121.5773987,-9.773757087 121.2056079,-9.285967581 119.9593652,-9.369248716 119.1711687,-9.547708292 118.9153767,-9.726167867 119.0938362,-9.828815543 119.685285,-10.46380078 120.2508491,-9.758885456 121.6398595,-10.66010631 121.5268351,-10.61251709 121.9164718,-10.11516156 122.1523326,-10.37159667 123.0913307,-10.78800234 122.7998467,-10.90994972 122.8355387,-10.92184702 123.1062023,-10.46181789 123.7843487,-10.36663945 126.6634966,-13.57929791 128.7634911,-14.25348901 128.2874787,-13.70026432 127.3267713,-13.77462248 126.7378547,-14.4795378 125.217974,-15.16958149 125.0514117,-15.49669903 124.4434001,-15.82988192 124.4149059,-16.12434022 124.6022885,-16.34146604 124.2096774,-16.10630003 123.6265001,-16.65079597 123.549377,-16.90063938 123.8676299,-17.1415598 123.8289636,-17.02853541 123.5850689,-17.19509768 123.6445554,-17.56391413 123.5672229,-16.66864193 123.0169726,-16.38905526 122.9902036,-16.54966888 122.7938981,-16.76976902 122.820667,-16.91551101 122.4815938,-17.15345351 122.2779076,-17.47171002 122.1484693,-17.98329413 122.2020072,-17.98626846 122.3715438,-18.11713882 122.3626208,-18.44134038 121.9521638,-18.45323768 121.8183191,-18.94400152 121.589296,-19.34850989 121.3305296,-19.6102506 121.024174,-19.85897703 120.3376261,-19.96716975 119.7809056,-20.07127117 119.5964974,-19.96716975 119.1295281,-20.28379903 118.7463001,-20.35085784 118.1717951,-20.66911074 117.7643124,-20.7434689 117.4103676,-20.70182833 117.2081134,-20.61557287 117.1605242,-20.73454592 116.9017578,-20.66911074 116.7917077,-20.41034436 116.8809375,-20.71075131 116.6638117,-20.87136493 116.3128412,-20.85054465 116.2057654,-20.96356904 116.1700735,-21.07956777 115.9023842,-21.23720706 115.8250517,-21.87966153 114.6353212,-22.10571033 114.5163481,-22.13815203 114.0855761,-21.81212803 114.1896491,-21.79340607 114.0910195,-21.94212238 113.9542005,-22.27822125 113.8352274,-22.56078224 113.6597422,-23.02477714 113.8352274,-23.49472069 113.7727666,-23.62856537 113.6091786,-24.22343062 113.4009758,-24.4702997 113.4039501,-24.7528607 113.6299989,-25.03244736 113.6716395,-25.70167077 113.3266176,-26.61478893 113.7341003,-26.65499704 113.6786991,-26.14484538 113.4336934,-26.14187106 113.1511324,-26.42145773 113.3176946,-26.64750652 113.567538,-27.05498922 113.8560477,-27.51303546 114.1058911,-28.06742404 114.1638051,-28.49753745 114.5193224,-29.13106895 114.8375754,-29.57424356 114.9684457,-30.56766853 115.0903931,-31.73955307 115.7268989,-32.88764301 115.6287461,-33.65501918 115.2093661,-33.53009748 115.0041376,-33.96434911 114.9743944,-34.26773039 115.0428039,-34.35696018 115.1617769,-34.27070472 115.1409566,-34.30639663 115.2123405,-34.33316557 115.3937744,-34.52649678 115.7179759,-35.01131196 116.2830979,-35.08864444 117.9219517,-34.38372912 119.4715757,-34.25880741 119.5280879,-34.27665337 119.7243934,-34.53015173 119.7362907,-35.39377835 118.1817628,-35.94649939 116.5581447,-35.94649939 114.1745352,-35.0483277 110.4782133,-26.51569666 101.2201359,-20.22849483 100.9437754,-14.97621096 104.6418894,-9.53283666 101.5795161,-7.998084312 106.6192145,-8.309853192 111.7458284,-8.771169021 114.5708991,-8.438284598 114.8167551,-8.521565733 114.998189,-8.694076656 115.126085,-8.827921337 115.5841312,-8.408541335 115.7060786,-8.004032964 115.7596165,-7.995109985 115.9916139,-8.753563181 116.0659721,-8.747614529 115.8399233,-8.783306444 115.8220773,-8.875510558 115.9856653,-9.110482332 117.0534484,-8.884433536 118.4394844,-8.741665876 119.1235795,-8.509668428 119.3496283,-8.804126727 119.8582381,-9.177999538 123.2974515

Acknowledgements

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-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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Santos

APPENDIX C – EPBC ACT PROTECTED MATTERS SEARCH REPORTS (OPERATIONAL AREA AND EMBA) AND ABORIGINAL HERITAGE INQUIRY SYSTEM SEARCHES

Australian Government
Department of the Environment and Energy

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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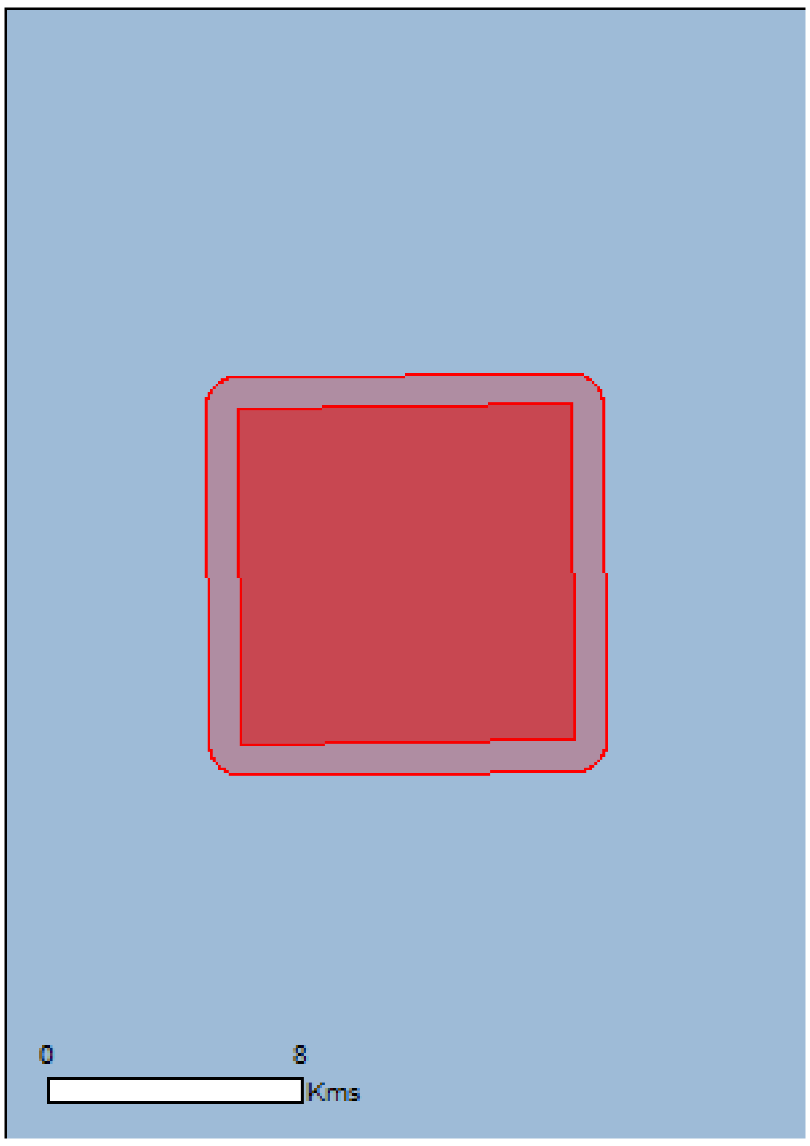
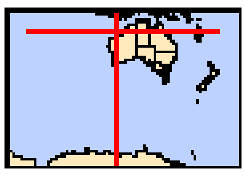


This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

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:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	14
Listed Migratory Species:	29

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:	None
Listed Marine Species:	55
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

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		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may 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 may occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata		
Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat may occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Species or species habitat may occur within area
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely 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
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may 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 may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may 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
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

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		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Fish		
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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 flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		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
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 grayi Mud Pipefish, Gray's Pipefish [66221]		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

Names	Threatened	Type of Presence
Micrognathus micronotopterus Tidepool Pipefish [66255]		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
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may 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 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 likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat 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

Names	Threatened	Type of Presence
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		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
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely 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	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area

Names	Status	Type of Presence
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat may occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

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

-18.9825 118.69559,-18.9816 118.79055,-19.07193 118.79152,-19.07283 118.69651,-18.9825 118.69559

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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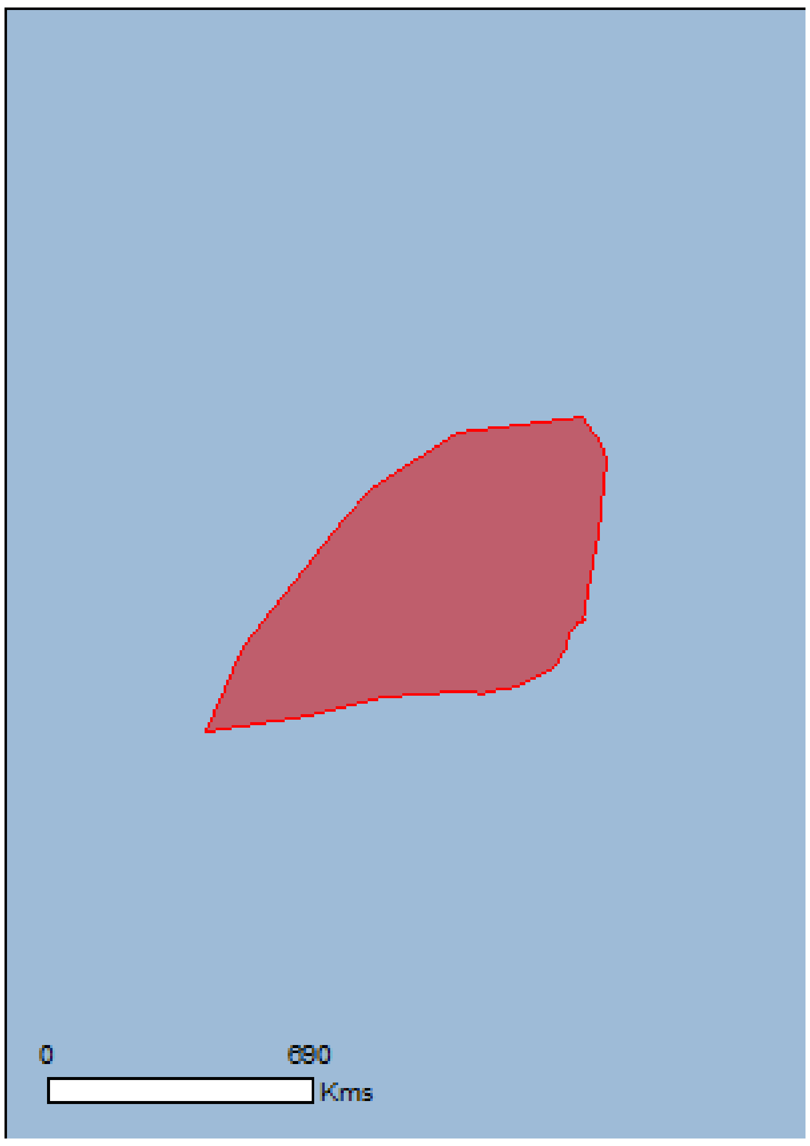
EPBC Act Protected Matters Report

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.

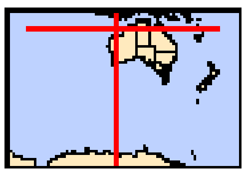
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 19/02/20 18:57:26



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

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:	None
Listed Threatened Species:	42
Listed Migratory Species:	82

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:	2
Listed Marine Species:	137
Whales and Other Cetaceans:	31
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	9

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:	15
Nationally Important Wetlands:	3
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
Eighty-mile beach	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 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
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known 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

Names	Status	Type of Presence
		within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	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
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 [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to 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 likely to occur within area
Isoodon auratus barrowensis Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Translocated population known to occur within area
Lagorchestes conspicillatus conspicillatus Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Translocated population known to occur within area
Lagorchestes hirsutus Central Australian subspecies Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat may occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped	Vulnerable	Species or species

Name	Status	Type of Presence
Sheathtail Bat [66889]		habitat may occur within area
Reptiles		
[Aipysurus apraefrontalis](#) Short-nosed Seasnake [1115]	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
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
[Eretmochelys imbricata](#) Hawksbill Turtle [1766]	Vulnerable	Breeding 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
[Liasis olivaceus barroni](#) Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat may occur within area
[Natator depressus](#) Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
[Carcharias taurus (west coast population)](#) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
[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	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]		Species or species habitat likely to occur within area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Names	Threatened	Type of Presence
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]		Species or species habitat known to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding likely 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 habitat known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		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

Names	Threatened	Type of Presence
		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]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding 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	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat likely to 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	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

Names	Threatened	Type of Presence
		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
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may 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 may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting 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 likely to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area

Names	Threatened	Type of Presence
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting 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]		Roosting 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 minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Heritage Places

[Resource Information]

Name	State	Status
Natural		
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		
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
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting 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 likely to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting 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	Roosting known to occur within area

Names	Threatened	Type of Presence
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		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]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting 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
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting 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]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area

Names	Threatened	Type of Presence
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may 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 minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting 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 likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
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

Names	Threatened	Type of Presence
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Roosting 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 stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting 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 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

Names	Threatened	Type of Presence
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 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

Names	Threatened	Type of Presence
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]		Species or species habitat known 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 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 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

Names	Threatened	Type of Presence
		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
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding 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

Name	Threatened	Type of Presence
		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	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 acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		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
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
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

Names	Status	Type of Presence
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 likely 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]		Species or species habitat 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
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]

Names	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)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Multiple Use Zone (IUCN VI)
Kimberley	Multiple Use Zone (IUCN VI)
Kimberley	National Park Zone (IUCN II)
Mermaid Reef	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Bedout Island	WA
Jarrkunpungu	WA
Jinmarnkur	WA
Jinmarnkur Kulja	WA
Karajarri	WA
Kujungurru Warrarn	WA
Kujungurru Warrarn	WA
Lacepede Islands	WA
Montebello Islands	WA
North Turtle Island	WA
Nyangumarta Warrarn	WA
Unnamed WA40828	WA
Unnamed WA41080	WA
Unnamed WA44672	WA
Unnamed WA52366	WA
Unnamed WA53015	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		
Passer montanus Eurasian Tree Sparrow [406]		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

Name	Status	Type of Presence
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
Sus scrofa Pig [6]		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
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		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
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
De Grey River	WA
Eighty Mile Beach System	WA
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
Canyons linking the Argo Abyssal Plain with the	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	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

-16.1796 116.342,-18.9846 113.9659,-20.8968 113.1122,-20.5295 115.5458,-20.5262 115.5478,-20.1333 117.3207,-19.9921 118.9796,-20.0247 119.0556,-20.0232 119.1787,-20.0235 119.1792,-20.0232 119.2086,-20.0228 119.2165,-20.0141 119.3689,-20.0072 119.3972,-20.0231 119.4342,-20.0879 119.5706,-20.0249 119.7592,-19.9825 119.7644,-19.974 120.0271,-19.947 120.1303,-19.9307 120.1928,-19.8948 120.3297,-19.8092 120.5631,-19.7214 120.7794,-19.7197 120.7832,-19.7091 120.8065,-19.6122 121.0193,-19.5244 121.1585,-19.4922 121.2077,-19.3359 121.3469,-19.2695 121.3962,-19.1389 121.4968,-19.0575 121.5439,-19.0358 121.5416,-18.943 121.5487,-18.7928 121.5786,-18.7913 121.5789,-18.7567 121.5858,-18.706 121.5959,-18.5793 121.731,-18.5775 121.7329,-18.5772 121.7334,-18.5589 121.7715,-18.5104 121.81,-18.5058 121.8093,-18.5035 121.8089,-18.4999 121.8072,-18.4966 121.8057,-18.4802 121.798,-18.4526 121.8208,-18.454 121.8389,-18.4716 121.8592,-18.4754 121.8637,-18.4743 121.8821,-18.4735 121.8965,-18.4718 121.8991,-18.4492 121.9323,-18.4126 121.9864,-18.4105 122.0099,-18.3662 122.0441,-18.3629 122.0387,-18.3584 122.0315,-18.4028 122.0004,-18.4033 121.9975,-18.4043 121.9957,-18.4041 121.9944,-18.4046 121.9923,-18.4042 121.9905,-18.4097 121.9799,-18.4103 121.9799,-18.4104 121.9787,-18.4287 121.9602,-18.4393 121.9467,-18.4407 121.9432,-18.4407 121.9412,-18.4395 121.9402,-18.4395 121.9396,-18.4426 121.9354,-18.444 121.9344,-18.4485 121.929,-18.4488 121.9269,-18.4497 121.9245,-18.4526 121.9201,-18.4587 121.9121,-18.4607 121.9094,-18.4615 121.9084,-18.4641 121.9036,-18.4655 121.8998,-18.4662 121.898,-18.467 121.8941,-16.4813 122.2624,-14.8188 122.479,-14.4342 122.3735,-13.8473 121.8947,-14.2126 118.9638,-15.5107 116.9925,-16.1796 116.342

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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Department of Planning, Lands and Heritage
GOVERNMENT OF WESTERN AUSTRALIA

Aboriginal Heritage Inquiry System

List of Registered Aboriginal Sites

For further important information on using this information please see the Department of Planning, Lands and Heritage's Disclaimer statement at https://www.dplh.wa.gov.au/about-this-website

Search Criteria

No Registered Aboriginal Sites in Coordinates - Area (Book1.xlsx) - 118.7905475°E, 18.98160194°S (GDA94) : 118.7915158°E, 19.071934°S (GDA94) : 118.6965069°E, 19.072832°S (GDA94) : 118.69559°E, 18.98249611°S (GDA94)

Disclaimer

The *Aboriginal Heritage Act 1972* preserves all Aboriginal sites in Western Australia whether or not they are registered. Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist.

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Copyright

Coordinate Accuracy

Coordinates (Easting/Northing metres) are based on the GDA 94 Datum. Accuracy is shown as a code in brackets following the coordinates.

Basemap Copyright

Santos

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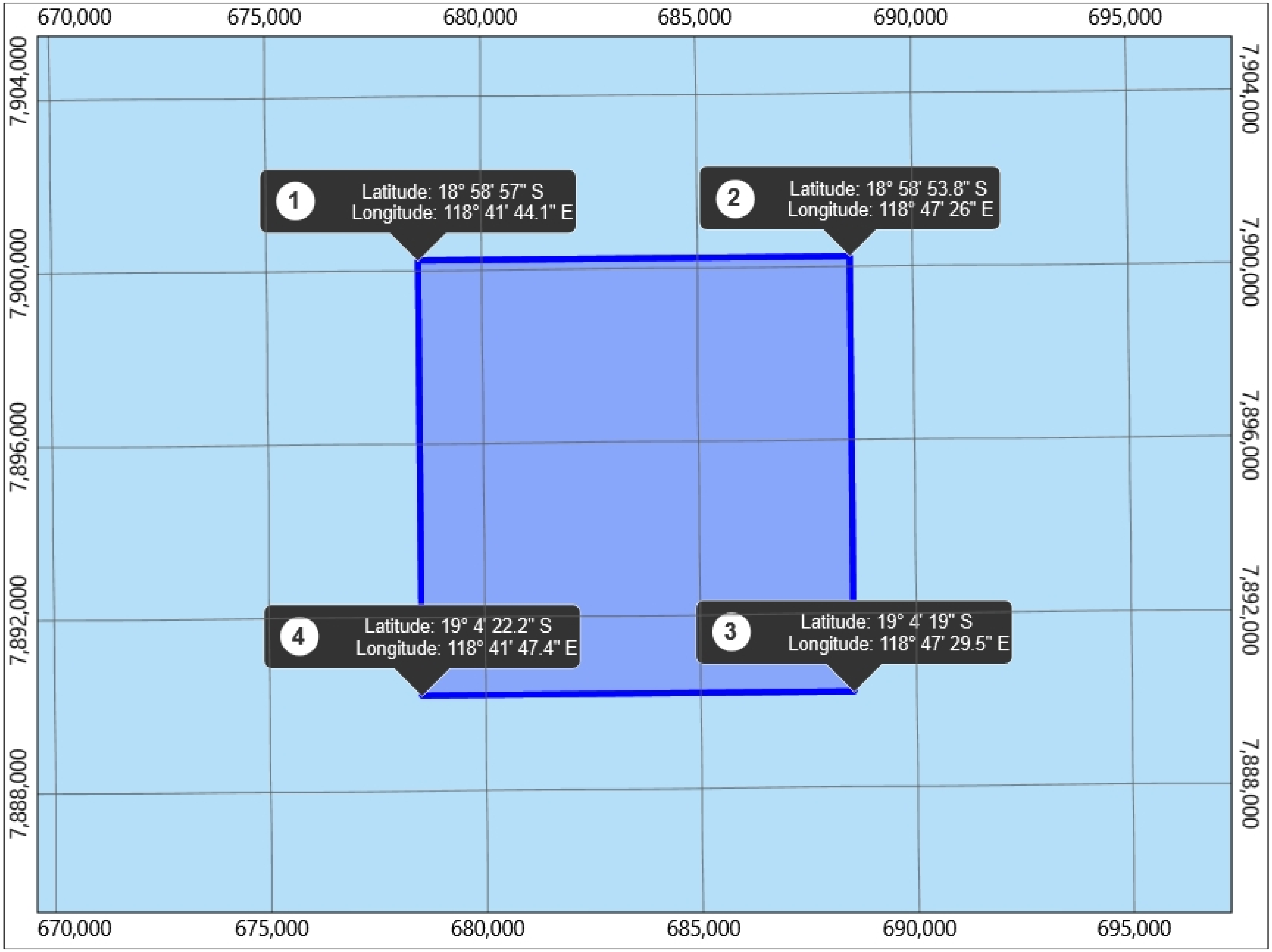
GOVERNMENT OF WESTERN AUSTRALIA

Aboriginal Heritage Inquiry System

Map of Registered Aboriginal Sites



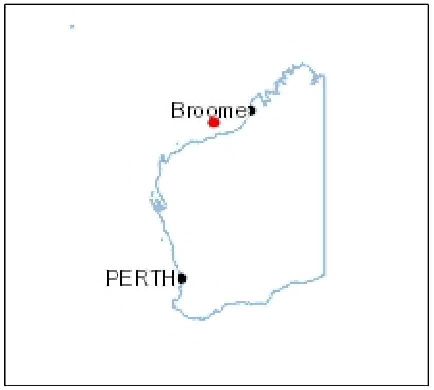
Legend

- Registered Aboriginal Site
- Search Area
- Town
- Road
- River
- Local Government Authority

4.68 kilometres

Map Scale 1 : 142,000

MGA Zone 50 (GDA94)



Map created: 03/04/2020 3:00:06 PM by: GIS_NET_USER

Identifier: 445503

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GOVERNMENT OF WESTERN AUSTRALIA

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List of Registered Aboriginal Sites

Search Criteria

28 Registered Aboriginal Sites in Coordinates - Area (Book1.xlsx) - 113.9659°E, 18.9846°S (GDA94) : 113.1122°E, 20.8968°S (GDA94) : 115.5458°E, 20.5295°S (GDA94) : 115.5478°E, 20.5262°S (GDA94) : 117.3207°E, 20.1333°S (GDA94) : 118.9796°E, 19.9921°S (GDA94) : 119.0556°E, 20.0247°S (GDA94) : 119.1787°E, 20.0232°S (GDA94) : 119.1792°E, 20.0235°S (GDA94) : 119.2086°E, 20.0232°S (GDA94) : 119.2165°E, 20.0228°S (GDA94) : 119.3689°E, 20.0141°S (GDA94) : 119.3972°E, 20.0072°S (GDA94) : 119.4342°E, 20.0231°S (GDA94) : 119.5706°E, 20.0879°S (GDA94) : 119.7592°E, 20.0249°S (GDA94) : 119.7644°E, 19.9825°S (GDA94) : 120.0271°E, 19.974°S (GDA94) : 120.1303°E, 19.947°S (GDA94) : 120.1928°E, 19.9307°S (GDA94) : 120.3297°E, 19.8948°S (GDA94) : 120.5631°E, 19.8092°S (GDA94) : 120.7794°E, 19.7214°S (GDA94) : 120.7832°E, 19.7197°S (GDA94) : 120.8065°E, 19.7091°S (GDA94) : 121.0193°E, 19.6122°S (GDA94) : 121.1585°E, 19.5244°S (GDA94) : 121.2077°E, 19.4922°S (GDA94) : 121.3469°E, 19.3359°S (GDA94) : 121.3962°E, 19.2695°S (GDA94) : 121.4968°E, 19.1389°S (GDA94) : 121.5439°E, 19.0575°S (GDA94) : 121.5416°E, 19.0358°S (GDA94) : 121.5487°E, 18.943°S (GDA94) : 121.5786°E, 18.7928°S (GDA94) : 121.5789°E, 18.7913°S (GDA94) : 121.5858°E, 18.7567°S (GDA94) : 121.5959°E, 18.706°S (GDA94) : 121.731°E, 18.5793°S (GDA94) : 121.7329°E, 18.5775°S (GDA94) : 121.7334°E, 18.5772°S (GDA94) : 121.7715°E, 18.5589°S (GDA94) : 121.81°E, 18.5104°S (GDA94) : 121.8093°E, 18.5058°S (GDA94) : 121.8089°E, 18.5035°S (GDA94) : 121.8072°E, 18.4999°S (GDA94) : 121.8057°E, 18.4966°S (GDA94) : 121.798°E, 18.4802°S (GDA94) : 121.8208°E, 18.4526°S (GDA94) : 121.8389°E, 18.454°S (GDA94) : 121.8592°E, 18.4716°S (GDA94) : 121.8637°E, 18.4754°S (GDA94) : 121.8821°E, 18.4743°S (GDA94) : 121.8965°E, 18.4735°S (GDA94) : 121.8991°E, 18.4718°S (GDA94) : 121.9323°E, 18.4492°S (GDA94) : 121.9864°E, 18.4126°S (GDA94) : 122.0099°E, 18.4105°S (GDA94) : 122.0441°E, 18.3662°S (GDA94) : 122.0387°E, 18.3629°S (GDA94) : 122.0315°E, 18.3584°S (GDA94) : 122.0004°E, 18.4028°S (GDA94) : 121.9975°E, 18.4033°S (GDA94) : 121.9957°E, 18.4043°S (GDA94) : 121.9944°E, 18.4041°S (GDA94) : 121.9923°E, 18.4046°S (GDA94) : 121.9905°E, 18.4042°S (GDA94) : 121.9799°E, 18.4097°S (GDA94) : 121.9799°E, 18.4103°S (GDA94) : 121.9787°E, 18.4104°S (GDA94) : 121.9602°E, 18.4287°S (GDA94) : 121.9467°E, 18.4393°S (GDA94) : 121.9432°E, 18.4407°S (GDA94) : 121.9412°E, 18.4407°S (GDA94) : 121.9402°E, 18.4395°S (GDA94) : 121.9396°E, 18.4395°S (GDA94) : 121.9354°E, 18.4426°S (GDA94) : 121.9344°E, 18.444°S (GDA94) : 121.929°E, 18.4485°S (GDA94) : 121.9269°E, 18.4488°S (GDA94) : 121.9245°E, 18.4497°S (GDA94) : 121.9201°E, 18.4526°S (GDA94) : 121.9121°E, 18.4587°S (GDA94) : 121.9094°E, 18.4607°S (GDA94) : 121.9084°E, 18.4615°S (GDA94) : 121.9036°E, 18.4641°S (GDA94) : 121.8998°E, 18.4655°S (GDA94) : 121.898°E, 18.4662°S (GDA94) : 121.8941°E, 18.467°S (GDA94) : 122.2624°E, 16.4813°S (GDA94) : 122.479°E, 14.8188°S (GDA94) : 122.3735°E, 14.4342°S (GDA94) : 121.8947°E, 13.8473°S (GDA94) : 118.9638°E, 14.2126°S (GDA94) : 116.9925°E, 15.5107°S (GDA94) : 116.342°E, 16.1796°S (GDA94)

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Coordinate Accuracy

Coordinates (Easting/Northing metres) are based on the GDA 94 Datum. Accuracy is shown as a code in brackets following the coordinates.

Terminology (NB that some terminology has varied over the life of the legislation)

Place ID/Site ID: This a unique ID assigned by the Department of Planning, Lands and Heritage to the place.

Status:

- Registered Site: The place has been assessed as meeting Section 5 of the Aboriginal Heritage Act 1972.
- Other Heritage Place which includes:
  - Stored Data / Not a Site: The place has been assessed as not meeting Section 5 of the Aboriginal Heritage Act 1972.
  - Lodged: Information has been received in relation to the place, but an assessment has not been completed at this stage to determine if it meets Section 5 of the Aboriginal Heritage Act 1972.

Access and Restrictions:

- File Restricted = No: Availability of information that the Department of Planning, Lands and Heritage holds in relation to the place is not restricted in any way.
- File Restricted = Yes: Some of the information that the Department of Planning, Lands and Heritage holds in relation to the place is restricted if it is considered culturally sensitive. This information will only be made available if the Department of Planning, Lands and Heritage receives written approval from the informants who provided the information. To request access please contact AboriginalHeritage@dplh.wa.gov.au.
- Boundary Restricted = No: Place location is shown as accurately as the information lodged with the Registrar allows.
- Boundary Restricted = Yes: To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the place is located. If you are a landowner and wish to find out more about the exact location of the place, please contact the Department of Planning, Lands and Heritage.
- Restrictions:
  - No Restrictions: Anyone can view the information.
  - Male Access Only: Only males can view restricted information.
  - Female Access Only: Only females can view restricted information.

Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place. This has been replaced by the Place ID / Site ID.

Basemap Copyright

Aboriginal Heritage Inquiry System

List of Registered Aboriginal Sites

ID	Name	File Restricted	Boundary Restricted	Restrictions	Status	Type	Knowledge Holders	Coordinate	Legacy ID
873	MONTEBELLO IS: NOALA CAVE.	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter, Rockshelter, BP Dating: 27,220 +/- 640	*Registered Knowledge Holder names available from DAA	348188mE 7741053mN Zone 50 [Reliable]	P07287
926	MONTEBELLO IS: HAYNES CAVE.	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter, Rockshelter, Arch Deposit	*Registered Knowledge Holder names available from DAA	348289mE 7741005mN Zone 50 [Reliable]	P07286
7784	BUNNEENYA.	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter, Water Source	*Registered Knowledge Holder names available from DAA	780640mE 7783456mN Zone 50 [Unreliable]	P05053
7785	WALUBIDI-MARINGDJINE.	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter, Water Source	*Registered Knowledge Holder names available from DAA	781090mE 7783956mN Zone 50 [Unreliable]	P05054
7786	BAALYINNYE.	Yes	Yes	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter, Water Source	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	P05055
11397	PARDOO 1	Yes	Yes	No Gender Restrictions	Registered Site	Artefacts / Scatter, Repository / Cache	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	P00747
12468	GALYUNGA	Yes	Yes	No Gender Restrictions	Registered Site	Ceremonial, Fish Trap, Mythological	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	K02772
12469	GUNJI CEREMONIAL GROUND	Yes	Yes	No Gender Restrictions	Registered Site	Ceremonial	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	K02773
12470	GULGUDUNG	Yes	Yes	No Gender Restrictions	Registered Site	Mythological	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	K02774
12471	MARUNGUDA	Yes	Yes	No Gender Restrictions	Registered Site	Mythological	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	K02775
12550	CONDINI LANDING WEST	No	No	No Gender Restrictions	Registered Site	Skeletal Material / Burial	*Registered Knowledge Holder names available from DAA	737640mE 7789656mN Zone 50 [Unreliable]	K02698
12964	CAPE KERAUDREN 2	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter	*Registered Knowledge Holder names available from DAA	791440mE 7789156mN Zone 50 [Reliable]	K02265

Department of Planning, Lands and Heritage

GOVERNMENT OF WESTERN AUSTRALIA

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ID	Name	File Restricted	Boundary Restricted	Restrictions	Status	Type	Knowledge Holders	Coordinate	Legacy ID
12965	CAPE KERAUDREN 3.	Yes	Yes	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter, Camp, Water Source	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	K02266
12966	CAPE KERAUDREN 4	No	No	No Gender Restrictions	Registered Site	Midden / Scatter	*Registered Knowledge Holder names available from DAA	788440mE 7786856mN Zone 50 [Reliable]	K02267
12967	CAPE KERAUDREN 5	Yes	Yes	No Gender Restrictions	Registered Site	Midden / Scatter, Skeletal Material / Burial	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	K02268
12968	CAPE KERAUDREN 6	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter, Grinding Patches / Grooves, Midden / Scatter	*Registered Knowledge Holder names available from DAA	791940mE 7789556mN Zone 50 [Reliable]	K02269
12969	WARRA MURRANGA TALU	Yes	Yes	No Gender Restrictions	Registered Site	Ceremonial, Mythological	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	K02270
14341	SHELLBOROUGH 1-3.	Yes	Yes	No Gender Restrictions	Registered Site	Artefacts / Scatter, Grinding Patches / Grooves, Man-Made Structure, Midden / Scatter, Skeletal Material / Burial, Camp, Other: ?	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	K00773
14433	PORT SMITH.	Yes	Yes	No Gender Restrictions	Registered Site	Ceremonial, Camp	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	K00651
17572	CAPE VILLARET AREA 07 / BARNES BEACH MIDDEN	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter, Other: Baler shell	*Registered Knowledge Holder names available from DAA	398437mE 7969011mN Zone 51 [Reliable]	
17573	CAPE VILLARET AREA 08	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter, Arch Deposit, BP Dating: 1800+/-70, Ochre	*Registered Knowledge Holder names available from DAA	391987mE 7963761mN Zone 51 [Reliable]	
17574	CAPE VILLARET AREA 09	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter	*Registered Knowledge Holder names available from DAA	389337mE 7961161mN Zone 51 [Reliable]	
17575	CAPE VILLARET AREA 10	No	No	No Gender Restrictions	Registered Site	Midden / Scatter	*Registered Knowledge Holder names available from DAA	388087mE 7960511mN Zone 51 [Reliable]	
17576	CAPE VILLARET AREA 11 / GUMALIINGA	No	No	No Gender Restrictions	Registered Site	Midden / Scatter	*Registered Knowledge Holder names available from DAA	386937mE 7959761mN Zone 51 [Reliable]	

Department of Planning, Lands and Heritage
GOVERNMENT OF WESTERN AUSTRALIA

Aboriginal Heritage Inquiry System

List of Registered Aboriginal Sites

ID	Name	File Restricted	Boundary Restricted	Restrictions	Status	Type	Knowledge Holders	Coordinate	Legacy ID
17577	CAPE VILLARET AREA 12	No	No	No Gender Restrictions	Registered Site	Artefacts / Scatter, Midden / Scatter, BP Dating: 1700+/-60, Other: Baler shell	*Registered Knowledge Holder names available from DAA	379037mE 7957761mN Zone 51 [Reliable]	
17578	CAPE VILLARET AREA 13	No	No	No Gender Restrictions	Registered Site	Midden / Scatter	*Registered Knowledge Holder names available from DAA	378787mE 7958211mN Zone 51 [Reliable]	
17579	CAPE VILLARET AREA 14	No	No	No Gender Restrictions	Registered Site	Midden / Scatter, BP Dating: 3060+/-50, Camp, Other: Baler shell	*Registered Knowledge Holder names available from DAA	378844mE 7957964mN Zone 51 [Reliable]	
17580	CAPE VILLARET AREA 15	No	No	No Gender Restrictions	Registered Site	Midden / Scatter, Camp, Other: Baler shell	*Registered Knowledge Holder names available from DAA	376937mE 7959911mN Zone 51 [Reliable]	

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Map of Registered Aboriginal Sites

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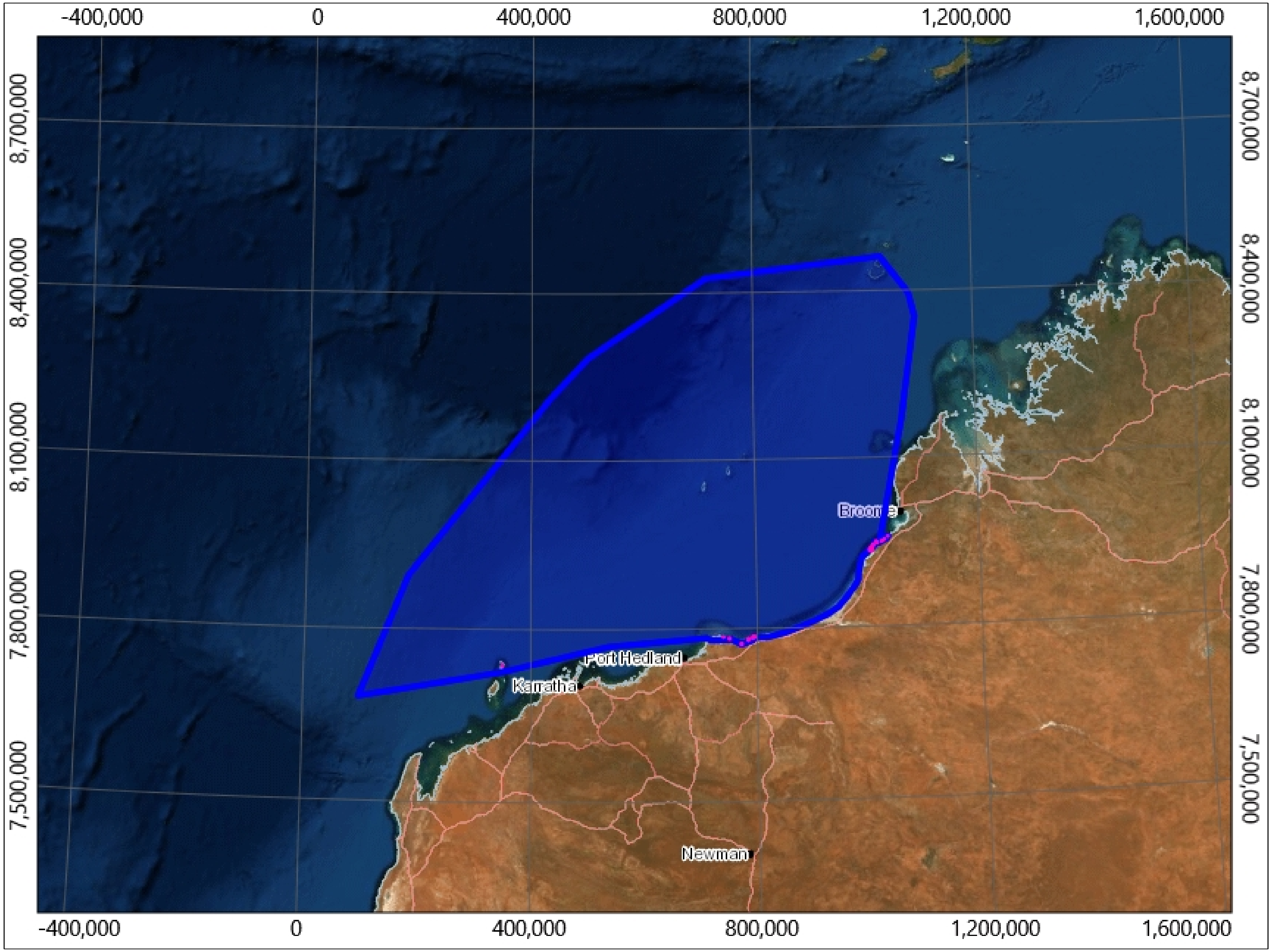


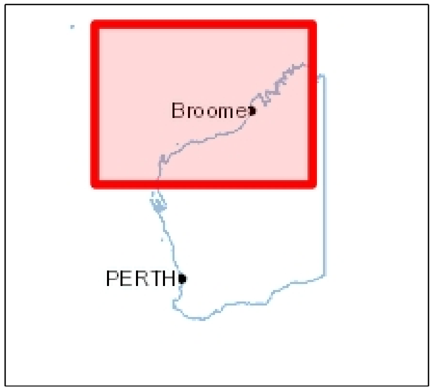
Legend

- Registered Aboriginal Site
- Search Area
- Town
- Road
- River
- Local Government Authority

358.15 kilometres

Map Scale 1 : 10,850,000

MGA Zone 50 (GDA94)



APPENDIX D – STAKEHOLDER CONSULTATION

Santos

WA-437-P Geotechnical and Geophysical Survey

STAKEHOLDER CONSULTATION

Santos

STAKEHOLDER CONSULTATION

Consultation Correspondence

From: Consultation, [redacted]
Bcc: [redacted]
Subject: Santos Consultation | WA-437-P Geotechnical and Geophysical Survey
Date: Friday, 28 February 2020 9:58:00 AM
Attachments: image001.jpg
Santos Consultation - WA-437-P Geotechnical & Geophysical Survey.pdf
image003.jpg
image005.jpg
image007.jpg

Good Morning

On behalf of Santos, please find attached consultation material relating to Santos' proposed WA-437-P Geotechnical and Geophysical Survey.

Santos proposes to undertake the geophysical and geotechnical site investigations to support engineering feasibility studies for the proposed Dorado development located in Permit WA-437-P, approximately 125 km offshore from Port Hedland in Western Australia.

The survey is planned to commence in a window between Q2 2020 and be completed by Q4 2021. The survey duration will be approximately 60 days (allowing contingency for potential downtime for example due to inclement weather conditions). Subject to vessel availability during this window, the proposed activity may need to be completed in two phases. If the survey is split, then Phase 1 is expected to take approximately 15 days, and Phase 2, 45 days (including contingency).

Santos is preparing an Environment Plan for the site investigations in accordance with the *Commonwealth Offshore Petroleum and Greenhouse Gas Storage* (*Environment*) *Regulations 2009* (OPGGS(E)R) for acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Should you require additional information or have a comment to make about the proposed activity, please be in touch via the contact details below. All correspondence relating to this EP will be provided to NOPSEMA by Santos, as required by the Environment Regulations. The EP will contain a summary of all comments received, however Santos will not use or disclose your personal information in the EP. Full transcripts of all correspondence will be contained in a separate Sensitive Information Report to NOPSEMA.

Kind regards

[redacted]
Santos Limited, Level 7 100 St Georges Tce, Perth WA 6000
[redacted] [redacted]
https://www.santos.com/

Consultation, [redacted]

From: Consultation, [redacted]
Sent: Wednesday, 11 March 2020 7:48 AM
To: [redacted]
Subject: Santos Consultation | Permit WA-437-P - Geotechnical & Geophysical Survey
Attachments: Santos Consultation - WA-437-P Geotechnical & Geophysical Survey.pdf; FISa5616_Dorado_GeoTechPhys_Surv_NWSlope_WTunaBill.pdf; FISa5614_Dorado_GeoTechPhys_Surv_PTrawl_fish.pdf; FISa5610_Dorado_GeoTechPhys_Surv_PTrap_fish.pdf; FISa5611_Dorado_GeoTechPhys_Surv_PLine_fish.pdf; FISa5612_Dorado_GeoTechPhys_Surv_Mackerel_fish.pdf; FISa5613_Dorado_GeoTechPhys_Surv_PearlOyster_fish.pdf

Good morning [redacted]

Santos is preparing a NOPSEMA Environment Plan (EP) for a Geotechnical & Geophysical survey program approximately 125km offshore from Port Hedland.

A geophysical and geotechnical survey is used to collect and analyse data to better understand seabed and subsurface conditions. These surveys help engineers determine potential engineering constraints and identify safety hazards by collecting information on the nature and mechanical properties of the seabed. This survey is not a seismic survey.

Please find attached a consultation pack with further information on the proposed geotechnical and geophysical survey, including a site map, and other fishery overlay maps for the Pilbara Trawl, Pilbara Trap, Pilbara Line, Mackerel Area 2, Pearl Oyster and Commonwealth fisheries.

Summary:

- Location Approximately 125 km offshore from Port Hedland.

		Latitude	Longitude
Operational Area	1	18° 58' 56.986" S	118° 41' 44.124" E
	2	18° 58' 53.767" S	118° 47' 25.971" E
	3	19° 04' 18.963" S	118° 47' 29.457" E
	4	19° 04' 22.198" S	118° 41' 47.425" E

- Water Depth: Approximately 88 metres to 94 metres.
- Operational Area: All activities will take place within a 10 kilometre by 10 kilometre block.
- Survey Schedule: Planned to commence in a window between Q2 2020 and be completed by Q4 2021. Subject to vessel availability during this window.
- Survey Duration: Approximately 60 days (allowing contingency for potential downtime for example due to inclement weather conditions). The survey may need to be split. If so, Phase One is expected to take approximately 15 days and Phase Two to take 45 days (including contingency).
- Exclusion Zone: A 500 metre exclusion zone around the survey vessel (this is not a seismic survey so there are no streamers) at all times.
- Notifications: Santos will notify relevant commercial fishers of the start and finish dates of the activity once known, as well as advise if the survey is to be undertaken in phases or not.
- Vessels: One survey vessel, with an intermittent support vessel.

As part of the preparation of the WA-437-P Geotechnical and Geophysical Environment plan, Santos has reviewed the 2009 – 2018 fishing effort data, and the monthly fishing data from 2014 – 2018 to help inform survey timing. In summary, this data indicated:

- The Pilbara Trap Managed Fishery has recorded fishing effort all year round within the relevant fishing block that overlaps the proposed Operational Area, however no particular pattern was identified in relation to peak fishing effort.
- The Pilbara Fish Trawl (Interim) Managed Fishery has recorded fishing effort all year round within the relevant fishing block that overlaps the proposed Operational Area, however no particular pattern was identified in relation to peak fishing effort.
- The Pilbara Line Managed Fishery has recorded no fishing effort since 2016 within the relevant fishing block that overlaps the proposed Operational Area. Prior to that fishing effort occurred variably in the months of May through to August.
- Both the Mackerel Managed Fishery (Area 2) and the Nickol Bay Prawn Limited Entry Fishery recorded no fishing effort within the fishing block for that overlaps with the proposed Operational Area.

Based on this assessment of the FishCube data, and the duration of the proposed survey, Santos has determined that there is no best possible or worst possible period for the survey to be undertaken to minimise interaction with commercial fishers. However, Santos re-affirms its commitment to commercial fishers to:

- Provide notification prior to the commencement and on cessation of the survey;
- Ensure a visual and radar watch is maintained on the vessel bridge at all times;
- Not restrict commercial fishing access to the operational area and commit to concurrent operations, where safety of either vessel is not compromised; and
- Ensure Santos vessels transiting to and from the Operational Area avoid commercial vessels that are actively fishing.

If you have any comments or questions regarding the proposed activities please contact me directly on the details below.

All correspondence relating to this EP will be provided to NOPSEMA by Santos, as required by the Environment Regulations. The EP will contain a summary of all comments received, however Santos will not use or disclose your personal information in the EP. Full transcripts of all correspondence will be contained in a separate Sensitive Information Report to NOPSEMA.

Kind regards

[redacted]

From: [redacted]
Sent: Tuesday, 10 March 2020 3:13 PM
To: [redacted]
Cc: [redacted]
Subject: ![EXT]: 2020 Mar 10 - Santos - Permit WA-437-P - Geotechnical & Geophysical Survey - Mackerel Area 2
Attachments: FISa5612_Dorado_GeoTechPhys_Surv_Mackerel_fish.pdf; Santos Consultation - WA-437-P Geotechnical & Geophysical Survey.pdf

Good afternoon Mackerel Area Two licence holders

Santos is preparing a NOPSEMA Environment Plan (EP) for a Geotechnical & Geophysical survey program approximately 125km offshore from Port Hedland.

A geophysical and geotechnical survey is used to collect and analyse data to better understand seabed and subsurface conditions. These surveys help engineers determine potential engineering constraints and identify safety hazards by collecting information on the nature and mechanical properties of the seabed. This survey is not a seismic survey.

WAFIC is sending this information to commercial fishers on a fee-for-service basis on behalf of Santos to ensure all licence holders receive this information in a timely manner via an accurate list. All feedback / input etc is to go directly to [redacted] at Santos (see below).

Please find attached a fact sheet with further information on the proposed geotechnical and geophysical survey, a site map including bathy lines as well as your fishery overlay maps for Mackerel Area 2 so you can get a clear visual where this activity is proposed to take place over your fishing area.

Santos has noted that for Mackerel Area 2 there is no fishing effort recorded within the fishing block that overlaps with the proposed Operational Area. Note the water depth is at the high end for usual mackerel fishing.

Based on the Santos assessment of the FishCube data, and the duration of the proposed survey, Santos has determined that there is no best possible or worst possible period for the survey to be undertaken to minimise interaction with commercial fishers. However, Santos re-affirms its commitment to commercial fishers to:

- Provide notification prior to the commencement and on cessation of the survey;
- Ensure a visual and radar watch is maintained on the vessel bridge at all times;
- Not restrict commercial fishing access to the operational area and commit to concurrent operations, where safety of either vessel is not compromised; and
- Ensure Santos vessels transiting to and from the Operational Area avoid commercial vessels that are actively fishing.

Summary:

- Location — Approximately 125 km offshore from Port Hedland.

		Latitude	Longitude
Operational Area	1	18° 58' 56.986" S	118° 41' 44.124" E
	2	18° 58' 53.767" S	118° 47' 25.971" E
	3	19° 04' 18.963" S	118° 47' 29.457" E
	4	19° 04' 22.198" S	118° 41' 47.425" E

- Water Depth: Approximately 88 metres to 94 metres.
- Operational Area: All activities will take place within a 10 kilometre by 10 kilometre block.
- Survey Schedule: Planned to commence in a window between Q2 2020 and be completed by Q4 2021. Subject to vessel availability during this window.
- Survey Duration: Approximately 60 days (allowing contingency for potential downtime for example due to inclement weather conditions). The survey may need to be split. If so, Phase One is expected to take approximately 15 days and Phase Two to take 45 days (including contingency).
- Exclusion Zone: A 500 metre exclusion zone around the survey vessel (this is not a seismic survey so there are no streamers) at all times.
- Notifications: Santos will notify relevant commercial fishers of the start and finish dates of the activity once known, as well as advise if the survey is to be undertaken in phases or not.
- Vessels: One survey vessel, with an intermittent support vessel likely transiting from Port Hedland (TBC).

If you have any queries regarding the proposed activities please respond directly to Santos: [redacted] or [redacted]

All correspondence relating to this EP will be provided to NOPSEMA by Santos, as required by the Environment Regulations. The EP will contain a summary of all comments received, however Santos will not use or disclose your personal information in the EP. Full transcripts of all correspondence will be contained in a separate Sensitive Information Report to NOPSEMA.

Best regards

[redacted]

WAFIC FISHING PEARLING AQUACULTURE

[redacted]

Santos

STAKEHOLDER CONSULTATION

Consultation Pack

STAKEHOLDER CONSULTATION

Santos

WA-437-P

Geotechnical & Geophysical Survey

Overview

Santos Limited (Santos) proposes to undertake a geotechnical and geophysical survey to support engineering feasibility studies for the proposed Dorado development located in Permit WA-437-P, approximately 125 km offshore from Port Hedland in Western Australia.

The survey area is shown in **Figure 1**.

Before Santos can undertake the geotechnical and geophysical survey the company must prepare and have an accepted Environment Plan (EP). As part of the EP process, Santos must have consulted with relevant stakeholders.

The EP will be developed and implemented in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R) for acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Effective from the 25th April 2019, environment plans submitted to NOPSEMA must be published on their website. Santos anticipates that its geotechnical and geophysical EP will be made publicly available in March 2020.

As a relevant and potentially affected party to these activities Santos seeks your feedback. Please advise if you have any issues or concerns or if you require any additional information about the proposed activity. Santos will address these issues prior to the EP being submitted for assessment.

Activity Description

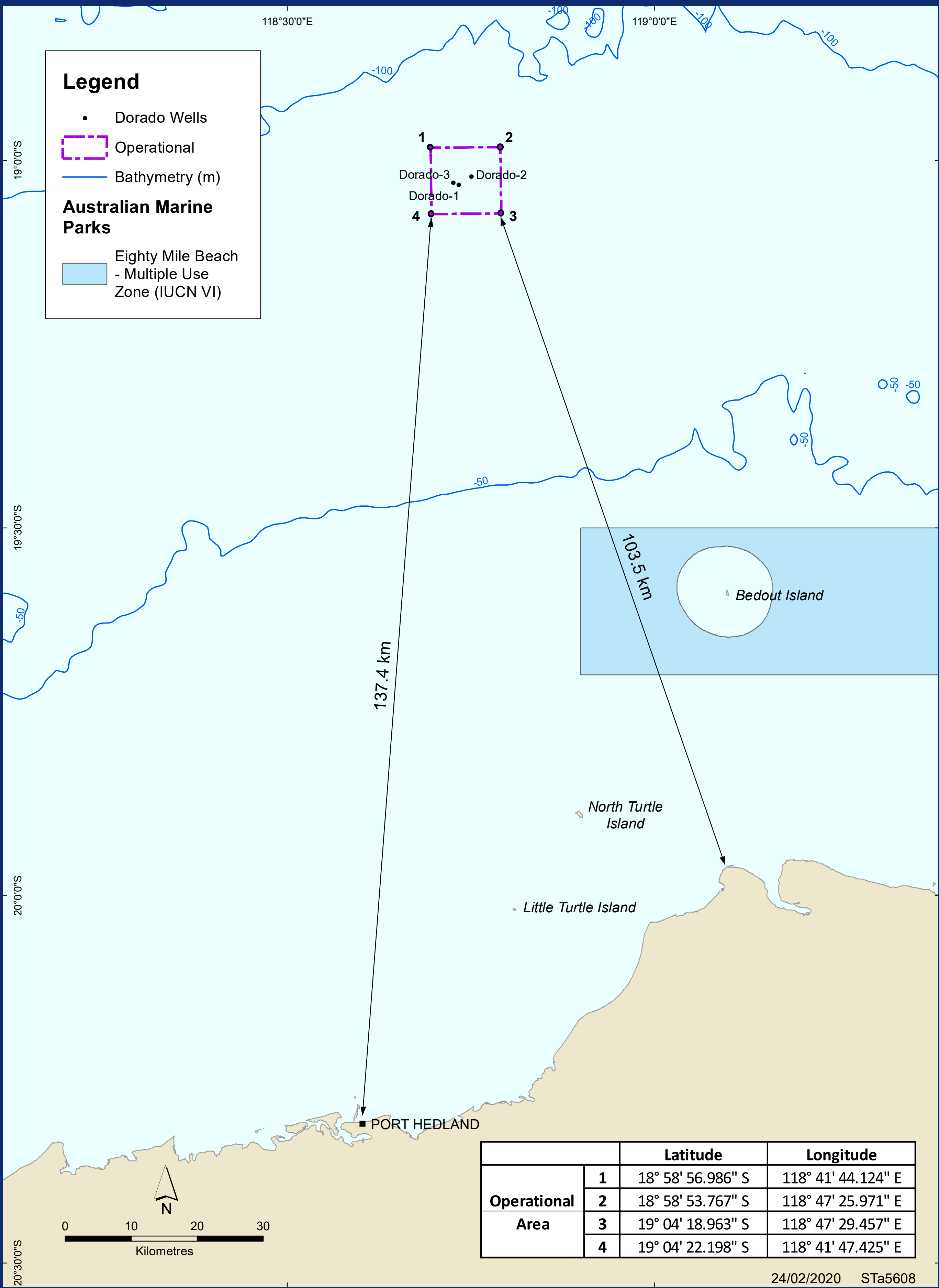
The vessel-based activity will be undertaken using geophysical and geotechnical survey techniques. The operational area is within a 10 km x 10 km area encapsulating all smaller survey locations.

The survey will involve:

+ Acquiring geologic cores using borehole sampling (e.g. piston coring, vibro coring and/or rock coring) and box coring to aid in the understanding the local geology.
+ Dissipation testing using in-situ penetration testing via piezocone penetration tests (PCPTs), cone penetration test (CPT), T-Bar or a similar probe test, to determine soil strength and support data informing soil stratigraphy delineation.
+ Acquisition of multi-beam echo sounding (MBES), side-scan sonar sounding (SSS) and/or single beam echo sounding (SBES) to define the bathymetry / seafloor morphology (e.g. depth, bedform character) and confirm the absence of debris or other anomalous seabed features.
+ Identification of any hazards through sub-bottom profiling (SBP) including ultra-high resolution (UHR), including lateral variability in layer properties, adverse near-seabed stratigraphy, anomalous layers of hard/soft formations, localised/regional outcrops or sub-crops, mobile bedforms, and impediments.
+ Grab sampling or drop cores for ground-truthing the surficial geophysics.

Data acquired from the site survey will subsequently be processed to generate site survey reports to inform engineering feasibility studies.

Figure 1: WA-437-P Geotechnical and Geophysical Survey Location



		Latitude	Longitude
Operational Area	1	18° 58' 56.986" S	118° 41' 44.124" E
	2	18° 58' 53.767" S	118° 47' 25.971" E
	3	19° 04' 18.963" S	118° 47' 29.457" E
	4	19° 04' 22.198" S	118° 41' 47.425" E

SITE SURVEY ACTIVITY DETAILS			
Permit number	WA-437-P		
Water depth	Approx. 88 m to 94 m		
Exclusion zone	500 m around the survey vessel at all times		
Operational area		**Latitude (GDA 94)**	**Longitude (GDA 94)**
	Point 1	18º 58' 56.986"S	118º 41' 44.124"E
	Point 2	18º 58' 53.767"S	118º 47' 25.971"E
	Point 3	19º 04' 18.963" S	118º 47' 29.457"E
	Point 4	19º 04' 22.198"S	118º 41' 47.425"E
Equipment	A survey vessel with an intermittent support vessel will be utilised to undertake the activity. The survey vessel will be approximately 90 m long, multi-purpose vessel of opportunity.		
Description of natural environment	The activity overlaps the Northwest Shelf Provincial Bioregion (based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0).		
Timing and duration	The survey is planned to commence in a window between Q2 2020 and be completed by Q4 2021. The survey duration will be approximately 60 days (allowing contingency for potential downtime for example due to inclement weather conditions, equipment breakdowns) operating 24 hours per day. Subject to vessel availability during this window, the proposed activity may need to be completed in two phases. If the survey is split, then Phase 1 is expected to take approximately 15 days, and Phase 2, 45 days (including contingency).		
Nearest proximity to key regional features	**Regional Feature**		**Operational Area**
	Barrow Island		382km SW
	Varanus Island		270 km SW
	Dampier		272km SW
	Port Hedland		137.4 km S
	Bedout Island (closest island)		65.2 km SE
	Closest Mainland (Larrey Point)		103.5 km SSE
	Eighty Mile Beach Australian Marine Park		48.6 km SSE
	Rowley Shoals Marine Park		141.4km N
	Argo- Rowley Terrace Australian Marine Park		136.4km N
	Mermaid Reef Australian Marine Park		210 km NE
Worst case hydrocarbon spill scenario	650 m^3 diesel (fuel oil) from a vessel collision.		
Response tier required	In the event of an oil spill, a Level 2 response would be implemented as defined in the activity-specific Oil Pollution Emergency Plan.		

Potential Environmental Risks and Impacts

Santos has conducted the following assessment of potential environmental risks and impacts from the survey activity.

POTENTIAL RISKS AND/OR IMPACTS	MANAGEMENT MEASURES
Interaction with other marine users and Commercial Fishers	· Relevant stakeholders will be notified prior to the commencement and on cessation of the survey. · Relevant maritime notices issued. · A visual and radar watch will be maintained on the vessel bridge at all times. · Santos will not restrict commercial fishing access to the operational area and is committed to concurrent operations, where safety of either vessel is not compromised. · Vessels transiting to and from the Operational Area will avoid commercial vessels that are actively fishing. · Survey vessel will be prohibited from recreational fishing within the operational area.
Fauna interactions (acoustic and collision)	· Monitoring of the surrounding environment for marine fauna is undertaken from the survey vessel/s bridge. · Survey vessels will comply with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure as per EPBC Regulations (Part 8) for interacting with cetaceans, which includes the following controls: - Vessel will not travel at greater than 6 knots within 300 m of a whale. - Vessel will not approach within 100 m of a whale.
Light emissions	· Minimum lighting that is required for safe navigation and operations will be maintained in compliance with International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and SOLAS/AMSA Marine Orders.
Atmospheric emissions	· Survey vessels use marine diesel (fuel oil) sulphur content is compliant with MARPOL/AMSA Marine Order. · Survey vessels have Air Pollution Prevention Certification in accordance with Marine Order 97.
Seabed disturbance	· Vessels will either be moving or will use dynamic positioning to maintain location, unless anchoring is required for safety reasons. · Objects dropped overboard are recovered (where possible) to mitigate the environmental consequences from objects remaining in the marine environment.
Operational vessel discharges	· Routine vessel discharge (sewage, bilge water, food waste) associated with daily functioning of vessels will meet Australian requirements. · Deck cleaning products will not be harmful to the marine environment.
Biosecurity risk management	· Survey vessels are managed to low risk in accordance with the Santos Invasive Marine Species Management Plan prior to movement/transit into or within the invasive marine species management zone, which requires: - assessment of applicable vessels using the DPIRD Vessel Check Tool; and - the management of immersible equipment to low risk.
Spill response operations	· In the event of a hydrocarbon spill, the Santos WA OPEP requirements are implemented to mitigate environmental impacts.

Consultation

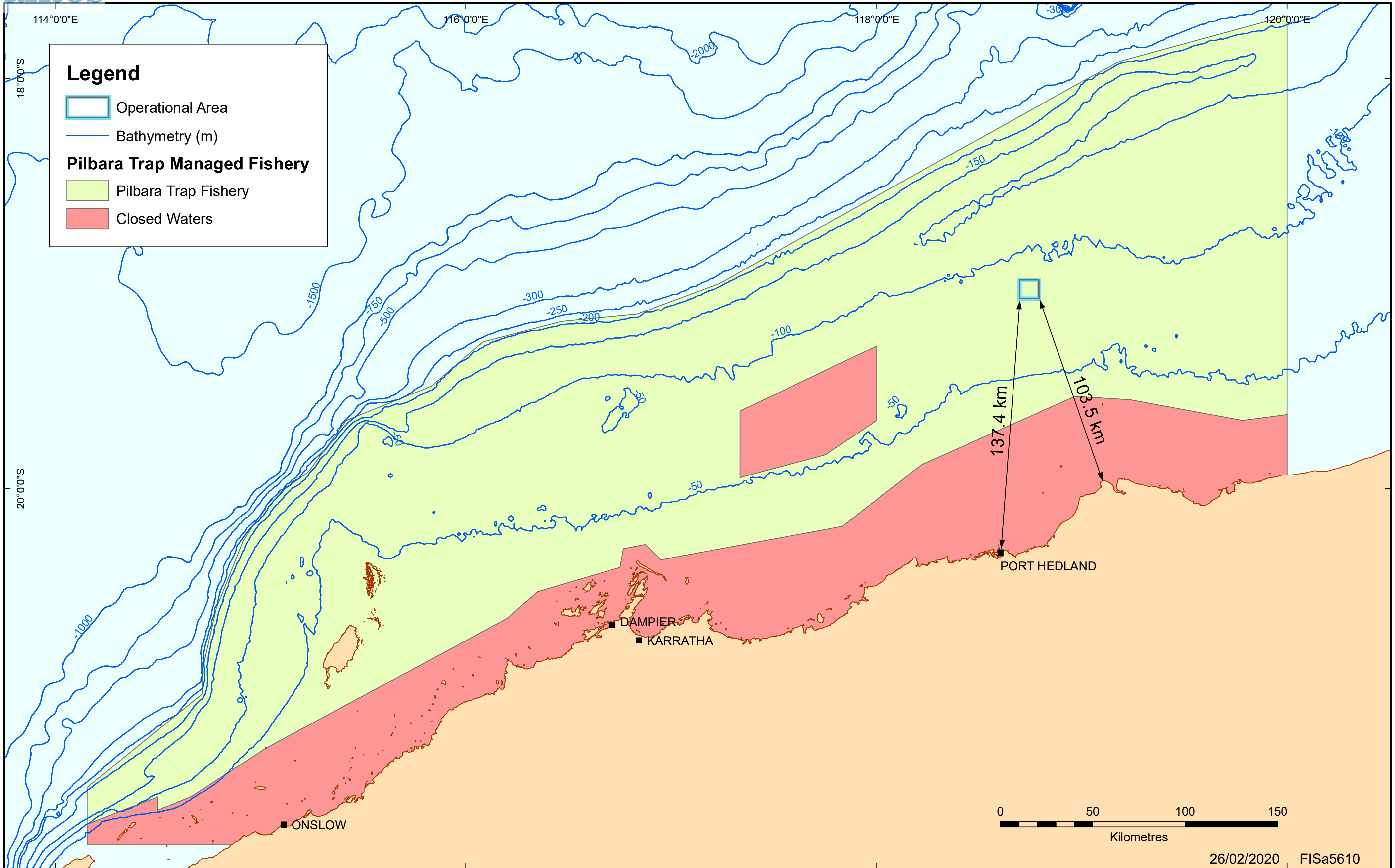
Relevant stakeholders have been provided information in this Stakeholder Consultation document to allow stakeholders to assess potential impacts and risks to their functions, interests or activities. If you wish to comment on these activities please respond or contact Santos on the contact details below.

[redacted]

Santos
PO Box 5624, Perth, 6831
Telephone: 08 6218 [redacted]
[redacted]

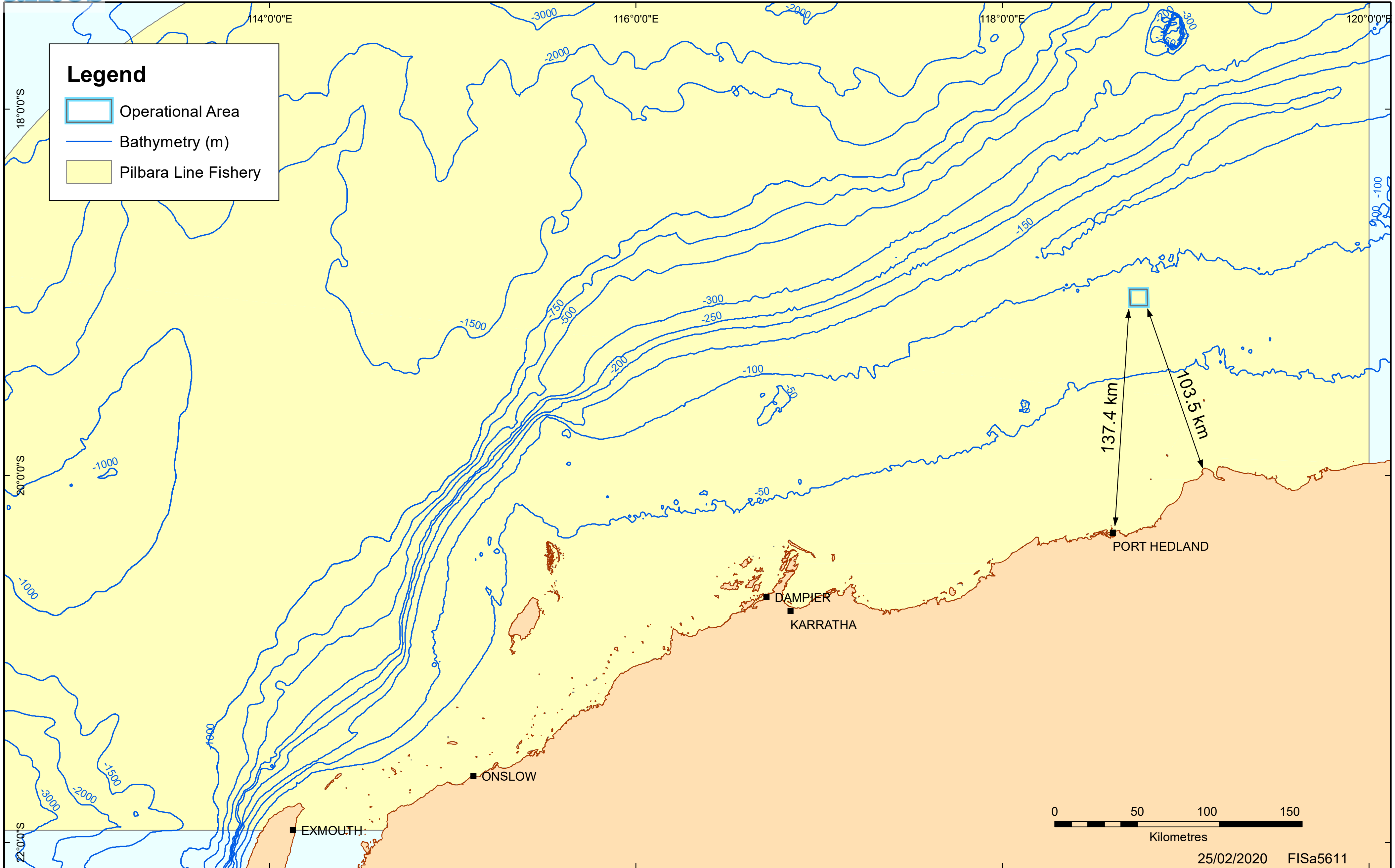
STAKEHOLDER CONSULTATION

Consultation Maps



WA-437-P GEOTECHNICAL & GEOPHYSICAL SURVEY

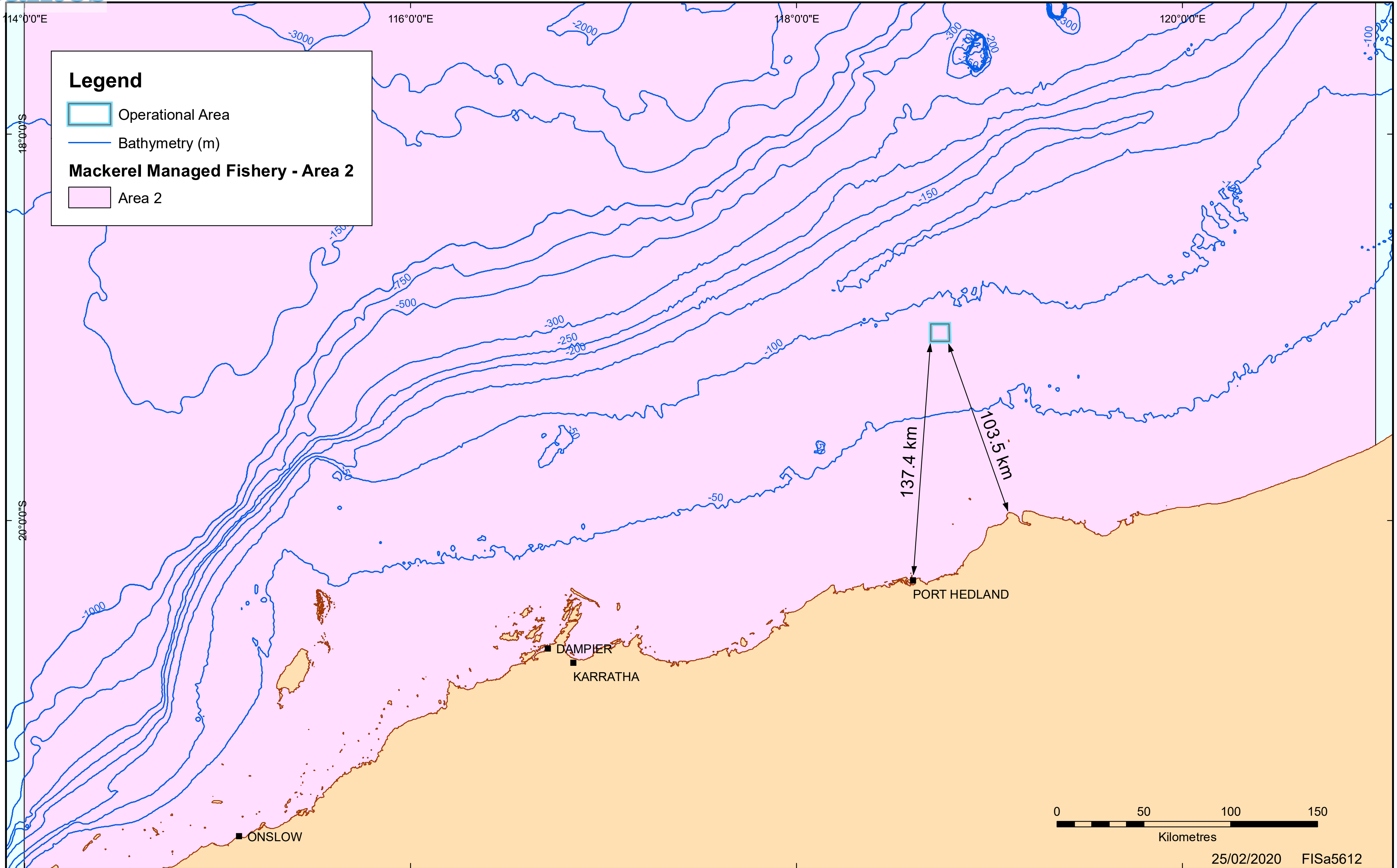
PILBARA TRAP MANAGED FISHERY



Santos

WA-437-P GEOTECHNICAL & GEOPHYSICAL SURVEY

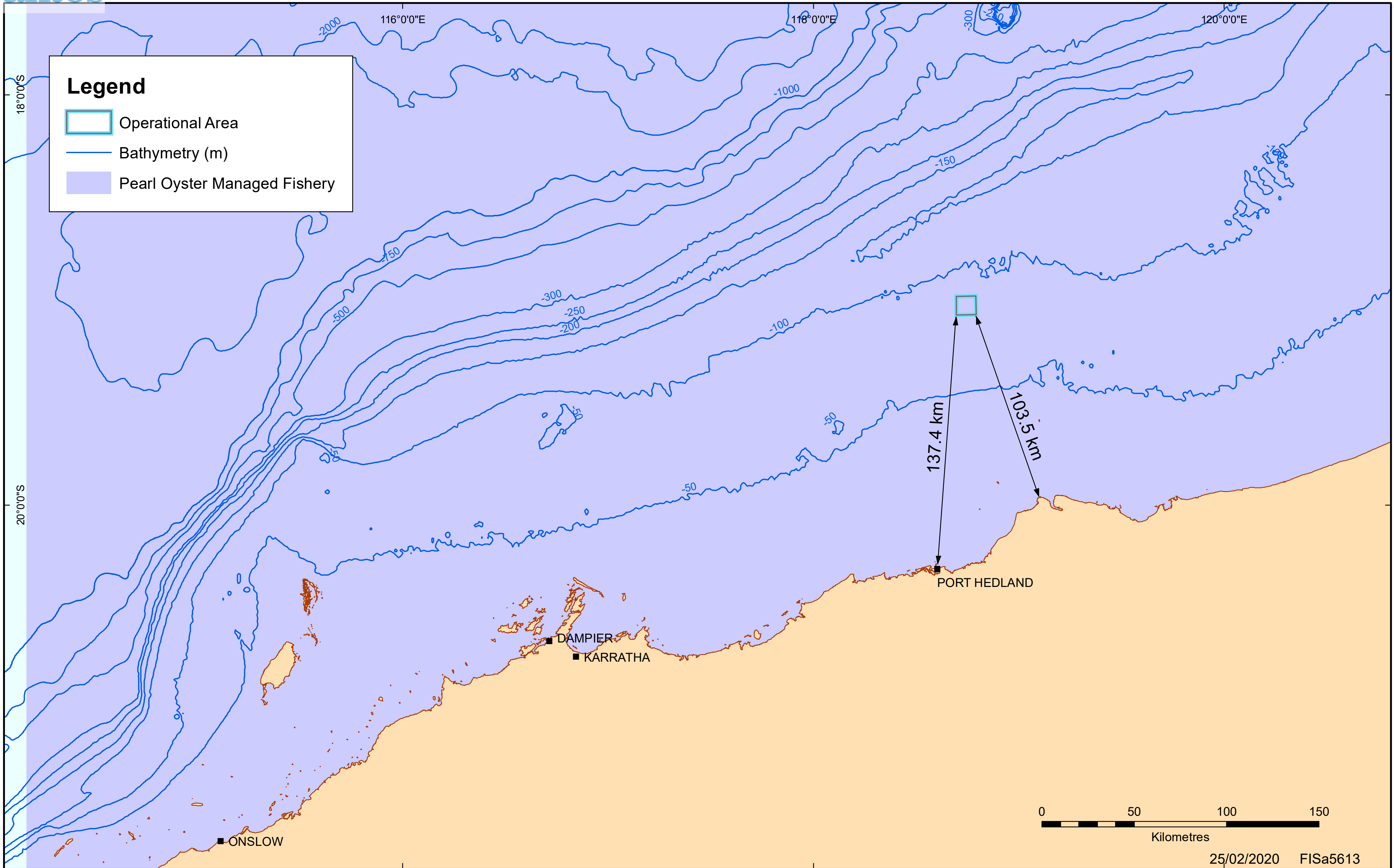
PILBARA LINE FISHERY



Santos

WA-437-P GEOTECHNICAL & GEOPHYSICAL SURVEY

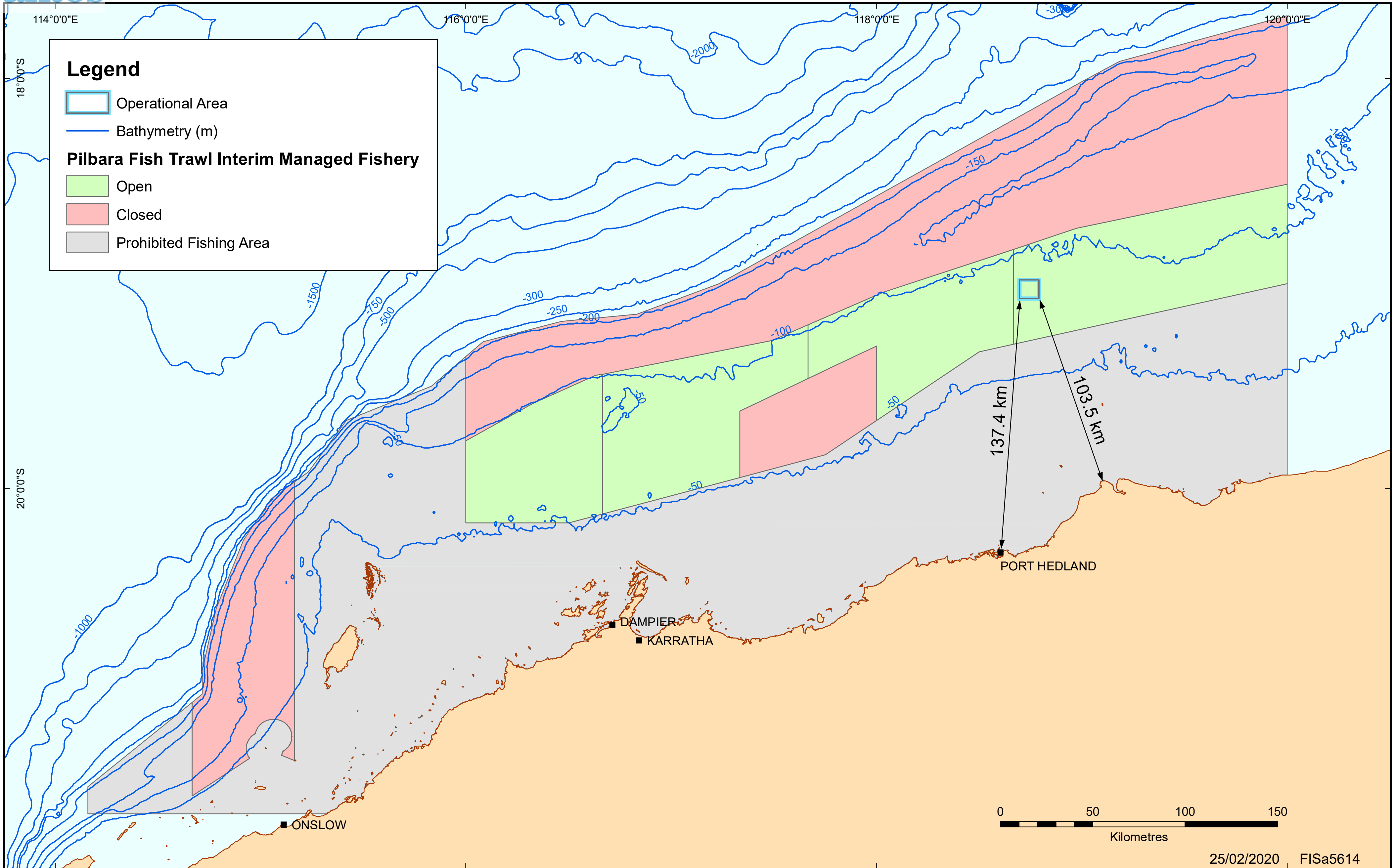
MACKEREL MANAGED FISHERY - AREA 2



Santos

WA-437-P GEOTECHNICAL & GEOPHYSICAL SURVEY

PEARL OYSTER MANAGED FISHERY



WA-437-P GEOTECHNICAL & GEOPHYSICAL SURVEY

PILBARA FISH TRAWL INTERIM MANAGED FISHERY

APPENDIX E – SANTOS RISK MATRIX AND CONSEQUENCE TABLE

Santos

			SEVERITY					
			1. Negligible	2. Minor	3. Moderate	4. Major	5. Critical	
			First Aid Case	Medical Treatment Case / Restricted Work Day Case	Lost Time Injury	Severe Injury[1], Permanent Disability, Single Fatality	Multiple Fatalities	**Health & Safety**
			Environmental impact lasting days up to 1 week	Environmental impact lasting weeks up to 12 months	Environmental impact lasting from 1 to 10 years	Environmental impact lasting 10 to 20 years	Environmental impact lasting more than 20 years to no recovery	**Environmental**
			Impact less than $500k	Impact of $500k to $10M	Impact of $10M to $50M	Impact of $50M to $500M	Impact greater than $500M	**Financial (AUD)**
			Short term local concern (community), no legal or reputation impact	Short term regional/ community concern (WA), local press, potential impact on reputation	Short term national coverage, JV oversight impact, short term impact on reputation but no legal proceedings	National coverage, short term brand impact, litigation almost certain, serious damage to reputation with adverse publicity	International coverage, long term brand impact, litigation, sustained serious damage to reputation	**Reputation**
LIKELIHOOD	**5. Probable**	1. Event has occurred frequently within the Company 2. Between 1 and 10 incidents every 10 years (i.e. up to frequency 1/year)						
	4. Likely	1. Event has occurred frequently within Industry 2. Between 1 and 10 incidents every 100 years (i.e. up to frequency 10^{-1}/year)						
	3. Unlikely	1. Event has occurred occasionally within the Company 2. Between 1 and 10 incidents every 1000 years (i.e. up to frequency 10^{-2}/year)						
	2. Very Unlikely	1. Has occasionally occurred within the Industry 2. Between 1 and 10 incidents every 10,000 years (i.e. up to frequency 10^{-3}/year)						
	1. Rare	1. Could happen under exceptional circumstances only 2. Between 1 and 10 incidents every 100,000 years (i.e. up to frequency 10^{-4}/year)						

High Risk - reduction of risk required

Medium Risk - reduction of risk required based on ALARP principle

Low Risk - deemed acceptable based on standard risk controls in place

Notes:

1. As per Injury Severity Score
2. Worst case Severity category shall be used if multiple categories are applicable
3. All fields bordering high (red) risks require special attention and effort to reduce to a lower risk.
4. Financial loss shall be a potential pre-tax loss in the reporting period including cash leakage, value of lost production, potential write downs in asset values, uplifts to liabilities/provisions, reduction in QE equity value, etc. All losses shall be gross (QE and JVP share) and in AUD. This excludes insurances offsets.
5. Refer to Risk Management Procedure QE-91-IF-10052 for guidance on the use of this matrix.

	Consequence level	A – Negligible	B – Minor	C – Moderate	D – Major	E – Critical
	Acceptability	Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable
	Severity	*No impact or negligible impact.* *Environmental impact lasting days up to 1 week*	*Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect* *Environmental impact lasting weeks up to 12 months*	*Significant impact to local population, industry or ecosystem factors.* *Environmental impact lasting 1 to 10 years*	*Major long-term effect on local population, industry or ecosystem factors.* *Environmental impact lasting 10 to 20 years*	*Complete loss of local population, industry or ecosystem factors AND/ OR major wide-spread regional impacts with slow to no full recovery.* *Environmental impact lasting more than 20 years to no recovery*
Environmental Receptors	**Fauna** In particular, EPBC Act listed threatened/migratory fauna or WA Wildlife Conservation Act 1950 specially protected fauna	Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity; No decrease in local population size; No reduction in area of occupancy of species; No loss/disruption of habitat critical to survival of a species; No disruption to the breeding cycle of any individual; No introduction of disease likely to cause a detectable population decline.	Detectable but insignificant decrease in local population size (excluding protected species); Insignificant reduction in area of occupancy of species; Insignificant loss/disruption of habitat critical to survival of a species; Insignificant disruption to the breeding cycle of local population.	Significant decrease in local population size but no threat to overall population viability; Significant behavioural disruption to local population; Significant disruption to the breeding cycle of a local population; Significant reduction in area of occupancy of species; Significant loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a significant decline in local population is likely; Introduce disease likely to cause a significant population decline.	Long term decrease in local population size and threat to local population viability; Major disruption to the breeding cycle of local population; Major reduction in area of occupancy of species; Fragmentation of existing population; Major loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a long term decline in local population is likely; Introduce disease likely to cause a long term population decline	Complete loss of local population; Complete loss of habitat critical to survival of local population; Wide spread (regional) decline in population size or habitat critical to regional population.
	Physical Environment / Habitat Includes: air quality; water quality; benthic habitat (biotic/abiotic), particularly habitats that are rare or unique; habitat that represents a Key Ecological Feature[4]; habitat within a protected area; habitats that include benthic primary producers[5] and/ or epi-fauna[6]	No or negligible reduction in physical environment / habitat area/function.	Detectable but localised and insignificant loss of area/function of physical environment / habitat. Rapid recovery evident within ~ 1 year (seasonal recovery)	Significant loss of area and/or function of local physical environment / habitat. Recovery over medium term (2–10 years)	Major, large-scale loss of area and/or function of physical environment / local habitat. Slow recovery over decades.	Complete destruction of local physical environment / habitat with no recovery; Long term (decades) and wide spread loss of area or function primary producers on a regional scale
	Threatened ecological communities (EPBC Act listed ecological communities)	No decline in threatened ecological community population size, diversity or function; No reduction in area of threatened ecological community; No introduction of disease likely to cause decline in threatened ecological community population size, diversity or function.	Detectable but insignificant decline in threatened ecological community population size, diversity or function; Insignificant reduction in area of threatened ecological community.	Significant decline in threatened ecological community population size, diversity or function; Significant reduction in area of threatened ecological community; Introduction of disease likely to cause significant decline in threatened ecological community population size, diversity or function.	Major long term decline in threatened ecological community population size, diversity or function Major reduction in area of threatened ecological community Fragmentation of threatened ecological community Introduce disease likely to cause long term decline in threatened ecological community population size, diversity or function	Complete loss of threatened ecological community
	Protected Areas Includes: World Heritage Properties; Ramsar wetlands; Commonwealth/ National Heritage Areas; Land/ Marine Conservation Reserves.	No or negligible impact on protected area values; No decline in species population within protected area; No or negligible alteration, modification, obscuring or diminishing of protected area values.*	Detectable but insignificant impact on one of more of protected area's values. Detectable but insignificant decline in species population within protected area. Detectable but insignificant alteration, modification, obscuring or diminishing of protected area values*	Significant impact on one of more of protected area's values; Significant decrease in population within protected area; Significant alteration, modification, obscuring or diminishing of protected area values.	Major long term effect on one of more of protected area's values Long term decrease in species population contained within protected area and threat to that population's viability Major alteration, modification, obscuring or diminishing of protected area values	Complete loss of one of more of protected area's values; Complete loss of species population contained within protected area.
	Socio-economic receptors Includes: fisheries (commercial and recreational); tourism; oil and gas; defence; commercial shipping.	No or negligible loss of value of the local industry; No or negligible reduction in key natural features or populations supporting the activity.	Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local activity.	Significant loss of value of the local industry; Significant medium term reduction of key natural features or populations supporting the local activity.	Major long-term loss of value of the local industry and threat to viability. Major reduction of key natural features or populations supporting the local activity.	Shutdown of local industry or widespread major damage to regional industry; Permanent loss of key natural features or populations supporting the local industry.

* Excluding World Heritage Areas

[4] As defined by the Department of Environment (DoE)
[5] Benthic photosynthetic organisms such as seagrass, algae, hard corals and mangroves
[6] Fauna attached to the substrate including sponges, soft corals and crinoids.

APPENDIX F – HYDROCARBON PATHWAYS AND THRESHOLDS

The hydrocarbon fate and transport modelling method described in this EP is able to track hydrocarbon concentrations of floating oil, entrained oil (WAF) and dissolved WAF below biologically significant impact levels. Consequently, exposure values are specified for the model to control what contact is recorded for surface (floating oil) and subsurface locations (entrained and dissolved) to ensure that recorded contacts are for biologically meaningful concentrations.

The determination of biologically meaningful impact levels is complex since the degree of impact will depend on the sensitivity of the biota contacted, the duration of the contact (exposure) and the toxicity of the hydrocarbon mixture making the contact. The toxicity of a hydrocarbon will change over time, due to weathering processes altering the composition of the hydrocarbon. To ensure conservatism in the environmental impact assessment process, the exposure values applied to the model are selected to adopt the most sensitive receptors that may be exposed, the longest likely exposure times and the more toxic hydrocarbons.

Impact pathways and exposure values are detailed below for surface (floating) oil, entrained oil (total WAF) and dissolved WAF. Exposure values are consistent with NOPSEMA Bulletin #1 Oil Spill Modelling (2019).

Exposure Values	Surface oil concentration (g/m^2)	Total water accommodated fraction (WAF) concentration (ppb)	Dissolved water accommodated fraction (WAF) concentration (ppb)	Time-integrated Dissolved water accommodated fraction (WAF) concentration (ppb.hr)	Hydrocarbon Ashore – accumulated (g/m^2)
Low	1	10	10	-	10
Moderate	10	-	50	4,800	100
High	50	100	400	38,400	1000

Surface Hydrocarbons

Exposure Pathways

Marine/coastal fauna, habitats and socio-economic receptors may be impacted by floating oil in the following way:

- Marine mammals, reptiles and birds can be exposed to oil when at the water surface. For marine mammals and reptiles this can occur when surfacing within a slick to breathe while for birds this includes contact from diving into a slick or floating on the sea surface while feeding or resting. For marine fauna surfacing in floating oil contact to sensitive areas may occur (e.g. eyes, mouth and respiratory system) creating irritation and potentially cell damage. Volatile compounds evaporating form surface oil may be inhaled by marine mammals and reptiles, particularly when the oil is fresh and relatively unweathered. Inhalation of these compounds may cause damage to internal respiratory structures. It is generally considered that marine mammals with smooth skin (e.g. cetaceans) are less susceptible to coating of oil than those covered with hair given hair has a greater potential to trap and retain oil causing longer exposure times. Birds are particularly susceptible to impact from floating oil in that feathers retain oil, particularly when the oil is ‘sticky’ (e.g. heavy crudes and HFO). The coating of oil on birds may hinder flight and feeding, reduce the ability of the bird to thermoregulate (control body temperature) and irritate/damage sensitive surfaces such as eyes, ears and nasal structures. Secondary impacts can occur through the ingestion of oil as birds attempt to preen contaminated feathers. Ingestion may lead to oil absorption and further toxic impacts.

- Surface oil can coat emergent habitats such as coral or rocky reefs and intertidal and shoreline areas around islands or along coastlines. Habitats that can be affected include rocky shorelines, sandy beaches, mangrove communities and intertidal areas which may support seagrass, algae and coral reef communities. The physical coating of mangroves, in particular their root system, can prevent gas exchange and/or cause toxicity at the cellular level. Mangrove response to oil contact includes deforestation, yellowing of leaves and mortality. Other chronic responses include reduced growth, reduced reproductive output and success, and genetic mutation. Intertidal areas may be contacted at low tides where emergent habitat is coated by oil. Seagrass, algae and sessile fauna such as hard corals, soft corals and sponges may be smothered as well as small low mobility fauna that live in close association with these and other benthic habitats or within/on sediments. Smothering of intertidal photosynthetic organisms such as seagrass, algae and hard coral may reduce their capacity for photosynthesis (energy production) or lead to a toxic response at the cellular level. For seagrass and algae this could lead to plant death, shedding of leaves/thalli, reduced growth, reduced reproductive output/success and genetic mutation. Similarly, for hard corals, bleaching, colony death, reduced growth and reduced reproductive capacity may occur. Such impacts may be exacerbated if these organisms are already under stress from marginal environmental conditions or if impacts occur during critical life-history stages (e.g. spawning periods). Small fauna smothered by oil may be hindered in their ability to move and feed or may suffer a toxic response from mortality to reduced growth rate or reproductive success. The coating of habitats can lead to secondary impacts to marine/coastal fauna. For example, marine turtles and shorebirds may be contacted by oil when using nesting beaches or when roosting/feeding along shorelines, respectively. Marine/coastal fauna may also ingest oil when feeding on coated habitats, e.g. dugongs or turtles ingesting coated seagrass/algae and shorebirds ingesting coated intertidal organisms such as molluscs and crabs.
- Surface oil may impact on socio-economic receptors such as the oil and gas industry, commercial shipping, fisheries/aquaculture and tourism. The presence of floating oil may pose a human health risk from volatile compounds depending on the nature and freshness of the oil (i.e. fresh light oils and condensates posing the greatest risk) while oil spill response activities targeting floating oil may preclude or disrupt activities by other users in the area both offshore and at oil affected shorelines. This could have an economic impact on affected industries. In addition, floating and stranded oil may be highly visible to the general public and have a resultant negative effect on tourism in affected areas. Real or perceived deterioration of nearshore and coastal habitats may also have long lasting effect on the tourism value of an area and of fisheries activities that may rely on those areas to support healthy fish stocks.

Exposure Values

The low exposure value of 1 g/m^2 represents the area within which socio-economic impacts to the visual amenity of the marine environment may occur but is below concentrations at which ecological impacts are expected to occur.

The moderate exposure value of 10 g/m^2 represents the minimum oil thickness at which ecological impacts (e.g. to birds and marine mammals) are expected to occur. There is a paucity of data on floating oil concentrations with respect to impacts to marine organisms. The impact of floating oil on birds is better understood than other receptors. Estimates for the minimum oil thickness that will harm seabirds (through ingestion from preening of contaminated feathers or loss of thermal protection of their feathers) range from at 10 g/m^2 (O'Hara and Morandin, 2010) to 25 g/m^2 (Koops *et al*., 2004). A conservative exposure value of 10 g/m^2 has been applied to impacts from marine gas oil (MDO/MGO). This hydrocarbon exposure value is also considered appropriate for turtles, sea snakes and marine mammals (NRDAMCME, 1997) and has also been applied herein to determine impacts of surface oils to emergent habitats.

The high exposure value of 50 g/m^2 approximates the estimated minimum floating hydrocarbon threshold for containment and recovery and informs response planning.

Entrained Oil and Dissolved Aromatic Hydrocarbons

Exposure Pathways

Entrained oil is oil that is dispersed within the water column as oil droplets and could also be referred to as 'total water accommodated fraction'. For oil spills released at surface, entrained oil is created in the top few meters of the water column through mixing (entrainment) of surface oil by wave (wind and current induced) action. For oil spills released subsea (e.g. pipelines leaks, subsea well blowouts) entrained oil may be distributed deeper within the water column due to the hydrocarbon plume entraining ambient water (thus counter balancing the buoyancy force) as it rises. Dissolved aromatic hydrocarbons (DAHs) are the water soluble portion of the entrained and floating oil and include Monocyclic Aromatic Hydrocarbons (MAHs, including BTEX - Benzene, Toluene, Ethylbenzene and Xylene) and low molecular weight Polycyclic Aromatic Hydrocarbons (PAHs). Aromatic hydrocarbons dissolve more favourably from entrained oil than floating oil since oil droplets within the water column have a greater surface area across which these aromatics can dissolve. In conditions where entrainment is minimal (e.g. calm conditions) evaporation plays a greater role in the loss of aromatic hydrocarbons from the discharged oil.

Due to the toxic nature of MAHs, low molecular weight PAHs and the ability for these to be transferred across cellular structures, DAHs contribute to the acute toxicity of an oil. The proportion of BTEX, and other DAHs that are readily dissolved or evaporated, diminish over time. DAH concentration is therefore higher around fresh oil than weathered oil. The toxicity of DAHs to an organism is dependent on both the concentration of the oil and the amount of time an organism is exposed to a given concentration.

Marine/coastal fauna, habitats and socio-economic receptors may be impacted by entrained oil and DAHs in the following ways:

- Marine mammals, reptiles, fish and plankton (including invertebrates and invertebrate/fish larvae) may be exposed to entrained oil and DAHs following a spill at surface or subsea. Birds may also be exposed while diving but this is likely to be of less significance than exposure to floating oil. Physical contact of oil to sensitive tissues (e.g. eyes, mouth and respiratory system) may lead to irritation and cell damage. Plankton assemblages contain eggs, larvae and early life stages of marine invertebrates and fish. These organisms are particularly sensitive to toxic impacts from DAHs given they are going through important processes of organ differentiation and development and are passive or of low mobility organisms restricting their ability to avoid entrained oil and DAHs. Impacts to eggs/larvae include mortality, reduced growth and growth defects. Fish are also highly susceptible to entrained oil through contact of oil across gill structures which promotes uptake of toxic compounds from entrained oil. Other internal contact and uptake can occur by ingestion during feeding. Ingestion/uptake of compounds from entrained oil can potentially lead to toxic impacts, within fish in particular, including reduced swimming and feeding ability, increased risk of predation, lowered growth rates and reduced reproductive output and success. Susceptibility of small/juvenile fish is likely to be greater due to restricted capacity for avoiding entrained oil/DAHs while benthic fish in deeper waters are likely to be less affected since entrained oil is most likely to within the upper water column in deeper water.
- Entrained oil can contact subtidal/intertidal habitats such as rocky reefs, bare sediments, seagrass, algae and coral reef communities. Contact to photosynthetic organisms such as seagrass, algae and hard coral may reduce capacity for photosynthesis either through a reduction in light availability or through toxic effects of DAH uptake or direct contact by entrained oil. For seagrass and algae this could lead to shedding of leaves/thalli, reduced growth and reproductive output/success. For hard corals, bleaching may occur (expulsion of zooxanthellae), sediment clearing and feeding ability may be diminished, growth or reproductive capacity may be reduced, and reproductive success may be diminished. Small fauna associated with the above mentioned habitats may be hindered in their ability to move and feed or may suffer a toxic response such as mortality, reduced growth or reproductive success. Habitats particularly susceptible during important life-cycle stages such as spawning periods or when other physiological stresses are present (e.g. when water temperature at upper range of tolerance or where a high degree of sedimentation is occurring).
- The coating of habitats can lead to secondary impacts to marine/coastal fauna. For example, marine/coastal fauna may ingest oil when feeding on coated habitats, e.g. dugongs or turtles ingesting

coated seagrass/algae and shorebirds ingesting coated intertidal organisms such as molluscs and crabs. The loss or damage of habitat may also impact associated epi- and in-faunal communities which rely on the habitat (e.g. seagrass meadows, algae beds, coral reefs) for shelter and food.

- Entrained oil and DAHs may impact socio-economic receptors such as fisheries/aquaculture and tourism. Fisheries and aquaculture may potentially be impacted from a decrease in stock levels. Reduced marketability of product could also arise from a real or perceived tainting of flesh caused from contact of target species with oil. While entrained oil and DAHs are largely invisible from the water's surface tourism may be impacted from a real or perceived reduction in health or mortality of habitats that support tourism activities such as snorkelling, diving and fishing. Aquaculture facilities growing pearl oysters may be affected by oil or DAH in the water column through reduction in water quality and through direct ingestion (toxicity) by stock.

Exposure Values - Entrained

The low exposure value of 10 ppb for entrained hydrocarbons has been adopted to represent the planning area for scientific monitoring in the event of a diesel spill based on potential for exceedance of water quality triggers in the ANZECC 2000 Guidelines (ANZECC 2000).

The high exposure value of 100 ppb is based on a detailed expert review of hydrocarbon toxicity undertaken by French-McCay et al. (2018). French-McCay reports 100 ppb to be a highly conservative threshold for total water accommodated fraction that could result in sub-lethal effects to marine biota, including sensitive organisms and early life stages of fish (e.g. embryos, larvae).

Exposure Values – Dissolved (Instantaneous)

For dissolved aromatic hydrocarbons, toxicity is a function of the aromatic content and composition in the hydrocarbon, the fate and partitioning of those components in the environment and the duration of exposure by sensitive receptors.

The low exposure value of 10 ppb for dissolved hydrocarbons has been adopted to represent the planning area for scientific monitoring in the event of a diesel spill based on potential for exceedance of water quality triggers in the ANZECC 2000 Guidelines (ANZECC 2000).

Global data shows species sensitivity (95 per cent of fish and invertebrates tested) to PAH, for exposure periods greater than 96 hours under varying environmental conditions, varied in tests considering sensitive life stages such as eggs and larvae across test organisms (French, 2000; French-McCay, 2002).

Based on this information, a moderate contact threshold of 50 ppb is considered a conservative exposure value for the assessment of impacts from dissolved hydrocarbons for MDO/MGO, representing potential toxic effects, particularly sublethal effects, to highly sensitive species. The high exposure value of 400 ppb represents the threshold at which lethal effects to sensitive species may occur.

Exposure Values – Dissolved (Time-Averaged)

It is noted that the use of instantaneous exposure values for dissolved hydrocarbons is highly conservative and they are considered more relevant to time-based exposures (i.e. applied across a 96-hour interval). Using the moderate (50 ppb) and high (400 ppb) exposure values as appropriate for assessment of impacts of dissolved aromatic hydrocarbons, contact threshold for dosage were determined based on an exposure period of greater than 96 hours (French, 2000; French-McCay, 2002). The resulting time-averaged exposure values are 4,800 ppb.hrs (moderate) and 38,400 ppb.hrs (high).

Accumulated Hydrocarbons

Exposure Pathways

Shoreline and intertidal habitats comprise of mangroves, sandy beaches and rocky shorelines. These habitats and marine fauna known to use shorelines are most at risk of exposure to shoreline accumulations of oil, due to smothering of intertidal habitats (such as mangroves and emergent coral reefs) and coating of marine fauna. Shoreline hydrocarbons can impact shorebirds and also nesting turtles when they come ashore, with

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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. Turtle 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 (Milton *et al*., 2003).

Exposure Values

The low exposure value of 10 g/m^2 represents light oiling (equivalent to 2 teaspoons of oil per m^2) and predicts the area within which socio-economic impacts to the visual amenity may occur, but is below concentrations at which ecological impacts are expected to occur. Owens and Sergy (2004) classifies a shoreline 'stain' as oil accumulation below 0.1 mm thick (i.e. below approximately 100 g/m^2) which creates a visible mark on coarse shoreline sediments or bedrock that cannot be scratched off easily. Oil well below this threshold manifests as a transparent or translucent film or sheen (Owens and Sergy, 2004).

The moderate exposure value of 100 g/m^2 represents the minimum oil thickness at which potentially lethal ecological impacts (e.g. to intertidal invertebrates) are expected to occur. Shoreline accumulation of hydrocarbons above this exposure value may result in lethal impacts for benthic epifaunal invertebrates on intertidal habitats that consist of hard substrates (e.g. rocky, artificial/man-made rip rap) and sediments (i.e. mud, silt, sand and gravel) (French-McCay *et al*., 2003, French-McCay *et al*., 2004; French-McCay, 2009). The moderate exposure value also predicts areas likely to require clean-up effort.

The high exposure value of 1000 g/m^2 predicts areas likely to require intensive clean-up effort.