Santos

Frigate-1 Wellhead Environment Plan

SO-91-BI-20024

PROJECT / FACILITY	Frigate-1
REVIEW INTERVAL (MONTHS)	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s *Managerial / Technical / Site*	Approver
0	Asset Retirement Manager	Environmental Approvals Team Leader	Manager Barossa, Browse & PT Development
		Dawn MacInnes	

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A	14/02/2022	Consultant / Santos	Santos Internal Review
B	16/03/2022	Consultant / Santos	Santos Final Review
0	28/04/2022	Consultant / Santos	Submission to NOPSEMA

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Abbreviations

Abbreviation	Description
°C	Degrees Celsius
µ	Micron
3D	Three-dimensional
ACN	Australian company number
AHO	Australian Hydrographic Office
AHS	Australian Hydrographic Service
AIS	Automatic identification system
ALARP	As low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park (Commonwealth)
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
BIAs	Biologically important areas
BOD	Biochemical Oxygen Demand
BTEX	benzene, toluene, ethylbenzene, and xylene
CAES	Catch and Effort System
CH_4	Methane
CHARM	Chemical hazard and risk management
CO_2	Carbon dioxide
DAHs	Dissolved aromatic hydrocarbons
DAWE	Department of Agriculture, Water and the Environment
dB	Decibels
DBCA	Department of Biodiversity, Conservation and Attractions (Western Australia)
DMIRS	Department of Mines, Industry Regulation and Safety (Western Australia)
DoD	Department of Defence
DoT	Department of Transport
DP	Dynamic positioning
DPaW	Department of Parks and Wildlife (Western Australia)
DPIRD	Department of Primary Industries and Regional Development (Western Australia)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
E	East
EHS	Environment, Health & Safety

EMBA	Environment that may be affected
ENVID	Environmental hazard identification workshop
EP	Environment Plan
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPO	Environmental performance outcome
EPS	Environmental performance standard
ESD	Ecologically Sustainable Development
g/cm^3	Gram per cubic centimetre
g/m^2	Grams per square metre
GHG	Greenhouse gas
ha	Hectare
HEV	High Environmental Value
HEVA	High Exposure Value Area
HSE	Health, safety and environment
HYCOM	Hybrid Coordinate Ocean Model
Hz	Hertz
IAPP	International air pollution prevention
IBC	Intermediate bulk container
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMDG	International maritime dangerous goods
IMS	Invasive marine species
IMSMP	Invasive Marine Species Management Plan
IMT	Incident Management Team
ITOPF	International Tanker Owners Pollution Federation Ltd
IUCN	International Union for Conservation of Nature
JRCC	Joint Rescue Coordination Centre
KEF	Key ecological feature
kHz	Kilo hertz
km	Kilometre
km^2	Square kilometres
L	Litre
LOWC	Loss of well control
m	Metres
m/s	Metres per second

m^2	Square metres
m^3	Cubic metres
MAH	Monoaromatic Hydrocarbons
MARPOL	International Convention for the Prevention of Pollution from Ships
MCS	Maximum Credible Scenario
MDO	Marine diesel oil
MEVA	Moderate exposure value area
mm	Millimetres
MNES	Matters of National Environmental Significance
MoC	Management of change
MoU	Memorandum of Understanding
MSDS	Material safety data sheet
N	North
N_2O	Nitrous oxide
NCAR	National Centre for Atmospherics Research
NCEP	National Centre for Environmental Protection
NEBA	Net environmental benefit analysis
nm	Nautical mile
NMFS	National Marine Fisheries Service (US)
NPF	Northern Prawn Fishery
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOx	Oxides of nitrogen
OCNS	Offshore Chemical Notification Scheme
ODS	Ozone-depleting substance
OPEP	Oil Pollution Emergency Plan
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OSCAR	Oil Spill Contingency and Response
OSPAR	Convention for the Protection of the Marine Environment of the Northeast Atlantic
OWM	Oil Weathering Model
OWR	Oiled Wildlife Response
P&A	Plug and abandon
Pa	Pascal
PAH	Polycyclic aromatic hydrocarbons
PMST	Protected Matters Search Tool

PNEC	Predicted No Effect Concentration
ppb	Parts per billion
ppm	Parts per million
ppt	Parts per thousand
PTS	Permanent threshold shift
RAMSAR	Convention on Wetlands of International Importance Especially as Waterfowl Habitat
ROV	Remotely operated vehicle
S	South
SDS	Safety data sheet
SEL	Sound exposure level measured as dB re 1 $\mu Pa^2 \cdot s$
SINTEF	The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology
SOLAS	Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SOx	Oxides of sulphur
t	tonnes
TD	Total depth
TSSC	Threatened Species Scientific Committee
TTS	Temporary threshold shift
UK	United Kingdom
VSP	Vertical seismic profiling
W	West
WA	Western Australia
WAF	Water Accommodated Fraction
WAOWRP	WA Oiled Wildlife Response Plan
WBM	Water-based mud
WDAS	Well Design Automation System
WDCS	Whale and Dolphin Conservation Society
WOMP	Well Operations Management Plan

1 Introduction

1.1 Environment Plan Summary

OPGGS(E)R 2009 Requirements
Regulation 11(3)
Within 10 days after receiving notice that the Regulator has accepted an Environment Plan (EP) (whether in full, in part or subject to limitations or conditions), the titleholder must submit a summary of the accepted plan to the Regulator for public disclosure.
Regulation 11(4)
The summary: a) must include the following material from the environment plan: (i) the location of the activity (ii) a description of the receiving environment (iii) a description of the activity (iv) details of environmental impacts and risks (v) a summary of the control measures for the activity (vi) a summary of the arrangements for ongoing monitoring of the titleholder's environmental performance (vii) a summary of the response arrangements in the oil pollution emergency plan (viii) details of consultation already undertaken, and plans for ongoing consultation (ix) details of the titleholder's nominated liaison person for the activity b) must be to the satisfaction of the Regulator.

This Frigate-1 Wellhead Environment Plan (EP) summary has been prepared from material provided in this EP. The summary consists of the following as required by regulation 11(4) of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (OPGGS(E)R 2009):

EP Summary Material Requirement	Relevant Section of EP containing EP Summary Material
The location of the activity	**Section 2.1**
A description of the receiving environment	Section 3 and **Appendix C** – Santos' Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062)
A description of the activity	**Section 2**
Details of the environmental impacts and risks	**Sections 6** and **7**
The control measures for the activity	**Sections 6** and **7**
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 8**
Response arrangements in the oil pollution emergency plan	**Sections 6.8** and **7.2**

	See OPEP
Consultation already undertaken and plans for ongoing consultation	**Section 4**
Details of the titleholders nominated liaison person for the activity	**Section 1.4.1**

1.2 Activity Overview

The Frigate-1 exploration well was drilled in 1978 in WA-40-R targeting potentially commercial gas resources; but did not encounter any hydrocarbons (i.e. was 'dry'). The well was plugged and abandoned in the same year, and the wellhead was left in place. The well was abandoned with three cement plugs and a corrosion cap was installed on the wellhead.

This EP has been prepared to meet the requirements of the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act) for decommissioning. The defined petroleum activity for this EP is limited to:

+ A survey to locate and inspect the Frigate-1 wellhead; providing updated coordinates for the wellhead location and to validate the assumptions of the wellhead condition used in the options assessment (Section **2.4**).
+ Subsequent permanent abandonment of the Frigate-1 wellhead in-situ.

The petroleum activity ends upon completion of the survey and submission and acceptance of the notifications as required under Regulation 29 (end of activity) and Regulation 25A (end of EP) of the OPGGS(E)R 2009.

At process end, Santos Ltd (Santos) will have made arrangements satisfactory to NOPSEMA for leaving the wellhead (property) in-situ in perpetuity compliant to Section 270(3)(ii) of the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGS Act).

Given the age of the wellhead and potential inaccuracy in historical location data, a survey is required to locate the wellhead and validate the assumptions made in the Decommissioning Options Assessment presented in **Section 2.4** of the EP.

1.3 Purpose of this Environment Plan

The 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 Activity and demonstrates how these are reduced to As Low As Reasonably Practicable (ALARP) and to an acceptable level.

The EP provides an implementation strategy 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 Health and Safety Policy (***Appendix A** – Santos EHS Policy

Appendix A – Santos EHS Policy) and with all relevant legislation. This EP documents relevant stakeholder consultation performed during the planning of the Activity. This EP is valid from the date that it is accepted by NOPSEMA for a period of time not exceeding five years, until submission and acceptance of Regulation 25A end-of-operation of EP notification.

1.4 Titleholder

OPGGS(E)R 2009 Requirements
Regulation 15. Details of titleholder and liaison person.
15(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) f) if the titleholder is a body corporate that has an Australian Company Number (ACN) (within the meaning of the *Corporations Act 2001*). 15(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) e) email address (if any).

1.4.1 Details of Titleholder

Santos is the title holder undertaking the Activity within Permit WA-40-R-. Bonaparte Gas and Oil Pty Limited is wholly owned by Santos Limited (Santos). Titleholder details are provided in **Table 1-1**.

Table 1-1: Titleholder Details

Title	Titleholder	ACN / ARBN	Permit % Interest	Address
WA-40-R	Bonaparte Gas & Oil Pty. Limited [1]	060 530 109	65%	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia 6000 Telephone number: (08) 6218 7100 Fax number: (08) 8116 5149Email address: offshore.environment.admin@santos.com
	Santos Limited	007 550 923	35%	

[1] Santos holds 100% interest in this company

1.4.2 Details for Santos' Nominated Liaison Person

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

Name: Dawn MacInnes

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

1.4.3 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.

1.5 Environmental Management Framework

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Requirements 13(4) The environment plan must: i. describe the requirements, including legislative requirements, that apply to the Activity and are relevant to the environmental management of the Activity ii. 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.

1.5.1 Environmental Health and Safety Policy

The activity will be conducted in accordance with the Santos Environment, Health and Safety (EHS) Policy (Appendix A – Santos EHS Policy) and relevant legislative requirements presented within

Appendix B – Legislative Requirements Relevant to the Activity, 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 details and evaluates 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.

1.5.2 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 B** – Legislative Requirements Relevant to the Activity.

1.5.3 Commonwealth Legislation

The petroleum activity described in this EP (**Section 2**) takes place within the Commonwealth jurisdictional boundary and therefore is subject to 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 B** – Legislative Requirements Relevant to the Activity.

A Well Operations Management Plan (WOMP) is not required for this petroleum activity under the *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011*.

1.5.4 State Legislation

As the environment that may be affected by the petroleum activity is limited to Commonwealth waters, no relevant state legislation has been identified for this EP.

2 Activity Description

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Description of the Activity: 13 (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 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 Activity Location

2.1.1 Well and survey location

The Frigate-1 wellhead is located within the Petroleum Retention Lease WA-40-R. The coordinates as recorded in the Well Completion Report (Geoscience Australia, 1978) are shown in **Table 2-1** and shown in **Figure 2-1**.

Santos has undertaken systematic checks of the grid coordinates for Frigate-1 wellhead with all known regulatory and known digital sources of its location. To confirm the exact location of the wellhead Santos proposes to undertake an ROV survey as outlined in **Section 2.3**, because there remains some location uncertainty due to the accuracy of GIS systems in the 1970s.

To account for the uncertainty in the accuracy of the coordinates, Santos has converted the datum used in 1970 (assumed AGD66 datum) to the most current datum (GDA94 datum), where the grid coordinates were compared by computing the offset distances and directions between the various sources. From the datum conversion, the coordinates could be around ± 100 m from the reported coordinates shown in **Table 2-1.**

Table 2-1: Wellhead Indicative Coordinates

Wellhead	Title	Approx. Water Depth (m)	Coordinates (Datum/Projection: GDA 94 Zone 50)	
			Latitude	Longitude
Frigate-1	WA-40-R	112.2	13° 10' 41.84" S	127° 55' 29.45" E

Based on current location data, the Frigate-1 wellhead is approximately 101 km from the closest shoreline; 68 km southwest of Petrel-1 and 14 km west of Tern-1 well. The water depth is approximately 112 m.

2.1.2 Operational Area

The Operational Area covered under this EP is the area within which all planned activities will occur (i.e. survey).

The Operational Area for Frigate-1 encompasses a circular area with a 2 km radius from the Frigate-1 wellhead (**Figure 2-1**).

The approximate distances of key features from the Operational Area are provided in **Table 2-2**.

Table 2-2: Distances of Key Features from Operational Area

Key Features	Approximate Distance and Direction from Operational Area
Tern-1	16 km NW
Oceanic Shoals Australian Marine Park	53 km N

Joseph Bonaparte Gulf Australian Marine Park	122 km SE
North Kimberly Marine Park	162 km W
Darwin	466 km E
Kalumburu	186 km SW
Wadeye	209 km SE

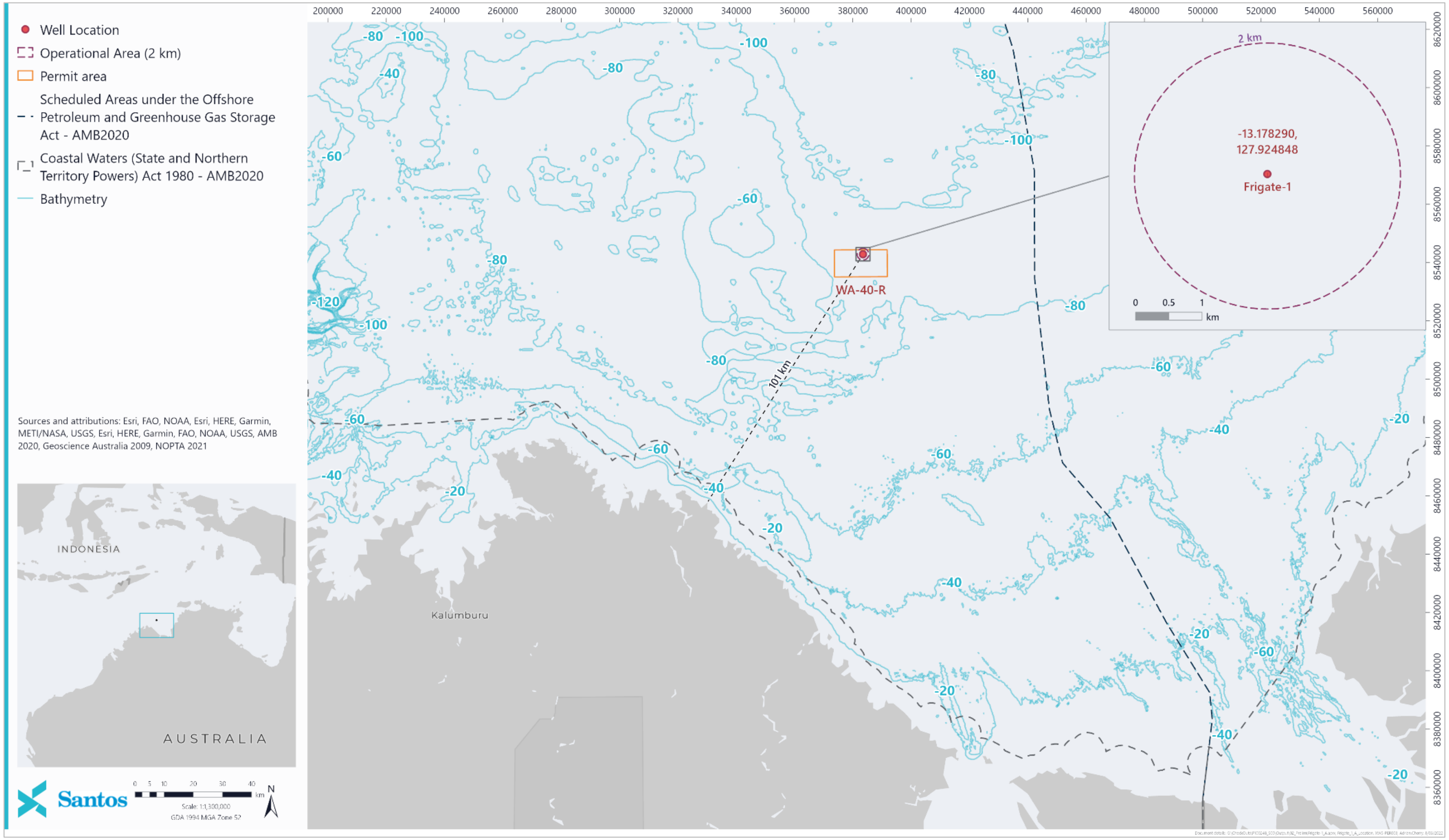


Figure 2-1: Frigate-1 Well Location and Permit Area

2.2 Wellhead Details

The Frigate-1 exploration well was drilled in 1978 by ARCO Australia Ltd. There were no indications that hydrocarbons were encountered (i.e. the well was ‘dry’) (Geoscience Australia, 2021).

The Well Completion Report (Geoscience Australia, 1978) shows that the well was plugged and abandoned with two cement plugs set in open hole, the first plug from 1271.9 m to 1206.0 m and the second plug from 1051.5m to 985.7m. A 13-3/8” bridge plug was set at 737.5 m and the casing was pressure tested to 2000 psi. The 13-3/8” casing as then perforated at 209 m, and a cement retainer set at 198.1 m. A third cement plug was placed above and below the cement retainer with 200 sacks of cement squeezed below the retainer and into the 13-3/8” x 20” annulus, and 100 sacks of cement placed on top of the retainer. Plug-back TD was 156.6 m. A corrosion cap was installed on the wellhead.

2.3 Well Inspection Survey

Santos became the titleholder of WA-40-R in 2011. A well inspection survey will be undertaken to confirm the status and location of the Frigate-1 wellhead in order to validate the assessment of decommissioning options.

An ROV will be deployed from a small utility vessel to locate and inspect the wellhead.

The survey may take up to 7 days, including time to locate the well. The ROV inspection of the wellhead itself is expected to take approximately 4 hours.

This survey is notionally proposed to take place in September 2022, depending on the availability of vessels as well as the timing of the neap tides. The month of September has been identified as a suitable time of year as it is the end of the dry season and provides the best possible visibility in the field. Since the actual timing of the surveys is dependent on vessel availability and weather conditions, this EP has accounted for activities occurring in any season.

Work will be undertaken 24 hours a day.

2.3.1 Survey Techniques

Acoustic surveying techniques will be used in a search pattern in an approximately 200 m radius around the expected location of the Frigate-1 wellhead.

Once located, an inspection of the wellhead will be undertaken using a General Video Inspection (GVI).

Table 2-3 details the survey techniques that may be used for this activity.

Table 2-3: Descriptions of Survey Techniques

Survey Type	Description
Side-scan Sonar (SSS)	SSS identifies large objects on the sea floor that could potentially be the Frigate-1 wellhead. SSS involves towing a set of transducers mounted on either side of a ‘tow fish’ approximately 10 to 20 m above the seabed, producing pulses at high frequencies.
Multibeam Echo Sounder (MBES)	MBES 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.

Survey Type	Description
Ultra-short Baseline System (USBL)	A USBL system will be used to track underwater survey and ROV equipment. 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 and measured by the ultra-short baseline (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.
General Video Inspection (GVI)	Visual inspection using camera/video equipment will be used once the wellhead is located.

2.3.2 Vessel Operations

The total duration of the inspection survey (and therefore vessel operations) is expected to take up to 7 days.

The survey is notionally scheduled for September 2022 (dependant on weather and vessel availability). All vessels are likely to mobilise out of Darwin Harbour in the Northern Territory. Only one vessel will be mobilised to undertake the activity.

Vessels will be fuelled by marine diesel fuel, and there is no planned vessel refuelling to take place in the operational area. All vessel fuelling is proposed to take place within the nearest suitable harbour (likely Darwin).

At this time, the small utility vessel that will be used to undertake inspection survey activity has not been identified, however would typically be less than 30 m in length and support a crew of approximately 15 persons.

The vessel transiting to and from the operational area is not included in the scope of this EP; and will operate under the Commonwealth *Navigation Act 2012* and are subject to existing Australian Maritime Law.

2.3.3 ROV Operations

ROV operations are proposed to locate the wellhead and then undertake the inspection of the wellhead itself.

To assist in locating the wellhead, an ROV will use various geophysical and hydrographic survey techniques such as Multibeam echo-sounder (MBES), Side-scan Sonar (SSS), Ultra-short Baseline System (USBL) and General Video Inspection (GVI).

Once the wellhead has been located, the ROV will record imagery of the wellhead and the surrounding seabed enabling an assessment of the state of the wellhead and surrounds.

2.4 Decommissioning Options Assessment

2.4.1 Overview

Section 572(3) of the OPGGS Act states that "a titleholder must remove from the title area all structures that are, and all equipment and other property that is, neither used nor to be used in connection with the operations in which the titleholder is or will be engaged and that are authorised by the permit, lease, licence or authority.”

The Offshore Petroleum Decommissioning Guideline (DISER, 2020) clarifies that the Base Case is complete removal of all equipment and property. Options other than complete removal may be considered if the titleholder can demonstrate that the alternative decommissioning approach delivers equal or better environmental and safety outcomes compared to complete removal, and that the approach complies with all other requirements (DISER, 2020).

To inform the scope of the petroleum activity for this EP, Santos conducted an options assessment to evaluate wellhead decommissioning options relative to the Base Case. Consistent with the Decommissioning Guidelines, the options assessment considered environmental, social and safety criteria to evaluate each decommissioning option, however it was the environmental criteria alone that were used to determine the decommissioning option. In accordance with the Section 572 Maintenance and Removal of Property Policy (NOPSEMA,2020b), the EP must evaluate the feasibility of all options, therefore technical feasibility criteria are also considered in the options assessment.

Stakeholders were consulted on the selected option as described in **Section 4**.

Section 2.4.2 describes the decommissioning options assessment process based on the possible findings of the well inspection survey (scenarios) and the credible decommissioning options to determine Santos’ preferred option for decommissioning the Frigate-1 wellhead.

The preferred decommissioning option is evaluated in **Section 6**.

2.4.2 Process

The process used to conduct the decommissioning options assessment for Frigate-1 wellhead prior to being able to confirm location and condition status, comprised four steps:

1. Identify credible wellhead condition scenarios
2. Identify credible decommissioning options
3. Define suitable environmental, social and safety criteria and ratings
4. Rank the credible options against defined criteria.

2.4.2.1 Wellhead Condition Scenarios

A screening assessment was undertaken prior to the decommissioning options assessment to identify potential credible conditions of the wellhead that could be expected to be observed from the proposed well inspection survey.

As no assessment has been conducted since the plug and abandonment in 1978, a well inspection survey will confirm the location and status of the Frigate-1 wellhead. The Frigate-1 wellhead report provides some detail which has been drawn on to inform the expected outcome of the planned September 2022 survey and, along with the surveys of other legacy wells of a similar era and location (Tern-1 was drilled in 1971 and surveyed in 2020), assumptions can be made that the Frigate-1 wellhead will be similar to that found for the Tern-1 wellhead.

The Tern-1 wellhead is made of steel and is approximately 1 m in diameter and 3 m above the seafloor. A wellhead corrosion cap was installed over the Tern-1 wellhead, the same as described for Frigate-1. Tern-1 also has external infrastructure present including a guide base (GB) and guideposts.

Table 2-4 describes the potential wellhead scenarios.

Table 2-4: Assessment of Credible Wellhead Condition Scenarios

Potential Wellhead Status Scenario	Description	Credible	Justification
Casing only (no external obstructions)	The presence of the wellhead and casing without additional external obstructions.	✓	The absence of external structures around the wellhead is a credible consideration given the lack of description in the well completion report from 1978.
Presence of external obstructions	External obstructions could include guideposts/guide base/cement/combination of these, on or around the wellhead structure restricting access.	✓	The presence of external structures, such as a guide base and/or cement patio, is highly likely given their presence at another legacy well of a similar era and location.
Drilling cutting mound	The presence of a drilling cutting mound over or around the wellhead will restrict access. Moving cuttings could result in the disturbance of potentially hazardous material.	✓	The presence of drill cuttings is a credible consideration; however, the well report details a water-based mud (WBM) was used for drilling and is not regarded as an environmental concern, therefore it was decided to group the presence of drill cuttings with the external obstructions scenario as it is also a physical impediment.
No wellhead	The possibility of no wellhead found after a seven-day survey effort.	✓	The possibility of no wellhead being located during the survey is considered a credible scenario given the age of the wellhead and challenge of shifting coordinates over time. Effort has been made to estimate the current coordinates and improve the accuracy of the search area during the survey. The Tern-1 well survey had success with the proposed GIS coordinate datum conversion method and grid approach, however, the possibility remains that it may not be found and up to 7 days has been allocated to locate the wellhead.
Gas bubbles	The presence of gas bubbles seeping from seabed could indicate a leak from a gas bearing formation.	X	Gas bubbles indicating a gas leakage from a gas bearing formation were not considered credible given the Frigate-1 well did not encounter hydrocarbons.

			This scenario was not carried through to the options assessment.

2.4.2.2 Decommissioning Options

The screening assessment considered the credible decommissioning options. **Table 2-5** describes these options.

The screening assessment was also informed by an independent study by Add Energy, commissioned by Santos, to determine the technical feasibility of the removal of the Tern-1 wellhead; a recent decommissioning activity in the neighbouring permit WA-27-R. The report by Add Energy was used as a point of reference for Frigate-1 due to the similarities in age of the two wellheads, the proximity of the two titles and the similarities in scope.

Table 2-5: Assessment of Credible Decommissioning Options

Decommissioning Option	Description	Credible
Option A – Base Case: Removal by external cutting above mudline	External cutting: utilises cutting tools deployed from the outside of the wellhead (above the mudline where there is access) to sever the wellhead, conductor and internal casing strings from the casing stump by cutting from the outside. This method will usually leave a stump (100 mm) protruding from the seafloor. Both conventional diamond wire saw (DWS) methods and tooling and a newly designed DWS tool were considered. Conventional DWS methods have significant technical issues likely to prevent it from being a suitable option. DWS require mounting to the conductor, requiring removal of the Guide Base (GB) or dredging below to allow access to the conductor below the GB. Crane deployment is not practical below the GB and both DWS and wellhead structure require crane support during the cut. A newly designed DWS tool is a possible alternative external cut option and is more suitable for installation around the GB. However, this technology is not field proven. It has not been designed specifically for wellhead removal so may require some modification. It is bulky and difficult to handle/deploy therefore presents safety risks. As the wellhead is likely covered in marine growth, the condition of the wellhead and the extent of corrosion is unknown. It is anticipated that two campaigns, to remove the wellhead, would be required: a cleaning and inspection campaign (which would include a determination of well bore pressure) and a subsequent removal campaign. Removal may not be feasible and would be dependent on the condition of the wellhead and extent of corrosion.	✓
Option B – Base Case: Removal by internal cutting below the mudline	Internal cutting utilises cutting tools deployed from the inside of the wellhead (below the mudline to sever the wellhead and internal casing string from the inside of the casing stump. The severed wellhead and casing/conductor stumps (and any surrounding cement attached) are then pulled and recovered using	✓

Decommissioning Option	Description	Credible
	the same tooling used to make the cut. This method should leave nothing protruding from the seafloor. The wellhead removal study by Add Energy for the Tern-1 wellhead assessed a number of internal mechanical and water jet cutting options for wellhead removal. The internal abrasive water jet cutting tool provides the maximum flexibility in mounting the tool and gaining access to the well bore. As per Option A, this removal option would require two campaigns.	
Option C - Install a wellhead cover or cap	The installation of a wellhead cover or cap on top of the wellhead is intended to reduce the potential for snagging risks to commercial trawl fishers. However, previous experience/consultation with the Tern-1 decommissioning activity revealed this option would reduce, but not remove, the navigational hazard and snagging risk posed by the wellhead (assessed in the Tern-1 Wellhead Abandonment EP (SO-91-BI-20008), accepted by NOPSEMA in September 2021). The option was carried through to assessment to evaluate against the other decommissioning options.	✓
Option D - Leave the wellhead in-situ	The wellhead has been in place since its plug and abandonment in 1978. No removal campaign/s or additional activities would be required.	✓

2.4.3 Assessment Criteria and Rating Details

The criteria and sub-criteria used for the options assessment are detailed in **Table** 2-6 and the rating details described in **Table 2-7.**

+ selected option.

Table 2-6: Options Assessment Criteria and Sub-criteria

Criteria	Sub-criteria	Description
Environment	Water quality and sediment quality	Assessment of water and sediment quality.
	Ecological services	Assessment of biodiversity and habitat changes due to the physical presence of property, and seabed disturbance because of the petroleum activity.
	Emissions	Emissions such as light, noise, air and marine discharges.
	Waste	Volume and type of waste associated with offshore operations (e.g. landfill, recyclables).
Technical Feasibility	Engineering and execution complexity	The extent to which the option requires the use of proven technology.

Criteria	Sub-criteria	Description
		The ability to recover from unplanned excursions and complete the planned option.
Health and Safety	Risk to personnel (offshore and onshore)	Health and safety risks to company-related personnel both onshore (e.g. logistics) and offshore.
	Residual risk to other marine users	Health and safety risks to marine users such as commercial vessels, fishers and members of the public.
Social	Effect on commercial fisheries	Displacing commercial fisheries or affecting their catch.
	Other socio-economic effects	Effects on local communities, recreational users, commercial activities, etc.
Economic	Financial cost	Operational / capital costs to Santos.

Table 2-7: Options Assessment Rating Template

Criteria	Sub-criteria	Score		
		Most Preferred	Neutral	Least Preferred
Environment	Water quality and sediment quality	Low impact or risk to water quality and sediment quality. Potential effects short term/immediate vicinity of the property.	Moderate impact or risk to water quality and sediment quality. Potential effects medium term/local.	High impact or risk to water quality and sediment quality. Potential effects long term /extensive.
	Ecological services	Retention of hard substrate. Minimal level of seabed disturbance.	Some loss of hard substrate. Low-moderate level seabed disturbance.	Complete or significant loss of hard substrate. Moderate-high level of seabed disturbance.
	Emissions	No or low number of onshore vehicle and offshore vessel days (i.e. days).	Moderate number of onshore vehicle and offshore vessel days (i.e. weeks).	High levels of emissions. Large number of onshore vehicles and offshore vessel days (i.e. months).
	Waste	No or low levels of operational waste.	Moderate levels of operational waste.	High levels of operational waste.
Technical Feasibility	Engineering and execution complexity	Scope is defined and understood. Low levels of technical risk. Methods widely used across industry.	Some uncertainty in parts of the scope and equipment used. Moderate levels of technical risk. Some examples of the method being used in industry.	Uncertainty in many areas of the scope and in equipment used. High levels of technical risk. Method not widely used across industry.
Health and Safety	Risk to personnel (offshore and onshore)	Low level of personnel exposure hours and/or health and safety risk.	Moderate level of personnel exposure hours and/or health and safety risk.	High level of personnel exposure hours and/or health and safety risk.

Criteria	Sub-criteria	Score		
		Most Preferred	Neutral	Least Preferred
	Residual risk to other marine users	Low risk as property completely removed or remaining property presents no material health and safety risks to identified marine users.	Some property left in-place. Moderate health and safety risks to identified marine users. Risk reduction measures potentially required.	Extensive property left in place. High health and safety risks to identified marine users. Significant risk reduction measures required.
Social	Effect on commercial fisheries	Site/property will have no effect on current or future commercial fisheries. Potential benefits to commercial fishers.	Site will be available to current and future commercial fisheries, but some property will remain. Potential for low fishing gear and/or navigational risks.	Site will no longer be accessible to current and future commercial fisheries, and/or has significant fishing gear and/or navigational risks.
	Other socio-economic effects	Site/ property not expected to be of a material socio-economic concern. Potential benefits.	Site/property not expected to exclude other marine users. Potential for some socioeconomic concerns.	Site/property may exclude other marine users. Potential for significant socio-economic concerns.
Economic	Financial cost[1]	<$300,000	<$3,000,000	>$3,000,000

[1] Costs align with the financial category of the Santos risk matrix

2.4.4 Options Evaluation

A workshop was held to evaluate the decommissioning options for the Frigate-1 wellhead. **Table 2-8** provides a summary of this assessment with the average colour rating used to represent the criteria. Where the colours were equally divided, the worst case was chosen for this summary. The detailed evaluation is shown in **Appendix H** – Decommissioning Options Assessment.

Table 2-8: Options Assessment Summary for Frigate-1 Wellhead

Scenario	Criteria	Score	Option A – Base Case: Removal by external cutting above mudline	Score	Option B – Base Case: Complete removal by internal cutting below the mudline	Score	Option C – Install a wellhead cover or cap	Score	Option D – Leave the wellhead in-situ
1) No wellhead remaining/found	Environment	No action required							
	Technical Feasibility								
	Health and Safety								
	Social								
	Economic								
2) Casing only (no external obstructions)	Environment		Wellhead removal by external cutting above mudline is only possible if there are no external obstructions as those obstructions would prevent direct access to the wellhead. The presence of external infrastructure, such as a GB, would require removal or dredging to access the conductor below the GB. Other obstructions could include cement and the extent of cement at seabed level below the GB is unknown. A cement patio will also create a physical barrier to dredging. If a GB is present, the only viable method for external removal involves the utilisation of a prototype tool that has never been tested in the field and requires modification for wellhead removal. This presents a risk in terms of technical feasibility. Therefore, external cutting is considered to hold a high level of complexity with a low likelihood of success. As well as being technically difficult, this option also rates poorly in all other categories. The assessment indicated: + associated vessel impacts and risks from two campaigns – i.e. operational discharges, emissions, unplanned releases and introduction of IMS + Impact to water and sediment quality, removal of marine growth, associated impacts and risks of vessel and ROV activity (i.e. discharges, MDO spill risk, marine fauna interaction, etc.)		Complete removal by internal cutting below the mudline is the least preferred option out of Option A and B. It performs the worst across all criteria except for social where this option is considered the best outcome for other marine users, in particular fishers, as it removes any snag risk associated with the wellhead. This option presents as the most technically challenging in both scenarios due to the unknown condition of the wellhead temporary cap, internal housing, and latching mechanism on the wellhead. There is also potential difficulty in being able to identify these components due to the visibility in the area, age and possible condition of the wellhead. This poses a risk to obtaining access to the wellbore for internal cutting. If internal cutting is possible, it also presents a series of environmental, health and safety and economic concerns including: + associated vessel impacts and risks from two campaigns – i.e. operational discharges, emissions, unplanned releases and introduction of IMS + impact to water and sediment quality when completely removing the wellhead from the seabed, removal of marine growth, associated impacts and risks of vessel and ROV activity (i.e. discharges, MDO spill risk, marine fauna interaction, etc.)		Installing a wellhead cover or cap is not the most preferred option across all criteria when considering scenarios 2 and 3. This option would still require a vessel campaign (potentially two) to install the cap/cover. A larger vessel would also be required with sufficient crane capability to manoeuvre the cover/cap. In general, this option assesses better than the two base case removal options (Option A and B), however, fishers report a snag risk remains with a cap or cover, therefore it does not perform better than the leave in-situ option for overall benefit. This option presents a series of environmental, health and safety and economic concerns including: + associated vessel impacts and risks from 1-2 campaigns – i.e. operational discharges, emissions, unplanned releases and introduction of IMS. + health and safety risks to offshore and onshore personnel as the activity would take place over 1-2 campaigns + this option is estimated at approximately $1 million, for limited benefit.		Leave in-situ is the preferred option for scenarios 2 and 3 as it: + poses no technical risk + eliminates the health and safety risks to personnel + Carries no environmental risks associated with vessel activity including vessel discharges, emissions, waste, or MDO risk + The wellhead provides a habitat for marine life with a potential local environmental benefit + The slow degradation and corrosion of steel from the wellhead is only toxic to marine organisms at extremely high concentrations (Grimwood and Dixon, 1997) and these concentrations are unlikely to be reached in this offshore location. + It also carries no economic cost The leave in-situ option is least favourable from a social perspective as the wellhead poses a snag risk to commercial fishers. However, the wellhead has been in place since its plug and abandonment in 1978 and fishing intensity data for the NPF (**Figure 3-7**) confirms that the area around the Frigate-1 wellhead is currently not actively trawled. The distance to the closest area of any fishing effort (low at <3 vessels) is approximately 48 km. During stakeholder consultation, the NPFI had no objection to leaving the wellhead in-situ (**Section 4.4**).
	Technical Feasibility								
	Health and Safety								
	Social								
	Economic								
3) External obstructions (i.e. guide base (GB), concrete patio, drill cuttings)	Environment								
	Technical Feasibility								

Scenario	Criteria	Score	Option A – Base Case: Removal by external cutting above mudline	Score	Option B – Base Case: Complete removal by internal cutting below the mudline	Score	Option C – Install a wellhead cover or cap	Score	Option D – Leave the wellhead in-situ
	Health and Safety		+ potential need to dredge sediment and / or disturb drill cuttings preventing access + general waste and disposal of wellhead material + health and safety risks to offshore and onshore personnel as the activity would take place over two campaigns + the wellhead and any associated obstructions may not be removed at / below the seabed, therefore a snag risk remains to trawl fishing operations + this option also carries a high cost with limited benefit across the criteria (< $3 million)		+ general waste and disposal of wellhead material + health and safety risks to offshore and onshore personnel as the activity would take place over two campaigns + this is also the most expensive option at > $3 million				
	Social								
	Economic								

2.4.5 Recommendations

A summary of the option assessment results is presented in **Table 2-8**, with the full assessment provided in **Appendix H** – Decommissioning Options Assessment.

The options assessment against environmental criteria alone shows that Option D (leave in-situ) is the preferred option. Option D was ranked 'most preferred' for all four sub-criteria of water and sediment quality, ecological services, emissions and waste. This is largely because Option D does not require one or two additional vessel campaigns; unlike the other options. This means Option D does not have any associated vessel impacts and risks – i.e. operational discharges, emissions, unplanned releases and introduction of IMS.

Option A (removal by external cutting below the mudline) has the additional environmental impact due to the requirement to dredge up to 15 m^3 of sediment in order to remove the wellhead if external obstructions are in place. Both Option A and B would require disturbance of the seabed and any original drill cuttings, resulting in a localised impact to water and sediment quality.

If the wellhead is left in-situ it would slowly degrade overtime releasing corrosion material. However, based on the low toxicity of iron, the slow release rate and rapid dilution of the open ocean environment, any impacts to sediment and water quality will be low and in the immediate vicinity of the wellhead.

Option D (leave in-situ) is the preferred option in terms of technical, environmental, safety and economic criteria.Option B (complete removal by internal cutting below the mudline) was conservatively selected as the preferred option in terms of social criteria (effect on commercial fisheries), as there is a snag risk associated with leaving the wellhead in situ.

Option C (install cap/cover) was thought to be a good option to reduce snag risk to fisheries, but previous consultation and feedback from fisheries stakeholders determined this option would still present as a snag risk if used. The distance to the closest area of any fishing effort (low effort with <3 vessels) is approximately 48 km.

Although no concerns were raised by stakeholders during the stakeholder engagement process (**Section 4**), Santos has introduced an additional control measure to ensure that the AHO, NPFI, and NPF are informed of the wellhead location, once confirmed by the survey (FRI-CM-031).

On this basis, Option D (leave in-situ) was selected as it was the preferred option overall and when environmental criteria alone are considered. The options assessment demonstrated that Option D (leave in-situ) provides a better environmental, and safety outcome in either wellhead scenario compared to the other three options. The wellhead is expected to have a low profile (approximately 3 m above the seabed), and the area around the Frigate-1 wellhead is currently not actively trawled. The distance to the closest area of any fishing effort (low effort with <3 vessels) is approximately 48 km. Feedback from the NPFI during stakeholder consultation confirmed there is no objection to leaving the wellhead in-situ (**Section 4.4**).

Santos is therefore proposing a deviation from the removal requirements of subsection 572(3) of the OPGGS Act and Option D (leave in-situ) has been defined as the preferred decommissioning activity for the purposes of this EP.

2.5 Operational Details of the Petroleum Activity

An assessment of potential wellhead scenarios and decommissioning options against comprehensive criteria (**Appendix H** – Decommissioning Options Assessment) identified that irrespective of the condition of the wellhead, the leave in-situ option was the preferred decommissioning option for all criteria except for the social aspect.

Santos has extensive operational experience in offshore petroleum activities and recently successfully located and surveyed the Tern-1 wellhead, despite also having outdated coordinates for the wellhead location. This gives confidence that the proposed techniques will successfully locate the Frigate-1 wellhead.

Therefore, the petroleum activity within the scope of this EP is limited to:

- Survey to locate and inspect the Frigate-1 wellhead; providing updated coordinates for the wellhead location and to validate the assumptions of the wellhead condition used in the options assessment (**Section 2.4**).
- Subsequent permanent abandonment of the Frigate-1 wellhead in-situ.

In the event that the inspection survey reveals an unforeseen outcome not evaluated in the options assessment (**Section 2.4**), the Management of Change (MOC) process described in **Section 8.10.2** would be followed and Regulations 7, 8 and 17 of the OPGGS(E)R 2009 considered.

3 Description of the Environment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Description of the environment 13(2) The environment plan must — a) describe the existing environment that may be affected by the petroleum activity; and b) include details of the particular relevant values and sensitivities (if any) of that environment. Note: The definition of environment in regulation 4 includes its social, economic and cultural features. 13(3) Without limiting paragraph (2)(b), particular relevant values and sensitivities may include the following: • the world heritage values of a declared World Heritage property within the meaning of the EPBC Act • the national heritage values of a National Heritage place within the meaning of that Act • the ecological character of a declared Ramsar wetland within the meaning of that Act • the presence of a listed threatened species or listed threatened ecological community within the meaning of that Act • the presence of a listed migratory species within the meaning of that Act • any values and sensitivities that exist in, or in relation to, part or all of: a. a Commonwealth marine area within the meaning of that Act b. Commonwealth land within the meaning of that Act

3.1 Environment that May Be Affected (EMBA)

This section summarises the key physical, biological, socio-economic and cultural characteristics of the existing environment that may be affected (EMBA) by the activity, both from planned and unplanned events associated with the activity.

Santos has defined the EMBA based on oil spill modelling for the maximum credible hydrocarbon spill event that might occur from the vessel during the survey. For the activity under this EP, the EMBA is therefore based on the unplanned release of 60 m^3 of marine diesel oil (MDO) from a vessel failure (see activity description in **Section 2**, and description of credible spill scenario in **Section 7.1**).

Stochastic hydrocarbon dispersion and fate modelling, applied to the worst-case spill scenario identified as relevant to the activity (**Section 7.2**), was undertaken to inform the EMBA. The modelling considered four key physical or chemical phases of hydrocarbons that pose differing environmental and socioeconomic risks: surface, entrained, dissolved aromatic and shoreline accumulated hydrocarbons. The modelling used defined hydrocarbon exposure values, as relevant, to identifying an area that might be contacted by hydrocarbons, environment risk assessment and oil spill response planning, for the various hydrocarbon phases. Refer to **Table 3-1** for the exposure values used and to **Section 7.1** to **7.2** for further information on the reasons why these exposure values have been selected and how they relate to the risk assessment.

The EMBA is based on stochastic modelling, using the low exposure values (**Table 3-1**) from NOPSEMA's Bulletin #1 Oil Spill Modelling. The EMBA encompasses the outer most boundary of the overlaid worst-case spatial extent of the four hydrocarbon phases listed above for the credible spill scenario. The EMBA is illustrated in **Figure 3 1.**

The low exposure values are used as a predictive tool to set the outer boundaries of an EMBA and may not necessarily result in ecologically significant impacts. To inform the evaluation of potential environmental consequences of a hydrocarbon release (impact assessment), modelling is undertaken using higher exposure values (i.e. the concentrations at which environmental consequences may result). The higher exposure values known as 'moderate' and 'high' are described and explained within **Section 7.1.6**. Applying the same method used to determine the EMBA, spatial areas were derived for moderate exposure value area (MEVA) and high exposure value area (HEVA) from the oil spill modelling as illustrated on figures throughout **Section 3**.

A low exposure threshold, which represents a visible oil (rainbow) sheen, has been used to provide an indication of the extent to which stakeholders may visually observe oil on the sear surface. This is considered to provide a conservative extent of potential impacts to visual amenity. Biological impacts are expected to occur within the moderate and high exposure values which represent a subset of the EMBA.

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 110 different simulations for any one spill event. 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.

The potential area impacted by planned activities is expected to be contained within Operational Area defined as a 2 km radius around the wellhead location and shown in **Figure 3-1**.

For the purposes of impact assessment, the following spatial areas are also considered:

+ a light emissions assessment boundary area of up to 20 km from the operational area, which is recommended by the National Light Pollution Guidelines (CoA, 2020) (refer Section **6.4**)
+ a noise emissions assessment boundary area of up to 20 km from the Operational Area.
+ a MEVA which is the moderate threshold for impact assessment.

No activity will occur within the 20 km boundary or MEVA. It is described purely for environmental impact assessment purposes only in the relevant impact sections.

A desktop search of the Operational Area, light and noise assessment boundary, and EMBA was undertaken using the DAWE Protected Matters Search Tool to identify Matters of National Environmental Significance (MNES) listed under the Environmental Protection and Biodiversity Conservation (EPBC) Act. The results of this search, undertaken on 2 December 2021, are provided in **Table 3-3** and **Appendix D** – EPBC Protected Matters Search Tool Results.

A summary of the information derived from the Protected Matters Search, bioregional plans and fauna recovery plans relevant to the operational area is provided throughout this section.

Table 3-1: Hydrocarbon Exposure Values

Hydrocarbon Phase	Exposure Value		
	Low	Moderate	High
Surface (g/m^2)	1	10	50
Shoreline accumulation (g/m^2)	10	100	1,000
Dissolved aromatics (ppb)	10	50	400
Entrained (ppb)	10	100	-

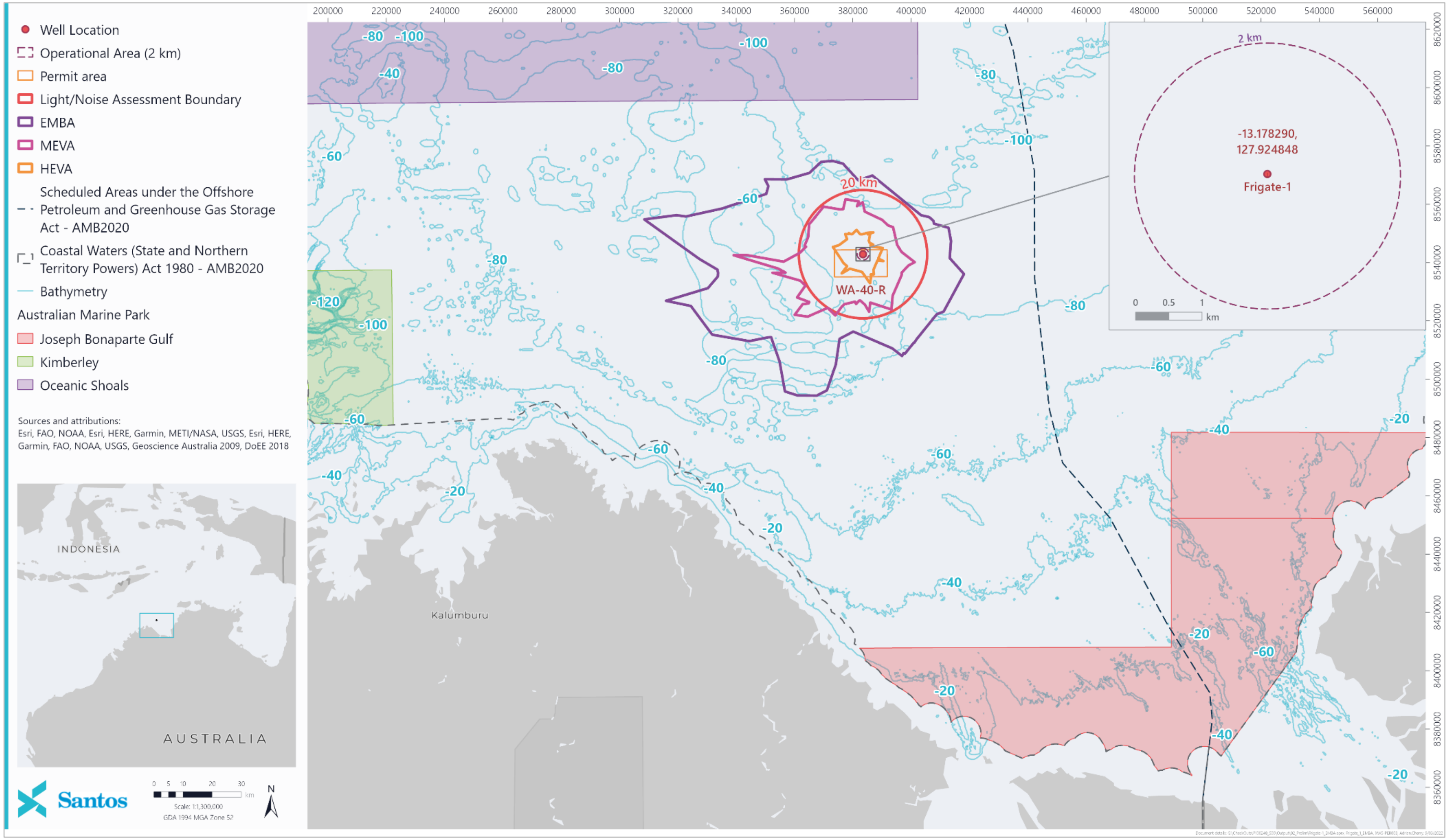


Figure 3-1: Operational Area, Light/Noise Assessment Boundary, MEVA and EMBA for Frigate-1

3.2 Environmental Values and Sensitivities

This section summarises environmental values and sensitivities, including physical, biological, social, economic and cultural features within the marine and coastal environment that is relevant to the operational area and EMBA.

A summary of the information derived from the Department of Agriculture, Water and Environment (DAWE) PMST, Bioregional Plans and Fauna Recovery Plans relevant to the operational area and the EMBA is provided in this section. A detailed and comprehensive description of the environment (in accordance with Regulation 13(1)(2) of the OPGGS(E)R) is available in **Appendix C** – Santos' Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062).

Appendix C draws upon existing knowledge and a comprehensive review of information about the marine environmental values and sensitivities in the region.

Copies of the DAWE PMST outputs for the operational area, light and noise boundary area and the EMBA are also available in **Appendix D** – EPBC Protected Matters Search Tool Results.

The figures presented in **Section 3** of the EP have been zoomed to the extent of the data boundaries within the EMBA, to show all relevant data layers in a legible manner. Some data layers that sit within the map area but are not present within the EMBA are not displayed.

3.2.1 Physical Environment

3.2.1.1 Bioregions

Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA), Version 4.0 (DEH, 2006) IMCRA Version 4.0, the operational area occurs within the Northwest Shelf Transition IMCRA provincial bioregion **(Figure 3-2)**.

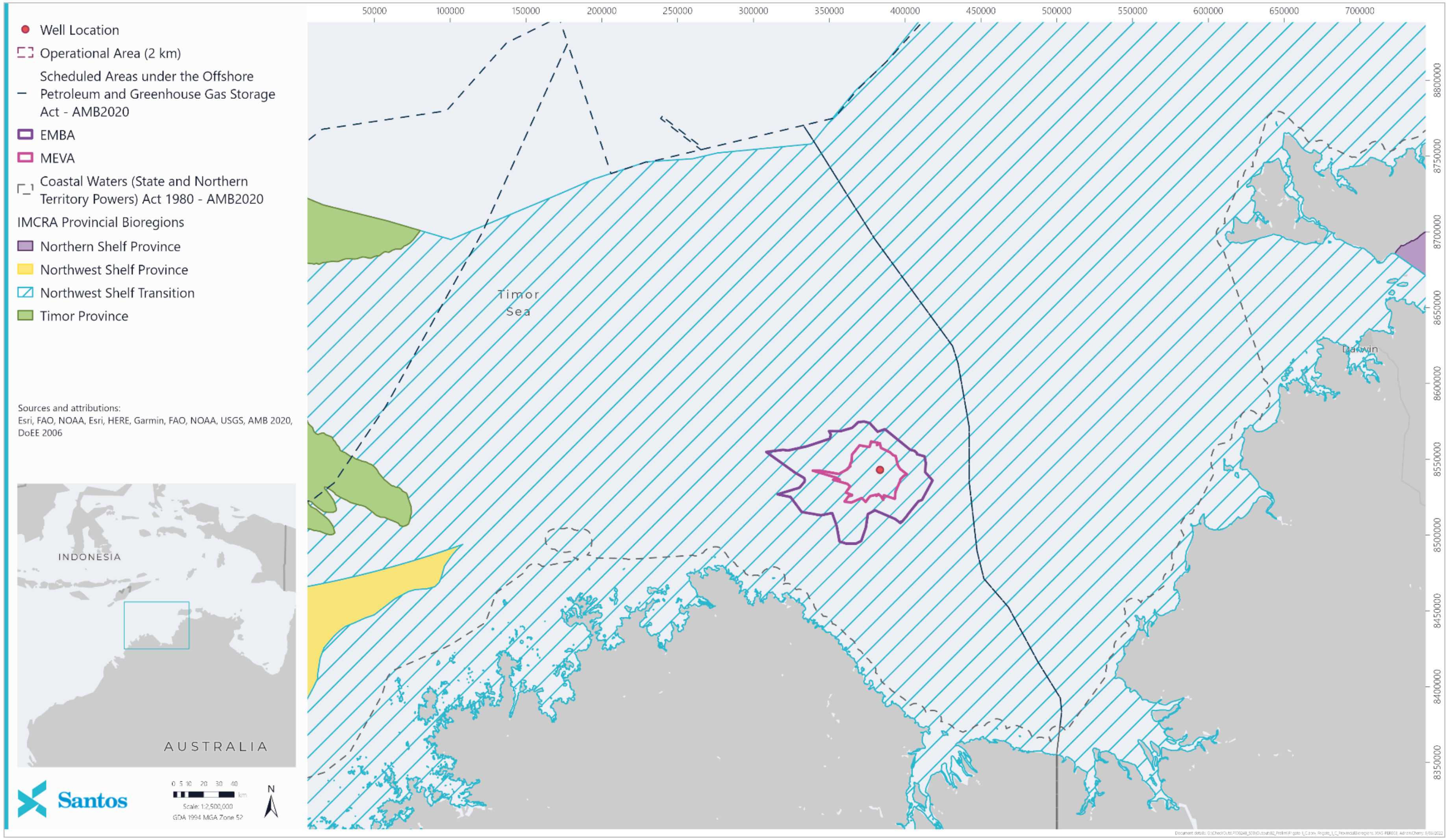


Figure 3-2: IMCRA 4.0 provincial bioregions within the environment that may be affected and operational area

3.2.1.2 Benthic Habitats

The presence of marine habitats within the operational area and EMBA are described below and shown in **Figure 3-3**. A detailed description of these habitats with reference to the IMCRA provincial bioregions is provided in **Appendix C** – Santos' Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062)**.**

More detailed description of the benthic habitats within the EMBA is not provided, as the potential impacts from a hydrocarbon spill (from vessel collision) are limited to the surface waters only.

The EMBA does not intersect any coastal habitats.

In adjacent permit areas, surveyed benthic habitats were characterised by soft sediment seabed comprised of predominantly sand, with a proportion of silt and clay (Santos, 2020).

Benthic habitat mapping and surveys were conducted for the nearby Tern field (approximately 14 km from Frigate-1). A total of 18 benthic habitat sites were sampled in November 2011 with depths ranging from 85-99 m. This is assumed to be comparable to the benthic habitat of the EMBA and Operational Area as they are in adjacent permit areas. The survey and benthic mapping found that generally the seabed composition was similar, with sparse sessile benthos except for an unidentified white colonial organism (presently recorded as a hydrozoan) across all sampled fields. Estimated percentage cover was low for octocorals and sponges (~2% for each) while the unidentified hydroid comprised between 11-30% at all sites (Santos, 2020).

There are around 150 shoal/bank features across the Sahul Shelf and a high level of interconnectivity exists between them (Santos, 2021). The Carbonate bank and terrace system of the Sahul Shelf KEF overlaps with the EMBA. The Pinnacles of the Bonaparte Basin overlap with the Operational Area.

These KEFs provide areas of hard substrate in an otherwise soft sediment environment and so are important for sessile species (DAWE, 2020a). Communities include sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species. These KEFs are also recognised as a biodiversity hotspot for sponges as they are home to more sponge species and different communities than the surrounding seafloor (DAWE, 2020a).

Further information on KEFs is available in **Appendix C** – Santos' Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062).

3.2.2 Protected / Significant Areas

There are no Commonwealth or State marine protected areas, wetlands of international or national importance, World, National or Commonwealth heritage properties or places, or Indigenous Protected Areas that intersect with the operational area or EMBA. The closest Australian Marine Park is the Oceanic Shoals located approximately 21 km from the EMBA and approximately 50 km from the operational area.

The EMBA intersects two Key Ecological Features (KEFs):

+ pinnacles of the Bonaparte Basin KEF; and the
+ carbonate bank and terrace system of the Sahul Shelf KEF.

Table 3-2: Approximate distances from respective Operational Area boundary to protected areas within the EMBA

Value/Sensitivity	Name	Within Operational Area	Within Light/Noise Assessment Boundary	Within EMBA	Distance to Operational Area	Protection Classification / Zone
Australian Marine Parks	Oceanic Shoals	X	X	X	~ 50 km	Multiple Use Zone (VI)
State Marine Parks and Marine Management Areas	North Kimberley Marine Park	X	X	X	~ 91 km	Unassigned (IUCN VI)
Key Ecological Features	Carbonate bank and terrace system of the Sahul Shelf	X	✓	✓	~ 11 km	-
	Pinnacles of the Bonaparte Basin	✓	✓	✓	Within operational area	-
Ramsar Wetlands	Ord River Floodplain	X	X	X	~ 190 km	-

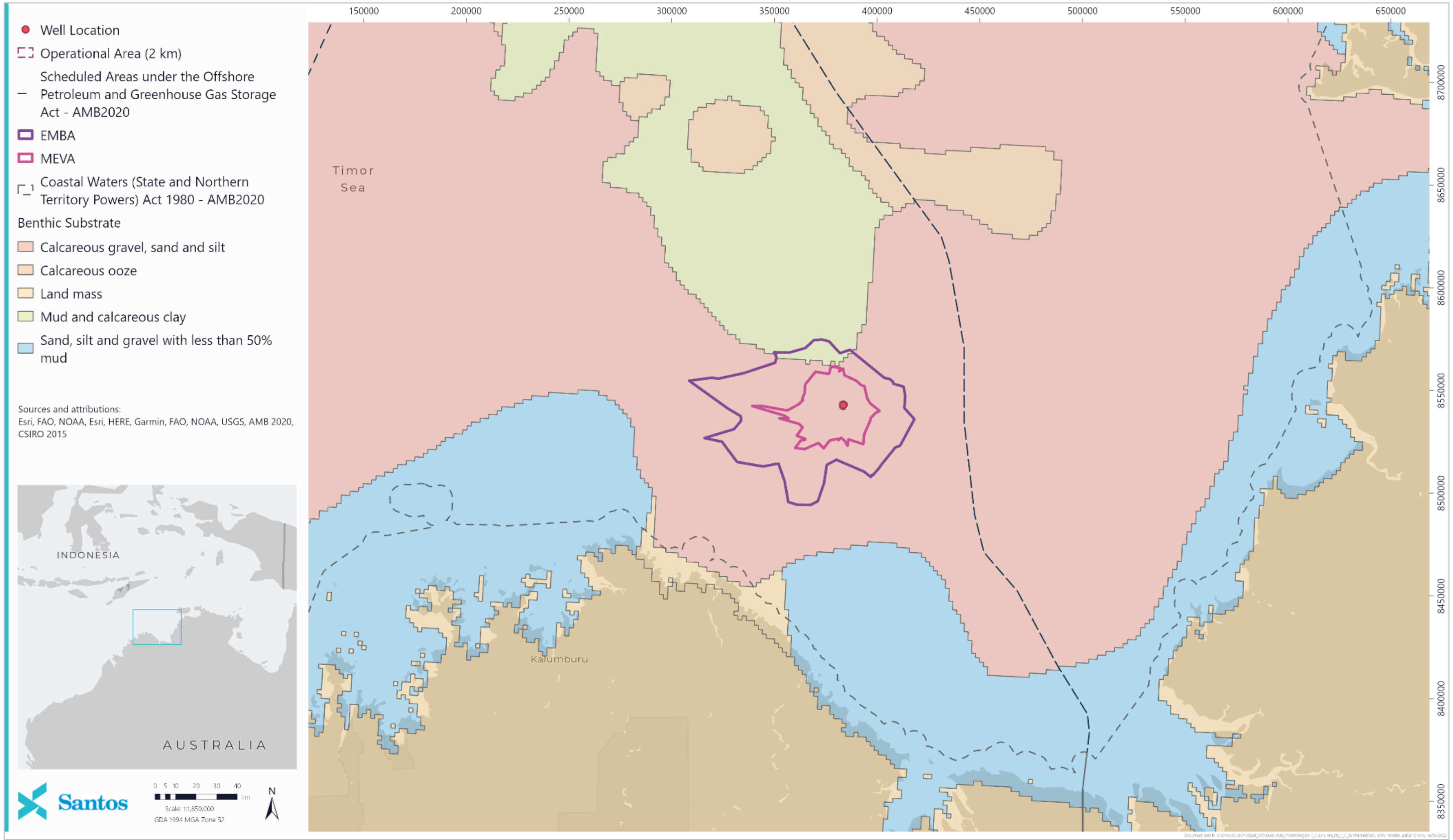


Figure 3-3: Benthic Habitat within the Operational Area and EMBA

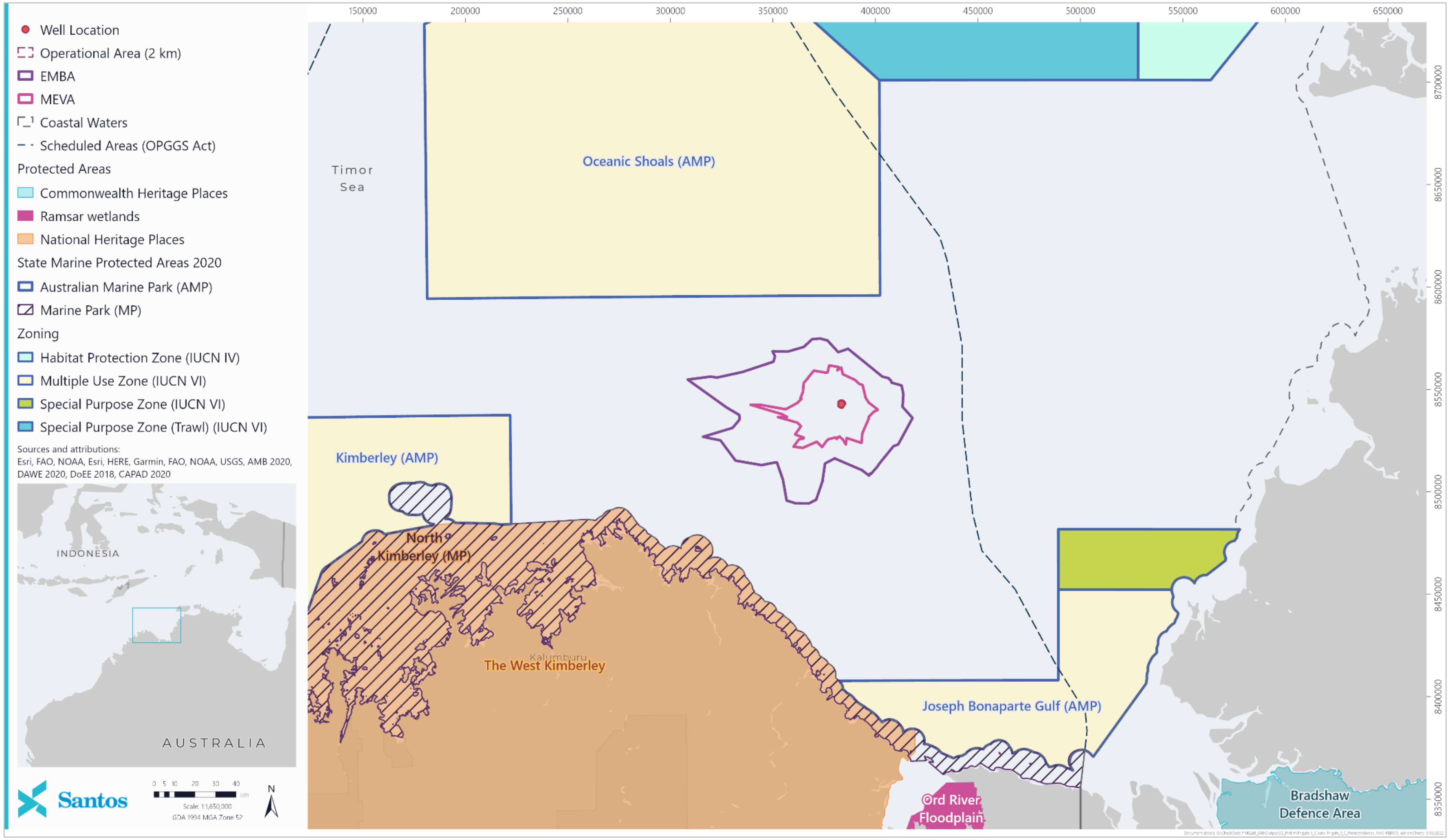


Figure 3-4: Protected Areas within and near the Operational Area and EMBA

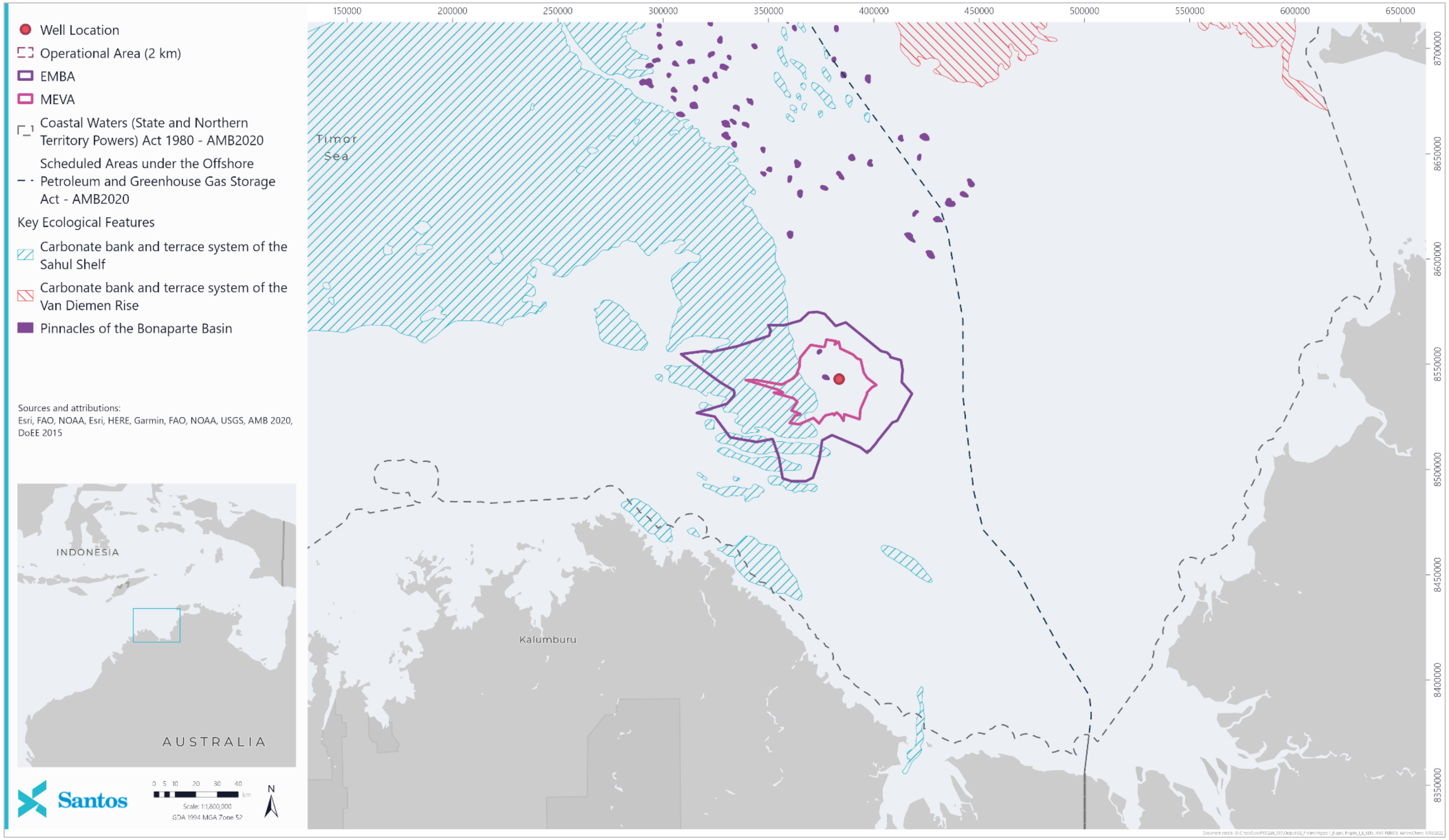


Figure 3-5: Key Ecological Features within and near the Operational Area and EMBA

3.2.3 Threatened and Migratory Fauna

Table 3-3 presents the environmental values and sensitivities (threatened and migratory species) within the operational area, light and noise assessment boundary and EMBA. These include all relevant Matters of National Environmental Significance (MNES) protected under the EPBC Act 1999 as identified in the PMST search for the operational area, light and noise assessment boundary and EMBA (**Appendix D** – EPBC Protected Matters Search Tool Results. For each species identified, the extent of likely presence is provided.

Recovery Plans are also in place for some species and set out the research and management actions necessary to stop the decline of and support the recovery of listed threatened species. Relevant conservation advice, recovery plans and management plans for marine fauna identified in the PMST for the operational area, light and noise assessment boundary and the EMBA are provided in **Table 3-4**. A summary of the specific requirements of the plans relevant to the activity have also been included, as well as how the current management actions have been taken into account.

Biologically important areas (BIAs) such as an aggregation, breeding, resting, nesting or feeding area, or known migratory routes for these species within the operational area, light and noise assessment boundary and EMBA, are shown in **Figure 3-6** and are also described in **Table 3-5**. BIAs and habitats critical to the survival of a species are also described in the Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062).

Note that terrestrial species (such as terrestrial mammals, reptiles and bird species) that appear in the EPBC search of the EMBA and do not have habitats along shorelines are not relevant to the activity impacts and risks have been excluded from **Table 3-3**.

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):

- Marine turtles; and
- KEFs.

Table 3-3: Environmental Values and Sensitivities within the EMBA, Light and Noise Assessment Boundary and Operational Area – Threatened and Migratory Marine Fauna

Value / Sensitivity		Threatened Status	Marine Listing	Migratory Listing	Operational Area Presence	Light & Noise Assessment Boundary Presence	EMBA Presence
Common Name	Scientific Name						
Fish							
Dwarf Sawfish	*Pristis clavata*	V	-	✓	-	-	KO
Freshwater Sawfish	*Pristis pristis*	V	-	✓	KO	KO	KO
Giant Manta Ray	*Mobula birostris*	-	-	✓	LO	LO	LO
Green Sawfish	*Pristis zijsron*	V	-	✓	KO	KO	KO
Longfin Mako	*Isurus paucus*	-	-	✓	LO	LO	LO
Narrow Sawfish	*Anoxypristis cuspidata*	-	-	✓	MO	MO	MO
Northern River Shark	*Glyphis garricki*	E	-	-	MO	MO	MO
Oceanic Whitetip Shark	*Carcharhinus longimanus*	-	-	✓	MO	MO	MO
Reef Manta Ray	*Mobula alfredi*	-	-	✓	LO	LO	LO
Scalloped Hammerhead	*Sphyrna lewini*	Conservation Dependent	-	-	LO	LO	LO
Shortfin Mako	*Isurus oxyrinchus*	-	-	✓	LO	LO	LO
Whale Shark	*Rhincodon typus*	V	-	✓	MO	MO	MO
White Shark	*Carcharodon carcharias*	V	-	✓	MO	MO	MO
Sygnathids							

Value / Sensitivity		Threatened Status	Marine Listing	Migratory Listing	Operational Area Presence	Light & Noise Assessment Boundary Presence	EMBA Presence
Common Name	Scientific Name						
Australian Messmate	*Corythoichthys intestinalis*	-	✓	-	-	MO	MO
Banded Pipefish	*Doryrhamphus dactyliophorus*	-	✓	-	-	MO	MO
Beady Pipefish	*Hippichthys penicillus*	-	✓	-	MO	MO	MO
Bentstick Pipefish	*Trachyrhamphus bicoarctatus*	-	✓	-	MO	MO	MO
Bluestripe Pipefish	*Doryrhamphus excisus*	-	✓	-	MO	MO	MO
Brock's Pipefish	*Halicampus brocki*	-	✓	-	MO	MO	MO
Cleaner Pipefish	*Doryrhamphus janssi*	-	✓	-	MO	MO	MO
Corrugated Pipefish	*Bhanotia fasciolata*	-	✓	-	-	MO	MO
Double-end Pipehorse	*Syngnathoides biaculeatus*	-	✓	-	MO	MO	MO
Fijian Banded Pipefish	*Corythoichthys amplexus*	-	✓	-	MO	MO	MO
Hedgehog Seahorse	*Hippocampus spinosissimus*	-	✓	-	MO	MO	MO
Flat-faced Seahorse	*Hippocampus planifrons*	-	✓	-	MO	MO	MO
Gunther's Pipehorse	*Solegnathus lettiensis*	-	✓	-	MO	MO	MO
Mud Pipefish	*Halicampus grayi*	-	✓	-	MO	MO	MO
Pacific Short-bodied Pipefish	*Choeroichthys brachysoma*	-	✓	-	MO	MO	MO

Value / Sensitivity		Threatened Status	Marine Listing	Migratory Listing	Operational Area Presence	Light & Noise Assessment Boundary Presence	EMBA Presence
Common Name	Scientific Name						
Pallid Pipehorse	*Solegnathus hardwickii*	-	✓	-	MO	MO	MO
Pig-snouted Pipefish	*Choeroichthys suillus*	-	✓	-	MO	MO	MO
Red-hair Pipefish	*Halicampus dunckeri*	-	✓	-	-	MO	MO
Reticulate Pipefish	*Corythoichthys flavofasciatus*	-	✓	-	MO	MO	MO
Ribboned Pipehorse	*Haliichthys taeniophorus*	-	✓	-	MO	MO	MO
Robust Ghostpipefish	*Solenostomus cyanopterus*	-	✓	-	MO	MO	MO
Roughridge Pipefish	*Cosmocampus banneri*	-	✓	-	-	MO	MO
Schulz Pipefish	*Corythoichthys schultzi*	-	✓	-	MO	MO	MO
Spiny Seahorse	*Hippocampus histrix*	-	✓	-	MO	MO	MO
Spiny-snout Pipefish	*Halicampus spinirostris*	-	✓	-	MO	MO	MO
Spotted Seahorse	*Hippocampus kuda*	-	✓	-	MO	MO	MO
Straightstick Pipefish	*Trachyrhamphus longirostris*	-	✓	-	MO	MO	MO
Three-keel Pipefish	*Campichthys tricarinatus*	-	✓	-	MO	MO	MO
Tidepool Pipefish	*Micrognathus micronotopterus*	-	✓	-	MO	MO	MO
Tiger Pipefish	*Filicampus tigris*	-	✓	-	-	MO	MO
Birds							

Value / Sensitivity		Threatened Status	Marine Listing	Migratory Listing	Operational Area Presence	Light & Noise Assessment Boundary Presence	EMBA Presence
Common Name	Scientific Name						
Common Noddy	*Anous stolidus*	-	✓	✓(M)	MO	MO	MO
Common Sandpiper	*Actitis hypoleucos*	-	✓	✓(W)	MO	MO	MO
Curlew Sandpiper	*Calidris ferruginea*	CE	✓	✓(W)	MO	MO	MO
Eastern Curlew	*Numenius madagascariensis*	CE	✓	✓(W)	MO	MO	MO
Great Frigatebird	*Fregata minor*	-	✓	✓(M)	MO	MO	MO
Lesser Crested Tern	*Thalasseus bengalensis*	-	✓	-	-	-	KO
Lesser Frigatebird	*Fregata ariel*	-	✓	✓(M)	LO	LO	LO
Pectoral Sandpiper	*Calidris melanotos*	-	✓	✓(W)	MO	MO	MO
Red Knot	*Calidris canutus*	E	✓	✓(W)	MO	MO	MO
Sharp-tailed Sandpiper	*Calidris acuminata*	-	✓	✓(W)	MO	MO	MO
Streaked Shearwater	*Calonectris leucomelas*	-	✓	✓(M)	LO	LO	LO
Marine Reptiles							
Turtles							
Flatback Turtle	*Natator depressus*	V	✓	✓	KO	KO	KO
Green Turtle	*Chelonia meydas*	V	✓	✓	LO	LO	KO
Hawksbill Turtle	*Eretmochelys imbricata*	V	✓	✓	LO	LO	LO
Leatherback Turtle	*Dermochelys coriacea*	E	✓	✓	LO	LO	LO

Value / Sensitivity		Threatened Status	Marine Listing	Migratory Listing	Operational Area Presence	Light & Noise Assessment Boundary Presence	EMBA Presence
Common Name	Scientific Name						
Loggerhead Turtle	*Caretta caretta*	E	✓	✓	LO	LO	KO
Olive Ridley Turtle	*Lepidochelys olivacea*	E	✓	✓	LO	LO	KO
Seasnakes							
Beaked Seasnake	*Enhydrina schistosa*	-	✓	-	MO	MO	MO
Black-ringed Seasnake	*Hydrelaps darwiniensis*	-	✓	-	MO	MO	MO
Black-headed Seasnake	*Hydrophis atriceps*	-	✓	-	MO	MO	MO
Black-headed Sea Snake	*Leioselasma coggeri*	-	✓	-	-	-	MO
Dubois' Seasnake	*Aipysurus duboisii*	-	✓	-	MO	MO	MO
Elegant Seasnake	*Hydrophis elegans*	-	✓	-	MO	MO	MO
Horned Seasnake	*Acalyptophis peronii*	-	✓	-	MO	MO	MO
Olive Seasnake	*Aipysurus laevis*	-	✓	-	MO	MO	MO
Olive-headed Seasnake	*Disteira major*	-	✓	-	MO	MO	MO
Plain Seasnake	*Chitulia inornata*	-	✓	-	-	MO	MO
Small-headed Seasnake	*Hydrophis macdowelli*	-	✓	-	MO	MO	MO
Spectacled Seasnake	*Disteira kingii*	-	✓	-	MO	MO	MO
Spine-bellied Seasnake	*Lapemis curtus*	-	✓	-	MO	MO	MO
Spine-tailed Seasnake	*Aipysurus eydouxii*	-	✓	-	MO	MO	MO
Spotted Seasnake	*Chitulia ornata*	-	✓	-	MO	MO	MO

Value / Sensitivity		Threatened Status	Marine Listing	Migratory Listing	Operational Area Presence	Light & Noise Assessment Boundary Presence	EMBA Presence
Common Name	Scientific Name						
Stoke's Seasnake	*Astrotia stokesii*	-	✓	-	MO	MO	MO
Yellow-bellied Seasnake	*Pelamis platurus*	-	✓	-	MO	MO	MO
Other Reptiles							
Saltwater Crocodile	*Crocodylus porosus*	-	✓	✓	LO	LO	LO
Marine Mammals							
Blue Whale	*Balaenoptera musculus*	E	-	✓	LO	LO	LO
Bottlenose Dolphin	*Tursiops truncatus s. str.*	-	-	-	MO	MO	MO
Bryde's Whale	*Balaenoptera edeni*	-	-	✓	MO	MO	MO
Common Dolphin	*Delphinus delphis*	-	-	-	MO	MO	MO
False Killer Whale	*Pseudorca crassidens*	-	-	-	LO	LO	LO
Fin Whale	*Balaenoptera physalus*	V	-	✓	MO	MO	MO
Humpback Whale	*Megaptera novaeangliae*	V	-	✓	LO	LO	LO
Indian Ocean Bottlenose	*Tursiops aduncus*	-	-	-	MO	MO	MO
Killer Whale	*Orcinus orca*	-	-	✓	MO	MO	MO
Risso's Dolphin	*Grampus griseus*	-	-	-	MO	MO	MO
Sei Whale	*Balaenoptera borealis*	V	-	✓	MO	MO	MO

Value / Sensitivity		Threatened Status	Marine Listing	Migratory Listing	Operational Area Presence	Light & Noise Assessment Boundary Presence	EMBA Presence
Common Name	Scientific Name						
Spotted Bottlenose	*Tursiops aduncus* (Arafura/Timor Sea populations)	-	-	✓	MO	MO	MO
Spotted Dolphin	*Stenella attenuata*	-	-	-	MO	MO	MO

<u>Legend</u> V – Vulnerable E – Endangered CE – Critically Endangered	MO – May Occur LO – Likely to Occur KO – Known to Occur ✓(W) – Migratory Wetlands ✓(M) – Migratory Marine

Table 3-4: Threats and Strategies from Recovery Plans, Conservation Advice and Management Plans relevant to the Activity

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
All Fauna					
All vertebrate fauna	Threat Abatement Plan for Impacts of Marine Debris on Vertebrate wildlife of Australia's coasts and oceans (2018)	There are four main objectives: + Contribute to the long-term prevention of the incidence of harmful marine debris + Remove existing harmful marine debris from the marine environment + Mitigate the impacts of harmful marine debris on marine species and ecological communities + Monitor the quantities, origins and impacts of marine debris and assess the effectiveness of management arrangements over time for the strategic reduction of debris.	Marine debris	No explicit management actions for non-fisheries related industries (note that management actions in the plan relate largely to management of fishing waste (for example 'ghost' gear), and State and Commonwealth management through regulation.	**Section 7.5**
Fish					
All sawfish and river sharks	Sawfish and River Sharks Multispecies Recovery Plan (2015)	The primary objective of this recovery plan is to assist the recovery of sawfish and river sharks in Australian waters with a view to:	Habitat degradation and modification	Identify risks to important sawfish and river shark habitat and measures needed to reduce those risks.	**Section 7.2**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
		+ Improving the population status leading t the removal of the sawfish and river shark species from the threatened species list of the EPBC Act + Ensuring that anthropogenic activities do not hinder recovery in the near future, or impact on the conservation status of the species in the future. The specific objectives of the recovery plan (relevant to industry) are: + Objective 5: Reduce and, where possible, eliminate adverse impacts of habitat degradation and modification on sawfish and river shark species. + Objective 6: 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.			

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
Freshwater Sawfish	Approved Conservation Advice for *Pristis pristis* Largetooth Sawfish (2014)	No explicit relevant objectives	Habitat Degradation and modification	Implement measures to reduce adverse impacts of habitat degradation and/or modification.	**Section 7.2**
Dwarf sawfish	Approved Conservation Advice for *Pristis clavata* Dwarf Sawfish (2009)	No explicit relevant objectives	Habitat degradation and modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as threats.	**Section 7.2**
Green Sawfish	Approved Conservation Advice for Green Sawfish (2008)	No explicit relevant objectives	Habitat degradation and modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as threats.	**Section 7.2**
Northern River Shark	Approved Conservation Advice for *Glyphis garricki* Northern River Shark (2014)	No explicit relevant objectives	Habitat degradation and modification	Implement measures to reduce adverse impacts of habitat degradation and/or modification.	**Section 7.2**
			Marine debris	No explicit relevant management actions; marine debris identified as a threat.	**Section 7.5**
Whale Shark	Conservation Advice *Rhincodon typus* Whale Shark (2015)	To maintain existing levels of protection for the whale shark in Australia while working to increase the level of protection afforded to the whale shark within the Indian Ocean and Southeast Asian region to enable population growth so that the species can be removed from	Boat strike from large vessels	Minimise offshore developments and transit time of large vessels in areas close to marine features likely to correlate with Whale Shark aggregations along the northward migration route that follows the northern Western Australian coastline along the 200 m isobath (as set out in	**Section 7.7**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
		the threatened species list of the EPBC Act.		the Conservation Values Atlas, DoE, 2014).	
			Habitat disruption from mineral exploration, production and transportation	Implement measures to reduce adverse impacts of habitat degradation and/or modification.	**Section 7.2**
			Marine Debris	No explicit relevant management actions; marine debris identified as a threat.	**Section 7.5**
			Climate Change	No explicit relevant management actions; climate change identified as threat.	**Section 6.6**
White Shark	Recovery Plan for the White Shark *Carcharodon carcharias* (2013)	The overarching objective of this recovery plan is to assist the recovery of the white shark in the wild throughout its range in Australian waters with a view to: + Improving the population status leading to future removal of the white shark from the threatened species list of the EPBC Act + Ensuring that anthropogenic activities do not hinder recovery in the near future, or impact on the	Ecosystem effects as a result of habitat modification and climate change	No explicit relevant management actions; habitat modification and climate change identified as threats.	**Section 7.2**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
		conservation status of the species in the future. The specific objectives of the recovery plan (relevant to industry) are: + Objective 7: Continue to identify and protect habitat critical to the survival of the white shark and minimise the impact of threatening processes within these areas.			
Birds					
All seabirds and shorebirds	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (2020)	Lighting objectives will need to consider the regulatory requirements and Australian standards relevant to the activity, location and wildlife present. Objectives should be described in terms of specific locations and times for which artificial light is necessary. Consideration should be given to whether colour differentiation is required and if some areas should remain dark – either to contrast with lit areas or to avoid light spill. Where relevant, wildlife requirements should form part of the lighting objectives.	Light pollution	Best practice lighting design incorporates the following design principles: + Start with natural darkness and only add light for specific purposes. + Use adaptive light controls to manage light timing, intensity and colour. + Light only the object or area intended – keep lights close to the ground, directed and shielded to avoid light spill.	**Section 6.4**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
		A lighting installation will be deemed a success if it meets the lighting objectives (including wildlife needs) and areas of interest can be seen by humans clearly, easily, safely and without discomfort.		+ Use the lowest intensity lighting appropriate for the task. + Use non-reflective, dark-coloured surfaces. + Use lights with reduced or filtered blue, violet and ultra-violet wavelengths.	
All seabirds	Draft Wildlife Conservation Plan for Seabirds (2019)	Seabirds and their habitats are protected and managed in Australia.	Pollution (Light and chemical contamination)	Enhance contingency plans to prevent and/or respond to environmental emergencies that have an impact on seabirds and their habitats.	**Section 6.4** **Section 7.2** **Section 7.4**
			Climate change	No explicit relevant management actions; identified as a threat.	**Section 6.6**
			Anthropogenic disturbance	Ensure all areas of important habitat for seabirds are considered in the development assessment process. Manage the effects of anthropogenic disturbance to seabird breeding and roosting areas.	**Section 7.7**
			Invasive species	Ensure seabirds are protected from the adverse effects of invasive species.	**Section 7.6**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
Migratory shorebirds	Wildlife Conservation Plan for Migratory Shorebirds (2015).	Anthropogenic threats to migratory shorebirds in Australia are minimised or, where possible, eliminated.	Habitat loss and degradation	No explicit relevant management actions; identified as a threat.	**Section 7.2**
			Anthropogenic disturbance	Investigate the significance of cumulative impacts on migratory shorebird habitat and populations in Australia. Ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment processes (specifically for coastal developments).	**Section 7.7**
			Climate change	Investigate the impacts of climate change on migratory shorebird habitat and populations in Australia.	**Section 6.6**
	EPBC Act Policy Statement 3.21 – Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (2017)	The purpose of this policy statement is to assist proponents in avoiding, assessing and mitigating significant impacts on migratory shorebirds listed under the EPBC Act.	Habitat loss and degradation	Actions should be designed to avoid reducing the capacity of important habitat to support migratory shorebirds by implementing measures to manage likely impacts. Best practice waste management should be implemented.	**Section 7.2**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
Curlew Sandpiper	Conservation Advice *Calidris ferruginea* Curlew Sandpiper (2015)	Australian Objective: + Reduce disturbance at key roosting and feeding sites	Habitat loss and degradation from pollution	No explicit relevant management actions; oil pollution recognised as a threat.	**Section 7.2**
Eastern Curlew	Conservation Advice *Numenius madagascariensis* Eastern Curlew (2015)	Australian objectives: + Achieve a stable or increasing population. + Maintain and enhance important habitat. + Reduce disturbance at key roosting and feeding sites.	Habitat loss and degradation from pollution	No explicit relevant management actions; habitat loss and degradation recognised as a threat.	**Section 7.2**
Red Knot	Conservation Advice *Calidris canutus* Red Knot (2016)	No explicit relevant objectives	Pollution/contamination impacts	No explicit relevant management actions; pollution / contamination recognised as a threat.	**Section 7.2**
			Habitat loss and degradation	Protect important habitat in Australia. Maintain and improve protection of roosting and feeding sites in Australia	**Section 7.2**
			Climate Change	No explicit relevant management actions; climate change recognised as a threat.	**Section 6.6**
			Anthropogenic disturbance	Manage disturbance at important sites which are subject to anthropogenic	**Section 7.7**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
				disturbance when red knot are present.	
Marine Reptiles					
All marine turtles	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (2020)	Lighting objectives will need to consider the regulatory requirements and Australian standards relevant to the activity, location and wildlife present. Objectives should be described in terms of specific locations and times for which artificial light is necessary. Consideration should be given to whether colour differentiation is required and if some areas should remain dark – either to contrast with lit areas or to avoid light spill. Where relevant, wildlife requirements should form part of the lighting objectives. A lighting installation will be deemed a success if it meets the lighting objectives (including wildlife needs) and areas of interest can be seen by humans clearly, easily, safely and without discomfort.	Light pollution	Best practice lighting design incorporates the following design principles: + Start with natural darkness and only add light for specific purposes. + Use adaptive light controls to manage light timing, intensity and colour. + Light only the object or area intended – keep lights close to the ground, directed and shielded to avoid light spill. + Use the lowest intensity lighting appropriate for the task. + Use non-reflective, dark-coloured surfaces. + Use lights with reduced or filtered blue, violet and ultra-violet wavelengths.	**Section 6.4**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Long-term recovery objective: + Minimise anthropogenic threats to allow for the conservation status of marine turtles to improve so that they can be removed from the EPBC Act threatened species list. Interim objective 3: + Anthropogenic threats are demonstrably minimised.	Marine Debris	Reduce the impacts from marine debris: + Support the implementation of the EPBC Act Threat Abatement Plan for the impacts of marine debris on vertebrate marine life.	**Section 7.5**
			Chemical and terrestrial discharge	Minimise chemical and terrestrial discharge.	**Sections 6.7, 7.2 - 7.4**
			Vessel Disturbance	Vessel interactions identified as a threat; no specific management actions in relation to vessels prescribed in the plan.	**Section 7.7**
			Light Pollution	Minimise light pollution: + Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats. + Develop and implement best practice light management guidelines for existing and future developments adjacent to marine turtle nesting beaches.	**Section 6.4**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
				+ Identify the cumulative impact on turtles from multiple sources of onshore and offshore light pollution.	
			Noise interference	Assess and address anthropogenic noise: + Understand the impacts of anthropogenic noise on marine turtle behaviour and biology.	**Section 6.5**
			Habitat modification	Manage anthropogenic activities to ensure marine turtles are not displaced from identified habitat critical to the survival. Manage anthropogenic activities in Biologically Important Areas to ensure that biologically important behaviour can continue.	**Section 7.2**
			Disease and pathogens	No explicit management actions; disease and pathogens recognised as a threat.	**Section 7.6**
			Climate Change	risk and build resilience to climate change and variability:	**Section 6.6**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
				+ Continue to meet Australia's international commitments to address the causes of climate change. + Identify, test and implement climate-based adaptation measures.	
Leatherback Turtle	Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (2009)	No explicit relevant objectives	Boat strike	No explicit relevant management actions; vessel strikes identified as a threat.	**Section 7.7**
			Habitat degradation (Changes to breeding sites and degradation of foraging areas)	Identify and protect migratory corridors between nesting beaches and common foraging areas to facilitate colonization.	**Section 6.4 and Section 7.2**
			Marine Debris	No explicit relevant management actions; marine debris identified as a threat.	**Section 7.5**
			Climate Change	No explicit relevant management actions; climate change identified as a threat.	**Section 6.6**
Marine Mammals					

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
Blue Whale	Blue Whale Conservation Management Plan 2015 - 2025 (2015)	The long-term recovery objective is to minimise anthropogenic threats to allow the conservation status of the Blue Whale to improve so that it can be removed from the threatened species list under the EPBC Act.	Noise interference	Assess and address anthropogenic noise: shipping, industrial and seismic noise.	**Section 6.5**
			Habitat modification	No explicit relevant management actions; habitat modification identified as a threat.	**Section 7.2**
			Vessel disturbance	Minimise vessel collisions: + Develop a national vessel strike strategy that investigates the risk of vessel strike on blue whales and also identifies potential mitigation measures. + Ensure all vessel strike incidents are reported in the National Ship Strike Database. Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented.	**Section 7.7**
			Climate Change	Understanding impacts of climate variability and change:	**Section 6.6**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
				+ Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica.	
			Marine debris	No explicit relevant management actions; marine debris identified as a threat.	**Section 7.5**
Fin Whale	Conservation Advice *Balaenoptera physalus* Fin Whale (2015)	Determine population abundance, trends and population structure for sei whales, and establish a long-term monitoring program in Australian waters. Describe the spatial and temporal distribution of Sei Whales and further define biologically important areas (feeding and breeding), and migratory routes within Australian and Antarctic waters.	Habitat degradation	No explicit relevant management actions; habitat degradation identified as a threat.	**Section 7.2**
			Pollution	No explicit relevant management actions; pollution identified as a threat.	**Section 7.2**
			Noise interference	Once the spatial and temporal distribution (including biologically important areas) of Fin Whales is further defined, assess the impacts of increasing anthropogenic noise (including seismic surveys, port expansion, and coastal development).	**Section 6.5**
			Vessel strike	Develop a national vessel strike strategy that investigates the risk of	**Section 7.7**

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
				vessel strikes on Fin Whales and identifies potential mitigation measures. Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	
			Climate Change	Understanding impacts of climate variability and change: + Continue to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica.	**Section 6.6**
Sei Whale	Conservation Advice *Balaenoptera borealis* Sei Whale (2015)	Determine population abundance, trends and population structure for sei whales, and establish a long-term monitoring program in Australian waters.	Habitat degradation	No explicit relevant management actions; habitat degradation identified as a threat.	**Section 7.2**
			Pollution	No explicit relevant management actions; pollution identified as a threat.	**Section 7.2**
			Noise interference	Once the spatial and temporal distribution (including biologically important areas) of Fin Whales is further defined, assess the impacts of	**Section 6.5**

Santos

Common Name	Recovery Plan / Conservation Advice / Management Plan	Relevant Objectives	Threats / strategies identified as relevant to the activity	Relevant Conservation Advice	Section addressed (where relevant) in the EP
				increasing anthropogenic noise (including seismic surveys, port expansion, and coastal development).	
			Vessel strike	Minimising vessel collisions: + Develop a national vessel strike strategy that investigates the risk of vessel strikes on Sei Whales and also identifies potential mitigation measures. + Ensure all vessel strike incidents are reported in the National Vessel Strike Database.	**Section 7.7**
			Climate Change	Understanding impacts of climate variability and change: + Continue to meet Australia’s international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica.	**Section 6.6**

Table 3-5: Biologically Important Areas identified in the Operational Area and EMBA

Species	BIA Area	Presence in Operational Area	Light/Noise Assessment Boundary	Presence in EMBA
Loggerhead Turtle	Foraging	✓	✓	✓
Green Turtle	Foraging	✓	✓	✓
Flatback Turtle	Foraging	✓	✓	✓
Olive Ridley Turtle	Foraging	✓	✓	✓

Figure 3-6: Marine Turtle BIAs within Operational Area and Light Boundary Area

3.2.3.1 Marine Turtles

There are six marine turtle species (or species habitat) classified as threatened, migratory or listed marine that may occur within the operational area and light boundary area (**Table 3-3**). A list of the relevant conservation advice and/or recovery plans is also provided in **Table 3-4**, with the relevant management actions. The type of presence is predominantly likely to occur and known to occur for the Flatback turtle, with BIAs and habitat critical to the survival of turtles are shown in **Figure 3-6**. The operational area and light boundary area overlap with foraging BIAs for Flatback, Green, Loggerhead and Olive Ridley turtles. These turtle species and their BIAs are shown in **Table 3-5** and are described further in **Appendix C** – Santos' Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062)).

Flatback Turtle

The flatback turtle is a vulnerable and migratory species that may occur within the operational area (**Table 3-3**). The flatback turtle is found in tropical waters of northern Australia and is one of only two species of sea turtle without a global distribution (DAWE, 2021). Flatback Turtles are primarily carnivorous, feeding on soft-bodied invertebrates; juveniles eat gastropod molluscs, squid, siphonophores (DAWE, 2021). Limited data also indicates that cuttlefish, hydroids, soft corals, crinoids, molluscs and jellyfish may also form part of their diet (DAWE, 2021). A BIA for foraging has been identified within the operational area and light boundary area (**Figure 3-6**). Flatback turtles have been observed foraging on the carbonate banks of the Joseph Bonaparte Gulf and around the Pinnacles of the Bonaparte Depression (DSEWPAC 2012).

Any occurrence within the operational area is likely to be of a transient nature only; however, it is possible that the species may use the area for foraging.

Green Turtle

The green turtle is a vulnerable and migratory species that may occur within the operational area (**Table 3-3**). Green turtles are found in tropical and subtropical waters throughout the world; usually occurring within the 20°C isotherms, although individuals can stray into temperate waters (DAWE, 2021). Within Australia, green turtles typically nest, forage and migrate across tropical northern Australia (DAWE, 2021). Adult green turtles consume mainly seagrass and algae, although they will occasionally eat mangroves, fish-egg cases, jellyfish, and sponges; juvenile green turtles are typically more carnivorous and will also consume plankton during their pelagic stage (DAWE, 2021). The foraging BIA overlaps the operational area and light boundary area (**Figure 3-6**).

Any occurrence within the operational area is likely to be of a transient nature only; however, it is possible that the species may use the area for foraging.

Loggerhead Turtle

The loggerhead turtle is an endangered and migratory species that may occur within the operational area (**Table 3-3**). The loggerhead turtle has a global distribution throughout tropical, sub-tropical and temperate waters; and in Australia typically occurs in the waters of coral and rocky reefs, seagrass beds, or muddy bays throughout eastern, northern and western Australia (DAWE, 2021). While the species has a broad foraging range throughout Australian waters, a BIA has been identified within the operational area and light boundary area (**Figure 3-6**). Loggerhead turtles are carnivorous, feeding primarily on benthic invertebrates (DAWE, 2021).

Any occurrence within the operational area is likely to be of a transient nature only; however, it is possible that the species may use the area for foraging.

Olive Ridley Turtle

The olive ridley turtle is an endangered and migratory species that may occur within the operational area (**Table 3-3**). Olive Ridley Turtles are primarily carnivorous, feeding on soft-bodied invertebrates such as sea pens, soft corals, sea cucumbers, and jellyfish (DoEE 2017a). Both juveniles and adults have been observed foraging over shallow benthic habitats from northern Western Australia to south-east Queensland; although occurrences in pelagic foraging habitats also occur (DAWE, 2021). A BIA for foraging has been identified within the operational area and light boundary area This foraging is associated with the Pinnacles of the Bonaparte Basin (DSEWPAC 2012).

Any occurrence within the operational area is likely to be of a transient nature only; however, it is possible that the species may use the area for foraging.

Leatherback Turtle

The leatherback turtle is an endangered and migratory species that may occur within the operational area (**Table 3-3**). The leatherback turtle has the widest distribution of any marine turtle, occurring in tropical to sub-polar oceans (DEWHA, 2008a). In Australia, the leatherback turtle has been recorded foraging in all Australian states, but no large nesting populations have been recorded (DEWHA, 2008). The leatherback Turtles is a highly pelagic species, venturing close to shore mainly during the nesting season (DAWE, 2021). Adults feed mainly on pelagic soft-bodied creatures such as jellyfish, tunicates, salps, squid (DAWE, 2021).

Given their pelagic nature and no known breeding sites in the vicinity, any occurrence within the operational area is likely to be to a transient nature only.

Hawksbill Turtle

The hawksbill turtle is a vulnerable and migratory species that may occur within the operational area (**Table 3-3**). The hawksbill turtle is found in tropical, subtropical and temperate waters all around the world (DAWE, 2021). No nesting is known to occur within the vicinity of the operational area. Hawksbill turtles are omnivorous, feeding on sponges, hydroids, cephalopods (octopus and squid), gastropods (marine snails), cnidarians (jellyfish), seagrass and algae (DAWE, 2021). During their pelagic phase (while drifting on ocean currents), young hawksbill turtles will feed on plankton (DAWE, 2021). After their pelagic phase, hawksbill turtles will typically settle and forage in tropical tidal and sub-tidal coral and rock reef habitat (DoEE 2017a).

Given their habitat and foraging characteristics, any occurrence within the operational area is likely to be of a transient nature only.

3.3 Social Environment

There are no Commonwealth or State marine protected areas, wetlands of international or national importance, World, National or Commonwealth heritage properties or places, Indigenous Protected Areas, or maritime heritage sites (i.e. shipwrecks) that intersect the operational area.

Socio-economic activities that may occur within the operational area and EMBA include commercial fishing, oil and gas exploration and production, and to a lesser extent, recreational fishing and tourism, as summarised in **Table 3-6**.

More detailed descriptions of socio-economic considerations are provided in **Appendix C** – Santos' Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062)Appendix C – Santos' Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062).

Table 3-6: Summary of socio-economic activities that may occur within the Operational Area and EMBA

Value / Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant events with the Operational Area	Relevant events within the EMBA
Commercial Fisheries – Commonwealth	Four Commonwealth fisheries have management areas that intersect the operational area and wider EMBA (**Table 3-8**): + Northern Prawn Fishery + Southern Bluefin Tuna Fishery + Western Skipjack Fishery + Western Tuna and Billfish Fishery The Northern Prawn Fishery (NPF) is the only Commonwealth-managed fishery that may have activity within the vicinity of the operational area, however fishing intensity shows low levels of fishing outside the operational area.	✓	✓	Planned Interaction with other marine users (**Section 6.1**)	Unplanned MDO Spill (**Section 7.2**)
Commercial Fisheries – State	Eight State-managed commercial fisheries have management areas that intersect with the operational area (**Table 3-9**). + Abalone + Kimberley Crab Managed Fishery + Mackerel Managed Fishery + Marine Aquarium Fish Managed Fishery + Northern Demersal Scalefish Managed Fishery + Southwest Coast Salmon Fishery + Specimen Shell Managed Fishery + West Coast Deep Sea Crustacean However, no recent activity was identified by FishCube data for the 2017-2020 period within the operational area. In 2019 the Northern	X	✓	NA	Unplanned MDO Spill (**Section 7.2**)

Value / Sensitivity	Description	Operational Area Presence	EMBA Presence	Relevant events with the Operational Area	Relevant events within the EMBA
	Demersal Scalefish Managed Fishery had activity of less than 3 vessels within the EMBA.				
Recreational Fishing	Remoteness of operational area limits recreational fishing usage. Recreational fishing may occur within the EMBA and therefore could be impacted by a spill arising from a vessel collision.	X	✓	NA	Unplanned MDO Spill (**Section 7.2**)
Traditional Fishing	Traditional Australian indigenous fishing activities are generally concentrated within 3 nm of the Northern Territory / Western Australia coastline (DPIF, 2015).	X	X	NA	NA
Shipping	The operational area does not overlap any shipping fairways, though is adjacent to vessel traffic.	X	✓	NA	Unplanned MDO Spill (**Section 7.2**)
Defence	The operational area does not overlap with any defence training areas. However, the EMBA intersects with a defence training area.	X	✓	NA	Unplanned MDO Spill (**Section 7.2**)
Shipwrecks	No known sites of shipwrecks within the operational area or EMBA.	X	X	NA	NA
Oil and Gas	Various petroleum exploration and production activities have been undertaken within the Timor Sea, including some close to the operational area. The nearest platform to the operational area is Blacktip WHP (ENI Aus) approximately 97 km away.	X	✓	NA	Unplanned MDO Spill (**Section 7.2**)
Tourism	Remoteness of operational area limits tourism operators in the area. There is also no tourism expected within the EMBA.	X	X	NA)	NA
Cultural Heritage	No Native Title Claimant Applications or Determination Areas overlap operational area or EMBA. The EMBA does not intersect any areas of coastline.	X	X	NA	NA

3.3.1 Commonwealth Marine Regions

Six marine regions have been identified in Commonwealth waters around Australia; the operational area intersects with the North-west region. Key conservation values for this region are listed in **Table 3-7**.

Table 3-7: Key Conservation Values for the North-west Marine Region

Region	Key Conservation Values[1]
North-west	+ Seasonal calving habitat for the world's largest population of the humpback whale + Foraging and inter-nesting habitat for Olive Ridley, Green, Flatback, Loggerhead and Hawksbill turtles + Foraging habitat for the Whale Shark, several species of sea snake, sawfish and for several species of migratory seabirds + BIAs for several whale species, including the Australian Snubfin Dolphin and Humpback Whale + Protection for coral reefs in Commonwealth waters adjacent to the Kimberley with additional protection for Rowley Shoals and Ningaloo reefs + Eight key ecological features are included, fully or in part, in the marine reserve network + Eight provincial bioregions, nine meso-scale bioregions, 81 depth ranges within provincial bioregions, and 15 seafloor types represented in the network

[1]Key Conservation Values as listed in DEWHA, 2008.

3.3.2 Commercial Fisheries

3.3.2.1 Commonwealth Fisheries

Four Commonwealth-managed commercial fisheries have management areas that intersect with the operational area and broader EMBA (**Table 3-8**). One of these, the Skipjack Tuna Fishery, has been inactive since the 2008-2009 fishing season; and two fisheries (Southern Bluefin Tuna, and Western Tuna and Billfish) have their catch from areas well outside the Operational Area.

The Northern Prawn Fishery (NPF) is the only Commonwealth-managed fishery that may have activity within the vicinity of the Operational Area, with both the 1991 Australian Fisheries Zone data and the 2020 Draft Australian Fisheries Zone data identifying the operational area within the NPF management area. However, the NPF fishing intensity shows low levels of fishing outside the operational area (**Figure 3-7**).

The fishery covers an area of approximately 784,000 km^2 and extends from Joseph Bonaparte Gulf across the top end to the Gulf of Carpentaria (**Figure 3-7)**. The highest catches are taken offshore from mangrove forests, which are the juvenile nursery areas (Patterson et al. 2019).

Most of the trawling activity and harvest comes from within the Gulf of Carpentaria with the western most region of the fishery (the Joseph Bonaparte Gulf) seeing much lower fishing effort. The Joseph Bonaparte Gulf is fished primarily for Banana Prawn, which includes adults of the white Indian variety found in 45 to 85 m, adults of the common Banana Prawn are caught in water <45 m deep (NPF25 1994).

3.3.2.2 State Fisheries

Eight state-managed commercial fisheries have been identified with management areas that intersect with the operational area, these include:

+ Abalone Fishery
+ Kimberley Crab Managed Fishery
+ Mackerel Managed Fishery
+ Marine Aquarium Fish Managed Fishery
+ Northern Demersal Scalefish Managed Fishery
+ Southwest Coast Salmon Fishery
+ Specimen Shell Managed Fishery
+ West Coast Deep Sea Crustacean Fishery

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 10 nm x 10 nm Catch and Effort System (CAES) blocks for the 2010-2020 period. This data shows no fishing activity within the operational area, however, less than 3 vessels from the Northern Demersal Scalefish Managed Fishery were recorded in 2011, 2012 and 2019 within the EMBA. Details for the fisheries are provided in **Table 3-9**.

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.

Table 3-8: Commonwealth-managed Commercial Fisheries

Fishery	Area	Target Species	Season	Fishing Method	Fishing Activity Expected
Northern Prawn Fishery (NPF)	The NPF is located off Australia's northern coast from Cape York in Queensland to Cape Londonderry in Western Australia (**Figure 3-7**).	+ White Indian banana prawns (*Fenneropenaeus merguiensis, F. indicus*) + Tiger prawns – brown and grooved (*Penaeus esculentus, P. semisulcatus*) + Endeavour prawns (*Metapenaeus endeavouri, M. ensis*)	+ Season 1 (mainly banana prawns caught): 1 April – 15 June + Season 2 (mainly tiger prawns caught): 1 August – end of November + Note: season end date depends on catch rates + Consultation with NPF confirmed the Joseph Bonaparte Gulf fishery is effectively closed from 1 December to August for at least the next four years. All targeted prawn fishing in the Joseph Bonaparte Gulf now occurs between August and October inclusive (**Section 4.4**).	+ Otter Trawl -typically two, three or four bottom trawl nets. + Quad rig boats designed for fishing in shallow water + Banana prawns are primarily targeted during the day; tiger (and endeavour) prawns during the night	Unlikely (see fishing intensity shown in **Figure 3-7**)
Skipjack Tuna Fishery (Western)	The Skipjack Tuna Fishery covers the entire sea area around Australia, out to 200 nm from the coast. It is split into two sectors: the Eastern Skipjack Tuna	+ Skipjack tuna (*Katsuwonus pelamis*)	N/A	N/A	No (there has been no activity by this fishery since the 2008-2009 season).

Fishery	Area	Target Species	Season	Fishing Method	Fishing Activity Expected
	Fishery and the Western Skipjack Tuna Fishery.				
Southern Bluefin Tuna Fishery	The Southern Bluefin Tuna Fishery covers the entire sea area around Australia, out to 200 nm from the coast.	+ Southern bluefin tuna (*Thunnus maccoyii*)	+ 12-month season, beginning on 1 December	+ Purse seine + Pelagic longline	No Most of the fishing effort is concentrated in the Great Australian Bight and waters off of South Australia.
Western Tuna and Billfish Fishery	The Western Tuna and Billfish Fishery covers the sea area west from the tip of Cape York in Queensland, around Western Australia, to the border between Victoria and South Australia. Fishing occurs in both the Australian Fishing Zone and adjacent high seas.	+ Bigeye tuna (*Thunnus obesus*) + Yellowfin tuna (*Thunnus albacares*) + Broadbill swordfish (*Xiphias gladius*) + Striped marlin (*Tetrapturus audux*)	+ 12-month season, beginning on 1 February	+ Pelagic longline (monofilament mainline) + Minor line (handline, rod and reel, troll and poling) + Purse seine	No Fishing effort is concentrated off south-west Western Australia, with occasional activity off South Australia.

Table 3-9: State-managed Commercial Fisheries

Fishery	Area	Target Species	Fishing Method	Fishing Activity Expected within the Operational Area	Fishing Activity Expected within the EMBA
Abalone	All coastal waters of the Southern Ocean, Indian Ocean and Timor Sea between the Western Australian/Northern Territory Border and the Western Australian/South Australian border (i.e. all the waters of the state).	+ Roe's abalone + Greenlip abalone + Brownlip abalone	+ Hand collection (either wading or diving)	No FishCube data from 2010-2020 does not show activity within the vicinity of the operational area.	No FishCube data from 2010-2020 does not show activity within the vicinity of the EMBA.
Kimberley Crab Managed Fishery	The area of the Fishery includes the waters of northern Western Australia located east of 120°00' east longitude to the Northern Territory border, out to the Exclusive Economic Zone (200 nm).	+ Blue Swimmer Crab	+ Crab trap	No FishCube data from 2010-2020 does not show activity within the vicinity of the operational area.	No FishCube data from 2010-2020 does not show activity within the vicinity of the EMBA.
Mackerel Managed Fishery	All Western Australian waters of the Indian Ocean and the Timor Sea north of Cape Leeuwin (34° 22.51' south latitude).	+ All fish of the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium*	+ Handline + Troll line	No FishCube data from 2010-2020 does not show activity within the vicinity of the operational area.	No FishCube data from 2010-2020 does not show activity within the vicinity of the EMBA.
Marine Aquarium Fish (MAF) Managed Fishery	The licence area for the MAF extends into Commonwealth waters, spanning the coastline from the Northern Territory border to the South Australian border.	+ Multi-species fishery that targets over 250 species of fish + Sygnathids	+ Hand-held nets only + Primarily a dive-based fishery, water depth constraints will determine the	No FishCube data from 2010-2020 does not show activity within the	No FishCube data from 2010-2020 does not show

Fishery	Area	Target Species	Fishing Method	Fishing Activity Expected within the Operational Area	Fishing Activity Expected within the EMBA
	However, in practice, the fishery currently operates only in WA state waters.	+ Coral + Live Rock + Invertebrates + Seagrass and algae	extent where collections can occur.	vicinity of the operational area.	activity within the vicinity of the EMBA.
Northern Demersal Scalefish Managed Fishery	All Western Australian waters off the north coast of Western Australia east of longitude 120° E. These waters extend out to the edge of the Australian Fishing Zone (200 nautical mile) limit under the Offshore Constitutional Settlement (OCS) arrangements. The fishery is divided into two fishing zones, Zone 1 (inshore) and Zone 2 (offshore). The boundary between Zone 1 and Zone 2 approximates the 30 m depth contour.	+ Scarlet perch (*Lutjanus malabaricus*) + Spangled emperor (*Lethrinus nebulosus*) + Various species of cods and groupers (Family *Serranidae*)	+ Traps + Line (handline and/or dropline	No FishCube data from 2010-2020 does not show activity within the vicinity of the operational area.	Possible FishCube data from 2010-2020 shows activity within the vicinity of the EMBA in 2011, 2012 and 2019 of less than 3 vessels.
Southwest Coast Salmon Fishery	The Southwest Coast Salmon Managed Fishery operates on various beaches south of the metropolitan area.	+ Western Australian salmon (*Arripis truttaceus*)	+ Beach seine nets + Rod and line beach fishing	No FishCube data from 2010-2020 does not show activity within the vicinity of the operational area.	No FishCube data from 2010-2020 does not show activity within the vicinity of the EMBA.

Fishery	Area	Target Species	Fishing Method	Fishing Activity Expected within the Operational Area	Fishing Activity Expected within the EMBA
Specimen Shell Managed Fishery	The fishing area includes all Western Australian waters between the high-water mark and the 200 m isobath.	+ Various shells	+ Hand collection	No FishCube data from 2010-2020 does not show activity within the vicinity of the operational area.	No FishCube data from 2010-2020 does not show activity within the vicinity of the EMBA.
West Coast Deep Sea Crustacean	The fishery operates off the west coast of Western Australia (WA), on the seaward side of the 150 m isobath out to the extent of the Australian Exclusive Economic Zone (EEZ; 200 nm boundary). The fishery covers three WA management bioregions: North Coast, Gascoyne Coast and West Coast, however, the majority of fishing activities are centred in the Gascoyne and West Coast Bioregions.	+ Crystal Crab *(Chaceon albus)*	+ Traps operated in long- lines	No FishCube data from 2010-2020 does not show activity within the vicinity of the operational area.	No FishCube data from 2010-2020 does not show activity within the vicinity of the EMBA.

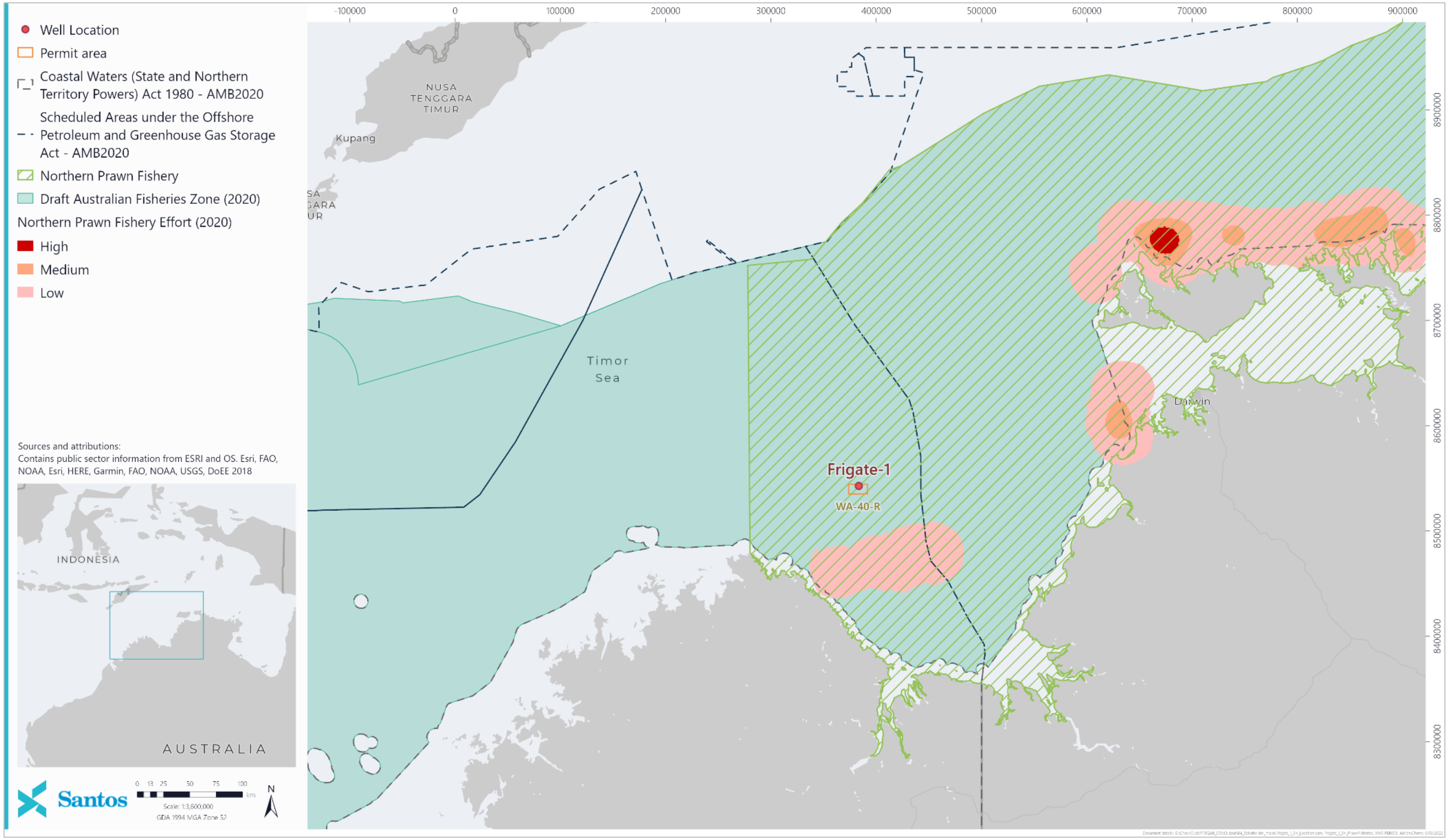


Figure 3-7: Northern Prawn Fishery Management Area and Fishing Intensity

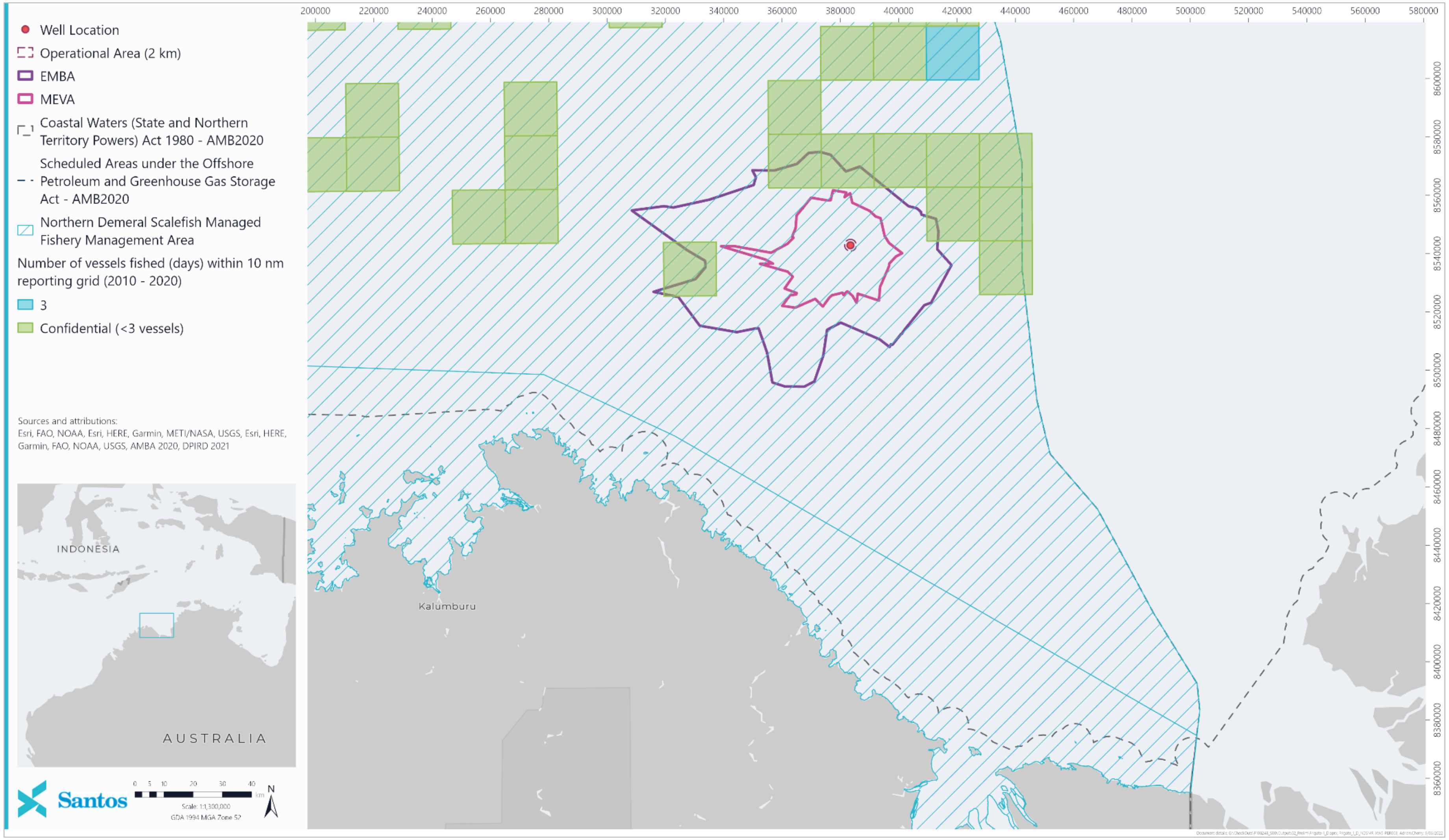


Figure 3-8: State Commercial Northern Demersal Scalefish Managed Fishery Management Area and Fishing Activity

3.3.3 Tourism

The operational area is located in deep (approximately 112 m) offshore waters that are not likely to be accessed for tourism activities, such as recreational fishing, snorkelling, diving, surfing and boating and charter boat operations. These activities tend to be centred around nearshore waters, islands and coastal areas. The operational area is 101 km from the closest shore, and 466 km to the closest large port settlement (Darwin).

3.3.4 Industry

3.3.4.1 Petroleum Industry

Petroleum exploration in the Bonaparte Basin commenced in the late 1940's. Santos currently has commercial interests in the Petrel/Tern/Frigate field complex in the Petrel sub-basin, with Santos as the titleholder for the adjoining WA-27-R title.

The Petrel sub-basin seismic survey is due to be completed by March 2022. The permit areas for the Petrel survey intersect with the EMBA (WA-454-P, WA-27-R and WA-40-R).

The nearest platform is the ENI Blacktip Platform approximately 97 km to the southeast of the operational area (**Figure 3-9**).

3.3.4.2 Commercial Shipping

Coastal shipping traffic is common to offshore areas; the largest port in coastal waters adjacent to the activity location is the Port of Darwin. The Port of Darwin is important for trading vessels, fishing vessels, navy ships and cruise ships, and also services activity associated with the operation of the Australasia Railway and the Timor Sea oil and gas developments.

There are no known recognised major shipping routes within the immediate vicinity of the operational area, however vessels may pass through the general area (**Figure 3-10**).

The Frigate-1 wellhead appears on the RAN Chart 318 nautical chart.

3.3.4.3 Defence

The operational area is not located within a military training or practice zone (**Figure 3-11**). The closest exercise zone incorporates the majority of the Northern Territories portion of the Bonaparte Basin and is mainly utilised for activities associated with border protection including surveillance, illegal immigration and illegal fishing. The operational area is approximately 20 km from the defence training area. Consultation with the Department of Defence indicated that unexploded ordnance may be present on and in the seafloor.

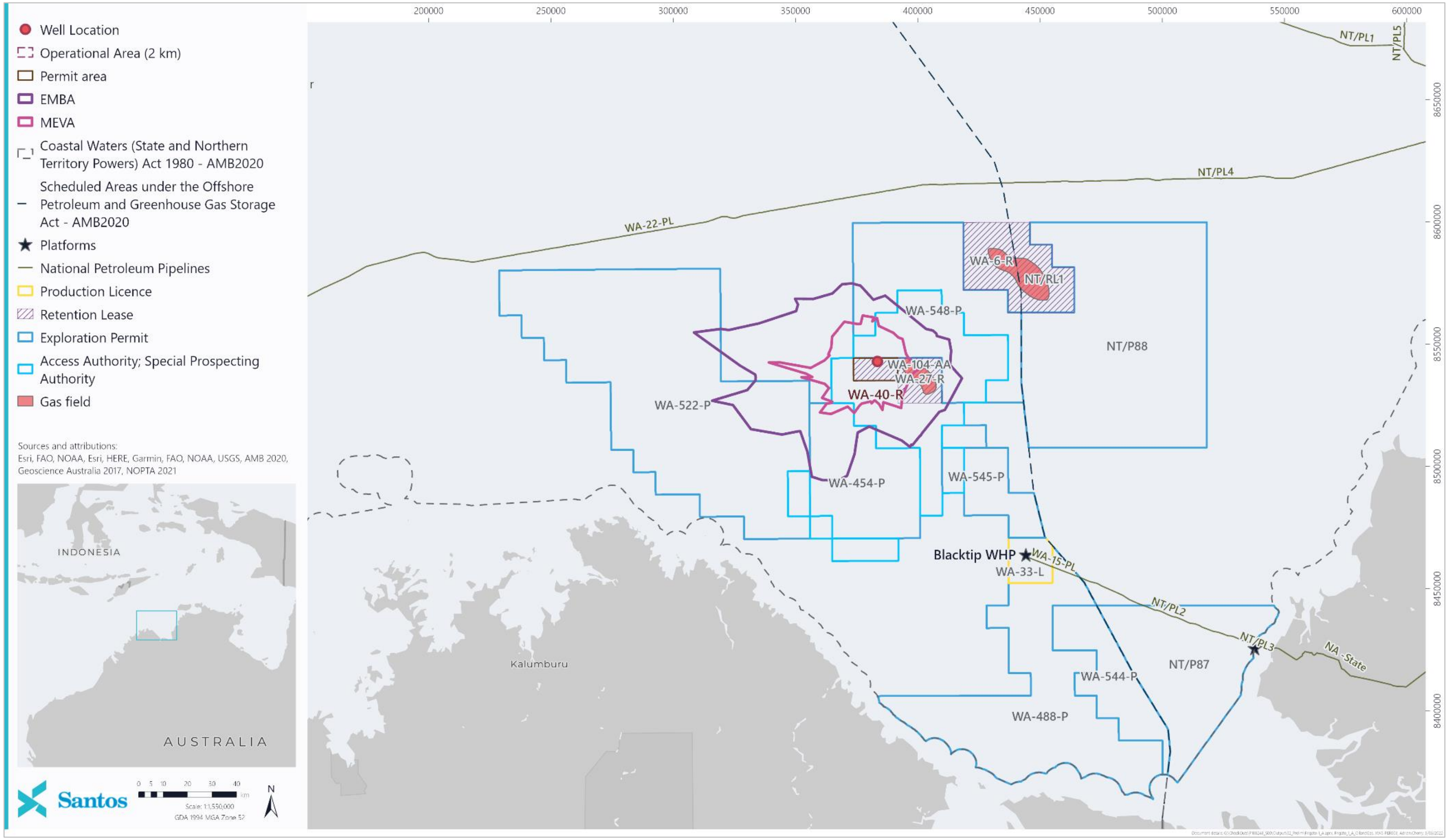


Figure 3-9: Existing petroleum infrastructure within the EMBA

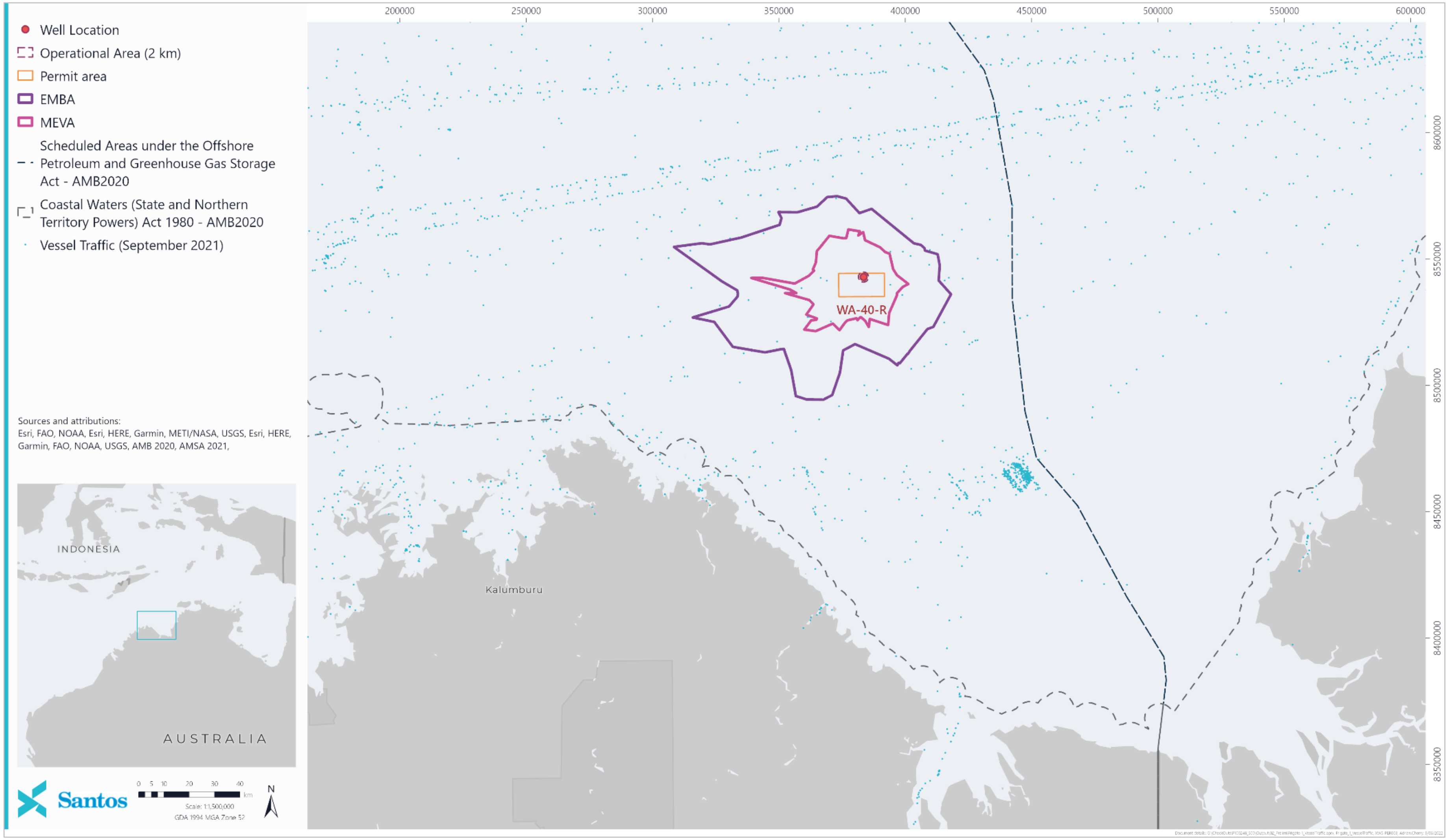


Figure 3-10: Commercial shipping routes within the EMBA

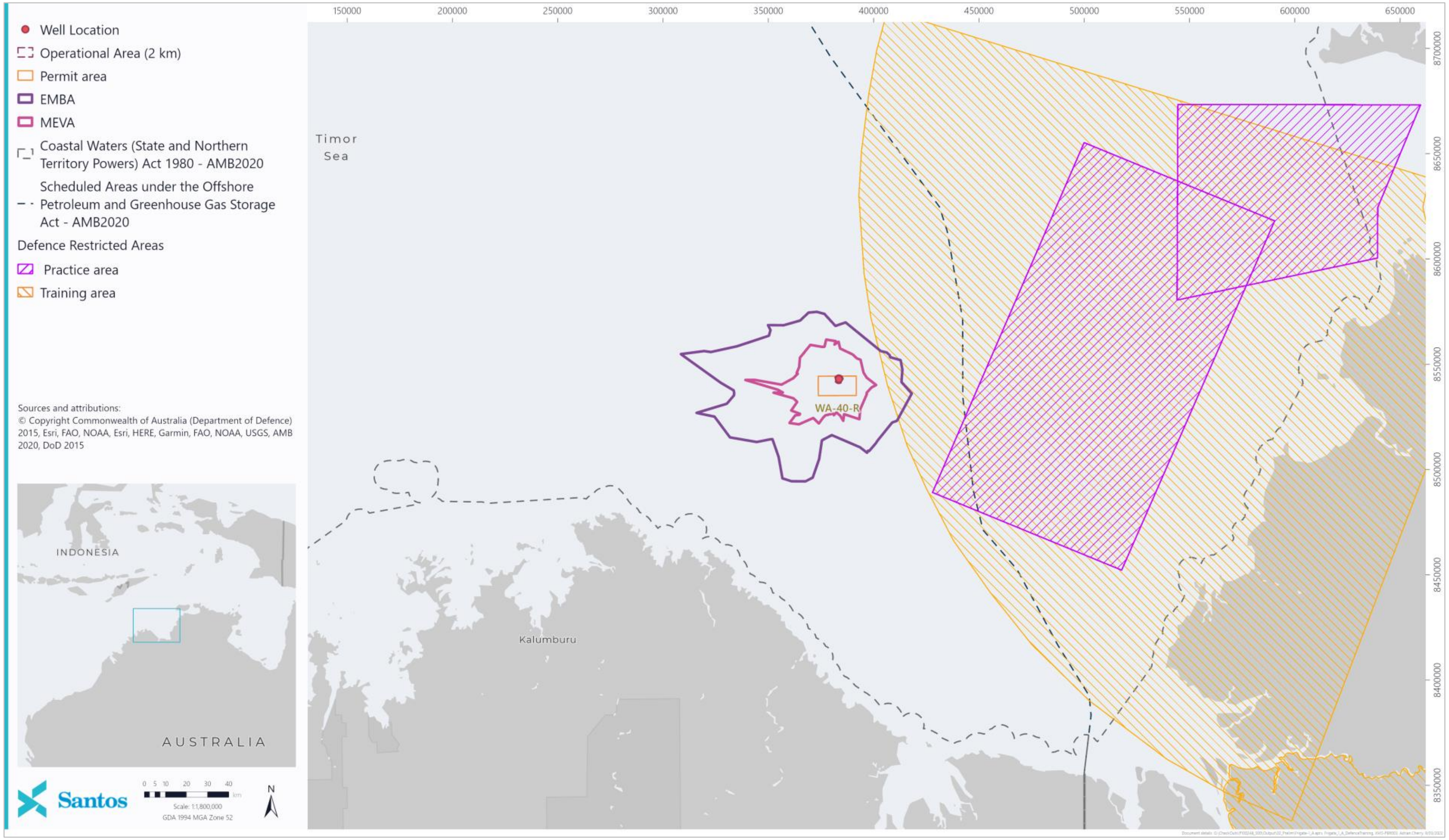


Figure 3-11: Defence areas within the EMBA

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 (b) the name of the titleholder who submitted the plan (c) a description of the activity or stage of the activity to which the plan relates (d) the location of the activity (e) a link or other reference to the place where the accepted offshore project proposal (if any) is published (f) details of the titleholder's nominated liaison person for the activity. Note: If the plan is a seismic or exploratory drilling environment plan, the Regulator must also publish an invitation for public comment on the plan: see regulation 11B.
Regulation 16
16 The environment plan must contain the following: (b) a report on all consultations under regulation 11A of any relevant person by the titleholder, that contains: (i) a summary of each response made by a relevant person (ii) an assessment of the merits of any objection or claim about the adverse impact of each activity to which the environment plan relates (iii) a statement of the titleholder's response, or proposed response, if any, to each objection or claim (iv) a copy of the full text of any response by a relevant person.

4.1 Summary

Santos has a history of stakeholder engagement in the Bonaparte region through historical exploration drilling, seismic surveys, the previously proposed Bonaparte Floating LNG project and as a Joint Venture Partner in Darwin LNG. Santos is familiar with interested stakeholders and marine users in the region.

Stakeholders (**Table 4-2**) were informed of activities covered in this EP via several channels of engagement commencing in January 2022, including:

+ WA-40-P Frigate-1 Wellhead Inspection Survey consultation package distributed to identified stakeholders from 21 January 2022,
+ Reminder email and fishery map sent to identified stakeholders with commercial fishing interests on 18 February 2022, and

- Follow-up discussions with fishing industry bodies on the consultation package.

Based on Santos' experience with previous EPs, stakeholder feedback and regulator discussions, the primary stakeholder issues raised for this activity are the potential impact of any items remaining on the seabed to trawl fishers (addressed in **Section 6.1**).

Santos has considered all stakeholder responses as outlined in **Section 4.4**. A summary of Santos' response statements is provided in **Table 4-2.** Santos has considered all stakeholder responses as outlined in **Section 4.4**.

Santos considers that the consultation with relevant stakeholders has been adequate to inform the development of this EP

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 areas (refer to **Section 2.1.2**) and the relevance of the stakeholder according to Regulation 11A of the OPGGS(E) Regulations 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, as required, of the most recent Department of Primary Industries and Regional Development (DPIRD) FishCube data;
- Updated fishing licence holder contact details, from these identified fisheries, as provided by DPIRD;
- Discussions with identified stakeholders to identify other potentially impacted persons;
- Active participation in industry bodies and collaborations (e.g., AMOSC, APPEA, NERA); and
- Records from previous consultation activities in the area.

Current 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 Activities

Stakeholder	Relevant to Activity	Relevance/Reason for Engagement
Commonwealth government agencies/departments		
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 AFMA managed fisheries.
Australian Hydrographic Office (AHO)	Considered relevant persons under Regulation 11A(1)(a)	The AHO is the part of the Commonwealth Department of Defence responsible for maintaining and disseminating nautical charts, including the distribution of Notice to Mariners. The WA-40-R permit and operational area are 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 and a relevant agency when proposed offshore activities may impact on the safe navigation of commercial shipping in Australian waters. The WA-40-R permit and operational area are in Commonwealth waters.
Department of Agriculture, Water and the Environment (DAWE) – Biosecurity (marine pests)	Considered relevant persons under Regulation 11A(1)(a)	The DAWE (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 WA-40-R permit and operational area are in Commonwealth waters.
Department of Agriculture, Water and the Environment (DAWE) –Biosecurity (vessels, aircraft and personnel)	Considered relevant persons under Regulation 11A(1)(a)	DAWE (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

Stakeholder	Relevant to Activity	Relevance/Reason for Engagement
		biosecurity control) to offshore petroleum activities.
Department of Agriculture, Water and the Environment (DAWE) – Fisheries	Considered relevant persons under Regulation 11A(1)(a)	DAWE (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.
Department of Agriculture, Water and the Environment (DAWE) – Sea Dumping	Considered relevant persons under Regulation 11A(1)(a)	The London Protocol is implemented through Section 5 of the Sea Dumping Act; Article 1.4.1.4 of the London Protocol covers the abandonment of man-made structures.
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.
State government agencies/departments		
Department of Mines, Industry Regulation and Safety (DMIRS) WA	Considered relevant persons under Regulation 11A(1)(a)	WA Department responsible for the management of offshore petroleum in the adjacent state waters. DMIRS was provided a copy of the consultation pack.
Department of Primary Industries and Regional Development (DPIRD) WA	Considered relevant persons under Regulation 11A(1)(a)	DPIRD is responsible for managed West Australian State fisheries. The operational areas intersect with state managed fisheries.
Department of Transport (DoT) WA	Considered relevant persons under	DoT is the control agency for marine pollution emergencies in Western Australian state waters. DoT was provided a copy of the consultation pack.

Stakeholder	Relevant to Activity	Relevance/Reason for Engagement
	Regulation 11A(1)(a)	
Industry bodies		
Northern Prawn Fishery Industry (NPFI)	Considered relevant persons under Regulation 11A(1)(e)	NPFI is the peak body representing the northern prawn trawlers.
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.
Commercial Fisheries – Commonwealth Managed		
No expected interactions with Commonwealth fisheries in the operational area as per assessment in **Table** 3-8 However, given the proximity of the ongoing presence wellhead to the activities of the Northern Prawn Fishery, Santos has on this occasion chosen to engage licence holders in this fishery and its representative organisation, the Northern Prawn Fishery Industry.		
Commercial Fisheries – State Managed		
No expected interactions with State fisheries in the operational area as per assessment in **Table 3-9**.		
Other Stakeholders		
Australian Marine Oil Spill Centre (AMOSC)	Considered relevant persons under Regulation 11A(1)(a)	AMOSC operates the Australian oil industry's major oil spill response facility.

4.3 Stakeholder Consultation

The approach to stakeholder consultation for this EP follows similar processes adopted by Santos for previous EPs with bespoke modifications to approach adopted to suit current requirements. Some modifications include:

+ Where required, providing more detailed information to commercial fishers, targeted to their fishery, in the initial consultation packs;
+ 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.

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 contained details such as an activity summary, location map(s), coordinates, water depth, distance to key regional features, exclusion zone details and estimated timing and duration of activities. It also outlined potential risks and impacts together with a summary of proposed management control measures.

The intent of providing this level of information is to facilitate each party proceeding with their business in a safe and efficient manner, and without loss or conflict, by minimising the extent of interruption by the proposed activities to the lowest practicable level.

Stakeholders were afforded at least 35 days to review consultation packs and provide feedback, although Santos accepted stakeholder feedback after the consultation period closed on 25 February 2022 period. A summary of the Consultation material sent to stakeholders is contained in **Appendix F – Stakeholder Consultation**.

4.4 Assessment of Stakeholder Objections and Claims

A summary of the stakeholder consultation undertaken for this EP, including Santos' assessment of all stakeholder comments received, is outlined in **Table 4-2**.

Full transcripts between Santos and stakeholders are provided in the *WA-40-R Wellhead Environment Plan Sensitive Stakeholder Information Report* (SO-91-RI-20143) as a confidential submission to NOPSEMA.

Santos adopted the following process to address objections and claims received during the consultation process:

+ Santos acknowledged receipt of all comments made by stakeholders;
+ Santos assessed the merits of all objections and claims made by stakeholders. This included assessing all reasonably available options for resolving or mitigating the degree to which a stakeholder's functions, interests or activities may be affected. Control measures were proposed and adopted where reasonably practicable;
+ Santos responded to all stakeholder objections and claims, and advised the stakeholder how each of their objections and claims would be addressed in the EP; and
+ Santos invited the stakeholder to provide additional feedback and comment.

A similar process was applied to information provided and requests made by stakeholders not deemed to be an objection or claim.

Santos recognises the importance of ensuring a high degree of transparency in how a titleholder manages ongoing stakeholder consultation during the life of the EP. As such, should additional stakeholder comments be received to those described in **Table 4-2** then Santos will assess the comments using the above process and update the EP to document the assessment of additional objections or claims.

In relation to stakeholder consultation Santos is of the opinion that Regulation 10A of the OPGGS(E) Regulations has been met.

Table 4-2: Consultation Summary for Activity

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
Commonwealth departments/agencies		
Australian Border Force (Maritime Border Command)	Australian Border Force was provided the consultation package via email on 21 January 2022. No formal response has been received from the AHO. 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 and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.
Australian Fisheries Management Authority (AFMA)	AFMA was provided the consultation package via email on 21 January 2022. AFMA responded on 24 January 2022 noting its expectation for consultation with fishers who have entitlements to fish within the proposed area. AFMA advised this can be done through the relevant fishing industry associations or directly with fishers who hold entitlements in the area. Santos has consulted with relevant fishing industry associations as outlined in **Table 4-2** where fisheries have not been active in the operational area in recent years. Santos responded to AFMA on 25 March 2022 acknowledging that, while there was no recent fishing activity in the operational area for the proposed activity, Santos had chosen to consult licence holders in the Northern Prawn Fishery and the Northern Prawn Fishery Industry, representing Northern Prawn Fishery licence holders, given the ongoing presence of the wellhead. This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA. Santos has also consulted DAWE, given its interests in the management of Commonwealth fisheries. 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 and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.
Australian Hydrographic Office (AHO)	AHO was provided the consultation package via email on 21 January 2022 AHO notification requirements, as requested by AMSA are addressed in **Table 8-4.** This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA. 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 and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims**

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
		(OPGGS(E) Regulation 16 (b)(iii)), and information and requests
	No assessment required.	No response required.
Australian Maritime Safety Authority – maritime safety (AMSA)	AMSA was provided the consultation package via email on 21 January 2022. AMSA responded on 27 January 2022 requesting timely and relevant Maritime Safety Information is promulgated for the area and nature of operations as follows: + Contact AHO at datacentre@hydro.gov.au no less than four weeks before operations, with details relevant to the operations. AHO will promulgate the appropriate Notice to Mariners, which will ensure other vessels receive information about activities. **[REQUEST 001]** + Notify AMSA's Joint Rescue Coordination Centre (JRCC) by email rccaus@amsa.gov.au for promulgation of radio-navigation warnings at least 24-to-48 hours before operations commence. JRCC will require vessel details (including name, callsign and Maritime Mobile Service Identity), satellite communications details (including INMARSAT-C and satellite telephone numbers), area of operation, requested clearance from other vessels and any other information that may contribute to safety at sea. JRCC will also need to be advised when operations start and end. **[REQUEST 002]** + Provide updates to both the Australian Hydrographic Office and the JRCC on progress and, importantly, any changes to the intended operations. **[REQUEST 003]** + Exhibit appropriate lights and shapes to reflect the nature of operations –we remind vessels of their obligation to comply with the International Rules for Preventing Collisions at Sea (COLREGs), in particular the use of appropriate lights and shapes to reflect the nature of your operations (e.g., restricted in the ability to manoeuvre). Vessels should also ensure their navigation status is set correctly in the ship's Automatic Identification System unit. **[REQUEST 004]** + To obtain a vessel traffic plot showing Automatic Identification System 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 19 February 2022 and addressed the matters raised in its feedback of 27 January 2022 (refer assessment of stakeholder objections, claims, information and requests below). 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 and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	[REQUEST 001] Santos will notify AHO no less than four weeks before operations commence where practicable. Notification requirements are addressed in **Table 8-4.**	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	[REQUEST 002] Santos will notify AMSA's JRCC at least 24-to-48 hours before operations commence for each activity and advise when operations start and end. Notification requirements are addressed in **Table 8-4.**	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.
	[REQUEST 003] Santos will notify both AHO and AMSA's JRCC on any changes to the intended operations. Notification requirements are addressed in **Table 8-4.**	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.
	[REQUEST 004] Santos noted the advice on obligations to comply with COLREGs, in particular, the use of appropriate lights and shapes to reflect the nature of operations and this is addressed in **Section 6.4**.	Santos responded to AMSA and noted the information provided.
	[INFORMATION 001] Santos notes the information provided on traffic data.	Santos responded to AMSA and noted the information provided.
Australian Maritime Safety Authority – marine pollution (AMSA)	AMSA - marine pollution was provided the consultation package via email on 21 January 2022. No formal response has been received from AMSA - marine pollution. Management of oil spill preparedness is addressed in the OPEP in Section 4. 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 and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.
Department of Agriculture, Water and the Environment – Biosecurity (marine pests) (DAWE)	DAWE was provided the consultation package via email on 21 January 2022. No formal response has been received from DAWE-marine pests. Management of invasive marine pest species is addressed in **Section 7.6**. This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA. 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 and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	**Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests**
	No assessment required.	No response required.
	DAWE was provided the consultation package via email on 21 January 2022.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3">Department of Agriculture, Water and the Environment – fisheries
(DAWE)</td><td colspan="2">A reminder email and fishery map were sent to DAWE (fisheries) on 18 February 2022.
No formal response has been received from DAWE-fisheries.
Santos has assessed the impact to fish and commercial fisheries throughout Section 6 and Section 7.
While there has been no recent fishing effort in the operational area, Santos chose to consult AFMA, licence holders and representative bodies, given their interest in petroleum activities where licence holders are entitled to fish.
This stakeholder is listed as a recipient of Santos’ Quarterly Consultation Update for WA.
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><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Department of Agriculture, Water and the Environment – Biosecurity (vessels, aircraft and personnel)
(DAWE)</td><td colspan="2">DAWE was provided the consultation package via email on 21 January 2022.
No formal response has been received from DAWE.
Management of biosecurity is addressed in Section 7.6.
This stakeholder is listed as a recipient of Santos’ Quarterly Consultation Update for WA.
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><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Department of Agriculture, Water and the Environment – Sea Dumping
(DAWE)</td><td colspan="2">Santos met with DAWE on 20 October 2021 regarding Sea Dumping permit requirements for the wellhead.
A letter from DAWE on 6 December 2021, following this meeting, DAWE confirmed that as the Frigate-1 wellhead was plugged and abandoned in 1978, it predates the Environment Protection (Sea Dumping) Act 1981, and therefore there is no obligation to apply for a permit for this wellhead under the Act.</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests</th></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 DNP was provided consultation package via email on 21 January 2022.
DNP responded on 24 February 2022 advising:
Based on the factsheet provided, DNP noted the planned activities do not overlap any Australian Marine Parks. DNP noted Santos’ advice that the operational area is approximately 53 km, 122 km, and 162 km from Oceanic Shoals, Joseph Bonaparte Gulf and Kimberley marine parks respectively. [INFORMATION 001],</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	+ DNP provided advice on the presence of BIAs and KEFs in the title area and parts of the operational area and requested that activities that could affect the BIAs are managed accordingly. **[REQUEST 001],** + DNP provided advice on the potential need for a Sea Dumping permit and provided contact details for the relevant Australian Government Department. **[INFORMATION 002],** + DNP requested that in preparing the EP, Santos should consider the Australian marine parks and their representativeness. In the context of the management plan objectives and values, Santos should ensure the EP: **[REQUEST 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, and – clearly demonstrates that the activity will not be inconsistent with the management plan, + DNP advised the *North-west Marine Parks Network Management Plan 2018* came into effect on 1 July 2018 and provided further information about values for the Kimberley Marine Park, Oceanic Shoals and Joseph Bonaparte Gulf marine parks. DNP also advised that Australian marine park values are broadly defined into four categories: natural (including ecosystems), cultural, heritage and socio-economic. Information about the values for the marine parks is also located on the Australian Marine Parks Science Atlas **[INFORMATION 003],** + In the case of an emergency response, 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. The notification should include: **[REQUEST 003]** – titleholder details, – time and location of the incident (including name of marine park likely to be affected), – proposed response arrangements as per the OPEP (e.g., dispersant, containment, etc), – confirmation of providing access to relevant monitoring and evaluation reports when available, and – contact details for the response coordinator. Note, DNP may request daily or weekly Situation Reports, depending on the scale and severity of the pollution incident. Santos responded to DNP on 28 April 2022 and addressed the matters raised in its feedback of 24 February 2022 (refer assessment of stakeholder objections, claims, information and requests below). 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.
	[INFORMATION 001] Santos notes no authorisations are required from the DNP.	Santos responded to DNP and acknowledged their advice.
	[REQUEST 001] Santos confirmed the presence of BIAs and KEFs assessed in the EP, as outlined in **Section 3.2.2.**	Santos responded to DNP's request.
	[INFORMATION 002] Santos confirmed that a Sea Dumping permit would not be required for the proposed activities.	Santos responded to DNP and acknowledged their advice.
	[REQUEST 002] Santos has identified the relevant Australian Marine Parks and their values. Refer to **Section 3.2.2.**	Santos responded to DNP's request.
	[INFORMATION 003] Santos has considered information within the Australian Marine Parks North-West Marine Parks Network Management Plan (2018), North Marine Parks Network Management Plan (2018) and Australian Marine Parks Science Atlas. Refer to **Section 3.3.1.**	Santos responded to DNP and acknowledged their advice.
	[REQUEST 003] Santos has addressed DNP emergency notification requirements in **Table 8-4** of the EP and Section 7 of the OPEP.	Santos responded to DNP the OPEP for the activity includes DNPs notification requirements. These can be found in Section 7 of the OPEP.
Department of Industry Science, Energy and Resources (DISER)	DISER was provided the consultation package via email on 21 January 2022. No formal response has been received from DISER. This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA. 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 agencies/departments		
Department of Biodiversity and Conservation Attractions (DBCA)	DBCA was provided the consultation package via email on 21 January 2022. No formal response has been received from DBCA. This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA. 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.

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td rowspan="3">WA Department of Mines, Industry Regulation and Safety
(DMIRS)</td><td colspan="2">DMIRS was provided the consultation package via email on 21 January 2022.
No formal response has been received from DMIRS.
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">WA Department of Primary Industries & Regional Development
(DPIRD)</td><td colspan="2">DPIRD was provided the consultation package via email on 21 January 2022.
No formal response has been received from DPIRD.
Santos has assessed the impact to fish and commercial fisheries throughout Section 6 and Section 7.
This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA.
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">WA Department of Transport
(DoT)</td><td colspan="2">DoT was provided the consultation package via email on 21 January 2022.
DoT responded on 28 January 2022 advising:
+ if there is a risk of a spill impacting State waters from the activity, please ensure 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 (July 2020). [REQUEST 001],
This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA.
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>[REQUEST 001] Santos will ensure consultation with the DoT as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020).</td><td>No response required.</td></tr>
</table>

<table>
<tr><th colspan="3">Industry Bodies</th></tr>
<tr><td rowspan="4">Northern Prawn Fishing Industry
(NPFI)</td><td colspan="2">NPFI was provided the consultation package via email on 21 January 2022.
A reminder email and fishery map were sent to NPFI on 18 February 2022.
NPFI responded to Santos on 2 March 2022, acknowledged receipt of information sent on 21 January and outlined concerns in relation to the timing of the proposed activity [ISSUE 001] and the impact of the potential impact of acoustic survey technology on trawl grounds to the southwest of the well location [ISSUE 002].
Santos responded on 14 March 2022 and provided clarification on sound source methodology and limited impact on trawl grounds.
This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA.
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><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[ISSUE 001] Santos advised that survey timing has been confirmed for Q3 2022 based on vessel availability to coincide with the neap tide at the end of dry season, as this is when visibility is at its best. Santos acknowledged NPFIs suggested timing but advised that on-water interaction could be managed with appropriate communications protocols, noting also that the survey location is approximately 50 km north of the closest fishing effort area in the NPF.</td><td>Santos responded to NPFI's concern.</td></tr>
<tr><td>[ISSUE 002] Santos advised it had assessed potential impacts to the NPF from the use of acoustic survey methods as negligible, given the location of the survey, the short duration (no more than seven days) and the size of the acoustic source. Santos provided a summary of the assessment, which is provided in more detail in Section 6.5.</td><td>Santos responded to NPFI's concern.</td></tr>
<tr><td>Western Australian Fishing Industry Council
(WAFIC)</td><td colspan="2">WAFIC was provided the consultation package via email on 21 January 2022.
WAFIC acknowledged receipt of information on 10 February 2022 and welcomed further updates.
Santos responded to WAFIC on 22 February 2022 and committed to sharing expected environmental and safety impacts to assist their considerations and to providing further future updates.
WAFIC responded to Santos on 23 February recommending consultation with the Northern Prawn Fishing Industry [INFORMATION 001] and outlining concerns about overtrawl structure. [ISSUE 001]</td></tr>
</table>

	Santos responded to WAFIC on 9 March 2022 confirming consultation with NPFI and provided clarity on decommissioning options considered for the wellhead, and that leaving in situ was chosen as the preferred decommissioning option for Tern-1 based on technical, health and safety, environmental and social criteria WAFIC responded to Santos on 23 March 2002 advising it had no further comment at this stage given no State fisheries would be impacted. **[INFORMATION 002]** Santos responded on 25 March 2022 thanking WAFIC for its advice. This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA. 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 confirmed that it was consulting the Northern Prawn Fishery as part of consultation activities.	Santos responded to WAFIC and acknowledged their advice.
	[ISSUE 001] Santos notes WAFIC's concerns on the potential use of overtrawl structures and confirmed that leave in situ was the preferred decommissioning option for Tern-1 based on technical, health and safety, environmental and social criteria.	Santos responded to WAFIC's concern.
	[INFORMATION 002] Santos notes WAFIC's feedback that it had no further comment on proposed activities.	Santos responded to WAFIC and acknowledged their advice
Commercial Fisheries – Commonwealth Managed		
Northern Prawn Fishery (NPF)	Licence holders were provided the consultation package via email on 21 January 2022. A reminder email and fishery map were sent via email on 18 February 2022. No formal responses have been received from licence holders. 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.
Other stakeholders		
Australian Marine Oil Spill Centre (AMOSC)	AMOSC was provided the consultation package via email on 21 January 2022. No formal response has been received from AMOSC. This stakeholder is listed as a recipient of Santos' Quarterly Consultation Update for WA. 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.

4.5 Ongoing Consultation

Stakeholder consultation for this activity will be ongoing and Santos will work with stakeholders before, during and after the activity. Any new identified stakeholders (**Section 4.2**) 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, as committed to in **Section 8.9**.

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.

5 Environmental Impact and Risk Assessment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment
Evaluation of environmental impacts and risks 13(5) The environment plan must include: (a) details of the environmental impacts and risks for the activity; and (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. 13(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 impact and risk assessment refers to a process whereby planned and unplanned events that will or may occur during an activity are quantitatively and/or qualitatively assessed for their impacts on the environment (physical, biological, and socio-economic) at a defined location and specified period of time. In addition, unplanned events are assessed on the basis of their likelihood of occurrence which contributes to their level of risk.

Santos has undertaken environmental impact and risk assessments for the planned events (including any routine, non-routine and contingency activities) and unplanned events in accordance with the OPGGS(E)R 2009.

The following information relating to the environmental impact and risk assessment approach is provided in this Section of the EP:

+ Terminology used; and
+ Summary of the approach.

A full description of the process applied in identifying, analysing and evaluating the impacts and risks relating to the planned activity is documented in Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5).

5.1 Impact and Risk Assessment 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' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5).

Table 5-1: Impact and Risk Assessment Terms

Name	Definition
Acceptability	Determined for both impacts and risks. Acceptability of events is in part determined by the consequence of the impact following management controls. Acceptability of unplanned events is in part determined from its risk ranking following management controls. For both impacts and risks, acceptability is also determined from a demonstration of the ALARP principle, consistency with Santos Policies, consistency with all applicable legislation and consideration of relevant stakeholder consultation when determining management controls.
Activity	Specific tasks and actions undertaken throughout the life cycle of oil and gas exploration, production and decommissioning.
ALARP	As Low As Reasonably Practicable The term refers to reducing risk to a level that is As Low As Reasonably Practicable. In practice, this means showing through reasoned and supported arguments, that there are no other practicable options that could reasonably be adopted to reduce risks further.
Authorised Person	Person with authority to make the decision or take the action. Examples are Vessel Master, Field Superintendent, Supervisor, Person-in-charge, Company Authorised Representative, and Project Manager.
Control Measure	Means a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks[1].
DMIRS	Department of Mines, Industry Regulation and Safety
Environment	Includes the natural and socio-economic values and sensitivities which will or may be affected by the activity. Is defined by NOPSEMA and DMIRS as: (a) ecosystems and their constituent parts, including people and communities (b) natural and physical resources (c) the qualities and characteristics of locations, places and areas (d) the heritage value of places (e) the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).
Environmental consequence	A consequence is the outcome of an event affecting objectives. Note 1 An event can be one or more occurrences and can have several cases. Note 2 An event can consist of something not happening. (Reference ISO 73:2009 Risk Vocabulary)
Environmental impact	Defined by NOPSEMA[1] as any change to the environment, whether adverse or beneficial, wholly or partly resulting from a planned or unplanned event[1.] Defined by DMIRS as any change to the environment, whether adverse or beneficial, that wholly or partly results from a petroleum activity of an operator.
ENVID	Environmental hazard identification workshop

[1] Defined by the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

Environmental risk	Applies to unplanned events. Risk is a function of the likelihood of the unplanned event occurring and the consequence of the environmental impact that arises from that event.
Hazard	A situation with the potential to cause harm
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.
Impact assessment	The process of determining the consequence of an impact (in terms of the consequence to the environment) arising from a planned or unplanned event over a specified period of time.
Likelihood	The chance of an unplanned event occurring.
Non-routine planned event	An attribute of the planned activity that may occur or will occur infrequently during the planned activity. A non-routine planned event is intended to occur at the time.
Planned activity	A description of the activity to be undertaken, including the services, equipment, products, assets, personnel, timing, duration and location and aspect of the activity.
Planned event	An event arising from the activity which is done with intent (i.e. not an unplanned event) and has some level of environmental impact. A planned event could be routine (expected to occur consistently throughout the activity) or non-routine (may occur infrequently if at all). Air emissions, bilge water discharge and drill cuttings discharge would be examples of planned events.
Receptor	A feature of the environment that may have environmental, social and/or economic values.
Risk	The effect of uncertainty on objectives.
Risk assessment	The process of determining the likelihood of an unplanned event and the consequence of the impact (in terms of economic, human safety and health, or ecological effects) arising from the event over a specified period of time.
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.
SLT	Senior Leadership Team
Unplanned event	An event that results in some level of environmental impact and may occur despite preventive safeguards and control measures being 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 operates under an overarching Risk Management Policy (QE-91-IF-10050). The company Risk Procedure (SMS MS1 ST01) underpins the Risk Management Policy and is consistent with the requirements of AS/NZS ISO 31000:2018, Risk Management – Guidelines (ISO, 2018).

The key steps to risk management are illustrated in **Figure 5-1**. The forum used to undertake the assessment is the environmental hazard workshop, referred to as an ENVID, which is described in Section 4 of Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5).

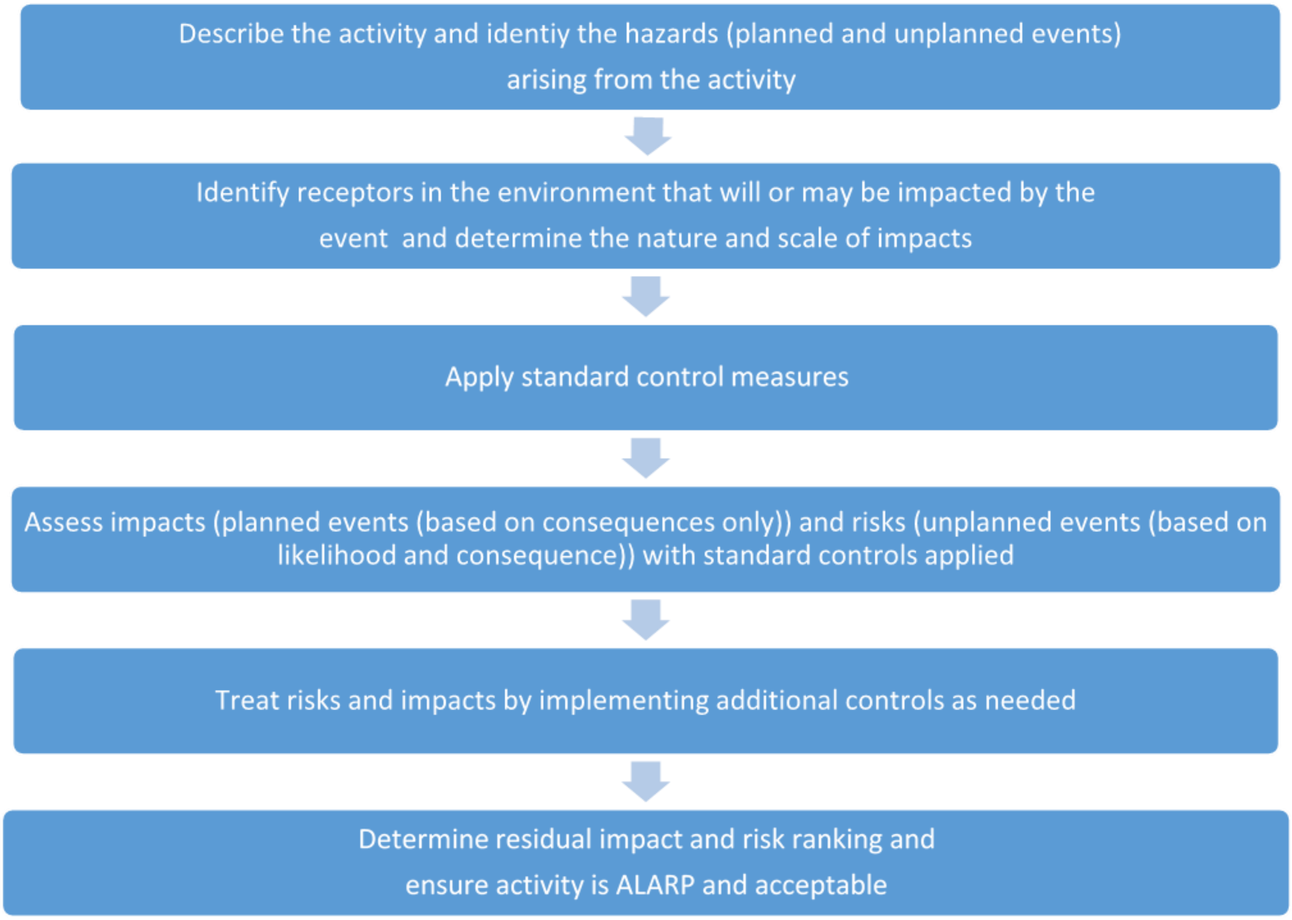


Figure 5-1: Environmental Impact and Risk Assessment Process

Santos’ *Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004) 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;
- Santos’ Environmental Management Policy and Standards;
- Principles of Ecologically Sustainable Development (ESD); and
- Santos acceptable levels of impact and risk.

These factors were considered in an environmental impact and risk assessment workshop held in December 2021 in which environmental hazards were identified and assessed (ENVID workshop). The workshop involved participants from Santos' Health, Safety and Environment (HSE), Subsurface, drilling and completions and specialist environmental consultants.

5.2.2 Describe the Activity and Hazards (planned and unplanned events)

The petroleum activity is described in **Section 2** of this Environment Plan. An assessment against the activity was undertaken, and the environmental hazards and aspects were identified. The outcome of this assessment is detailed in the relevant sub-sections of **Sections 6** and **7**.

5.2.3 Identify Receptors and Determine Nature and Scale of Impacts

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. A description of the environment (natural and socio-economic) within which hazards from the activity will, or may occur, is required (**Section 3**). This constitutes a crucial stage of the risk assessment, as an understanding of the environment that will or may be affected is required to determine the type and consequence of impacts from the activity are being assessed. The environment must be understood with respect to the spatial and temporal limits of the activity and key resources at risk that will or could be impacted by planned and unplanned events. Santos has developed a *Values and Sensitivities of the Marine and Coastal Environment (EA-00-RI-10062)* reference document which describes the existing environment that may be affected by Santos activities and is reviewed and updated on an annual basis.

Where the existing environment is being reviewed for regulatory approvals, a comparison shall be made against the *Values and Sensitivities of the Marine and Coastal Environment* (EA-00-RI-10062). A new protected matters search is required to ensure a thorough understanding of the existing environment to ensure all risks are assessed.

The extent of actual impacts from each planned activity or risks from each unplanned activity, are 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 **Section 3** and **Appendix D** – EPBC Protected Matters Search Tool Results.

5.3 Describe the Environmental Performance Outcomes and Control Measures

For each planned and unplanned event, a set of Environmental Performance Outcome(s), Control Measures, Environmental Performance Standards and Measurement Criteria are identified. The definitions of the performance outcomes, control measures, standards and measurement criteria must be consistent with the OPGGS(E)R 2009, and the NOPSEMA Environment Plan Content Requirements Guidance Note (NOPSEMA, 2020c).

For any hazard, additional controls, must also be considered and either accepted for use or rejected based on whether the standard controls reduce impacts and risks to levels that are ALARP and acceptable (refer **Section 5.5** and **5.6**).

Controls are allocated in order of preference according to **Figure 5-2**.

Control	Effectiveness	Example
Eliminate		*Removal of the risk.* Refueling of vessels at port eliminates the risks of an offshore refueling.
Substitute		*Change the risk for a lower one.* The use of low-toxicity chemicals that perform the same task as a more toxic additive.
Engineering		*Engineer out the risk.* The use of oil-in-water separator to minimise the volume of oil discharged.
Isolation		*Isolate people or the environment from the risk.* The use of bunding for containment of bulk liquid materials.
Administrative		*Provide instructions or training to people to lower the risk.* The use of Job Hazard Analysis to assess and minimise the environmental risks of an activity.
Protective		*Use of protective equipment.* Containment and recovery of spilt hydrocarbons.

Figure 5-2: Hierarchy of Controls

5.4 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 using the Santos Environment Consequence Descriptors (**Appendix G** – Santos Environment Consequence Descriptors).

These detailed environmental consequence descriptions are based on the consequence of the impact to relevant receptors in 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. Likelihood rankings are provided in the Santos risk in **Table 5-3**.

The level of information required to complete the impact or risk assessment depends on the nature and scale of the impact or risk. 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. Impacts to social and economic values are also considered based on existing knowledge and feedback from stakeholder consultation. As the result of historic consultation with stakeholders, the social and economic values in the region that are of interest are evident.

As planned events are expected to occur during the activity, the likelihood of their occurrence is not considered during the risk assessment, and only a consequence level is assigned.

Table 5-2: Summary of Environmental Consequence Descriptors

Consequence Level		Consequence Level Description
I	Negligible	No impact or negligible impact.
II	Minor	Detectable but insignificant change to local population, industry or ecosystem factors.
III	Moderate	Significant impact to local population, industry or ecosystem factors.
IV	Major	Major long-term effect on local population, industry or ecosystem factors.
V	Severe	Complete loss of local population, industry or ecosystem factors AND/ OR extensive regional impacts with slow recovery.
VI	Critical	Irreversible impact to regional population, industry or ecosystem factors.

For unplanned events, the consequence level of the impact is combined with the likelihood of the impact occurring (**Table 5-3**), to determine a residual risk ranking using the corporate Santos risk matrix (**Table 5-4**). For oil spill events, potential impacts to environmental receptors are assessed where they occur within the EMBA using results from modelling.

Table 5-3: Likelihood Description

No.	Matrix	Description
f	Almost Certain	Occurs in almost all circumstances OR could occur *within days to weeks*
e	Likely	Occurs in most circumstances OR could occur *within weeks to months*
d	Occasional	Has occurred before in Santos OR could occur *within months to years*
c	Possible	Has occurred before in the industry OR could occur *within the next few years*
b	Unlikely	Has occurred elsewhere OR could occur *within decades*
a	Remote	Requires exceptional circumstances and is unlikely even in the long term

Table 5-4: Santos Risk Matrix

		Consequence					
		I	II	III	IV	V	VI
Likelihood	F	Low	Medium	High	Very High	Very High	Very High
	E	Low	Medium	Medium	High	Very High	Very High
	D	Low	Low	Medium	High	High	Very High
	C	Very Low	Low	Low	Medium	High	Very High
	B	Very Low	Very Low	Low	Low	Medium	High
	A	Very Low	Very Low	Very Low	Low	Medium	Medium

5.5 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'.

5.6 Evaluating Impact and Risk Acceptability

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

+ The consequence of a planned event is ranked as I or II; or a risk of impact from an unplanned event is ranked Very Low to Low
+ An assessment has been completed to determine whether further information or studies are required to support or validate the consequence assessment
+ Assessment and management of risks has addressed the principles of ecologically sustainable development
+ That the acceptable levels of impact and risks have been informed by relevant species recovery plans, threat abatement plans and conservation advice can be demonstrated
+ Performance standards are consistent with legal and regulatory requirements
+ Performance standards are consistent with the Santos' Environmental Management Policy

- Performance standards are consistent with industry standards and best practice guidance (e.g., National Biofouling Management Guidance Guidelines for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018))
- Performance outcomes and standards are consistent with stakeholder expectations
- Performance standards have been demonstrated to reduce the impact or risk to ALARP.

6 Planned Activities Risk and Impact Assessment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Environmental performance outcomes and standards 13(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.

An ENVID workshop (as described in **Section 5** for planned activities was held in December 2021. This workshop identified eight potential sources of environmental impact associated with the planned activities to be undertaken in the operational areas. The results of the impact assessments are summarised in **Table 6-1**. Given that the risk of a planned event occurring is 100% likelihood (i.e., it will occur), the residual risk ranking is not assessed (as explained in **Section 5.1**). The potential impact assessment for each planned event and the subsequent control and management measures proposed by Santos to reduce the extent of the impacts are detailed in the following subsections.

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

EP Section Reference	Hazard		Residual Consequence Level
6.1	Physical presence (Wellhead in-situ)		I – Negligible
6.2	Interaction with other marine users (vessel operations)		I – Negligible
6.3	Seabed disturbance		I – Negligible
6.4	Light emissions		I – Negligible
6.5	Noise emissions		I – Negligible
6.6	Atmospheric emissions		I – Negligible
6.7	Planned Operational discharges		I – Negligible
6.8	Contingency Spill Response Operations	Light emissions	I – Negligible
		Noise emissions	I – Negligible
		Atmospheric emissions	I – Negligible
		Operational discharges and waste	I – Negligible
		Physical presence and disturbance	I – Negligible
		Disruption to other users of marine and coastal areas and townships	I – Negligible

6.1 Physical Presence (wellhead in-situ)

6.1.1 Description of Event

Event	Interaction with other marine users may occur as a result of: + Wellhead remaining in-situ The decommissioning options assessment (**Section 2.4**) presented Option D (leave in-situ) as the preferred option in terms of technical, environmental, safety and economic criteria. The permanent physical presence of the wellhead will continue to: + Provide a hard substrate resulting in the creation of a new habitat + Potentially interrupt natural sediment movement in the immediate vicinity of the wellhead remaining in-situ permanently + Introduce contaminants to the water column and sediment surrounding the wellhead as it degrades overtime. Unplanned interaction with other marine users as a result of the physical presence of the wellhead (e.g. snag risk) are assessed in **Section 7.8**).
Extent	Wellhead location
Duration	Long-term. The wellhead is expected to persist long term (i.e. it will take many decades to degrade completely).

6.1.2 Nature and Scale of Environmental Impacts

<u>Potential receptors: Physical environment (benthic habitats), Threatened, migratory or local fauna, protected and significant areas</u>

6.1.2.1 Physical environment

Benthic Habitats

Studies of erosion/accretion around subsea structures (e.g. shipwrecks, artificial reefs) indicate indirect impacts may be limited to within 20 m of the structure (Smiley 2006; Lewis and Pagano 2016). Given the small size of the Frigate-1 wellhead, this is considered a reasonable, if not conservative, potentially affected area.

The closest benthic habitat survey to the Frigate-1 wellhead was undertaken approximately 14km away in the adjacent Tern field in 2011(ERM, 2011). The ERM survey does not indicate a significant change in the existing seabed, with sand identified as the predominant seabed habitat and no unique marine invertebrates or benthic assemblages (**Section 3.2.1.2**).

As the wellhead degrades over time breakdown products (predominantly non-toxic iron oxides) will be released into the surrounding water column and the surrounding sediments. Ocean currents are expected to rapidly disperse the breakdown products.

As the wellhead integrity reduces over time, sections of the wellhead may break off and fall onto the surrounding seabed. This would only affect habitat (i.e. unconsolidated sediments) within 5 m of the wellhead.

6.1.2.2 Threatened / Migratory Fauna

The Frigate-1 wellhead has been plugged and abandoned since 1978. In this time, the wellhead is expected to have become a stable benthic habitat with higher marine life abundance and diversity (notably fish) than the surrounding naturally flat, sandy sediments.

This 'reef effect' of anthropogenic structures has been well documented (e.g. Love and York 2005; Pradella et al 2014). The value of the wellhead as artificial benthic habitat will continue until the wellhead has completely degraded (i.e. potentially in excess of a hundred years).

The release of breakdown compounds into the water column and accumulation in sediments may affect marine fauna, particularly infauna species surrounding the wellhead. Notwithstanding this, iron oxide is naturally occurring, and generally has low toxicity to marine fauna.

6.1.2.3 Protected and significant areas and socio-economic receptors

There is no exclusion zone in place around the wellhead that would exclude commercial fishing or other activities. The operational area is not extensively fished – commercially, traditionally or recreationally (**Section 3.3.2**).

The operational area does not intersect with any recognised shipping routes, with the nearest fairway located 880 km west, though there may be vessel traffic. Interactions between the wellhead and shipping activity has not been raised with Santos to date and is unlikely based on the water depth of the operational area (approximately 112 m) and with the height of the wellhead being only approximately 3 m.

There are no oil and gas facilities or infrastructure within the operational area, with the closest being the Tern-1 wellhead approximately 14 km from operational area.

There are no marine protected areas within the operational area. However, the operational area intersects the Pinnacles of the Bonaparte Basin Key Ecological Feature (KEF). It provides areas of hard substrate in an otherwise soft sediment environment, and high biodiversity of sponges is a key value.

6.1.3 Environmental Performance Outcomes and Control Measures

The wellhead is comprised predominantly of iron which is not considered to be a contaminant in the marine environment. Corrosion is likely to be a relatively slow process about 0.2 mm/year (Melchers, 2005). Based on the composition of the wellhead and the low corrosion rate of the wellhead materials environmental impacts associated with leaving the wellhead in situ are considered to be of an acceptable level.

As the potential impacts are considered to be acceptable and changes to the marine environment as a result of leaving the wellhead in situ are likely to be undetectable, environmental performance outcomes relating to environmental monitoring have not been included.

The ALARP evaluation for additional control measures for this event are shown in

Table 6-2.

Table 6-2: Control Measure Evaluation for Physical Presence (wellhead in-situ)

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Additional Control Measures				
N/A	Complete removal (base case)	Removing the wellhead will result in the environment being left in a condition close to what it was before the well was drilled. Removing the wellhead would mean no potential long-term corrosion, releasing trace amounts of metals into the water column. Due to water depth and wellhead material, corrosion is expected to be slow. Iron oxides are not considered a significant contaminant and are naturally abundant in marine sediments. Given the small size (assumed to be 1 m wide by 3 m tall) and properties of the wellhead (inert material) the environmental benefits of complete removal are expected to be small. Removal by internal cutting may not be technically feasible as the high-pressure housing, temporary abandonment cap and latching	It is estimated that wellhead removal costs would be in the range of AUD $3M to $5M* as two campaigns would be required. One campaign for marine growth cleaning and inspection, the other for removal of the wellhead. The removal operations would, amongst other environmental affects, cause localised seabed disturbance, generate metal cuttings and remove artificial habitat. The operation would result in health and safety risks to the workforce due to the unknown condition of the wellhead. There would also be GHG emissions associated with the removal campaign and subsequent wellhead disposal. * The lower estimate considers potential cost savings by completing one of the campaigns in conjunction with future nearby petroleum activities (e.g. Tern-2 plug and abandonment). The upper estimate is based on two dedicated	**Rejected –** As detailed in **Section 2.4**, leave in-situ is the preferred decommissioning outcome as it provides a benefit from an environmental, safety and technical perspective. Attempting to remove the wellhead would also introduce technical risks (described in Section 2.4) and cost in the range of AUD $3M to $5M. There is no ongoing exclusion zone around the wellhead to exclude other marine users from the area. Further unnecessary health and safety risks to the workforce would result. As such, the costs and health and safety risks to remove the wellhead are considered disproportionately high compared to the low risk of environmental effects of leaving the wellhead in-situ.

		mechanism are unknown potentially preventing internal access.	wellhead removal campaigns.	Note unplanned impact to other marine users (e.g. snag risk) is assessed in **Section 7.8**.
N/A	Wellhead monitoring	Monitoring of the wellhead would assist in validating the environmental assessment that concluded only negligible impacts.	It is estimated that each monitoring campaign would cost between AUD $100,000 to $200,000. Numerous monitoring campaigns would be required to collect meaningful data. Impacts are unlikely to be detectable beyond the immediate area surrounding the wellhead. Impacts are also unlikely to be detected for decades based on the slow rate of wellhead corrosion (0.2 mm/year) (Melchers, 2005). Similar to above, offshore vessel operations would generate associated emissions and discharges (e.g. GHG, noise, operational discharges) and risks (e.g. introduction of IMS, MDO spill). It would also result in maritime safety risks to the workforce.	**Rejected –** There is no compelling reason for wellhead monitoring given the environmental assessment is predicting negligible impacts. The level of uncertainty with the associated environmental impacts assessment is considered low. There is a low level of uncertainty associated with the impact prediction. As such, the costs and health and safety risks associated with an offshore monitoring program are considered disproportionately high to the low environmental benefits that a monitoring program would possibly provide.
N/A	Wellhead maintenance	No environmental benefit is expected from any wellhead maintenance. There is no risk of LOWC, as the well was permanently plugged and abandoned; therefore, there is no benefit to	Refer to above costs sand issues associated with vessel activities for wellhead maintenance campaigns.	**Rejected –** There is no justification for maintaining the wellhead. The wellhead is not expected to be contaminated with any hazardous material. The well has been permanently plugged and

		conducting any maintenance.		abandoned. Hence the wellhead is of no use. The wellhead will slowly degrade, lose its structural integrity and eventually break apart. This is inevitable, and the desired outcome.

6.1.4 Environmental Impact Assessment

Table 6-3: Impacts and Consequence Ranking – Physical Presence (Wellhead in-situ)

Receptor	Consequence Level
Physical Presence	
Threatened, migratory or local fauna	Corrosion of the wellhead over time could result in the release of trace amounts of metals (e.g., iron and manganese) to the water column and surrounding sediments. Due to the robustness of the materials of the wellhead and the deep-water location of the wellheads, corrosion is likely to be a relatively slow process about 0.2 mm/year (Melchers, 2005). Iron, the main constituent (~98%) of the wellheads and casing material, is not considered a significant contaminant in the marine environment and is only toxic to marine organisms at extremely high concentrations (Grimwood and Dixon, 1997) and is an abundant element in marine sedimentary systems (Taylor et al, 2011). Given the slow breakdown process, such levels will not be met at any point during the breakdown of the wellhead. The operational area overlaps the foraging BIAs for the green turtle, the olive ridley turtle and the flatback turtle (Section 3.3.6.1) although the presence of these species in the operational area for any duration is unlikely (**Section 3.2.3.1**). Given the low toxicity of iron (which is on the OSPAR PLONOR list), the slow release rate and rapid dilution in the open ocean environment, no impacts are expected to protected species that may occur at the depth of the wellhead (112 m). Several studies undertaken on wellheads on the NWS have observed a diverse range of reef dependant and transient pelagic species associating with structures including commercially fished species (Pradella et al. 2014). Wellheads in the NWS at depths between 82 and 135 m were found to sustain full populations of Prubrizonatus from juveniles through to adults (Fowler and Booth, 2012). The physical presence of the wellhead is likely to have a localised increase the diversity and abundance of some fish species; thereby providing the potential for fish assemblages. Therefore, impacts to threatened or migratory fauna are assessed as I (Negligible).

Receptor	Consequence Level
Physical environment or habitat	Localised scouring and accretion has the potential to alter the seabed and associated benthic communities around the wellheads. Studies of erosion/accretion around subsea structures (e.g. shipwrecks, artificial reefs) indicate indirect impacts may be limited to within 20 m of the structure (Smiley 2006; Lewis and Pagano 2016). Corrosion of the wellhead over time could result in the release of trace amount of metals (e.g. iron and manganese) to the water column and surrounding sediments. Considering the composition of the wellhead and the flat featureless benthic habitat within the operational area comprised predominantly of sand with a proportion of silt and clay, impacts to the physical environment or habitat are assessed as I (Negligible).
Threatened ecological communities	Not applicable – No threatened ecological communities occur at or near the wellhead.
Protected areas	There are no marine protected areas within the operational area. The operational area intersects the Pinnacles of the Bonaparte Basin KEF). It provides areas of hard substrate in an otherwise soft sediment environment, and high biodiversity of sponges is a key value. The wellhead has been in-situ since 1978 and would be colonised with marine growth and provide an additional area of hard substrate. There is no further disturbance to the KEF from the ongoing presence of the wellhead. Therefore, impacts to protected areas are assessed as I (Negligible).
Socio-economic receptors	Adverse impacts to commercial fisheries' target species are not predicted given the small size and profile and inherent properties of the wellhead. The wellhead will provide a hard substrate habitat on a seabed predominantly comprised of soft sediment. Unplanned interactions with marine users from the wellhead remaining in-situ is evaluated in **Section 7.8**. The impact of the physical presence of the wellhead on socio-economic receptors are considered to be I (Negligible) due to the fact that: + The operational area does not intersect with any recognised shipping routes, with the nearest fairway located 880 km west, though there may be vessel traffic. The water depth (approximately 112 m) and height of the wellhead (expected to be 3 m) will not displace any shipping activity. + There is no formal exclusion zone for the planned survey activity and nor is there an existing or proposed ongoing exclusion zone around the wellhead. The operational area is not extensively fished – commercially, traditionally or recreationally. The activity is unlikely to cause any fishing impacts. + There are no oil and gas facilities or infrastructure within the operational area, with the closest being the Tern-1 wellhead approximately 14 km from operational area. + Interactions between the wellhead and shipping activity is unlikely now or in the future based on the water depth of the operational area (approximately 112 m) and the height of the wellhead at approximately 3 m.

Receptor	Consequence Level
	+ The distance to the closest area of any fishing effort (low effort with <3 vessels) is approximately 50 km. During stakeholder consultation, the NPFI had no objection to leaving the wellhead in-situ (**Section 4.4**). + Stakeholder consultation and a review of recent shipping data did not raise any concerns regarding disruptions to commercial shipping or other oil and gas operators.
Overall worst-case consequence	I - Negligible

6.1.5 Demonstration of ALARP

As described in **Section 2.4**, leaving the wellhead in-situ (Option D) is the preferred option. The environmental impacts of this option have been assessed as negligible.

Option A and B (Removal by external cutting; and Internal cutting respectively) would require additional vessel campaigns, introducing additional environmental impacts, including vessel emissions and discharges, further impact to other users and unplanned risks (e.g. introduction of IMS and hydrocarbon spills). These options received a lower preference ranking for technical feasibility, maritime health and safety risks and financial costs.

While removing the wellhead would also result in negligible environmental impacts, this option introduces company financial costs, environmental risks (e.g. vessel fuel oil spills) and workforce health and safety risks. Santos has concluded that the financial costs and health and safety risks are disproportionately high to the low environmental benefits obtained from removing the wellhead.

Wellhead maintenance and monitoring control measures were considered but rejected given they provided no material environmental benefit. The cost and health and safety risks associated with these control measures could not be justified in this instance as detailed in **Section 6.2.3**. Therefore, it is considered that the impact is ALARP.

6.1.6 Acceptability Evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – maximum consequence from physical presence is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	N/A – no relevant requirements regarding this event in this area, given the localised nature and extent of the operational facilities. No plans identified seabed disturbance like those described above as being a threat to marine fauna or habitats.

	Santos has also consulted with relevant decision-making government authorities and no concerns or objections have been raised. DAWE has advised that a Sea Dumping Permit is not required in this instance because the Firgate-1 wellhead was plugged and abandoned in 1978 and it predates the *Environment Protection (Sea Dumping) Act 1981* (**Section 4.4**).
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – Feedback from the NPFI during stakeholder consultation confirmed there is no objection to leaving the wellhead in-situ as fishing effort is to the south. Following further consultation with the NPFI, no additional concerns were raised. Santos considers these concerns to have been addressed or will be addressed as per the Activity Notification and Reporting Requirements (**Table 8-4**).
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The potential environmental consequence of leaving the wellhead in-situ has been assessed as I (Negligible). No control measures are considered necessary to further reduce the environmental impacts unless the survey reveals an unexpected finding. The wellhead has been in place since 1978 without any known environmental or reported stakeholder impacts.

6.2 Interaction with Other Marine Users (vessel operations)

6.2.1 Description of Event

Event	Interaction with other marine users may occur as a result of: + Vessel Operations The survey will take up to 7 days at the Frigate-1 operational area. No support vessels are required during the survey; and there is no exclusion zone being imposed around the survey area. The movement of the survey vessel within the operational area has the potential to result in interactions with other marine users. The vessel will be either stationary or operating at slow speeds while undertaking activities within the operational area. No anchoring will occur within the operational area. The vessel transiting to and from the operational area are not included in the scope of this EP and operate under the *Navigation Act 2012*. The Activity could potentially inhibit or be a disturbance to marine user groups including commercial shipping and fishing. However, there are no known recognised major shipping routes within the vicinity of the operational area. For commercial fishing licence holders, the level of interaction could lead to temporary displacement to fishing grounds. The presence of the vessel could pose a navigational hazard and a collision risk (refer to **Section 7.2**).Unplanned interaction with other marine users as a result of the physical presence of the wellhead remaining in-situ (e.g. snag risk) are assessed in **Section 7.8**).

Extent	Vessel operations: within the operational area
Duration	Vessel Operations: for the duration of the activity (up to 7 days), as described in **Section 2**

6.2.2 Nature and Scale of Environmental Impacts

Potential Receptors: Commercial Fishers, Commercial Shipping, Petroleum Activity

Santos has identified the following stakeholders as potential marine users of the operational area; commercial fishers, commercial shipping and other petroleum-related vessels. These users may be temporarily displaced by the physical presence of the survey vessel.

The potential effects of noise on commercially valuable marine fauna, (relevant to commercial fishers), is addressed in **Section 6.5**.

6.2.2.1 Socio-economic

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 four Commonwealth fisheries with management areas that overlap the operational area and broader EMBA (**Table 3-8**). These include:

- Skipjack Tuna Fishery
- Southern Bluefin Tuna Fishery
- Western Tuna and Billfish Fishery
- Northern Prawn Fishery (NPF).

The NPF is recognised as the only Commonwealth fishery with activity within the vicinity of the operational area (**Table 3-8**).

There are also eight State fisheries with management areas that overlap with the operational area. These are summarised in **Table 3-9**.

An analysis of the historical fishing effort data, current fishery closures, depth range of activity, fishing methods and consultation feedback (refer to **Section 4** and **Table 3-9**) has revealed that there is a low potential for interaction with state commercial fisheries. FishCube data from 2010-2020 indicated that there was no activity within the operational area, however, the Northern Demersal Scalefish Managed Fishery recorded activity of less than 3 active vessels within the EMBA in 2011, 2012 and 2019.

The temporary disruption to fishing grounds due to the presence of the operational area during the survey is therefore not expected to be disruptive due to the short duration of the activity.

It is recognised that Indigenous subsistence fishing and traditional hunting may occur in waters close to shorelines, outside of the operational area and therefore interactions with the vessel will not occur. Consultation with indigenous users has raised no concerns about the activity occurring in offshore waters.

Unplanned interaction with other marine users as a result of the physical presence of the wellhead (e.g. snag risk during trawling) is assessed in **Section 7.8.**

Commercial Shipping

The Frigate-1 operational area does not intersect with any recognised shipping routes, with the nearest designated shipping route located 880 km away within the EMBA (**Figure 3-10**). Any deviation would be minor and given the duration of the survey, is not expected to effect travel times or fuel use of these vessels. There is no exclusion zone (Petroleum Safety Zone) required during the survey.

Petroleum Activities

Interaction with other petroleum activities is not expected to occur. The Bonaparte Basin hosts several oil and gas companies within the area. The Frigate-1 wellhead is approximately 68 km southwest of Petrel-1 and 14 km west of the neighbouring Tern-1 well.

The closest platform is the Blacktip WHP (ENI Aus), located approximately 97 km from the Frigate-1 operational area.

6.2.3 Environmental Performance Outcomes and Control Measures

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

+ 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 [FRI-EPO-05]

The Control Measures considered for this Activity are shown in **Table 6-4** with Environmental Performance Standards (EPS) and Measurement Criteria for the EPOs described in **Section 8.4**.

Table 6-4: Control Measures Evaluation for Interaction with Other Marine Users

Control Measure (CM) Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard Controls				
FRI-CM-002	Constant bridge-watch (visual and radar)	Crew of vessel(s) will maintain constant bridge watch, including for third party vessels which may be approaching or enter the exclusion zone.	Negligible costs associated with the personnel time.	**Adopted** – Benefits considered to outweigh negligible costs.
FRI-CM-011	Maritime Notices	Ensures other marine users are aware of the presence of the vessel(s), 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.

Control Measure (CM) Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
FRI-CM-016	Santos stakeholder consultation strategy	Ensures other marine users, such as commercial fishers, are aware of upcoming operations so they can plan their business accordingly.	Costs associated with personnel time in preparing and distributing information and collating/addressing any feedback provided.	**Adopted** – Benefits considered to outweigh negligible costs to Santos. Important control to ensure other marine users are aware of upcoming operations and potential business disruptions. Provides an opportunity for Santos and stakeholders to discuss additional ways of minimising on-water interference and business disruptions.
FRI-CM-022	Lighting will be used as required for safe work conditions and navigational purposes.	Ensures vessels are seen by other marine users. Reduced risk of environmental impact from vessel collisions due to ensuring safety requirements are fulfilled. Marine Order Part 30: Prevention of Collisions, and with Marine Order Part 21: Safety of Navigation and Emergency Procedures, requires vessels to have navigational equipment to avoid collisions.	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.
FRI-CM-023	No fishing from vessel(s)	Reduces potential impacts to fisheries in the vicinity of the activity.	Negligible cost	**Adopted** – Benefits considered to outweigh negligible costs to Santos

Control Measure (CM) Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
FRI-CM-024	Seafarer certification	Requires appropriately trained and competent personnel to navigate vessels, which reduces negative interaction with other marine users.	Costs associated with personnel time in obtaining qualifications.	**Adopted** – Benefits considered to outweigh costs and is a legislated requirement.
FRI-CM-025	Marine Assurance Standard	Ensures vessels meet Marine assurance standards and are operated, maintained and manned in accordance with industry standards.	Costs associated with personnel time in checking vessel.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant, outweighs the costs. Regulatory requirement must be adopted.
Additional Control Measures				
N/A	Manage the timing of the operational activities to avoid peak marine user periods (e.g., fishing).	Would eliminate potential impacts to other marine users.	High cost in moving or delaying activity schedule for operational reasons (schedule dependent on availability of offshore survey vessel(s) and well sequence). The risk to all other marine users cannot be reduced due to variability in timing of key periods and unlikely presence in operational area given distance offshore and survey location being approximately 50 km north of the closest fishing effort for the NPF.	**Rejected** – Cost disproportionate to low socio-economic benefit given the location of the activity has low-usage by other marine users and any on-water interaction can be managed with appropriate communication protocols adopted above.
N/A	Eliminate the use of vessels	Would eliminate potential impacts to other marine users.	Not considered feasible as a vessel is the only form of	**Rejected – Not** considered feasible

Control Measure (CM) Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
			transport that can undertake the activities.	
N/A	If wellhead is not located after grid search is complete, continue search until wellhead is located.	Would confirm location of wellhead and the condition of the wellhead. This would validate the decommissioning options evaluation which recommended the wellhead be left in-situ (**Section 2.4.5**).	Continuation of the search for the wellhead once the search grid is completed would extend the survey; meaning: + an increase to the duration of vessel activity (with associated impacts and risks such as emissions, discharges and spill risk). + extend duration of acoustic survey activities (i.e., noise emissions). + increase the cost of the survey.	**Rejected –** continuation of the search for the wellhead once the search grid is completed would lead to increased potential environmental impacts and risks from vessel activities and acoustic survey techniques. The wellhead has been in place since 1978. Santos have recently located the nearby Tern-1 well of similar vintage using a similar grid search. If the well cannot be found, it is assumed it is buried.

6.2.4 Environmental Impact Assessment

Table 6-5: Impacts and Consequence Ranking – Interaction with Other Marine Users

Receptor	Consequence Level
Interaction with other marine users	
Threatened, migratory or local fauna	Not applicable – related to socio-economic receptors only.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	The impact of the vessel operations on socio-economic receptors are considered to be I (Negligible) due to the fact that:

Receptor	Consequence Level
	+ The operational area does not intersect with any recognised shipping routes, with the nearest fairway located 880 km west, though there may be vessel traffic. Any risk to commercial shipping activities is mitigated through notifications sent to the AMSA's Joint Rescue Coordination Centre (JRCC) for Auscoast warnings and the Australian Hydrographic Service (AHS) for Notices to Mariners, as outlined in **Section 6.2.3.** + Transiting vessels could be expected to divert around the survey vessel, but this would be temporary given the duration of the activity –a maximum duration of 7 days is expected at the operational area to conduct the survey. + Tourism activities are not expected to occur in the operational area given the water depth (approximately 112 m), and distance from shore. + The operational area is not extensively fished – commercially, traditionally or recreationally. There is no formal exclusion zone during the survey activity. The activity is unlikely to cause any fishing impacts. There are no oil and gas facilities or infrastructure within the operational area, with the closest being the Tern-1 wellhead approximately 14 km from operational area. + NPFI raised concerns about potential impacts to commercial fishing from the survey timing and acoustic survey techniques. However, following further consultation with the NPFI, no additional concerns were raised. + Stakeholder consultation and a review of recent shipping data did not raise any concerns regarding disruptions to commercial shipping or other oil and gas operators.
Overall worst-case consequence	I - Negligible

6.2.5 Demonstration of ALARP

Vessel Operations

There are no alternatives to the use of a vessels to undertake the activity. Navigational controls, as specified in the Navigation Act, will be implemented (lighting, communication aids and charting). The survey location is approximately 50 km north of the closest NPF fishing activity and no concerns have been raised by stakeholders regarding potential interaction during the survey period (**Section 4.4**). If the management controls are adhered to, then the risk of interacting with other users of the sea will have been reduced to ALARP.

Santos' stakeholder consultation process is described 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 impacted for the duration of the activity, and the potential schedule. Notice to Mariners will be issued detailing the location and nature of activities and the vessels will maintain navigation aids.

6.2.6 Acceptability Evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – maximum consequence from interaction with other marine users is I (Negligible).

Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with Safety of Life at Sea (SOLAS) 1974 and *Navigation Act 2012*.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – NPFI raised concerns about the potential impacts to commercial fishing from the survey timing and acoustic survey techniques. NPFI responded with the following: + no objection to the proposed petroleum activity given fishing effort to the south. + requested the survey to be conducted outside of their now reduced window for trawling – was two seasons (quarters), now one for sustainability reasons – August to October + confirmation on use of acoustic source will be used for wellhead location. Santos responded to NPF's concerns during consultation, and no additional concerns were raised. Santos considers these concerns to have been addressed or will be addressed as per the Activity Notification and Reporting Requirements (**Table 8-4**).
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The presence of the vessel and the remaining wellhead is not expected to significantly affect other marine users, including commercial fishing operations or shipping traffic, given:

+ There is no exclusion zone required for this activity
+ Short duration of the survey activity – up to 7 days at the operational area
+ Charting the updated wellhead location on nautical charts via the AHO
+ Notification of the wellhead location to NPF licence holders via the NPF Industry
+ No ongoing exclusion zone required to leave the wellhead in-situ

+ Low profile of the wellhead (approx. 3 m) in approximately 112 m water depth

The controls proposed will ensure that other users are aware of the presence of the vessel and are able to navigate accordingly, such that potential impacts are ALARP and are considered to be environmentally acceptable.

6.3 Seabed Disturbance

6.3.1 Description of Event

Event	Potential seabed disturbance (temporary) may occur in the operational area as a result of: + ROV Operations + Wellhead survey During the survey, the ROV will be operating close to the seabed, and the ROV's thrusters may result in the suspension of seabed material. If USBL is used to locate the wellhead, transponders may be temporarily placed on the seabed. Seabed disturbance from the physical presence of the well is not considered within the scope of this EP, as the well was drilled in the 1970's and the wellhead has been in-situ since then. There will be no anchoring or mooring of the vessels within the operational area.
Extent	Any seabed disturbance will occur within the operational area.
Duration	Temporary - for the duration of the activity, <7 days.

6.3.2 Nature and Scale of Environmental Impacts

<u>Potential receptors: Physical environment (benthic habitats), Threatened, migratory or local fauna, protected and significant areas</u>

Operational activities may disturb seabed and benthic habitat through the following impacts:

+ Smothering and alteration of benthic habitats
+ Indirect disturbance to benthic habitats and associated marine fauna by sedimentation
+ Localised and temporary increase in turbidity near the seabed.

6.3.2.1 Physical environment

Benthic Habitats – smothering and alteration of benthic habitats

The use of equipment (i.e. transponders) for the survey will directly contact the seafloor and will inevitably result in very localised impact (direct and indirect) to water quality, seabed features and the benthic environment in the operational area. Environmental impacts would be directly associated with temporarily placing survey equipment on the seabed, however, the impacts to seabed are expected to be highly localised and of short duration.

Parking the ROV on the seabed is not a planned activity. Operating an ROV within close proximity to the seabed may disturb the sediment; expected to be approximately <1.5 m^2. Therefore, any impact will be limited to the immediate vicinity of the well location, and thus the extent of potential impact is considered to be very localised.

The benthic habitat within the operational area is characterised by primarily sand, coarse shell fragments and silt; with infauna assemblages and sparse coverage of sessile epibenthic organisms. The benthic area around the well is not dissimilar to the rest of the operational area.

Given the lack of sensitive benthic receptors, and that potential damage would only occur within a small area, it is expected that any localised impacts from the ROV and transponders contacting the seabed would rapidly recolonise and recover from any disturbance. Therefore, the potential impact has been determined as Negligible (I).

Benthic Habitats – localised and temporary increase in turbidity near the seabed

Benthic habitat may be disturbed through the temporary increase in turbidity near the seafloor when the thrusters are used. The impact from the thrusters is not expected to cause the suspension of a large volume of material. In addition, the high settling velocity of sand (and coarser) material would ensure that the particles do not remain in suspension for an extended period of time.

The location of the well within a homogenous seabed area, and lack of sensitive benthic features, means that turbidity resulting from the described activities is expected to result in only temporary and localised impacts or disturbance, therefore the potential impact has been determined as Negligible (I).

Indirect disturbance to benthic habitats and associated marine fauna by sedimentation

Indirect impacts associated with a temporary (several hours) and localised (within tens of metres) 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. It is not considered that localised impacts within the operational area will result in significant indirect impacts (in other words, turbidity) to nearby marine reserves, offshore reefs or islands, given their distance from the activity.

6.3.2.2 Threatened / Migratory Fauna

Habitat modification is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-4**). Disturbance of the seabed is not anticipated to significantly affect mobile marine fauna, such as marine mammals, marine reptiles, fish, sharks and rays. The area of seabed to be disturbed within the operational area also represents a negligible portion of the habitat available for these species. No decrease in local population size, area of occupancy of species, loss or disruption of critical habitat or disruption to the breeding cycle of any of these protected matters is expected.

The benthic biota around the operational area is expected to be similar to that of the wider region, with a low species abundance and high species richness. The habitat present within the operational area is representative of habitats within the broader region. Permanent displacement of habitat from seabed disturbance is not expected due to the small scale of the activity.

Fish, sharks and rays may also forage in the soft sediments for marine invertebrates. However, given the small scale of the activity and the regional availability of habitat, seabed and benthic habitat disturbance is not expected to affect these species.

6.3.2.3 Protected and significant areas and socio-economic receptors

Commercial fisheries that target benthic fauna in the operational areas are not predicted to be significantly affected due to the short duration of the activity and the area of seabed disturbance is insignificant compared to the total available fishing area. Potential impacts to benthic habitats and subsequently to associated fish species of commercial importance are not likely to occur, therefore there are no impacts to fish at a population level.

Similarly, the temporary turbidity and sedimentation associated with ROV operations is not considered likely to cause environmental impact given the sparseness of benthic cover (**Section 3.2.1.2**) and the highly localised impact zone. In this context, any potential sediment movement caused by the activity is likely to have negligible impacts.

There are no marine protected areas within the operational area. The Oceanic Shoals Marine Park is the closest at approximately 50 km from the operational area.

The operational area intersects the Pinnacles of the Bonaparte Basin Key Ecological Feature (KEF). It provide areas of hard substrate in an otherwise soft sediment environment, and high biodiversity of sponges is a key value. However, any disturbance to the seabed during the survey is temporary and very localised (approximately <1.5 m^2).

6.3.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event is:

+ Seabed disturbance is limited to planned activities and defined locations within the operational areas. [FRI-EPO-04]

The control measures considered for this event are shown in **Table 6-6**, and the EPS measurement criteria for the EPOs are described in **Section 8.4**.

Table 6-6: Control Measure Evaluation for Seabed Disturbance

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-003	Dropped object prevention procedure	Prevents ongoing impact to the seabed due to equipment being left in situ	Negligible cost to Santos – personnel costs of reviewing information	**Adopted –** Helps to minimise impacts and extent of seabed disturbance.
FRI-CM-018	No anchoring in operational area	No impacts from anchoring to the seabed.	Negligible cost as DP will be used	**Adopted** – Benefits outweigh negligible costs

FRI-CM-033	Recovery of all deployed equipment	Prevents ongoing impact to the seabed due to equipment being left in situ	Minimal additional cost to recover equipment	**Adopted –** Helps to minimise impacts and extent of seabed disturbance.
FRI-CM-034	Dropped object recovery	Requires dropped objects to be recovered (where safe and practicable to do so) unless the environmental consequences are negligible.	Additional personnel and vessel costs to plan and undertake if safe and practicable to do so.	**Adopted –** Benefits of recovering dropped objects where safe and practicable, unless the environmental consequences are negligible to do so, outweigh the costs.
Additional Control Measures				
N/A				

6.3.4 Environmental Impact Assessment

Table 6-7: Impacts and Consequence Ranking – Seabed Disturbance

Receptor	Consequence Level
Seabed disturbance	
Threatened, migratory or local fauna	No sensitive seabed features are expected within the operational area based on surveys at similar water depths in adjacent permits. The areas of seabed that will be impacted are expected to include calcareous gravel, sand and silt. These sediments are un-vegetated and likely to have sparse benthic and epi-benthic communities with low biodiversity (refer to **Section 3.2.1.2**) and include species with widespread regional distributions. Therefore, significant loss of habitat is not expected. Marine invertebrates may inhabit soft sediments and can contribute to the diet of some fauna. The area of soft sediment habitat that is potentially impacted is small compared to the amount of habitat available and therefore the disturbance is not expected to affect prey availability, or protected fauna species. Habitat modification is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-4**). However, the area of disturbance has not been identified as a habitat that supports any protected species. Impacts will be temporary, and the area potentially impacted is small compared to the size of the areas used by these species for foraging. Therefore, no long-term impacts to these species are expected. No decrease in local population size, area of occupancy of species, loss or disruption of critical habitat or disruption to the breeding cycle of any of these protected matters is expected. Given the small-scale area 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 or migratory species at a population level. The consequence level is therefore considered to be I (Negligible).

Receptor	Consequence Level
Physical environment or habitat	The area of benthic habitat that may be disturbed by the ROV's thrusters and transponders is expected to be limited (< 1.5 m^2) and temporary. As such, long-term or significant impacts to habitat values or ecosystem function are not expected. Impacts to the physical environment or habitat are assessed as I (Negligible).
Threatened ecological communities	Not applicable – No threatened ecological communities are identified in the area where seabed disturbance could occur.
Protected areas	There are no protected or significant areas intersecting the operational area where seabed disturbance could occur. The Pinnacles of the Bonaparte Basin KEF intercepts the operational area, however the relevant values of the KEF are not anticipated to be significantly affected by the seabed disturbance activities during the survey (<1.5 m^2).
Socio-economic receptors	Not applicable – Disturbance of the seabed and benthic habitat within the operational areas is highly unlikely to impact socio-economic receptors such as shipping and tourism. Any minor alteration or modification to habitats is not expected to impact commercial fisheries' target species based on the small size of disturbance relative to the available fishing grounds. No stakeholder concerns have been raised regarding this aspect.
Worst-case consequence level	I - Negligible

6.3.5 Demonstration of ALARP

There are no additional practicable alternatives in order to proceed in a successful and safe manner to reduce seabed disturbance associated with the survey. Management controls and installation procedures are designed to further limit the extent of direct seabed disturbance.

The activity within the operational area mostly occurs in the water column with potential to impact benthic habitats (primarily soft sediments with little epifauna) that are widely represented at a regional scale. Impact to benthic habitats will be localised within the operational area and in the immediate vicinity of the well. The potential impacts of ROV operations and placement of survey equipment (transponders) may cause a temporary increase in water column turbidity, but this will be limited to the top layer of sediment. Given the lack of sensitive receptors within the operational area and the expected rapid recovery time, negligible environmental impacts are expected.

All practicable control measures have been reviewed (**Section 6.3.3**) and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be negligible and cannot be reduced further. The proposed management controls for seabed disturbance are in accordance with the Santos' risk management criteria and are considered appropriate to manage the risk to ALARP.

6.3.6 Acceptability Evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	Yes – maximum consequence from seabed disturbance is I (Negligible).

Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	N/A – no relevant requirements regarding this event in this area, given the localised nature and extent of the operational facilities. No plans identified seabed disturbance like those described above as being a threat to marine fauna or habitats. The benthic environment within the operational area is described as soft sediment seabed comprised of predominantly sand, with a proportion of silt and clay with no known seabed features (e.g. shoals, banks). However, the operational area overlaps the Pinnacles of the Bonaparte Basin KEF (**Section 3.2.1.2.**). Impacts to the marine environment from seabed disturbance will be highly localised.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts 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 above.

6.4 Light Emissions

6.4.1 Description of Event

Event	Light emissions will occur as a result of: + Vessel operations The vessel will routinely have external lighting to facilitate navigation and safe operations at night. Lighting typically consists of bright white (i.e., metal halide, halogen, fluorescent) lights, and are not dissimilar to other offshore activities in the region, including fishing and shipping. Lighting levels will be determined primarily by operational safety and navigational requirements under relevant legislation, specifically the *Navigation Act 2012*. The vessel will be required to generate navigational lighting at night to indicate its position and must indicate its limited ability to manoeuvre during operations under the *Navigation Act 2012*. + ROV Operations

	The ROV will be used during the activity, and it will require the use of spot lighting while it is underwater working. Lighting will typically consist of bright white (i.e., metal halide, halogen, fluorescent) lights. A minimum level of lighting is required for safety and navigational purposes onboard the vessel so it cannot be eliminated if the proposed activity is to proceed.
Extent	The light assessment boundary of 20 km from the operational area will be used as the extent of light exposure, in accordance with National Light Pollution Guidelines for Wildlife (Commonwealth of Australia, 2020). This additional 20 km buffer around the operational area is the extent relevant to the impact assessment for planned light emissions. As this extends beyond the described area designated as the operational area (**Section 2.1.2**) for other planned activities; the values and sensitivities of this additional 20 km area were identified using PMST reports (**Appendix** D – EPBC Protected Matters Search Tool Results). **Table 3-3** identifies the species recognised within each 20 km area; and **Table 3-5** identifies the BIAs intersected by the light assessment boundaries.
Duration	Navigational and safety lighting will be required on a 24-hour basis for the duration of the activity (<7 days) as described in **Section 2.**

6.4.2 Nature and Scale of Environmental Impacts

<u>Potential Receptors: Ambient Light, Threatened, migratory or local fauna (marine mammals, marine turtles, sharks, rays, fish and seabirds), protected and significant areas</u>

Continuous lighting emanating from the same location for an extended period of time may result in alterations to fauna behaviour. The combination of colour, intensity, closeness, direction and persistence of a light source are key factors in determining the magnitude of environmental impact (EPA, 2010). Disturbance may include the following:

+ Seabirds may either be attracted by the light source itself or indirectly due to marine fauna prey (such as fish and invertebrates) being attracted to light
+ Marine turtles and turtle hatchlings may be misoriented and disoriented by lights
+ Fish and zooplankton may be directly or indirectly attracted to lights.

A PMST search was undertaken for the 20 km light assessment boundary around the operational area as recommended in the National Light Pollution Guidelines. **Table 3-3** identifies the species present within the light boundary.

Biologically important areas (BIA) have also been identified within the 20 km light assessment boundary and are shown in **Table 3-5**.

6.4.2.1 Marine Mammals

There is no evidence to suggest that artificial light sources adversely affect the migratory, feeding or breeding behaviours of marine mammals. Marine mammals predominantly utilise acoustic senses to monitor their environment rather than visual sources (Simmonds et al., 2004), so light is not considered to be a significant factor in marine mammal behaviour or survival.

Four threatened species were identified by the PMST report as may or likely to occur in the operational area or light assessment boundary (**Table 3-3**). These species include the Blue, humpback, fin and sei whales, however, light is not listed as a threat in the Conservation Advice or Conservation Management Plans for these species, and impact from light is not anticipated.

6.4.2.2 Plankton, Fish (pelagic) and Sharks

Fish at the surface of the water have the potential to be impacted by artificial light. Sharks and rays are not known to be significantly attracted to light sources at sea; however, they may be attracted to the fish that are attracted to the light. Therefore, disturbances to behaviour may occur.

Fishes will likely not be affected by navigational lighting for mariners (Morandi et al. 2018). However, other light emissions from the vessel (such as deck lights for operational 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. 2005).

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 aggregation of plankton from light may result in the presence of whale sharks foraging as they are filter feeders, that primarily feed on plankton and zooplankton.

Four vulnerable fish species have been identified by the PMST report; Freshwater Sawfish, Green Sawfish, Whale Shark and White Shark. Relevant Conservation Advice and Recovery Plans for these species do not identify light emissions as a threat (**Table 3-4**).

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

6.4.2.3 Marine Turtles

The Recovery Plan for Marine Turtles in Australia: 2017-2027 (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
+ 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).

The National Light Pollution Guidelines states that a 20 km buffer (based on sky glow) to important habitat for turtles should be applied when considering possible impacts (DoEE, 2020). The distance to the nearest coastline is approximately 80 km away from the light boundary area, light from the vessel will not be visible and therefore impacts to nesting females, emerging hatchlings and internesting females is not credible. At these distances post-dispersal hatchings will be well dispersed, so the chances of them drifting through the operational area is reduced compared to nearshore areas adjacent to nesting beaches.

The light assessment boundary (20 km buffer from the operational area) intersects with the following marine turtle foraging BIAs as shown in **Table 3-5:**

- Loggerhead
- Green
- Flatback
- Olive Ridley.

Light emissions may be visible to turtles transiting or foraging in the surrounding area, however, given the large distances typically covered by foraging individuals, lighting from the survey vessel area should not impact foraging behaviour. The location of the operational area and associated artificial light sources are approximately 80 km from the closest shoreline and approximately 64 km from the closest turtle interesting buffer. The relatively low predicted light levels from navigation lighting on the vessel and the temporary nature of the artificial light, disruption to biologically important behaviours or displacement from the area is not predicted to occur at population levels.

It is considered that the activity will not compromise the objectives as set out in the marine turtle recovery plan and impact of lighting associated with the activity to turtles is minor.

The potential impacts of light emissions to marine 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 activity being short-term (up to 7 days) and the light assessment boundary is within undesirable environments for habitat critical to the survival of flatback turtles – i.e. the light assessment boundary is not within an area identified as habitat critical for the survival of the species (CoA, 2017). 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 I (Negligible).

6.4.2.4 Seabirds

Seabirds have been shown to be attracted to artificial light sources. Artificial light can disorient seabirds and potentially cause injury and/or death through collision with infrastructure. Birds may starve as a result of disruption to foraging, hampering their ability to prepare for breeding or migration. High mortality of seabirds occurs through grounding of fledglings as a result of attraction to lights and through interaction with vessels at sea (DoEE, 2020).

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). Birds may either be attracted by the light source itself or indirectly as structures in deep water environments tend to attract marine life at all tropic levels, creating food sources and providing artificial shelter for seabirds (Surman, 2002). The light sources associated with the vessels may also provide enhanced capability for seabirds to forage at night.

In general, young birds (fledglings) are more likely to become disorientated by artificial light sources. Fledglings have been observed being affected by lights up to 15 km away; and fledgling seabirds may also not take their first flight if their nesting habitat never becomes dark (CoA 2020a). Emergence during darkness is believed to be a predator-avoidance strategy and artificial lighting may make the fledglings more vulnerable to predation (CoA 2020a). It is thought that if artificial lights override the sea-finding cues of a fledgling and initially disorient its path, they may not be able to imprint their natal colony, preventing them from returning to nest when they mature (CoA 2020a).

The National Light Pollution Guidelines for Wildlife recommend using a 20 km threshold, which provides a precautionary limit based on observed effects of sky glow on fledgling seabirds grounded in response to artificial light 15 km away (Commonwealth of Australia 2020).

The operational area does not overlap any BIAs for seabirds, with the operational area approximately 101 km from the closest shoreline; therefore, the location of the operational area should not significantly impact seabird behaviour, given the large distances typically covered by breeding individuals.

The vessel will be within the operational area for up to 7 days As a result, the activity is unlikely to attract large numbers of seabirds.

Consequently, light emissions from the vessel is unlikely to attract and/or affect the behaviour of large numbers of seabirds and the impact of lighting associated with the activity to seabirds is negligible.

6.4.2.5 Protected and significant areas and socio-economic receptors

There are no marine protected areas within the operational area or light assessment boundary. The Oceanic Shoals Marine Park is the closest at approximately 50 km from the operational area and approximately 32 km from the light assessment boundary.

The light assessment boundary intersects the Pinnacles of the Bonaparte Basin Key Ecological Feature (KEF).However, its key values are related to benthic biodiversity, and not marine fauna known to be sensitive to light.

6.4.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event is:

+ Reduce impacts to marine fauna from lighting through limiting lighting to that required by safety and navigational lighting requirements [FRI-EPO-02]
+ Do not displace marine turtles from habitat critical to the survival of the species or disrupt biologically important behaviours from occurring within biologically important areas [FRI-EPO-09]

The control measures for this activity are shown in **Table 6-8** with EPS and measurement criteria for the EPOs described in **Section 8.4**.

Table 6-8: Control Measure Evaluation for Light Emissions

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
FRI-CM-022	Lighting will be used as required for safe work conditions and navigational purposes	Light spill from unnecessary lighting reduced, even further lowering likelihood of impacts to the fauna from vessel lighting Lighting is assessed to only provide necessary lighting for safety and navigation during the activity. Reducing the potential for additional light pollution to the environment, thus reducing the potential impacts to fauna.	Additional costs associated with implementing control.	**Accepted** – Cost is considered acceptable for the benefit that may be realised from this control.
Additional Control Measures				
N/A	Manage the timing of the activity to avoid sensitive periods at the location (e.g. turtle nesting/hatching).	Reduce risk of impacts from light emissions during environmentally sensitive periods for listed marine fauna (e.g. turtle nesting/ hatching).	High cost in moving or delaying activity schedule for operational reasons (schedule dependent on availability of offshore vessel(s)). The risk to all listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods and unpredictable presence of some species.	**Rejected** – Cost is disproportionate to increase in environmental benefit. There are forging BIAs for the loggerhead, green, flatback and olive ridley turtles. However, the light assessment boundary is approximately 64 km from the closest turtle interesting buffer where light sensitive nesting and hatching behaviour takes place.
N/A	Review lighting to a type (colour)	Could reduce potential impacts of artificial light on certain fauna.	High cost to complete lighting change-out on vessel(s) in area of low sensitivity.	**Rejected** – Given the distances from the nesting beaches, short duration of the activity and controls

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	that has less impact.		Navigational lighting colours are stipulated by law.	in place to limit lighting, the cost is considered disproportionate.
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 activity; increase impacts or potential impacts in other areas, including increase in waste, air emissions, risk of vessel collision etc. A minimal level of artificial lighting will still be required on-board the vessel(s) on a 24-hour basis for safety reasons.	**Rejected** – Given the minimal risk of impacts to turtles occurring, the financial and environmental costs by requiring all works to be undertaken during daylight hours only are not considered appropriate given the extended duration of the activity that would occur.

6.4.4 Environmental Impact Assessment

Table 6-9: Impacts and Consequence Ranking – Light Emissions

Receptor	Consequence Level
Light emissions	
Threatened, migratory or local fauna	Artificial lighting may result in behavioural changes to fauna, particularly marine turtles and seabirds. The light assessment boundary (20 km buffer from the operational area) intersects with foraging BIAs for the loggerhead, green, flatback and olive ridley turtles. Light emissions may be visible to turtles transiting or foraging in the surrounding areas and given the large distances typically covered by foraging individuals, light from the Frigate operational area should not impact foraging behaviour. The light assessment boundary does not intersect the area identified as habitat critical for the survival of the marine turtle species (CoA, 2017). The National Light Pollution Guidelines for Wildlife states a 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings, demonstrated to occur at 15 to 18 km and fledgling seabirds grounded in response to artificial light 15 km away. This is particularly in relation to lights onshore rather than offshore, due to the use of visual cues to find the ocean being disrupted. However, the light assessment boundary is approximately 64 km from any nesting or internesting sites where turtles are

Receptor	Consequence Level
	most affected by light. The activities will also be intermittent and short in duration so impacts will be negligible. Cetaceans and marine mammals are not known to be significantly attracted to light sources at sea; therefore, disturbance to behaviour is unlikely. Indirect impacts on food sources or habitats also unlikely (see below). Fish, sharks and birds have been shown to be attracted to artificial light sources; however, the short duration of the activity is unlikely to lead to large-scale changes in species abundance or distribution. Impacts to transient fish, sharks and seabirds will therefore be limited to short-term behavioural effects, with no decrease in local population size or area of occupancy of species, loss or disruption of critical habitat, or disruption to the breeding cycle. Due to management controls in place and distance from sensitive receptors, the artificial lighting is considered to have a negligible impact on fauna.
Physical environment or habitat	Not applicable – No impacts to physical environments and/ or habitats from light emissions are expected.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which light emissions are expected.
Protected areas	There are no marine protected areas within the light assessment boundary. The Pinnacles of the Bonaparte Basin and Carbonate bank and terrace system of the Sahul Shelf KEFs intercept the light assessment boundary, however the relevant values of the KEF are not anticipated to be significantly affected by light emissions.
Socio-economic receptors	Not applicable – Lighting is not expected to cause an impact to socio- economic receptors other than to act as a visual cue for avoidance of the area by other marine users for safety purposes.
Overall worst-case consequence	I - Negligible

6.4.5 Demonstration of ALARP

With the described controls, the consequence of artificial light on marine fauna and seabirds is considered to be negligible with insignificant impacts to ecological function. No population level impacts are expected, and the consequence is considered environmentally acceptable. Artificial lighting is required 24 hours a day for operational and navigational safety during the activity. A minimum level of artificial lighting is required on a 24-hour basis to alert other marine users of the activity. There are also minimum light requirements that will be necessary to provide safe working conditions. To reduce lighting at night further would restrict the activity hours resulting in the activity taking approximately twice as long to complete. This would increase the period of time the vessel is present within the operational area and the amount of waste, discharges and emissions produced.

The increased risks / impacts with potentially larger scale consequences associated with reduced light levels are considered to present a cost that is grossly disproportionate to any environmental benefit. Given that lighting on the vessel will be consistent with industry standards and will result in negligible consequences, and that no reasonably practicable additional controls or alternatives were identified, it is considered that the environmental impacts of using 24-hour artificial lighting at an intensity to allow work to proceed safely are ALARP.

Avoiding periods of higher sensitivity for marine fauna is not considered feasible for all species. The light assessment boundary overlaps with foraging BIAs for the loggerhead, flatback, green and olive ridley turtles. However, it does not overlap with any hatching or nesting BIAs for turtle or seabird species which are known to be sensitive to light, therefore, low potential impacts to individual fauna are expected and there is not expected to be an impact at population level or significant impacts on migratory or nesting behaviours.

The activity will not compromise the objectives as set out in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a), the Draft Wildlife Conservation Plan for Seabirds (Commonwealth of Australia 2019) or the National Light Pollution Guidelines for Wildlife (Commonwealth of Australia, 2020), as biologically important have not been identified. The assessed residual consequence for this impact is negligible and cannot be reduced further. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 6.4.3**. Therefore, it is considered that the impact of the activities conducted are acceptable and ALARP.

6.4.6 Acceptability Evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	Yes – maximum consequence from light emissions is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with the Convention of the Safety of Life at Sea (SOLAS) 1974 and the *Navigation Act 2012*. The following material published in relation to threatened and migratory species within the operational area identifies light as a threat (**Table 3-4**): **Recovery Plans:** + National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020). The management of artificial light emissions are aligned with the objectives of this plan through the adoption of FRI-EPO-02, FRI-EPO-09 and FRI-CM-23. + Recovery Plan for Marine Turtles in Australia (2017) identifies light pollution as a threat to marine turtles. Nesting females and hatchling turtles are at greatest risk of light impacts; however, the light assessment boundary does not overlap nesting or interesting BIAs or habitat critical to the survival of the species. Foraging BIAs have been identified for green,

	flatback, loggerhead and olive ridley turtles. Impacts to turtles from operational activity lighting are expected to be restricted to localised attraction and temporary disorientation, but with no long-term or residual impact due to the activity's short-term nature. Action Area A8 of the plan (minimise light pollution) will be managed through the adoption of FRI-EPO-02, FRI-EPO-09 and FRI-CM-23. + Draft Conservation Plan for Seabirds (2019) identifies light pollution as a minor threat to seabirds. Frigate-1 is aligned to Objective 2 of the plan by ensuring seabirds and their habitats are protected and managed. This is achieved through the implementation of FRI-EPO-02, FRI-EPO-09 and FRI-CM-23 where lighting on the vessel is managed to reduce light spill to the environment and seabird habitat. Recovery Plans / Conservation Advice for other species that may occur in the operational area do not identify light emissions as a key threat or have explicit relevant objectives or management actions related to light emissions. The objectives and actions of these publications were considered during the assessment of impacts and risks. The controls outlined in **Table 6-8** are consistent with the objectives of the material listed above and Santos considers the impacts of light emissions to not be inconsistent with these objectives.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts 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.

Lighting of the vessel is industry standard and required to meet relevant maritime and safety regulations. The potential consequences of the anthropogenic light sources in the operational area is considered to be insignificant in nature and restricted to short-term behavioural impacts on individual fauna that may be present in the operational area during the activity.

The 20 km light assessment boundary does not overlap any BIAs for seabirds. Light emissions from the vessel are unlikely to attract and / or affect the behaviour of large numbers of seabirds and the impact of lighting associated with the activity to seabirds is negligible. Significant impacts are not expected on fauna, including nesting turtles or hatchlings.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) specifies the following priority action for the turtles in relation to light pollution:

+ Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats.

No impacts to Marine Park values are expected as the operational area and light assessment boundary do not overlap Marine Parks or Protected Areas. No stakeholder concerns have been raised regarding lighting for the activity.

The potential consequence of light emissions on receptors is assessed as I (Negligible). With the control measures in place, including compliance with navigational safety legislation, no significant impacts are expected. Therefore, the impacts of light emissions to the receiving environment are ALARP and considered environmentally acceptable.

6.5 Noise Emissions

6.5.1 Description of Event

Event	The operation of the vessel and the survey activity, will introduce a range of underwater noises into the surrounding water column that will propagate through the water and contribute to and/or exceed ambient noise levels in the area. The main sources of underwater noise during operational activities are from: + Survey activities (MES and SSS and USBL) + ROV Operations + Vessel Operations (e.g., vessel engines, thrusters and other machinery).
Extent	Impacts from all potential noise sources will be within 20 km of the noise source. This is based on: + noise from ROV operations being limited to when ROVs are operating within the operational area + acoustic surveying techniques + a vessel using main engines and bow thrusters to maintain position will become inaudible above background noise within thousands of metres (~1 km) A 20 km radius around the operational area has been assumed as a conservative area within which impacts could occur, which includes physiological and behavioural impacts to all fauna. Cumulative effects from the activity and from other activities conducted in the vicinity are not expected, due to the short-term nature of the activity, and the low sound levels generated by continuous noise sources.
Duration	For the duration of the activity (<7 days), as described in **Section 2.**

6.5.1.1 Noise generated by survey operations

Geophysical survey equipment, including multibeam echosounder (MBES) and side-scan sonar (SSS) as well as underwater acoustic positioning equipment such as an ultra-short baseline (USBL) system will generate underwater acoustic emissions. The geophysical survey is expected to take up to 7 days at the operational area to complete.

Multibeam Echosounder (MBES)

The representative MBES considered for the survey is an R2Sonic 2024, operating at 200-400kHz with a 60° total beam width. The transmit power from this 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.

Side Scan Sonar (SSS)

The representative SSS considered for this survey is the EdgeTech 4200-FS Digital Towfish which outputs signals at 120 and 410 kHz. Measurements of an EdgeTech 4200 were reported in Austin et al. (2013), 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 in-beam pulses to an SPL of 160 dB re 1 µPa calculated to be 130 m. The sonar is highly directional, with distances to sound levels outside the beam significantly less than those in the beam. The EdgeTech 4200-FS Digital Towfish in use for this survey will be towed approximately 10 to 20 metres above the seabed, thus the beam will be restricted to a swath close to the seabed. Additionally, this 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.

Underwater acoustical positioning equipment – Ultra-short Baseline (USBL) System

A low baseline or ultra-short baseline transponder may be temporarily attached on equipment that is being lowered to or positioned on the seabed. Transponders typically emit pulses of medium frequency sound, generally within the range 21 to 31 kHz. The estimated sound pressure level (SPL) would be 180 to 206 dB re 1 µPa at 1 m (Jiménez-Arranz et al., 2017). Transmissions are not continuous but consist of short ‘chirps’ with a duration that ranges from 3 to 40 milliseconds. A DP compatibility transponder/beacon may also be deployed temporarily on the seabed. All transponders/beacons will be recovered to vessel deck after each deployment.

6.5.1.2 Noise generated by the vessel

Vessel operational noise consists of machinery noise (such as engine noise) and hydrodynamic noise (such as water flowing past the hull and propeller singing). All machinery on a ship radiates sound through the hull into the water.

For the survey vessel, the noisiest anticipated activity is when the vessel uses thrusters to maintain its position. McCauley (1998) measured underwater sound pressure levels equivalent to approximately 182 dB re 1 µPa @ 1 m with a frequency range of 20 Hz to 10 kHz from a vessel holding station in the Timor Sea. The thruster noise dropped below 120 dB re 1 µPa within 3 to 4 km and was audible above ambient noise up to 20 km away (McCauley, 1998). McCauley (1998) also measured underwater sound levels from the Pacific Ariki, a 64 m long support vessel with 8000 HP (6,000 kW) main engines during calm conditions in the Timor Sea in 110 m of water while transiting at 11 knots, and found the distance to 120 dB re 1 µPa to be approximately 1 km. More recently, Koessler and McPherson (2020) modelled underwater sound levels from an offshore support vessel (OSV) in 90 m of water, with underwater SPL of 183 dB re 1 µPa @ 1 m whilst operating all three thrusters. The modelling indicated that thruster noise dropped below 120 dB re 1 µPa within 4 to 5 km. This has been taken as the greatest noise-generating activity for assessment purposes, as other vessel activities will require the vessel to be idle or moving; e.g., inspection and maintenance activities will typically require the vessel to be moving slowly at around four knots.

The work rate of vessel engines, and thus output power and noise, will depend upon speed and sea-state, and the propagation will depend upon the location. Practical spreading loss, 15log10 (Range) (Urick, 1983), is a reasonably conservative approach to take in waters on the continental shelf, representing a balance between spherical and cylindrical spreading. If practical spreading loss is applied with the monopole source level of the Ocean Pioneer under transit, 166.3 dB re 1 µPa @ 1 m, the distance to 120 dB re 1 µPa (sound pressure level, or 'SPL') will be less than 1,200 m.

The thrusters on survey vessels are significantly smaller than the main engines; therefore, use of the monopole source level, derived from the main engines to represent the vessel during position holding, is conservative. To place this in context with available information, McCauley (1998) calculated the Pacific Ariki to have a monopole source level equivalent to approximately 182 dB re 1 µPa @ 1 m while holding position using both main engines and an unspecified bow thruster.

The distance to 120 dB re 1 µPa (SPL), estimated using practical spreading loss for the Ocean Pioneer under transit, is used as a conservative estimate of the representative vessel under DP.

Considering the vessel to have a monopole source level of 166.3 dB re 1 µPa, and operating in a single location for 24 hours, allows the accumulated sound levels to be estimated through the addition of 10*log10 (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.

6.5.1.3 Noise generated from ROV operations

During the activities associated with the survey, notably inspections of the wellhead and seabed, and in the event of dropped objects, ROVs may be used. This will be undertaken from a vessel and the noise generated will typically be of considerably lower intensity than vessel noise.

As underwater sound levels are dependent on the primary (noisiest) sound source rather than being strictly additive, and since ROV operations will be undertaken from a vessel, they will make little contribution to the overall noise emissions associated with vessel activities, as described above and are not risk assessed further.

6.5.2 Nature and Scale of Environmental Impacts

<u>Potential Receptors: Threatened/migratory fauna (invertebrates, marine mammals (particularly cetaceans), marine turtles, sharks, rays and fish), protected and significant areas</u>

A PMST search was undertaken for the 20 km noise assessment boundary around the operational area as a conservative buffer to identify any MNES species that could be affected by noise outside of the operational area (**Appendix D** – EPBC Protected Matters Search Tool Results. **Table 3-3** identifies the species present within this boundary.

Biologically important areas (BIA) have also been identified within the 20 km noise assessment boundary and are shown in **Table 3-5**.

Marine fauna use sound in a variety of functions, including social interactions, foraging, orientation and responding to predators. Underwater noise can affect marine fauna in three main ways:

+ Attraction
+ Increased stress levels
+ Disruption to underwater acoustic cues
+ Localised avoidance
+ Injury to hearing or other organs. Hearing loss may be temporary (temporary threshold shift (TTS)) or permanent (permanent threshold shift (PTS))
+ Disturbance leading to behavioural changes or displacement to fauna. The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation
+ Masking or interfering with other biologically important sounds (including vocal communications, echolocation, signals and sounds produced by predators or prey)
+ 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. Fish choruses are capable of raising background noise levels to 120 to 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 extent of the impacts of underwater noise on marine animals will depend upon the frequency range and intensity of the noise produced and the type of acoustic signal (i.e. continuous (vessels) or impulsive (SSS,MBES and USBL). These sound sources are both non-impulsive (vessel) and impulsive (MBES, SSS and USBL), 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 temporary threshold shift (TTS) from which an animal recovers within minutes or hours, or a permanent threshold shift (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.

6.5.2.1 Invertebrates

Underwater noise emissions from the activity are not expected to cause a change in behaviour to benthic invertebrates.

Continuous noise

Benthic invertebrates are unlikely to be negatively impacted from noise generated from vessel operations, there is no convincing scientific evidence for any significant effects induced by non-impulsive noise in benthic invertebrates.

Plankton, including fish eggs and larvae, and pelagic invertebrates could drift into close proximity to high-energy noise sources (for example, 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.

Impulsive noise

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. The survey does not include activities that generate low-frequency noise such as SBP. Therefore, negligible impact is expected to invertebrates from the survey activity.

6.5.2.2 Fish and Sharks

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
- 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.

The EPBC PMST Report for the noise assessment boundary identified several fish species including five with a threatened status:

- Freshwater Sawfish (Vulnerable)
- Green Sawfish (Vulnerable)
- Northern River Shark (Endangered)
- Whale Shark (Vulnerable)
- White Shark (Vulnerable)

There are no BIAs identified for fish in the noise assessment boundary. The relevant Conservation Advice and Recovery Plans for these species does not identify noise emissions as a threat.

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 6-10**) and impulsive (**Table 6-11**) noise sources have been adopted.

Table 6-10: Continuous Noise: Criteria for Noise Exposure for Fish

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	(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

motion detection)					(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

Source: Popper et al. (2014)

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 6-11: Impulsive Noise: Criteria for Noise Exposure for Fish

Potential Marine Fauna Receptor	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	> 219 dB SEL24h or > 213 dB PK	> 216 dB SEL24h or > 213 dB PK	>> 186 dB SE L24h	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL24h or > 207 dB PK	203 dB SEL24h or > 207 dB PK	>> 186 dB SE L24h	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL24h or > 207 dB PK	203 dB SEL24h or > 207 dB PK	186 dB SEL2 4h	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Fish eggs and fish larvae	> 210 dB SEL24h or > 207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low

			(F) Low		(F) Low

Source: Popper et al. (2014)

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.

Continuous noise

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.

Impulsive noise

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 6.5.1**. 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. All survey equipment which operates at frequencies between mid and high range which is unable to be heard by most fish and 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 metres. However, this is only relevant for the lower frequency noise (such as a boomer sub-bottom profiler), as all other sources have signals outside the hearing range of most fish in the region, which reduces the risk of impact. Impacts to fish and sharks are not considered significant as:

+ Noise levels from the vessel that may cause behavioural responses are expected to generally be confined to the operational area and concentrated within a radius of a few hundred metres of the noise source.
+ Noise effects to fish may result in indirect impacts to fisheries in the operational area that are 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, although limited fishing is expected in the area.

6.5.2.3 Marine Mammals

No known migrating, aggregation, resting, breeding or feeding areas for cetaceans intersect the 20 km noise assessment boundary. However, marine mammal species may be encountered as they transit through the area. The EPBC PMST Report for the noise assessment boundary identified several marine mammal species including four with a threatened status:

- Blue Whale (Endangered)
- Fin Whale (Vulnerable)
- Humpback Whale (Vulnerable)
- Sei Whale (Vulnerable)

Relevant Conservation Management Plans and Conservation Advice for these threatened species identify noise interference as a potential threat.

To better reflect the auditory similarities between phylogenetically closely related species, but also significant differences between species groups among the marine mammals, Southall et al. (2019) assigned the extant marine mammal species to functional hearing groups based on their hearing capabilities and sound production.

Exposure to impulsive noise may be more hazardous to hearing than continuous (non-impulsive) noise. For marine mammals, National Marine Fisheries Service (NMFS) issued a Technical Guidance document that provides acoustic thresholds for the onset of TTS and PTS in marine mammal hearing for all sound sources (NMFS, 2018). Southall et al. (2019) published an updated set of criteria for onset of TTS and PTS in marine mammals. While the authors propose a new nomenclature and classification for the marine mammal functional hearing groups, the proposed thresholds and weighting functions for exposure to underwater sound do not differ in effect from those proposed by NMFS (2018). These thresholds that detail receptor noise impacts and behavioural response for continuous noise (vessels) and impulsive noises, along with the new nomenclature and classifications for marine mammals are summarised in **Table 6-12** and **Table 6-13.** These tables detail receptor noise impact and behavioural thresholds for continuous noise (vessel) and impulsive noises (survey equipment), being:

- low-frequency cetaceans: which consists of baleen whales such as humpback whales
- high-frequency cetaceans: which consists of toothed whales except porpoises and river dolphins.

Behavioural reactions to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing or physiology. Hence, it is difficult to determine thresholds for behavioural response in individual cetaceans as the way they respond often varies (Nowacek et al., 2004; Gomez et al., 2016; Southall et al., 2019) and is influenced by both biological and environmental factors such as age, sex and the activity at the time. Observed disturbance responses to anthropogenic sound in cetaceans include altered swimming direction; increased swimming speed including pronounced ‘startle’ reactions; changes to surfacing, breathing and diving patterns; avoidance of the sound source area and other behavioural changes.

For non-impulsive noise, NMFS currently uses step function (all-or-none) threshold of 120 dB re 1 µPa SPL (unweighted) to assess and regulate noise-induced behavioural impacts for marine mammals (NOAA, 2019), while for impulsive noise, NMFS uses step function thresholds of 160 dB re 1 µPa SPL (unweighted) (NOAA, 2018; NOAA, 2019). The behavioural disturbance threshold criteria applied summates the most recent scientific literature on the impacts of sound on marine mammal hearing, considered the most relevant to this activity.

Table 6-12: Continuous Noise: Acoustic Effects of Continuous Noise on Cetaceans: 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 SEL24h (LE,24h; dB re 1 µPa2·s)	Weighted SEL24h (LE,24h; dB re 1 µPa2·s)
Low-frequency cetaceans	120	199	179
High-frequency cetaceans		198	178
Very High-frequency cetaceans		173	153

L_e denotes cumulative exposure over a 24 hour period and has a reference value of 1 µPa2s

Table 6-13: Impulsive Noise: Unweighted SPL, SEL24h and PK Thresholds for Acoustic Effects on y Cetaceans

Hearing Group	NMFS (2014)	NMFS (2018)			
	Behaviour	PTS onset thresholds (received level)		TTS onset thresholds (received level)	
	SPL (Lp; dB re 1 µPa)	Weighted SEL24h (LE,24h; dB re 1 µPa2·s)	PK (Lpk; dB re 1 µPa)	Weighted SEL24h (LE,24h; dB re 1 µPa2·s)	PK (Lpk; dB re 1 µPa)
Low-frequency Cetacean	160	183	219	168	213
High-frequency Cetaceans		185	230	170	224
Very High-frequency cetaceans		155	202	140	196

<u>Continuous noise</u>

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 whale 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 within thousands of metres (Clark et al., 2009).

There is a potential for auditory masking impacts to whales due to vessel noise, however, impacts are considered temporary and localised because the individual and the vessels will be almost constantly moving and therefore no individual will be impacted for any length of time.

Noise from the project vessels would likely exceed PTS thresholds at the source for very high-frequency cetaceans, whilst noise from projects vessels is not expected to be above PTS thresholds for low-frequency or high-frequency cetaceans at any time. Noise form project vessels would likely exceed TTS thresholds for up to hundreds of meters from the source. However, since marine fauna are transient in the operational area, which lacks aggregating habitat such as resting or calving areas, individuals are expected to pass through the operational area, potentially showing localised avoidance via behavioural responses (see below). PTS to very high-frequency cetaceans is unlikely as individuals will likely show avoidance before getting within range, individuals are therefore not expected to remain within the vicinity of the noise source for the duration (24 hours, **Table 6-12**) required to exceed PTS. Underwater noise generated by vessels (continuous noise) does not have the intensity and characteristics likely to cause physiological damage in marine fauna (Nedwell & Edwards, 2004; Hatch & Southall, 2009). For TTS, individuals would need to pass within hundreds of metres of the project vessels during operations. This would result in a temporary impact to a low proportion of the migrating population.

Based on the field measurements and studies discussed in **Section 6.5.1**, the distance from the source to the behavioural threshold for cetaceans (120 dB re 1 µPa) is estimated to be 5 km.

<u>Impulsive noise</u>

The sound levels from positioning equipment (USBL) are described in **Section 6.5.1.1**. The proposed positioning equipment has sound levels that could reach the threshold for behavioural disturbance (**Table 6-13**) 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 6-13**), PTS and TTS are not predicted to occur from the positioning equipment.

The sound levels from MBES are described in **Section 6.5.1.1**. The measurement study from Martin et al. (2012) indicates the threshold for behavioural disturbance (**Table 6-13**) could be exceeded within less than 10 m. PTS and TTS due to SEL are not predicted to occur, considering a measurement along a trackline with a closest point of approach of 4 m did not 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 6-13**), PTS and TTS due to the MBES are not predicted to occur.

The sound levels from SSS are described in **Section 6.5.1.1**. The measurement study by Austin et al. (2015) indicates the threshold for behavioural disturbance (**Table 6-13**) could be exceeded within less than 130 m for marine mammals in the highly directional source output beam pattern. The reported per-pulse sound levels at 40 m are similar to those from the MBES, and as it is not predicted to exceed either the PTS or TTS criteria, when considering both SEL and PK metrics (**Table 6-13**), neither is the SSS. Additionally, the per-pulse peak pressure source level of the SSS is below the PK criteria threshold; therefore, the criteria cannot be exceeded and PTS and TSS impacts are not predicted to occur.

Survey and positioning equipment could cause auditory 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, within hundreds of metres. The masking will apply to MF whales for the positioning equipment, MBES and SSS with all signals above 2 kHz.

Given the transient and mobile nature of marine mammals, the operating frequencies and noise maxima of the survey equipment (detailed in **Section 2.3**), effects of noise on marine mammals is expected to be limited to behavioural responses within up to a few kilometres of the vessel depending on the heading range of the receptors.

6.5.2.4 Marine Reptiles

Turtles

Turtles use shallow waters around mainland Australia for feeding, nesting, breeding and internesting. The 20 km noise assessment boundary intersects with the foraging BIAs for the Loggerhead (Endangered), Green (Vulnerable), Flatback (Vulnerable) and Olive Ridley turtles (Endangered) (**Table** 3-5).

The EPBC PMST Report for the noise assessment boundary also identified a further two marine turtle species with a threatened status; Leatherback (Endangered) and Hawksbill turtles (Vulnerable).

Marine turtles use sounds for navigation, to avoid predators and to find prey (Dow Piniack, 2012). Turtles have been shown to become agitated to impulsive noise 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 to impulsive noise (NSF, 2011).

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a) highlights noise interference from anthropogenic activities as a threat to marine turtles. The plan refers to vessel noise and the operation of some oil and gas infrastructure as sources of chronic (continuous) noise in the marine environment, exposure to which may lead to avoidance of important turtle habitat. The Recovery Plan 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 to 700 Hz (Bartol and Musick, 2003).

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. Popper et al. (2014) suggested thresholds for onset of mortal injury (including PTS) and mortality for sea turtles and, in the absence of taxon-specific information, adopted the levels for fish that do not hear well (suggesting this would likely be conservative for sea turtles).

Finneran et al. (2017) presented revised thresholds for sea turtle injury and hearing impairment (TTS and PTS). Their rationale is that sea turtles have best sensitivity at low frequencies and are known to have poor auditory sensitivity (Bartol & Ketten, 2006; Dow Piniak et al., 2012; Martin et al., 2012). Accordingly, TTS and PTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper et al., 2014).

Studies show that behavioural responses occur to received sound levels of approximately 166 dB re 1 µPa and that avoidance responses occur at around 175 dB re 1 µPa (McCauley et al., 2000). These levels overlap with the sound frequencies produced by vessels and VSP activities. Based on the limited data regarding noise levels that illicit a behavioural response in turtles, the lower level of 166 dB re 1 µPa level drawn from National Science Foundation (NSF, 2011) is typically applied, both in Australia and by NMFS, as the threshold level at which behavioural disturbance could occur.

The recommended criteria for impulsive and continuous sound sources are shown in **Table 6-14** and **Table 6-15**.

Table 6-14: Continuous Noise: Criteria for Vessel Noise Exposure for Turtles

<table>
<tr><th rowspan="2">Potential Marine Fauna Receptor</th><th colspan="2">Popper *et al*. 2014</th><th colspan="2">Finneran *et al*. (2017)
Weighted SEL_{24h} ($LE_{,24h}$; dB re 1 µPa^2·s)</th></tr>
<tr><th>Masking</th><th>Behaviour</th><th>PTS onset threshold</th><th>TTS onset threshold</th></tr>
<tr><td>Marine Turtle</td><td>(N) High
(I) High
(F) Moderate</td><td>(N) High
(I) Moderate
(F) Low</td><td>220</td><td>200</td></tr>
</table>

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 6-15: Impulsive Noise: Criteria for Impulsive Noise Exposure for Turtles: unweighted SPL, SEL24h and PK thresholds

<table>
<tr><th>NFS (2011)</th><th>Moein et al. (1995), McCauley et al. (2000b; 2000a)</th><th colspan="4">Finneran et al. (2017)</th></tr>
<tr><th colspan="2">Behaviour</th><th colspan="2">PTS onset threshold</th><th colspan="2">TTS onset threshold</th></tr>
<tr><th colspan="2">SPL (L_p; dB re 1 µPa)</th><th>Weighted SEL_{24h} ($LE_{,24h}$; dB re 1 µPa^2·s)</th><th>PK (L_{pk}; dB re 1 µPa)</th><th>Weighted SEL_{24h} ($LE_{,24h}$; dB re 1 µPa^2·s)</th><th>PK (L_{pk}; dB re 1 µPa)</th></tr>
<tr><td>166</td><td>175</td><td>204</td><td>232</td><td>189</td><td>226</td></tr>
</table>

There is limited information about 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.

<u>Continuous noise</u>

Based on the criteria detailed within **Table 6-14** there is a low risk of any injury to marine turtles from vessel noise (**Section 6.5.1.2**). Behavioural changes, for example, 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 metres 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. Turtles may use sound in a social manner to synchronise activities during the nesting season (Ferrara et al., 2014); however, this has not been demonstrated for marine 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.

Impulsive noise

The sound levels of the survey equipment and positioning equipment (**Section 6.5.1.1**) are below those associated with the PK criteria for injury (**Table 6-15**) 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 6-15**). Behavioural changes, for example, avoidance and diving, are only predicted for individuals in close proximity to the vessels (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. This is in part because the sounds from most survey and positioning equipment are all outside of the hearing frequency range for turtles, which for green and loggerhead turtles approximately 50 to 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).

In summary, temporary impairment from operational sounds to marine turtles due to TTS is expected to only occur at close ranges (within tens of metres) (JASCO, 2016). Behavioural impacts may occur at close to intermediate ranges (within hundreds of metres).

Considering the open-ocean location of the operational area, only individual turtles may be affected as they transit the area, and impacts are not considered significant based on the following:

+ The noise assessment boundaries for the operational area are within a foraging BIA for the Flatback, Loggerhead, Olive Ridley and Green turtles. Considering the water depths of the operational area (approximately 112 m) and the distance offshore (approximately 112 km), impacts to turtles are not expected at the individual or population level
+ Vessel noise is expected to be below the thresholds for PTS and TTS given the typical size of vessel used during the activity and the slow vessel speeds within the operational area, the received levels may result in behavioural impacts, but for a limited duration and will not result in significant impacts.
+ Although behavioural responses are expected to occur near the sources, these will be limited to avoidance or temporary change in swimming behaviour.

6.5.2.5 Protected and significant areas and socio-economic receptors

There are no marine protected areas within the operational area or noise assessment boundary. The Oceanic Shoals Marine Park is the closest at approximately 50 km from the operational area and approximately 32 km from the noise assessment boundary.

The noise assessment boundary intersects the Pinnacles of the Bonaparte Basin Key Ecological Feature (KEF); however, its key values are related to benthic biodiversity, and not marine fauna known to be sensitive to noise.

6.5.3 Environmental Performance Outcome and Control Measures

The EPOs relating to this event include:

+ No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed marine fauna during operational activities [FRI-EPO-01].
+ Do not displace marine turtles from habitat critical to the survival of the species or disrupt biologically important behaviours from occurring within biologically important areas [FRI-EPO-09]

The control measures considered for this event are outlined in **Table 6-16**, and the EPS' and measurement criteria for the EPOs are described in **Section 8.4**.

Santos

Table 6-16: Control Measure Evaluation for Noise Emissions

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-001	Procedure for interacting with marine fauna	Vessel master compliance with distances and interaction procedures so to minimise behaviour disturbance to marine fauna from noise associated with vessel presence and installation and commissioning.	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. Procedure aligns with Part 8 of the EPBC Act.
FRI-CM-026	Vessel Planned Maintenance System (PMS) to maintain vessel DP, engines and machinery	Ensures equipment which generates noise is operating optimally and sound sources levels are appropriately verified and within desired operating range.	Costs are standard for routine PMS	**Adopted –** benefits in reducing noise impacts.
FRI-CM-027	Vessel activities environmental awareness and training (inductions) covers protected marine fauna sighting procedure	Project environmental awareness and training (inductions) covers use protected marine fauna sighting procedure. Provides explanation to personnel for Santos WA's Protected Marine Fauna Interaction and Sighting Procedure with aim to increase compliance.	No additional costs associated with inclusion in induction content.	**Adopted-** no additional costs to implement procedure.
Additional Control Measures				
N/A	Dedicated Marine Fauna Observer on vessels[1]	Improved ability to spot and identify marine fauna at risk of impact by vessel noise.	Additional cost of contracting several specialist Marine Fauna Observers.	**Rejected –** Cost disproportionate to increase in environmental benefit. Potential impacts are low and of short duration for each noise survey; do not intersect

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				with marine mammal BIAs and therefore the potential for interaction is considered low.
N/A	Manage the timing of the activity to avoid sensitive periods at the location	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.	**Reject** – Cost is disproportionate to increase in environmental benefit. There are also no marine mammal BIAs within the noise boundary area, presence will be of a transitory nature.
N/A	Site specific acoustic modelling[1]	The distance at which fauna could experience behavioural impacts can be predicted and compared to literary publications. Additional management controls can then be included if required to support an ALARP justification and reduce potential impacts to marine fauna.	Additional cost to contract consultant to develop a model and produce predicted noise outputs.	**Rejected** – The cost associated with site specific modelling, outweighs any environmental benefit, and no further controls can be implemented to reduce vessel noise, MBES or SSS other than not undertaking the activity. Given the potential impacts are expected to be negligible and limited to temporary and minor behavioural changes only, and noise levels from vessels, MBES and SSS will decay rapidly; site specific modelling will not provide additional information which

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				would alter the current ALARP position. Also, the activity does not occur in a humpback whale resting, foraging, calving or confined migratory pathway, as described in the conservation advice.
N/A	Noise management plan[1]	Impacts are predicted to be negligible (e.g. potential temporary and minor behavioural changes) therefore, a management plan, and associated management controls, will have little or no benefit in terms of outcomes i.e. reducing impacts further.	No additional cost other than negligible personnel costs of preparing and reviewing the management plan.	**Rejected** – The activity does not occur in any resting, foraging, calving or confined migratory pathway for protected cetacean species, therefore the cost associated with the development of a management plan outweighs the little or no benefit for a short duration activity which has a negligible impact (e.g., potential temporary and minor behavioural changes).
N/A	Limit or exclude night-time operations	Reduce probability of a cetacean occurring within the low power/shutdown zone and not being detected.	Increases time of survey. Increase cost due to increased survey time.	**Rejected** – The activity does not occur in any resting, foraging, calving or confined migratory pathway for protected cetacean species. Cost disproportionate to increase in environmental benefit. Risks associated with physical presence also increase with the increased survey time.

[1] As recommended in 'Approved Conservation Advice for Megaptera novaeangliae (humpback whale) (2015)'

6.5.4 Environmental Impact Assessment

Table 6-17: Impacts and Consequence Ranking – Noise Emissions

Receptor	Consequence Level
Acoustic Disturbance	
Threatened, migratory or local fauna	While the level of noise expected from temporary and intermittent operational activities has the potential to cause physical injury to marine fauna, most species that may transit through the operational area are expected to demonstrate avoidance behaviour if noise levels approach those that could cause pathological effects. Avoidance behaviour is likely to be localised (approximately 1 km) within the area of the activity (due to small spatial extent of elevated noise) and temporary, i.e., for the duration of the activity only. Some behavioural response to vessel noise could occur to benthic fish communities within the noise assessment boundaries. The calcareous gravel, sand and silt seabed of the operational area suggests there are unlikely to be any areas of particularly high abundance or diversity of fishes within this area, although it is likely that there will be some attraction of fishes to the subsea infrastructure. Potential PTS to low-frequency whales (for example, humpback and blue whales) could occur within 12 m of the centre of the vessel (considering a representative vessel that is 54 m long) if the vessel and the cetacean remained in the same place for 24 hours. The noise assessment boundary does not intersect any marine mammal BIAs. As whale presence is expected to be of a transitory nature and will be moving through the area, the potential for this impact is extremely low. Behavioural impacts may be expected for marine mammals from the vessels and equipment. Behavioural responses to vessel noise are expected to be limited to within 5 km of the vessel. Although a foraging BIA exists for marine turtles, including green, loggerhead, olive ridley and flatback within the noise assessment boundary, impacts are not expected on a population level or on turtle habitat as the closest shoreline is approximately 80 km from the noise assessment boundary and approximately 101 km from the operational area. Behavioural impacts could occur within the immediate vicinity of the vessel and equipment for a short duration and will likely result in the turtles moving away from the area. As the area within which foraging and distribution of all turtle species is widespread, the minimal disturbance is not expected to significantly impact the critical habitat for turtles, or impact at a population level due to the nature and scale of the activity (temporary, short duration, vessel-based activity). In the Recovery Plan for Marine Turtles in Australia, noise interference to marine turtles is separated depending on whether the exposure is short (acute) or long-term (chronic). Activities such as pile driving, seismic activity and some forms of dredging generate acute noise, and sources of chronic noise are identified as including shipping channels and the operation of some oil and gas infrastructure. The level of noise generated by this activity is acute, temporary and may result in behavioural impacts to marine turtles. Given the generally low level of noise expected from the vessel and associated activities, and the relatively short duration of noise emissions, significant impacts to threatened or migratory species are not expected. Some temporary and localised behavioural response may result from the noise levels emitted, but these will not be at levels that could cause mortality or injury to marine fauna or cause a decrease in local population size or area of occupancy of species. The consequence level for fauna is considered to be I - Negligible.

Physical environment or habitat	Not applicable – Noise emissions will not impact the physical environment / habitats, apart from increasing ambient noise levels which is considered under other receptors.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which noise emissions are expected.
Protected areas	No protected areas are identified in the noise assessment boundary. The Pinnacles of the Bonaparte Basin and Carbonate bank and terrace system of the Sahul Shelf KEFs intercept the noise assessment boundary, however the relevant values of the KEF are not anticipated to be significantly affected by noise emissions. Noise levels are not expected to impact on habitats or species at a population or community level.
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 given the potential for temporary avoidance behaviour during the activity. However, given the short duration of the activity, limited impacts from the noise levels emitted from the activity, the area available for the respective commercial fisheries and the area over which commercial species spawn, impacts to fisheries are considered negligible. There are no recreation areas within the area expected to be impacted by noise given the distance from shore.
Overall worst-case consequence	I - Negligible

6.5.5 Demonstration of ALARP

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

The vessel is also expected to produce similar noise emissions to other marine vessels that frequent or transit through the vicinity of the 20 km noise assessment boundaries (in other words, oil and gas industry vessels). The vessel will adhere to the EPBC Regulations (Part 8) to ensure that actions are undertaken to avoid marine mammals, turtles and whale sharks within 500 m of a vessel, and all crews will be inducted into these requirements. It is further expected that the vessel will typically emit sufficient noise for sensitive marine fauna to exhibit avoidance behaviour and move away from the activity to avoid physical impact zones.

The sound levels generated by geophysical surveys are medium to high frequency and decay rapidly with distance travelled from the source, as demonstrated by Zykov (2013), with the furthest distance noise is expected to travel is less than 1.5 km.

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 metres). The use of equipment is necessary to undertake the survey to inform planned future activities. No viable alternatives exist.

Santos have considered the actions prescribed in various recovery plans and conservation advice such as Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017), Blue Whale Conservation Management Plan 2015–2025 (2015) and Approved Conservation Advice for Megaptera novaeangliae (humpback whale) (2015) when developing the controls relevant to potential VBA to minimise noise impacts on marine cetaceans, sharks, fish and marine turtles. Management controls are in place to reduce operating noise, including vessel operational protocols, through adherence to the Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003). This requires compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 and includes controls to reduce the risk of disturbance to or collision with EPBC Act– listed marine fauna. Santos has considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a) when developing these controls to minimise noise impacts on marine turtles.

Avoiding periods of higher sensitivity such as migration or nesting periods for whales and turtles (for example) is not considered feasible. The noise assessment boundary overlaps with a foraging BIA for various turtle species (**Table 3-5**), however, given the low potential impacts to individual fauna, there is not expected to be an impact at population level or significant impacts on foraging behaviours.

Significant impacts are not expected on fauna, including cetaceans and turtles, and the assessed residual consequence for this impact is I- Negligible. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit (see **Section 6.5.3**). Therefore, the impact from noise associated with the activities is ALARP.

6.5.6 Acceptability Evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – maximum consequence from noise emissions is II (Minor).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	The following material published in relation to threatened and migratory species within the operational area identifies noise as a threat (**Table 3-4**): **Conservation Advice:** + Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (2009) + Conservation Advice *Balaenoptera physalus* Fin Whale (2015) + Conservation Advice *Balaenoptera borealis* Sei Whale (2015) **Recovery Plans:** + Recovery Plan for Marine Turtles in Australia (2017) identifies noise interference as a threat to marine turtles. The noise assessment boundary overlaps the

	foraging BIAs for green, flatback, loggerhead and olive ridley turtles. There is no overlap with habitat critical to the survival of the species. Action Area B.3 from the management plan: Assessing and addressing anthropogenic noise, will be managed through the adoption of YO-EPO-01, YO-EPO-09 and the control measures outlined in **Table 6-16**. + Conservation Management Plan for Blue Whales (2015) identifies noise interference as a threat to blue whales. Action Area B.3 from the plan: assessing and addressing anthropogenic noise, will be managed through the adoption of YO-EPO-01, YO-EPO-09 and the control measures outlined in **Table 6-16**. Recovery Plans / Conservation Advice for other species that may occur in the operational area do not identify noise emissions as a key threat or have explicit relevant objectives or management actions related to noise emissions. The objectives and actions of these publications were considered during the assessment of impacts and risks. The controls outlined in **Table 6-16** are consistent with the objectives of the material listed above and Santos considers the impacts of noise emissions to not be inconsistent with these objectives.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – Feedback from the NPFI during stakeholder consultation confirmed there is no objection to leaving the wellhead in-situ as fishing effort is to the south. Following further consultation with the NPFI, no additional concerns were raised. Santos considers these concerns to have been addressed or will be addressed as per the Activity Notification and Reporting Requirements (**Table 8-4**).
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The survey activity will be conducted over a short period (up to 7 days) in a remote offshore location with a relatively low probability of encountering significant numbers of noise sensitive fauna.

Minimal behavioural changes are expected from all marine fauna in the noise assessment boundaries, 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' 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.

The activity that will generate noise are standard offshore industry practice and the potential impacts well documented. With the controls proposed including Part A of EPBC Act Policy Statement 2.1; EPBC Regulations Part 8 (Vessels and Aircraft) and aligned with the applicable management actions outlined in relevant Recovery Plans and Approved Conservation Advice, the potential consequences of impacts to noise sensitive receptors in the area are assessed to be I - Negligible and ALARP.

6.6 Atmospheric Emissions

6.6.1 Description of Event

Event	Atmospheric emissions will occur as a result of: + Vessel operations Gaseous greenhouse gas (GHG) emissions, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG emissions, such as sulphur oxides (SOx) and nitrogen oxides (NOx), are discharged to the atmosphere during continued operations of vessel engines, generators, mobile and fixed plant, and equipment. Vessels may utilise ozone-depleting substances (ODS) in closed-system rechargeable refrigeration systems. There is no plan to release ODS to the atmosphere. Vessels may also use an incinerator to manage wastes.
Extent	Localised: The quantities of gaseous emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere.
Duration	For the duration of the activity (up to 7 days), as described in **Section 2.3**

6.6.2 Nature and Scale of Environmental Impacts

Potential receptors: Physical environment (air quality and climate).

Hydrocarbon combustion may result in a temporary, localised reduction of air quality in the environment immediately surrounding the discharge point during the activity. Non-GHG emissions, such as NOX and SOX, can lead to a reduction in local air quality. GHG emissions are recognised to also contribute to the greenhouse gas emissions loading globally. which could in turn contribute to climate change.

As the activity will occur in open-ocean offshore waters, the combustion of fuels and incineration in such remote locations will not impact on air quality in coastal towns, the nearest being Kalumburu (approximately 186 km southwest from the operational area). The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere. Air emissions will be similar to other vessels operating in the region for both petroleum and non-petroleum activities.

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.

Potential impacts are expected to be short-term, and relate to localised reduction in air quality, limited to the immediate vicinity of the emissions release. Atmospheric emission impacts are not expected to have direct or cumulative impacts on sensitive environmental receptors or be above National Environmental Protection (Ambient Air Quality) measures.

6.6.3 Environmental Performance Outcomes and Control Measures

The EPOs relating to this event include:

+ Reduce impacts to air and water quality from planned discharges and emissions from the activities [FRI-EPO-03]
+ No unplanned objects, emissions or discharges to sea or air [FRI-EPO-06]

The control measures for this event are shown in **Table 6-18**, and the EPS' and measurement criteria for the EPOs are described in **Section 8.4**.

Table 6-18: Control Measure Evaluation for Atmospheric Emissions

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-013	Waste incinerator	Where present, ensure vessels incinerator are managed in a way that is responsible and as per international standards.	No additional cost	**Adopted** – Negligible environmental impact outweighs the costs associated with transporting waste to shore for landfill.
FRI-CM-014	Fuel oil quality	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
FRI-CM-015	Air pollution prevention certification	Ensure vessels are operating with acceptable emissions as per international standards.	No additional costs, as this is a regulatory requirement.	**Adopted** – Benefit of ensuring vessel is compliant outweighs the minimal costs and it is a legislated requirement.
FRI-CM-025	Marine Assurance Standard	Reduces emissions from vessels because equipment operating within its parameters.	Cost associated with implementing procedures.	**Adopted –** Benefit of ensuring vessel is compliant outweighs the minimal costs and it is a legislated requirement.
FRI-CM-026	Vessel Planned Maintenance System (PMS) to maintain vessel DP, engines and	Ensure vessel is running efficiency and are per manufacture specifications. As such routine maintenance endeavours to ensure	No additional costs, is industry best practice.	**Adopted** – no additional costs

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	machinery Vessel machinery, equipment and maintenance	emissions are minimal.		
FRI-CM-028	Ozone-depleting substance (ODS) handling procedures	Where present, ensure vessels ODS are managed in a way that is responsible and as per international standards.	No additional cost	**Adopted** – Benefit of ensuring no ozone-depleting substance release outweighs the negligible costs.
FRI-CM-029	Compliance with Marine Order 97 Marine Pollution Prevention – Air Pollution (division 7)	Ensure vessels are operating with acceptable emissions as per Australian standards.	No additional costs, as is regulatory requirement.	**Adopted –** no additional costs
Additional Control Measures				
N/A	No incineration during vessel-based operations activities	Removes all emissions associated with incineration activities during the Project	Increase in health risk from storage of wastes. Increase in risk due to transfers (increased fuel usage, potential increase in collision risk, disposal on land).	**Rejected** – Health and safety risks outweigh the benefit given the offshore location. Cost associated with transporting waste to shore for landfill or incineration outweighs onboard incineration.
N/A	Prohibit use of Ozone-depleting Substances (ODS)	Eliminates emissions associated with ODS activities during the project.	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 vessel's ability to undertake the activity; therefore, there is no practical solution to the use	**Rejected** – Based on cost to replace all equipment and there is only a low potential for ozone-depleting substance releases.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			of refrigeration. It is noted that ozone-depleting substances are rarely found on vessels.	
N/A	Use incinerators and engines with higher environmental efficiency	Reduces project emissions associated with incinerators and engines.	Significant cost in changing unknown vessel equipment.	**Rejected –** Cost grossly disproportionate to low environmental benefit (impact rated Negligible).
N/A	Alternative fuel type (non-hydrocarbon based) selected for the vessel	Could reduce level of pollutants released to the environment during fuel combustion	Practical and reliable alternative fuel types and power sources for the vessel have not been identified. If an alternative was available, vessels have fuel specification for equipment. Change of fuel may require further modifications to equipment.	**Rejected** – Not feasible

6.6.4 Environmental Impact Assessment

Table 6-19: Impacts and Consequence Ranking – Atmospheric Emissions

Receptor	Consequence Level
Air emissions	
Threatened, migratory or local fauna	Emissions from the Activity are relatively small and will, under normal circumstances quickly dissipate into the surrounding atmosphere. Short-term behavioural impacts to seabirds could be expected if they overfly the location; they may avoid the area. No decrease in local population size or area of occupancy of species, loss or disruption of critical habitat, disruption to the breeding cycle or introduction of disease. 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 I (Negligible).

Receptor	Consequence Level
Physical environment or habitat	The activity will occur in the open ocean and offshore waters, the combustion of fuels and rare ODS releases in such a remote location 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 vessel. Therefore, the consequence level is assessed as I (Negligible).
Threatened ecological communities	Not applicable – No threatened ecological communities present.
Protected areas	Not applicable – there are no protected areas within the operational area over which air emissions are expected. Gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere.
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 vessel and therefore will not impact on other marine users in the vicinity. Atmospheric emissions will add to the global inventory of GHGs; however, they and non-GHGs are not expected to have any local environmental consequences. The consequence is assessed as I (Negligible).
Worst-case consequence level	I - Negligible

6.6.5 Demonstration of ALARP

Combustion of fossil fuels is essential to undertaking the activity to power the vessel and equipment. Practical and reliable alternative fuel types and power sources for the vessel has not been identified.

Implementation of a zero-incineration policy on the vessel would result in significant costs associated with the transport of waste to shore for disposal. Further transportation of the waste to shore would increase the environmental impacts and risks associated with the activity through increased vessel movements and generate greater volumes of emissions associated with the vessel movements. Since incineration is a permitted maritime operation in accordance with Marine Order 97 (reflecting International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI requirements) it is considered ALARP.

Lack of refrigeration systems (i.e., air conditioning) on-board the vessel would lead to unacceptable workplace conditions and poor food hygiene standards, limiting the vessel's ability to undertake the activities, therefore there is no practical alternative to the use of refrigeration.

The assessed residual consequence for this impact is I (Negligible) and cannot be reduced further. Additional control measures were considered but rejected, since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 6.6.3**. Therefore, it is considered that the impact of the activities conducted is ALARP.

6.6.6 Acceptability Evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	Yes – maximum consequence from atmospheric emissions is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with Convention of SOLAS 1974, *Navigation Act* 2012, and pursuant to Marine Order 97 (Marine pollution prevention – air pollution), which gives effect under Australian law to Australian Marine Order 97. The following material published in relation to threatened and migratory species within the operational area identifies climate change as a threat (**Table 3-4**): **Conservation Advice:** + Conservation Advice *Rhincodon typus* Whale Shark (2015) + Conservation Advice *Calidris canutus* Red Knot (2016) + Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (2009) + Conservation Advice *Balaenoptera borealis* Sei Whale (2015) + Conservation Advice *Balaenoptera physalus* Fin Whale (2015) **Recovery Plans:** + Recovery Plan for the White Shark *Carcharodon carcharias* (2013) identifies ecosystem effects as a result of climate change as a threat to white sharks. The overall objective of the recovery plan is to assist the recovery of the white shark, and will be managed through the adoption of FRI-EPO-03 and the control measures outlined in **Table 6-18**. + Draft Wildlife Conservation Plan for Seabirds (Commonwealth of Australia 2019) identifies climate change as a threat. The overall objective of the plan is to protect and manage seabird habitat. This objective will be managed through

	the adoption of FRI-EPO-03 and the control measures outlined in **Table 6-18**. + Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia 2015) identifies climate change as a threat. The overall objective of the plan is to minimise or eliminate, where possible, anthropogenic threats to migratory shorebirds in Australia. This objective will be managed through the adoption of FRI-EPO-03 and the control measures outlined in **Table 6-18**. + Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017) identifies climate change and variability as a threat to marine turtles. Action Area A.2: continuing to meet Australia's international commitments to address the causes of climate change and identify, test and implement climate-based adaptive measures, will be managed through the adoption of FRI-EPO-03 and the control measures outlined in **Table 6-18**. + Blue Whale Conservation Management Plan 2015 - 2025 (2015) identifies climate change as a threat to Blue Whales. Action Area A.3: continuing to meet Australia's international commitments to reduce greenhouse gas emissions and regulate the krill fishery in Antarctica, will be managed through the adoption of FRI-EPO-03 and the control measures outlined in **Table 6-18**. Recovery Plans / Conservation Advice for other species that may occur in the operational area do not identify climate change as a key threat or have explicit relevant objectives or management actions related to climate change. The objectives and actions of these publications were considered during the assessment of impacts and risks. The controls outlined in **Table 6-18** are consistent with the objectives of the material listed above and Santos considers the impacts of atmospheric emissions to not be inconsistent with these objectives.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental Health and Safety Policy.
Are risks and impacts 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 above.

Atmospheric emissions from the vessel is permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which is enacted in Australian waters by Marine Order 97 (Marine pollution prevention – air pollution) (which also reflects MARPOL Annex VI requirements). This is an internationally accepted standard that is utilised industry wide, and compliance with Australian Marine Order standards is considered to be an appropriate management measure in this case.

The overall impacts to the atmosphere and sensitive receptors are expected to be I (Negligible) if the emissions management is adhered to and impacts from emissions that are generated by the various operational activities are considered to be ALARP and environmentally acceptable.

6.7 Planned Operational Discharges

6.7.1 Description of Event

Event	Planned operational discharges will occur as a result of: + Vessel Operations Discharges from vessel operations will include (refer to **Table 6-20**): + Sewage and grey water disposal + Putrescible waste disposal + Desalination brine disposal + Cooling water disposal + Deck drainage disposal + Bilge water disposal Planned vessel operational discharges will be treated in compliance with relevant legislation. Impacts associated with planned operational discharges are typically restricted to the operational area, given the low quantities of discharge and the short duration of the survey activity.
Extent	Localised: The small volumes of non-hazardous discharges may cause localised nutrient enrichment, organic and particulate loading, toxic impacts to marine fauna, thermal impacts and increased salinity in waters around discharge points and in the direction of the prevailing current. The environment that may be affected by operational discharges will likely be contained within the operational area and are predicted to be restricted to within approximately 100 m of the discharge point in the upper 5 m of the water column.
Duration	For the duration of the activity (up to 7 days), as described in **Section 2.3**; water quality conditions will return to normal within minutes to hours of cessation of discharges.

6.7.1.1 Vessel Operations

The vessel will discharge planned operational discharges within the operational area. A description of each discharge stream is provided in **Table 6-20**.

Table 6-20: Planned Operational Discharges from Vessel Operations

Discharge	Description
Sewage and grey water	The use of ablution, laundry and galley facilities by personnel will result in the discharge of sewage and grey water. The volume of sewage is directly proportional to the number of persons on-board the vessel. Approximately 0.04 and 0.45 m^3 of sewage/ greywater will be generated per person per day (EMSA, 2016). Treated sewage will be disposed in accordance with Marine Order 96 (Marine pollution prevention – sewage) requirements, and MARPOL Annex V.
Putrescible waste	The generation of food waste from feeding personnel will result in the discharge of food waste from the galley. Food scraps are generated onboard vessels (approximately 1 L of food waste per person per day). The scraps are macerated and discharged within the operational area as permitted under the Marine Order requirements.
Cooling water	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.
Brine	Concentrated brine is a waste stream created through the vessel desalination equipment for potable water generation. Potable water is generated through reverse osmosis (RO) or distillation resulting in the discharge of seawater with a slightly elevated salinity. Brine generated from the water supply systems on-board the vessel 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.
Deck drainage and bilge	Deck drainage from 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. Bilge water consists of water, oily fluids, lubricants, cleaning fluids, and other similar wastes that have accumulated in the lowest part of the vessel, typically from closed deck drainage and machinery spaces that may contain contaminants such as oil, detergents, solvents, chemicals and solid waste. While in the operational area, the vessel may discharge oily water after treatment to 15 parts per million (ppm) via Australian Marine Order 91-approved oily water filter system. Bilge water will be disposed in accordance with Marine Order 91 (Marine pollution prevention – oil, as appropriate to class) requirements. Assessment of the spillage of hydrocarbons and other environmentally hazardous chemicals and liquid waste are discussed in **Section 7.4** and **7.5.**

6.7.2 Nature and Scale of Environmental Impacts

The potential environmental impacts from routine vessel discharges include:

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

+ temporary and localised increase in sea surface water temperature
+ temporary and localised increase in sea surface salinity.

Potential receptors: Physical environment (water quality), threatened or migratory fauna (marine mammals, marine reptiles, sharks and rays, fish (pelagic) and seabirds), protected and significant areas

6.7.2.1 Physical environment

Planned non-hazardous discharges associated with the activity will be small and intermittent, with volumes dependent on a range of variables. The discharge point will vary for the vessel as it will be frequently moving, and not be stationary for long periods. The survey vessel will be present at the operational area for up to 7 days and does not require any support or supply vessels.

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. 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.

Specifics of potential impacts to water quality from vessel discharges are as follows.

Eutrophication

The discharges of treated sewage and grey water may result in water discolouration, 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. Liquid sewage generally contains more than 99% fresh water, with trace contaminants and nutrients such as organic carbon, nitrogen and phosphorus, which could cause toxicity impacts to the marine environment, as well as suspended solids and bacterial organisms that could transmit disease to marine fauna and humans. However, dispersion and dilution of discharges is expected to be rapid as the discharges are of low volume and short duration, from a vessel that will be moving for most of the activity. The operational area is located in deep offshore waters dominated by open ocean currents, and the survey will only take <7 days; resulting in short-term changes to the surface water quality within the operational area.

Salinity Increases

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 parts per thousand (ppt). The volume of the discharge is dependent on the requirement for fresh (or potable) water and the number of people on board. Changes to seawater salinity can play a significant role in the growth and size of aquatic life and the marine species disturbance, either in a beneficial (for example, shellfish) or in an adverse way.

According to some studies about the effects of changes in the salinity of sea water on marine organisms, the primary and apparent changes might occur firstly in mobile species such as plankton and fish; the reaction will be highest in those organisms with a plankton stage in their life history (Hiscock et al., 2004, cited in Danoun, 2007). However, impacts differ between different sorts of organisms. In some fish, juvenile stages are more vulnerable to salinity changes than the adult generation.

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 and intermittent nature of brine discharge, low salinity increases and, open water surrounding the vessel, impact on the water quality in the operational area is expected to be negligible, temporary and localised.

<u>Changes in water 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).

Several studies have been performed to determine how the distribution and abundance of marine flora and fauna species react to a change in temperature. Temperature can influence the growth and reproduction of marine species. Mobile species such as plankton and fish are the first and most likely sort of marine life to be influenced due to changes in the seawater temperature (Hiscock et al., 2004, cited in Danoun, 2007). Temperature increase can have a positive effect on reproduction and growth rate but also lead to a shorter lifespan, depending on the species affected and the extent of temperature change.

Given the relatively short duration of the activity (up to 7 days), low volume of cooling water, temperature differential, the deep open water surrounding the vessels, impact of a change in water temperature on water quality is expected to be Negligible and short-term and within the immediate vicinity of the discharge.

<u>Oily Water</u>

Discharges of oily bilge water could result in a localised reduction in water quality, with impacts on protected marine fauna and plankton. Oily water discharged from the vessel will be treated to a concentration (<15 ppm of oil content) in accordance with MARPOL and Marine Order 91: Marine Pollution Prevention – Oil requirements; therefore, it is unlikely lead to any impacts to the receiving environment. Modelling by Shell (2010) indicates that upon release, hydrocarbon and other chemical concentrations are rapidly diluted and expected to be below Predicted No Effect Concentration (PNEC) within a relatively short period of time, within less than 100 m of the discharge. That is, the concentration of any bilge or deck drainage discharge will rapidly fall below levels which will adversely affect the marine environment and will most likely not occur during long-term or short-term exposures.

<u>Toxicity</u>

Discharges from vessel systems may include chemicals within sewage systems, greywater, desalination and residues of those used for cleaning decks.

On discharge to the marine environment, the low volumes of these types of chemicals are expected to rapidly disperse in the offshore marine environment. Hence, any potential impacts would be confined to a localised area immediately surrounding the discharge.

There may be a localised and temporary (hours) reduction in water quality in the immediate vicinity of the release. Toxicity impacts to marine fauna from the release of chemicals are unlikely to eventuate because:

+ strong ocean currents result in the discharge being further diluted upon release to the marine environment, so the duration of exposure of chemicals to fauna will be minimal
+ deck cleaning products planned to be released to sea will meet the criteria for not being harmful to the marine environment, according to MARPOL Annex V
+ potential discharges will be intermittent and temporary within the operational area

6.7.2.2 Threatened or migratory fauna

As discussed in the sections above, the discharge extent for all planned discharges is localised, and rapid dilution is predicted to occur within the open ocean environment. Marine fauna within the operational area is likely to be transient. If contact does occur with any marine fauna, it will be for a short duration due to the rapid dispersion of the plume and the transient fauna movement, such that any exposure is likely not of sufficient duration to cause a toxic effect.

Given the nature of discharged chemicals, the small volumes that could be released to the marine environment and the nature of the marine environment within the vicinity of the operational area, the operational planned discharges are not predicted to have ecologically significant effects.

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.

6.7.2.3 Protected and significant areas and socio-economic receptors

There are no marine protected areas within the operational area. The Oceanic Shoals Marine Park is the closest at approximately 50 km from the operational area.

The operational area intersects the Pinnacles of the Bonaparte Basin Key Ecological Feature (KEF). Impacts to the physical environment and marine fauna are discussed in the sections above. Planned operational discharges are not expected to significantly impact the key values of the KEF.

6.7.3 Environmental Performance Outcomes and Control Measures

The EPOs relating to this event include:

- Reduce impacts to air and water quality from planned discharges and emissions from the activities. [FRI-EPO-03]
- Seabed disturbance limited to planned activities and defined locations within the operational area. [FRI-EPO-04]
- No unplanned objects, emissions or discharges to sea or air. [FRI-EPO-06]

The control measures considered for this event are shown in **Table 6-21**, and EPS' and measurement criteria for the EPOs are described in **Section 8.4**.

Table 6-21: Control Measure Evaluation for Planned Operational Discharges

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-004	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 outweigh the minimal costs of personnel time and it is a legislated requirement.
FRI-CM-006	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 of ensuring vessel is compliant and those deck cleaning products planned to be released to sea meet Australian Marine Orders criteria.
FRI-CM-007	General chemical management procedures.	Reduces potential for inappropriate discharge of water at sea, through appropriate handling, to maintain planned discharges to sea	Personnel time associated with chemical selection and approval as per chemical selection process.	**Adopted** – Environmental benefit of using lower toxicity chemicals outweighs procedural

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		meet the criteria for not being harmful to the marine environment.		implementation costs.
FRI-CM-020	Sewage treatment system.	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 is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
FRI-CM-021	Oily water treatment system.	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 is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
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 depth of operational area, risk of impacting sensitive	High costs to alter vessel to allow for discharge of cooling water at different height, reduction in temperature would be minimal compared to cost of altering the discharge height.	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer. Discharge of cooling water permitted maritime practice.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		environmental receptor is unlikely.		
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 Project oily water by avoiding requirement to discharge.	This would result in an increase in environmental impacts through increased fuel consumption and increased atmospheric emissions, both by the vessel (or transport vessel) having to return to port a number of times 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	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges.
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.	This would result in an increase in environmental impacts through increased fuel consumption and increased atmospheric emissions, both by the vessel (or transport vessel) having to return to port a number of times to unload the wastes, and by land transport to the nearest disposal facility. Increased	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			energy consumption and atmospheric emissions would also result from the disposal (e.g. incineration, treatment etc.) of the wastes	
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 vessel, storage space required for containment of drained liquids, increase in transfers to vessel 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.	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer.
N/A	Scupper plugs on vessel are continuously in place to prevent deck drainage	Would eliminate potential impacts of contaminants being discharged to sea in rain water.	Increased health and safety risks from wet deck not draining. Large amounts of water on a vessel's deck can also cause stability issues (free surface effect).	**Rejected** - Safety considerations outweigh the benefit given small volumes of contaminants.

6.7.4 Environmental Impact Assessment

Table 6-22: Impacts and Consequence Ranking – Planned Operational Discharges

Receptor	Consequence Level
Operational discharges	

Receptor	Consequence Level
Threatened, migratory or local fauna Physical environment or habitat	Operational discharges in the same location for an extended period of time may result in significant water quality perturbations and alteration to marine fauna behaviour. Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals, and seabirds. Any effects on water quality are expected to be within the surface waters only and have no effect on seabed receptors. Given that the activity will be for a limited duration and is located approximately 101 km from the nearest shoreline (Northeast of Kalumburu), impacts will be limited to short-term water quality impacts and temporary behavioural effects observed in fish, marine mammals, sharks 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. Consequently, 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. Given the nature of the planned operational discharges, the small volumes that could be released to the marine environment, the high levels of dilution and the nature of the marine environment in the vicinity of the operational area, impacts to the physical environment and habitat are expected to be I- (Negligible).
Socio-economic receptors	Not applicable – planned operational discharges are not expected to impact on socio-economic receptors. No stakeholder concerns have been raised regarding this event.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which operational discharges are expected.
Protected areas	No protected areas are identified in the area where operational discharges are expected to disperse. The Pinnacles of the Bonaparte Basin KEF intercepts the operational area; however, the relevant values of the KEF are not anticipated to be significantly affected by planned operational discharges.
Overall worst-case consequence	I - Negligible

6.7.5 Demonstration of ALARP

Vessel presence is required to undertake the activity and the associated generation of operational wastes cannot be eliminated. Onboard treatment of most wastes and their subsequent discharge to the marine environment is considered to be the most environmentally sound method of disposal, considering that the waste 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. In addition, they will meet legislated requirements, where applicable.

The alternative to discharging these small amounts of liquid wastes to the marine environment is to store and transport the wastes to land, where they would be disposed of in line with industry best practice. However, this would result in an increase in environmental impacts through increased fuel consumption and increased atmospheric emissions, both by the vessel (or transport vessel) having to return to port a number of times 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 (for example, incineration or treatment) of the additional wastes. The vessel size would also potentially need to be larger to accommodate the additional storage for such wastes. Therefore, this option would be of no net environmental benefit and would increase the risk associated with the activity, so it has not been adopted.

With the control measures adopted, the assessed residual consequence for this impact is I- (Negligible) and cannot be reduced further. Additional control measures were considered but rejected since the associated cost, effort or safety considerations were grossly disproportionate to any benefit, as detailed in **Section 6.7.3**. Therefore, it is considered that the impact of operational discharges is ALARP.

6.7.6 Acceptability Evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	Yes – maximum consequence from planned operational discharges is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' *Offshore Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes - management consistent with the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which in Australian waters is enacted by the Marine Orders. The following material published in relation to threatened and migratory species within the operational area identifies habitat degradation / modification as a threat (**Table 3-4**): **Conservation Advice:** + Approved Conservation Advice for *Pristis pristis* Largetooth Sawfish (2014) + Approved Conservation Advice for Green Sawfish (2008) + Approved Conservation Advice for *Glyphis garricki* Northern River Shark (2014) + Conservation Advice *Rhincodon typus* Whale Shark (2015) + Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (2009) + Conservation Advice *Balaenoptera borealis* Sei Whale (2015) + Conservation Advice *Balaenoptera physalus* Fin Whale (2015)

	Recovery Plans: + Sawfish and River Sharks Multispecies Recovery Plan (2015) identifies habitat degradation as a threat to sawfish and river sharks. Frigate-1 is aligned to Objective 5 of the plan by reducing and, where possible, eliminating adverse impacts of habitat degradation and modification. This is achieved through the implementation of FRI-EPO-03, FRI-EPO-04, FRI-EPO-06 and the control measures outlined in **Table 6-21** to prevent accidental and ongoing impact to the marine environment. + Recovery plan for the White Shark (*Carcharodon carcharias*) (2013) identifies habitat modification as a threat to white sharks. Frigate-1 is aligned with Objective 7 of the recovery plan by continuing to protect habitat critical to the survival of the white shark and minimising the impact of threatening processes within these areas. However, no habitat critical or BIAs have been identified for white sharks within the operational area. The species is highly mobile and transitory in nature and the area impacted is small compared to the amount of habitat available. With the adoption of FRI-EPO-03, FRI-EPO-04, FRI-EPO-06 and the control measures outlined in **Table 6-21,** Santos considers the impacts of operational discharges to not be inconsistent with the recovery plan. + Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017) identifies habitat modification as a threat to marine turtles. Foraging BIAs have been identified for green, loggerhead, flatback and olive ridley turtles within the operational area. Impacts from operational discharges may result in a temporary, localised impact to the marine environment, which will recover rapidly. Interim Objective 3 states that anthropogenic threats are demonstrably minimised and this is upheld with the adoption of FRI-EPO-03, FRI-EPO-04, FRI-EPO-06 and the control measures outlined in **Table 6-21**. + Blue Whale Conservation Management Plan 2015 - 2025 (2015) identifies habitat modification as a threat to blue whales. The long-term recovery objective is to minimise anthropogenic threats to allow the conservation status of the blue whale to improve so that it can be removed from the threatened species list under the EPBC Act. The species is highly mobile and transitory in nature and

	the area impacted is small compared to the amount of habitat available. With the adoption of FRI-EPO-03, FRI-EPO-04, FRI-EPO-06 and the control measures outlined in **Table 6-21,** Santos considers the impacts of operational discharges to not be inconsistent with the recovery plan. Recovery Plans / Conservation Advice for other species that may occur in the operational area do not identify habitat degradation / modification as a key threat or have explicit relevant objectives or management actions related to habitat degradation / modification. The objectives and actions of these publications were considered during the assessment of impacts and risks. The controls outlined in **Table 6-21** are consistent with the objectives of the material listed above and Santos considers the impacts of operational discharges to not be inconsistent with these objectives.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts 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 above.

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 in Australian waters reflects Australian Marine Orders requirements respectively, and is enacted by:

+ Marine Order 91 (Marine pollution prevention – oil)
+ Marine Order 96 (Marine pollution prevention – sewage)
+ Marine Order 95 (Marine pollution prevention – garbage).

The operational discharges are not expected to significantly impact the receiving environment given the management controls proposed, including compliance with all relevant Marine Orders requirements. The Marine Orders are considered to be the most appropriate standard given that the nature and scale of the events is expected to reduce the potential for environmental impacts to a level that is considered ALARP and environmentally acceptable.

6.8 Spill Response Operations

6.8.1 Description of Event

Event	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 Net Environmental Benefit Analysis (NEBA) process, outlined in this EP and the Oil Pollution Emergency Plan (OPEP) (SO-91-BI-20025). Spill response will be under the

	direction of the relevant Controlling Agency, as defined within the OPEP (Section 4.2), which may be Santos and/or another agency. In all instances, Santos will undertake a 'first-strike' spill response and will act as the Controlling Agency until the designated Controlling Agency assumes control. The response strategies deemed appropriate for the worst-case oil spill scenarios identified for the Activity are detailed in Table 6-4 of the OPEP and comprise: + Source control + Monitor and evaluate (operational monitoring) + Mechanical Dispersion + Oiled Wildlife Response + Scientific Monitoring. 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. The greatest potential for impacts additional to those described for routine operations is from oiled wildlife response operations, where fauna disturbance may occur. There is no shoreline contact predicted by modelling, and no proposed shoreline spill response.
Extent	Extent of spill.
Duration	Until termination criteria are met.

6.8.2 Nature and Scale of the Environmental Impacts and Risks for the Activities

Potential receptors: Physical environment (water quality), threatened or migratory fauna (marine mammals, marine reptiles, sharks and rays, fish (pelagic) and seabirds), protected and significant areas, socio-economic receptors.

Given spill response operations will be within offshore waters and shorelines, primarily using vessels, the types of impact are consistent with operations described elsewhere within this EP for routine operations. Details of these environmental impacts and risks for spill response operations are outlined in **Table 6-23**.

Table 6-23: Nature and scale of environmental impacts and risks for activities – spill response operations

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. Spill response activities will also 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 and 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 (**Table 3-3**), have been identified as key fauna susceptible to lighting impacts during spill response activities. **Section 6.4** provides further detail on the nature of impacts to fish and sharks, birds and marine turtles. The EMBA does not intersect any shorelines; therefore, there are no proposed terrestrial spill response activities. There are no expected impacts on turtle nesting beaches or shorelines used by nesting and feeding birds. There are no Commonwealth or State marine protected areas that intersect within the EMBA. Because of impacts to fauna, lighting has the potential to impact supported industries such as tourism and indirect impacts on the values of protected areas.	
Noise Emissions	
Spill response activities will involve the use of aircraft and vessels which will generate noise offshore.	
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. **Section 6.5** provides further detail on these impacts from vessels and helicopters. Cetaceans have been identified as the key concern for vessel noise within the EMBA. There are no marine mammal BIAs within the EMBA; though transient individuals may be present. There are foraging BIAs for several marine turtle species within the EMBA. The EMBA does not intersect any shorelines; therefore, there are no proposed terrestrial spill response activities. There are no Commonwealth or State marine protected areas that intersect within the EMBA. 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 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 (SOx) and nitrous oxides (NOx). 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
- 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.

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 6.7**. These may impact a different set of receptors than previously described in that section given vessel use may 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, however, discharges will be very localised and temporary. The EMBA does not intersect any shorelines or areas of coral or seagrass. There are no proposed terrestrial spill response activities; therefore no potential impact to coastal areas. There are no Commonwealth or State marine protected areas that intersect within the EMBA.

Cleaning of oil contaminated equipment 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.

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 the environment areas, 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, personnel and equipment, undertaking spill response activities has the potential to disturb the physical environment and marine 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.

The EMBA does not intersect any shorelines or coastal waters; therefore, there are no proposed terrestrial or shallow water spill response activities. There are no Commonwealth or State marine protected areas that intersect within the EMBA.

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 are described in **Section 7.6** and are not described further in this section. 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 and aircraft, disrupting use of an offshore area by the general public or industry (e.g. fisheries, defence, shipping). 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 offshore environment and the undertaking of spill response activities may exclude the general public and industry use of the affected environment. The EMBA does not intersect any shorelines or coastal waters; therefore, there are no proposed terrestrial spill response activities. 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; though a small-scale response is expected for a 60 m^3 MDO spill.

6.8.3 Environmental Performance and Control Measures – Spill Response Operations

For EPOs, EPS and measurement criteria relating to spill response in event of a spill during this Activity refer to the Frigate-1 OPEP (SO-91-BI-20025).

Table 6-24: Control Measure Evaluation for Spill Response Operations

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Competent Incident Management Team (IMT) and oil spill responder personnel.	Ensures that spill response strategy selection and operational activities consider the potential for additional environmental impacts.	Personnel and operational costs associated with maintaining competent IMT team and responder personnel.	**Adopted** – Considered a standard spill response control.
Use of competent vessel crew and personnel.	Reduces potential for environmental impacts from vessel usage.	Personnel and operational costs associated with maintaining contracts with competent vessel crew and personnel.	**Adopted** – Considered a standard spill response control.
Noise Emissions			

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Vessels and aircraft compliant with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA- 91-11-00003).	Reduces potential for behavioural disturbance to cetaceans.	No cost/issue associated with this control measure	**Adopted** –Ensures compliance with Part 8 of the EPBC Regulations 2000, which is considered a standard spill response control (regulatory requirement).
Light Emissions			
N/A			
Atmospheric Emissions			
International Air Pollution Prevention (IAPP) Certificate	Reduces level of air quality impacts.	Personnel and operational costs associated with maintaining Air Pollution Certificate.	**Adopted** – Considered a standard spill response control (regulatory requirement).
Disruption to Other Marine Users			
Stakeholder consultation	Promotes awareness and reduces potential impacts from response to socio-economic activities	Minimal cost in relation to overall effort/costs in managing incident	**Adopted** – Considered a standard control for incident management
Utility resource assessment and support to be conducted if activity is of significant size in comparison to the size of the coastal community	Reduces potential impact due to higher utility demands causing disruptions to local community.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Operational Discharges and Waste			
Vessels meet applicable Australian Marine Orders and Marine Park sewage disposal requirements	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted** – Considered a standard spill response control (regulatory requirement).
Vessel meet applicable Australian Marine Orders requirements for oily water (bilge) discharges	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted** – 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.	No cost/issue associated with this control measure.	**Adopted** – Considered a standard spill response control (regulatory requirement).

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Physical Presence and Disturbance			
Spill response activities selected on basis of a net environmental benefit analysis.	Provides a systematic and repeatable process for evaluating strategies with net least environmental impact.	No cost/issue associated with this control measure	**Adopted** – Considered a standard spill response control.
Vessels and aircraft compliant with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA- 91-11-00003).	Reduces potential for behavioural disturbance to cetaceans.	No cost/issue associated with this control measure	**Adopted** – Ensures compliance with Part 8 of the EPBC Regulations 2000, which is considered a standard spill response control (regulatory requirement).
Adhere to WA Oiled Wildlife Response Plan and Pilbara Regional Oiled Wildlife Response Plan	Oiled wildlife hazing, capture, handling and rehabilitation meet minimum standards as outlined within the WA Oiled Wildlife Response Plan.	Operational costs associated with response plan.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.

6.8.4 Environmental Impact Assessment

Receptor	Consequence Level
Light Emissions	
+ Threatened, migratory, and local fauna; + Protected Areas. + Socio-economic receptors	The receptors considered most sensitive to lighting from vessel operations are seabirds/shorebirds and marine turtles, particularly over summer months with respect to marine turtles where emerging hatchlings are sensitive to light spill onto beaches. The EMBA intersects with marine turtle foraging BIAs; but is approximately 46 km from the closest shoreline, which is where marine turtle or bird behaviour would be most vulnerable to impact from artificial light. The EMBA does not intersect any shorelines or coastal waters; therefore, there are no proposed terrestrial or nearshore spill response activities. There are no Commonwealth or State marine protected areas that intersect within the EMBA. Impacts from vessel lighting are considered to be I – Negligible.
	Fauna (including Threatened/ Migratory/ Local Fauna): I (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: I (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.

Receptor	Consequence Level
	Socio-economic receptors: I (Negligible) – no or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the activity
Overall worst-case consequence level	I – Negligible
Acoustic Disturbance	
+ Threatened, migratory, and local fauna; + Protected Areas. + Socio-Economic Receptors	The receptors considered most sensitive to vessel noise disturbance are populations of cetaceans. There are no marine mammal BIAs within the EMBA; though transient individuals may be present. There are foraging BIAs for several marine turtle species within the EMBA. though there are foraging BIAs for several marine turtle species. The EMBA does not intersect any shorelines, and there are no proposed terrestrial or nearshore spill response activities. Therefore, there is no impact expected to marine turtles or birds active on the coastline. However, following the adoption of control measures to limit close interaction with protected fauna (i.e. Santos Protected Marine Fauna Interaction and Sighting Procedure), a temporary behavioural disturbance is expected only with a consequence of Negligible.
	Fauna (including Threatened/ Migratory/ Local Fauna): I (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: I (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: I (Negligible) – no or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the activity.
Overall worst-case consequence level	I – Negligible
Atmospheric Emissions	
+ Physical environment and habitat/air quality + Threatened, migratory, and local fauna; + Protected areas. + Socio-economic receptors	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, physical environment and socio-economic receptors are predicted to be Negligible.
	Physical environment/habitat: I (Negligible) – No or negligible reduction in habitat area/function. Fauna (including Threatened/ Migratory/ Local Fauna): I (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.

Receptor	Consequence Level
	Protected areas: I (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: I (Negligible) – no or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the activity.
Overall worst-case consequence level	I – Negligible
Operational Discharges and Waste	
+ Threatened, migratory, and local fauna; + Physical environment and habitats; + Protected areas. + Socio-economic receptors	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. The EMBA does not intersect any shorelines or coastal waters; therefore, there are no proposed nearshore spill response activities. There are no Commonwealth or State marine protected areas that intersect within the EMBA. Because of impacts to fauna, operational discharges from vessels have 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 I -negligible. There are no proposed terrestrial spill response activities; therefore, no potential onshore impacts.
	Physical environment/habitat: I (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: I (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: I (Negligible) – no or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the activity.
Overall worst-case consequence level	I – Negligible
Physical Presence and Disturbance	
+ Threatened, migratory, and local fauna	The use of vessels offshore has the potential to disturb benthic habitats. The EMBA does not intersect any shorelines or coastal waters; therefore, there are no proposed terrestrial or nearshore spill response activities. There is no potential to disturb sensitive habitats in coastal waters such as corals, seagrass, macroalgae and

Receptor	Consequence Level
+ Physical environment and habitats + Protected areas.	mangroves; or important habitats of threatened and migratory fauna including nests of turtles and birds and bird roosting 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 Negligible consequence following compliance with the WA Oiled Wildlife Response Plan and the East Kimberley Region Oiled Wildlife Response Plan. There are no Commonwealth or State marine protected areas that intersect within the EMBA. The disturbance to marine natural habitat may have flow on impacts to socio-economic values and industry (e.g. tourism, fisheries). This impact is considered negligible (I).
	Physical environment/habitat: I (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: I (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: I (Negligible) – no or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the activity.
Overall worst-case consequence level	I – Negligible
Disruption to Other Users of Marine and Coastal Areas and Townships	
+ Socio-economic receptors.	The use of vessels in offshore environment and spill response may exclude general public and industry use. The EMBA does not intersect any shorelines or coastal waters; therefore, there are no proposed terrestrial or nearshore spill response activities. 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.
	Socio-economic receptors: I (Negligible) – no or negligible loss of value of the local industry. No or negligible reduction in key natural features or populations supporting the activity.
Overall worst-case consequence level	I – Negligible

6.8.5 Demonstration of ALARP

A NEBA is the primary tool used during spill response to evaluate response strategies with the goal of selecting strategies that result in the least net impact to key environmental sensitivities. The NEBA process conducted as a spill occurs, 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 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. The EMBA does not intersect any shorelines or coastal waters; therefore, there are no proposed terrestrial or nearshore spill response activities; and therefore potential impacts in these areas.

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.

Santos have considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a) and Approved Conservation Advice for other relevant threatened fauna relevant to spill responses for the activities to minimise noise and light impacts on marine cetaceans, fish, sharks and marine turtles, especially flatback 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, 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 grossly disproportionate costs. It is considered therefore that the impact of the activities conducted is ALARP.

6.8.6 Acceptability Evaluation

Is the consequence ranked as I (Negligible) or II (Minor)?	Yes – Maximum consequence is II (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 well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes - Activity evaluated in accordance with the Offshore *Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5) which considers principles of ESD.

Are control measures and performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	The following material published in relation to threatened and migratory species within the EMBA identifies habitat degradation / modification, pollution or oil spills as a threat (**Table 3-4**): **Conservation Advice:** + Approved Conservation Advice for *Pristis pristis* Largetooth Sawfish (2014) + Approved Conservation Advice for *Pristis clavata* Dwarf Sawfish (2009) + Approved Conservation Advice for Green Sawfish (2008) + Approved Conservation Advice for *Glyphis garricki* Northern River Shark (2014) + Conservation Advice *Rhincodon typus* Whale Shark (2015) + EPBC Act Policy Statement 3.21 – Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (2017) + Conservation Advice *Calidris ferruginea* Curlew Sandpiper (2015) + Conservation Advice *Numenius madagascariensis* Eastern Curlew (2015) + Conservation Advice *Calidris canutus* Red Knot (2016) + Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (2009) + Conservation Advice *Balaenoptera physalus* Fin Whale (2015) + Conservation Advice *Balaenoptera borealis* Sei Whale (2015) **Recovery Plans:** + Sawfish and River Sharks Multispecies Recovery Plan (2015) + Recovery Plan for the White Shark *Carcharodon carcharias* (2013) + Draft Wildlife Conservation Plan for Seabirds (2019) + Wildlife Conservation Plan for Migratory Shorebirds (2015). + Recovery plan for marine turtles in Australia 2017 – 2027 (2017) + Blue Whale Conservation Management Plan 2015 - 2025 (2015) Recovery Plans / Conservation Advice for other species that may occur in the EMBA do not identify habitat degradation / modification, pollution or oil spills as a key threat or have explicit relevant objectives or management actions. The objectives of these publications were considered during the assessment of impacts and risks and the activity is not inconsistent with these objectives.

Are control measures and performance standards consistent with the Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety 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, AMSA) will occur and thus there will be ongoing consultation with relevant stakeholders on the acceptability of response operations. If required, wildlife response will be conducted in accordance with the WA Oiled Wildlife Response Plan (WA OWRP) and East Kimberley 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).

The implementation of response activities to reduce the potential impacts from a spill are required by legislation. The spill response options selected have been demonstrated to show a net environmental benefit, are standard industry practice and consistent with relevant standards and guidelines, including the NatPlan. No concerns from stakeholders have been raised regarding response activities and the controls proposed reduce the consequences of the potential impacts to minor and ALARP. The controls used during spill response activities are therefore considered to reduce additional impacts and risks to an acceptable level.

7 Environmental Assessment for Unplanned Events

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Evaluation of environmental impacts and risks 13(5) The environment plan must include: (a) details of the environmental impacts and risks for the activity; and (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. 13(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* 13(7) The environment plan must: (a) set environmental performance standards for the control measures identified under paragraph (5)(c); and (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.

An ENVID workshop (as described in **Section 5**) for unplanned activities was held in December 2021 which identified seven potential sources of environmental risks associated with 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 subsections.

Table 7-1: Summary of the Risk Assessment Ranking for Unplanned Activities

EP Section Reference	Event	Consequence	Likelihood	Residual Risk Level
7.2	Hydrocarbon release (surface) of MDO	II - Minor	B - Unlikely	Very Low
7.3	Minor hydrocarbon releases (surface and subsurface)	II - Minor	B - Unlikely	Very Low
7.4	Non-hydrocarbon and chemicals release (surface) - liquids	I- Negligible	C - Possible	Very Low
7.5	Release of Solid Objects	I- Negligible	C - Possible	Very low
7.6	Introduction of invasive marine species	III - Moderate	B - Unlikely	Low
7.7	Marine fauna interaction	II - Minor	B - Unlikely	Very Low
7.8	Interaction with other marine users (wellhead in-situ)	II - Minor	B - Unlikely	Very Low

7.1 Overview of Unplanned Release of Hydrocarbons

7.1.1 Credible Release Scenarios

Unplanned events may occur during the activity, resulting in the potential release of hydrocarbons (Marine Diesel Oil (MDO)) to the marine environment.

The surface release of MDO from vessel collision / fuel tank failure was identified as being the only potentially credible scenario.

Table 7-2 presents the Maximum Credible Scenario (MCS) for the release scenario.

Table 7-2: Summary of Maximum Credible Spill Scenarios

Maximum Credible Spill Scenario	Hydrocarbon Type	Maximum Credible Volume	Comment	EP Section
Surface release of MDO from the vessel as a result of an external impact (vessel collision) / fuel tank failure	MDO	60 m^3 released over 6 hours	Maximum credible volume based of MDO bunker tanks, with the largest tank having a capacity of 60 m^3	**7.2**

7.1.1.1 Non-credible Scenarios

Vessel grounding was discussed and considered but determined non-credible given the offshore location of the operational area and water depth (approximately 112 m); and therefore is not discussed further.

A loss of well control (LOWC) is not considered credible due to:

+ the Frigate-1 well was permanently P&A'd in 1978, with three cement plugs (Geoscience Australia, 1978)

- the Frigate-1 well did not encounter any hydrocarbons when it was drilled (i.e. was 'dry').

7.1.2 Spill Modelling Overview

Oil spill modelling was carried out with SINTEF's Oil Spill Contingency and Response (OSCAR) system (version 13.0) (Xodus, 2022). OSCAR is a system of integrated models to quantitatively assess the fate and transport of hydrocarbons in the marine environment, as well as evaluate the efficacy of response measures. OSCAR provides an integrated hydrocarbon transport and weathering model that accounts for hydrocarbon advection, dispersion, surface spreading, entrainment, dissolution, biodegradation, emulsification, volatilisation and shoreline interaction.

Three-dimensional (3D) OSCAR modelling was undertaken in stochastic mode (total of 110 realisations for each of the four seasons). Inputs into the model were sourced from HYCOM (global ocean currents, temperature and salinity profiles), TPXO9 (tidal currents) and European Centre for Medium Range Weather Forecasts (ECMWF) (global dataset for winds).

The justification for the hydrocarbon type modelled is in the Hydrocarbon Specifications for Modelling- Condensate Analogue section below.

Table 7-3 provides details on the model input specifications for the modelled scenarios presented in **Table 7-2**.

Table 7-3: Model Input Specifications

Parameter	Surface MDO
Location	Frigate-1 wellhead Latitude: 13° 10' 48" S Longitude: 127° 55' 25" E
Depth of release	0 m (surface spill)
Hydrocarbon type	Marine Diesel Oil (MDO)
Hydrocarbon discharge rate	-
Liquid release volume	60 m^3
Time of the year	All months*
Spill duration	6 hours
Modelling duration	10 days

* The stochastic model was run based on the survey occurring at any time of the year, with 110 realisations for each of the four seasons.

7.1.3 Hydrocarbon Characteristics

ITOPF (2011) and Australian Maritime Oil Spill Centre-AMOSC (2011) categorises MDO as a light group II hydrocarbon. In the marine environment, a 5% residual of the total quantity of diesel spilt will remain after the volatilisation and solubilisation processes associated with weathering (**Table** 7-4).

Table 7-4: Characteristics of MDO

Oil Type	Initial density g/cm³ at 15°C	Viscosity (cP) (15°C)	Component	Volatiles (%)	Semi-volatiles (%)	Low Volatility (%)	Residual (%)	Aromatics (%)
			Boiling Points (°C)	<180	180-265	256-380	>380	Of whole oil <380
				NON-PERSISTENT			PERSISTENT	
Marine Diesel Oil	0.8368	4	% of total	6.0	34.6	54.4	<5	3.0

Source: Xodus (2022)

7.1.3.1 Weathering Modelling

Weathering modelling was undertaken with the SINTEF Oil Weathering Model (OWM). OWM predicts the weathering (i.e. mass balance partitioning) of hydrocarbons under steady-state met-ocean conditions. OWM simulations were run for sustained wind speeds of 1 m/s (low winds), 5 m/s (moderate winds) and 10 m/s (high winds). The simulations are based on a test case of 60 m^3 of hydrocarbon released onto the sea surface over 6 hours.

ITOPF (2011) and AMOSC (2011) categorise MDO as a light 'group II' hydrocarbon. In the marine environment, MDO is expected to behave as follows:

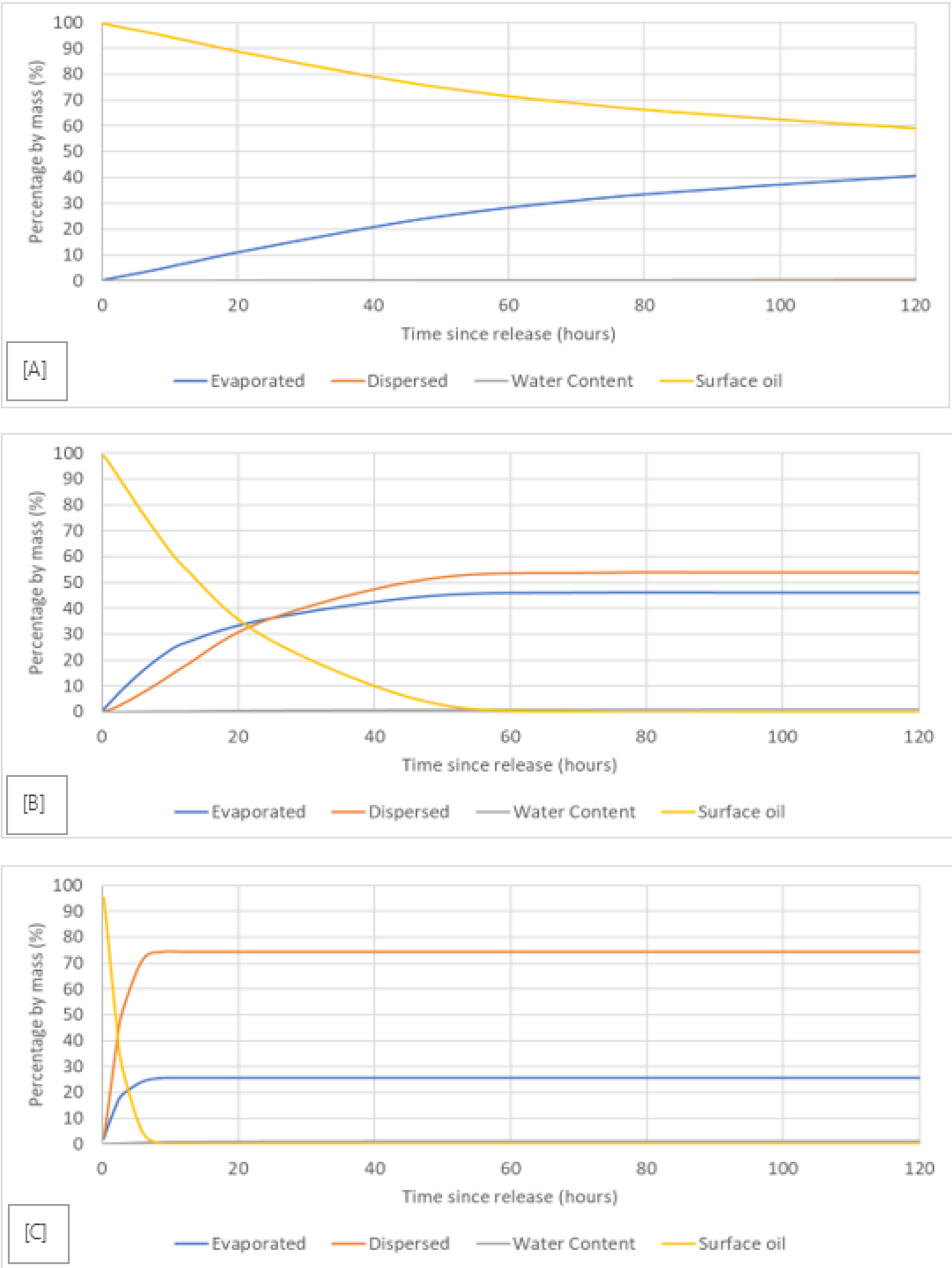
+ MDO will spread rapidly in the direction of the prevailing wind and waves
+ Evaporation will be the dominant process contributing to the fate of spilled diesel from the sea surface and will account for 60 to 80% reduction of the net hydrocarbon balance
+ The evaporation rate of diesel will increase in warmer air and sea temperatures
+ MDO residues usually consist of heavy compounds that may persist longer and will tend to disperse as oil droplets into the upper layers of the water column.

The results of the weathering analyses are presented in **Figure 7-2.**

Marine Diesel (IKU) has been used as an analogue for MDO in the modelling study (Xodus, 2022). Marine Diesel (IKU) has a very low tendency for emulsion formation, with only 1% water content entrained into the surface slick after 120 hours for all wind conditions assessed (Xodus, 2022) (**Figure 7-2**).

MDO is most often light and non-persistent, which because of its' volatile nature and low viscosity tend to disappear rapidly from the sea surface. Under low winds (1 m/s), 59% of the surface slick is predicted to remain after 120 hours (five days). With moderate winds (5 m/s), no MDO is predicted to remain on the surface after 72 hours and under high winds (10 m/s) after 6 hours (Xodus, 2022) (**Figure 7-2**).

Under lower wind speeds the MDO will remain on the surface longer, spread quicker and in turn increase the evaporative process. Conversely, stronger wind speeds will generate breaking waves at the surface, causing a higher amount of MDO to be dispersed in the water column and reducing the amount available to evaporate. OWM predicted that after 120 hours, approximately 41% evaporated and 1% dispersed under low winds, 46% and 54% under moderate winds and 26% and 74% under high winds, respectively.



Source: Xodus, 2022

Figure 7-1: Weathering of a 60 m^3 MDO release over 6 hours (tracked for 5 days) during three static wind conditions (A = 1 m/s, B = 5 m/s and C = 10 m/s)

7.1.4 Hydrocarbon Exposure Values

To inform the impact assessment it is important to understand the concentrations of hydrocarbons within the EMBA after a spill. To do this NOPSEMA recommends identifying hydrocarbon exposure values that broadly reflect the range of consequences that could occur at certain concentrations (NOPSEMA, 2019). The exposure values that have been applied to this EP are described below.

The EMBA shown in **Figure 3-1** was determined using low exposure values predicted by modelling (Xodus, 2022). These low exposure values are not considered to be representative of a biological impact, but they are adequate for identifying the full range of environmental receptors that might be contacted by surface and/or subsurface hydrocarbons (NOPSEMA, 2019).

To inform impact assessment, exposure values that may be representative of biological impact have also been identified. These are called “moderate exposure values” and “high exposure values”. Moderate and high exposure values are modelled to identify the receptors contacted by surface, subsurface (entrained hydrocarbon and DAH’s), and shoreline accumulation.

Determining exposure values that may be representative of biological impact is complex since the degree of impact will depend on the sensitivity of the receptors contacted, the duration of the exposure and the toxicity of the hydrocarbon type making the contact. The toxicity of a hydrocarbon will also change over time, due to weathering processes altering the composition of the hydrocarbon. To identify appropriate exposure values, Santos have considered the advice provided by NOPSEMA Bulletin #1 Oil Spill Modelling (April 2019) and scientific literature. The selected hydrocarbon exposure values are discussed in **Table 7-5, Table 7-6, Table 7-7** and **Table** 7-8 below.

Table 7-5: Surface Oil Exposure Values

Surface Oil Concentration (g/m^2)	Exposure Value	Description
1	Low	<u>Risk Evaluation</u> It is recognised that a lower surface oil concentration of 1 g/m^2 (equivalent to a thickness of 0.001 mm or 1 ml of oil per m^2) is visible as a rainbow sheen on the sea surface. Although this is lower than the exposure value for ecological impacts, it may be relevant to socio-economic receptors and has been used as the exposure value to define the spatial extent of the environment that might be contacted (EMBA) from surface oil. <u>Response Planning</u> Contact at 1 g/m^2 (as predicted by oil spill trajectory modelling) is used as a conservative trigger for activating scientific monitoring plans as detailed in the OPEP.
10	Moderate	<u>Risk Evaluation</u> There is a paucity of data on surface oil concentrations with respect to impacts to marine organisms. Hydrocarbon concentrations for registering biological impacts resulting from contact of surface slicks have been estimated by different researchers at about 10–25 g/m^2 (French et al., 1999; Koops et al., 2004; NOAA, 1996). The impact of surface oil on birds is better understood than on other receptors.

Surface Oil Concentration (g/m^2)	Exposure Value	Description
		A conservative exposure value of 10 g/m^2 has been applied to impact assessment from surface oil in **Sections 7.2** of this EP. Although based on birds, this hydrocarbon exposure value is also considered appropriate for turtles, sea snakes and marine mammals (NRDAMCME, 1997). Response Planning Contact at 10 g/m^2 is not specifically used for spill response planning.
50	High	Risk Evaluation At greater thicknesses the potential for impact of surface oil to wildlife increases. All other things being equal, contact to wildlife by surface oil at 50 g/m^2 is expected to result in a greater impact. Response Planning Containment and recovery effectiveness drop significantly with reduced oil thickness (McKinney et al., 2017; NOAA, 2014). McKinney et al. (2017) tested the effectiveness of various oil skimmers at various oil thicknesses. Their results showed that the oil recovery rate of skimmers dropped significantly when oil thickness was less than 50 g/m^2-(less than Bonn Agreement Code 4). Hence, 50g/m^2 has been set as a guide for planning effective containment and recovery operations. Similarly, surface oil >50 g/m^2 (Bonn Agreement Code 4/5 and equivalent to oil observed as discontinuous or continuous true colour) is considered to be a lower limit for effective dispersant operations and is therefore considered for planning. Note that containment and recovery and dispersant application are assessed as not being suitable response strategies for MDO or Reindeer Condensate.

Table 7-6: Shoreline Hydrocarbon Accumulation Exposure Values

Shoreline Accumulation (g/m^2)	Exposure Value	Description
10	Low	Risk Evaluation An accumulated concentration of oil above 10 g/m^2 on shorelines is considered to represent a level of socio-economic effect (NOPSEMA, 2019) e.g. reduction in visual amenity of shorelines. This value has been used in previous studies to represent a low contact value for interpreting shoreline accumulation modelling results (French-McCay, 2005, 2006). Response Planning Not specifically used for response planning because below the limit that can be effectively cleaned.
100	Moderate	Risk Evaluation The impact exposure value concentration for exposure to hydrocarbons stranded on shorelines is derived from levels likely to cause adverse impacts to marine or coastal fauna and habitats. 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

Shoreline Accumulation (g/m²)	Exposure Value	Description
		reefs) and coating of marine fauna. Environmental risk assessment studies (French-McCay, 2009) report that an oil thickness of 0.1 mm (100 g/m^2) on shorelines is assumed as the lethal exposure value for invertebrates on hard substrates (rocky, artificial or man- made) and sediments (mud, silt, sand or gravel) in intertidal habitats. A conservative exposure value of 100 g/m^2 has been applied for impact assessment from shoreline accumulation of hydrocarbons in **Sections 7.2** of this EP. <u>Response Planning</u> A shoreline concentration of 100 g/m^2, or above, is likely to be representative of the minimum limit that the oil can be effectively cleaned according (AMSA, 2015; NOPSEMA, 2019) and is therefore used as a guide for shoreline clean- up planning. This exposure value equates to approximately ½ a cup of oil per square meter of shoreline contacted.
1,000	High	<u>Risk Evaluation</u> At greater thicknesses the potential for impact of accumulated oil to shoreline receptors increases. All other things being equal, accumulation of oil above 1,000 g/m^2 is expected to result in a greater impact. <u>Response Planning</u> As oil increases in thickness the effectiveness of oil recovery techniques increases. This value can therefore be used to prioritise oil recovery efforts, assuming oil recovery is deemed to have an environmental benefit.

Table 7-7: Dissolved Hydrocarbon Exposure Values

Dissolved hydrocarbons (ppb)	Exposure Value	Description
10	Low	<u>Risk Evaluation</u> Dissolved Hydrocarbons (also referred to as dissolved WAF or DAH) include the monoaromatic hydrocarbons (MAHs) (compounds with a single benzene ring such as BTEX [benzene, toluene, ethyl benzene, and xylenes]) and polycyclic aromatic hydrocarbons (PAHs) (compounds with multiple benzene rings such as naphthalenes and phenanthrenes). These compounds have a greater bioavailability that other components of oil and are considered to be main contributors to oil toxicity. The toxicity of dissolved hydrocarbons is a function of the concentration and the duration of exposure by sensitive receptors with greater concentration and exposure time causing more sever impacts. Typically tests of toxicity done under laboratory conditions measure toxicity as proportion of test organisms affected (e.g. 50% mortality or LC50) at the end of a set time period, often 48 or 96 hours. French-McCay (2002) in a review of literature, reported LC50 for dissolved PAHs with 96 h exposure, range between 30 ppb for sensitive species (2.5th-percentile species) and 2,260 ppb for insensitive species (97.5th-percentile species), with an average of about 250 ppb. The range of LC50s for PAHs

Dissolved hydrocarbons (ppb)	Exposure Value	Description
		obtained under turbulent conditions (this includes fine oil droplets) was 6 ppb to 410 ppb with an average of 50 ppb (French-McCay, 2002). The dissolved hydrocarbon 10 ppb exposure value has been used to inform the EMBA in Section **7.2**. An exposure value of 10 ppb is appropriate as it is concentration that could have some potential negative effect on marine organisms. Response Planning Contact at 10 ppb (as predicted by oil spill trajectory modelling) is used as a trigger for activating scientific monitoring plans as detailed in the OPEP. Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers (NOPSEMA, 2019).
50	Moderate	Risk Evaluation Approximates potential toxic effects, particularly sublethal effects to sensitive species (refer to above text). Consistent with NOPSEMA (2019). For most marine organisms, a concentration of between 50 and 400 ppb is considered to be more appropriate for risk evaluation. Response Planning Encompassed by response to 10ppb. There is no different response planning for higher exposure values.
400	High	Risk Evaluation Approximates toxic effects including lethal effects to sensitive species (NOPSEMA, 2019). Response Planning Encompassed by response to 10 ppb. There is no different response planning for higher exposure values.

Table 7-8: Entrained Hydrocarbon Exposure Values

Entrained hydrocarbons (ppb)	Exposure Value	Description
10	Low	Risk Evaluation Entrained hydrocarbons (also referred to as total WAF), as opposed to dissolved, are oil droplets suspended in the water column and insoluble. Entrained hydrocarbons are not as bioavailable to marine organisms compared to DAHs and on that basis are considered to be a less toxic, especially over shorter exposure time frames. Entrained hydrocarbons still have potential effects on marine organisms through direct contact with exposed tissues and ingestion (NRC, 2005) however the level of exposure causing effects is considered to be considerably higher than for dissolved hydrocarbons. Much of the published scientific literature does not provide sufficient information to determine if toxicity is caused by entrained hydrocarbons, but rather the toxicity of total oils which includes both dissolved and entrained components. Variations in the methodology of the total water accommodated fraction (TWAF

Entrained hydrocarbons (ppb)	Exposure Value	Description
		(entrained and dissolved)) may account for much of the observed wide variation in reported exposure values, which also depend on the test organism types, duration of exposure, oil type and the initial oil concentration. Total oil toxicity acute effects of total oil as LC50 for molluscs range from 500 to 2,000 ppb (Clark et al., 2001; Long and Holdway, 2002). A wider range of LC50 values have been reported for species of crustacea and fish from 100 to 258,000,000 ppb (Gulec et al., 1997; Gulec and Holdway, 2000; Clark et al., 2001) and 45 to 465,000,000 ppb (Gulec and Holdway, 2000; Barron et al., 2004), respectively. The 10 ppb exposure value represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC (2018) water quality guidelines. This is consistent with NOPSEMA (2019) guidance. Response Planning Contact at 10 ppb (as predicted by oil spill trajectory modelling) is used as a trigger for activating scientific monitoring plans as detailed in the OPEP. Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers (NOPSEMA, 2019).
100	Moderate	Risk Evaluation The 100 ppb exposure value is considered to be representative of sub-lethal impacts to most species and lethal impacts to sensitive species based on toxicity testing as described above. This is considered conservative as toxicity to marine organisms from oil is likely to be driven by the more bioavailable dissolved aromatic fraction, which is typically not differentiated from entrained hydrocarbon in toxicity tests using water accommodated fractions (WAFs). Given entrained hydrocarbon is expected to have lower toxicity than dissolved aromatics, especially over time periods where these soluble fractions have dissoluted from entrained hydrocarbon, the moderate exposure value is considered appropriate for risk evaluation. The entrained hydrocarbon 100 ppb exposure value has been used to inform the risk assessments within **Sections 7.2**. Response Planning Encompassed by response to 10ppb. There is no different response planning for higher exposure values.

7.1.5 Spill Risk Assessment Approach

A consistent risk assessment approach is applied to the unplanned hydrocarbon release scenario in **Section 7.2** (MDO). The spill risk assessment approach is based on Santos' Oil Spill Risk Assessment and Response Planning Procedure (QE-91-II-20003). The procedure describes the spill risk assessment process as follows:

+ Identify the spatial extent of the EMBA. This has been completed for this EP as part of the assessment of the existing environment and receptors that are known to occur or may occur within the EMBA are described in **Section 3**

- Identify areas of high environmental value (HEV) within the EMBA (HEVs are described in **Section 7.1.5.2**)
- Identify and then risk assess hot spots. Hotspots are effectively a subset of HEVs and their determination is described in **Section 7.1.5.3**)
- Identifies priorities for protection (for consideration of spill response strategies in the Frigate-1 OPEP (SO-91-BI-20025).

7.1.5.1 Spill EMBA

Defining the EMBA by an oil spill is the first step in oil spill risk assessment. For activities where there is the potential for multiple spill scenarios, the spill scenario, or combination of spill scenarios, resulting in the greatest spatial extent of impacts is used to define the overall EMBA for the activity. The EMBA is further described in **Section 3.1**.

7.1.5.2 Areas of High Environmental Value

Santos has predetermined areas of HEV (**Figure 7-2**) 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 listed threatened species – 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)
- 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 and Northern Territory 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.

7.1.5.3 Hot Spots

While the entire EMBA will be considered during risk assessment and spill response planning, it is best practice to concentrate greatest effort and level of detail 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)
- The greatest potential concentration or volume of oil arriving at the area.

These areas are termed 'Hot Spots'. Defining Hot Spots is typically the first step in undertaking detailed spill risk assessment and spill response planning. Hot Spots are a subset of HEV areas that:

- Have the highest probability of contact (at least higher than 5%) above the impact assessment
- exposure values for surface hydrocarbons and shoreline accumulation based on modelling results
- Receive the greatest concentration or volume of oil, either floating or stranded oil, entrained hydrocarbon or DAHs above contact exposure values described in **Section 7.1.4**.

7.1.5.4 Priorities for Protection

For the purposes of a spill response preparedness strategy, it is not necessary for all Hot Spots to have detailed planning. For example, wholly submerged Hot Spots may only be contacted by entrained hydrocarbon, and the response would be largely to implement scientific monitoring to determine impact and recovery. Hot Spots with features that are not wholly submerged (i.e., emergent features) should have specific spill response planning conducted. This final determination of 'Priority for Protection' sites, for the oil spill response strategy, is based on the worst-case estimate of surface oil concentration, shoreline loading and minimum contact time at exposure value concentrations.

Further detail on the process for selection of Priority for Protection sites is detailed in the *Oil Spill Risk Assessment and Response Planning Procedure* (QE-91-II-20003).

The oil spill response strategies for Priority for Protection sites are undertaken within the activity OPEP.

An assessment of each protection priority will be undertaken to determine the most appropriate spill response strategies based on the type of oil and the values of the protection priority area. This can be done through a strategic Net Environmental Benefit Analysis (NEBA) approach.

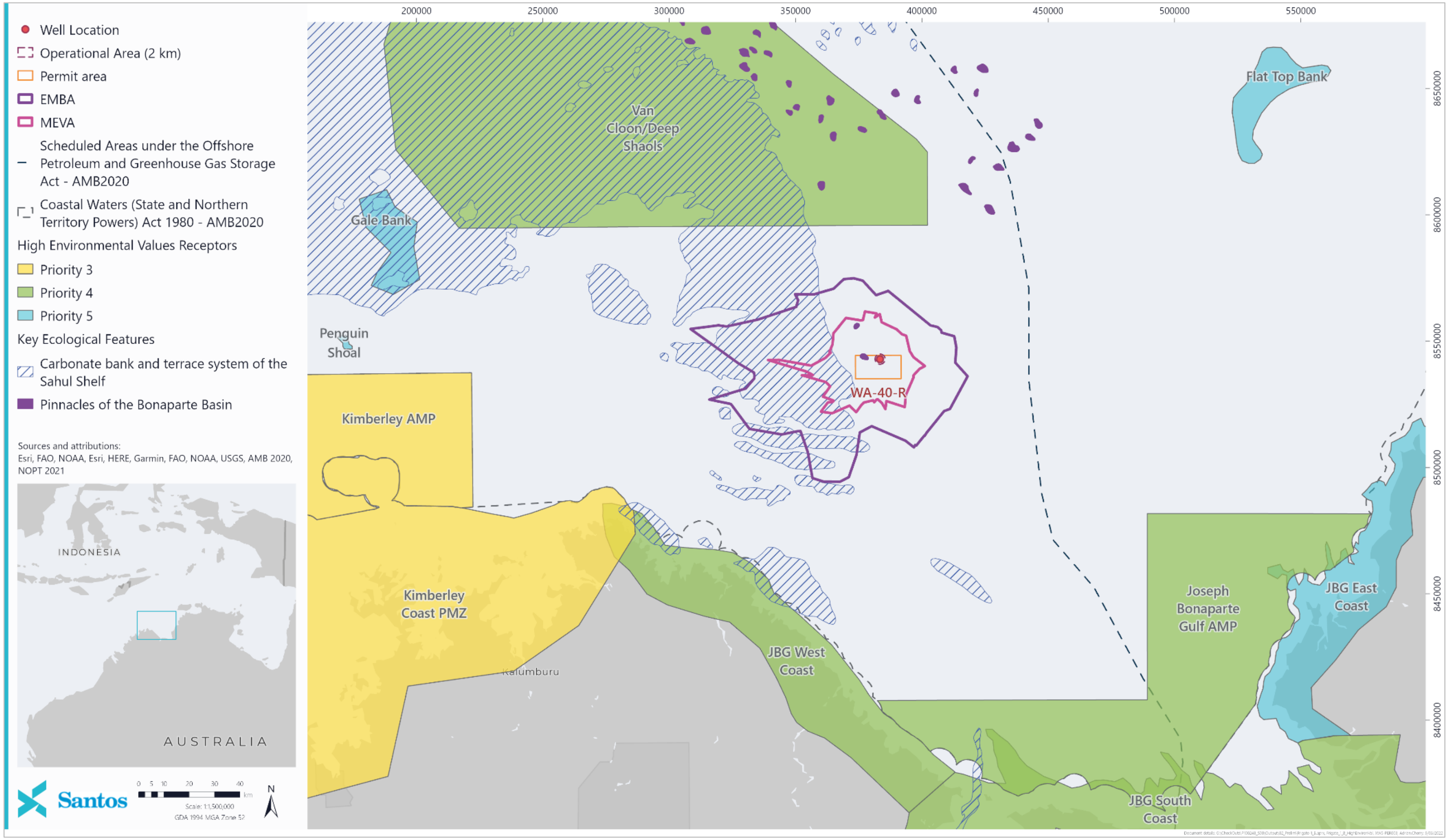


Figure 7-2: All Environmental Value Areas (North WA and NT)

7.1.5.5 Potential Hydrocarbon Impact Pathways

To help inform the hydrocarbon spill risk assessment receptors within the EMBA, the potential physical and chemical impact pathways have been defined. Physical pathways include contact from surface oil, accumulated shoreline oil, or entrained hydrocarbon droplets from an MDO or LOWC condensate release. Chemical pathways include ingestion, inhalation or contact from any hydrocarbon phase. These are summarised in **Table 7-9** and the information is drawn upon within the hydrocarbon risk assessment for each release scenario (**Section 7.2**). **Table 7-10** further describes the nature and scale of the hydrocarbon spills associated with the Activity on marine fauna and socio-economic receptors found within the MEVA.

Table 7-9: Physical and Chemical Pathways for Hydrocarbon Exposure and Potential Impacts on Receptors

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Seagrasses and macroalgae	Coating of leaves/thalli reducing light availability and gas exchange. Degree of coating depends upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	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.
Non-coral benthic 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 oil.	Mortality. Behavioural disruption. Impaired growth.	Ingestion and inhalation. External contact and adsorption across exposed skin and cellular membranes. Uptake of DAH 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. Behavioural disruption.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Sharks, rays and fish	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 DAH across cellular membranes (for example, 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 (seabirds and shorebirds)	Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Feather and skin irritation and damage, with the potential to cause secondary impacts such as: Physical restriction of flight and swimming movement. Mortality. Hypothermia / impairing the waterproofing of feathers. Disruption to feeding / starvation. Disruption to breeding. Disruption to migration.	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.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Marine reptiles	Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Irritation of eyes/mouth and potential illness, which may cause secondary impacts such as: Mortality. Disruption to feeding / starvation. Physical restriction. Behavioural disruption.	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 hatchling success. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine mammals	Fur damage and matting, reduced mobility and buoyancy (for applicable species). Coating of feeding apparatus in some species (baleen whales).	Irritation of eyes/mouth, damage to fur and potential illness, which may cause secondary impacts such as: Mortality. Disruption to feeding / starvation. Physical restriction. Behavioural disruption.	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.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Plankton	Coating of feeding apparatus. Reduced mobility and capacity for oxygen exchange.	Mortality. Behavioural disruption (for example, reduced mobility).	Inhalation. Ingestion. External contact.	Mortality. Impairment of biological activities (for example, feeding, respiration). Reduced mobility.
Water quality and sediment quality	Presence of hydrocarbon residue in the water, which may filter down to sediments or continue to biodegrade on the surface. Degree of loading in the water column is dependent upon the influence of wave energy and tidal range.	Impacts to flora and fauna, as discussed in rows above.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation. Impacts to flora and fauna, as discussed in rows above.	Impacts to flora and fauna, as discussed in rows above.
Protected areas	Coating of benthic habitats, shoreline habitats and marine fauna/flora within protected areas as discussed in rows above.	Mortality, injury or behavioural disruption to marine fauna. Death or impairment of habitats within protected areas. Reduction in the quality of the marine environment within protected areas. Environmental value of protected areas is degraded.	Impacts to flora and fauna, as discussed in rows above.	Mortality, injury or behavioural disruption to marine fauna. Death or impairment of habitats within protected areas. Reduced growth of benthic habitats. Reduction in the quality of the marine environment within protected areas. Environmental value of protected areas is degraded.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Socio-economic environment (fisheries, tourism, shipping, defence, shipwrecks, Indigenous users, oil and gas)	Presence of hydrocarbon residue in the water, which may filter down to sediments or continue to biodegrade on the surface. Coating of benthic habitats, shoreline habitats and marine fauna/flora within protected areas as discussed in rows above.	Degradation of cultural or maritime heritage sites. Disruption to tourism, recreation or shipping activities. Reduction in resource available for commercial and recreational fisheries.	Impacts to flora, fauna and the physical environment as discussed in rows above. Commercial/recreational fish species – refer to 'fish' as discussed above.	Degradation of cultural or maritime heritage sites. Disruption to tourism, recreation or shipping activities. Reduction in resource available for commercial and recreational fisheries.

7.1.5.6 Summary of Potential Impacts

Table 7-11 provides a summary of the potential impacts of hydrocarbon releases to sensitive receptors and values at the moderate exposure values (see **Section 7.1.4**).

Table 7-10: Nature and Scale of Hydrocarbon Spills on Environmental and Socio-economic Receptors

Receptors	Impacts of Hydrocarbon release on sensitive receptors at the moderate exposure value	
	Entrained and dissolved	**Surface hydrocarbons**
Marine fauna		
Plankton (including zooplankton; coral larvae)	+ There is potential for localised mortality of plankton due to reduced water quality and toxicity. Also, through physical contact of small oil droplets, plankton mobility, feeding and/or respiration may be impaired. Plankton could include the eggs and larvae of marine invertebrates and fish and therefore entrained oil could impact on recruitment of invertebrate/fish species. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest. Plankton using the sea surface layer could be impacted by floating oil.	+ Plankton using the sea surface layer could be impacted by floating oil.
	+ Plankton could include the eggs and larvae of marine invertebrates and fish and therefore impact on recruitment of invertebrate/fish species. The operational area has the potential to overlap with spawning of some fish species, given the year-round spawning of some species. In the unlikely event of a spill occurring, fish larvae may be impacted by hydrocarbons entrained in the water column. Following a hydrocarbon release a portion of the slick will rapidly evaporate and disperse in the offshore environment, reducing the concentration and toxicity of the spill. + Maximum entrained oil concentrations were predicted within 18 km of the spill location. Plankton using the sea surface layer, as well as pelagic invertebrates, could be impacted from floating oil. Exposure to entrained oils and DAHs may result in lethal or sub-lethal impacts to plankton or pelagic invertebrates through a direct contact pathway. Such contact could impair the mobility, feeding and respiration of these fauna and exchange of chemicals could occur.	
Marine mammals	+ Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.	+ At risk of direct contact with surface hydrocarbons due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive

Receptors	Impacts of Hydrocarbon release on sensitive receptors at the moderate exposure value	
	Entrained and dissolved	Surface hydrocarbons
		epidermal surfaces. Potential impact to feeding apparatus of some species; in other words, baleen whales.
	+ 13 marine mammals were identified by the EPBC Protected Matters search for the EMBA (**Section 3.2**). + There are no marine mammal BIAs overlapping the EMBA or MEVA. + Other migratory marine mammals may encounter either surface or water column hydrocarbons in the EMBA. Dugongs may be particularly susceptible to surface slicks, a reduction of seagrass habitat for foraging and/or ingestion of seagrass coated with oil. Dugongs occur throughout the shallow waters and are unlikely in the deeper offshore waters of the MEVA.	
Marine reptiles	+ Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. + The Recovery Plan for Marine Turtles in Australia: 2017–2027 (Commonwealth of Australia, 2017) highlights acute chemical discharge as one of several threats to marine turtles.	+ At risk of direct contact with surface hydrocarbons due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces. + Contact with hydrocarbons that have accumulated on shorelines particularly at nesting beaches. Oiling of eggs/hatchlings may occur. Shoreline hydrocarbons are expected to be less toxic than fresh oils due to weathering processes such as photo oxidation and biodegradation reducing the levels of lighter chain hydrocarbons which are generally more toxic.
	+ Six species of threatened marine turtles were identified as possibly being impacted by a spill: flatback, hawksbill, leatherback, green, Olive-Ridley and loggerhead turtles which are widely dispersed across the North Australian and NWS and in the unlikely event of a hydrocarbon spill occurring, individuals traversing open water may come into contact with water column or surface hydrocarbons. + Foraging BIAs for the flatback turtle, green turtle, olive ridley turtle and loggerhead turtle all are within the extent of the MEVA. There is no habitat critical for the survival of marine turtles identified within the MEVA or EMBA.	

<table>
<tr><th rowspan="2">Receptors</th><th colspan="2">Impacts of Hydrocarbon release on sensitive receptors at the moderate exposure value</th></tr>
<tr><th>Entrained and dissolved</th><th>Surface hydrocarbons</th></tr>
<tr><td></td><td colspan="2">+ The greatest potential for impact to turtles or seasnakes is likely to be in feeding areas where surface and/or entrained hydrocarbons have contacted shallow water foraging habitats (e.g. seagrass, hard coral and macroalgae) or, in the case of turtles, at any turtle nesting beaches that have been contacted by stranded surface MDO.
+ There is no contact with intertidal zones or shorelines predicted by modelling.</td></tr>
<tr><td rowspan="2">Seabirds and shorebirds</td><td>+ Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.
+ May encounter entrained hydrocarbons while diving and foraging.</td><td>+ Particularly vulnerable to surface slicks. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Smothering can lead to reduced water proofing of feathers and ingestion while preening. In addition, direct contact with hydrocarbons can erode feathers causing chemical damage to the feather structure that subsequently affects ability to thermoregulate and maintain buoyancy on water.
+ Shorebirds may be impacted by the presence of hydrocarbons accumulated on shorelines which may result in exposure to eggs and ingestion by foraging individuals. Shoreline hydrocarbons are expected to be less toxic than fresh oils due to weathering processes such as photo oxidation and biodegradation reducing the levels of lighter chain hydrocarbons which are generally more toxic.</td></tr>
<tr><td colspan="2">+ 11 threatened or migratory species of seabirds and shorebirds were identified within the EMBA by the PMST (Table 3-3).
+ The closest BIAs for these seabirds and shorebirds were located more than 35 km away from the closest boundary of the MEVA (Figure 3-13) therefore, species may be impacted by surface and entrained hydrocarbons while foraging (dive Birds (seabirds and shorebirds) are highly susceptible to hydrocarbon spills, with impacts primarily attributed to oiling of birds at the sea surface from slicks and oil on shorelines. Given the worst-case surface oil at moderate exposure could extend up to 46 km from the release location, impacts to birds may include coating by oil when floating in open water, and diving into open waters to feed on fish.</td></tr>
</table>

<table>
<tr><th rowspan="2">Receptors</th><th colspan="2">Impacts of Hydrocarbon release on sensitive receptors at the moderate exposure value</th></tr>
<tr><th>Entrained and dissolved</th><th>Surface hydrocarbons</th></tr>
<tr><td></td><td colspan="2">+ There are no BIAs overlapping the MEVA for EPBC listed seabird or shorebird species.
+ The risk to shorebirds and coastal species would depend upon where hydrocarbon accumulates; accumulation near nesting colonies or areas supporting feeding aggregations (i.e. sand/mud flats) would result in greatest impacts. There is no shoreline contact predicted by the modelling. Therefore, there are no impacts expected from wading, foraging in coastal/intertidal waters or roosting on sandy beaches.</td></tr>
<tr><td rowspan="2">Fish and sharks</td><td>+ Hydrocarbon droplets can physically affect fish, sharks and rays exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sub-lethal effects of reduced oxygen exchange, and coating of body surfaces may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth.
+ There is potential for localised mortality of fish eggs and larva due to reduced water quality and toxicity. Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest and therefore demersal fish communities (including those associated with the Carbonate Bank and Terrace System of the Sahul Shelf KEF located approximately 11 km from the operational area may be exposed.</td><td>+ While fish, sharks and rays do not generally break the sea surface, individuals may feed at the surface. For diesel spills where a slick is expected to quickly disperse and evaporate, prolonged exposure to surface hydrocarbons by fish, shark and ray species is unlikely. However, for diesel the surface slick may extend 46 km from the release location at the moderate exposure value and will weather at the sea surface over time with little entrainment into the water column.
+ Due to the filter-feeding nature of whale sharks they may be susceptible to ingesting surface hydrocarbons, both fresh and weathered (tar balls) if feeding at the sea surface particularly from diesel spills.</td></tr>
<tr><td colspan="2">+ The NWS and North Australia support a diverse assemblage of fish, particularly in shallower water near the mainland and islands. There are 13 threatened species identified by the PMST include the white shark, whale shark, sawfishes (freshwater, dwarf, green, narrow), giant manta ray and reef manta ray, Northern river shark, mako sharks, and oceanic white tip sharks which may be present in the EMBA. However, given the absence of critical habitat for most of these species, significant numbers are not expected to be exposed to hydrocarbons in the event of a spill. These threatened and migratory fish and sharks could be present at low densities all year round within the operational area and EMBA; however, the</td></tr>
</table>

Receptors	Impacts of Hydrocarbon release on sensitive receptors at the moderate exposure value	
	Entrained and dissolved	**Surface hydrocarbons**
	absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted if an unplanned release were to occur. + There are no fish or shark BIAs intersecting the MEVA.	
Shoreline habitats		
Shoreline Habitats	+ There is no shoreline contact predicted by modelling. The boundary of the MEVA is approx. 70 km from the closest shoreline.	
Intertidal/subtidal habitats		
Hard corals	+ There is no contact with emergent, intertidal features or shorelines predicted by modelling.	
Macroalgae and seagrass	+ There is no contact with intertidal zones or shorelines predicted by modelling.	
Mangroves	+ There is no contact with intertidal zones or shorelines predicted by modelling.	
Intertidal mud/sandflats	+ There is no contact with intertidal zones or shorelines predicted by modelling.	
Intertidal rocky reefs	+ There is no contact with intertidal zones or shorelines predicted by modelling.	
Socio-economic		
Commercial and recreational Fisheries	+ Hydrocarbons in the water column can have toxic effects on fish (as outlined above) potentially reducing catch rates and rendering fish unsafe for human consumption.	+ In addition to the effects of entrained and DAHs, exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen. Weathered diesel slicks may form tar balls which may result in oiling of nets and fishing infrastructure.
	+ Several commonwealth and state fisheries have management areas intersecting the MEVA and include:	

Receptors	Impacts of Hydrocarbon release on sensitive receptors at the moderate exposure value	
	Entrained and dissolved	**Surface hydrocarbons**
	– Four Commonwealth fisheries with management areas intersecting the operational area. No fisheries have had activity in the MEVA from 2010-2020 so are unlikely to be present. – Eight state-managed commercial fisheries have been identified with management areas that intersect with the operational area. There has been no activity within the MEVA from 2010-2020. + Hydrocarbons in the water column can have toxic effects on fish (as outlined above) and cause 'tainting' reducing catch rates and rendering fish unsafe for consumption. + Exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen. + Hydrocarbon releases have the potential to lead to temporary financial losses due to impact to fish. Hydrocarbon contact on fish/invertebrate gill structures, the ingestion of hydrocarbon by target species and the potential for entrained hydrocarbon to interfere with the development of fish eggs and larvae could potentially impact fisheries for a period after the spill is contained.	
Recreation and Tourism	+ There is the potential for surface, entrained and/or dissolved aromatic hydrocarbon to temporarily disrupt tourism activities which rely on the presence of marine fauna and/or the use of vessels (e.g. snorkelling/scuba diving, whale/whale shark watching/swimming and recreational fishing) via reduction in fauna abundance due to avoidance of the area. However, tourism activity is not expected in the MEVA give the distance from shore (approximately 70 km) and water depth (approximately 112 metres).	
Shipping	+ Hydrocarbons in the water column will have no effect on shipping.	+ In the event of a hydrocarbon spill shipping activities may be impacted by exclusion zones surrounding a spill. Exclusion zones could reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable) meaning vessels may have to take detours leading to potential delays and increased costs. + There are no shipping fairways intersecting the MEVA.
Defence	+ There are no defence areas intersecting the MEVA, therefore the level of defence activities performed in the vicinity of operational area is low. Interference of defence activities due to a hydrocarbon spill is expected to be minimal.	

<table>
<tr><th rowspan="2">Receptors</th><th colspan="2">Impacts of Hydrocarbon release on sensitive receptors at the moderate exposure value</th></tr>
<tr><th>Entrained and dissolved</th><th>Surface hydrocarbons</th></tr>
<tr><td rowspan="2">Shipwrecks</td><td>+ Shipwrecks may be of important heritage value and/or act as dive sites. Surface hydrocarbons will have no impact on shipwrecks.</td><td>+ Hydrocarbons in the water column either as entrained oil or DAHs may extend hundreds of kilometres from the release location. The potential for in-water hydrocarbons to impact on shipwrecks is poorly documented however it has been proposed that exposure to oil may alter bacterial community composition (biofilms) inhabiting shipwrecks possibly altering corrosion potential (Salerno et al., 2016).</td></tr>
<tr><td colspan="2">+ There are no shipwrecks intersecting the MEVA. The closest shipwreck is in Northern Territory waters, approximately 70 km from the operational area.</td></tr>
<tr><td>Indigenous</td><td colspan="2">+ Marine resource use by indigenous people is generally restricted to coastal waters. Fishing, hunting and the maintenance of maritime culture and heritage through ritual, stories and traditional knowledge continue as important uses of the nearshore region and adjacent areas.
+ Indigenous users may be impacted by surface hydrocarbons, exclusion zones around spill sites during spill response and fishing and hunting stocks may be impacted by entrained and dissolved hydrocarbons.
+ There is no shoreline contact predicted by modelling. The boundary of the MEVA is approx. 70 km from the closest shoreline.</td></tr>
<tr><td>Existing oil and gas activity</td><td colspan="2">+ The nearest petroleum infrastructure is the Inpex Ichthys-Darwin production pipeline approximately 75 km to the north of the wellhead, and the ENI Blacktip Platform approximately 97 km to the southeast (see Section 3.3). This lies outside of the MEVA.
+ Santos currently has commercial interests in the Petrel/Tern/Frigate field complex in the Petrel sub-basin with Santos as the titleholder for the adjoining WA-27-R title. The Petrel sub-basin seismic survey is proposed for December 2021- March 2022 or the following year, December 2022 to March 2023. The following permit areas for the Petrel survey intersect with the MEVA: WA-454-P, WA-27-R and WA-40-R.
+ A surface spill has the potential to disrupt activity with associated economic impact. Exclusion zones surrounding spills will reduce access, potentially resulting in delays to work schedules with possible subsequent financial implications.</td></tr>
<tr><th colspan="3">Protected Areas</th></tr>
</table>

Receptors	Impacts of Hydrocarbon release on sensitive receptors at the moderate exposure value	
	Entrained and dissolved	Surface hydrocarbons
Commonwealth and State Marine Protected Areas	+ There are no Commonwealth or State marine protected areas, wetlands of international or national importance, World, National or Commonwealth heritage properties or places, or Indigenous Protected Areas that intersect with the MEVA.	
KEFs	+ The MEVA intersects two KEFs (**Section 3.2**). The following KEFs could be contacted at the moderate exposure value: – Pinnacles of the Bonaparte basin – Carbonate bank and terrace system of the Sahul Shelf + These KEFs support communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species. Benthic invertebrates may be impacted by oiling interfering with feeding and respiratory structures. + There is also the potential for hydrocarbon to be ingested by filter feeding invertebrates such as molluscs and sponges; bivalves could potentially bioaccumulate hydrocarbons. Given the non-persistent nature of MDO, potential impacts from physical smothering are low. Hydrocarbon effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest and therefore demersal fish communities are not expected to be impacted (see 'Fish and Sharks').	
RAMSAR Wetlands	+ There are no RAMSAR wetlands that intersect the MEVA.	

7.2 Hydrocarbon Spill – Marine Diesel Oil

Surface release of marine diesel oil (MDO) from a ruptured vessel fuel tank as a result of a collision or fuel tank failure.

7.2.1 Description of Event

Event	Diesel spills have the potential to impact on the marine environment through reductions in water quality and exposure to fauna and habitats. *Worst-Credible MDO Spill* It is considered credible that a release of MDO to the marine environment could occur between a passing third-party vessel and survey vessel, or due to a fuel tank failure. The worst-case environmental incident resulting from a vessel collision is the rupturing of a vessel fuel tank resulting in the release of MDO to the environment. Vessel collision could occur due to factors such as human error, poor navigation, vessel equipment failure or poor weather. A maximum credible spill volume has been determined based on technical guidance provided by AMSA (AMSA, 2015). This guidance states that for a vessel other than an oil tanker, the maximum credible spill from a collision can be determined from the volume of the largest single fuel tank. In reviewing the general arrangements and fuel tank capacities of typical vessels likely to be utilised for the drilling activities, the largest single fuel tank capacity identified was no greater than approximately 60 m^3 of MDO for support vessels (**Section 7.2.1)**. This scenario would result in a spill of MDO at the sea surface.
Extent	Spill trajectory modelling (Xodus, 2022) indicated that there was some probability of a 60 m^3 MDO spill extending as follows (using the moderate exposure thresholds): + Surface oil was predicted to occur within approximately 46 km + Entrained hydrocarbons were predicted to occur within approximately 72 km at the low threshold; and 19 km at the high threshold + Dissolved hydrocarbons were predicted to occur within approximately 25 km + No shoreline loading was predicted (at any threshold). Refer to MDO Spill Modelling Results summary below in **Section 7.2.2** for further information.
Duration	Modelling of an MDO release was undertaken for 6 hours. MDO 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 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 three 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 Spill Modelling Results summary below in **Section 7.2.2** for further information.

7.2.2 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.

Potential Receptors: Physical environment (water and sediment quality), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks and KEFs), socio-economic receptors (fisheries, tourism and recreation).

Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-9** and potential impacts to receptors found within the EMBA are further described in **Table 7-10**.

7.2.2.1 Spill Modelling Results

To determine the spatial extent of impacts from a potential surface release of MDO, and the dispersion characteristics over time, modelling was completed by Xodus (Xodus, 2022). A volume of 60 m^3 released over 6 hours was modelled.

Modelling results have been provided for each of the four hydrocarbon fates: shoreline accumulation; surface; dissolved and entrained.

The modelling results are provided in **Table 7-11** for the fate of hydrocarbon at the exposure values defined in **Section 7.1.2** has been provided for the purposes of risk evaluation, displaying the following parameters:

+ Minimum time to contact from moderate and high exposure value
+ Maximum hydrocarbon concentration from high exposure value
+ Maximum oil accumulation on shoreline from moderate and high exposure value
+ Length of shoreline oiled.

The spill modelling results are provided in **Appendix** E – Spill Modelling Results.

Further parameters required to inform spill response strategies are described further in the Frigate-1 Wellhead OPEP.

Table 7-11: Summary of MDO Release Modelling Results for Frigate-1

Exposure	MDO Modelling
Surface Oil	The maximum distance that surface oiling was predicted to occur from the release site was 78 km WNW at the low threshold (1 g/m2) and 46 km W at the medium threshold (10 g/m^2) during summer. The maximum distance that surface oiling was predicted to occur from the release site at the high threshold (50 g/m2) was 11 km, in an SSE direction during summer and WNW direction during the first transitional period (April). The probability of surface oiling contamination at low, moderate and high thresholds were not predicted to cross into State waters; or contact any HEVs as a result of the MDO release.
Dissolved Oil	The maximum distance that dissolved hydrocarbons will travel from the release site was predicted to be 52 km W at the low threshold (10 ppb) during summer and 28 km SW at the moderate threshold (50 ppb) during the first transitional period (April). No dissolved hydrocarbons were predicted to exceed the high threshold (400 ppb) during any of the seasons.

Exposure	MDO Modelling
	The probability of dissolved hydrocarbons at low, moderate and high thresholds were not predicted to cross into State waters; or contact any HEVs as a result of the MDO release.
Total Submerged Oil	The maximum distance that entrained hydrocarbons will travel from the release site was predicted to be 72 km NW at the low threshold (10 ppb) during summer and 19 km NW at the high threshold (100 ppb) during the first transitional period (April). The probability of entrained hydrocarbons at low and high thresholds were not predicted to cross into State waters; or contact any HEVs as a result of the MDO release.
Shoreline Accumulation	There was no shoreline contact predicted at any threshold; and therefore, no shoreline loadings or contamination of shoreline receptors were predicted.

Source: Xodus, 2022

7.2.3 Environmental Performance Outcomes and Control Measures

The EPOs relating to this event include:

+ No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed marine fauna during operational activities. [FRI-EPO-01].
+ No loss of containment of hydrocarbon to the marine environment [FRI-EPO-08]

The control measures considered for this activity are shown below with EPS' and measurement criteria for the EPOs described in **Section 8.4**.

Table 7-12: Control Measure Evaluation for the Surface Release of MDO

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-002	Constant bridge-watch (visual and radar)	Minimises risk of collision through visual identification and avoidance of other vessels.	No additional cost given it is a regulatory requirement.	**Adopted** – Benefits of ensuring procedures are followed outweighs the minimal costs of personnel time.
FRI-CM-009	Vessel Emergency Management Plan/SOPEP	Implements response plans on board vessels to deal with unplanned hydrocarbon releases and spills quickly and efficiently to reduce impacts to the marine environment.	Administrative costs of preparing documents. Generally undertaken by vessel contractor so time for Santos personnel to confirm and check vessel emergency management plan or SOPEP in place.	**Adopted** – Benefits of ensuring response plans in place, are followed and measures implemented and that the survey vessel is compliant outweigh costs.
FRI-CM-011	Maritime notices	Ensure other marine users are aware of the presence of the vessel and the relatively slow speed and restricted manoeuvrability	Limited additional costs to Santos. Stakeholders time required to review consultation material and communicate with Santos.	**Adopted** – Benefits are considered to outweigh negligible costs to Santos.
FRI-CM-012	Accepted Oil pollution emergency plan (OPEP)	Optimises efficiencies and preparedness of incident response.	No additional cost given is a regulatory requirement.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				that the vessels are compliant outweigh the costs.
FRI-CM-014	Fuel oil quality	Use of diesel 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.
FRI-CM-022	Lighting will be used as required for safe work conditions and navigational purposes	Ensures vessels meet minimum safety standards therefore reducing potential for vessel collision events with associated diesel spill to the environment. Marine Order Part 30: Prevention of Collisions, and with Marine Order Part 21: Safety of Navigation and Emergency Procedures requires vessels to have navigational equipment to avoid collisions. Requirement of the Navigation Act 2012.	Costs associated with personnel time in checking vessel certifications are in place. Negligible costs of operating navigational equipment.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweighs the costs. Ensures that vessels are compliant.
FRI-CM-024	Seafarer Certification	Requires appropriately trained and competent personnel, in accordance with Marine Order 70, to navigate vessels to	Costs associated with personnel time in obtaining qualifications.	**Adopted –** Benefits considered to outweigh costs and is a legislated requirement.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		reduce interaction with other marine users.		
FRI-CM-025	Marine Assurance Standard	Ensures vessels meet Marine assurance standards to reduce the likelihood of unplanned discharge.	Costs associated with personnel time in checking vessel.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant outweigh the costs. Regulatory requirement must be adopted.
FRI-CM-026	Vessel Planned Maintenance System (PMS) to maintain DP, engines and machinery	Reduces discharges from the vessel(s) because equipment is operating within its parameters.	Additional personnel costs of ensuring equipment is maintained and certified as appropriate and that procedures are in place and followed.	**Adopted –** Benefits of ensuring procedures are followed and equipment is compliant outweigh the minimal costs of personnel time.
FRI-CM-032	No fuel bunkering in the operational area	Eliminates the probability of a hydrocarbon spill or leak occurring during bunkering in the operational area.	No additional costs	**Adopted –** Refuelling not required in the operational area given short duration of activity (<7 days)
Additional Control Measures				
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, however, shoreline contact is predicted to take 50 hours meaning benefits are negligible	Large costs associated with a dedicated resource on location. Modelling does not predict any shoreline contact, and the greatest extent of actionable surface oil is 46 km; or 70 km from the closest shoreline.	**Rejected** – Large cost associated with dedicated resources on location deemed grossly disproportionate compared to low risk of large MDO spill and subsequent rapid dispersion and evaporation.

7.2.4 Environmental Impact Assessment

The below environmental impact assessment follows the risk assessment approach detailed in **Section 7.1.3**.

7.2.4.1 Identification of Hotspots for Consequence Analysis

While the entire EMBA is considered during risk assessment and spill response planning, it is best practice to concentrate greatest effort and level of detail on the HEVs – i.e. those parts of the EMBA that have greatest intrinsic environmental value and are impacted by high probability and/or concentration of oil (summarised in **Section 7.1.5**).

All HEVs within the EMBA (low exposure value) are listed in **Table 7-13**; and filters the HEVs to identify the hotspots where they meet the criteria described in **Section 7.1.5.** The values and sensitivities associated with these HEVs have been described in **Appendix C**.

Table 7-13: Identified High Exposure Value and Hotspot Receptors – Frigate-1

Receptor	HEV Value	Exposure Value			Hotspot
		Low	Moderate	High	
Pinnacles of the Bonaparte Basin KEF	5	✓	✓		✓
Carbonate bank and terrace system of the Sahul Shelf KEF	5	✓	✓		✓
Joseph Bonaparte Gulf AMP	4				
JBG West Coast	4				
Van Cloon/Deep Shoals	4				
Kimberly Coast PMZ	3				
Gale Bank	5				
Kimberly AMP	3				

This process identified the following Hotspots:

- Pinnacles of the Bonaparte Basin KEF
- Carbonate bank and terrace system of the Sahul Shelf KEF.

Table 7-14 provides a simplified summary of the consequence assessment results for each of the Hotspot areas for the two sets of model outputs. The consequence assessment was based on predicted contact and concentration of surface oil, accumulated oil, entrained hydrocarbon and dissolved hydrocarbons. For each Hotspot area the consequence to the key values were assessed using the methodology described in **Section 7.1.5**.

Table 7-14: Hotspot Consequence Assessment Results from Surface Release of MDO

Receptor Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Frigate-1	Consequence Category	Worst-case Consequence Ranking	Total
Pinnacles of the Bonaparte Basin KEF	5	<u>Habitats</u> + Hard substrate, pinnacles + Fish and sponge habitat <u>Marine Fauna</u> + Benthic invertebrates (biodiversity hotspot for sponges) + Demersal fish aggregations	Probability of contact by surface oil at 10 g/m^2	(%)	49.1	+ physical habitat + protected areas	II – Minor II - Minor	II - Minor
			Minimum time to contact by surface oil 10 g/m^2	Time (d)	0.75			
			Maximum oil loading on shorelines >100g/m^2	(tonnes)	NC			
			Maximum accumulated concentration >100g/m^2	(g/m^2)	NC			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	NC			
			Maximum concentration of entrained hydrocarbon >100 ppb	(ppb)	103.5			
			Maximum concentration of dissolved aromatic hydrocarbon >10 ppb	(ppb)	101.8			
Carbonate bank and terrace system of the Sahul Shelf KEF	5	<u>Habitats</u> + Hard substrate + Algal banks	Probability of contact by surface oil at 10 g/m^2	(%)	21.8	+ physical habitat + protected areas	II – Minor II - Minor	II - Minor
			Minimum time to contact by surface oil 10 g/m^2	Time (d)	0.95			

Receptor Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Frigate-1	Consequence Category	Worst-case Consequence Ranking	Total
		Marine Fauna + Benthic habitats and communities	Maximum oil loading on shorelines >100g/m^2	(tonnes)	NC			
			Maximum accumulated concentration >100g/m^2	(g/m^2)	NC			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	NC			
			Maximum concentration of entrained hydrocarbon >100 ppb	(ppb)	NC			
			Maximum concentration of dissolved aromatic hydrocarbon >10 ppb	(ppb)	131.0			

7.2.4.2 Surface Release of MDO from a vessel collision / fuel tank failure

Receptors	+ Marine fauna – plankton, fish and sharks, marine mammals, marine reptiles, seabirds/shorebirds + Physical Environment / Habitats + Protected areas + Socio-economic and heritage receptors
Consequence	II-Minor

A summary of the consequence assessment for each receptor category is presented below. Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-9**, and potential impacts to receptors found within the EMBA are further described in **Table 7-9**.

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 (60 m^3). Given the properties of MDO, dilution and dispersion from natural weathering processes, such as evaporation and ocean currents, indicate that the extent of exposure will be limited in extent and duration.

In the unlikely event of a vessel collision/fuel tank failure resulting in a spill of MDO, 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. Diesel will rapidly lose toxicity with time and spread thinner as evaporation continues.

Physical environment and habitats

A surface release of MDO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column. As a light hydrocarbon, MDO undergoes rapid spreading and evaporative loss in warm waters, indicating that a surface slick will be temporary.

Under moderate winds (5 m/s), 40% of the initial surface slick is predicted to remain as surface oil after 24 hours, decreasing further to approximately 10% after 48 hours and approximately 1% after 72 hours (Xodus, 2022).

The modelling does not predict any contact at any threshold with emergent, intertidal features or shorelines; or any reefs or shoals. The boundary of the MEVA is approximately 70 km from the closest shoreline. Benthic habitats, hard substrate and pinnacles are identified as key values of the two KEFs; though due to the water depth at Frigate-1 (approximately 112 m), intersection of in-water hydrocarbon and the seabed is not expected.

The worst-case consequence to the physical environment/habitats from a vessel collision resulting in a worst-case unplanned hydrocarbon release was ranked as II – Minor.

Threatened/migratory fauna

The high rate of evaporation means that little MDO will become entrained and few aromatic hydrocarbons are predicted to become dissolved reducing impact to marine fauna.

The susceptibility of marine fauna to hydrocarbons depends on hydrocarbon type and exposure duration. The high volatility of marine diesel will result in the rapid evaporation and loss of the more toxic aromatic components, resulting in a reducing toxicity threat to marine fauna with time; as such, exposure to marine fauna from this hazard is not expected to result in a fauna fatality. Potential impacts to marine fauna from a hydrocarbon exposure are described in detail in **Table 7-9**.

Surface oil, and entrained hydrocarbon in the sea surface layer, could have the physical effect of coating fauna interacting within and under the surface, including plankton, pelagic invertebrates and fishes, marine reptiles, marine mammals and seabirds, and may also affect some species through ingestion of oiled fish (as described in **Table 7-10**).

There are no BIAs intersecting the MEVA or EMBA for EPBC listed seabird or shorebird species. Surface oil at the moderate exposure is only extends 46 km from the release location; and is approximately 70 km from the closest shoreline.

The EMBA intersects foraging BIAs for four marine turtle species. There is no habitat critical for the survival of marine turtles identified within the MEVA or EMBA. The greatest potential for impact to turtles is likely to be in feeding areas where surface and/or entrained hydrocarbons have contacted shallow water foraging habitats (e.g. seagrass, hard coral and macroalgae) or, in the case of turtles, at any turtle nesting beaches that have been contacted by stranded surface MDO. There is no contact with intertidal zones or shorelines predicted by modelling.

There are no BIAs for marine mammals intersecting the MEVA or EMBA; however transient individuals may be present.

Deteriorating water quality/chemical and terrestrial discharge is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species (**Table 3-4**). Habitat modification, degradation and disruption, pollution and/or loss of habitat are also identified as threats to sharks, birds, cetaceans and turtles in conservation management and recovery plans.

The potential sensitive receptors in the surrounding areas of the spill will include those in the water column, such as fish, marine mammals, marine reptiles and seabirds at the sea surface, as discussed in **Table 7-10**. 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.

The two hotspots identified were the Pinnacles of the Bonaparte Basin KEF and Carbonate bank and terrace system of the Sahul Shelf KEF. Neither of the KEFs have threatened /migratory fauna identified as a key value; though the Pinnacles of the Bonaparte Basin KEF does identify demersal fish aggregations.

The worst-case consequence to threatened/migratory fauna from a vessel collision resulting in a worst-case unplanned hydrocarbon release was ranked as II – Minor.

Protected areas

There are no Commonwealth or State marine protected areas, wetlands of international or national importance, World, National or Commonwealth heritage properties or places, or Indigenous Protected Areas that intersect with the MEVA. The Pinnacles of Bonaparte KEF and Carbonate bank terrace system of Sahul Shelf KEF could be impacted at the moderate exposure value for surface and entrained oil.

Benthic habitats, hard substrate and pinnacles are identified as key values of the two KEFs; though due to the water depth at Frigate-1 (approximately 112 m), intersection of in-water hydrocarbon and the seabed is not expected.

The Pinnacles of the Bonaparte Basin KEF and Carbonate bank and terrace system of the Sahul Shelf KEF key values include benthic habitats and communities and demersal fish aggregations. The two KEFs support communities of sessile benthic invertebrates. Hydrocarbon effects will be greatest in the upper 10 m of the water column and areas close to the spill source; and unlikely to intersect with the seabed at 112 m water depth.

The worst-case consequence to threatened/migratory fauna from a vessel collision resulting in a worst-case unplanned hydrocarbon release was ranked as II – Minor.

Socio-economic receptors

There is the potential for hydrocarbons to temporarily disrupt fishing activities if the surface or entrained hydrocarbon moves through fishing areas. However, the high rate of evaporation means that little MDO will become entrained and few aromatic hydrocarbons are predicted to become dissolved.

It is possible that there could be accumulation of oil in fish tissues to the extent that could result in hydrocarbon tainting of fish flesh. Given the volume of MDO that could potentially be released, it is possible impacts could be detected to fisheries on a stock level, although it is more likely natural variation in fish abundance would be on a greater scale than any impacts attributable to a hydrocarbon spill. 12 State and

Commonwealth fisheries have management areas intersecting the EMBA; however, data shows that no fisheries have had any activity within the MEVA from 2010-2020; so are unlikely to be impacted. There are no oil and gas facilities, defence areas or shipping fairways intersecting the MEVA or EMBA. Tourism activity is not expected in the MEVA give the distance from the closest shore (approximately 70 km) and water depth (approximately 112 metres). The closest port settlement is Darwin (466 km away). The worst-case consequence to socioeconomic receptors from a vessel collision resulting in a worst-case unplanned hydrocarbon release was ranked as II – Minor.	
Likelihood	b – Unlikely
A worst-case diesel 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 water depth and the transient nature of marine fauna in this area. Long-term impacts resulting in complete habitat loss or degradation are not considered likely given the control measures proposed to prevent releases; therefore, the activity will be conducted in a manner that is considered acceptable. The likelihood of a diesel release occurring due to refuelling is limited given the set of mitigation and management controls in place. Consequently, the likelihood of a vessel collision releasing hydrocarbons to the environment, is considered to be b- Unlikely.	
Residual Risk	The residual risk associated with this hazard is Very **Low**

7.2.5 Demonstration of ALARP

The use of vessels is integral to activity and therefore vessels and associated risks of unplanned hydrocarbon releases, cannot be completely eliminated.

Offshore refuelling will not be undertaken during the wellhead survey as the short duration of the survey does not require it. This eliminates one source of a potential hydrocarbon release. Other hydrocarbon types such as HFO, IFO have specifically not been selected for this Activity (only diesel will be used in the operational areas) to ensure potential environmental impacts are reduced to ALARP.

The combination of the standard prevention CMs (which reduce the likelihood of the event happening), and the spill response strategies (which may reduce the consequence) together reduce the overall hydrocarbon spill risk.

No additional controls have been identified and given the controls in place detailed above, the assessed residual risk for this impact is Low and cannot be reduced further. It is considered therefore that the impact of the activities conducted is reduced to ALARP.

In terms of spill response activities, Santos will implement oil spill response as specified within the OPEP. A detailed ALARP assessment on the adequacy of arrangements available to support spill response strategies and CMs is presented in the OPEP.

The North-west Marine Parks Network Management Plan states that actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with mining operations authorised under the OPGGS Act may be conducted in all zones of the marine parks identified with the EMBA (DNP, 2018a) without an authorisation issued by the Director, provided that the actions are taken in accordance with an EP that has been accepted by NOPSEMA, and the Director is notified in the event of oil pollution within a marine park, or where an oil spill response action must be taken within a marine park, so far as reasonably practicable, prior to response action being taken.

7.2.6 Acceptability Evaluation

Is the risk ranked between Low to Medium?	Yes – maximum credible spill volume from vessel collision (60 m^3) residual risk is ranked as low.
Is further information required in the consequence assessment?	Yes – Hydrocarbon spill modelling results used to determine consequence and risk.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' Offshore *Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	The following material published in relation to threatened and migratory species within the EMBA identifies habitat degradation / modification, pollution or oil spills as a threat (**Table 3-4**): **Conservation Advice:** + Approved Conservation Advice for *Pristis pristis* Largetooth Sawfish (2014) + Approved Conservation Advice for *Pristis clavata* Dwarf Sawfish (2009) + Approved Conservation Advice for Green Sawfish (2008) + Approved Conservation Advice for *Glyphis garricki* Northern River Shark (2014) + Conservation Advice *Rhincodon typus* Whale Shark (2015) + EPBC Act Policy Statement 3.21 – Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (2017) + Conservation Advice *Calidris ferruginea* Curlew Sandpiper (2015) + Conservation Advice *Numenius madagascariensis* Eastern Curlew (2015) + Conservation Advice *Calidris canutus* Red Knot (2016) + Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (2009) + Conservation Advice *Balaenoptera physalus* Fin Whale (2015) + Conservation Advice *Balaenoptera borealis* Sei Whale (2015) **Recovery Plans:** + Sawfish and River Sharks Multispecies Recovery Plan (2015) + Recovery Plan for the White Shark *Carcharodon carcharias* (2013) + Draft Wildlife Conservation Plan for Seabirds (2019) + Wildlife Conservation Plan for Migratory Shorebirds (2015). + Recovery plan for marine turtles in Australia 2017 – 2027 (2017)

	+ Blue Whale Conservation Management Plan 2015 - 2025 (2015) Recovery Plans / Conservation Advice for other species that may occur in the EMBA do not identify habitat degradation / modification, pollution or oil spills as a key threat or have explicit relevant objectives or management actions. Australian Marine Park zoning principles and objectives were also considered: + North-west Marine Parks Network Management Plan (2008); noting the EMBA does not intersect any AMPs. The objectives of these publications were considered during the assessment of impacts and risks. The activity is not inconsistent with these objectives. The controls outlined in **Table 7-12** are consistent with the objectives of the material listed above and in **Table 3-4**. Santos considers the impacts of hydrocarbon spill – MDO to not be inconsistent with these objectives.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts 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 above).

The potential impacts and risks from diesel spills are well understood, and the activities will be managed in accordance with relevant legislation and standards. With the implementation of industry-standard and activity-specific control measures to reduce the likelihood of a diesel spill event (and minimise impacts), the residual risk is assessed to be low and ALARP. No stakeholder concerns have been raised regarding this hazard. Therefore, it is considered that the proposed control measures will reduce the risk of impact from a diesel spill to a level that is acceptable.

7.3 Minor Hydrocarbon Release (Surface and Subsea)

7.3.1 Description of Event

Event	Sources of risk from a minor hydrocarbon release may occur as a result of: + Vessel Operations + ROV Operations Causes for accidental hydrocarbon releases (other than diesel release from a vessel collision or refuelling) include: + ROV failure (including oil seal, hydraulic system hose and quick disconnect system failures) + Loss of primary containment (drums, tanks, intermediate bulk containers (IBC), etc.) due to handling, storage and dropped objects (e.g. swinging load during ROV lifting activities)

	+ Vessel pipework failure or rupture, hydraulic hose failure, inadequate bunding + Lifting – dropped objects damaging diesel infrastructure (hoses, pipes, tanks, etc.). The vessel's main engines and equipment such as pumps, cranes, winches, power packs and generators require MDO 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 support vessels. Small hydrocarbon leaks could occur from loss of primary containment due to handling, storage and dropped objects (during lifting activities). Volumes are likely to be small and limited to the volume of individual containers (e.g., IBC, 44-gallon drums, etc.) stored on the deck of vessels. The credible spill for this scenario is considered to be the loss of an IBC (1 m^3) through loss of containment. Equipment deployed overboard during the survey (e.g., ROV operations) can result in unplanned discharges (of hydraulic fluids) directly to the marine environment due to equipment failure, equipment interactions with the vessel thrusters and/or accidental contact with subsea infrastructure. The largest credible hydrocarbon spill from ROV operations would be an accidental release of approximately 0.05 m^3 (50 L) of hydraulic fluid from the deployed ROV. The vessel doesn't require any refuelling or supply while in the operational area (up to 7 days). 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 which could result in impacts to water quality and hence sensitive environmental receptors. For environmental impacts of planned discharges, please refer to previous **Section 6.7** and **Section 6.8**.
Extent	Any hydrocarbon-based liquid accidentally discharged within the operational area will either sink within the surrounding area or disperse rapidly within the operational area (in the case of small leaks/spills).
Duration	An instantaneous release occurring during the activity not extending beyond the operational area.

7.3.2 Nature and Scale of Environmental Impacts

Potential Receptors: Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands), threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds).

Hydrocarbons released into the marine environment through onboard spills and leaks directed through deck drainage or from a release of hydraulic oil from an ROV umbilical would disperse quickly in waters within the vicinity of the operational area.

There are no marine protected areas within the operational area or EMBA.

7.3.2.1 Physical environment

Lubricating and hydraulic oils will behave similarly to MGO if spilt to the marine environment, although lubricating oils are more viscous and so the spreading rate of a slick of these oils would be slightly slower. Hydraulic oils are medium oils of light to moderate viscosity and have a relatively rapid spreading rate and dissipate quickly in higher sea states.

7.3.2.2 Threatened/migratory fauna

A release could potentially impact plankton, fish and sharks, marine mammals and marine reptiles although given the highly dispersive waters within the operational area, the extent of the water column and the relatively small potential volumes associated with such a release, rapid dilution is expected, and concentrations are unlikely to persist for periods of time where impacts would likely be felt. The greatest potential for impact would likely be for passive or low mobility fauna such as plankton, including both invertebrates and fish larvae which may be exposed for the greatest periods of time and likely have a permanent presence within the operational area. 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.

Large, more mobile fauna (including protected species such as cetaceans, marine turtles, seabirds and whale sharks) are likely to be transient within the operational area and toxic impacts are unlikely to occur to these species in the event of a small liquid hazardous hydrocarbon release (although refer **Sections 7.2** for potential impacts of larger unplanned hydrocarbon release).

With respect to demersal fishes, it is possible that some impact may occur through the release of hydraulic oil from an ROV near the seabed. However, given the small volume of any credible ROV release (approximately 50 L) and the lack of any natural seabed features that would indicate a high abundance or diversity of demersal fishes, it is considered that such a release would have a negligible impact on the demersal fish populations.

7.3.2.3 Protected and significant areas and Socio-economic receptors

There are no marine protected areas within the operational area or EMBA. The Oceanic Shoals Marine Park is the closest at approximately 50 km from the operational area and approximately 21 km from the EMBA.

The operational area intersects the Pinnacles of the Bonaparte Basin Key Ecological Feature (KEF). Impacts to the physical environment and marine fauna are discussed in the sections above. Minor hydrocarbon releases are not expected to significantly impact the key values of the KEF.

Recreational users are not expected in the operational area given the distance from shore and the water depth within the operational area (approximately 112 m). Commercial fishing is also limited in this area (**Section 3.3.2**).

7.3.3 Environmental Performance Outcomes and Control Measures

The EPOs relating to this event include:

+ No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed marine fauna during operational activities. (FRI-EPO-01).
+ No loss of containment of hydrocarbon to the marine environment (FRI-EPO-08)

The control measures considered for this event are shown in **Table 7-15**, and EPS' and measurement criteria for the EPOs are described in **Section 8.4**.

Table 7-15: Control Measure Evaluation for Minor Hydrocarbon Release (Surface and Subsea)

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-003	Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects where possible. Ensures lifting equipment certified and inspected.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
FRI-CM-005	Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to sea by controlling the storage, handling and clean-up.	Personnel cost associated with implementation of procedures and permanent or temporary storage areas.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
FRI-CM-007	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 of personnel time.
FRI-CM-008	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 outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
FRI-CM-009	Vessel Emergency Management Plan/SOPEP	Potential impacts to the environment are reduced through effective management of an accidental spill (discharge to sea).	Personnel cost associated with developing plan, ongoing management (spill response exercises) and implementation of plans.	**Adopted** – Benefits of ensuring response plans in place, are followed, measures implemented, and that the vessel is compliant outweighs costs.
FRI-CM-010	ROV inspection and maintenance procedures	Maintenance and pre-deployment inspection on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to the marine environment.	Personnel costs associated with labour or access requirements of undertaking maintenance.	**Adopted** – Benefits of ensuring procedures are followed outweigh costs.
FRI-CM-012	Accepted Oil pollution emergency plan (OPEP)	Implements response plan to deal with an unplanned hydrocarbon spills quickly and efficiently in order to reduce impacts to the marine environment.	Personnel and administrative costs associated with preparing documents, ongoing management (spill response exercises) and implementation of OPEP.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweighs costs.
FRI-CM-032	No fuel bunkering in the operational area	Eliminates the probability of a hydrocarbon spill or leak occurring during bunkering in the operational area.	No additional costs	**Adopted –** Refuelling not required in the operational area given short duration of activity (<7 days)
Additional Control Measures				
No additional control measures are considered as the risk is considered ALARP				

7.3.4 Environmental Impact Assessment

Table 7-16: Impact, Likelihood and Consequence Ranking – Minor Hydrocarbon Release (Surface and Subsea)

Receptors	+ Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands) + Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks, fish, rays and birds)
Consequence	II - Minor
In the event of a minor hydrocarbon spill, the quantities would be limited to approximately 1 m^3 for the loss of the contents of an IBC, or 50 L for ROV hydraulic fluid. The small volumes, dilution and dispersion from natural weathering processes such as ocean currents are such that spills will be limited in area and duration. The number of receptors present at the activity location are expected to be limited to a small number of transient individuals. 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. The small volumes of worst-case discharges are such that, the impacts to receptors will decline rapidly with time and distance at the sea surface. Rapid dilution at depth would also result in the impacts to receptors declining rapidly 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 Conservation Advice (**Table 3-4**). With control measures in place, the activity will be conducted in a manner that reduces potential impacts to ALARP and an acceptable level. Toxic impacts are not expected to the benthic community due to the water depths. 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 hydrocarbons. 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. The potential minor hydrocarbon releases are not expected to significantly impact the receiving environment with control measures proposed to prevent releases and therefore the activity will be conducted in a manner that is considered acceptable. 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 Minor (II) consequence.	
Likelihood	b – Unlikely
A small hydrocarbon liquid release is unlikely to have widespread ecological effects given: + The nature of the hydrocarbons (hydraulic fluids, lubricant oils and waste oils) stored on-board + The small volumes that could be released + The water depth + The transient nature of marine fauna in this area + The control measures in place to prevent spills + The procedures in place to clean up a spill. Consequently, the likelihood of releasing minor volumes of hydrocarbons to the environment, which results in a minor consequence, is considered Unlikely (b).	

Residual Risk	The residual risk associated with this event is **Very Low**.

7.3.5 Demonstration of ALARP

Storage and use of hydraulic and lubricating oils/ fluids for equipment and machinery, including for ROV operations, are required to undertake the activity, so their removal from the activity is not viable. A thorough set of control measures have been proposed to ensure the risks of minor hydrocarbons spills and leaks occurring and subsequent impacts are minimised. The resulting impacts to marine fauna that could potentially result from a spill of this size would be negligible, with impacts restricted to a small number of individuals within a localised area. The assessed residual risk for this impact is low and cannot be reduced further. Therefore, it is considered that the impact of the activities conducted is ALARP.

7.3.6 Acceptability Evaluation

Is the risk ranked between Low and Medium?	Yes - maximum minor hydrocarbon spill residual risk is ranked as Low.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' Offshore *Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with International Convention of the Safety of Life at Sea (SOLAS) 1974 and Navigation Act 2012, Marine Order 91 (Marine pollution prevention – oil). The following material published in relation to threatened and migratory species within the operational area identifies habitat degradation / modification as a threat (**Table 3-4**): **Conservation Advice:** + Approved Conservation Advice for *Pristis pristis* Largetooth Sawfish (2014) + Approved Conservation Advice for Green Sawfish (2008) + Approved Conservation Advice for *Glyphis garricki* Northern River Shark (2014) + Conservation Advice *Rhincodon typus* Whale Shark (2015) + Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (2009) + Conservation Advice *Balaenoptera borealis* Sei Whale (2015)

	+ Conservation Advice *Balaenoptera physalus* Fin Whale (2015) **Recovery Plans:** + Sawfish and River Sharks Multispecies Recovery Plan (2015) identifies habitat degradation as a threat to sawfish and river sharks. Frigate-1 is aligned to Objective 5 of the plan by reducing and, where possible, eliminating adverse impacts of habitat degradation and modification. This is achieved through the implementation of FRI-EPO-01, FRI-EPO-08 and the control measures outlined in **Table 7-15** to prevent accidental and ongoing impact to the marine environment. + Recovery plan for the White Shark (*Carcharodon carcharias*) (2013) identifies habitat modification as a threat to white sharks. Frigate-1 is aligned with Objective 7 of the recovery plan by continuing to protect habitat critical to the survival of the white shark and minimising the impact of threatening processes within these areas. However, no habitat critical or BIAs have been identified for white sharks within the operational area. The species is highly mobile and transitory in nature and the area impacted is small compared to the amount of habitat available. + Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017) identifies habitat modification as a threat to marine turtles. Foraging BIAs have been identified for green, loggerhead, flatback and olive ridley turtles within the operational area. Impacts from an unplanned minor hydrocarbon release may result in a temporary, localised impact to the marine environment, which will recover rapidly. Interim Objective 3 states that anthropogenic threats are demonstrably minimised. + Blue Whale Conservation Management Plan 2015 - 2025 (2015) identifies habitat modification as a threat to blue whales. The long-term recovery objective is to minimise anthropogenic threats to allow the conservation status of the blue whale to improve so that it can be removed from the threatened species list under the EPBC Act. The species is highly mobile and transitory in nature and the area impacted is small compared to the amount of habitat available.

	+ For all the recovery plans identified above, the objectives are achieved through the adoption of FRI-EPO-01, FRI-EPO-08 and the control measures outlined in **Table 7-15**; and Santos considers the impacts of an unplanned minor hydrocarbon release to not be inconsistent with these recovery plan. Recovery Plans / Conservation Advice for other species that may occur in the operational area do not identify habitat degradation / modification as a key threat or have explicit relevant objectives or management actions related to habitat degradation / modification. The objectives and actions of these publications were considered during the assessment of impacts and risks. The controls outlined in **Table 7-15** are consistent with the objectives of the material listed above and Santos considers the impacts from an unplanned minor hydrocarbon release to not be inconsistent with these objectives.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts 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 above.

With the control measures in place to prevent the accidental release of minor volumes of hydrocarbons, and potential social and environmental impacts and risk well understood and considered low, the environmental risk associated with a minor hydrocarbon release is considered acceptable.

7.4 Non-hydrocarbon and Chemicals Release (Surface) – Liquids

7.4.1 Description of Event

Event	Sources of risk from an accidental release of non-hydrocarbon and chemical release (liquids) may occur as a result of: + Vessel Operations Non-hydrocarbon liquids including miscellaneous chemicals and waste streams (brine, mixed cement, cleaning and cooling agents, stored or spent chemicals and leftover paint materials) are used or stored on-board the vessel during the activity. The presence of non-hydrocarbons liquids and chemicals represents a potential spill risk during chemical storage and handling e.g., due to tank damage, or human error. Another credible spill is due to a hose that parts when loading/offloading brine. Rupture of the pumping hose used to transfer these chemicals may occur due to dropped object, vessel motion, or hose failure. An accidental release of chemicals and other non-hydrocarbon liquids into the marine environment has the potential to occur from the following activities:

	+ Vessel operations + Transferring, storing or using bulk products + Mechanical failure of equipment + Handling and storage spills and leaks + Hose or hose connection failure or leak + Lifting – dropped objects damaging liquid vessels (containers). Accidental loss of non-hydrocarbon liquids or chemicals to the marine environment could occur via tank pipework failure or rupture, inadequate bunding and/ or storage, insufficient fastening or inadequate handling may result in impacts to water quality and hence sensitive environmental receptors.
Extent	The maximum volume of non-hydrocarbon liquids or chemicals that could be released during routine operations is likely to be small and realistically limited to the volume of individual containers (e.g., drums etc.) stored on deck of vessel. The environment that may be affected for non-hydrocarbon liquids or chemical release resulting in a decrease in water quality is likely to be restricted to around the vessel but contained within the operational area.
Duration	Instantaneous release during the activity.

7.4.2 Nature and Scale of Environmental Impacts

Potential Receptors: Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands), threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds)

7.4.2.1 Physical environment

Non-hydrocarbon liquids or chemicals released to the marine environment may lead to contamination of the water column in the vicinity of the vessel. The potential impacts would most likely 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).

The changes to water quality that may result could potentially lead to short-term impacts (few hours) on marine fauna (e.g. plankton, pelagic/benthic fish, epifauna, cetaceans, marine reptiles and seabirds), with chronic impacts not expected owing to the short exposure times and is unlikely to lead to widespread ecological effects.

7.4.2.2 Threatened/migratory fauna

Changes to water quality could potentially lead to short-term impacts on marine fauna (e.g., pelagic fish and sharks, marine mammals, marine reptiles and seabirds). As summarised in **Table 3-5**, the operational area overlaps the foraging BIA for the green, flatback, loggerhead and olive ridley turtles.

Recovery plans and conservation advice for numerous bird species identify marine pollution and contamination impacts as a threat to the species (**Table 3-4**). This includes the following marine species identified as potentially occurring within the operational area: red knot, curlew sandpiper and eastern curlew. The Draft Wildlife Conservation Plan for Seabirds (DoEE, 2019) also lists chemical contamination through chronic pollution as a threat to seabirds. In addition, the Recovery Plan for Marine Turtles in Australia 2017 – 2027 (DoEE, 2017) identifies deteriorating water quality as a threat to all species of marine turtles in Australia. Given the foraging BIAs for several turtle species overlap the operational area, these species are expected to be transient within the operational area.

Chemical spills are unlikely to have widespread ecological effects on threatened or migratory fauna, given the nature of the chemicals on board, the small volumes that could be released, and the open-ocean environment of the location. Physical coating of marine fauna, in particular those present at the sea surface (e.g., seabirds), by entrained or surface hazardous liquids and sublethal or lethal effects from toxic chemicals are considered unlikely given the expected low concentrations and short exposure times.

Plankton, Fish (pelagic) & Sharks

A release of hazardous chemicals could potentially impact plankton, pelagic invertebrates and pelagic fish in the immediate vicinity of the release, however given the highly dispersive waters within the operational area, the extent of the water column (water depth approximately 112 m) and the relatively small potential volumes associated with such releases, rapid dilution is expected, and concentrations are unlikely to persist for periods of time where impacts would likely be felt. The greatest potential for impact would likely be for passive or low mobility fauna such as plankton, pelagic invertebrates and pelagic fish which may be exposed for the greatest periods of time and likely have a permanent presence within the operational area.

Marine Mammals

A release of hazardous chemicals could potentially impact marine mammals in the immediate vicinity of the release, however given the highly dispersive waters within the operational area, the extent of the water column (water depth approximately 112 m) and the relatively small potential volumes associated with such releases, rapid dilution is expected, and concentrations are unlikely to persist for periods of time where impacts would likely be felt. There are no BIAs identified for marine mammals in the operational area or EMBA. Marine mammals are large and more mobile fauna are likely to be transient within the operational area and toxic impacts are unlikely to occur to these species in the event of a small liquid hazardous hydrocarbon release.

The EPBC PMST Report identified four marine mammal species with a threatened status that may transit through the operational area:

+ Blue Whale (Endangered)
+ Fin Whale (Vulnerable)
+ Humpback Whale (Vulnerable)
+ Sei Whale (Vulnerable)

The Conservation Management Plan for Blue Whales (DoE, 2015a) has identified acute and chronic chemical discharge as a threat to pygmy blue whales. However, the impacts are concentrated within operational area and the potential release of hazardous/ non-hazardous liquids is not expected to significantly impact the receiving environment.

The Conservation Advice fin (TSSC, 2015b) and sei whales (TSSC, 2015c) have also identified the pollution as a potential threat but specifies the pollutant as persistent and toxic. While the Conservation Advice for humpback whales (TSSC, 2015d) did not identify the potential release of hazardous/ non-hazardous liquids into the marine environment to be a threat to the species.

Marine Turtles

The operational area is within a foraging BIA for the loggerhead, flatback, green and olive ridley turtles. The Recovery Plan for Marine Turtles in Australia 2017 – 2027 (Commonwealth of Australia, 2017a) identifies deteriorating water quality as a threat to all species of marine turtles in Australia. Given the presence of a foraging BIA within the operational area, these species are expected to be transient within the operational area.

Seabirds

The Draft Wildlife Conservation Plan for Seabirds (DoEE, 2019) lists chemical contamination through chronic pollution as a threat to seabirds. However, given the highly dispersive waters within the operational area, the extent of the water column (water depth approximately 112 m) and the relatively small potential volumes associated with such releases, rapid dilution is expected, and concentrations are unlikely to persist for periods of time where impacts would likely be felt.

7.4.2.3 Protected and significant areas and Socio-economic receptors

There are no marine protected areas within the operational area. The Oceanic Shoals Marine Park is the closest at approximately 50 km from the operational area.

The operational area intersects the Pinnacles of the Bonaparte Basin Key Ecological Feature (KEF). Impacts to the physical environment and marine fauna are discussed in the sections above. Non-hydrocarbon and chemical releases are not expected to significantly impact the key values of the KEF.

Recreational users are not expected in the operational area given the distance from shore and the water depth within the operational area (approximately 112 m). Commercial fishing is also limited in this area (**Section 3.3.2**).

7.4.3 Environmental Performance Outcomes and Control Measures

The EPOs relating to this event include:

+ No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed marine fauna during operational activities. [FRI-EPO-01].
+ No unplanned objects, emissions or discharges to sea or air (FRI-EPO-06)

The control measures for this event are shown in **Table 7-17**, and the EPS' and measurement criteria for the EPOs are described in **Section 8.4**.

Table 7-17: Control Measure Evaluation for Non-hydrocarbon and Chemicals Release (Surface) – Liquids

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-003	Dropped object prevention procedure	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects where possible. Minimises drop risk during lifting operations. Ensures lifting equipment certified and inspected.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweighs costs.
FRI-CM-005	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.	Personnel cost associated with implementation of procedures and permanent or temporary storage areas.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
FRI-CM-006	Deck cleaning product selection	Improves water quality discharge (reduced toxicity) to the marine environment. Those 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	Personnel costs of implementing, potential additional cost and delays of chemical substitution.	**Adopted –** Benefits of ensuring MODU/vessels are compliant and those deck cleaning products planned to be released to sea meet Australian Marine Orders criteria.
FRI-CM-007	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

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				outweigh the costs of personnel time.
FRI-CM-008	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 costs.
FRI-CM-010	ROV inspection and maintenance procedures	Maintenance and pre-deployment inspection on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to the marine environment.	Additional personnel costs of ensuring procedures in place and followed.	**Adopted –** Benefits of ensuring procedures are followed outweigh costs.
FRI-CM-026	Vessel PMS to maintain vessel DP, engines and machinery	Reduces discharges from the vessel because equipment is operating within its parameters	Operational costs and labour or access requirements of undertaking maintenance	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweighs costs.
Additional Control Measures				
No additional control measures are considered as the risk is considered ALARP				

7.4.4 Environmental Impact Assessment

Table 7-18: Impact, Likelihood and Consequence Ranking – Non-hydrocarbon and Chemicals Release (Surface) – Liquids

Receptors	+ Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands) + Marine fauna – Plankton, fish, sharks, marine mammals, marine reptiles, seabirds
Consequence	I – Negligible

In the event of a non-hydrocarbon liquid or chemical spill, the quantity of a worst-case liquid release is unlikely to be greater than 1 m^3, but for the conservative approach it could possibly be up to 100 m^3. 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 non-hydrocarbon liquids and chemicals is dependent on the type and exposure duration however given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fauna fatality. Impacts from discharges to the marine environment to water quality would be short-term and localised, due to the nature and behaviour of the chemicals identified as being at risk of spilling; only pelagic fauna present in the immediate vicinity of the spill would likely be at risk of impact. Habitat degradation, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species (that may be present in the operational area) in relevant Recovery Plans and Conservation Advice (**Table 3-4**) and to MNES (DoE, 2013). However, the potential non-hydrocarbon releases of liquids or chemicals are not expected to significantly impact the receiving environment with control measures proposed to prevent releases. Given that a non-hydrocarbon or chemical spill would not result in a decreased population size at a local or regional scale and there are no protected areas within the operational area, it is expected that a spill of this nature would result in a I (Negligible) consequence.	
Likelihood	C – Possible
A small non-hydrocarbon liquid release is unlikely to have widespread ecological effects, given the nature of the chemicals on board, the small volume that could be released, the depth and transient nature of marine fauna in this area, and the prevention and management procedures in place to clean up a spill. Santos reviewed non-hydrocarbon liquid spills and leaks from equipment and machinery in recent history (due to split hoses, small leaks, or handling errors). Most of the spills and leaks reported occurred within bunded areas, were less than 100 L, did not reach the marine environment and were cleaned up immediately. The likelihood of a small hazardous liquids release occurring is limited given the set of mitigation and management controls in place for this program. Consequently, the likelihood of releasing hazardous liquids to the environment, which results in a minor consequence, is considered to be Possible (c).	
Residual Risk	The residual risk associated with this event is **Very Low**.

7.4.5 Demonstration of ALARP

Non-hydrocarbon liquids and chemicals will be required to undertake the activity, so their removal from the operation is not viable. Dangerous chemicals used during the activity will be managed where applicable, in compliance with the Maritime Dangerous Goods Code. Objects will need to be moved around the decks of the vessel. Control measures in place will ensure correct lifting, storage and handling procedures are followed as well as ensuring the maintenance of equipment is undertaken according to preventative management systems. No beneficial additional control measures were identified to further reduce the risk of this hazard. The control measures proposed align with applicable actions described in relevant recovery plans and conservation advice to reduce risk of habitat degradation and deteriorating water quality (e.g., from pollution) to a level considered ALARP by Santos. The assessed residual risk for this impact is low and cannot be reduced further. It is considered therefore that the risk of the activities is ALARP.

7.4.6 Acceptability Evaluation

Is the risk ranked between Very Low to Medium?	Yes – maximum hazardous liquid release (surface) residual risk is ranked Very Low.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' Offshore *Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with Marine Order 94 (Marine pollution prevention – packaged harmful substances). The following material published in relation to threatened and migratory species within the operational area identifies habitat degradation / modification as a threat (**Table 3-4**): **Conservation Advice:** + Approved Conservation Advice for *Pristis pristis* Largetooth Sawfish (2014) + Approved Conservation Advice for Green Sawfish (2008) + Approved Conservation Advice for *Glyphis garricki* Northern River Shark (2014) + Conservation Advice *Rhincodon typus* Whale Shark (2015) + Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (2009) + Conservation Advice *Balaenoptera borealis* Sei Whale (2015) + Conservation Advice *Balaenoptera physalus* Fin Whale (2015) **Recovery Plans:** + Sawfish and River Sharks Multispecies Recovery Plan (2015) identifies habitat degradation as a threat to sawfish and river sharks. Frigate-1 is aligned to Objective 5 of the plan by reducing and, where possible, eliminating adverse impacts of habitat degradation and modification. + Recovery plan for the White Shark (*Carcharodon carcharias*) (2013) identifies habitat modification as a threat to white sharks. Frigate-1 is aligned with Objective 7 of the recovery plan by continuing to

	protect habitat critical to the survival of the white shark and minimising the impact of threatening processes within these areas. However, no habitat critical or BIAs have been identified for white sharks within the operational area. The species is highly mobile and transitory in nature and the area impacted is small compared to the amount of habitat available. + Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017) identifies habitat modification as a threat to marine turtles. Foraging BIAs have been identified for green, loggerhead, flatback and olive ridley turtles within the operational area. Impacts from unplanned non-hydrocarbon and chemicals release may result in a temporary, localised impact to the marine environment, which will recover rapidly. Interim Objective 3 states that anthropogenic threats are demonstrably minimised and this is upheld with the adoption of relevant control measures. + Blue Whale Conservation Management Plan 2015 - 2025 (2015) identifies habitat modification as a threat to blue whales. The long-term recovery objective is to minimise anthropogenic threats to allow the conservation status of the blue whale to improve so that it can be removed from the threatened species list under the EPBC Act. The species is highly mobile and transitory in nature and the area impacted is small compared to the amount of habitat available. + For all the recovery plans identified above, the objectives are achieved through the adoption of FRI-EPO-01, FRI-EPO-06 and the control measures outlined in **Table 7-17**; and Santos considers the impacts of unplanned non-hydrocarbon and chemicals release to not be inconsistent with these recovery plan. Recovery Plans / Conservation Advice for other species that may occur in the operational area do not identify habitat degradation / modification as a key threat or have explicit relevant objectives or management actions related to habitat degradation / modification. The objectives and actions of these publications were considered during the assessment of impacts and risks. The controls outlined in **Table 7-17** are consistent with the objectives of the material listed above and Santos considers the impacts of unplanned non-hydrocarbon and chemicals release to not be inconsistent with these objectives.

Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts 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 above.

With the controls in place to prevent an accidental release of small volumes of non-hydrocarbon liquids and chemicals and the negligible impacts predicted from an unplanned release of such material, the risk to the marine environment is considered low. Potential risks are unlikely to be greater than those caused by other commercial marine vessels or offshore petroleum activities in deep water.

The materials will be managed in accordance with relevant legislation and standards and Santos procedures. The small volumes negate the need for any further contingencies to be in place that are included for some of the larger spill scenarios associated with the activity.

With the controls in place to prevent accidental spills and the I (Negligible) impacts predicted from a spill of this size, the environmental risk of using and handling the required chemicals is considered ALARP and environmentally acceptable.

7.5 Release of Solid Objects

7.5.1 Description of Event

Event	Sources of risks from an accidental release of solid waste (non-hydrocarbon) may occur as a result of: + Vessel Operations Solid objects, such as those listed below, can be accidentally released to the marine environment: + Non-hazardous solid wastes, such as paper and packaging + Hazardous solid wastes, such as batteries, fluorescent tubes, and aerosol cans + Equipment and materials, such as hard hats, tools, or infrastructure parts. Release of these waste streams may occur as a result of overfull and/ or uncovered bins, incorrectly disposed items, or dropped objects/ lost equipment.
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

<u>Potential Receptors: Physical environment (shoals and banks, benthic habitats, offshore reefs and islands), threatened or migratory fauna (marine mammals, marine reptiles, sharks and rays, fish and birds), protected and significant areas.</u>

Solids such as plastics have the potential to affect benthic environments and to harm marine fauna through entanglement or ingestion. Marine turtles and seabirds are particularly at risk from entanglement. Marine turtles may mistake plastics for food; once ingested, plastics can damage internal tissues and inhibit physiological processes, which can both potentially result in fauna fatality. Floating, non-biodegradable marine debris has been highlighted as a threat to marine turtles, whales, and whale sharks in the relevant recovery plans and approved conservation advice (refer to **Table 3-4**). The recovery plans and approved conservation advice, as well as the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018), have specified a number of recovery actions to help combat this threat. Of relevance to this event is the legislation for the prevention of garbage disposal from vessels. As the activity is of short duration, the risk of unplanned release of plastics is low.

Release of hazardous solids (for example, wastes such as batteries) may result in the pollution of the immediate receiving environment, leading to detrimental health impacts to marine flora and fauna. Physiological damage can occur through ingestion; or absorption may occur in individual fish and sharks, marine mammals, marine reptiles or seabirds.

The Recovery Plans and Approved Conservation Advice 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.

The ROVs typically used for offshore surveys present limited capacity for seabed impact due to the equipment being tethered and prevent seafloor contact; and in the event of low power, they are designed to float to the surface and transmit their position for recovery. Therefore, it is unlikely this equipment would impact on the seabed during the survey; however, equipment dropped over the side of the vessel could impact on the seabed for example, accidentally dropped and not tethered.

The area of potential seabed disturbance due to release of a heavier non-hydrocarbon solid would be restricted to the operational area (for example, equipment). The habitat type in the operational area is widely distributed and well represented in the region.

While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within the (in other words, the epifauna and infauna) will 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 they gradually infill over time. The seafloor of this bioregion is strongly affected by cyclonic storms, long-period swells and large internal tides, which can resuspend sediments within the water column and move sediment across the seafloor. In this context, any potential sediment movement caused by the event is likely to have minimal impacts.

Impacts to socio-economic receptors as a result of debris is not expected. Given the remote location, recreational users are not expected in the operational area due to the distance from shore and the water depth within the operational area (approximately 112 m). Commercial fishing is also limited in this area (**Section 3.3.2**).

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 varies, but is generally made up of silts, sands and some small rubble/shell fragments and limited benthic faunal communities. No protected areas in the vicinity, however the Pinnacles of the Bonaparte Basin KEF has been identified within the operational area. The Pinnacles of the Bonaparte basin provide areas of hard substrate in an otherwise soft sediment environment and are recognised as a biodiversity hotspot for sponges (DAWE, 2021).

The area of potential disturbance due to a non-buoyant dropped object would be restricted to the operational area. In the unlikely event of damage to or loss of equipment, potential environmental effects could be limited to physical impacts on benthic communities arising from associated equipment sinking to the seabed.

With appropriate management measures in place, solid non-hydrocarbon releases are not expected to occur frequently or to a scale that may cause significant pollution that would impact the values of the Pinnacles of the Bonaparte Basin KEF.

7.5.3 Environmental Performance Outcomes and Control Measures

The EPOs relating to this event include:

+ No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed marine fauna during operational activities. [FRI-EPO-01]
+ No unplanned objects, emissions or discharges to sea or air [FRI-EPO-06]

The control measures for this event are shown in **Table 7-19**, and the EPS' and measurement criteria for the EPOs are described in **Section 8.4**.

Table 7-19: Control Measure Evaluation for the Release of Solid Objects

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-003	Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects unless the environmental consequences are negligible or there are risks to safety. Ensures lifting equipment certified and inspected.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh cost to Santos.
FRI-CM-004	Waste (Garbage) Management Procedure	Reduces probability of waste being discharged to sea, reducing potential impacts to marine fauna. Ensures food waste is discharged in manner	Personnel cost of vessel audits and inspections, and in recording and reporting waste management.	**Adopted –** Benefits of ensuring vessel is compliant outweighs the minimal costs of personnel time and it is a legislated requirement.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		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.		
FRI-CM-008	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 outweigh costs.
FRI-CM-026	Vessel PMS to maintain vessel DP, engines and machinery	Reduces discharges from the vessel because equipment is operating within its parameters	Operational costs and labour or access requirements of undertaking maintenance	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweighs costs.
FRI-CM-034	Dropped object recovery	Requires dropped objects to be recovered (where safe and practicable to do so) unless the environmental consequences are negligible.	Additional personnel and vessel costs to plan and undertake if safe and practicable to do so.	**Adopted –** Benefits of recovering dropped objects where safe and practicable, unless the environmental consequences are negligible to do so, outweigh the costs.
Additional Control Measures				
N/A	Eliminate lifting in field.	Reduces the risk release of non-hydrocarbon solid to the marine environment due to dropped object.	Lifting is required to handle the ROV and other survey equipment on the vessel.	**Rejected** – Not feasible to eliminate lifting in the field.

7.5.4 Environmental Impact Assessment

Table 7-20: Impact, Likelihood and Consequence Ranking – Release of Solid Objects

<table>
<tr><td>Receptors</td><td>Physical environment (benthic habitats)
Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds)
Protected and significant areas</td></tr>
<tr><td>Consequence</td><td>I – Negligible</td></tr>
<tr><td colspan="2"> Physical Environment 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 adjacent permit areas showed benthic habitats were similarly characterised by soft sediment seabed comprised of predominantly sand, with a proportion of silt, clay and limited benthic faunal communities. 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 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 3-4). 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. Protected and significant areas and Socio-economic receptors Impacts to socio-economic receptors as a result of debris is not expected. Given the remote location, recreational users are not expected in the operational area due to the distance from shore and the water depth within the operational area (approximately 112 m). Commercial fishing is also limited in this area (Section 3.3.2). In the event of a release of a buoyant object that cannot be recovered, it would 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. </td></tr>
</table>

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. Impacts to the Pinnacles of the Bonaparte Basin have the potential to occur through non-buoyant objects sitting on the KEF, adversely impacting the sponge communities that are likely to have developed over the hard surface of the KEF. Given the limited quantities associated with this unplanned event, even a worst-case release of solid waste is unlikely to have flow-on effects significant enough to cause population impacts to the sponge communities or damage the KEF. However, there will be a detectable impact, so the consequence level is therefore assessed as I (Negligible).	
Likelihood	C – Possible
Control measures proposed ensure that the risk of dropped objects, lost equipment or release of non-hydrocarbon solid waste to the environment has been minimised. Given the controls in place, the likelihood of releasing non-hydrocarbon solids to the environment resulting in a minor consequence is considered Possible (c).	
Residual Risk	The residual risk associated with this event is **Very Low**.

7.5.5 Demonstration of ALARP

Solid waste will be generated during the activity and lifting operations and vessel operations are required as part of the activity. Equipment loss and dropped objects, which might occur during lifting operations in the field will be managed through lifting and transfer procedures and equipment management. The control measures proposed reduce the risk of non-hydrocarbon solid releases to a residual risk level that is Very Low and cannot be reduced further. There are no reasonably practicable additional control measures identified that would reduce the chance of a loss of non-hydrocarbon solid release.

Therefore, it is considered that the impact of the activities conducted is ALARP.

7.5.6 Acceptability Evaluation

Is the risk ranked between Very Low to Medium?	Yes – release of solid objects risk is ranked Very Low.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' Offshore *Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with Marine Order 95. Controls implemented will minimise the potential impacts from the activity to species identified in recovery plans and approved conservation advice as having the potential to be impacted by solid objects. The following material published in relation to threatened and migratory species within the operational area identifies marine debris as a threat (**Table 3-4**): **Conservation Advice:**

	+ Approved Conservation Advice for *Glyphis garricki* Northern River Shark (2014) + Conservation Advice *Rhincodon typus* Whale Shark (2015) + Approved Conservation Advice for *Dermochelys coriacea* Leatherback Turtle (2009) **Recovery Plans:** + Threat Abatement Plan for Impacts of Marine Debris on Vertebrate wildlife of Australia's coasts and oceans (2018). Specific actions that contribute to the long-term prevention of marine debris (Objective 1 of the plan) have been adopted, including FRI-EPO-01, FRI-EPO-06 and control measures outlined in **Table 7-19.** + Recovery plan for marine turtles in Australia 2017 – 2027 (2017) identifies marine debris as a threat to marine turtles. Action A3 of the plan: reduce the impacts from marine debris, will be managed through the adoption of FRI-EPO-01, FRI-EPO-06 and control measures outlined in **Table 7-19**. + Blue Whale Conservation Management Plan 2015 - 2025 (2015) identifies marine debris as a threat to blue whales. The long-term recovery objective is to minimise anthropogenic threats to allow the conservation status of the blue whale to improve so that it can be removed from the threatened species list under the EPBC Act. With the adoption of FRI-EPO-01, FRI-EPO-06 and control measures outlined in **Table 7-19**, Santos considers the impacts of unplanned non-hydrocarbon and chemicals release to not be inconsistent with the recovery plan. Recovery Plans / Conservation Advice for other species that may occur in the operational area do not identify marine debris as a key threat or have explicit relevant objectives or management actions related to marine debris. The objectives and actions of these publications were considered during the assessment of impacts and risks. The controls outlined in **Table 7-19** are consistent with the objectives of the material listed above and Santos considers the impacts of unplanned release of solid objects to not be inconsistent with these objectives.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts 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 above.

The handling and use of non-hydrocarbon solid materials is standard industry practice and the potential impacts well understood. This aspect will be managed consistent with relevant legislation, regulations and guidelines and the residual risks are low and ALARP.

The control measures proposed are consistent with applicable actions described in the relevant Recovery Plans and Approved Conservation Advice and no stakeholder concerns have been raised regarding this event.

With the control measures in place to prevent accidental releases and the negligible impacts predicted from these types of solids, the low risk of a non-hydrocarbon solid release to the environment is considered environmentally acceptable.

7.6 Introduction of Invasive Marine Species

7.6.1 Description of Event

Event	Introduction of invasive marine species (IMS) may occur due to: + Biofouling on vessels and external/internal (e.g., sea chests, seawater systems) niches + Biofouling on equipment that is routinely submerged in water (e.g., ROVs) + Discharge of high-risk ballast water Once established, IMS have the potential to out-compete indigenous species and affect overall native ecosystem function.
Extent	Localised (seabed within the operational area) to widespread if successfully translocated to new areas via ocean currents or project equipment transit.
Duration	Temporary to long-term (in the event of successful translocation and establishment).

7.6.2 Nature and Scale of Environmental Impacts

Potential receptors: Physical environment (shoals and banks, benthic habitats, offshore reefs and islands), threatened/migratory fauna (marine mammals, marine reptiles, sharks, fish and rays), protected and significant areas (marine parks), socio-economic receptors (fisheries, tourism and recreation).

IMS are marine plants, animals and algae that have been introduced into a region that is beyond their natural range but that have the ability to survive and possibly thrive (DAWE, 2019). The majority of climatically compatible IMS to the North West Shelf are found in southeast Asian countries. Some IMS pose a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (DAWE, 2019; Wells et al., 2009). When IMS achieve pest status, they are commonly referred to as introduced marine pests or IMPs. IMPs can cause a variety of adverse effects in a receiving environment, including:

+ Over predation of native flora and fauna
+ Displacement of native marine species
+ Outcompeting of native flora and fauna for food

- Depletion of viable fishing areas and aquaculture stock
- Human illness through released toxins
- Reduction of coastal aesthetics
- Damage to marine and industrial equipment and infrastructure

The above impacts can result in flow-on detrimental effects to marine parks, tourism and recreation.

IMS 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 invasive marine species introductions, which is why ports are often areas of higher IMS risk (Neil et al., 2005). However, in Australia there are limited records of detrimental impact from IMS compared to other tropical regions (such as the Caribbean).

Following their establishment, eradication of IMS populations is difficult, limiting management options to ongoing control or impact minimisation. Case studies in Australia indicate that, from detection to eradication, this can take approximately four weeks (Bax et al., 2003). However, this depends 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 is responsible for 20 to 30% of all marine pest 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 (DAFF, 2011). The potential biofouling risk presented by vessels will relate to:

- The length of time that these vessels have already been operating in Australian waters or, if they have been operating outside Australian waters
- The locations of the operations they have been undertaking
- The length of time spent at these locations
- Whether the vessels have undergone hull inspections, cleaning and application of new anti-foulant coating prior to returning to operate in Australia.

Vessels based in local ports, such as Darwin or Broome, do not carry the same quarantine risks as international vessels (e.g., offtake tankers) or out of State vessels, as they supply the same waters as those the operational area resides in.

7.6.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event is:

- No introduction of invasive marine species [FRI-EPO-07]

The control measures for this event are shown in **Table 7-21**, and the EPS' and measurement criteria for this EPO are described in **Section 8.4**.

Table 7-21: Control Measure Evaluation for the Introduction of Invasive Marine Species

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-017	Compliance with the Biosecurity Act 2015	Reduces the risk of introducing IMS through implementation of the vessel assessments and requirement for immersible equipment to be cleaned.	Personnel costs involved in demonstrating vessel(s) are of 'low risk' of introducing IMS through completion of risk assessments as well as the requirement for equipment to be cleaned could lead to potential delays in activity schedule should remediation activities (e.g. additional cleaning and inspections) be required, potentially affecting vessel contracting process.	**Adopt** – Benefits considered to outweigh costs. Regulatory requirement must be adopted.
FRI-CM-019	Anti-foulant System	The risk of introducing IMS is reduced due to anti-foulant systems.	Could lead to potential delays and therefore costs, in vessel contracting process due to availability of vessels with appropriate anti foulant systems.	**Adopted –** minimal potential delays or costs to project are considered outweighed by the benefits of reducing the risk of IMS.
Additional Control Measures				
N/A	Heat or chemical 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 chemicals or water at much higher temperature than surrounding marine environment would likely be toxic or result in death of native marine species.	**Rejected** – Based on increased risk to marine environment and high cost considered disproportionate compared to base case risk (after application of standard controls (see above)).
N/A	Contract vessel only operating in local, State or Commonwealth waters to	Reduce potential for IMS to be transported into area since vessels would not have originated elsewhere.	Vessel and equipment suitable for the activity may not be available in State/Commonwealth waters. Potential significant costs and delay in activity	**Rejected** – Not feasible.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	reduce potential for IMS.		schedule by only contracting a vessel working in State/ National waters.	
N/A	Mandatory dry docking of vessels prior to entering field to clean vessel and/or equipment and remove biofouling.	Ensures that no IMS are present on vessel or associated equipment.	Significant cost (grossly disproportionate to the risk) would lead to scheduling delays.	**Rejected –** Costs disproportionately high compared to environmental benefit given other controls in place already reduce the risk.
N/A	Utilise an alternative ballast system to avoid uptake and discharge of water in vessels.	Eliminate need for ballast water exchange, therefore decreasing risk of introducing IMS through ballast water.	MODU/vessels suitable for the activity may not have options for alternative ballast, therefore would require modification at significant cost.	**Rejected** – Cost disproportionately high compared to environment benefit.
N/A	Zero discharge of ballast water.	Would reduce the potential for IMS by implementation of no ballast water exchange policy on the vessel.	Ballast water exchange required on the vessel for stability.	**Rejected** – On the basis that ballast water exchange is a safety-critical activity for marine operations.

7.6.4 Environmental Impact Assessment

Table 7-22: Impact, Likelihood and Consequence Ranking – Introduction of Invasive Marine Species

Receptors	+ Physical environment (shoals and banks, benthic habitats, offshore reefs and islands) + Threatened, migratory and local fauna (marine mammals, marine reptiles, sharks, fish and rays) + Protected and significant areas + Socio-economic receptors (marine parks, fisheries, tourism and recreation)
Consequence	III – Moderate
IMS, if they successfully establish, can outcompete native species for food or space, prey on native species or change the nature of the environment and can subsequently impact on fisheries or aquaculture. This is primarily through altering benthic habitats, which in turn may result in changes to faunal assemblages and a reduction in diversity. However, given the soft sediment and lack of diversity expected in the operational area, as well as the extensiveness of similar benthic habitat in the region, there would only be a minor reduction in the physical environment. No threatened ecological communities or protected areas are	

present in the environment that could be affected. Any such reduction in diversity or health of the ecosystem may result in economic losses with long-term effects on industry. Given the soft sediment and low biodiversity expected in the operational area, the overall consequence level was assessed as Moderate (III).	
Likelihood	A – Remote
The pathways for IMS introduction are well known; consequently, standard preventive 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). The risk of an IMS being able to successfully establish itself will depend on depth, distance from the coast, water movement and latitude. The depth of the operational area (approximately 112 m) creates an unfavourable habitat for colonisation (i.e., light limiting and low habitat biodiversity with sparse epibiota). The time a vessel spends in a location (residence time) has an influence on the likelihood of species attachment or uptake at a source. The longer a vessel sits in any one location, the more likely it is to be colonised by biofouling species and can also impact on the performance of some types of antifouling coatings (MIAL 2020). The vessel will only be at the operational area for up to 7 days. The vessel expected to be used for the activity will have been in Australian waters, prior to mobilising to the operational area to start work under this EP (i.e. they will not be mobilised from international waters). Therefore, the risk of translocation of IMS from international waters is very low. There is a low likelihood that IMS would be able to survive translocation and subsequently establish and colonise. Given the dispersive open-ocean environment of the operational area, the successful translocation to surrounding shallower habitats of an IMS introduced to the are unlikely. With controls in place to reduce the risk of IMS introduction, the likelihood is considered Remote (A).	
Residual Risk	The residual risk associated with this event is **Very Low**.

7.6.5 Demonstration of ALARP

There are no alternatives to the use of a vessel or submersible survey in order to undertake the activity. The risks from IMS are well understood and, with the proposed control measures, the activity will comply with relevant regulations and guidelines. The proposed management controls are considered appropriate to manage the risk of introduction of IMS to ALARP.

Ballast water exchange will be managed through a Ballast Water Management Plan (as applicable) , and a vessel biosecurity risk assessment in accordance with the *Invasive Marine Species Management Plan* (EA-00-RI-10172) will be undertaken to demonstrate that the vessel is low risk so that IMS are not introduced.

Santos 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 North West Shelf and North Australia 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 IMS 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.

The biofouling risk assessment approach adopted by Santos will ensure that the *Aquatic Resources Management Act 2016* and associated regulations prohibiting the introduction of non-endemic fish species will be met.

With adherence to the proposed management controls, the risk to the environment from IMS has been reduced to ALARP.

7.6.6 Acceptability Evaluation

Is the risk ranked between Very Low to Medium?	Yes – introduction of IMS residual risk ranking is Very Low
Is further information required in the consequence assessment?	No – potential impacts and risks well understood through the information available
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' Offshore *Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with Biosecurity Act 2015, National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018) and the *Aquatic Resources Management Act 2016*. The following material published in relation to threatened and migratory species within the operational area identifies invasive species or disease as a threat (**Table 3-4**): **Recovery Plans:** + Recovery plan for marine turtles in Australia 2017 – 2027 (2017) identifies disease and pathogens as a threat to marine turtles. Interim Objective 3 states that anthropogenic threats are demonstrably minimised and this is upheld with the adoption of FRI-EPO-07, FRI-CM-18 and FRI-CM-20. Recovery Plans / Conservation Advice for other species that may occur in the operational area do not identify invasive species or disease as a key threat or have explicit relevant objectives or management actions related to invasive species or disease. The objectives and actions of these publications were considered during the assessment of impacts and risks. The controls outlined in **Table 7-21** are consistent with the objectives of the material listed above and Santos considers the impacts of unplanned release of solid objects to not be inconsistent with these objectives.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.

Are risks and impacts 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 above.

The mobilisation of the vessel and equipment to undertake offshore petroleum activities is industry standard practice, and the IMS risks are well understood and subject to regulation. The vessels and equipment that are internationally mobilised will meet Australian biosecurity requirements, and proposed management is consistent with National Biofouling Management Guidance for the petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018).

Application of the proposed control measures and adherence to legislation and regulations reduce the likelihood of introducing IMS into the operational area, and the dispersive offshore location in the operational area reduces the probability of successful establishment in the unlikely event of introduction.

No stakeholder concerns have been raised regarding this aspect, and the proposed controls will reduce the residual level of risk to Low and ALARP. Therefore, the residual risk associated with IMS is considered by Santos to be environmentally acceptable.

7.7 Marine Fauna Interaction

7.7.1 Description of Event

Event	Marine fauna interactions may occur as a result of: + Vessel operations + ROV operations There is the potential for the vessel or equipment from the vessel involved in operational activities to interact with marine fauna, including potential strike or collision, potentially resulting in severe injury or mortality.
Extent	Within the operational area, in the immediate vicinity of the vessel and survey equipment.
Duration	For the duration of the Activity, as described in **Section 2**

7.7.2 Nature and Scale of Environmental Impacts

<u>Potential receptors: Fish and Sharks, Marine Mammals and Marine Turtles; protected and significant areas</u>

Movement of the vessel in the operational area introduces the potential for interaction with marine fauna present at the same location during the activity. 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 **Table 3-5**, the operational area overlaps foraging BIAs for the flatback turtle, green turtle, loggerhead turtle and Olive Ridley turtle.

Vessel strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advice (**Table 3-4**). Incidents with marine fauna are recorded and reported by Santos as described in **Section 8.8**.

7.7.2.1 Threatened/Migratory fauna

Marine Mammals and Fish and Sharks

The Approved Conservation Advice and Conservation Management Plans for the Blue Whale, Fin Whale, Sei Whale and Humpback Whale lists vessel strike as a threat to these threatened species. The Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d) indicates that humpback whales are one of the most frequently reported whale species involved in vessel strikes worldwide (Laist et al., 2001; Jensen & Silber, 2003). This observation is supported by Australian studies referenced in The National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE, 2017). The increase in vessel numbers (Silber & Bettridge, 2012) is not only a threat to humpback whales in relation to vessel strikes but also in relation to disturbance and displacement from key habitats. Similarly, vessel strike is also recognised by the Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a) as one of the threats to the recovery of whale sharks. Whale sharks are at risk from vessel strikes when feeding at the surface or in shallow waters (where options to dive are limited).

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). Instances of cetacean deaths as a result of vessel collisions in Australian waters have been recorded (e.g., a Bryde's whale in Bass Strait in 1992) (WDCS, 2006), although the data indicates this is likely to be associated with container ships and fast ferries. The Whale and Dolphin Conservation Society also indicates that some cetacean species, such as humpback whales, can detect and change course to avoid a vessel (WDCS, 2006). The reaction of whales to the approach of a ship is quite variable. Some species remain motionless when in the vicinity of a ship while others are known to be curious and often approach ships that have stopped or are slow-moving, although they generally do not approach and sometimes avoid faster-moving ships (Richardson et al., 1995).

No constraints within the operational areas (e.g., shallow water or shorelines) would prevent whale sharks from moving away from vessels. Vessel speed has been demonstrated to be a key factor in relation to collision with marine fauna, particularly cetaceans, with faster-moving vessels posing a greater collision risk than slower vessels (Laist et.al., 2001; Jensen & Silber, 2003; Hazel, 2009). Laist et al., (2001) suggest that the most severe and lethal injuries to cetaceans are caused by vessels travelling at 14 knots or faster.

There are no BIAs for marine mammals, fish or sharks within the operational area.

Marine Turtles

Marine turtle and vessel interactions arising from increased vessel traffic is recognised as one of a number of key threats to marine turtles in the Recovery Plan for Marine Turtles (DoEE, 2017). It is likely that flatback, green, loggerhead and Olive Ridley turtles may be transient within the operational area due to the presence of foraging BIAs.

Marine turtle mortality due to vessel strike has been identified as an issue in Queensland waters in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017). However, turtles appear to be more vulnerable to vessel 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 vessel strike, possibly due to the relatively low human population density of the North West Shelf coastline.

Turtles will typically avoid vessels by rapidly diving; however, their ability to respond varies greatly depending on the speed of the vessel. Hazel (2009) reported that the number of turtles that fled vessels decreased significantly as vessel speed increased. Turtles are also adapted to detect sound in water (Popper et al., 2014) and will generally move from anthropogenic noise-generating sources, including vessels, within their detection range.

7.7.2.2 Protected and significant areas and Socio-economic receptors

There are no marine protected areas within the operational area. The Oceanic Shoals Marine Park is the closest at approximately 50 km from the operational area.

The operational area intersects the Pinnacles of the Bonaparte Basin Key Ecological Feature (KEF); which does not identify marine fauna as a key value.

7.7.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event is:

+ No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed marine fauna during operational activities. [FRI-EPO-01].

The control measures for this event are shown in **Table 7-23**, and the EPS' and measurement criteria for this EPO are described in **Section 8.4**.

Table 7-23: Control Measure Evaluation for Marine Fauna Interaction

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-001	Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from vessels and helicopters. If marine fauna is sighted, then 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 accepted.	**Adopted** – Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos. Control measure ensures compliance with Part 8 of the EPBC Regulations.
FRI-CM-002	Constant bridge-watch (visual and radar)	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional costs. Industry practice and regulated by AMSA.	**Adopted** – Industry practice, benefits outweigh cost.
Additional Control Measures				

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Manage the timing of the activity to avoid sensitive periods at the location	Reduce risk of collisions (causing harm) during environmentally sensitive periods for listed marine fauna.	High cost in moving or delaying schedule while the risk to all listed marine fauna cannot be reduced due to variability in timing of migration periods and unpredictable presence of some species.	**Rejected** – Grossly disproportionate to incremental environmental benefit.
N/A	Dedicated Marine Fauna Observer	Improves ability to spot and identify marine fauna at risk of collision (that may cause harm).	Additional cost of contracting several specialist Marine Fauna Observers.	**Rejected –** Cost disproportionate to increase in environmental benefit. Potential impacts are low, and activity is of short duration. Therefore, the potential for interaction is considered low.
N/A	Limit or exclude night-time operations	Reduced potential for a vessel-fauna collision occurring as activities only undertaken during daylight hours when visibility highest.	Lengthens duration of the activity as operations only continue for approximately 10 hours per day. Increased cost due to increased activity time (more than double the cost). Lengthened schedule results in increased impacts and risks (e.g. planned emissions and discharges, interference with other marine users, etc.).	**Rejected –**Substantial additional cost due to doubling of activity duration. No overall environmental benefit as results in increased impacts and risks.

7.7.4 Environmental Impact Assessment

Table 7-24: Impact, Likelihood and Consequence Ranking – Marine Fauna Interaction

Receptors	+ Threatened or migratory fauna (marine mammals, marine turtles, sharks and rays, fish and birds)
Consequence	I – Negligible
In the event of a collision with marine fauna, there is the potential for injury or death to an individual. The number of receptors present at the operational area during the short duration of the activity is expected to be limited to a small number of transient individuals. There are foraging BIAs within the operational area for marine turtles, however, the operational area only overlaps a portion of the BIA for these species. Turtles will also typically avoid vessels by rapidly diving. Boat strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant Recovery Plan and Conservation Advice (**Table 3-4**). The above information demonstrates that with control measures in place the activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. There is the potential for death or injury of EPBC Act 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, it is expected that the loss of an individual would be a negligible consequence.	
Likelihood	B – Unlikely
Given the presence of a foraging BIA for a number of turtles, they are expected to be present in the operational area. However, the operational area does not overlap any BIAs for marine mammals or fish and no known aggregation areas (breeding, resting or calving) occur within the operational area. Therefore, concentrations of milling individuals are unlikely. The vessel will be moving very slowly whilst inside the operational area, posing a low risk of collision with marine fauna. In addition, the noise generated from vessel operations will deter marine fauna from coming within close proximity to the vessel. With controls in place ensuring the vessel is compliant with EPBC Regulations, the likelihood of a collision with marine fauna resulting in a very low/negligible consequence is considered to be b-Unlikely.	
Residual Risk	The residual risk associated with this event is **Very Low**

7.7.5 Demonstration of ALARP

There are no alternatives to the use of the vessel to undertake the activity. The inherent likelihood of encountering fauna in the operational area is limited by the short duration of the activity and the separation from areas of high surface fauna density. With relatively low vessel speeds and compliance with fauna interaction procedures, including Regulation 8 of the EPBC Regulations 2000, a fauna collision is considered very unlikely.

With the control measures adopted, the assessed residual risk for this impact is Very Low and cannot be reduced further. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 7.7.3**. Therefore, it is considered that the impact of the activities conducted is ALARP.

7.7.6 Acceptability Evaluation

Is the risk ranked between Very Low to Medium?	Yes – marine fauna interaction residual risk ranking is Very Low.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' Offshore *Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – Management consistent with Part 8 of the EPBC Regulations. The following material published in relation to threatened and migratory species within the operational area identifies vessel interaction or vessel strike as a threat (**Table 3-4**): **Conservation Advice:** + Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015) **Recovery Plans:** + Recovery Plan for Marine Turtles in Australia (2017) identifies vessel interaction as a threat to marine turtles. Foraging BIAs have been identified for green, loggerhead, flatback and olive ridley turtles within the operational area. Risk of vessel interaction is a possibility. Interim Objective 3 states that anthropogenic threats are demonstrably minimised and this is upheld with the adoption of FRI-EPO-01, FRI-CM-001 and FRI-CM-002. + Conservation Management Plan for the Blue Whale, 2015–2025 (2015) identifies vessel collisions as a high priority threat to the species. Action Area A.4 of the plan: minimising vessel collisions, will be managed through the adoption of FRI-EPO-01, FRI-CM-001 and FRI-CM-002. Recovery Plans / Conservation Advice for other species that may occur in the operational area do not identify vessel interaction or vessel strike as a key threat or have explicit relevant objectives or management actions related to vessel interaction or vessel strike. The objectives and actions of these publications were considered during the assessment of impacts and risks.

	The controls outlined in **Table 7-23** are consistent with the objectives of the material listed above and Santos considers the impacts of unplanned release of solid objects to not be inconsistent with these objectives.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts 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 above.

It is unavoidable to undertake the activity without movement of the vessel within the operational area. The possibility of vessel strike is a well understood risk for maritime operations, including for commercial shipping and fishing.

Vessel movements will comply with all relevant maritime standards and regulations, including EPBC regulations to minimise risks to marine fauna. Application of the proposed management controls and adherence to Commonwealth regulations reduces the likelihood of vessel interactions with marine fauna. While the potential exists for a collision to occur, it is considered an unlikely (b) scenario. As part of Santos' reporting requirements for the activity, in the unlikely event that an impact did occur in the operational area, it will be reported in the National Ship Strike Database (refer to **Table 8-4**).

Therefore, the impact is considered to be ALARP and environmentally acceptable.

With application of the proposed control measures, the potential impacts and risks to threatened fauna will be managed consistent with relevant Recovery Plans and Approved Conservation Advice. No stakeholder concerns have been raised regarding this event. Therefore, the impact is considered to be ALARP and environmentally acceptable.

7.8 Interaction with Other Marine Users (wellhead in-situ)

7.8.1 Description of Event

Event	Interaction with other marine users may occur as a result of: + Wellhead remaining in-situ. The physical presence of the wellhead may interfere with third-party activities including: + Current and future commercial fishing activities (accidental damage to trawling equipment) + Future oil and gas activities + Future shipping activities There are no current recognised major shipping routes within the vicinity of the operational area; or any current oil and gas activities within the permit. There is the potential for the vessel or equipment from the vessel involved in operational activities to interact with marine fauna, including potential strike or collision, potentially resulting in severe injury or mortality.
Extent	Within the operational area
Duration	The potential effects may occur until equipment degrades (i.e. many decades)

7.8.2 Nature and Scale of Environmental Impacts

Santos has identified the following stakeholders as potential marine users of the operational area; commercial fishers, commercial shipping and other petroleum-related vessels.

7.8.2.1 Socioeconomic receptors

Commercial fisheries

Consultation

Fisheries which may be active within the vicinity of the operational area include the Northern Prawn Fishery (NPF) and Northern Demersal Scalefish Fishery (**Section 3.3.2**). The NPF is a trawl fishery; hence, the wellhead may represent a trawl net snag hazard.

Santos consulted with the NPFI, all individual fishing licence holders within the NPF, and WAFIC – as described in **Section 4.4**. No concerns were raised regarding the physical presence of the wellhead or potential snag risk. One licence holder within the NPF confirmed that trawl grounds are not within the vicinity of the operational area. This is supported by 10 years of FishCube data which shows that the distance to the closest area of any fishing effort (low effort with <3 vessels) is approximately 48 km.

Given uncertainty over the exact location of the wellhead and changes in geographic datum systems over time, and to confirm the condition of the wellhead, as part of this EP, Santos will conduct an ROV survey of the wellhead. The survey will confirm the wellhead location, surrounding benthic environment and the condition of the wellhead.

Following the survey, Santos will provide the confirmed wellhead coordinates to NOPTA and AHO, to update navigation charts, as well as to the NPFI, who will disseminate the wellhead location to vessel crews. The NPF licence holder confirmed they do not trawl in the vicinity of the operational area, and no further concerns have been raised by the licence holder regarding the wellhead remaining in-situ.

Fishing effort in the operational area

Santos has previously engaged a Subject Matter Expert, the AMC, to undertake an assessment of the potential impacts of a wellhead on the NPF in this region. The study was conducted for the Tern-1 decommissioning assessment in the neighbouring title WA-27-R, as part of the Tern-1 Wellhead Abandonment EP (SO-91-BI-20008), accepted by NOPSEMA in September 2021.

Given the Frigate-1 and Tern-1 wellheads are approximately 14 km apart and of a similar vintage, this assessment has been used to inform potential concerns of the NPFI. The study found that most of the trawling activity and harvest comes from the Gulf of Carpentaria, especially during the tiger prawn season. The western most area of the fishery (Joseph Bonaparte Gulf in the vicinity of the operational area) has a much lower fishing effort. This is consistent with both the 1991 Australian Fisheries Zone data and the 2020 Draft Australian Fisheries Zone data (**Figure 3-7**).

The Joseph Bonaparte Gulf is fished primarily for Banana prawns which are found at shallower depths than the operational area (approximately 112 m). The common Banana prawn is caught in water <45 m deep (NPF25, 1994). Adults of the deeper water Indian white variety of banana prawns are found in depths from 45-85 m.

The number of vessels working in the NPF has also decreased in the last four decades from a peak of 292 licenced vessels in the 1980s to 52 vessels in present day. With this reduction in vessel numbers there is less capacity in the fleet for exploratory fishing, therefore remote areas such as the Joseph Bonaparte Gulf are less frequently fished. This is unlikely to change in the foreseeable future, fishing in the Joseph Bonaparte Gulf may decrease even further as larger fishing companies acquire boat licences (AMC, 2021).

Double rig and quad rig vessels operating in the NPF are designed for fishing in relatively shallow waters (<50 m), due to the inside board clearance requirement, and therefore are unlikely to venture to the deeper waters of the operational area (approximately 112 m) (AMC, 2021).

Based on this information although the wellhead is located within a trawlable area, fishing effort in the vicinity of the operational area is likely to be low.

Assessment of snag risk

The NPF vessels are equipped with one or more echosounders and GPS plotters (AMC, 2021). Echo sounders detect strong target strength seabed obstacles such as the wellhead. Given the water depth of the operational area, the trawl gear in approximately 112 m of water may reside some 250 to 300 m astern of the vessel, so there would be sufficient time and room to manoeuvre to avoid the obstacle. GPS plotters accurately show the vessels position relative to marked seabed infrastructure such as the well-head and allow trawlers to plan their routes to safety avoid the obstacle (John Wakeford Pers Comm, 2021).

Further, a review of the historical fishing vessel incident data from AMSA Monthly Domestic Vessel Incident Reporting Database (2 year data set) and Australian Transport Safety Bureau (ATSB) Marine Safety Investigations Reports (1982-2020) shows that there are no reported fishing vessel incidents confirmed as related to offshore oil and gas infrastructure in Australia.

Outside of Australia, historically, wellheads are recorded to have caused fewer snag incidents in commercial fisheries, compared to pipelines and marine debris from oil and gas operations, which accounted for more than 50% of incidents in the UK between 1989 and 2016 (Rouse, 2020). In comparison, production infrastructure, which includes wellheads, were involved in 4% of incidents over the same period (Rouse, 2020). Overall, the likelihood of interactions between trawl equipment and oil and gas infrastructure is reducing over time, as a result of an increase in communication between the oil & gas industry and improvement in fishery GPS equipment (Rouse, 2020).

Based on the low level of fishing effort in the area, the navigational equipment on board the NPF vessels and likely improvements in GPS fishing equipment in the future, the risk of trawl net snagging is low.

Risk of vessel capsizing

In the unlikely event of snagging, potential consequences are financial loss to commercial fishers either through lost fishing time or damages to, and losses of, fishing gear (Rouse, 2020). Studies of historical snag incidents in the UK have found that vessel damage or loss occurred less than 0.5% of the time, with one capsize resulting in fatalities/injuries occurring in the UK between 1989 and 2016 (Rouse, 2020), equating to 0.06% of incidents.

The Northern Demersal Scalefish Fishery is a trap and line fishery. As it is not a trawl fishery, the wellhead does not represent a trawl net snag hazard. Further, analysis of DPIRD FishCube data over the 2010 to 2020 period indicates there was no fishing effort in a 10 NM block surrounding the Tern-

1 wellhead (**Figure 3-8**). Impacts to the current and future Northern Demersal Scalefish fishery are considered negligible.

Petroleum Industry

The presence of the wellhead on the seabed may interfere with future petroleum activities (e.g. interfere with drill rig placement). However, due to the small footprint of the wellhead (~1 m diameter) and known presence of the wellhead any such interference would be insignificant.

Due to the water depth at Frigate-1, a floating rig would likely be used, meaning any interference with positioning of the rig is unlikely.

Shipping

There are no known recognised major shipping routes within the immediate vicinity of the operational area, however vessels may pass through the general area. Interactions with shipping is unlikely currently or in the future based on the water depth of the operational area (approximately 112 m) and the height of the wellhead (approx. 3 m).

7.8.3 Environmental Performance Outcomes and Control Measures

The EPO relating to this event is:

+ 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-05]

The control measures for this event are shown in **Table 7-25**, and the EPS' and measurement criteria for this EPO are described in **Section 8.4**.

Table 7-25: Control Measure Evaluation for Interaction with Other Marine Users

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
FRI-CM-030	Navigational Charting of Property	Ensures other marine users, such as commercial fishers, are aware of the wellhead location so they can plan their business accordingly.	Negligible cost	**Adopted** – The positive benefits of identifying the wellhead to other marine users by confirming it continues to be charted with the AHO is considered acceptable. Charting is considered an effective measure to reduce the snag risk to other

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				marine users. Under the Navigation Act 2012, AHO is responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications. Specifically, subsea infrastructure is identified as a potential subsea hazard to commercial shipping activities (such as fisheries) and thus locations are included on appropriate marine charts.
FRI-CM-031	Notification to AHO, NPFI, and NPF of wellhead location once confirmed	AHO, NPFI and NPF are aware of the location of the wellhead and can avoid the area if fishing in the vicinity.	Negligible cost	**Adopted** – Benefits considered to outweigh negligible costs to Santos
Additional Control Measures				
N/A	Complete Removal (Base Case)	Removing the wellhead will remove the current and future trawl net snag hazard risk. However, removal by external cutting may not be technically feasible if there is the presence of external obstructions (i.e. Guide Base or concreate patio) and	It is estimated that wellhead removal costs would be in the range of AUD 3M to 5M* as two campaigns would be required. One campaign for marine growth cleaning and inspection, the other for removal of the wellhead.	**Rejected** – As detailed in **Section 2.4**, leave in-situ is the preferred decommissioning outcome as it provides a benefit from an environmental, safety and technical perspective. Attempting to remove the

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		would result in seabed disturbance. Removal by internal cutting may not be technically feasible as the high-pressure housing, temporary abandonment cap and latching mechanism are unknown potentially preventing internal access.	The removal operations would, amongst other environmental affects, cause localised seabed disturbance, generate metal cuttings and remove artificial habitat. The operation would result in health and safety risks to the workforce due to the unknown condition of the wellhead. There would also be GHG emissions associated with the removal campaign and subsequent wellhead disposal. * The lower estimate considers potential cost savings by completing on of the campaigns in conjunction with future nearby petroleum activities (e.g. Tern-2 plug and abandonment). The upper estimate is based on two dedicated wellhead removal campaigns.	wellhead would also introduce technical risks (described in **Section 2.4**) and cost in the range of AUD 3M to 5M. Given the wellhead is in an area that is not actively trawled, will be marked on navigational charts and the trawl vessels are equipped with navigational equipment such as echo sounders and GPS plotters the risk of snagging is low. Future fishing effort in the area is likely to be low as the larger fishing companies acquire available boat licences, leaving less capacity for exploratory fishing. Interactions between trawl equipment and oil and gas equipment are likely to reduced overtime due to improvements in fishery GPS equipment. Based on the low current and future likelihood of interactions between the well

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				head and the NPF fishery and the environmental impacts, potential technical difficulties and costs associated with removal, leaving the wellhead in situ is the preferred option.
NA	Install a wellhead cover or cap	Installing a wellhead cover or cap to reduce snagging risks to commercial trawl fishers.	Significant cost (in the range of AUD 1.4M to 1.8 M.) associated with conducting installation program. Offshore campaign would introduce environmental impacts and risks, including air emissions and fuel oil spill risks, associated with vessel operations. Disturbance to seabed while placing the cover or cap on the seabed. Health and safety risks associated with vessel and installation operations, plus onshore logistics operations.	**Rejected** – The height of the wellhead may need to be reduced to allow for the placement of a 'low profile' cover or cap. The impacts would be similar to those associated with complete removal. This option was rejected as it provided little benefit over the base case.

7.8.4 Environmental Impact Assessment

Table 7-26: Impact, Likelihood and Consequence Ranking – Interaction with Other Marine Users

Receptors	+ Socio-economic (commercial fisheries, commercial shipping, petroleum industry)
Consequence	II – Minor
The impact of the wellhead remaining in-situ on socio-economic receptors is considered to be II (Minor) due to the fact that: + There is no exclusion zone placed over the wellhead, therefore fishing can occur. Commercial trawling activity will be excluded as a result of the snag risk although the displacement area is very small. + The wellhead location will be updated and marked on nautical charts. + The equipment presents an isolated, small vertical feature in a relatively flat seabed that will be detectable to sonar used by trawling vessels. + The small size and profile of the wellhead (approx. 1 m diameter, approx. 3m height) means any deviation from normal fishing practices would be minimal. Based on historical data, the operational area is not frequently fished by commercial fishers. + The risk of the wellhead being a snag hazard is considered low due to the low level of fishing effort in the area, and low profile of the wellhead. + The operational area is not extensively fished – commercially, traditionally or recreationally. Based on NPF fishing intensity data indicating the wellhead is 21.7 km north of low-moderately trawled areas, as well as confirmation that vessels in the NPF have equipment (echo sounders, GPS etc) designed to avoid navigation hazards and there has been no recorded fishing incidents related to the oil and gas industry recorded in Australia, the risk The risk of the wellhead being a snag hazard is considered low. + Any future users could reasonably be expected to become aware of its presence through due diligence (e.g., reviewing nautical charts). + Feedback from the NPFI during stakeholder consultation confirmed there is no objection to the activity / leaving the wellhead in-situ (**Section 4.4**). NPFI confirmed there is no trawling in the vicinity of the operational area, and the distance to the closest area of any fishing effort (low effort with <3 vessels) is approximately 50 km to the south. Following further consultation with the NPFI, no additional concerns were raised. + Stakeholders did not raise any concerns due to the presence of the wellhead regarding disruptions to commercial fisheries, commercial shipping or petroleum activities.	
Likelihood	B – Unlikely
Given the operational area is not extensively fished, and the low profile (approx. 3 m) and water depth; unplanned impacts to commercial fisheries are considered unlikely. The likelihood of any impact to commercial shipping or petroleum activities from a low-profile wellhead is low. The wellhead has been in place since 1978 without any reported impact to stakeholders. With controls in place ensuring the presence of the wellhead is known and marked on nautical charts, the likelihood of unplanned interaction with other marine users resulting in a minor consequence is considered to be b-Unlikely.	
Residual Risk	The residual risk associated with this event is **Very Low**

7.8.5 Demonstration of ALARP

As described in **Section 2.4**, leaving the wellhead in-situ (Option D) is the preferred option.

Option A and B (Removal by external cutting; and Internal cutting respectively) would require additional vessel campaigns, introducing additional environmental impacts, including vessel emissions and discharges, further impact to other users and unplanned risks (e.g. introduction of IMS and hydrocarbon spills). These options received a lower preference ranking for technical feasibility, maritime health and safety risks and financial costs.

No concerns were raised by stakeholders regarding the physical presence of the wellhead or potential snag risk. The NPFI confirmed that trawl grounds are not within the vicinity of the operational area (**Section 4.4**). This is supported by 10 years of FishCube data which shows that the distance to the closest area of any fishing effort (low effort with <3 vessels) is approximately 50 km to the south (**Figure 3-7**).

However, fishing effort in the vicinity of the wellhead is likely to be low due to the following factors:

- The main fishing effort of the NPF is within the Gulf of Carpentaria.
- Joseph Bonaparte Gulf is fished primarily for Banana prawns which are found at shallower depths than the wellhead location (approximately 112 m)
- The number of working vessels in the NPF has decreased in recent years
- The vessels operating within the NPF are configured for fishing in shallow water and are therefore unlikely to venture into the deeper waters of the Operational area
- The wellhead will be marked on navigational charts and the NPF is equipped with echo sounders and GPS plotters therefore snag risk is also low.
- The location of the wellhead is approximately 48 km from low and 240 km from moderately fished areas (**Figure 3-7**)

The SME report concluded fishing effort is likely to remain low in the future as larger companies acquire more available boat licenses reducing the capacity for exploratory fishing (AMC, 2021).

Given the low risk of interaction with current and future prawn trawlers, Santos considers the financial costs and health and safety risks disproportionately high in comparison to the negligible benefits to other marine users obtained from removing the wellhead.

With the controls adopted, the assessed residual consequence for this impact is negligible and cannot be reduced further. Additional control measures were considered but rejected since the associated cost / effort was grossly disproportionate to any benefit as detailed in **Section 6.2.3**. Therefore, it is considered that the impact is ALARP.

7.8.6 Acceptability Evaluation

Is the risk ranked between Very Low to Medium?	Yes –interaction with other marine users residual risk ranking is Very Low.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' Offshore *Division Environmental Hazard Identification and Assessment Guideline* (EA-91-IG-00004_5), which considers principles of ecologically sustainable development.

Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – Santos has consulted with relevant decision-making government authorities and no concerns or objections have been raised. DAWE has advised that a Sea Dumping Permit is not required in this instance.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – Feedback from the NPFI during stakeholder consultation confirmed there is no objection to leaving the wellhead in-situ as fishing effort is to the south. Following further consultation with the NPFI, no additional concerns were raised. Santos considers these concerns to have been addressed or will be addressed as per the Activity Notification and Reporting Requirements (**Table 8-4**).
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The potential socio-economic risk of leaving the wellhead in-situ has been assessed as Very Low. With the control measures in place, including charting on nautical charts via the AHO and notification of the well head location to NPF licence holders via the NPF Industry no significant impacts are expected. The wellhead has been in place since 1978 without any reported impact to stakeholders.

8 Implementation Strategy

OPGGS(E)R 2009 Requirements
Regulation 14(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.
Regulation 14(10)
The implementation strategy must comply with the Act, the regulations and any other environmental legislation applying to the activity.

The specific measures and arrangements that will be implemented in the event of an oil pollution emergency are detailed within the OPEP.

Stakeholder engagement is assessed separately for the requirements of the activities. Ongoing stakeholder management strategies are discussed in **Section 4.5**.

8.1 Environmental Management System

OPGGS(E)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.

The Santos 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 Health, Safety and Environment (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
+ Workforce commitments are understood and demonstrated.

This implementation strategy is designed to meet the requirements of the EP to require 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
+ Stakeholder consultation is maintained throughout the activity as appropriate.

8.2 Environmental, Health and Safety (EHS) Policy

Santos' Environmental, Health and Safety Policy (**Appendix A** – Santos EHS Policy

Appendix A – Santos EHS Policy) clearly sets out Santos' strategic environmental objectives and the commitment of the management team to continuous environmental performance improvement. This EP has been prepared in accordance with the fundamentals of this policy. By accepting employment with Santos, each employee and contractor is made aware during the recruitment process that he or 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 below.

To ensure that environmental risks and impacts remain acceptable and ALARP during the activity and for the duration of this EP, hazards will continue to be identified, assessed and controlled as described in Document Management (**Section 8.10**) and Audits and Inspections (**Section 8.11**).

Any new, or proposed amendment to a control measure, EPS or EPO will be managed in accordance with the *Environment Management of Change (MoC) Procedure (EA-91-IQ-10001)* (**Section 8.10.2**).

Oil spill response control measures and environmental performance standards and outcomes are listed in the OPEP.

8.4 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** for planned activities and unplanned events, those relating to oil spill response are listed in the OPEP. These outcomes will be achieved by implementing the identified control measures to the defined environmental performance standards.

Table 8-1: Environmental Performance Outcomes

Reference	Environmental Performance Outcomes
EPO-1	No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed fauna during activities
EPO-2	Reduce impacts to marine fauna from lighting on vessels through limiting lighting to that required by safety and navigational lighting requirements
EPO-3	Reduce impacts to air and water quality from planned discharges and emissions from the activities
EPO-4	Seabed disturbance limited to planned activities and defined locations within the operational area
EPO-5	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-6	No unplanned objects, emissions or discharges to sea or air
EPO-7	No introduction of marine pest species
EPO-8	No loss of containment of hydrocarbon to the marine environment
EPO-9	Do not displace marine turtles from habitat critical to the survival of the species or disrupt biologically important behaviours from occurring within biologically important areas

8.4.1 Control Measures and Performance Standards

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. EPS') are listed in **Table** 8-2. Measurement criteria outlining how compliance with the control measure and the expected environmental performance could be evidenced are also listed.

All Control Measures, Environmental Performance Standards and associated measurement criteria relating to preparedness and response operations are contained within the Frigate-1 Wellhead OPEP (SO-91-BI-20025).

Table 8-2: Control Measures and Environmental Performance Standards for the Proposed Activity (Environment Plan)

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
Procedure for interacting with marine fauna	FRI-CM-001	Vessel(s) comply with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003) which ensures compliance with Part 8 of *Environment Protection and Biodiversity Regulations 2000* which includes controls for minimising the risk of collision with marine fauna.	FRI-CM-001-EPS-01	Conformance checked on receipt of marine fauna sighting datasheets.	FRI-EPO-01
				Completed vessel statement of conformance.	
		Any vessel strikes with cetaceans will be reported in the National Ship Strike Database.	FRI-CM-001-EPS-02	Conformance checked on Santo's receipt of incident report.	
		Santos WA will complete a project kick-off meeting with the vessel contractor. The meeting will outline the key environmental risks and impacts, Vessel Master captain/crew roles and responsibilities and control measures to be complied with for vessel 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.	FRI-CM-001-EPS-03	Kick-off meeting register	
				Incident report receipts and/or induction material/attendance record.	
Constant bridge-watch (visual and radar)	FRI-CM-002	Competent crew shall maintain constant bridge-watch.	FRI-CM-002-EPS-01	Vessel log of times and persons on watch and / or crew training records and completed vessel statement of conformance.	FRI-EPO-01

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		A visual and radar watch will be maintained on the vessel bridge at all times.	FRI-CM-002-EPS-02	Vessel log or times and persons on watch.	
Dropped object prevention procedure	FRI-CM-003	Lifting operations managed in accordance with vessel work instructions or procedures.	FRI-CM-003-EPS-01	Vessel work instructions or procedures. Fate of dropped objects detailed in incident documents.	FRI-EPO-04
		Objects dropped overboard are recovered 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.	FRI-CM-003-EPS-02		
Waste (garbage) management procedure	FRI-CM-004	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 + bin storage.	FRI-CM-004-EPS-01	Completed inspection checklist.	FRI-EPO-04 FRI-EPO-06
		No waste (garbage[2]) discharged to sea, unless the waste is food waste disposed in accordance with MARPOL Annex V.	FRI-CM-004-EPS-02	Completed garbage disposal record book or recording system.	
		Pursuant to MARPOL Annex V, placards displayed to notify personnel of waste disposal restrictions.	FRI-CM-004-EPS-03	Completed inspection checklist.	

[2] Garbage as defined by MARPOL Annex V and excludes waste generated as part of the 'drilling' process as described in these standards.

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
Hazardous Chemical[3] Management Procedures	FRI-CM-005	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. + 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 safety data sheet (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. + Spill response equipment readily available.	FRI-CM-005-EPS-01	Completed inspection checklist.	FRI-EPO-06 FRI-EPO-08
Deck cleaning product selection	FRI-CM-006	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.	FRI-CM-006-EPS-01	SDS and product supplier supplementary data as required. Completed inspection checklist.	FRI-EPO-03 FRI-EPO-06

[3] Chemical in both liquid and solid form

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
General chemical management procedures	FRI-CM-007	SDS[4] available for all chemicals to aid in the process of hazard identification and chemical management.	FRI-CM-007-EPS-01	Completed inspection checklist.	FRI-EPO-04
		Chemicals managed in accordance with SDS in relation to safe handling and storage, spill response and emergency procedures, and disposal considerations.	FRI-CM-007-EPS-02	Completed inspection checklist.	
Maritime Dangerous Goods Code	FRI-CM-008	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDGC) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	FRI-CM-008-EPS-01	Completed Multimodal Dangerous Goods Form.	FRI-EPO-08
				Completed inspection checklist.	
Vessel Emergency Management Plan/SOPEP	FRI-CM-009	Vessel has and implements a vessel emergency management plan or SOPEP pursuant to MARPOL Annex I.	FRI-CM-009-EPS-01	Approved vessel emergency management plan or SOPEP	FRI-EPO-08
		Vessel emergency management plan or SOPEP spill response exercises conducted at least every three months to ensure personnel are prepared.	FRI-CM-009-EPS-02	Spill exercise records or evidence of a spill exercise in an operational report.	
ROV inspection and maintenance procedures	FRI-CM-010	Preventative maintenance on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to sea.	FRI-CM-010-EPS-01	Maintenance records or evidence of maintenance in operational reports.	FRI-EPO-04 FRI-EPO-06

[4] Safety data sheet or material safety data sheet.

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		ROV pre-deployment inspection completed to reduce the risk of hydraulic fluid releases to sea.	FRI-CM-010-EPS-02	Completed pre-deployment inspection checklist.	FRI-EPO-08
Maritime notices	FRI-CM-011	Information provided to either AMSA, Department of Defence, AHO and/or nearest port authority on MODU arrival and departure so that the maritime industry is aware of petroleum activities.	FRI-CM-011-EPS-01	Transmittal records demonstrate notification of activity prior to the activity commencing.	FRI-EPO-05
Accepted OPEP	FRI-CM-012	In the event of an oil spill to sea, the Santos OPEP requirements implemented to mitigate environmental impacts.	FRI-CM-012-EPS-01	Completed incident documentation.	FRI-EPO-08
Waste incineration	FRI-CM-013	Waste incinerator used in accordance with operating manual and in accordance with relevant MARPOL and Marine Orders.	FRI-CM-013-EPS-01	Completed waste record book or recording system.	FRI-EPO-03 FRI-EPO-06
		As per MARPOL 73/78 Annex VI, incinerators shall be approved by the Administration and the manufacturer's operating manual shall be on-board and followed.	FRI-CM-013-EPS-02	Completed waste record book or recording system.	
Fuel oil quality	FRI-CM-014	MARPOL-compliant (Marine Order 97) fuel oil (diesel) will be used during the activity.	FRI-CM-014-EPS-01	Fuel bunkering records and/or relevant purchase records.	FRI-EPO-03 FRI-EPO-06
		Intermediate fuel oil or heavy fuel oil will not be used during the activity.	FRI-CM-014-EPS-02		
Air pollution prevention certification	FRI-CM-015	Pursuant to MARPOL Annex VI, the MODU and vessels will maintain a current International Air Pollution Prevention Certificate, which certifies	FRI-CM-015-EPS-01	Current international air pollution prevention certificate.	FRI-EPO-03 FRI-EPO-06

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		that measures to prevent ODS emissions, and reduce NOx, Sox, and incineration emissions during the activity are in place.			
Santos stakeholder consultation strategy	FRI-CM-016	Santos will notify all relevant stakeholders listed, or as revised, in **Section 4** of relevant activity details prior to commencement, including activity timing, vessel movements, proposed cessation date and vessel details.	FRI-CM-016-EPS-01	Santos correspondence to relevant stakeholders.	FRI-EPO-05
		All correspondence with external stakeholders is recorded.	FRI-CM-016-EPS-02	Saved consultation records.	
		Santos' Consultation Coordinator is contactable before, during and after completion of the planned activity to ensure stakeholder feedback is evaluated and considered during the operational activity phases.	FRI-CM-016-EPS-03	Consultation Coordinator contact details provided to relevant persons in all correspondence.	
		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.	FRI-CM-016-EPS-04	Incident records show nil incidents of complaints of restrictions to the commercial fishing access to the operational area and show nil incidents of vessel safety being compromised by concurrent operations.	
Compliance with the Biosecurity Act 2015	FRI-CM-017	Vessels are managed to low risk in accordance with the Santos Invasive Marine Species Management Plan (IMSMP) (EA-00-RI-10172) prior to movement or transit into or within the	FRI-CM-017-EPS-01	Completed vessel check report demonstrating vessel(s) are 'low risk'	FRI-EPO-07

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		invasive marine species management zone, which requires: + assessment of applicable vessels using the IMSMP risk assessment + the management of immersible equipment to low risk.			
		Vessel(s) receive entry clearance from DAWE (Seaports) as necessary (or as applicable to their location and movements).	FRI-CM-017-EPS-02	Records show a complete Questionnaire for Biosecurity Exemptions for Biosecurity Control Determination issued to Seaports at least one month in advance where practicable	
No Anchoring	FRI-CM-018	No planned anchoring of vessel(s) within the operational area.	FRI-CM-018-EPS-01	Daily Vessel Reports.	FRI-EPO-04
Anti-foulant system	FRI-CM-019	Vessel anti-foulant system maintained in compliance with *International Convention on the Control of Harmful Anti-fouling Systems on Ships.*	FRI-CM-019-EPS-01	Current International Anti-Fouling System Certificate.	FRI-EPO-07
Sewage treatment system	FRI-CM-020	Pursuant to MARPOL Annex VI, MODU and support vessel(s) have a current International Sewage Pollution Prevention Certificate which certifies that required measures to reduce impacts from sewage disposal are in place (as applicable to vessel class).	FRI-CM-020-EPS-01	Current International Sewage Pollution Prevention Certificate.	FRI-EPO-03 FRI-EPO-06
		Sewage discharged in accordance with MARPOL Annex IV.	FRI-CM-020-EPS-02	Completed inspection checklist.	

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	FRI-CM-020-EPS-03	Maintenance records.	
Oily water treatment system	FRI-CM-021	Oily mixtures (bilge water) only discharged to sea in accordance with MARPOL Annex I.	FRI-CM-021-EPS-01	Completed inspection checklist.	FRI-EPO-03 FRI-EPO-06
				Oil record book or log.	
		Preventative maintenance on oil filtering equipment completed as scheduled.	FRI-CM-021-EPS-02	Maintenance records or evidence of maintenance in operational reports.	
		Pursuant to MARPOL Annex I, a MODU and support vessel(s) will have an International Oil Pollution Prevention Certificate which certifies that required measures to reduce impacts of planned oil discharges are in place.	FRI-CM-021-EPS-03	Current International Oil Pollution Prevention Certificate.	
Lighting will be used as required for safe work conditions and navigational purposes.	FRI-CM-022	Vessel navigation lighting and equipment is compliant with COLREGS/Marine Orders 30: Prevention of Collisions, and with Marine Orders 21: Safety of Navigation and Emergency Procedures.	FRI-CM-022-EPS-01	Vessel certification confirms compliance with applicable regulations.	FRI-EPO-02
		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 will be maintained.	FRI-CM-022-EPS-02	Audit report	

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
No fishing from vessel	FRI-CM-023	Personnel are prohibited from recreational fishing activities vessel(s).	FRI-CM-023-EPS-01	Induction records confirm no fishing prohibition is communicated to all personnel.	FRI-EPO-05
Seafarer certification	FRI-CM-024	Vessel crew are trained and competent, in accordance with Flag State regulations, to navigate vessels.	FRI-CM-024-EPS-01	Training records.	FRI-EPO-05
Marine assurance standard	FRI-CM-025	Vessels selected and on-boarded in accordance with the *Offshore Marine Assurance Procedure* (SO-91-ZH-10001) to ensure contracted vessels are operated, maintained and manned in accordance with industry standards (for example, Marine Orders) and regulatory requirements (this EP) and the relevant Santos procedures mentioned in this EP.	FRI-CM-025-EPS-01	Completed documentation in accordance with procedure.	FRI-EPO-01 FRI-EPO-02 FRI-EPO-03 FRI-EPO-04 FRI-EPO-05 FRI-EPO-06 FRI-EPO-07 FRI-EPO-08
Vessel Planned Maintenance System (PMS) to maintain DP, engines and machinery	FRI-CM-026	Documented maintenance program is in place for equipment on vessels that provides a status on the maintenance of equipment.	FRI-CM-026-EPS-01	Vessel daily/weekly records IMCA Common Marine Inspection Document (CMID) Vessel contractor written verification demonstrates compliance with PMS. CMMS records	FRI-EPO-03 FRI-EPO-04 FRI-EPO-05 FRI-EPO-06
		Combustion engines are maintained in accordance with vessel PMS.	FRI-CM-026-EPS-02		

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
Vessel activities environmental awareness and training (inductions) covers protected marine fauna sighting procedure	FRI-CM-027	Marine fauna (being whales, dolphins, turtles, dugongs and whale sharks) sightings shall be recorded on Santos WA Marine Fauna Sighting Datasheets and submitted to Santos WA.	FRI-CM-027-EPS-01	Record of sightings; stored in Santos WA's Marine Fauna Sighting Database.	FRI-EPO-01
Ozone Depleting Substance (ODS) handling procedure	FRI-CM-028	Ozone-depleting substances (ODS) managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air.	FRI-CM-028-EPS-01	Completed ODS record book or recording system.	FRI-EPO-03 FRI-EPO-06
Compliance with Marine Order 97 Marine Pollution Prevention – Air Pollution (Division 7)	FRI-CM-029	Fuel use will be measured, recorded and reported.	FRI-CM-029-EPS-01	Bunker Note	FRI-EPO-03 FRI-EPO-06
		Vessels will use low sulphur fuel in accordance with Marine Order 97: Marine Pollution Prevent – Air Pollution (Division 7).	FRI-CM-029-EPS-02	Bunker Note	
Navigational Charting of Property	FRI-CM-030	Wellhead is charted on AHO nautical charts so that marine users are aware of its location, and can therefore avoid the wellhead if required thus reducing snag risk.	FRI-CM-030-EPS-01	Santos correspondence with AHO	FRI-EPO-05
		Marine users will not be excluded from the area.	FRI-CM-030-EPS-02	Consultation records	
Notification to AHO, NPFI, and NPF of wellhead location once confirmed	FRI-CM-031	AHO, NPFI, and NPF are made aware of the wellhead location once confirmed by the survey, so they can therefore avoid the wellhead if required thus reducing snag risk.	FRI-CM-031-EPS-01	Santos stakeholder correspondence with AHO, NPFI, and NPF once wellhead location is confirmed	FRI-EPO-05
No fuel bunkering	FRI-CM-032	Survey vessel will not refuel within the operational area	FRI-CM-032-EPS-01	Vessel logs	FRI-EPO-08

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
Recovery of all deployed equipment	FRI-CM-033	All equipment deployed during any activity will be recovered at the end of each drilling campaign.	FRI-CM-033-EPS-01	Survey records	FRI-EPO-04
Dropped object recovery	FRI-CM-034	Objects dropped overboard are recovered 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.	FRI-CM-034-EPS-01	Fate of dropped objects detailed in incident documents.	FRI-EPO-04

8.5 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.

While Santos' Chief Executive Officer has the overall accountability for the implementation of Santos' WA management system and Environment, Health and Safety Policy, Santos' Manager – Offshore Drilling and Completions, is accountable for ensuring implementation, management and review of this EP.

The effective implementation of this EP requires collaboration and cooperation among Santos and its contractors. The chain of command and accountabilities of personnel in relation to the implementation, management and review of the EP is outlined in **Table 8-3**. It is also outlined in the OPEP for oil spill response.

Table 8-3: Chain of Command, Key Leadership Roles and Responsibilities

Role	Responsibilities
Asset Retirement Manager	+ 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. + Ensures the annual HSE improvement plan is completed.
Company Site Representative	Has responsibility for: + implementing EP commitments + ensuring personnel competency + ensuring compliance with procedures and work instructions + being site focal point for onshore/offshore communications + reporting all incidents and potential hazards + leading site-based incident response + implementing 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

Role	Responsibilities
	+ 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 vessel to all regulatory and class requirements + maintaining their vessel in a state of preparedness for emergency response + reporting environmental incidents to PIC and ensuring follow-up actions are performed.
Santos HSE Manager	Has overall responsibility for: + ensuring incident preparedness and response arrangements meet Santos and regulatory requirements + approving the OPEP + providing ongoing resources to maintain compliance with the OPEP and other Santos incident response requirements.
Santos HSE Team Leader	Has overall responsibility for: + Provide advice to ensure compliance with the Santos Environment Health and Safety Policy and this EP + Providing operational HSE oversight and advice + Facilitating the development and implementation of environmental management of change documents + Ensuring EP-required reporting is accurate and timely + Ensuring environmental incidents are appropriately investigated + Ensuring that appropriate enforcement mechanisms to prevent breaches of this EP are implemented + Providing advice to ensure environmental incident reporting meets regulatory requirements (as outlined in the EP) and the Santos internal incident reporting and investigation procedure.
Senior Stakeholder Adviser	+ Ensures relevant stakeholders are identified throughout the life of the EP + Maintains a stakeholder contact and information database + Maintains a Stakeholder Notification Log specific to the EP + Maintains records of all stakeholder correspondence specific to the EP + Prior to commencement of the activity and on advice of HSE Team Lead, provides a notification to all relevant stakeholders listed, or as revised, in **Table** 8-4. The notification will include information on activity timing, vessel movements and vessel details + On advice of HSE Team Lead, provide cessation notifications to relevant stakeholders identified in **Table 8-4** + Is available before, during and after the activity to ensure opportunities for stakeholders to provide feedback are available + Prepares and distributes quarterly consultation updates to relevant stakeholders
Santos HSE Coordinator(s)	+ Ensures the EP is managed and reviewed: monitors conformance with EPOs and EPSs, and the implementation strategy in the EP.

Role	Responsibilities
	+ 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. + Ensures subcontractors are communicated the EP requirements.
HSE Team Lead – Security and Emergency Response	Has overall responsibility for: + overarching incident and crisis management responsibility + managing the Crisis Management Team and IMT personnel training program + reviewing and assessing competencies for Crisis Management Team, IMT, and field-based Incident Response Team members + managing the Duty roster system for Crisis Management Team and IMT personnel + managing the maintenance and readiness of incident response resources and equipment.
Senior Oil Spill Response Advisor	Has 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 third-parties + developing and defining objectives, strategies and tactical plans for response preparedness defined in this OPEP and IRP + undertaking assurance activities on arrangements outlined within the OPEP.

8.6 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.

8.6.1 Activity Inductions

All offshore personnel on the vessel will complete an induction that will include a component addressing their EP responsibilities. Induction attendance records for all personnel will be maintained. Inductions will include information on:

- Santos' Environment, Health and Safety Policy
- Regulatory regime (NOPSEMA regulations)
- EPBC Act Policy Statement 2.1 and how it applies to the activity
- operating environment (e.g., nearby protected marine areas, sensitive environmental periods)
- interaction with other marine users (i.e., topic to reinforce the importance of marine communications regarding any potential interactions with active commercial fishing)
- activities with highest risk (e.g., invasive marine species and hydrocarbon releases)
- EP commitments (e.g., **Table 8-1** and **Table 8-2**)
- incident reporting and notifications
- regulatory compliance reporting
- management of change process for changes to EP activities
- oil pollution emergency response (e.g., OPEP requirements).

8.6.2 Training and Competency

All members of the workforce on the vessel will complete relevant training and hold qualifications and certificates for their role.

Santos and its contractors are individually responsible for ensuring that their personnel are qualified and trained. The systems, procedures and responsible persons will vary and will be managed through the use of 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, facility acceptance testing, inductions, crew change, and operational inspections and audits.

8.6.3 Workforce Involvement and 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 that all personnel attend daily toolbox or 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, dropped objects).

8.7 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.

Santos will implement the activity OPEP (SO-91-BI-20025) in the event of a hydrocarbon spill. The OPEP details how Santos will prepare and respond to a spill event and meets the requirement of the OPGGS(E)R 2009.

8.8 Incident Reporting, Investigation and Follow-up

OPGGSR 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 performance for the activity; and (b) 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.

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 will be documented in the incident management systems as appropriate. HSE incidents will be investigated using root cause analysis.

Environmental recordable and reportable incidents will be reported to NOPSEMA as required, in accordance with **Table 8-4**. The incident reporting requirements will be provided to all crew on board the facilities and support vessels with special attention to the reporting time frames to provide for accurate and timely reporting.

For the purposes of this activity, in accordance with OPGGS(E) Regulations:

+ a recordable incident, for an activity, means a breach of an EPO or EPS, in the EP that applies to the activity, that is not a reportable incident
+ a reportable incident, for an activity, means an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage.

For the purposes of this EP, a reportable incident is an incident that is assessed to have an environmental consequence of moderate or higher in accordance with the Santos environmental impact and risk assessment process outlined in **Section 5**. Of the planned and unplanned events assessed within this EP, the following were identified to have a potential consequence level of Moderate or higher if the event were to occur and would therefore be a reportable incident:

+ Introduction of invasive marine species (Moderate).

8.9 Reporting and Notifications

OPGGSR 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 performance for the activity; and (b) provide that the interval between reports will not be more than 1 year.
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.

8.9.1 Notification and Compliance Reporting

Regulatory, other notification and compliance reporting requirements are summarised in **Table 8-4**.

Table 8-4: Activity Notification and Reporting Requirements

Initiation	Required Information	Timing	Type	Recipient
Before the Activity				
AHO Notification – as requested by Defence and AMSA during consultation.	Pre-start notification with details relevant to the activity. The AHO will promulgate the appropriate Notice to Mariners, which will ensure other vessels receive information about activities.	At least four weeks before the activity commences where practicable.	Written	AHO at datacentre@hydro.gov.au
DMIRS requirement requested during consultation	Pre-start notification. Notification of proposed start and end dates for the activity.	At least four weeks before the activity commences where practicable	Written	DMIRS petroleum.environment@dmirs.wa.gov.au
DBCA requirement requested during consultation	Pre-start notification. Notification of proposed start and end dates for the activity.	At least four weeks before the activity commences where practicable	Written	DBCA EMBAdmin@dbca.wa.gov.au
DAWE (Fisheries) requirement requested during consultation	Pre-start notification.	At least two weeks before the activity commences where practicable	Written	DAWE Petroleum&Fisheries@agriculture.gov.au
DAWE – Biosecurity (vessels, aircraft, and personnel) - as requested by DAWE during consultation	In addition to completing an IMS Risk Assessment in accordance with FRI-CM 18, Santos will: + pursuant to the *Biosecurity Act 2015* and the *Biosecurity (Exposed Conveyances – Exceptions from Biosecurity Control) Determination 2016*, undertake a vessel biosecurity risk and be assessed as 'low' by the Commonwealth Department of Agriculture prior to interacting with domestic support vessels and aircraft	At least one month prior to the commencement of the activity MARS reporting at least 12 hours prior to arrival.	Written	DAWE: seaports@agriculture.gov.au

Initiation	Required Information	Timing	Type	Recipient
	+ undertake pre-arrival approval for the vessels (where applicable) using the Maritime Arrivals Reporting System (MARS) to meet the DAWE biosecurity reporting obligations.			
OPGGS(E) Regulation 29 & 30 – Notifications NOPSEMA must be notified that the activity is to commence.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form prior to each campaign.	At least ten days before the activity commences.	Written	NOPSEMA website
AMSA JRCC Notification – as requested by AMSA during consultation.	Notification to AMSA's JRCC of proposed start and end dates and any other relevant information for the Notice to Mariners to be issued. AMSA's JRCC requires the: + vessel details (including name, callsign and Maritime Mobile Service Identity) + satellite communications details (including INMARSAT-C and satellite telephone numbers) + area of operation + requested clearance from other vessels + any other information that may contribute to safety at sea + when operations start and end.	24 to 48 hrs prior to activity commencement.	Written	AMSA's JRCC rccaus@amsa.gov.au
During the Activity				

Initiation	Required Information	Timing	Type	Recipient
OPGGS(E) Regulation 26B – Recordable Incidents NOPSEMA must be notified of a breach of an EPO or EPS, in the environment plan 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
OPGGS(E) 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.	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 any adverse environmental impacts of the reportable incident + the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	As soon as practicable, and in any case not later than two hours after the first occurrence of a reportable incident, or 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 National Offshore Petroleum Titles Administrator
	A written report must contain: + all material facts and circumstances concerning the reportable incident known	Must be submitted as soon as practicable, and in any case not later than three days after the first occurrence of the	Written	NOPSEMA National Offshore Petroleum Titles Administrator

Initiation	Required Information	Timing	Type	Recipient
	or by reasonable search or enquiry could be found out + any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident + the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident + the action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future. Consider reporting using NOPSEMA's Report of an Accident, Dangerous Occurrence or Environmental Incident form.	reportable incident unless NOPSEMA specifies otherwise. Same report to be submitted to within seven days after giving the written report to NOPSEMA.		
OPGGS(E) 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 the completion of the activity.	Written	NOPSEMA
AMSA Reporting	Any changes to the intended operations.	As soon as practicable.	Written	AMSA's JRCC rccaus@amsa.gov.au

Initiation	Required Information	Timing	Type	Recipient
Under the MoU between Santos and AMSA and as requested by AMSA during consultation	Titleholder agrees to notify AMSA of any marine pollution incident[5].	Within two hours of incident.	Oral	AMSA
	POLREP and SITREP available online (refer OPEP).	POLREP as requested by AMSA following verbal notification. SITREP as requested by AMSA within 24 hours of request.	Written	AMSA
AHO and JRCC Notification – as requested by Defence and AMSA during consultation.	Any changes to the intended operations	As soon as practicable.	Written	AHO at datacentre@hydro.gov.au
Santos' commitment to include activity in Quarterly Consultation Update until activity ends.	The Quarterly Consultation Update will include the activity. This consultation will cease once the activity has ended.	Quarterly.	Written	The Quarterly Consultation Update is circulated to a broad group of Santos stakeholders, including many of the stakeholders identified in **Table 4-2**.
DAWE Reporting + Any harm or mortality to EPBC Act-listed threatened marine fauna. + Marine Fauna Sighting Data.	Notification of any harm or mortality to an EPBC listed species of marine fauna whether attributable to the activity or not.	Within seven days to EPBC.permits@environment.gov.au	Written	DAWE
	Marine fauna sighting data recorded in the marine fauna sighting database.	As soon as practicable, in any case no later than three months of the end of the activity.	Written	DAWE

[5] For clarity and consistency across Santos regulatory reporting requirements Santos will meet the requirement of reporting marine oil pollution by reporting oil spills assessed to have an environmental consequence of moderate or higher in accordance with Santos environmental impact and risk assessment process outlined in **Section 5**.

Initiation	Required Information	Timing	Type	Recipient
Any harm or mortality to fauna listed as threatened under the *WA Biodiversity Conservation Act 2016*.	Notification of any harm or mortality to fauna listed as a threatened species under the *WA Biodiversity Conservation Act 2016* as a result of Santos activities.	A fauna report will be submitted to DBCA within seven days to fauna@dbca.wa.gov.au.	Written	DBCA fauna@dbca.wa.gov.au
Australian Marine Mammal Centre Reporting Any ship strike incident with cetaceans will also be reported to the National Ship Strike database.	Ship strike report provided to the Australian Marine Mammal Centre: https://data.marinemammals.gov.au/report/shipstrike.	As soon as practicable.	Written	DAWE https://data.marinemammals.gov.au/report/shipstrike
Department of Biodiversity, Conservation and Attractions Reporting Impacts to marine mammals or turtles in reserves.	Notification of any incidence of entanglement, boat collisions and stranding of marine mammals in the reserves and any incident of turtle mortality and incidents of entanglement in the reserves.	Within 48 hours.	Written	DBCA
Department of Transport Reporting All actual or impending MOP incidents that are in, or may impact, State waters resulting from an offshore petroleum activity.	Notification of actual or impending spillage, release or escape of oil or an oily mixture that is capable of causing loss of life, injury to a person or damage to the health of a person, property or the environment	Within two hours.	Oral	DoT
	WA DoT POLREP and SITREP available online (refer OPEP).	As requested by DoT following verbal notification.	Written	DoT

Initiation	Required Information	Timing	Type	Recipient
End of Activity				
OPGGS(E) Regulation 29 – Notifications NOPSEMA must be notified that the activity is completed.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form for both notifications.	Within ten days after cessation of each campaign.	Written	NOPSEMA
AHO AMSA JRCC DAWE DBCA DMIRS DNP	Activity Cessation Notification.	Within ten days after cessation of each campaign.	Written	AHO: datacentre@hydro.gov.au AMSA's JRCC: rccaus@amsa.gov.au DAWE: Petroleum&Fisheries@agriculture.gov.au DBCA: EMBAdmin@dbca.wa.gov.au DMIRS: petroleum.environment@dmirs.wa.gov.au PPA: shipping@pilbaraports.com.au DNP: marineparks@awe.gov.au
Commercial fishers notification – requested during consultation	Activity Cessation Notification provided to relevant commercial fishing stakeholders, as agreed with WAFIC or relevant industry body	Within ten days after cessation of each campaign.	Written	WAFIC oilandgas@wafic.org.au
OPGGS(E) Regulation 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.	An environmental performance report will be submitted within three months of completion of each campaign	Written	NOPSEMA

Initiation	Required Information	Timing	Type	Recipient
OPGGS(E) Regulation 25A EP 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
Consultation requirements	Santos will include the activity in Quarterly Consultation Update until activity ends.	Quarterly	Written	The Quarterly Consultation Update is circulated to a broad group of Santos stakeholders, including many of the stakeholders identified in **Section 4.**

8.9.2 Monitoring and Recording Emissions and Discharges

OPGGS(E)R 2009 Requirements
Regulation 10A(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.

Vessel-based discharges to the marine environment, associated with this activity will be recorded and controlled in accordance with requirements under relevant marine orders.

Santos and vessel contractors will maintain records so that emissions and discharges can be determined or estimated. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request. Santos' records discharges or emissions (where practicable), to the environment as described in **Table 8-5**.

Table 8-5: Monitoring Methods for Emissions and Discharges

Discharge/emission	Parameter	Quantitative Record	Recording frequency
Chemicals (discharged to marine environment as per **Section 6.7**)	Volume	Chemical Risk Assessment Volumes used will be estimated based on known inventories	For every chemical use with a fate to the marine environment
Oily water	Volume and location	Oil Record Book* or equivalent report	For every discharge
Garbage (including food scraps)	Volume and location	Garbage Record Book*	For every discharge
Sewage	Volume and location	Sewage Record Book*	For every discharge
Ballast water	Volume and location	Ballast water record book or log**	For every discharge
Unplanned discharge of solid objects	Volume	Incident report	For every discharge
Unplanned discharge of hazardous liquids	Volume	Incident report	For every discharge
Unplanned hydrocarbon release	Volume	Incident report	For every discharge

*Maintained as per vessel class in accordance with relevant Marine Orders.

**Maintained as per Australian Ballast Water Management Requirements 2017.

8.10 Document Management

8.10.1 Information Management and Document Control

This EP and OPEP, as well as approved management of change documents, are controlled documents; and current versions will be available on Santos' intranet. Santos contractors are also required to maintain current versions of these documents.

Environmental performance outcomes and standards will be measured based on the measurement criteria listed in **Table 8-2**. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request.

8.10.2 Management of Change

The MoC process provides a systematic approach to initiate, assess, document, approve, communicate and implement changes to EPs and OPEPs.

The MoC process considers Regulations 7, 8 and 17 of the OPGGS(E)R 2009 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 about the MoC process is provided in **Figure 8-1**.

The MoC procedure also allows for the assessment of new information that may become available after EP acceptance, such as new management plans for AMPs, new recovery plans or conservation advice for species, and changes to the EPBC Protected Matters Search results. If a review identifies new information, this is treated as a "Change that has an impact on EP", and the MoC process is followed accordingly.

The MoC procedure also includes an assurance check process which applies the MoC process to long term (usually five-year multi-activity EPs) EPs that may have lengthy periods of time between use or acceptance and activity commencement. Where there is an identified change from the accepted EP content, a check is done to test the 'significance' of the change, to determine whether it can be accommodated which may then result in an MoC as described above.

Accepted MoCs become part of the in-force EP or OPEP, are tracked on a register and are made available on Santos' intranet. Where appropriate, the EP compliance register will be updated so that CM or EPS changes are communicated to the workforce and implemented. Any MoC will be distributed to the management people identified in **Table 8-3** (excluding the Chief Executive Officer and Directors), and the most relevant management position will ensure the MoC is communicated and implemented, which may include crew meetings, briefings or communications as appropriate for the change.

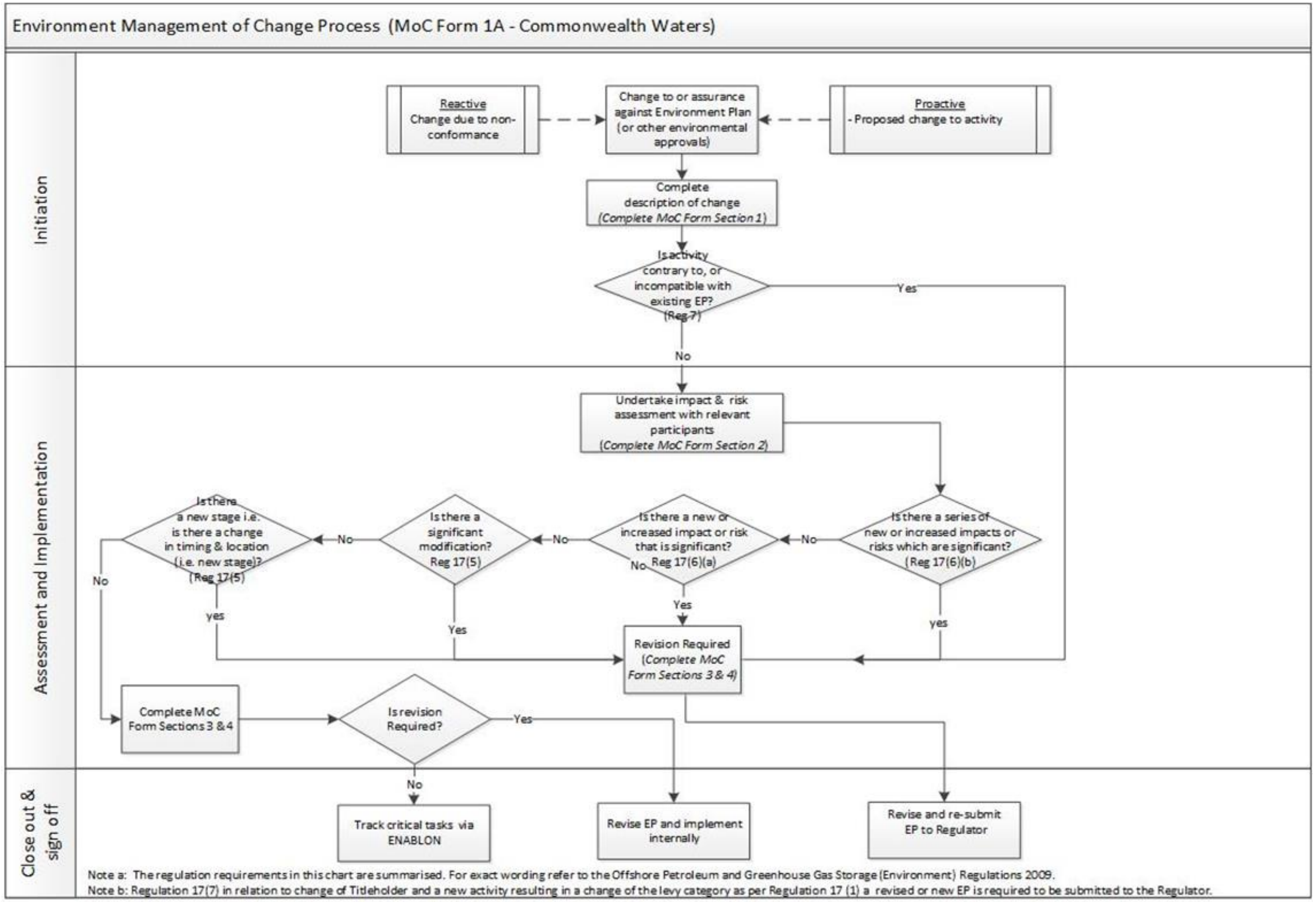


Figure 8-1: Environment Management of Change Process

8.10.3 Reviews

This EP has assessed impacts and risk 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 over the validity of this EP things may change, such as:

+ legislation
+ businesses conditions, activities, systems, processes and people
+ industry practices
+ science and technology
+ societal and stakeholder expectations.

To ensure Santos maintains up-to-date knowledge of the industry, legislation and conservation advice, the following tasks are undertaken:

+ Maintain membership of APPEA (Australian Petroleum Production & Exploration Association), which provides a mechanism for communicating potential changes in legislation, industry practice and other issues that may affect EP implementation to relevant personnel in Santos.
+ Undertake annual spill response exercises to check spill response arrangements and capability are adequate.
+ Identify stakeholders prior to the activity commencing under this EP via the mechanisms outlined in **Section 4**.
+ Review the Values and Sensitivities within the EMBA which includes completing a new EPBC Protected Matters Search, reviewing Appendix D – EPBC Protected Matters Search Tool Results against relevant legislation to capture and review any relevant updates and incorporate as required, and reviewing any recently known published relevant scientific papers.
+ Subscribe to various regulator updates.
+ Have regular liaison meetings with Regulators.

Through maintenance of up-to-date knowledge, these changes are identified. If the changes have an impact on the activity or risks described and assessed in this EP, the EP will be reviewed, and any changes required documented in accordance with Santos' MoC procedure (**Section 8.10.2**).

8.11 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.

8.11.1 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, personnel availability or high audit demand during certain periods (for example, regulatory audits, contractor audits). Santos will determine if a vessel audit is required following contract award and vessel confirmation.

Audits will be undertaken in a manner consistent with Santos' Management Standard for Assurance SMS MS15.

Audit scope typically includes a selection of CMs and EPSs and EPOs. However, audits may also include other parts of the EP.

Audits findings may include opportunities for improvement and non-conformances. Audit non-conformances are managed as described in **Section 8.11.3**.

8.11.2 Inspections

During an activity, HSE inspections (desktop or vessel based) will be conducted at least once during the activity to identify hazards, incidents and EP non-conformances. These inspections will also check compliance against all the EPOs and EPSs of this EP (**Table 8-2**) and inform end of activity reporting (**Table 8-4**). Any in field opportunities for improvement or corrective actions will be discussed during the inspection with the Vessel Master.

8.11.3 Non-conformance Management

EP non-conformances will be addressed and resolved by a systematic corrective action process as outlined in Santos' Management Standard for Assurance (MS15) and the Assurance Procedure (ST01). Non-conformances arising from audits and inspections will be entered into Santos' incident and action tracking management system (i.e., 'HSE Toolbox). 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.

8.11.4 Continuous Improvement

For this EP, continuous improvement will be driven by the list below, and may result in a review of the EP with changes applied in accordance with **Section 8.10.2**:

+ Improvements identified from the review of business-level HSE key performance indicators.
+ Actions arising from Santos and departmental 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 and MoC documents.
- 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 the MoC process to ensure any potential changes to this EP, or OPEP, are managed in accordance with the OPGGS(E)R 2009 and in a controlled manner.

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Appendix A – Santos EHS Policy

Appendix A – Santos EHS Policy

Environment, Health & Safety

Santos

Policy

Our Commitment

Santos is committed to being the safest gas company wherever we have a presence 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
2. Comply with all relevant environmental, health and safety laws and continuously improve our management systems
3. Include environmental, health and safety considerations in business planning, decision making and asset management processes
4. Identify, control and monitor risks that have the potential for harm to people and the environment, so far as is reasonably practicable
5. Report, investigate and learn from our incidents
6. Consult and communicate with, and promote the participation of all workers to maintain a strong environment, health and safety culture
7. Empower our people, regardless of position, to "Stop the Job" when they feel it necessary to prevent harm to themselves, others or the environment
8. Work proactively and collaboratively with our stakeholders and the communities in which we operate
9. Set, measure, review and monitor objectives and targets to demonstrate proactive processes are in place to reduce the risk of harm to people and the environment
10. 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 and VP Legal, Risk and Governance		
Approved by:	The Board	Version:	3

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Appendix B – Legislative Requirements Relevant to the Activity

Santos

Appendix B – Legislative Requirements Relevant to the Activity

Commonwealth Legislation

Requirement 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.	No	Commonwealth – Department of Agriculture, Water and the Environment (DAWE)	No activity being undertaken on land or near shore. No known sites of Aboriginal Heritage Significance within the operational area or EMBA.	**NA**
Australian Ballast Water Management Requirements, Version 8	Australian Ballast Water Management Requirements outline the mandatory ballast water management requirements to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ballast water from international vessels. These requirements are enforceable under the Biosecurity Act 2015.	Yes	Commonwealth – Department of Agriculture, Water and the Environment (DAWE)	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of IMS and potential ballast water exchange.	**Section 7.6** – Introduction of invasive marine species
Australian Heritage Council Act 2003	This Act identifies areas of heritage value listed on the Register of the	No	Australian Heritage Council	There are no heritage places found on the National Heritage	N/A

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	National Estate and sets up the Australian Heritage Council and its functions.			List, within the EMBA that could potentially be impacted by unplanned events.	
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 Order in Commonwealth waters. This Act 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 responsible for the	Yes	AMSA	This Act applies to the use of any vessel associated with operations and is relevant to the activity in regard to the unplanned pollution from ships.	**Section 7.2** – Marine Diesel Oil (MDO) **Section 7.3** – Minor hydrocarbon release

Requirement Legislation	Summary	Relevant to activity ?	Administering Authority	Relevant aspects of the activity	EP Section
	Australian National Plan for Maritime Environmental Emergencies.				
Aquatic Resources Management Act 2016	This Act will be the primary legislation used to manage fishing, aquaculture, pearling and aquatic resources in Western Australia. The Act was scheduled for commencement on 1 January 2019; however, this has been deferred while an amendment to the Act is progressed.	Yes	Department of Primary Industries and Regional Development (DPIRD)	Vessel movements have the potential to introduce IMS (IMS). This Act was considered during development of the Santos IMS Management Zone (IMSMZ) and *IMS Management Plan* (EA-00-RI-10172).	**Section 7.6** – Introduction of invasive marine species
Marine Orders	Marine Orders (MO) are subordinate rules made pursuant to the Navigation Act 2012 and Protection of the Sea (Prevention of Pollution from Ships) Act 1983 affecting the maritime industry. They are a means of implementing Australia's international maritime obligations by giving effect to international conventions in Australian law.	Yes	AMSA	Vessel movements, safety, discharges and emissions.	**Section 6** and **7** – planned and unplanned events
Maritime Powers Act 2013	Protects the heritage values of shipwrecks and relics for shipwrecks over 75 years. It is	No	The Department of Immigration and Border Protection	No planned interaction or interference. Potential impact could be due to a	N/A

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	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.			hydrocarbon spill, but the credible spill is to surface, and therefore shipwrecks are highly unlikely to be impacted.	
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	Yes	Commonwealth – Department of Agriculture, Water and the Environment (DAWE)	This Act applies to all internationally sources vessels operating in Australian Waters which could have the potential for the introduction of IMS and potential ballast water exchange.	**Section 7.6** – Introduction of invasive marine species

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	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.				
Corporations Act 2001	This Act is the principal legislation regulating matters of Australian companies, such as the formation and operation of companies, duties of officers, takeovers and fundraising.	Yes	Commonwealth – Australian Securities and Investments Commission	The titleholder has provided ACN details within the meaning of the Act	**Section 1.4**
Environment Protection and Biodiversity Conservation Act 1999 Environment Protection and Biodiversity Conservation Amendment Regulations 2006	The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) is the sole assessor for offshore petroleum activities in Commonwealth water (as of 28 February 2014). Under the new arrangements, environmental protection will be met through NOPSEMA's decision-making processes. This Act is the Australian Government's key piece of	Yes	Commonwealth – Department of Agriculture, Water and the Environment (DAWE)	This Act applies to all aspects of the activity that have the potential to impact MNES. Appropriate environmental approvals will be sought from NOPSEMA for all operations (this EP) which outlines compliance with the relevant regulations and plans under the Act. Where activities have existing approvals under the Act, these will continue to apply.	**Section 6.1** – Physical presence (Wellhead in-situ) **Section 6.4** – Light emissions **Section 6.5** - Noise emissions **Section 6.7** – Planned Operational Discharges **Section 7.2** – Hydrocarbon Spill (MDO) **Section 7.7** – Marine Fauna Interactions

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	environmental legislation and aims to: + Protect MNES + Provide for Commonwealth environmental assessment and approval processes + Provide an integrated system for biodiversity conservation and management of protected areas				
Underwater Cultural Heritage Act 2018 *Underwater Cultural Heritage (Consequential and Transitional Provisions) Act 2018*	This Act replaces the Historic Shipwrecks Act 1976 and extends protection to other wrecks such as submerged aircraft and human remains. It also increases penalties applicable to damaged sites. The Act came into effect on 1 July 2019.	Yes	Commonwealth – Department of Agriculture, Water and the Environment (DAWE)	This Act applies to the shipwrecks (more than 75 years old) within the EMBA. There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters. There are no known shipwrecks within the EMBA.	**Section 3**– Existing Environment **Section 7.2** and **7.3** – unplanned hydrocarbon spills
National Biofouling Management Guidance for the Petroleum Production and	The guidance document provides recommendations for the management of biofouling hazards by the petroleum industry.	Yes	Commonwealth – Department of Agriculture, Water and the Environment (DAWE)	Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk	**Section 7.6** – Introduction of invasive marine species

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Exploration Industry 2009				of the introduction of an introduced marine species.	
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 Agriculture, Water and the Environment (DAWE) Climate Change Authority	This Act applies to the atmospheric emissions through combustion engine use to operate the vessels associated with the activity. Implementation of the Act will reduce the impact of GHG emissions associated with vessel use for the installation and commissioning activity, through compliance with MARPOL Annex VI (Marine Order 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 Pollution from Ships) Act 2007	This Act implements the requirements of MARPOL 73/78 Annex VI for shipping in Commonwealth waters.	Yes	Commonwealth, Department of Infrastructure and Regional Development.	Implementation of this Act reduces the impact of GHG emissions associated with vessel use for the installation and commissioning activity, through compliance with MARPOL Annex VI (Marine Order Part 97: Marine Pollution Prevention – Air Pollution) and	**Section 6.6** – Atmospheric emissions

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
				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 Order 21: Safety and Emergency Arrangements + Marine Order 27: Safety of Navigation and Radio Equipment + Marine Order 30: Prevention of collisions + Marine Order 58: Safe Management of Vessels + Marine Order 70 – Seafarer Certification	Yes	AMSA (operational) Department of Infrastructure and Regional Development Minister for Infrastructure and Regional Development	All vessel movements associated with the activity will be governed by marine safety regulations and Marine Orders under the Act.	**Section 6.2** – Interaction with other marine users **Section 7.2** – Hydrocarbon release MDO
Offshore Petroleum and Greenhouse Gas Storage Act 2006 Offshore Petroleum and Greenhouse	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements specified in the OPGGS Act and	Yes	NOPSEMA	Environmental impacts and environmental risks of the activity due to: + noise emissions + artificial light	**Section 6** – Risk Assessments for Planned Events **Section 7** – Risk Assessments for

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Gas Storage (Environment) Regulations 2009	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. 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 sea-bed, 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			+ atmospheric emissions + seabed and benthic habitat disturbance + interaction with other marine users + vessel discharges + spill response operations + dropped objects + introduction of invasive marine species + marine fauna interaction + release of hydrocarbons. +	Unplanned Events

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	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 + to encourage industry to continuously improve its				

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	environmental performance.				
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 (and associated regulations)	Regulates the manufacture, importation and use of ozone depleting substances (ODS) (typically used in fire-fighting equipment and refrigerants). Applicable to the handling of any ODS.	Yes	Commonwealth - Department of Agriculture, Water and the Environment (DAWE)	The activity does not include import, export or manufacture activities of ODS. This Act applies where ODS is found on vessel refrigeration systems, however, this is a rare occurrence.	**Section 6.6** – Atmospheric emissions
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.	Potential impacts to commonwealth waters in the event of an unplanned + hydrocarbon spill.	**Section 7.2** – unplanned hydrocarbon spill (MDO)
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994	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	Yes	Commonwealth – Department of Infrastructure and Regional Development	This Act applies to vessel discharges and movements associated with the activity. The Act is relevant to the extent that Santos WA will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to	**Section 6.7** – Operational discharges **Section 7** – unplanned events

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	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 Order 91: Marine Pollution Prevention - Oil + Marine Order 93: Marine Pollution Prevention - Noxious Liquid Substances + Marine Order 94: Marine Pollution Prevention - Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage + Marine Order 97: Marine Pollution Prevention - Air Pollution			relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Order 91: Marine Pollution Prevention - Oil + Marine Order 93: Marine Pollution Prevention - Noxious Liquid Substances + Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage	
Protection of the Sea (Civil Liability of	This Act implements the requirements for the International	No	AMSA	This Act applies to diesel refuelling which will not be	NA

Requirement Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Bunker Oil Pollution Damage) Act 2008	Convention on Civil Liability for Bunker Oil Pollution Damage.			required during this activity.	
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 Development and AMSA	This Act applies to vessel movements in Australian Waters associated with the activity. Vessels are required to have biofouling systems in place to prevent introduction of IMS / harmful impact on Australian biodiversity.	**Section 7.6** – Introduction of IMS

International Agreements and Conventions

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.*	Yes	Planned operational discharges occur as part of the activity and include: + Sewage, grey water, and putrescible wastes generated from the MODU and support vessels + Deck drainage/deck wash-down, cooling, brine, ballast and bilge water from support vessels + Hydraulic fluid released by valve operation on subsea infrastructure + Various discharges from planned maintenance activities.	**Section 6.7** – Operational discharges
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	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging or nesting in area.	**Section 7.2** to **7.4** – unplanned hydrocarbon spills
Agreement Between the Government of Australia and the Government of the People's	This agreement recognises the special international concern for the protection of migratory birds and birds	Yes	Only relevant in so far as the credible spill scenario may result in impact to	**Section 7.2** to **7.4** – unplanned hydrocarbon spills

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
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)	in danger of extinction that migrate between Australia and China. Implemented in *EPBC Act 1999.*		migratory seabirds foraging or nesting in area.	
Convention for the Control of Transboundary Movements of Hazardous Wastes and Their Disposal 1989 (Basel Convention)	This convention deals with the transboundary movement of hazardous wastes, particularly by sea. Implemented in *Hazardous Waste (Regulation of Exports and Imports) Act 1989.*	No	Activity does not involve transboundary movement of hazardous wastes.	N/A
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 6.5** – Noise emissions **Section 6.4** – Light emissions **Section 6.3** – Seabed and benthic habitat disturbance **Section 7.7** – Marine Fauna Interaction **Section 7.2** to **7.4** – for unplanned releases

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, sea ports 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 7.2** to **7.4** – for unplanned releases **Section 6.8** – Spill response operations
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	Only relevant in so far as the credible spill scenario may result in impact to MNES protected migratory species.	**Section 7.2** to **7.4** – for unplanned releases **Section 6.8** – Spill response operations
International Convention for the Establishment of an International Fund for Compensation for Oil Pollution Damage (Fund 92)	This convention ensures compensation is provided for damage caused by oil pollution.	No	Relevant to oil tankers, not supply or support vessels.	N/A
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 six Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged	Yes	Already dealt with through the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* – refer to legislation table above	N/A

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
	substances, sewage, garbage and air pollution. 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.			
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 Implemented in the *Air Navigation Act 1920.*	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.	**Section 6.2** – Interaction with other marine users
International Convention on Civil Liability for oil pollution damage (1969)	This convention provides a mechanism for ensuring the payment of compensation for oil pollution damage.	No	Relevant to oil tankers	N/A
International Convention for *the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention) 2004*	The IMO has been addressing the problem of invasive marine species in ship's ballast water since the 1980s. Ballast water and sediments guidelines were adopted in 1991 and the ballast water convention was adopted in 2004. Recent accession by Finland has	Yes	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 7.6** – Introduction of invasive marine species

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
	triggered the final entry into force of these international requirements. As a result, the International Convention for the Control and Management of Ships Ballast Water and Sediment will enter into force on 8th September 2017 (IMO Briefing 22 2016). It aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. Ballast Water Management systems must be approved by the Administration in accordance with this IMO Guidelines.			
United Nations Convention on the Law of the Sea (UNCLOS) (1982)	Part XII of the convention sets up a general legal framework for marine environment protection. The convention imposes obligations on State Parties to prevent, reduce and control marine pollution from the various major pollution sources, including pollution from land, from the atmosphere, from vessels and from dumping (Articles 207 to 212). Subsequent articles provide a regime for the enforcement of national	Yes	Only relevant to the extent that Santos WA 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 Order 91: Marine Pollution Prevention - Oil	**Section 6.7** – Operational discharges **Section 7.2** to **7.4** – for unplanned releases **Section 7.6** – Introduction of invasive marine species

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
	marine pollution laws in the many different situations that can arise. Australia signed the agreement relating to the implementation of Part XI of the Convention in 1982, and UNCLOS in 1994.		+ Marine Order 93: Marine Pollution Prevention - Noxious Liquid Substances + Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage + Marine Order 97: Marine Pollution Prevention - Air Pollution	
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 to the extent that to reduce impact of GHG emissions associated with vessel use, Santos WA will comply with MARPOL Annex VI (Marine Orders Part 97: Marine Pollution Prevention – Air Pollution) and require the use of low sulphur fuel. The MODU and support vessels will use diesel, which is a low sulphur fuel.	**Section 6.6** – Atmospheric emissions

Appendix C – Santos' Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062)

EA-00-RI-10062

Values and Sensitivities of the Marine and Coastal Environment

PROJECT / FACILITY	All
REVIEW INTERVAL (MONTHS)	12 Months
SAFETY CRITICAL DOCUMENT	NO

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Santos

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1. Introduction

Santos WA Energy Limited (Santos) is the titleholder of multiple petroleum titles for exploration, development and operational activities located in marine waters off north-western Western Australia. With the exception of Bayu Undan, this document describes the combined 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 combined EMBA represents the largest possible spatial extent that could be contacted by combining the worst-case spill event modelled for Santos activities to date.

The combined EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of any 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 combined EMBA.

The combined EMBA does not represent the worst case loss of well control event of any one activity .

This document is informed by searches of the protected matters search tool (PMST) provided by the WA Department of Agriculture, Water and the Environment (DAWE) (previously the Department of the Environment and Energy (DoEE) (in December 2020 and June 2021 and provided in **Appendix A**), as well as published scientific literature and studies, and other State and Territory protected species databases where applicable. Descriptions of all fauna are provided, with a focus on protected species that are threatened and migratory. The PMST is performed annually and any changes from this updated search are detailed in a change register (**Appendix B**). This document is then reviewed annually and updated accordingly.

The PMST searches are completed using the exact coordinates that are utilised to produce the figures throughout Section 3 of the EP, ensuring that the combined EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons at the low exposure level in the highly unlikely event of a worst case oil spill.

On the first page of the PMST report, is a coarse graphic showing the area over which the search has been conducted. However, the granularity of this can make the output look different to the spatial area represented on figures.

The co-ordinates are also provided within the PMST report to allow for duplication of the searches and verification if required. Santos do not have control over the PMST search tool output, but instead have provided the reports and coordinates to ensure transparency.

Figures provided throughout this document are zoomed to the relevant data represented to allow detail to be shown at a readable scale.

1.1 Geographical Extent

The combined EMBA, includes the coastal waters and shoreline habitats of Western Australia (WA) and part of the Northern Territory (NT), encompassing the south of WA to the most northern coastlines of the NT 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 18 bioregions that occur within the combined 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 combined 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;
- Southwest Shelf Province;
- Southern Province; and
- Great Australian Bight Shelf Transition.

North Marine Region

- Northwest Shelf Transition (as above);
- Timor Transition; and
- Northern Shelf Province.

Other IMCRA 4.0 bioregions of interest include: Christmas Island Province and Cocos (Keeling) Island Province.

The international waters of south west Indonesia and Timor-Leste (in part) are also included in the combined EMBA and described where relevant throughout this document.

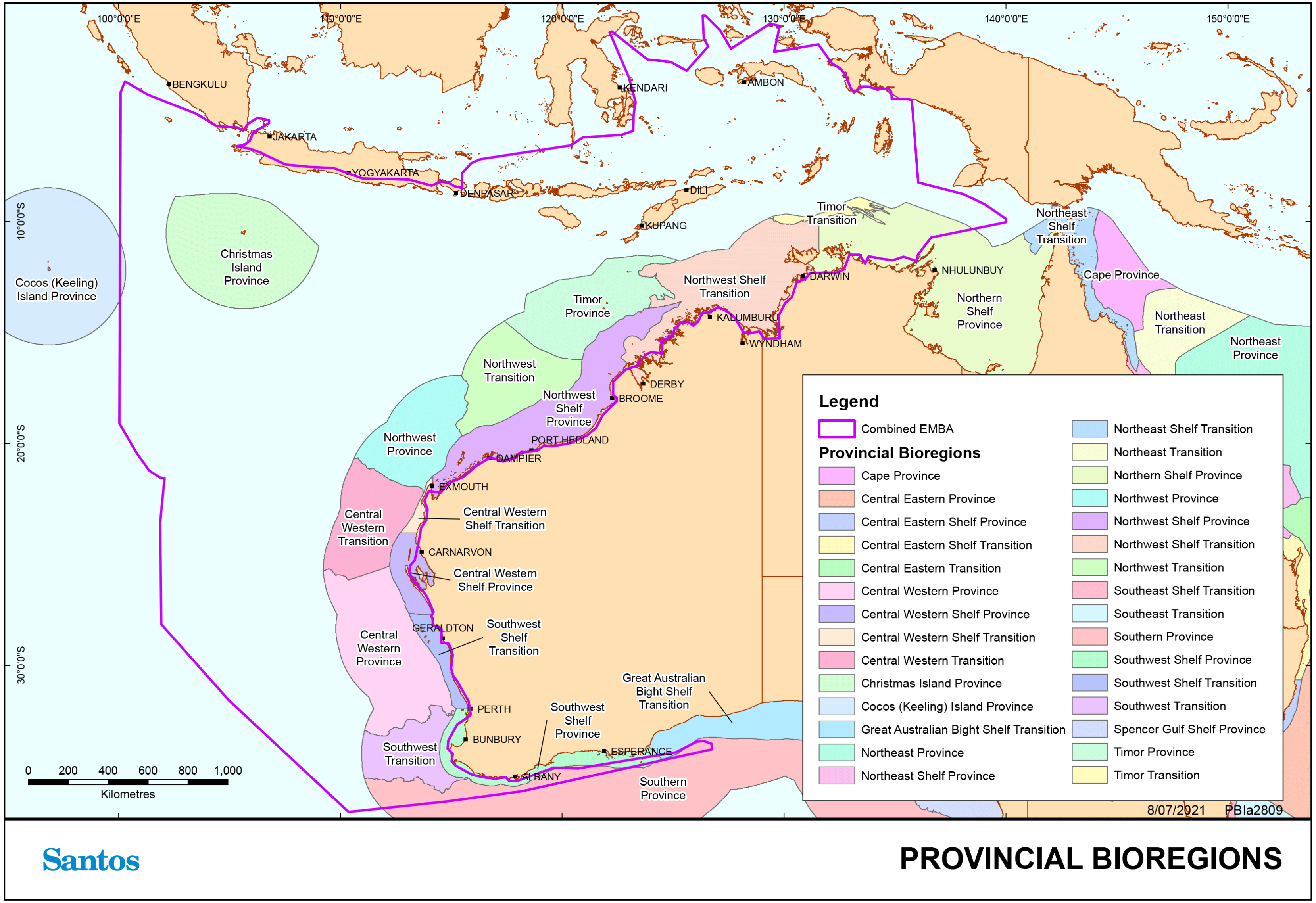


Figure 1-1: EMBA within IMCRA 4.0 Provincial Bioregion

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 combined 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 combined 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.

Several geomorphic formations within the combined EMBA have been associated with Key Ecological Features (DEWHA 2008a) and these are discussed in **Section 10**.

2.1.3 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.

2.1.4 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 combined 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.

2.1.5 Southwest Shelf Transition

This bioregion consists of a narrow continental shelf, ranging from approximately 40-80 km wide that is noted for its physical complexity. It includes a series of 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 (DEWHA, 2008b).

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 combined EMBA and include the Albany Canyons Group, the Ceduna and Eyre Terraces (covering approximately 147,150 km^2) and the Diamantina Fracture Zone.

2.1.6.1 Great Australian Bight

The Great Australian Bight Shelf Transition is characterised by the largest seafloor feature of the Region – an extensive flat continental shelf covering 177 130 km^2. The centre of the shelf reaches widths of 260 km narrowing to 80 km at its margins. Geomorphology, sedimentology and hydrodynamics interact to create ideal conditions for carbonate organisms such as molluscs and bryozoans to flourish without being smothered or buried. As a result carbonate sediments derived from invertebrate skeletons and shells make up over 80 per cent of shelf sediments, making the Bight part of the world's largest modern cool-water carbonate bioregion that extends along Australia's southern margin. Within the wave abrasion zone (0-120 m) sediments are typically rippled and coarse grained, forming a 'shaved shelf' where carbonate accumulation is less than the amount of active erosion and therefore there is a net loss of sediment from the shelf (DEWHA, 2008b).

2.1.7 Central Western Province

This bioregion is characterised by a narrow continental slope that is heavily incised by many submarine canyons as far north as Kalbarri. The Perth Canyon, located at the southern margin of the bioregion, is an order of magnitude larger than any other canyon in the Region (Figure 2.11). The Perth Canyon, formed by erosive processes associated with the ancient Swan River, cuts into the continental shelf at approximately the 150 m depth contour, north-east of Rottnest Island. Other relatively large canyons, such as the Murchison Canyon, occur in the bioregion but little is known about them as they have not yet been studied (DEWHA, 2008b).

The bioregion contains the most extensive area (52 185 km2) of continental rise on the Australian margin. The continental rise is located on the edge of the Perth Abyssal Plain (103 911 km2). There is a large terrace known as the Carnarvon Terrace on the continental slope, extending north from the Houtman Abrolhos Islands at an average of 780 m water depth (DEWHA 2008b).

2.1.8 Central Western Shelf Province

This bioregion is located on the Dirk Hartog Shelf and is generally very flat. It varies in width from less than 20 km in the north to around 125 km in the vicinity of Shark Bay. A small area of reef and tidal sandwaves or sandbanks occur at the entrance to Shark Bay and within its vicinity. Other topographic features of the bioregion include a deep hole and associated area of banks and shoals offshore of Kalbarri. The banks and shoals in this bioregion are of note because they occur at latitudes significantly south of banks and shoals elsewhere in the North-west Marine Region (DEWHA, 2008a).

2.1.9 Central Western Transition

The Central Western Transition is characterised by large areas of continental slope, with sediments dominated by muds and sands that decrease in grain size with increasing depth. The slope is incised by numerous topographic features such as terraces (i.e. the Carnarvon Terrace), canyons (i.e. Cloates Canyon and Carnarvon Canyon) and rises. A large part of the bioregion consists of the Cuvier Abyssal Plain. The Wallaby Saddle is another important feature of this bioregion and it is the most extensive area of this type of topographic feature in the North-west Marine Region (DEWHA, 2008a).

2.1.10 Central Western Shelf Transition

The Central Western Shelf Transition is located entirely on the continental shelf and is comprised mainly of sandy sediments. The close proximity of the coast to the shelf break is a significant feature of this bioregion and is an important factor in determining its biodiversity (DEWHA, 2008a).

Ningaloo Reef is the most significant geomorphic feature in the bioregion. It extends south of North West Cape along the Cape Range Peninsula, and stretches for over 260 km. It is the only example in the world of an extensive fringing coral reef on the west coast of a continent (DEWHA, 2008a).

2.1.11 Northwest Province

The bioregion occurs entirely on the continental slope and is comprised of muddy sediments. It is distinguished by a number of topographic features, such as the Exmouth Plateau, terraces and canyons (including the Swan and Cape Range canyons), as well as deep holes and valleys on the inner slope. The Montebello Trough occurs on the eastern side of the Exmouth Plateau and represents more than 90 per cent of the area of troughs in the North-west Marine Region. Significantly, this bioregion contains the steepest shelf break of the North-west Marine Region, along the Cape Range Peninsula near Ningaloo Reef (DEWHA, 2008a).

2.1.12 Northwest Transition

The majority (52 per cent) of the Northwest Transition bioregion occurs on the continental slope, with smaller areas in the north-west of the bioregion located on the Argo Abyssal Plain and continental rise. The sediments of the slope are dominated by sands, whereas the sediments of the abyssal plain/deep ocean floor are dominated by muds. More than 60 per cent of the Argo Abyssal Plain occurs within this bioregion and much of the Northwest transition occurs in water over 4000 m deep (DEWHA, 2008a).

Other topographic features within the bioregion include areas of rise, ridges, canyons and apron/fans. The bioregion also has reefs such as Mermaid, Clerke and Imperieuse reefs, which are collectively known as the Rowley Shoals (DEWHA, 2008a).

2.1.12.1 Northwest Shelf Province

The Northwest Shelf Province is located almost entirely on the continental shelf, except for a small area to the north of Cape Leveque that extends onto the continental slope. This bioregion includes more than 60% of the continental shelf in the North-west Marine Region (DEWHA, 2008a). The shelf gradually slopes from the coast to the shelf break, but displays a number of seafloor features such as banks/shoals and holes/valleys. These are thought to be morphologically distinct from other features of these types found elsewhere in the North-west Marine Region, and have a different sedimentology (DEWHA, 2008a). For example, the Glomar Shoals occur approximately 30–40 km offshore of Dampier in water depths of between 26–70 m and are distinguished by highly fractured molluscan debris, coralline rubble and coarse carbonate sand. The province also includes the

Leveque Rise, a large plateau, and one of only two shelf plateaux within the North-west Marine Region (DEWHA, 2008a).

2.1.12.2 Northwest Shelf Transition

The Northwest Shelf Transition is predominantly located on the continental shelf with a small portion extending onto the continental slope causing waters in the area to be relatively shallow, only up to 330 m. It also consists of geomorphic features that are unique to the Northwest Shelf Transition and not found elsewhere in the North-west Marine Region (DEWHA, 2008a). An example of this is that 90% of the Region's carbonate banks are located within the Northwest Shelf Transition (DEWHA, 2008a).

The Bonaparte Depression lies within the Northwest Shelf Transition, which is a 45 000 km^2 geomorphic basin that is the only occurrence of its type in the North-west Marine Region (DEWHA, 2008a). The Bonaparte Depression is a relatively flat feature with a higher content of mud and gravel than what is found elsewhere in the Northwest Shelf Transition and it has a number of pinnacles of which form the key ecological feature 'pinnacles of the Bonaparte Basin' (see **Section 9.8**).

2.1.12.3 Timor Province

The Timor Province is located on the continental slope. The notable topographical features include the Scott Plateau, the Ashmore Terrace and part of the Rowley Terrace and Argo Abyssal Plain (DEWHA, 2008a). Of these, the Scott Plateau is particularly significant with water depths of up to 3000 m and being fringed by spurs and valleys (DEWHA, 2008a). The Scott Plateau is also separated from Rowley Terrace by canyons that are up to 50 million years old (DEWHA, 2008a).

The Timor Province encompasses almost half of the reefs in the North-west Marine Region, including Scott Reef, Seringapatam Reef and Ashmore Reef which are all within the combined EMBA (DEWHA 2008a).

2.1.12.4 Timor Transition

The Timor Transition is predominantly shelf terrace and slope, which extend into waters that are 200-300 m deep. The deepest point (300 m) is the Arafura Depression. The Timor Transition is also dominated by a series of canyons that represent a drowned river system from the Pleistocene era (DEWHA, 2008c). The canyons are approximately 80-100 m deep and up to 20 km wide (DEWHA, 2008c).

2.1.12.5 Northern Shelf Province

The Northern Shelf Province consists of large areas of relatively featureless sandy and muddy sediments (DWEHA, 2008c). A significant feature of the Northern Shelf Province is the Gulf of Carpentaria, which is outside the combined EMBA, the majority of the reefs in the Northern Shelf Province are also outside the combined EMBA and form a broken margin around the Gulf of Carpentaria. However, within the combined EMBA is the Arafura Shelf which is characterised by continental shelf, canyons, terraces, the Arafura Sill and the Arafura Depression (DEWHA, 2008c).

2.1.12.6 Christmas Island Province

This bioregion contains the 4th largest abyssal plain/deep ocean floor area and smallest area of slope of all the National Benthic Marine Bioregionalisation (NBMB) bioregions (DEH, 2005a). Due to the similar geomorphology and location adjacent to Indonesia in the tropical Indian Ocean, the fauna contained in this bioregion is probably similar or related to the fauna associated with the Cocos (Keeling) Island bioregion.

2.1.12.7 Cocos (Keeling) Island Province

This bioregion contains the largest abyssal plain/deep ocean floor area of all the NBMB bioregions and is the deepest NBMB bioregion on average due to the relatively large areas of abyssal plain/deep ocean floor (DEH, 2005b). Due to the similar geomorphology and location adjacent to Indonesia in the tropical Indian Ocean, the fauna contained in this bioregion is probably similar or related to the fauna associated with the Christmas Island bioregion. The Cocos basin comprises dominantly flat abyssal plain occurring at water depths around 5,500 km.

2.1.13 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**.

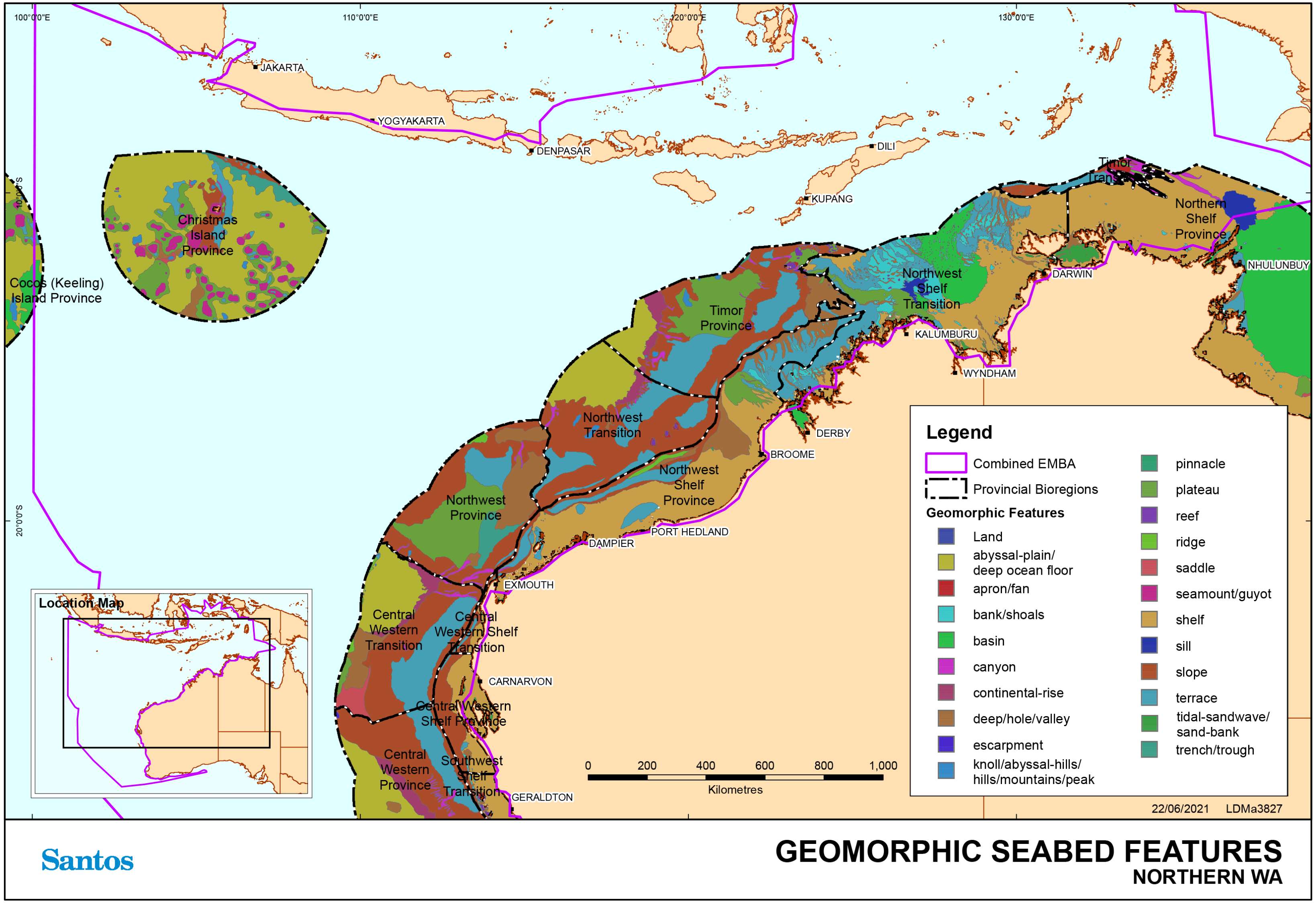


Figure 2-1: Geomorphic/seafloor features of Northern WA

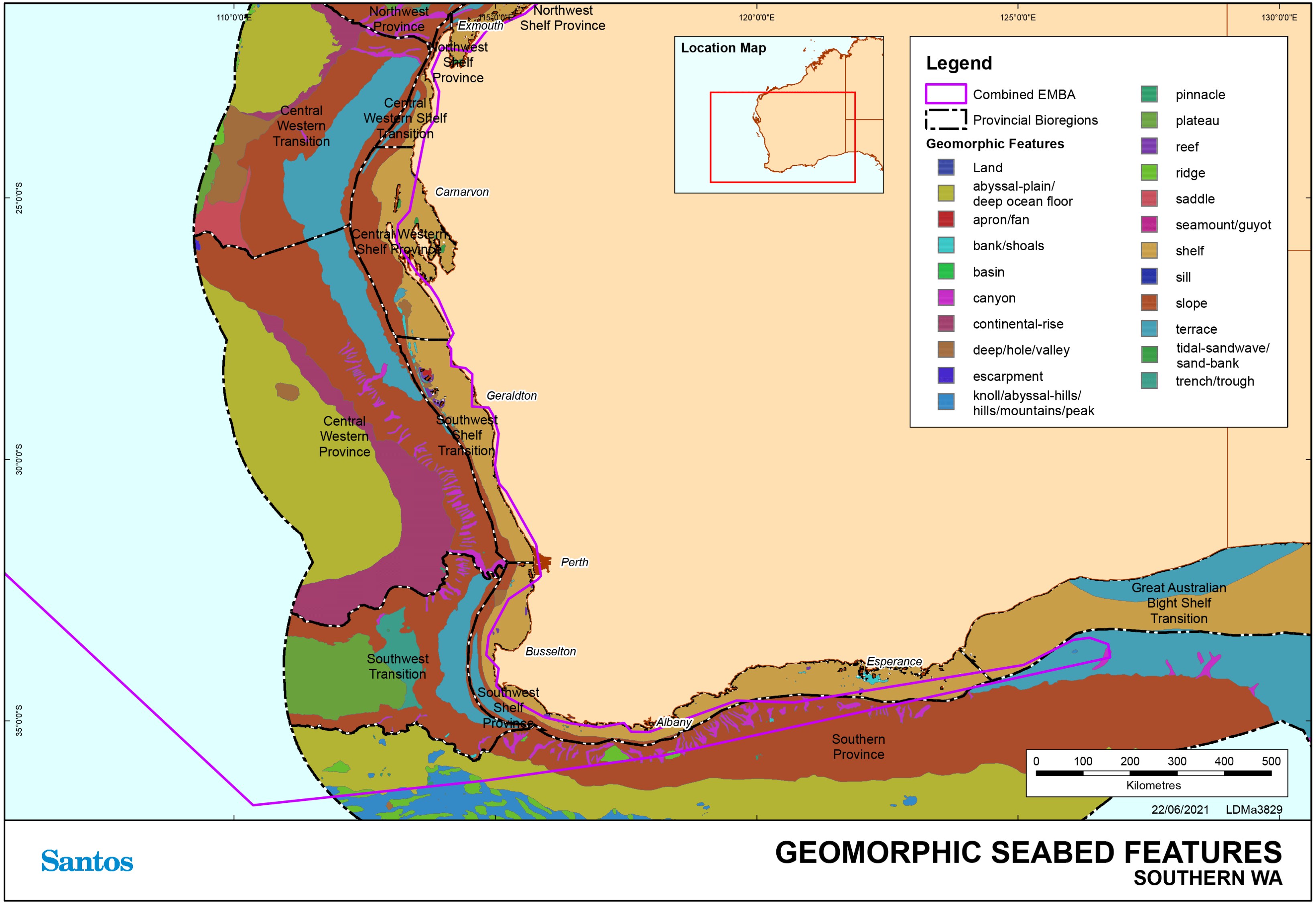


Figure 2-2: Geomorphic/seafloor features of Southern WA

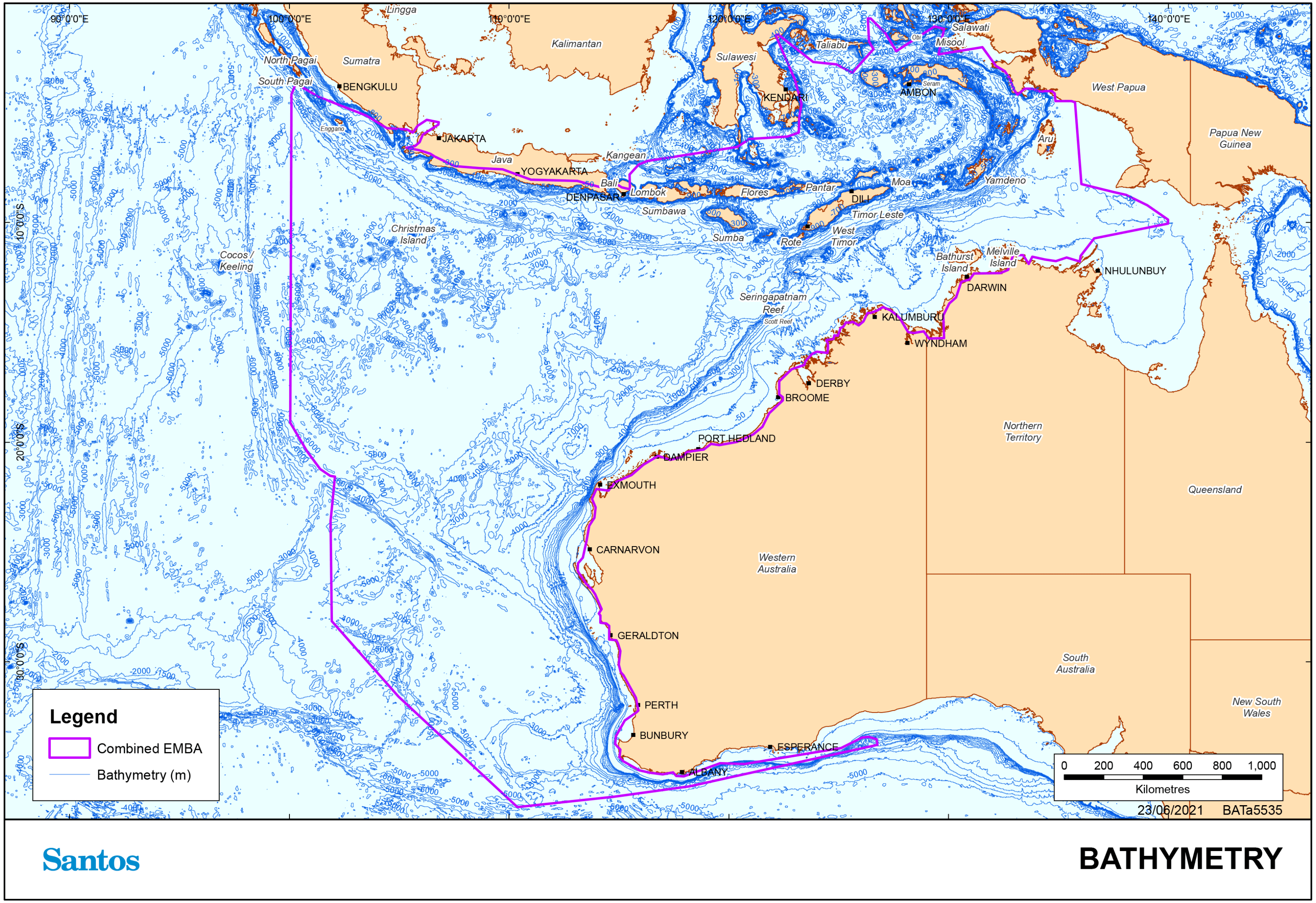


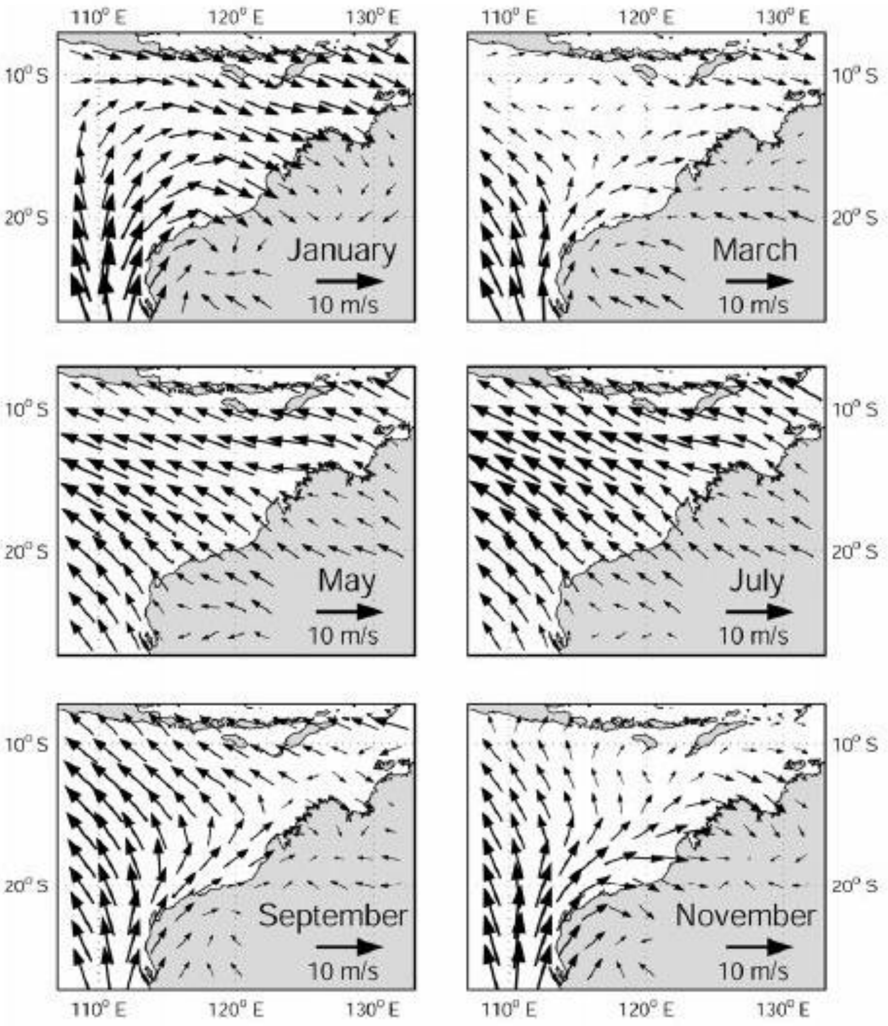
Figure 2-3: Bathymetry of the combined EMBA

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.

The Bonaparte Basin and Timor Sea region in the north has a tropical climate. These areas experience a distinct 'wet' season with summer monsoonal conditions from October to March and a distinct 'dry' season with cooler and drier conditions from April to September. The wet season usually comprises south-westerly winds capable of generating thunderstorm activity, high rainfall and cyclones. The dry season usually comprises dry and warm conditions with little rainfall (Fugro, 2015).

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). It is a relatively narrow boundary current that flows along the north-west shelf at between 100 m and 200 m depth, flowing towards the north-east in summer and the south-west in winter (Fugro, 2015).

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). Large-scale currents of the Timor and Arafura seas in the north are dominated by the Indonesian Throughflow. Christmas and Cocos (Keeling) Islands territories are located in the eastern Indian Ocean, in the path of the South Equatorial Current that carries the Indonesian Throughflow waters into the Indian Ocean.

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). Cyclones and tropical storms can greatly increase wave heights by up to 8 m in the outer Timor Sea during the cyclone season (Przeslawski et al. 2011).

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).

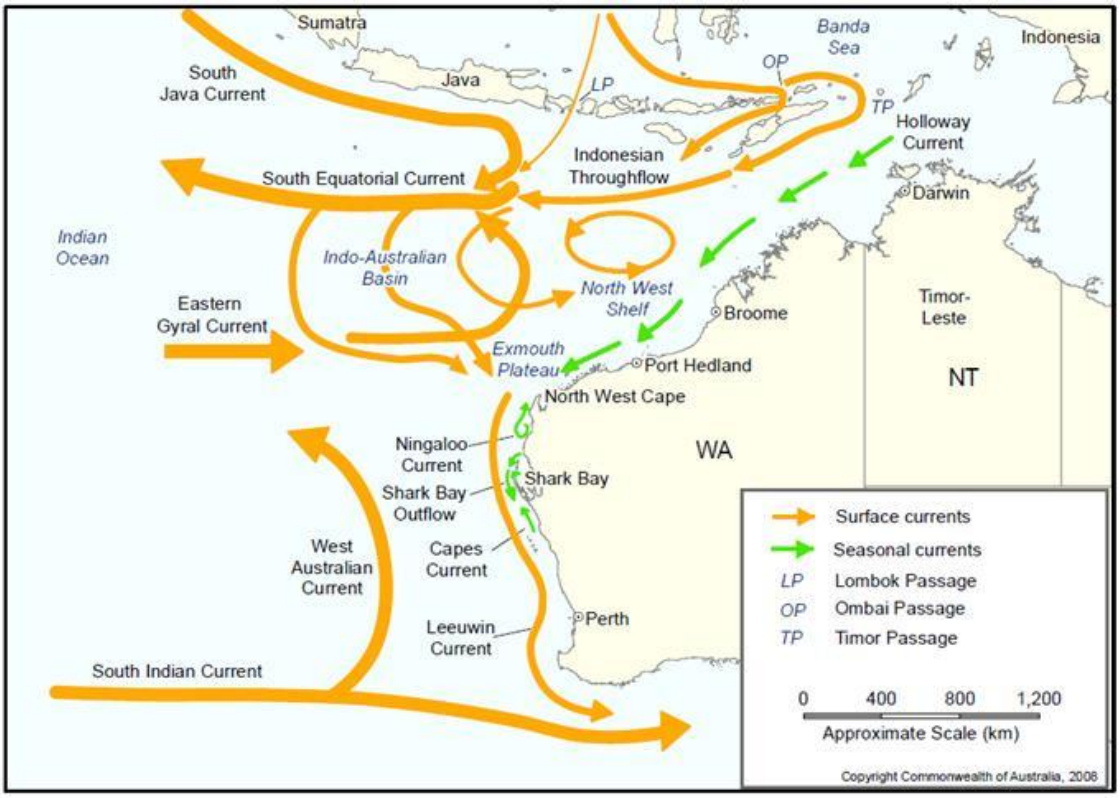


Figure 2-5: Surface currents in the Northern Territory and Western Australia

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 combined EMBA lie at depths ranging from LAT down to more than 6,000 m at Argo and Cuvier abyssal plains (DEWHA 2008a, 2008b, 2008c).

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 photic zone in the offshore north extends to 100 m (DEWHA 2008c).

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 18 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 combined 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.

Three bioregions (Northwest Province, Central Western Province and Central Western Transition) lie in deep waters below the photic zone. Two bioregions (Southwest Transition and Southern 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. The EMBA overlaps the deeper waters of the Cocos (Keeling) Island Province, (not those close to shore) which are greater than 4000m deep and therefore photosynthetic corals are not present.

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 Southwest Shelf Province

The Southwest Shelf Province is a nearshore bioregion that extends from Rottnest Island to Point Dempster, approximately 185 km east of Esperance. Adjacent to Commonwealth waters, the extensive area of granite reef (35 203 km2 of reef habitat) and seagrass habitat of the Recherche Archipelago is noted for its high diversity of warm temperate species including 263 known species of fish, 347 known species of molluscs, 300 known species of sponges, and 242 known species of macro-algae (DEWHA, 2008a).

3.1.3 Great Australian Bight Shelf Transition

Few species of scleractinian and soft coral (Orders Stolinifera, Telestacea and Alcyonacea) occur in southern Australia. Three reef-building species occur in shallow waters and >50 species of non-reef-building (ahermatypic) species occur in waters up to 900 m deep. The distribution patterns of corals in the GAB are largely unknown (McLeay et.al, 2003).

3.1.4 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).

3.1.5 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, are more prevalent (Waples & Hollander 2008).

3.1.6 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). Since 1997, mean coral cover has increased through periods of impact and recovery from cyclones, reaching the highest (71%) on record in 2017 (Gilmour *et al.* 2019). 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.

3.1.7 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.

3.1.8 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).

3.1.9 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).

3.1.10 Timor Transition

Due to the deep, offshore nature of the Timor Transition (up to 300 m with no coastal areas), there are no corals expected within this area (DEWHA 2008c). However, there is evidence of relic reef next to drainage channels of the outer slope of the Timor Transition. This is thought to be associated with local upwellings of cooler nutrient rich water from the Timor Sea (DEWHA 2008c).

3.1.11 Northern Shelf Province

The Northern Shelf Province contains submerged patch or barrier reefs in areas with approximately 30-50 m depth of water, these mainly occur around the margin of the Gulf of Carpentaria (which lies outside the combined EMBA) (DEWHA 2008c). The majority of the province is relatively featureless with sandy and muddy sediments and this is expected to be the case for the portion of the combined EMBA that overlaps the Northern Shelf Province.

3.1.12 Christmas Island Province

The subsurface marine habitat immediately surrounding Christmas Island consists of a relatively narrow and shallow coral reef shelf about 20 to 100 metres wide in approximately six to 20 metres of water depth. There are caves in some of the island’s rocky sea cliffs that adjoin the coral reef shelves. Coral reef shelves also contain areas of sand and rubble.

The shallow coral reef shelves drop off steeply to the island’s mid and deep-water marine habitats which include outer reef seaward slopes, vertical walls and oceanic waters. The marine boundary of the Christmas Island National Park extends 50 metres seaward from the low water mark, which means that the park has no true deep-water habitats but some outer reef slopes and vertical walls fall within the park’s waters (DNP, 2012).

3.1.13 International Waters

Important areas outside of the IMCRA bioregions include:

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).

The world heritage sites of Siberut and Ujung Kulon are also recognised for their extensive coral ecosystems, as well as marine national parks in the waters and islands surrounding Indonesia, such as Laut Sawu, Teluk Cenderawasih, Bunaken, Kapulauan Wakatobi, Togian Islands, Karimunjawa, the islands of Kepulauan Seribu, the table reefs of Taka Bonerate and the Savu Sea National Marine Conservation Area (refer to **Section 9.8**).

Majority of these sites form parts of the marine area known as the Coral Triangle, named for its staggering number of corals and associated marine life, situated in the waters of Indonesia, Malaysia, the Philippines, Papua New Guinea, Timor Leste and Solomon Islands (ADB, 2014).

Timor-Leste

See **Section 3.1.8** 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, and over 30 species of seagrasses have been recorded as occurring within Australian waters (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). Other seagrass meadows of note include those around Tiwi Islands which provide significant habitat to a number of species. Seagrass habitats also occur within shallower waters near islands and have potential to occur closer to the Indonesian and Timor-Leste coastlines.

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).

Four bioregions (Northwest Province, Central Western Province, Central Western Transition and Timor Transition) lie entirely in deep waters below the photic zone. Two bioregions (Southwest Transition and Southern Province) occur in waters that are too cold to support seagrasses. The EMBA overlaps the deeper waters of the Cocos (Keeling) Island Province, (not those close to shore) which are greater than 4000m deep and therefore seagrasses are not present.

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 Great Australian Bight Shelf Transition

The Australian coastline has the highest number of seagrass species of any continent. There are approximately 30 species of seagrasses in Australia belonging to 11 genera. Approximately one third (18 species) of all species known worldwide are endemic in Australia. Of these, 16 species are restricted to temperate waters.

Southern temperate waters have two endemic genera, *Heterozostera* and *Amphibolis*. Many endemic species belong to the genera *Posidonia*. The distribution and abundance of seagrasses is a function of topography and environment. A distinction exists between subtropical and warm temperate types. In southern Australia, species with warm water affinities (*Posidonia, Amphibolis*) decline in number from west to east as water temperatures decrease.

In South Australia, seagrasses cover approximately 9620 km2 and represent one of the largest seagrass ecosystems in the world. Seagrass distribution in the GAB is patchy and limited by exposure to swell. Most seagrass is found in sheltered bays or in the lee of reefs and islands in the eastern GAB. These areas contain nearly 10% of the seagrass meadows found in South Australia. Posidonia species dominate, especially *P. angustifolia, P. coriacea* at the base of cliffs and *P. australis* and *P. angustifolia* in the sheltered lee of fringing reefs. *Amphibolis antarctica* and *Heterozostera tasmanica* are present but less common in sheltered bays of the region (McLeay et al., 2003).

3.2.4 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).

3.2.5 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).

3.2.6 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).

3.2.7 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).

3.2.8 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 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.

3.2.10 Northern Shelf Province

Coastlines adjacent to the Northern Shelf Province contain seagrasses providing habitat to a number of marine species, particularly juvenile tiger prawns, which make up approximately 50% of the total prawn catch in the province. However, majority of these seagrass habitats exist within the Gulf of Carpentaria, which lies outside the combined EMBA.

3.2.11 Christmas Island Province

The subsurface marine habitat immediately surrounding Christmas Island consists of a relatively narrow and shallow coral reef shelf about 20 to 100 metres wide in approximately six to 20 metres of water depth. The sandy areas and some lagoons are also known to support seagrass habitat (DNP 2012).

3.2.12 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 combined 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, Laut Sawu Marine National Park, Bunaken National Park, Karimunjawa Marine National Park and Savu Sea National Marine Conservation Area are also known for their 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).

Three bioregions (Northwest Province, Central Western Province and Central Western Transition) lie entirely in deep waters below the photic zone. Two bioregions (Southwest Transition and Southern Province) occur in colder waters. The EMBA overlaps the deeper waters of the Cocos (Keeling) Island Province, (not those close to shore) which are greater than 4000m deep and therefore macroalgae are not present.

Macroalgae are not present hence these bioregions are not discussed.

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 Great Australian Bight Shelf Transition

Seaweed diversity and endemism in temperate waters of Australia is among the highest in the world, perhaps due to the length of the southerly-facing rocky coastline and the long period of geological isolation. The number of species found in southern Australia is 50-80% greater than other temperate regions of the world. A small number of tropical species and isolated species from tropical genera also occur in the GAB.

Oceanic waters of South Australia support one of the world's most diverse seaweed assemblages, with >1200 species recorded. Many species of macroalgae found in South Australian waters extend into the cool temperate waters of Victoria and Tasmania and warmer waters of Western Australia. However, South Australia has the highest concentration of species. The waters of the GAB are clear and allow chlorophyllus plants to live at depths of up to 70 m.

Among the green algae (Chlorophyta), few microscopic forms have been studied; however, a few southern Australian species are recognised in the genera *Ulva* (2) and *Bryopsis* (6). Coenocytic green algae are well represented, including *Codium* (15 species) and *Caulerpa* (19 species). Brown algae (*Phaeophyta*) and red algae (*Rhodophyta*) are particularly diverse. Approximately 43% of the genera (658) and 20% of the species

(~4000) of red algae that occur worldwide are found in southern Australia. Over 75% of red algae, 57% of brown algae, and 30% of green algae are endemic to southern Australia (Womersley 1990). Womersley (1984, 1987, 1994, 1996, 1998 and 2003) documents the macroalgae of southern Australia. (McLeay et al., 2003).

3.3.4 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 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).

3.3.5 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).

3.3.6 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).

3.3.7 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).

3.3.8 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).

It is also considered that in offshore parts of the Northwest Shelf Transition, there are high levels of primary production, including macroalgae. This is due to light penetration through relatively clear, shallow waters (DEWHA, 2008a). In particular, carbonate banks and reefs in the Northwest Shelf Transition are considered to support macroalgae, therefore macroalgae would be expected to be present within the Carbonate Bank and Terrace System of the Van Diemen Rise key ecological feature, located within the Northwest Shelf Transition.

3.3.9 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).

3.3.10 Timor Transition

There is a lack of published information regarding macroalage within the Timor Transition. However, the presence of the Shelf Break and Slope of the Arafura Shelf key ecological feature indicates that macroalgae may be present in association with this seabed feature. Upwelling associated with the topography of the shelf break lifts nutrient rich deep ocean water onto the edge of the shelf and into the euphotic zone, leading to enhanced biological productivity (DSEWPAC, 2012).

3.3.11 Northern Shelf Province

Macroalgae is sparse in the Northern Shelf Province (DEWHA, 2008c). However, around reef areas, there have been observations of phytoplankton blooms, thought to occur at localised micro-upwellings of nutrients potentially driven by wind and tidal eddies (DEWHA, 2008c).

3.3.12 Christmas Island Province

Coral reefs are 'turfed' with fine hair-like algae which are grazed by many animals. Some red algae form hard pink crusts which cement sand and dead coral together (DNP, 2012).

3.3.13 International Waters

No information on macroalgae in international waters has been identified other than for Timor-Leste waters.

See **Section 3.1.8** 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 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 Southwest Shelf Province

East of Albany, the dominant lobster species changes from the western rock lobster to the southern rock lobster. In this bioregion there is a notable increase in the ratio of benthic fish to crustaceans. Crustaceans appear to be less important in structuring shallow benthic communities here than in bioregions to the north and to the south-east of the Murray River mouth, around the Bonney Upwelling and Tasmania (DEWHA 2008b).

3.4.3 Southwest Shelf Transition

The inner shelf of the bioregion, extending between 0-50 m deep, includes distinct ridges of limestone reef with extensive beds of macro-algae (principally *Ecklonia* spp.). These inshore lagoons are inhabited by a diverse range of coralline algae, sponges, molluscs and crustaceans. On the outer shelf and shelf break filter feeding sponges and bryozoans dominate the hard bottom. The reefs around the Houtman Abrolhos islands support 492 known species of molluscs, 110 known species of sponges, 172 known species of echinoderms and 234 known species of benthic algae (DEWHA 2008b). Western rock lobster, the dominant large benthic invertebrate in this bioregion, is considered to be an important part of the food web of the inner shelf.

3.4.4 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).

3.4.5 Great Australian Bight Shelf Transition

The invertebrate fauna of the GAB also displays a high degree of endemism (85-95%, Shepherd 1991). South Australia's benthic invertebrate assemblages also include tropical species. Fossils of benthic foraminiferans, nektonic nautiloids and planktonic protists suggest that tropical species have been transported into South Australia by the Leeuwin Current since the Eocene.

Early research in the GAB included an expedition on Australia's first fisheries research vessel, the Southern Endeavour that reported the presence of hydroids, molluscs and sponges. Many of South Australia's invertebrate species are included in the South Australian Handbook Series Marine Invertebrates of Southern Australia. Part I, includes the Porifera, Cnidaria, Platyhelminths, Annelida, Sipuncula, Echiura, Bryozoa and Echinodermata (Shepherd and Thomas 1982); Part II deals solely with the Mollusca (Shepherd and Thomas 1989); and Part III includes the Nemertea, Entoprocta, Phoronida, Brachiopoda, Hemichordata, Pycnogonids and Tunicates (Shepherd and Davies 1997). The most notable group not covered by these books is the Crustacea. Edgar (2000) describes 1200 species of invertebrates, fish, algae and sea grasses that occur in the intertidal zone to 30 m depth between Sydney and Perth (McLeay et al., 2003).

3.4.6 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.

3.4.7 Central 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).

3.4.8 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).

3.4.9 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).

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3.4.10 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.

3.4.11 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).

3.4.12 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).

3.4.13 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).

3.4.14 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).

3.4.15 Timor Transition

Carbonate banks and reefs of the Timor Transition have been found to support non-coral communities and benthic invertebrate communities associated with hard substrates (DEWHA, 2008c). Of particular note is the Shelf Break and Slope of the Arafura Shelf key ecological feature which is located within the Timor Transition. This key ecological feature has been recognised for the invertebrates that is hosts, which are thought to be the basis for the offshore food webs in the area (DEWHA, 2008c). Furthermore, the Tributary Canyons of the Arafura Depression key ecological feature is also in the Timor Transition and surveys of this key ecological feature identified around 245 macroscopic species of invertebrates (Wilson, 2005).

3.4.16 Northern Shelf Province

Studies of taxa within the Northern Shelf Province found 684 taxa of infaunal benthic invertebrates in waters deeper than 20 m. However, the Gulf of Carpentaria Basin contains the most significant non-coral benthic habitats within the Northern Shelf Province, which is outside the boundary of the combined EMBA (DEWHA, 2008c).

3.4.17 Christmas Island Province

Three major molluscs grow on Christmas Island's reefs: bivalves, gastropods and cephalopods. Echinoderms include sea stars, brittle stars, feather stars, sea urchins and sea cucumbers (DNP, 2012). The deeper waters connecting Christmas Island to the Cocos (Keeling) Island Province are described below (**Section 3.4.18**).

3.4.18 Cocos (Keeling) Island Province

The hard substrates that occur on seamounts within the province are likely to provide surfaces and topographical structure for recruitment and growth of passive,sessile, epi-benthic suspension feeders (Genin et al., 1986) such as deep sea corals, sponges,crinoids, ascidians and bryozoans. Most of the seamounts within the subregion are relatively deep (>2000 m) and the deeper seamounts (>3000 m) are a unique feature of this subregion. Little is known about the communities that live on the tops and slopes of these seamounts. However, it seems likely that their unique position in the water column, and geographically, will support unique benthic and demersal communities (Brewer *et al*., 2009).

3.4.19 International Waters

No information on non-coral benthic invertebrates in international waters has been identified other than for Timor-Leste waters.

See **Section 3.1.8** 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 combined 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 combined 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.

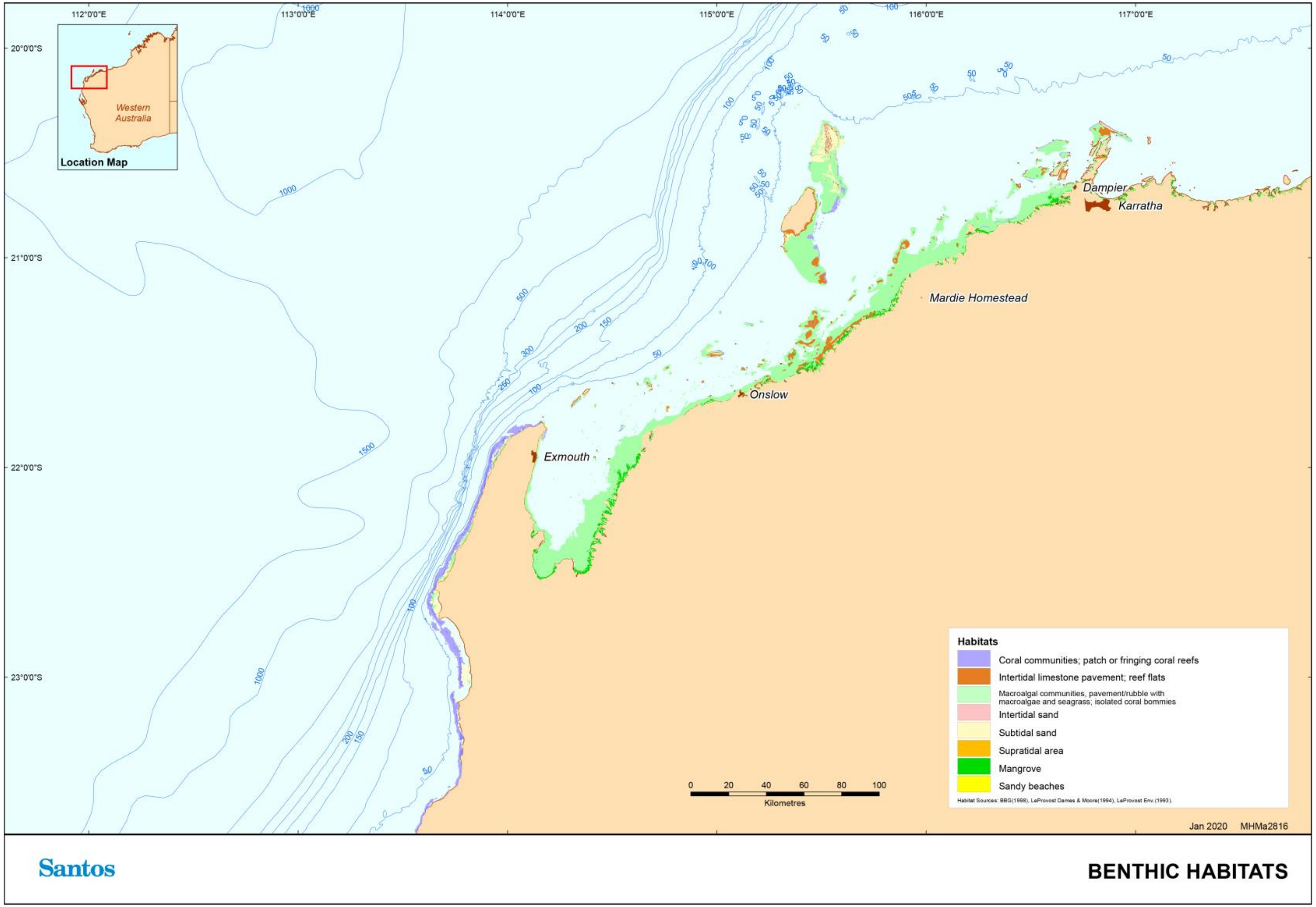

Figure 3-1: Benthic habitats from Coral Bay to Dampier

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 18 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. Noting that shoreline habitats of the Cocos (Keeling) Islands are not described as the combined EMBA is restricted to the outermost deep waters of the bioregion.

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.

Santos

4.1.1 Great Australian Bight Shelf Transition

Mangrove forests occur at sheltered sites on the South Australian coast and cover an area of approximately 230 km2. Mangroves are poorly represented in the Great Australian Bight as they show preference for low energy, muddy shorelines, particularly in the tropics. Of the 69 species in the world only one occurs in the eastern part of the GAB, the grey mangrove, Av*icennia marina*. It forms coastal woodlands up to 5m tall with the most significant stands in the GAB occurring near Ceduna in the east (McLeay, 2003).

4.1.2 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.

4.1.3 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).

4.1.4 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).

4.1.5 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).

Further north, mangroves also occur at the Tiwi Islands. Mangrove communities in the Tiwi Islands are predominantly within tidal creeks and are not expected along the shoreline. The Northern Territory mainland coastline, however, has a number of estuaries and rivers that drain into the surrounding hinterland during the wet season, this includes Darwin Harbour that contains approximately 260 km^2 of mangroves (INPEX, 2010).

4.1.6 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.1.7 Northern Shelf Province

Coastlines within the Northern Shelf Province are described as being dominated by mangroves, which provide significant habitat for commercial and non-commercial fish species. In particular, banana prawns tend to favour mangrove areas with the highest catch of banana prawns being recorded in areas with the highest concentration of mangroves (DEWHA, 2008).

4.1.8 Christmas Island Province

There are no coastal mangroves, but a stand of normally estuarine *Bruguiera gymnorhiza* and *B. sexangula* occurs at Hosnie's Spring (registered as a Ramsar Wetlands site of international importance) about 50 metres above sea level. Two other mangrove species occur on the east coast. *Heritiera littoralis* occurs on the inland terrace above Greta Beach (outside the park) and further south towards Dolly Beach, as well as a discrete stand on the terrace above Dean's Point. *Cynometra ramiflora* occurs in two small stands south of Ross Hill (DNP, 2012).

4.1.9 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 Laut Sawu Marine National Park, Karimunjawa National Park, Kepulauan Seribu National Park, Teluk Cenderawasih National Park, Kapulauan Wakatobi National Park, Meru Betiri National Park, Togian Islands National Park, Bali Barat National Park, Savu Sea National Marine Conservation Area and the World Heritage sites of Komodo National Park, Siberut and Ujung Kulon 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 a 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.

Further north, the Tiwi islands have also been identified as containing tidal flats, whilst the extent of these are not well documented they are thought to be closely related to the mangrove habitats at the Tiwi Islands (ConocoPhillips, 2020).

4.2.4 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.2.5 Northern Shelf Province

The subtidal and intertidal communities in Darwin Harbour and around the NT coastline, within the Northern Shelf Province are characterised as including a variety of shoreline habitats, including intertidal mud flats (URS 2010). The Tiwi Islands are also partially located within the Northern Shelf Province and are identified as supporting a number of shoreline habitats including sand and mud flats.

4.2.6 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 combined 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 Great Australian Bight Transition

The coastline is subject to moderate to high wave energy and high swells (2-4 m). This region features limestone cliffs interspersed by rocky headlands, narrow intertidal rock platforms, reefs and beaches backed by dune barriers.

The Eyre Region is subject to moderate to high wave energy and features a rocky coast with numerous headlands, sheltered bays, cliffs, shore platforms, beaches backed by dune barriers, offshore islands, seamounts and lagoon deposits in sheltered areas (McLeay, 2003).

4.3.3 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.

4.3.4 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.

4.3.5 Christmas Island Province

Rocky shore platforms occur at many locations around the island, more extensively on the western coastline between North West Point and Egeria Point. There are also tidal rock pools which are maintained by wave splash and tidal surge (DNP, 2012).

4.3.6 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 combined 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 combined 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**).

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.

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 Central Western Shelf Province

Sandy beaches are found along the coastline at Shark bay within the marine park which is further described in **Section 12.3.2**.

4.4.4 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).

4.4.5 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).

Significant sandy beaches occur on the Tiwi Islands, specifically the west coast of Bathurst Island and the north coast of Melville Island. These beaches are important areas for marine turtles with nesting dominated by flatback and olive ridley turtles (peak nesting in March to May) (Chatto and Baker, 2008).

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.

4.4.6 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.4.7 Christmas Island Province

These are formed of sand and of coral and shell rubble, often with limestone outcrops. Dolly and West White Beaches are the two largest beaches in the island, while Dolly and Greta Beaches hold sufficient sand to provide habitat for hermit and ghost crabs and to enable green turtles to dig nests (DNP, 2012).

4.4.8 International Waters

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**).

The World Heritage site of Ujung Kulon is also a known site of sandy beaches, as well as the marine national parks of Kepulauan Seribu and Taka Bonerate which are also known as important turtle nesting sites (See **Section 9.8**).

4.5 Rocky Shorelines

Rocky shorelines are found across the combined 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.

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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.

The World Heritage site of Ujung Kulon is also known for its coastline of rocky outcrops, among other ecosystems (see **Section 9.8**).

4.6 International Shorelines

The EMBA extends to the Indonesian, West-Timor and Timor-Leste coastline. The coastlines of these countries support a range of habitats and communities, including sand and gravel beaches, rocky shores and cliffs, intertidal mudflats, mangroves, seagrass and coral reefs (Tomascik et al. 1997; Asian Development Bank 2014). The coastal waters provide habitat for a number of protected species, including humphead wrasses, marine turtles, giant clams, some mollusc species, crustaceans, cetaceans (dolphins and whales) and dugongs, and commercially important species of fish, shrimps, and shellfish (Asian Development Bank, 2014). Nearshore waters also support significant capture fisheries (commercial and subsistence) that contribute to the nation’s economy and employment (Asian Development Bank 2014).

5. Fish and Sharks

Fish distributions in the combined 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 combined EMBA, according to the Protected Matters search (**Appendix A**), are shown in **Table 5-1** along with their WA and NT conservation listings (as applicable) and discussed in **Section 5.2** below.

The following WA conservation codes apply to WA conservation significant fauna:

+ Threatened species (listed under the *Biodiversity Conservation Act 2016* (WA) (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.

The following NT conservation codes apply to NT conservation significant fauna:

+ Threatened wildlife (listed under the Territory Parks and Wildlife Conservation Act 1976 (TPWC Act))
  - Extinct in the wild
  - Critically endangered
  - Endangered
  - Vulnerable
+ Protected wildlife (listed under the Territory Parks and Wildlife Conservation Act 1976)
  - Wildlife in a Territory park, reserve, sanctuary, wilderness zone or area of essential habitat
  - Any vertebrate that is indigenous to Australia

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* 2018/2019 (Gaughan *et al.*, 2020).

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Table 5-1: EPBC listed fish and shark species in the combined EMBA

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code	*TPWC Act 1976*		
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
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	-	Listed nationally	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)	-	Listed nationally	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to **Table 5-3**
Northern river shark (*Glyphis garricki*)	Endangered	-	Priority 1	Endangered	Breeding likely to occur within the area.	None - BIA not found in EMBA
Speartooth shark (*Glyphis glyphis*)	Critically Endangered	-	-	Vulnerable	Species or species habitat known to occur within area.	None - BIA not found in EMBA
Dwarf sawfish (*Pristis clavata*)	Vulnerable & Migratory	-	Priority 1	Vulnerable	Breeding known to occur within area.	Yes – Refer to **Table 5-3**

[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	*TPWC Act 1976*		
Freshwater sawfish (*Pristis pristis*)	Vulnerable & Migratory	-	Priority 3	Vulnerable	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	-	Vulnerable	Breeding known to occur within area.	Yes – Refer to **Table 5-3**
Oceanic whitetip shark (*Carcharhinus longimanus*)	Migratory	-	-	-	Species or species habitat likely to occur within area.	None - BIA not found in EMBA
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
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 combined EMBA:

- Orange roughy (Hoplostethus atlanticus);
- Southern blue fin tuna (*Thunnus maccoyii*);
- Southern dogfish (Centrophorus zeehaani);
- School shark (*Galeorhinus galeus*); and
- Scalloped hammerhead (*Sphyrna lewini*).

[2] Conservation dependent species are listed species under the EPBC Act and are considered as part of the Commonwealth marine area.

5.1 Regional Surveys

Within the combined EMBA a number of important geographical areas for fish exist, including Ningaloo Marine Park, Montebello/Barrow Island Marine Park, Abrolhos 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);
+ 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 Southern Province

The demersal fish assemblages inhabiting the shelf break and slope resemble those found on the Southeast Marine Region’s continental slope more than those of the Central Western Province. The canyons south of Kangaroo Island and adjacent shelf break appear to be important areas for biological productivity and for spawning and aggregation for a range of marine species, particularly during winter. The Albany Group of submarine canyons south of Albany and Esperance are also considered important for biological productivity that attracts feeding aggregations (DEWHA 2008b).

Scientists have described 463 species of fish on the slope of this bioregion, of which 26 are endemic. Only one extensive study of slope fish communities, undertaken during the late 1980s, has been conducted in this bioregion. There is a lower proportion of bottom-feeding demersal fish in this bioregion compared with the west coast, which appears to relate to greater availability of food such as meso-pelagic fish like myctophids (lantern fish) in the water column. Commercial fish landings taken from the shelf break and down the upper and mid-slope include orange roughy, blue grenadier, Bight redfish, school shark, gummy shark, angel shark, gemfish, deep water flatheads, leatherjackets, latchets, stingrays and stingarees (DEWHA 2008b).

Fisheries scientists and some fishers speculate that species such as blue grenadier and western gemfish may have spawning aggregations amongst the submarine canyons and other prominent geological features rising from the seafloor on the slope adjacent to Esperance and Hopetoun. The Diamantina Fracture Zone represents a unique but virtually unknown region of deep-sea habitat and experts speculate it is highly likely that marine communities in this area comprise unique species with high biodiversity. The physical complexity of numerous troughs and ridges and complex water circulation that occurs in this area support these assertions. A number of KEFs are defined which support enhanced productivity and aggregations of marine life (Section 10) (DEWHA 2008b).

5.1.4 Great Australian Bight Shelf Transition

Of the 600 species of fish occurring in southern Australia, 370 are recorded from South Australian waters (Scott et al. 1980). Species restricted to South Australia that occur in the GAB include the coastal stingaree (*Urolophus orarius*) and the crested threefin (*Norfolkia cristata*.

In South Australia, 77 species of fish are utilised commercially. The main fishes targeted by commercial fishers in the GAB are southern bluefin tuna (*Thunnus maccoyii)*, sardine (*Sardinops sagax*), school shark (*Galeorhinus galeus*), gummy shark (*Mustelus antarcticus*), bronzewhaler shark (*Carcharhinus brachyurus*), snapper *(Pagrus auratus*), King George whiting (*Sillaginodes punctata*) and deepwater species such as deepwater flathead (*Neoplatycephalus conatus*), bight redfish (*Centroberyx gerrardi*), deep sea trevalla (*Hyperoglyphe antarctica*) and orange roughy (*Hoplostethus atlanticus*). Surveys conducted by the CSIRO in the GAB between 1965 and 1989 collected information on species composition, sizes, and distribution patterns of fishes. Surveys were conducted by trolling (1979, 1981) and demersal (1978-81), pelagic (1979) and mid-water trawling (1978, 1980-81). CSIRO also have data from Russian surveys conducted in the GAB in 1965-1974.

Recreational fishers in the GAB target Australian salmon (*Arripis truttacea*), mulloway (*Argyrosomus japonicus*), snapper (*Pagrus auratus*), King George whiting (*Sillaginodes punctata*), Australian herring (*Arripis georgiana*) and yellowtail kingfish (*Seriola lalandi*) (Mcleay et al., 2003; DEWHA, 2008b).

5.1.5 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).

5.1.6 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 9.1.3**).

5.1.7 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).

5.1.8 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.

5.1.9 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 10.1.19**.

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 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).

5.1.11 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.

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											

5.1.12 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).

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).

5.1.13 Timor Transition

Records show that the Timor Transition hosts at least 284 demersal fish species (DEWHA, 2008c). The Timor Transition is also known to have a number of pelagic species that are prominent in the open water environment, including some which also have pelagic larval stages in the area (DEWHA, 2008c). The North Marine Bioregional Plan Profile specifically describes pelagic species found within the trough of the Timor Transition including snaggle-teeth fish, hatchet fish and lantern fish (DEWHA, 2008c). The soft-edge/slope of the Timor Transition is also known to support whale sharks and threadfin fish species, with the canyons and channels having distance genetic stocks of red snapper (DEWHA, 2008c).

5.1.14 Northern Shelf Province

Records of the fish species in the Northern Shelf Province show that the majority of available information shows an abundance of fish species in the Gulf of Carpentaria, which is outside the combined EMBA. However, other fish species, including sharks and sawfish are known to occur within the estuarine waters and coastal waters of the Northern Shelf Province (DEWHA, 2008c).

Within the combined EMBA, the Arafura Shelf supports a number of submerged reefs that are used for breeding and aggregation of a number of fish species including mackerel, mangrove jack and snapper (DEWHA, 2008c). Sea snakes and shark species have also been observed in the reef areas (DEWHA, 2008c). Furthermore, the Canyons of the Arafura Depression key ecological feature, which is also within the combined EMBA, is specifically identified as attracting aggregations of predatory fish, whale sharks and sawfish (DEWHA, 2008c).

5.1.15 Christmas Island Province

The Christmas Island Province is in deep, offshore waters (2,200 m – 6,000 m depth range). The island's predominantly intact fringing reefs and adjacent waters support a number of marine and coastal ecosystems and species, including over 600 fish species, with most being typical of the Indian Ocean region. 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)*. The island has more than 50 reef fish species that are not found anywhere else in Australia (although some species may also occur at the neighbouring Cocos Islands) (DNP, 2014).

5.1.16 Cocos (Keeling) Islands Province

The bulk of fish species are widespread or Indo-west Pacific in origin, which points to the significance of the Indonesian Throughflow current in delivering larval recruits to the island. About two thirds of fish species are shared with Christmas Island. A range of pipefish (syngnathidae) have been sighted in with eight identified at the Cocos (Keeling) Islands. This list is biased towards the shallow habitats where data has been collected by divers. There are likely to be more species occurring in these territories than recorded (e.g. in deeper water, on seamounts, slopes etc) (Brewer et al 2009).The province has an intermediate level of primary productivity due to the distance from upwelling events such as those associated with the Java coast. However, the shallower seamounts would be likely to have some significant upwelling or associated with them, which in turn will produce increased productivity and populations of pelagic fish such as bigeye (*Thunnus obesus*) and yellowfin tuna (*T. albacares*).

5.2 Fish Species

Four species of fish listed as Threatened under the EPBC Act (**Table 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 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, although no species is currently listed as threatened or migratory.

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 five species of shark and three species of sawfishes listed as threatened within the search area between south west WA and northern NT (**Table 5-1**), including:

- Grey nurse shark (*Carcharias taurus*);
- Great white shark (*Carcharodon carcharias*);
- Northern river shark (*Glyphis garricki*);
- Whale shark (*Rhincodon typus*);
- Speartooth shark (Glyphis glyphis);
- Dwarf sawfish (*Pristis clavata*);
- Freshwater sawfish (*Pristis pristis*); and
- Green sawfish (*Pristis zijsron*).

In addition, the oceanic whitetip shark (*Carcharhinus longimanus*), 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 5-1).**

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 combined 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 combined 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 combined EMBA are detailed in **Table 5-3** and is shown on **Figure 5-1** (DoEE 2019b).

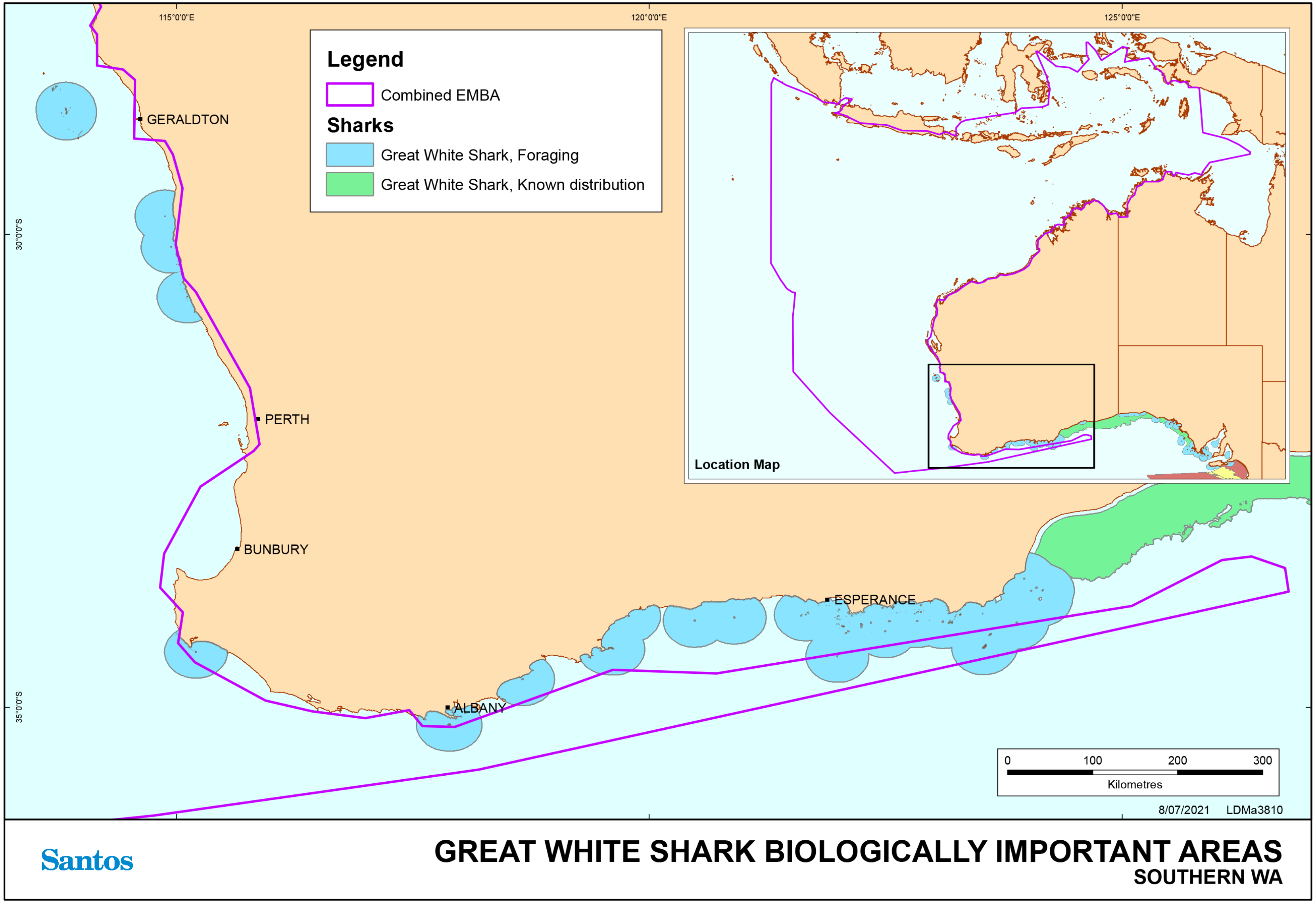

Figure 5-1: Biologically important area – great white shark

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 and as Endangered under the NT *Territory Parks and Wildlife Conservation Act 1976*.

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, NT Territory Parks and Wildlife Conservation Act 1976* 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’’ 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). Whale sharks are well known to occur in the Christmas Island territory. There is evidence that the Christmas Island territory is on the migration route for many individuals, but they are rarely sighted within the Cocos (Keeling) Islands territory.

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 combined 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).*

5.3.5 Speartooth Shark

The speartooth shark (*Glyphis glyphis)* is a medium sized shark found in tidal rivers and estuaries within the Northern Territory and Queensland (DAWE, n.d). It is listed as critically endangered under the EPBC Act and Vulnerable under the NT *Territory Parks and Wildlife Conservation Act 1976.*

There are three distinct geographical locations where the speartooth shark is known to occur with only one of these areas within the combined EMBA, the Van Diemen Gulf.

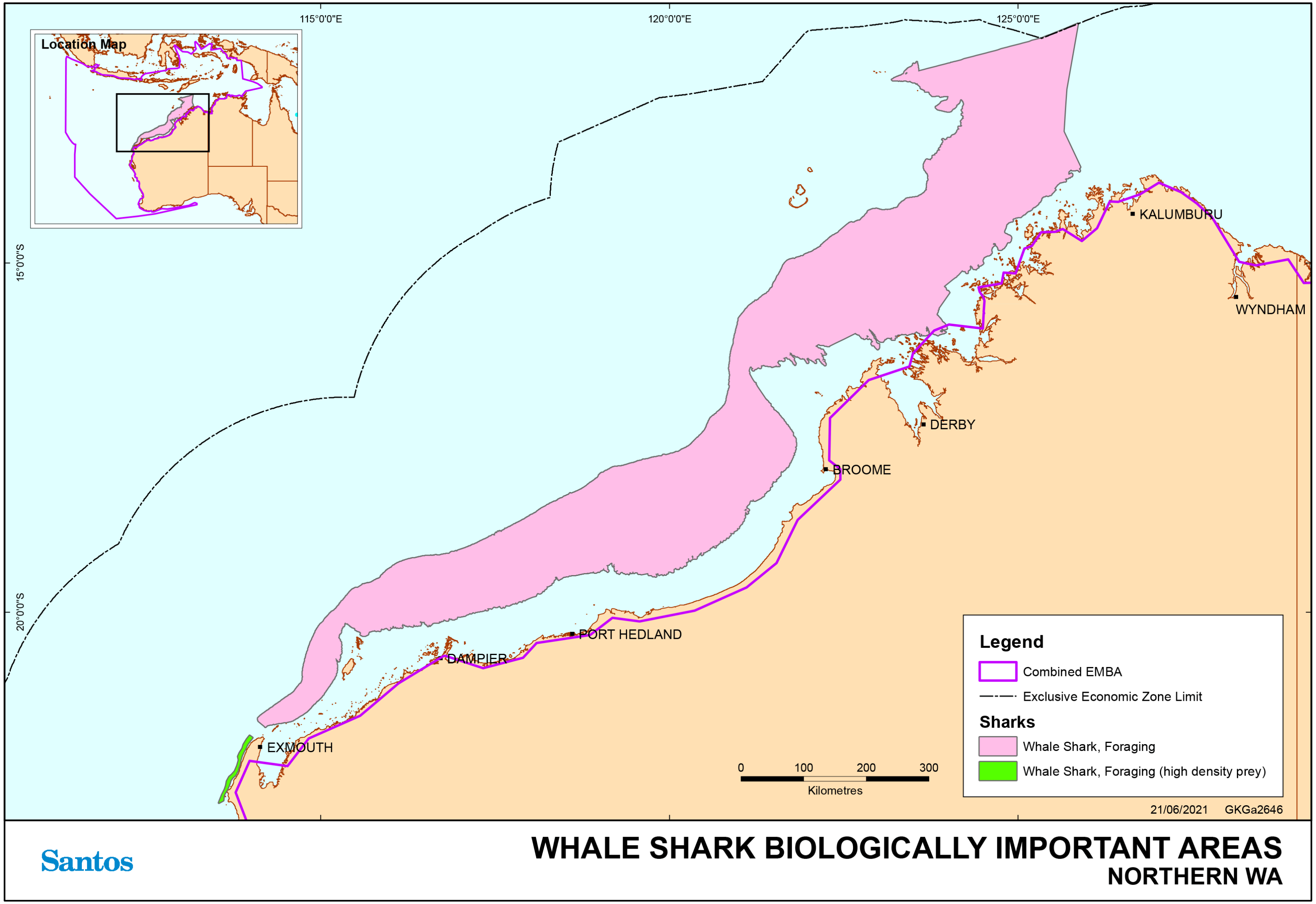

Figure 5-2: Biologically important area – whale shark

5.3.6 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 and as Vulnerable in the NT. 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 and the NT 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 combined EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

5.3.7 Freshwater and Green Sawfish

The freshwater sawfish (*Pristis pristis) (*also previously listed as the Largetooth sawfish*)* and green sawfish (*Pristis zijsron)* are listed as vulnerable under the EPBC Act. The freshwater sawfish is listed as a Priority 3 conservation species in WA, while the green sawfish is listed as Vulnerable under the BC Act and both species are listed as Vulnerable in the NT under the *Territory Parks and Wildlife Conservation Act 1976.*

The freshwater 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 combined EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

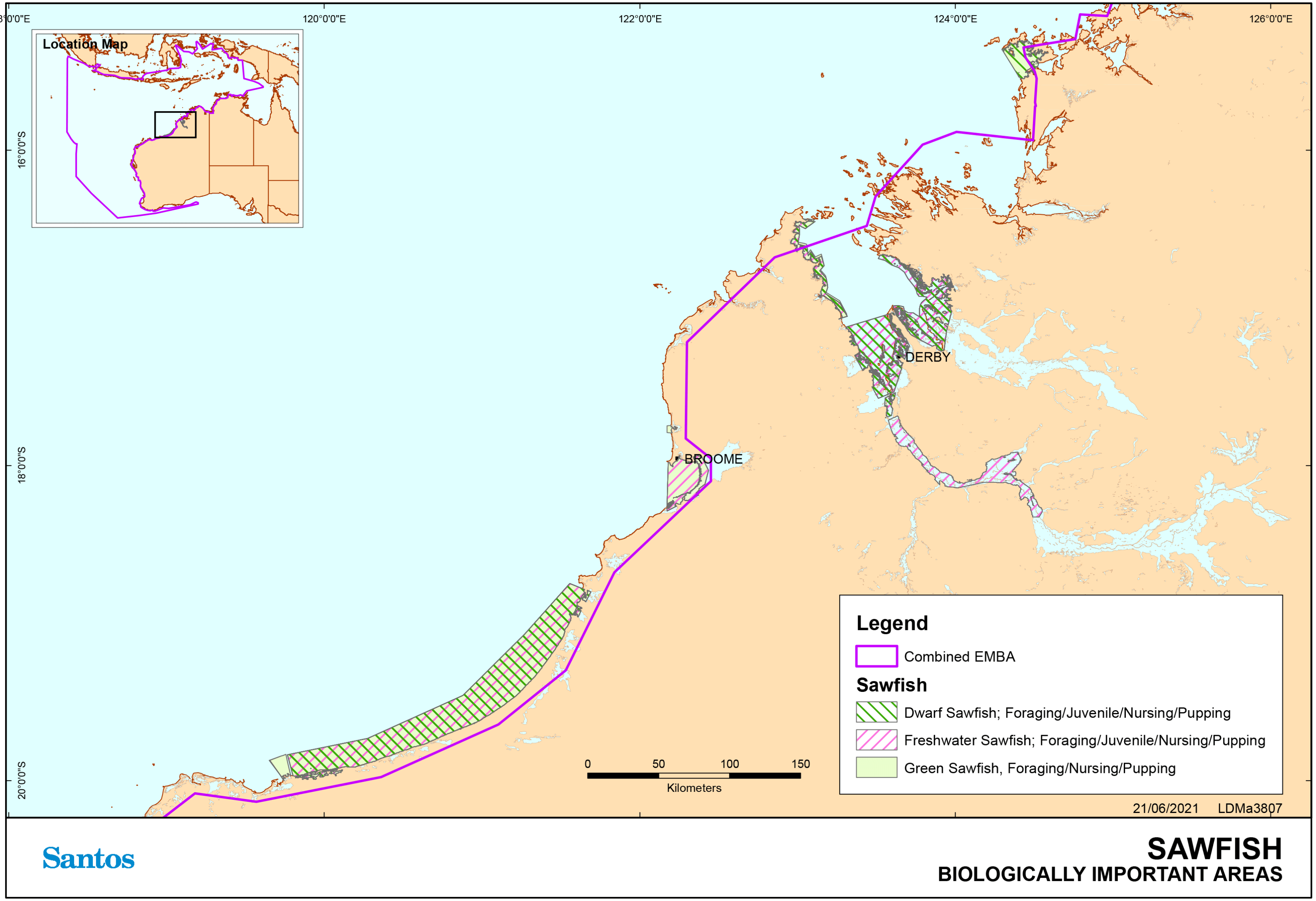

Figure 5-3: Biologically important areas – sawfish

5.3.8 Narrow Sawfish

The narrow sawfish (*Anoxypristis cuspidata*) 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).

5.3.9 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 (*Mobula birostris*) 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 (*Mobula birostris*) 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.

5.3.10 Oceanic Whitetip Shark

The oceanic whitetip shark (*Carcharhinus longimanus*) is listed as migratory under the EPBC Act. The oceanic whitetip shark is widespread throughout tropical and subtropical waters of the world (30° N to 35° S) (IUCN 2020). They are an oceanic and pelagic species that regularly occurs in waters of 18 to 28°C, usually >20°C (IUCN 2020). Within Australian waters, they are found from Cape Leeuwin (Western Australia) through parts of the Northern Territory, down the east coast of Queensland and New South Wales to Sydney (Last and Stevens 2009). They are usually found in surface waters, though can reach depths of >180 m (Castro et al. 1999). They have occasionally been recorded inshore but are more typically found offshore or around oceanic islands and areas with narrow continental shelves (Fourmanoir 1961, Last and Stevens 1994).

5.3.11 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.

5.3.12 Porbeagle (Mackerel Shark)

The porbeagle (mackerel shark) (*Lamna nasus*) is 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 combined 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 to 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. No provision is made under the Territory Parks and Wildlife Conservation Act 1976 for listing critical habitat.

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	Eighty Mile Beach Camden Sound - eastern shore Fitzroy River Mouth, May and Robinson River - tidal tributaries King Sound (inshore waters)

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
		Juvenile – King Sound, Fitzroy River and May Robinson River	
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 Foraging - Cape Keraudren, Roebuck Bay, Cape Leveque, Camden Sound Nursing - Cape Keraudren, Eighty Mile Beach, Ashburton River and Hooley Creek near Onslow	Eighty Mile Beach Camden Sound Cape Keraudren Cape Leveque Roebuck Bay Willie Creek Ashburton River Hooley Creek

6. Marine Reptiles

Thirty-four species of listed marine reptiles under the Commonwealth EPBC Act are known to occur in Australian waters in the combined 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 combined 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 and NT conservation listings (as applicable)[3]. BIAs within the combined EMBA area discussed in **Table 6-3**.

Table 6-1: EPBC listed marine reptile species in the combined EMBA

Species	Conservation Status				Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	*TPWC Act 1976*		
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	-	Vulnerable	Breeding known to occur within area	Yes – refer to **Table 6-3**
Loggerhead turtle (*Caretta caretta*)	Endangered Migratory	Endangered	-	Vulnerable	Breeding known to occur within area	Yes – refer to **Table 6-3**
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered Migratory	Endangered	-	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Leatherback turtle (*Dermochelys coriacea*)	Endangered Migratory	Vulnerable	-	Critically Endangered	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	*TPWC Act 1976*		
					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
Salt-water crocodile *(Crocodylus porosus)*	Migratory	Specially protected species (other specially protected fauna)	-	-	Species or species habitat likely 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 and around the combined EMBA. 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 and the hawksbill turtle, loggerhead turtle and leatherback turtle are also protected under the NT *Territory Parks and Wildlife Conservation Act 1976.*

A summary of the different habitat types used during the various life stages of marine turtle species identified in the combined 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 combined 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 Islands 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 internesting 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 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).

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). Loggerhead turtles have also been sighted in the Christmas and Cocos (Keeling) Islands. 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).

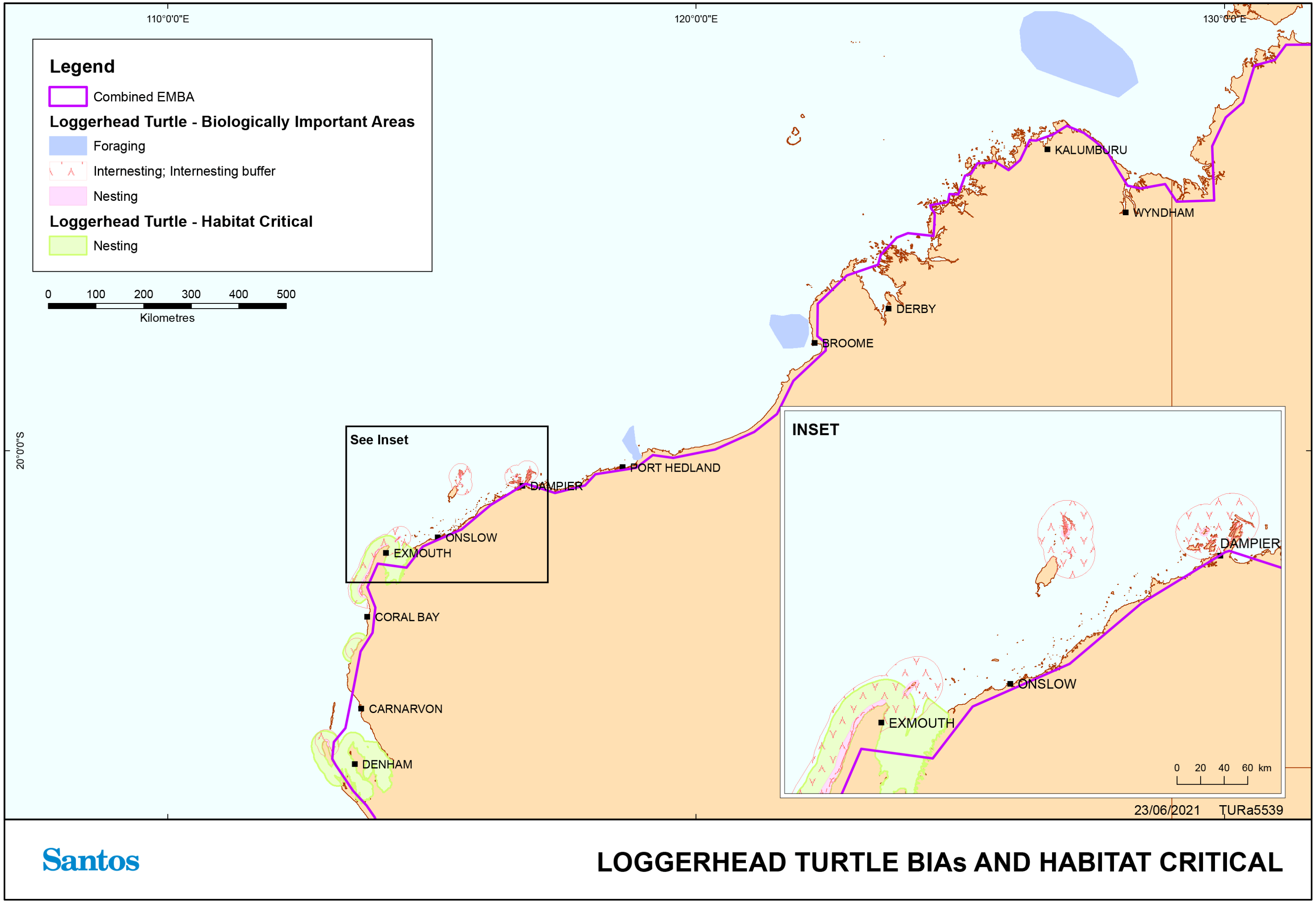

Figure 6-1: Biologically Important Areas and Habitat Critical – Loggerhead Turtle

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 and NT 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 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 on Varanus Island; three green turtles were observed to nest over a four week tagging effort (Astron 2017).

Green turtles have also been recorded nesting in the Bonaparte or Van Diemen Gulf bioregions and some nesting has been recorded on the west coast of Bathurst Island in the Tiwi Islands and Melville Island. BIAs for Green turtles occur on the north coast of the Tiwi Islands and an internesting buffer has been defined 20 km from the Tiwi Islands with internesting expected between October and April (DoEE, 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).

In northern and eastern Australia, fluctuations in green nesting numbers have been linked the Southern Oscillation Index (Limpus & Nicholls, 1994, Limpus & Nicholls, 1988) and sea surface temperatures (Solow et al., 2002). In the NT nesting sites occur mostly from the western end of Melville Island to near the border with Queensland (Northern Territory Government, n.d). There are also four nationally significant nesting sites in the NT being the Cobourg Peninsula, the mainland from Gove to the northern edge of Blue Mud Bay, the southeast of Groote Eylandt and the northern beaches of islands in the Sir Edward Pellew group (Northern Territory Government, n.d). The Cobourg Peninsula genetic stock of Green turtles is the closest to those found within the combined EMBA on the Tiwi Islands. The nesting period for these are between October and April with the peak nesting period occurring between December and January.

Green turtles nest on both Christmas and Cocos (Keeling) Islands, though in low densities on Christmas Island. Up to 100 green turtles nest per year on Cocos (Keeling) Islands, mainly on the north atoll. Green turtles nesting on both Christmas and Cocos (Keeling) Islands are likely to be unique genetic stocks. They also use shallow reef habitats on both islands to forage (Brewer et al, 2009).

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).

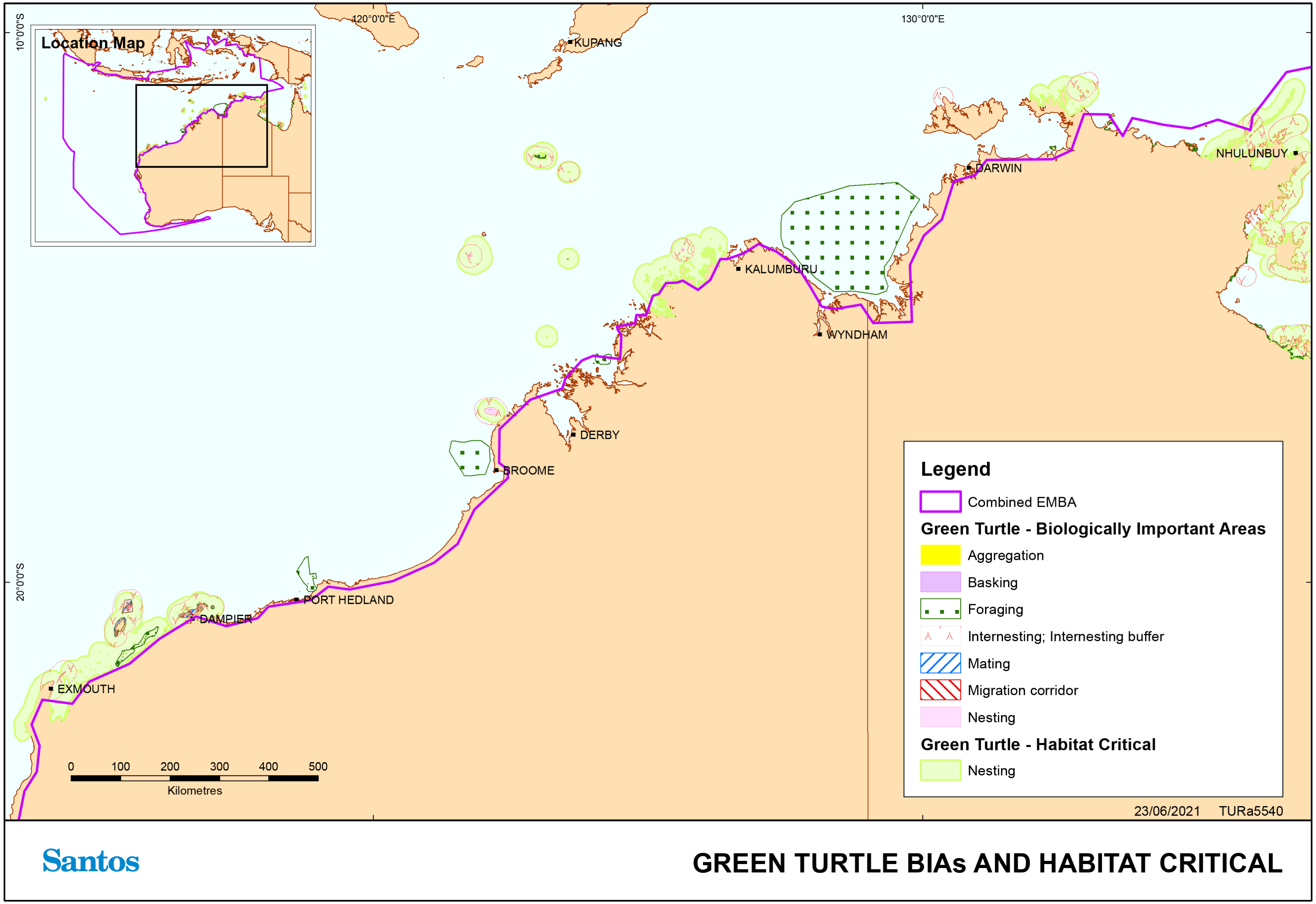

Figure 6-2: Biologically Important Areas and Habitat Critical – Green Turtle

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). There is a second major population of Hawksbill turtles in Australia, which is genetically isolated from the North West Shelf population located along the Northern Territory coast and north-eastern Queensland (Northern Territory Government, n.d).

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 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. Recent baseline data was collected at the Montebello and Dampier AMPs by Keesing, 2019 showing that only one hawksbill turtle was identified during the survey at the Dampier AMP only. No marine turtle species were identified during the survey at Montebello AMP.

In the NT, nesting occurs on islands rather than on mainland beaches. In particular, NT nesting sites are concentrated around north-eastern Arnhem land and Groote Eylandt (Northern Territory Government, n.d). Within the combined EMBA, nesting is known to occur at Ashmore Reef. Although Scott Reef has been described as a nesting beach for hawksbill turtles, this is based on the tagging and recapture of a single hawksbill at this location (Guinea, 2009). Small numbers of Hawksbill turtles also nest on Cocos (Keeling) Islands (mainly the north island). However, thousands of individuals forage in the shallow reef environments feeding on encrusting algae and sessile invertebrates (Brewer et al , 2009).

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). In the NT nesting is reported to occur from July – December (Chatto, 1997, 1998).

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).

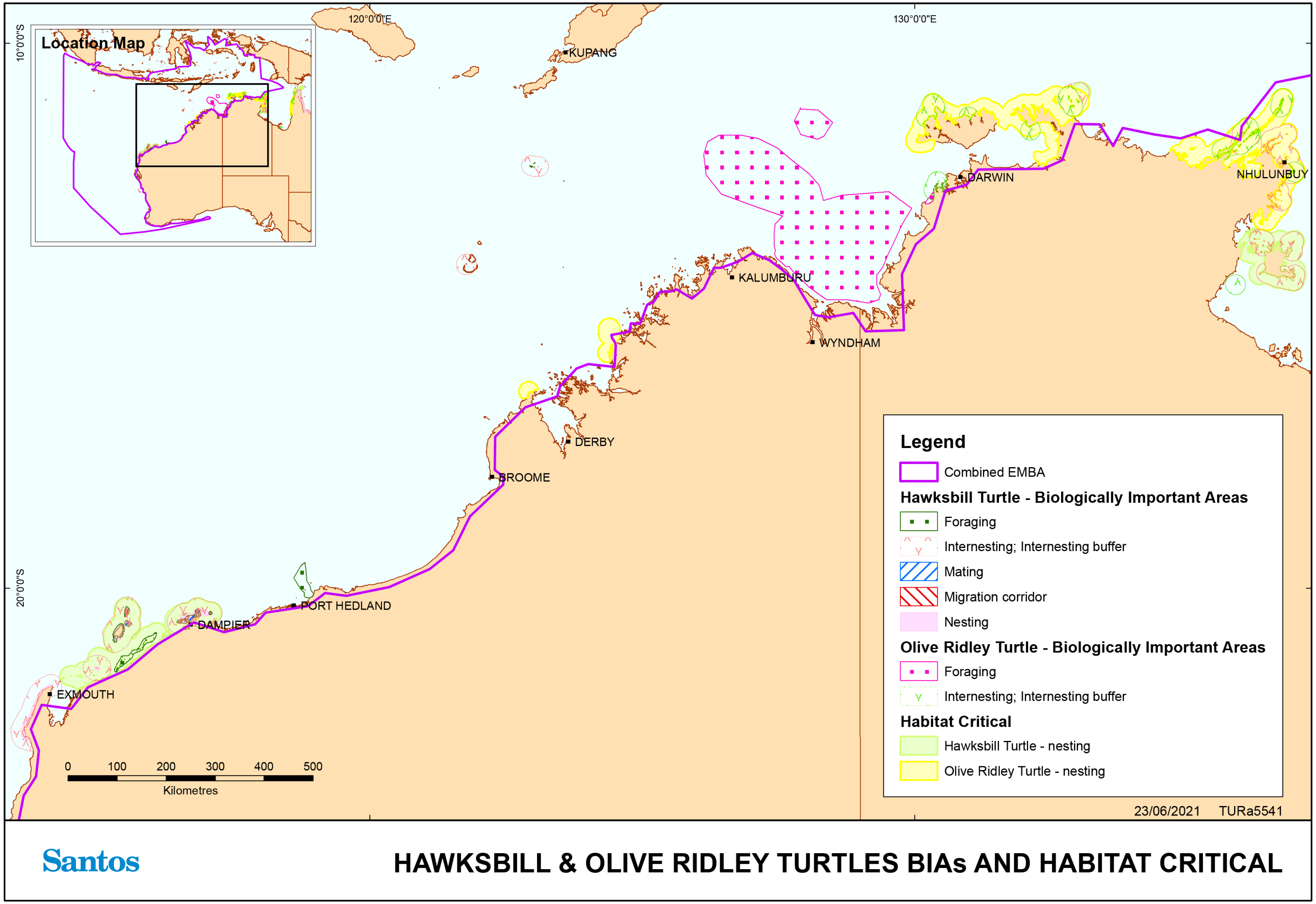

Figure 6-3: Biologically Important Areas and Habitat Critical – Hawksbill and Olive Ridley Turtle

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 breeds mainly in winter (July to September) (Commonwealth of Australia 2017a). The South-west Kimberley stock is also characterised by summer nesting. Populations in western NT are thought to nest all year round with nesting density reaching its peak in July. Populations in northern Australia also nest all year round, with nesting density reaching its peak between June and August (Limpus, 2007).

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). NT populations are typically found in the Gulf of Carpentaria, western Torres Strait, Wellesley Islands Group and Sand Islet.

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).

Santos

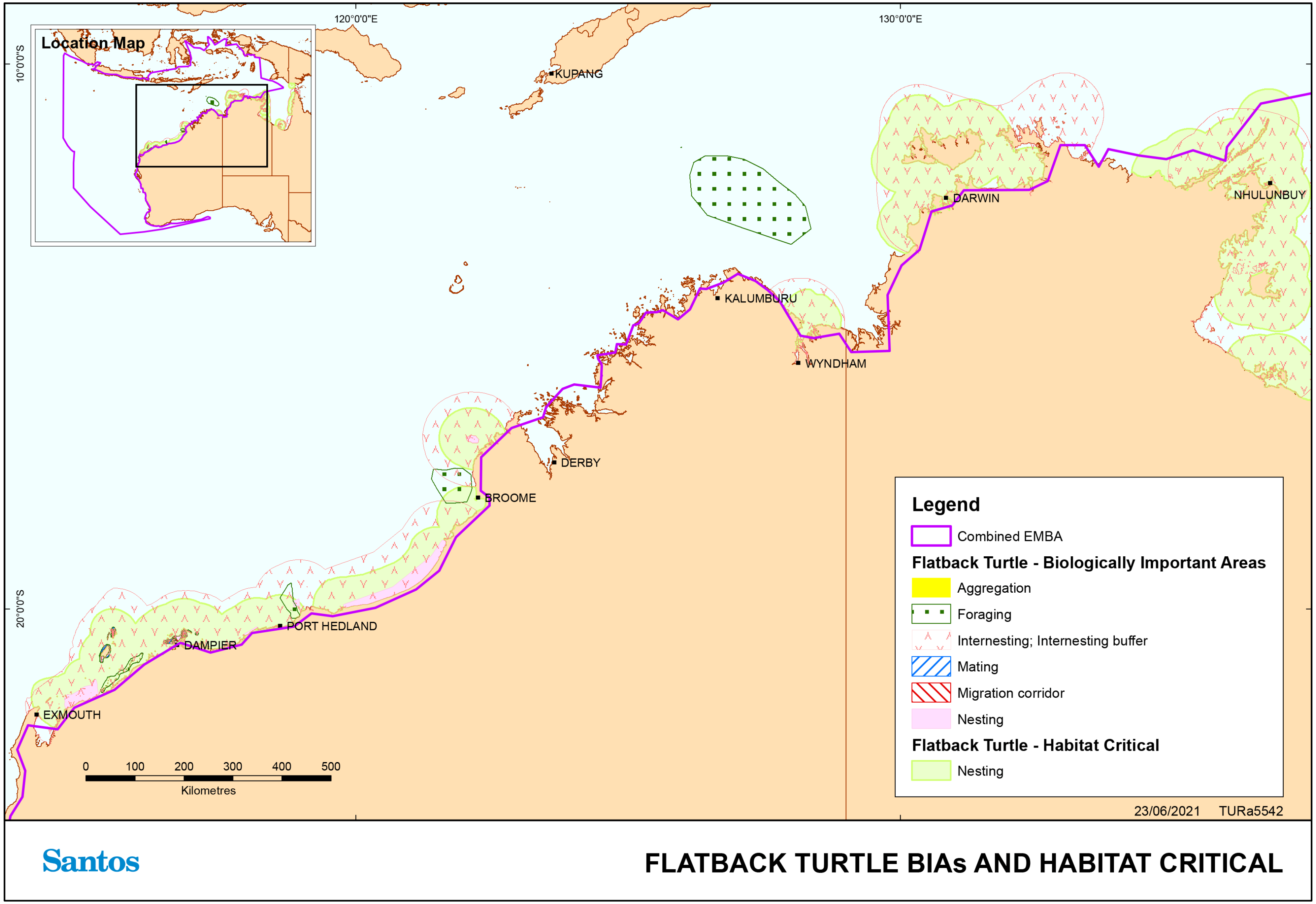

Figure 6-4: Biologically Important Areas and Habitat Critical – Flatback Turtle

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 and NT, 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 combined EMBA.

6.1.6 Olive Ridley Turtles

Olive ridley turtles (*Lepidochelys olivacea*) are the least common turtle species encountered with critical nesting habitat occurring near Vulcan Island, Darcy Island, Prior Point and Llanggi and Cape Leveque (Commonwealth of Australia 2017). They are also known to nest on Tiwi Islands, specifically on the west coast of Bathurst Island and the north coast of Melville Island. The turtles found nesting on the Tiwi Islands is the NT genetic stock whereby the long-term trends of this genetic stock are currently unknown (Commonwealth of Australia 2017). However, the number of females nesting on the Tiwi Islands are considered significant at the genetic stock, national and international level. Nesting of the NT genetic stock can occur year-round with a peak between April and June, and hatchling emergence peaking between June and August (Commonwealth of Australia, 2017).

Internesting habitat, critical to the survival of the olive ridley turtle, encompasses nearshore waters along the north, west and east coasts of the Tiwi Islands. Satellite tracking on a small sample of internesting olive ridley turtles in the region recorded that the individuals remained close to shore (waters depths typically less than 55 m deep) and within 37 km of the nesting beach during the internesting interval (Whiting et al. 2007, Whiting et al. 2005).

This species forages within the shallow benthic habitats of northern WA and the NT 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 and have also been sighted in the Christmas and Cocos (Keeling) Islands in the north of the combined EMBA.

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 combined 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 of WA and NT waters (**Appendix A**). Little is known of the distribution of individual species, population sizes or aspects of their ecology. Seasnakes 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). The limited evidence available suggests that there are no sea snakes in at least the coastal waters of Cocos (Keeling) Islands, and few sea snake sightings in the waters of the Christmas Island territory (Brewer *et al,* 2009).

Two species of seasnakes listed as threatened under the EPBC Act were identified in the Protected Matters search within the combined 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).

In the NT salt-water crocodile has been found in the Mary, Adelaide, Daly, Moyle, Victoria, Finniss, Wildman, West Alligator, East Alligator, South Alligator, Liverpool, Blyth, Glyde, Habgood, Baralminar, Goromuru, Cator and Peter John Rivers with a total 79 individuals per km identified in these river systems (Fukuda, 2007).

6.4 Biologically Important Areas/Habitat Critical – Marine Reptiles

Table 6-3 provides an overview of BIAs in the combined 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].

[4] Further background information on BIA and identification of critical habitat in recovery plans is provided in **Section 5.4**.

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. No provision is made under the Territory Parks and Wildlife Conservation Act 1976 for listing critical habitat.

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 North-west of Melville Island	
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 Island 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) New Year Island 20 km internesting buffer

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
Flatback turtle	*Natator depressus*	Nesting, migration, mating, aggregation, foraging, internesting – Islands of the North West Shelf and the Pilbara/Kimberley coastlines Mating, nesting – Barrow Island	Eighty Mile beach Barrow Island Cape Domett Cape Thouin/ Mundabullangana/ Cowrie Beach 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 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	Cape Domett and Lacrosse Island Lacepede Islands Eighty Mile beach Cemetary beach Eco Beach Mundabullangana Beach Dampier Archipelago Barrow Island, Montebello Island, coastal islands from Cape Preston to Locker Island Soldier Point to Pirlangimpi including Seafull Island 60 km internesting buffer Brace point to One Tree Point, including all offshore islands 60 km internesting buffer Waigait Beach to south of Point Blaze, including all offshore islands 60 km internesting buffer.

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
			Western Joseph Bonaparte Depression Melville Island, Cobourg Peninsula	
Leatherback turtle	*Dermochelys coriacea*	None within EMBA	None within EMBA	All sandy beaches from Coburg Peninsula to Cape Arnhem including Danger Point and Elcho Island 20 km internesting buffer
Olive ridley turtle	*Lepidochelys olivacea*	Foraging, migration – Joseph Bonaparte Gulf – Kimberley region	Western Joseph Bonaparte Depression Northern Joseph Bonaparte Gulf	Cape Leveque Prior Point and Llanggi Darcy Island Vulcan Island Soldier Point to Pirlangimpi including Seafull Island 20 km internesting buffer Brace Point to One Tree Point, including all offshore islands 20 km internesting buffer Croker Island, Coburg Peninsula, west of Murganella to the West Alligator River 20 km internesting buffer

7. Marine Mammals

Forty-four species of listed marine mammals are known to occur in Australian waters in the combined EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DAWE 2020a) showed that some listed mammal species are not expected to occur in significant numbers in the marine and coastal environments in the combined 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 and *Territory Parks and Wildlife Conservation Act 1976* (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**.

In addition, the New Zealand fur-seal *(Arctocephalus forsteri)*, has been identified as a species of relevance to the combined EMBA. The New Zealand fur seal is listed as a protected species under WA BC Act (other specially protected), but not listed as threatened under the EPBC Act.

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	TPWC Act 1976		
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 Migration route 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	TPWC Act 1976		
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 known 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 cinerea)*	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**

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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 (DAWE 2020a). There are no known mating or calving areas in Australian waters (Parker 1978 in DAWE 2020a). The National Conservation Values Atlas currently record no BIAs for this species (DAWE 2020b). Surveys of the Bonney Upwelling (outside of the combined EMBA) between 2000 and 2003 recorded sightings of sei whales feeding during summer and autumn, indicating that this is potentially an important feeding ground (DAWE 2020b).

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 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). A noise monitoring study conducted in 2014-15 recorded pygmy blue whales moving in a northward direction in August 2014 and between late-May to early July 2015 (JASCO Applied Sciences, 2016; McPherson, Craig et al., 2015). 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). No detections of the species were made during the period of their southward migration during the noise monitoring study.

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 combined EMBA include Ningaloo Reef and the Perth Canyon (DoE 2015a). The Ningaloo Reef area has the capacity to offer feeding opportunities to pygmy blue whales through unique biophysical conditions able to support large 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). Outside of the recognised feeding areas, possible foraging areas for pygmy blue whales include the greater region around the Perth Canyon, off Exmouth and Scott Reef in WA (DoE 2015a). 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, DAWE 2020a). There are no known breeding areas of significance to blue whales in waters from Busselton to the NT.

The BIAs for blue whale and pygmy blue whale are detailed in **Table 7-3** and depicted in **Figure 7-2** and **Figure 7-1.**

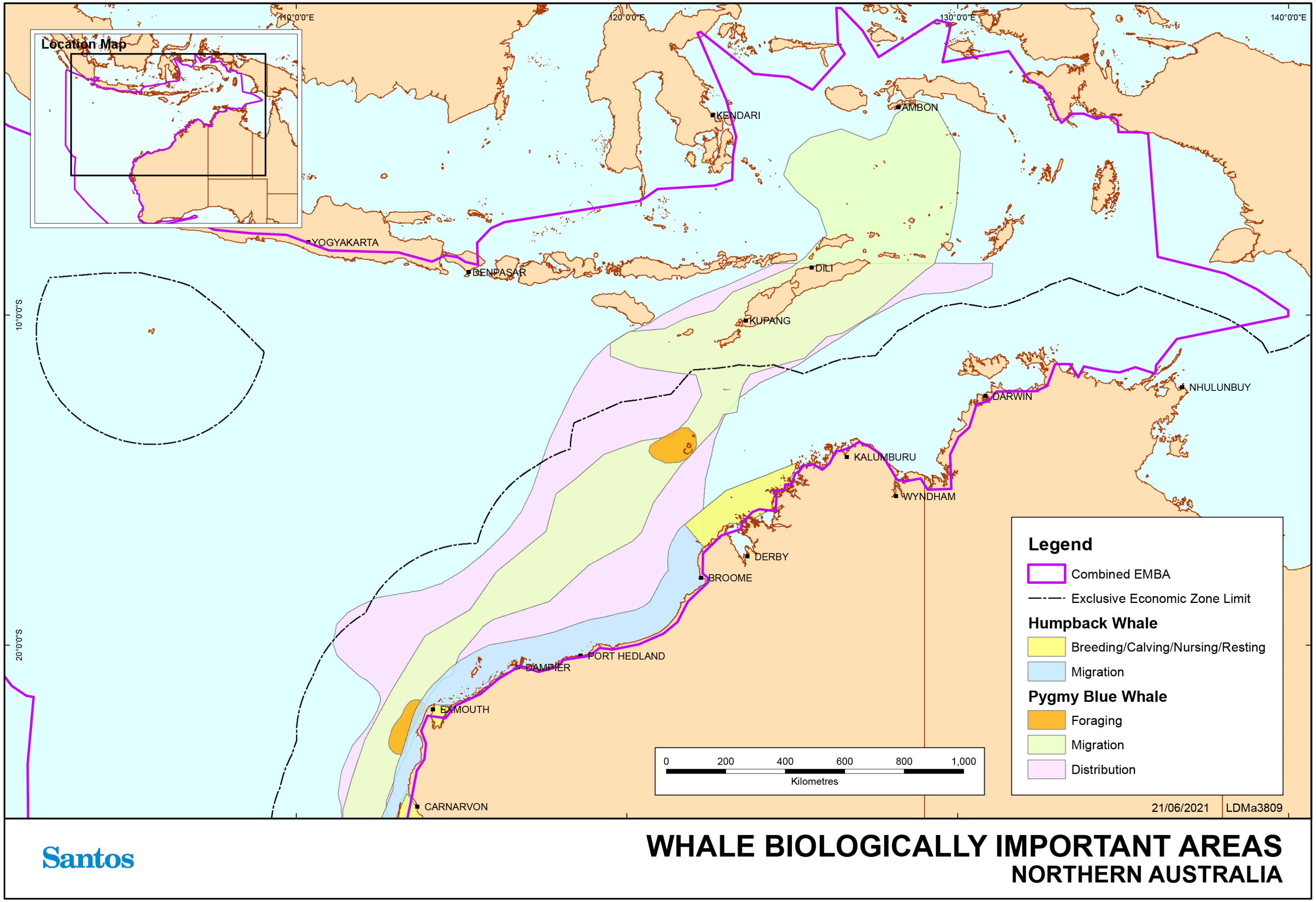


Figure 7-1: Biologically important areas – whales – Northern WA

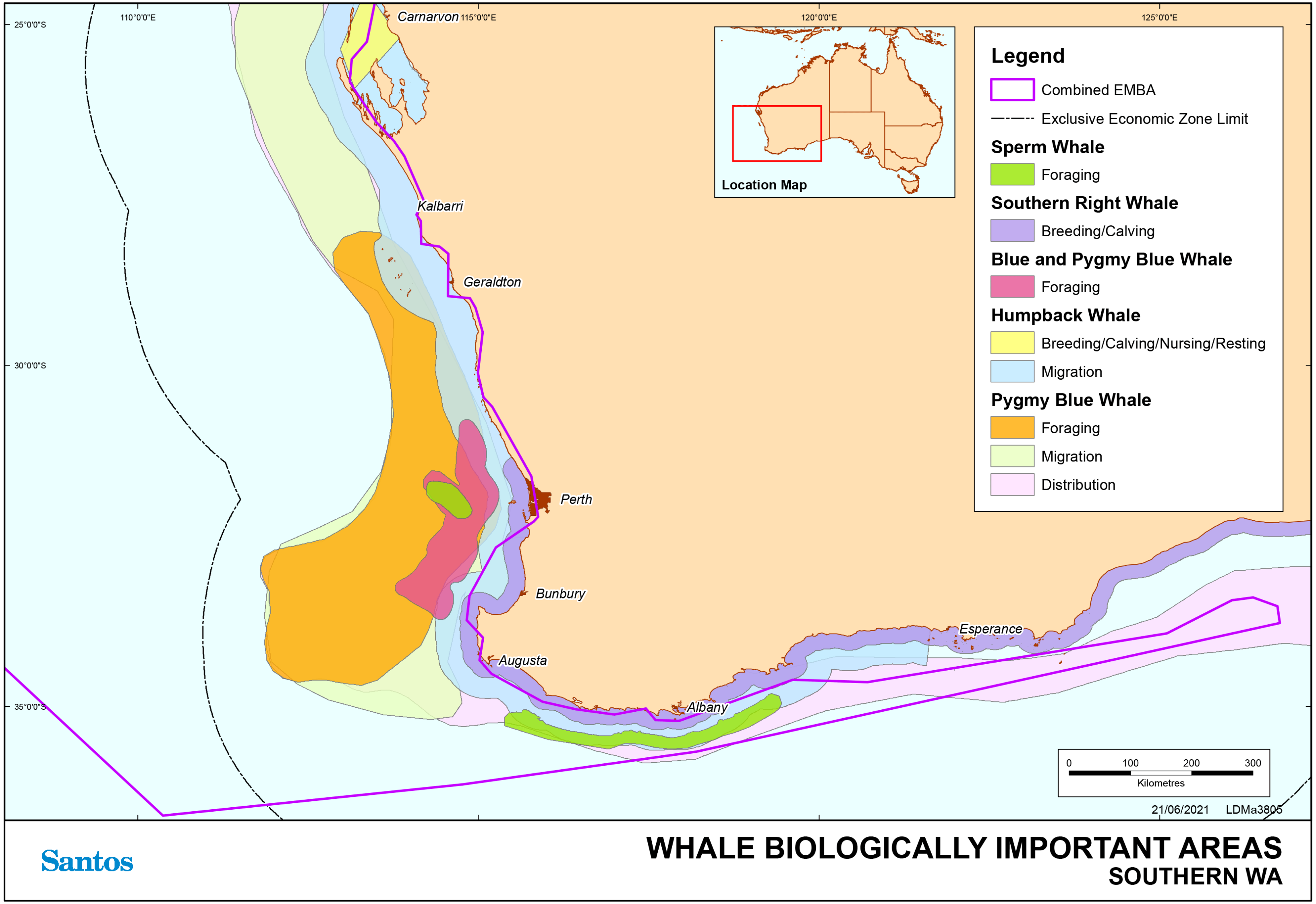


Figure 7-2: Biologically important areas – whales – Southern WA

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 (DAWE 2020a); 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 (DAWE 2020b).

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 (DAWE 2020b). Details on the BIA for southern right whale are provided in **Table 7-3** and depicted in **Figure 7-2** and **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).

Humpback whale populations have increased since being placed on the threatened species list for exploitation from whaling, resulting in a higher abundance of species off our Western Australian coastline. Humpback whales have been able to thrive and increase in numbers despite the heavy oil and gas exploration. A study presented by Bejder et al (2016) has prompted a review of the species being down listed under Commonwealth legislation and regulations, as they are not eligible for listing as a threatened species under all statutory criteria.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; Irvine et al., 2018). 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 was sighted at an average distance of 50 km from the mainland during the northern migration and 35 km during the southbound migration (RPS 2010a). Woodside have conducted aerial surveys that have confirmed that the reported distribution of migrating humpback whales off the North West Cape is consistent with baseline surveys first conducted in 2000 to 2001 (RPS, 2010 in Woodside 2020).

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 7-2** and **Figure 7-1**.

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 7-2** and **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 combined 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 shallower coastal areas. Killer whales are known to make seasonal movements and are most likely to follow the migratory routes of their prey, however, little is known about these movements (DoEE, 2019). They are more likely to be observed around seal colonies, with a significant seal colony within the combined EMBA being located in WA at the Abrolhos Islands.

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 combined 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 combined 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 combined 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.

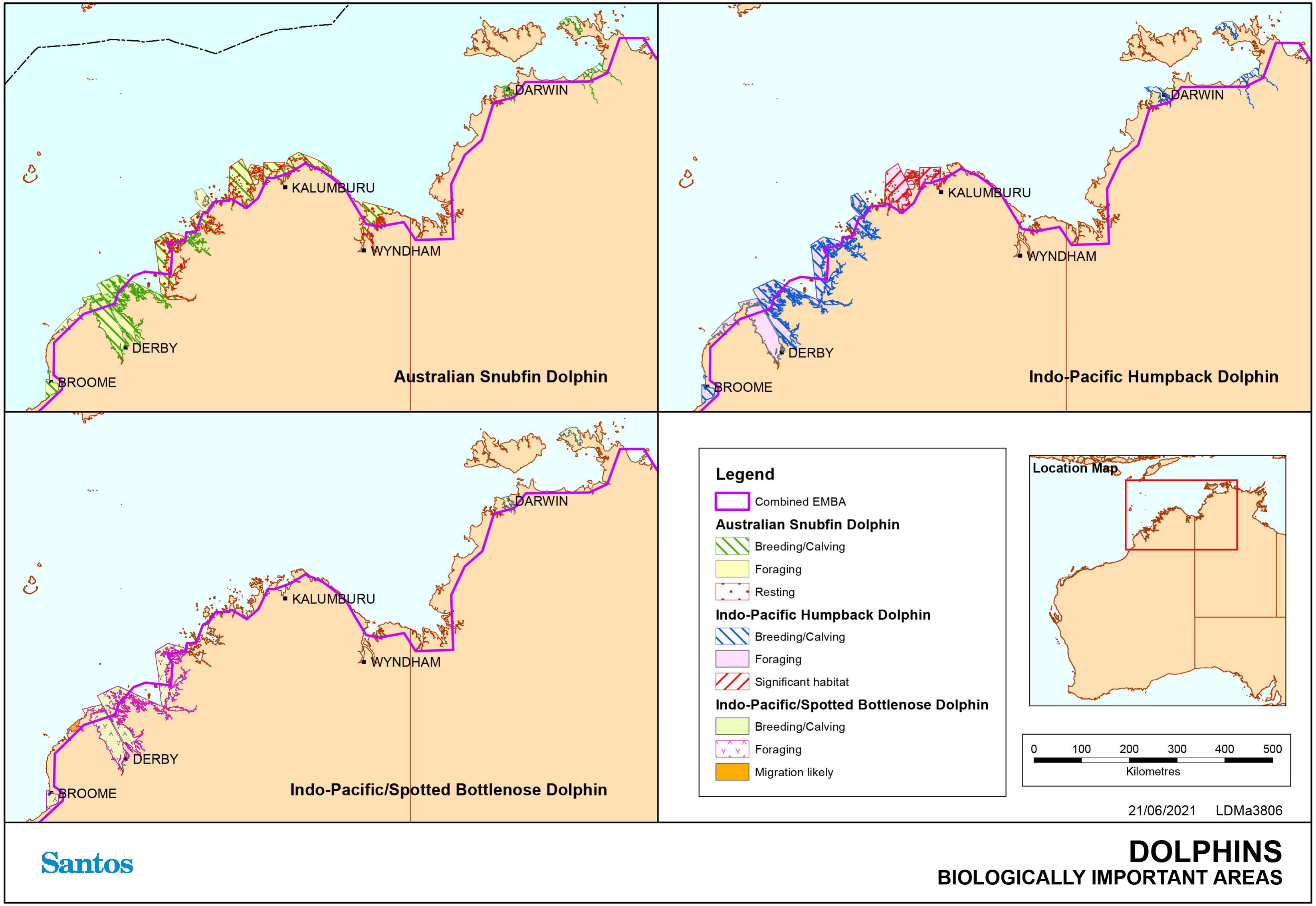


Figure 7-3: Biologically important areas – dolphins

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 (DAWE 2020b). 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 combined EMBA is outlined in **Table 7-3** and is depicted in **Figure 7-4.**

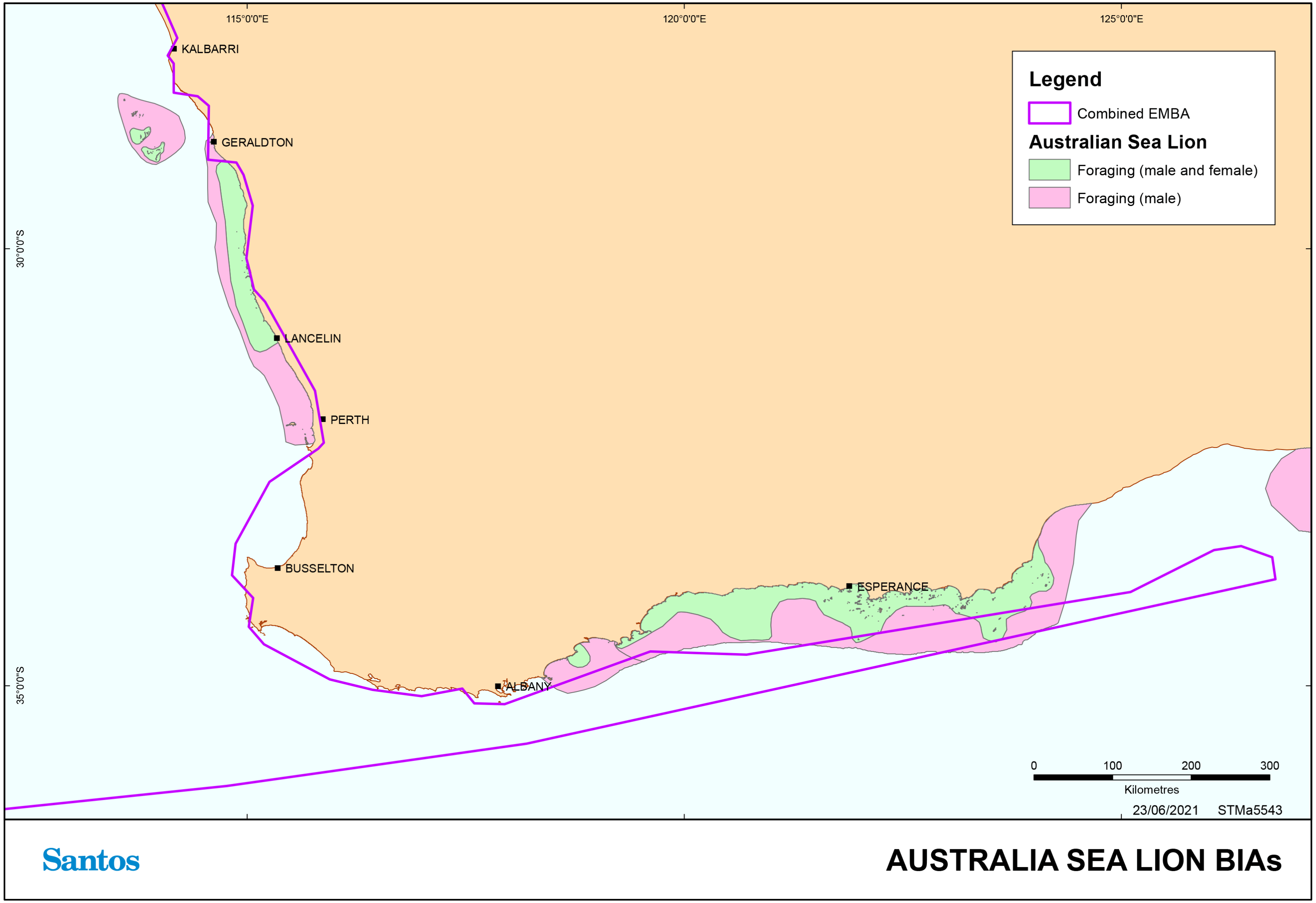


Figure 7-4: Biologically important areas – Australian sea lion

7.1.16 Dugongs

Dugongs (*Dugong dugon*) are large herbivorous marine mammals (up to 3 m) 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, and the north coast of the Tiwi Islands is recognised as a key site for the conservation of dugongs. A well-known major dugong aggregation of approximately 4, 400 individuals occurs in waters seaward (within approximately 50 km) of the Tiwi Islands and ranks in the top eight of dugong populations in the world.

Dugong distribution and movement is based on the abundance, size and species of seagrass meadow. Dugongs can migrate hundreds of kilometres between seagrass habitats. Dugongs have been tracked moving long distances of up to 300 km between the Australia mainland and the Tiwi Islands (Whiting et al., 2009). Satellite-tracking data from dugongs tagged as part of the INPEX Ichthys Project baseline surveys observed that dugongs around the Vernon Islands, south of Melville Island, spent time in Darwin Harbour and around the Tiwi Islands (INPEX, 2010). Routine sightings occur in various locations along the NT coastline, including within Darwin Harbour, to the south of Melville Island.

Dugongs in the NT coastal waters have been observed foraging in intertidal rocky reef flats supporting sponges and algae as seagrass habitat is thought to be rare in the north marine region bioregion (INPEX, 2010; Whiting et al., 2009). However, seagrass communities are known to exist along the north coast of the Tiwi Islands.

The dugong BIAs in the combined 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.

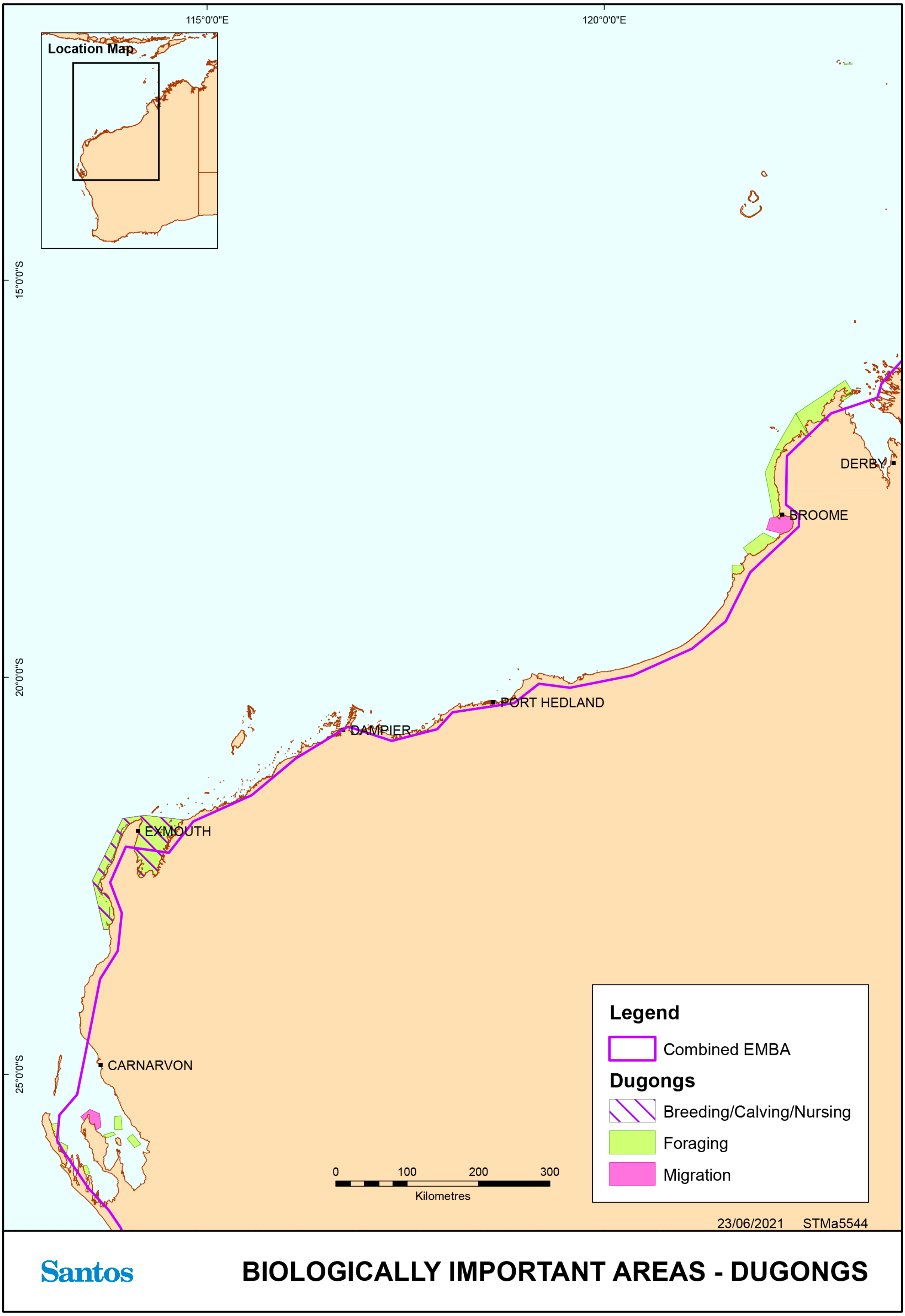


Figure 7-5: Biologically important areas – dugongs

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 combined 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. No provision is made under the Territory Parks and Wildlife Conservation Act 1976 for listing critical habitat.

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 Distribution – along the WA coastline towards and beyond Indonesia.	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	*Eubalaena 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 Vansittart Bay, Anjo Peninsula

Species	Scientific name	Aggregation area and use	BIAs within EMBA
			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 East of Faure Island, Shark Bay

Species	Scientific name	Aggregation area and use	BIAs within EMBA
		Breeding/calving/nursing – Exmouth and the Ningaloo coastline	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 combined 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 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 9.1.3**.

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 breeding 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%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 1,000,000 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-bellied 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 in 2013/14 indicate that South and North Muiron Islands are regionally significant in terms of wedge-tailed shearwater (*Ardenna pacifica*) 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 (*Ardenna pacifica*), Caspian terns (*Sterna caspia*), bridled terns (*Onychoprion 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 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).

8.1.6 Lowendal Island Group and Airlie and Serrurier Islands

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).

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 and demonstrated the colony sizes for wedge-tailed 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, 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 combined EMBA identified 33 bird species (**Appendix A**) listed as threatened under the EPBC Act.

An examination of the Species Profile and Threats database (DAWE 2020a) 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 combined 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 and NT conservation status (as applicable), and discussed below. There are an additional 51 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	*TPWC Act 1976*		
Shorebirds						
Red knot (Calidris canutus)	Endangered, Migratory	Endangered	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Christmas Island Goshawk (*Accipiter fasciatus natalis*)	Endangered	Endangered	-	-	Species or species habitat known to occur within area	None - No BIA defined
Curlew sandpiper (*Calidris ferruginea*)	Critically endangered, Migratory	Critically endangered	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Great knot (*Calidris tenuirostris)*	Critically endangered, Migratory	Critically endangered	-	Vulnerable	Roosting known to occur within area	None - No BIA defined
Greater sand plover (*Charadrius leschenaultii)*	Vulnerable, Migratory	Vulnerable	-	Vulnerable	Roosting known to occur within area	None - No BIA defined
Lesser sand plover (*Charadrius mongolus)*	Endangered, Migratory	Endangered	-	Vulnerable	Roosting known to occur within area	None - No BIA defined
Western Alaskan bar-tailed godwit (*Limosa lapponica baueri)*	Vulnerable, Migratory[7]	Vulnerable, Specially protected (migratory)[7]	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri)*	Critically endangered, Migratory[7]	Critically endangered, Specially protected (migratory)[7]	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined
Eastern curlew (*Numenius madagascariensis)*	Critically endangered, Migratory	Critically endangered	-	Vulnerable	Species or species habitat known to occur within area	None - No BIA defined

[7] Listed as migratory at species level

Species	Conservation Status				Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	*TPWC Act 1976*		
Australasian bittern (*Botaurus poiciloptilus*)	Endangered	Endangered	-	-	Species or species habitat known to occur within area	Yes – refer to **Table 8-6**
Australian painted snipe (*Rostratula australis*)	Endangered	Endangered	-	Vulnerable	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**
Fairy prion (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, Migratory	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

Species	Conservation Status				Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code	*TPWC Act 1976*		
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	Yes – refer to **Table 8-6**
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 may occur within area	None - BIA not found in EMBA
Abbott’s booby (*Papasula abbotti)*	Endangered	-	-	-	Species or species habitat likely to occur within area	Yes – refer to **Table 8-6**
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 nereis)*	Vulnerable	Vulnerable	-	-	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	*TPWC Act 1976*		
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)*	Endangered, Migratory	Vulnerable	-	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
White-capped albatross (*Thalassarche 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 and in the east for the lesser sand plover (DAWE 2020a).

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 (DAWE 2020a).

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 Australasian Bittern occurs mainly in freshwater wetlands and, rarely, in estuaries or tidal wetlands (Marchant & Higgins 1990). It favours wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and reeds (e.g. *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus*) or cutting grass (*Gahnia*) growing over a muddy or peaty substrate (Marchant & Higgins 1990). The diet of the Australasian Bittern includes aquatic animals such as small fish, frogs, freshwater crayfish, spiders, insects and small reptiles at night. Breeding occurs during summer from October to January.

All remaining natural habitat (including constructed wetlands) is considered critical habitat for this species. This species is known to occur on the western coastal plain between Lancelin and Busselton and the southern coastal region from Augusta to east of Albany within the combined EMBA (**Table 8-6**).

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 DAWE 2020a). 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 DAWE 2020a).

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 combined 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 (DAWE 2020a).

The National Conservation Values Atlas (DAWE 2020b) 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 NT 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 (Birdlife International 2019) but forages and roosts widely in south-east Asia and Indian Ocean No breeding colonies have ever been found away from Christmas Island. The Christmas Island Frigatebird predominantly nests in forests on shore terraces that are protected from prevailing south-east trade winds (TSSC 2020a). All forest containing nesting and roosting sites, including currently known nesting and roosting colonies and any other smaller groups of nests and roosts on Christmas Island is considered critical habitat (TSSC 2020a).

Christmas Island Goshawk

The Christmas Island Goshawk is considered to be the rarest endemic bird on Christmas Island, where it occurs in all habitats from primary and marginal rainforests to suitable areas of secondary regrowth vegetation. The total population size is thought to be very small, perhaps as few as 100 adults, and is probably limited by the availability of suitable rainforest habitat.

Santos

Crazy Ants pose an unknown but potentially critical threat to the survival of this bird. The National recovery plan for the Christmas Island Goshawk (*Accipiter fasciatus natalis*) aims to downgrade the Christmas Island Goshawk from Endangered to Conservation Dependent, primarily through successful implementation of the Invasive Ants on Christmas Island Action Plan and protection of habitat critical to the survival of the species from clearance. An assessment of goshawk population dynamics is the most essential requirement of this recovery plan, and community awareness and participation in the conservation of this endemic raptor are also important actions.

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 (DAWE 2020a).

The National Conservation Values Atlas (DAWE 2020b) 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 (DAWE 2020b) does not identify any BIAs for this species in the area spanning SW WA to the NT 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 DAWE 2020a).

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 combined EMBA, this species is unlikely to occur.

The National Conservation Values Atlas (DAWE 2020b) 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 and south-east Asia (TSSC 2020b). 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. Critical habitat is considered all known nesting trees and all forest vegetation within a 200m radius of known nesting trees on Christmas Island (TSSC 2020).

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 (DAWE 2020a). 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 DAWE 2020a). 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 (DAWE 2020b) 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 (DAWE 2020b) does not identify any BIAs for this species within the combined EMBA.

Fairy Prion (southern)

The fairy prion 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 (DAWE 2020b) does not identify any BIAs for this species within the combined EMBA.

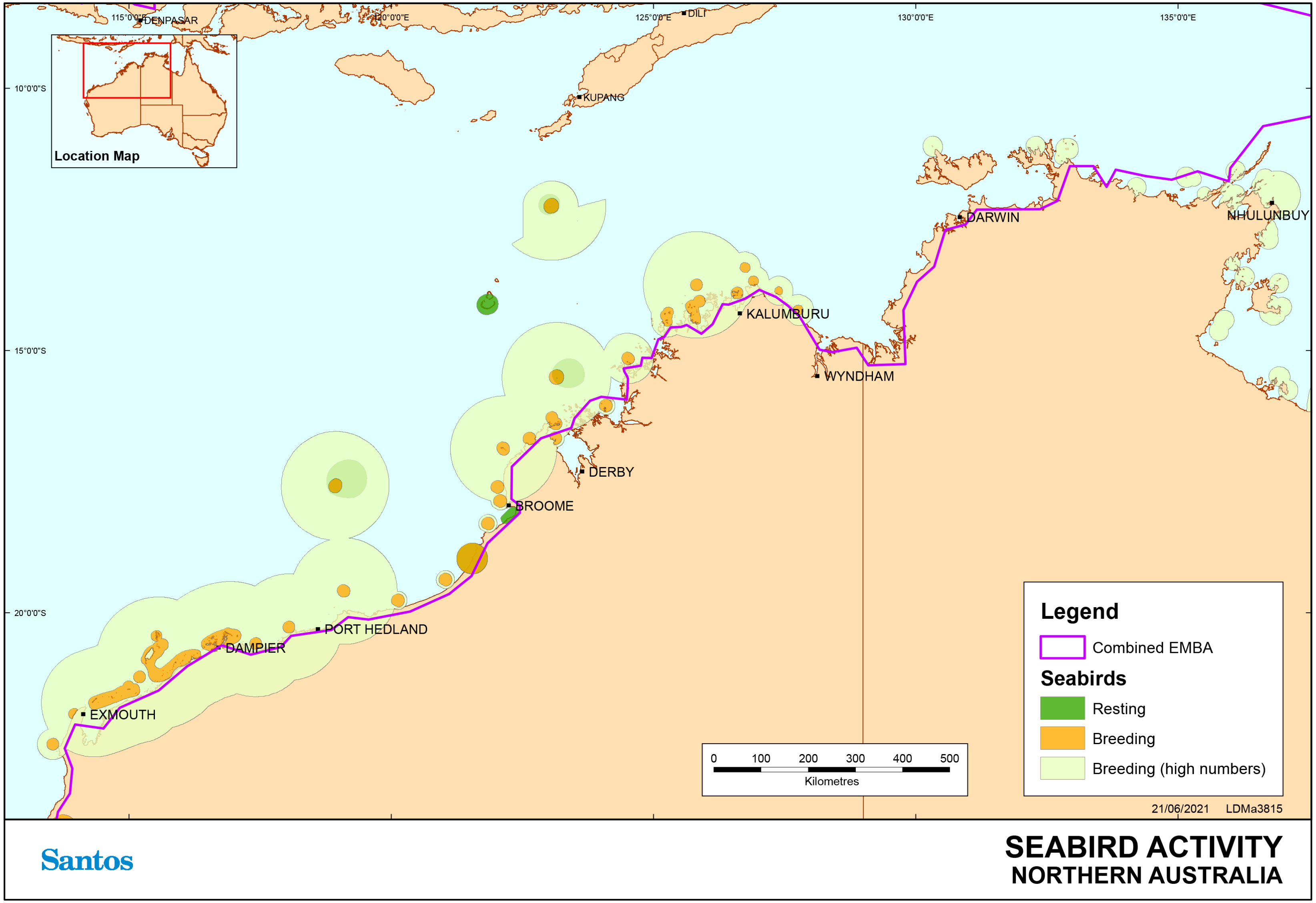
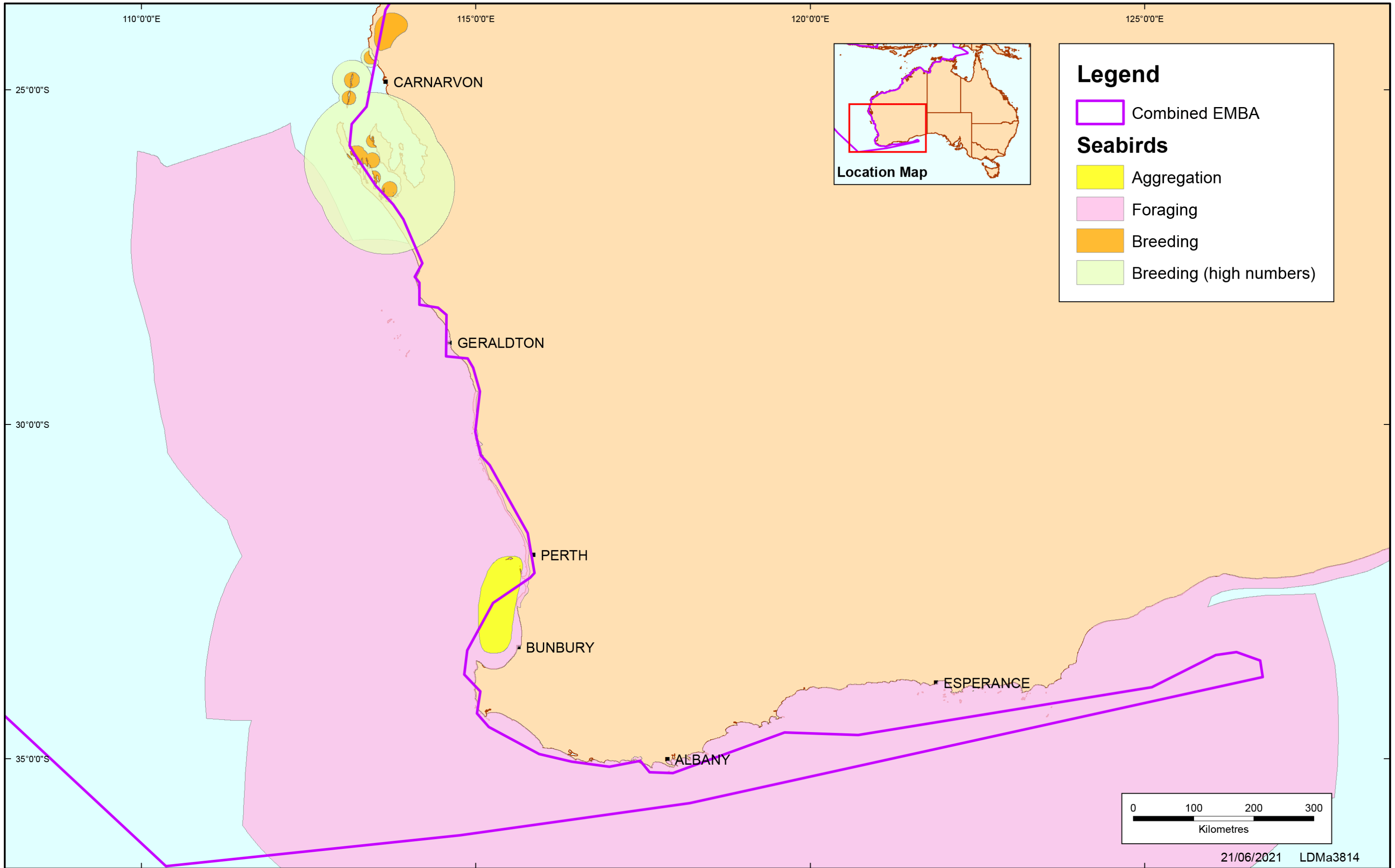


Figure 8-1: Biologically important areas – birds – Northern WA



Santos

SEABIRD ACTIVITY
SOUTHERN 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 combined 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 prion (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 an additional 51 species listed as migratory under the EPBC Act that may occur within the combined EMBA. These species are listed in **Table 8-3**. All of these species are also listed as migratory under the BC Act, with the exception of the flesh-footed shearwater, which is listed as vulnerable under the BC Act. Those species that are listed as both migratory and threatened under either the EPBC Act and/or BC 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 combined 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

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
Thalasseus bergii	Greater crested tern	Breeding known 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
Numenius minutus	Little curlew	Roosting 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
Tringa stagnatilis	Marsh sandpiper	Roosting 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
Gallinago stenura	Pin-tailed snipe	Roosting 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
Erythrotriorchis radiatus	Short-tailed shearwater	Species or species habitat may occur within area
Ardenna grisea	Sooty shearwater	Species or species habitat may occur within area

Species	Common Name	Likelihood of occurrence in EMBA
Calonectris leucomelas	Streaked shearwater	Species or species habitat known to occur within area
Gallinago magala	Swinhoe's snipe	Roosting known to occur within area
Xenus cinereus	Terek sandpiper	Roosting known to occur within area
Tringa glareola	Wandering Tattler	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
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.

Eleven internationally recognised areas that can support shorebird migrations are protected as wetlands of international importance. These wetlands are discussed further in **Section 9.1.3**.

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

Feeding habitat	Feeding guild	Species
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
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 (DoE 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. In the NT populations have been recorded from Darwin and Melville Island. Sites of international importance from WA and the NT include; + Eighty Mile Beach, WA (110,290 individuals); + Roebuck Bay, WA (65,000 individuals); + Milingimbi coast, NT (7,000 individuals); and + Elcho Island, NT (5,000 individuals).
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 inhabits 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

Migratory species	DoEE SPRAT information on distribution within the area of interest
	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). The NT does not have any sites of international importance.
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: + Roebuck Bay; and + Nuytsland Nature Reserve. NT distribution includes: + Kakadu National Park; and + Darwin area.
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). In the NT scattered records exist around some offshore islands, mostly south to Victoria River Downs.
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

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ 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 + 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, WA (approximately 60,000 birds); and + Roebuck Bay, WA (Approximately 8,500 birds).
Oriental pratincole	Internationally important site: + Eighty Mile Beach, WA (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, and throughout the entire coastline of the NT.
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.

Migratory species	DoEE SPRAT information on distribution within the area of interest
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 + 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.
Swinhoe's snipe	No conclusive records exist for this species in Australia so the number of individuals that appear in Western Australia are unknown. In WA the species has been recorded in parts of the Pilbara, the Kimberley, Mount Goldsworthy, Mount Blaize. It has also been found in the north west-regions around the Mitchell Plateau
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:

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ 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) + 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 / Critical Habitat– Birds

Table 8-6 below provides an overview of BIAs in the combined 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**[8].

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'. No provision is made under the Territory Parks and Wildlife Conservation Act 1976 for listing critical habitat.

Table 8-6: Critical habitat/ biologically important areas - birds

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Abbott's booby	*Papsula abbotti*	All known nesting trees and all forest vegetation within a 200m radius of known nesting trees for Abbott's booby	Christmas Island
Australasian bittern	*Botaurus poiciloptilus*	All natural habitat (including constructed wetlands with suitable habitat)	Western coastal plain between Lancelin and Busselton Southern coastal region from Augusta to east of Albany
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

[8] 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	Specific geographic locations for species
			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 tenuirostris melanops*	Foraging - Houtman Abrolhos Islands	Houtman Abrolhos Islands
Bridled tern	*Onychoprion 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.
Christmas Island frigatebird	*Fregeta andrewsii*	All forest containing nesting and roosting sites, including currently known nesting and roosting colonies and any other smaller groups of nests and roosts	Christmas Island
Greater crested tern	*Thalasseus bergii*	Breeding (high numbers)	Melville Island
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

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
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.
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-	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

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
		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

9. Protected Areas

A number of areas in the combined 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 9-2**, **Figure 9-3**, **Figure 9-4** and **Figure 9-4** 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 combined EMBA (**Appendix A**) identified several protected areas which were deemed to be irrelevant to Santos' 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. 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 combined EMBA

Area type	Title
World Heritage Area	Shark Bay
	The Ningaloo Coast
	Kakadu National Park
Wetland of International Importance (Ramsar)	Eighty Mile Beach
	Roebuck Bay
	Ashmore Reef National Nature Reserve
	Becher Point wetlands
	Peel-Yalgorup System
	Vasse-Wonnerup System
	Hosnies Spring
	Cobourg Peninsula
	Kakadu National Park
	Ord River Floodplain
	The Dales
Wetlands of National Importance	Ashmore Reef
	Mermaid Reef
	Vasse-Wonnerup Wetland System
	"The Dales", Christmas Island
	Adelaide River Floodplain System
	Eighty Mile Beach System
	Exmouth Gulf East
	Hosnies Spring, Christmas Island
	Kakadu National Park
	Mary Floodplain System

Area type	Title
	Hutt Lagoon System
	Lake Macleod
	Lake Thetis
	Learmonth Air Weapons Range – Saline Coastal Flats
	Leslie (Port Hedland) Saltfields System
	Prince Regent River System
	Roebuck Bay
	Rottnest Island Lakes
	Shark Bay East
	Cape Leeuwin System
	Doggerup Creek System
	Cape Range Subterranean Waterways
	Cobourg Peninsula System
	Daly-Reynolds Floodplain-Estuary System
	Finniss Floodplain and Fog Bay Systems
	Moyle Floodplain and Hyland Bay System
	Murgenella-Cooper Floodplain System
	Ord Estuary System
	Port Darwin
	Shoal Bay - Micket Creek
	Yalgorup System
National Heritage Place	HMAS Sydney II and HSK Kormoran Shipwreck Sites (Historic)
	Batavia Shipwreck Site and Survivor Camps Area 1629- Houtman Abrolhos (Historic)
	Dirk Hartog Landing Site 1616 - Cape Inscription Area (Historic)
	Dampier Archipelago (including Burrup Peninsula) (Indigenous)
	Kakadu National Park (Natural)
	The West Kimberley (Natural)
	The Ningaloo Coast (Natural)
	Shark Bay (Natural)
	Fitzgerald River National Park (Natural)
	Lesueur National Park (Natural)
Commonwealth Heritage Place	Scott Reef and Surrounds – Commonwealth Area
	Ningaloo Marine Area - Commonwealth Waters
	Mermaid Reef - Rowley Shoals
	Ashmore Reef National Nature Reserve
	Garden Island

Area type	Title
	Christmas Island Natural Areas
	Yampi Defence Area
	Learnmonth Air Weapons Range Facility
	Bradshaw Defence Area
	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
	Trombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)
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). One WHA is within the combined EMBA adjacent to NT, although most of the area is terrestrial: Kakadu National Park.

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.

9.1.3 Kakadu National Park

Kakadu National Park was included on the World Heritage List in 1981 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 significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals; 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 Kakadu National Park WHA covers an area of around 1,916,000ha and is the largest national park in Australia. The WHA is managed by the Director of National Parks who performs functions and exercises powers under the *Environment Protection and Biodiversity Conservation Act 1999* (the Act) in accordance with the park's management plan and relevant decisions of the Kakadu National Park Board of Management. Approximately 50% of Kakadu National Park is Aboriginal land under the Aboriginal Land rights (Northern Territory) Act 1976.

9.2 Wetlands of International Importance (Ramsar)

There are eleven wetlands of international importance (Ramsar wetlands) in waters from the South Australian border to the NT; all were listed in 1990 with the exception of the Cobourg Peninsula which was listed in 1974, Kakadu National Park which was listed in 1980 and further expanded in 1995, 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). The Ramsar wetland is managed under the Eighty Mile Beach Marine Park Management Plan 2014-2024 (DPAW, 2014).

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. The Ramsar wetland is currently managed under the Preliminary Draft Roebuck Bay Ramsar Site Management Plan (RBWG, 2010).

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. The Ramsar site is managed under the Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve Management Plan (Commonwealth of Australia, 2002).

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). The Ramsar wetland is managed under the Rockingham Lakes Regional Park Management Plan (DEC, 2010c).

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. The Rasmar site is managed under the Swan Coastal Plain South Management Plan (DPAW, 2016c).

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). This Rasmar site is also managed under the Swan Coastal Plain South Management Plan (DPAW, 2016c).

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). The Ramsar site is managed under the Christmas Island National Park Management Plan (DNP, 2002).

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). This Ramsar site is also managed under the Christmas Island National Park Management Plan (DNP, 2002).

9.2.9 Cobourg Peninsula

Under the Ramsar convention, the Cobourg peninsula site is listed as a Wetland of International Importance. The site is located 163km north-east of Darwin within the Timor Sea Drainage Division. Within 220'700 hectares, the site covers the entire peninsula and several nearby islands including the Sir George Hope Islands, Sandy Island No. I and II, Allaru Island, High Black Rock and Buford Island. Under the Cobourg Peninsula Aboriginal Land, Sanctuary and Marine act 1996, Cobourg peninsula and surrounding waters was declared a Nation Park (Garig Gunak Barlu National Park) BMT WBM (2011).

The Cobourg site is composed of a diverse coastal and inland wetland types. Wetland types present include intertidal forested wetlands and salt flats, seasonal freshwater marshes and permanent freshwater pools. Ramsar topology identifies ten coastal and ten inland types within the site. The site contains unique biodiversity and wildlife including terrestrial, riverine, freshwater, brackish and coastal/marine ecosystems. Identifiable wetland types include intertidal forested wetland and salt flats, seasonal freshwater marshes, and permanent freshwater pools.

Cobourg Peninsula is listed as a Wetland of International importance due to the diversity of coastal and inland wetland types that support population of threatened species, including a number of endangered turtles. The Cobourg site meets five of the current nine nomination criteria of the Ramsar Convention and is therefore recognised as a representative wetland habitat that is at bioregional level, support of populations of threatened species, support for key life-cycle functions such as marine turtle and waterbird breeding, refugia values, and its importance for supporting fish and nursery spawning habitats BMT WBM (2011). The Ramsar site is managed under the Cobourg Marine Park Plan of Management (DNREAS, 2011).

9.2.10 Kakadu National Park

Kakadu National Park Ramsar site is composed of a diversity of coastal and inland wetland types that range form intertidal forested wetlands and mudflats to seasonal freshwater marshes and permanent freshwater pools. Ramsar topology identifies 13 coastal types and 15 inland types throughout Kakadu National Park. Hydrology, fire regimes and notable biological processes, with supporting processes including climate, tidal hydraulics, groundwater, water quality, geology and geomorphology are ecosystem processes present in Kakadu National Park habitats (BMT WBM, 2010).

The site also meets all nine Nomination Criteria of the Convention, recognising the representative wetland habitats of the site at a bioregional level, support of populations of vulnerable wetland species, its characteristics as a centre of endemism and high biodiversity including its diversity of habitats, support for key life-cycle functions such as waterbird breeding and refugia values, its importance for supporting substantial populations of waterbirds and fish diversity and fish nursery and spawning habitats and its support of at least one percent of the national population of several non-avian wetland species (BMT WBM, 2010). The Ramsar site is managed under the Kakadu National Park Management Plan 2016-2026 (DNP, 2016).

9.2.11 Ord River Flood Plains

Site lies within the Victoria-Bonaparte bioregion and contains a wide range of wetland types and includes all inland and marine components. This Ramsar site comprises of Parry Lagoons, Ord Estuary and the False Mouths of the Ord. Parry Lagoons includes both the permanent waterholes, such as Marglu Billabong, as well as the broader area of the flood plain within the Parry Lagoons Nature Reserve that are subject to periodic inundation. The area from the boundary near Adolphis Island to the Rocks is known as the Ord Estuary. The False Mouths of the Ord is an area of extensive intertidal creeks and flats in the north of the Ramsar site.

The Ord River Floodplain Ramsar site meets seven of the nine Nomination Criteria. The site represents the best example of wetlands associated with the floodplain, and estuary of a tropical river system in the Kimberly Region of Western Australia. Ord River contains extensive and diverse mangrove community containing 14 of the 18 species of mangrove known to occurs in Western Australia (Hale, 2008).

A number of threatened species including Freshwater Sawfish (*Pristis microdon*), the Green Sawfish (*Pristis zijsron*) and the Australian Painted Snipe (*Rostratula australis*), which are listed as vulnerable under the EPBC Act are supported in this area. The site also provides one of the two known habitats for the nationally endangered Northern River Shark (*Glypis* sp. C). The Ord River Floodplain Ramsar site provides an important nursery, breeding and feeding ground for at least 50 species of fish and a migratory route for 15 diadromous species.

There is sufficient evidence to suggest the sire regularly supports 20,000 birds in the site alone, although it should be acknowledged that there are difficulties associated with surveying the Ord River Floodplain. According to the 4th edition of Waterbird Population Estimates, the site regularly supports 1% of the population of Plumed Whistling Duck and Little Curlew (Hale, 2008). The Ramsar site is managed under the Ord River and Parry Lagoons Nature Reserves Management Plan (DEC, 2012c).

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 Hosnies Spring, Christmas Island

See Hosnie'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 lakebed 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 Australian fairy tern (*Sterna nereis 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 site 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**).

9.3.21 Adelaide River Floodplain System

Several swamps, lakes, lagoons and dams are included in the 134,800-hectare site. Four principal plant structural formations are present consisting of mangal low closed-forest (mangroves) mainly in the far north-west but extending along the river to south of the site, scattered chenopod low shrubland (samphire) in the far north, patches of melaleuca open-forest near the floodplain edges and missed closed grassland/sedgeland (seasonal floodplain) over most of the site (Jaensch, 1993).

The site is of particular significance as it contains one of the largest blocks of mangroves associated with the Top End floodplain as well as near-permanent marsh (Fogg Dam and Melacca Swamp), a rare wetland type in the Northern Territory. A rare species of the wetland plant Goodenia quadrigida also occurs within the floodplain. Surface inflow from the Adelaide-Margaret River System as well as numerous creeks (e.g. Hollands, Sunday and Buffalo Creeks) and Manton River provides a water supply for the area. The total volume of inflow is moderately high. The area provides a good example of the major floodplain-tidal wetland system typical of the Top End Region with substantial area of each component wetland type (Jaensch, 1993).

Adelaide River Floodplain system is a major breeding area for multiple species such as the Magpie Goose (*Anseranas semipalmata*), Saltwater Crocodile (*Crocodylus porosus*) and herons and allies. It is also a major dry season refuge area for waterbirds and a significant migration stop-over area for shorebirds (Jaensch, 1993).

9.3.22 Kakadu National Park

See Kakadu National Park Ramsar site (**Section 9.2.10**).

9.3.23 Mary Floodplain System

Included in the 127,600hectare site is the entire floodplain of the Mary River, from near Bark Hit Inn downstream to Van Diemen Gulf (including intertidal mudflats) and including Swim Creek Plain. Three principal plant formations occur within the site. These include melaleuca open-forest (paperbark swamp), scattered chenopod low shrubland (samphire) in the north and centre-north; and the remainder, mixed closed-grassland/sedgeland (seasonal floodplain). Mangroves occur in the far north fringing the coast and at estuary mouths. The site includes some of the largest areas of wooded swamp in the Northern Territory. 21 of the 36 described floodplain flora communities occur in the Mary Floodplain system (Jaensch, 1993).

Water supply mainly occurs from the surface inflow form the Mary-McKinlay River system as well as many creeks. Mudflats, estuaries, and saline coastal flats are tidal. Tidal areas of mudflats and estuaries are inundated twice daily compared to the large parts of coastal flats that may be only periodically inundated. The floodplain water supply is seasonal, with near-permanent water in deeper channels and billabongs, as well as Eleocharis swamp. The site is a good example of a major floodplain-tidal wetland system typical of the Top End Region and features a complex network of channels and billabongs (Jaensch, 1993).

Mary Floodplain System provides a major breeding area for the Magpie Goose (*Anseranas semipalmata*) as well as refuge during dry season for waterbirds (geese, ducks and herons) and Saltwater Crocodiles (*Crocodylus porosus*). At least 75 species recorded within the area, of those 33 species were listed under treaties and 11 species were found breeding. The mudflat and coastal flats support at least several thousand migrant shorebirds at a time (Jaensch, 1993).

9.3.24 Cobourg Peninsula System

See Cobourg Peninsula Ramsar site (**Section 9.2.9**).

9.3.25 Daly-Reynolds Floodplain-Estuary System

The Daly-Reynold Floodplain-Estuary System includes the entire floodplain of the Daly River, entire floodplain of the Reynolds River and the tidal mudflats of north-east Anson Bay and is in the Darwin Coastal and Daly Basin biographical regions. Six principal plant formations exist within the 159,300-hectare site. This includes mixed closed-grassland/sedgeland (seasonal floodplain) over most of the site; Melaleuca open-forest (paperbark swamp) in patches throughout, Coolibah/Gutta-percha low woodland over grassland in the far south-east; closed-forest (monsoon vine-thicket) around the Daly River in the far south-east; mangal low closed-forest (mangroves), discontinuously along the Daly River estuary (to 1 km wide); and scattered chenopod low shrubland (samphire) at/near the coast and river mouth. The site provides a good example of a major floodplain-tidal wetlands system as it contains substantial areas of all the principal features of such a system in the Top End Region. It is also one of the largest floodplains in the Northern Territory (Jaensch, 1993).

31 of the 36 described floodplain flora communities occur on the Daly-Reynolds Floodplain. The Daly-Reynolds Floodplain-Estuary System plays an important ecological role by providing a top three breeding ground for Magpie goose (*Anseranas semipalmata*), as well as herons, allies and Saltwater Crocodiles. Additionally the site is a major dry season refuge area for waterbirds and a significant migration stop-over area for shorebirds. The site also contains more than 80 fauna species, 30 of which are listed under treaties. Up to 2100 shorebirds are known to frequent this site as a migratory stop over (Jaensch, 1993).

9.3.26 Finniss Floodplain and Fog Bay Systems

The floodplain and bay systems provide a good example of a beach-fringed, curved bay with intertidal mudflats and intact floodplain with extensive paperback swamps. Plant structural formations within the area include mixed closed grassland/sedgeland and melaleuca open forests. Small areas of mangal and samphire occur near the estuaries and the south-west part of the bay. Surface inflow from the Finniss River, and several creeks supply the site with water (Jaensch, 1993).

At least 70 species of fauna are recorded in the area, 20 of which are listed under treaties. Finnis Floodplain and Fog Bay Systems are major breeding areas for Magpie goose and Saltwater Crocodile, a significant dry season refuge area for water birds and a major migration stop-over for over 25’000 shorebirds. 24 of the described floodplain flora communities along with the best floating mats in the Northern territory occur within this site (Jaensch, 1993).

9.3.27 Moyle Floodplain and Hyland Bay System

Plant structural formations of the area consist of closed grassland/sledgeland latiform arrangements, some fringing and scattered patches of melaleuca open-forests, and mangal low closed forest (mangroves) along the lower river. Surface inflow to floodplain areas from multiple creeks and Moyle River is the main source of water supply.

The Moyle Floodplain and Hyland Bay System is one of the least distributed examples of a Top End floodplain system associated with a small river a mudflat-fringed bay. The site is a major breeding area for magpie goose, a refuge for waterbirds (whistling duck) in the dry season, migration stop over area for shorebirds and a major breeding area for Saltwater Crocodiles. 27 of the described floodplain flora communities occur at this site. 47 fauna species are known to occur on the floodplain and adjacent coast, 26 of which are listed under treaties (Jaensch, 1993).

9.3.28 Murgenella-Cooper Floodplain System

Murgenella-Cooper Floodplain System includes the entire contiguous floodplains and saline coastal flats, estuaries, and tidal mudflats of Murgenella, Cooper and Salt-Water Creeks within 81,500 hectares. Surface flow from Cooper Creek and several unnamed creeks provide water supply for the area. Plant structural formations that are present include mixed closed grassland/sedgeland over most of the site, scattered chenopod low shrubland and narrow areas of mangal closed-forest (mangroves) along tidal channels and at the coast. The site provides a good example of floodplain-tidal wetland system of the Top End Region, with relatively low volume of freshwater inflow (Jaensch, 1993).

13 of the 36 described floodplain flora communities occur within the site. The site is a major breeding ground for Magpie Goose, cormorants, herons and allies, a major dry season refuge area for waterbirds and a major migration stop-over area for more than 10'000 shorebirds. At least 71 species of fauna are recorded in the area, 26 of which are on treaties (Jaensch, 1993).

9.3.29 Ord Estuary System

See Ord River Flood Plains Ramsar site (**Section 9.2.11**).

9.3.30 Port Darwin

The entire Port Darwin site covers 48,800 hectares. The whole site is tidal with mangal low closed-forest (mangroves) plant structural formations present. The site provides a good example of a shallow branching embayment of the Top End Region, supporting one of the largest discrete areas of mangrove swamp in the Northern Territory (Jaensch, 1993).

36 flora species, 23 of them trees and tall shrubs are present within the mangrove communities. Including Northern territory endemic *Avicennia integra*. The mangrove communities of this site are the most extensive and species rich of any Northern Territory embayment. The site is a major nursery for estuarine and offshore fish and crustaceans in the Beagle Gulf area. 48 fauna species, with 25 listed under treaties existing within this site. Rare species such as Red-necked Phalarope have also been recorded within the site. Furthermore, Woods Inlet is frequented by the uncommon dolphin *Orcaella brevirostris*. At least 72 fish species occur within the site as well as there being an unusual richness in sponges (220 species), soft and hard coral as well as invertebrates (Jaensch, 1993).

9.3.31 Shoal Bay - Micket Creek

Shoal bay is approximately 10km immediately north-east of the City of Darwin and the site includes King Creek and Noogoo swamp within 1,600 hectares. The site contains wetland marshes, mangrove woodlands, beaches, mudflats, creeks and estuaries and is a good example of a spring fed coastal wetland system. Micket Creek is a tidal estuary flowing into Shoal Bay while King Creek and water from Noogoo Swamp all flow into Shoal Bay. All areas contain remnants of monsoon forest interspersed with open woodland bounded by grassed backsoil plain (Hodgson, 1995).

Within the site there are some notable species. It has a bird habitat of over 200 species and provides a dry season refuge for waterfowl and birds of prey. Migratory birds regularly use the areas of mudflats with more than 15,000 wader species and 25 of them listed on international agreements with Japan and China. The Nationally endangered Littler Tern and two other uncommon species, the Eastern Grass Owl and Peregrin Falcon have been recorded within Shoal Bay – Micker Creek (Hodgson, 1995).

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, with ten of these occurring within the combined EMBA. Kakadu National Park, 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).

9.4.10 Kakadu National Park

See Kakadu National Park World Heritage Area (**Section 9.1.3**).

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. Ten Commonwealth Heritage Places are found in or adjacent to the combined 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 (*Onychoprion 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.

9.5.10 Bradshaw Defence Area

The Bradshaw Defence Area is located in the Northern Territory and is bounded by the Fitzmaurice and Victoria Rivers on the shores of the Joseph Bonaparte Gulf and the Bradshaw Defence field training area.

The complex topography of the Bradshaw area results in a broad range of highly distinct environments and habitats that include lowland woodlands, heaths, grasslands, sandstone escarpments, monsoon rainforest patches and wetlands. Compared to surrounding areas, the vegetation within the Bradshaw area is more diverse and incorporates more than one fifth of the vegetation types that occur in the Top End of the Northern Territory and includes grassland, woodland flora that are restricted on a national level (DAWE, 2002).

The topological complexity that results in a broad range of environments also contributes to the unusually rich vertebrate fauna. The species richness of frogs, reptiles and mammals is considered significant at a national level. Furthermore, it is also worth noting that the Bradshaw area supports many species that have declined elsewhere in Australia (DAWE, 2002).

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. Most conservation areas in the NT are managed under the *Territory Parks and Wildlife Conservation Act*.

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.

In NT there are a number of types of terrestrial conservation reserves with legislative protection, those present within the combined EMBA include coastal reserves, national parks and conservation parks.

There are numerous terrestrial conservation reserves located adjacent to the coast in the combined 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 combined 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 WA 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[9]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Reserves of Northern WA (see Figure 9-6)				
Lawley River	Northern Kimberley	-	No [10]	Kimberley Marine Park
Mitchell River		-		
Prince Regent		-		
Reserves of North-West WA (see Figure 9-7)				
Murujuga	Pilbara	Murujuga National Park management plan 78 (DEC 2013)	Yes [11]	-
Cape Range	Carnarvon	Cape Range National Park Management Plan (DEC 2010a)	No	Ningaloo Marine Park
Reserves of Southern WA – (see Figure 9-8)				
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)	

[9] 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[9]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Houtman Abrolhos Islands	Geraldton Sandplains	-	No - extends to the high water mark only.	Abrolhos Commonwealth Marine Park
Kalbarri	Geraldton Sandplains	Kalbarri National Park Management Plan (DPAW 2015)	Yes [11]	-
Namburg	Geraldton Sandplains	Namburg National Park Management Plan (1998)	Yes	-
Yalgorup	Swan Coastal Plain	Yalgorup National Park Management Plan (CALM 1995)	Yes [11]	-
Leeuwin - Naturaliste	Warren	Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan (DPAW 2015)	No	Ngari Capes Marine Park
Torndirrup	Warren	Albany coast draft management plan 2016 (DPaW 2016b)	Yes[11]	
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[11]	Walpole and Nornalup Inlets Marine Park
Waychinicup	Southern Jarrah Forest and Fitzgerald	Albany coast draft management plan 2016 (DPAW 2016)	Yes[11]	
West Cape Howe	Warren	Albany coast draft management plan 2016 (DPaW 2016)	Yes[11]	
D'Entrecasteaux	Warren	Shannon and D'Entrecasteaux National Parks Management Plan No. 71 (DEC 2012b)	Yes[11]	
Fitzgerald River	Fitzgerald	Fitzgerald River National Park Management Plan 1991 – 2001 No. 15 (CALM 1991)	Yes[11]	
Reserves of the Northern Territory (NT) – (see Figure 9-5)				
Djukbinj National Park	Darwin Coastal and Pine Creek	-	Yes[11]	-

National Park	IBRA bioregion[9]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Garig Gunak Barlu National Park	Tiwi Cobourg	Cobourg Marine Park Plan of Management (PAWCNT, 2011)	Yes[11]	Cobourg Marine Park
Mary River National Park	Darwin Coastal	Mary River National Park Joint Management Plan March 2015 (PAWCNT, 2015)	Yes[11]	-
Keep River National Park	Victoria Bonaparte	-	Yes[11]	-
Charles Darwin National Park	Darwin Coastal	Charles Darwin National Park Plan of Management (NT government, nd)	Yes[11]	-

9.6.2 Coastal Nature Reserves and Conservation Parks

Protected coastal nature reserves and conservation parks managed under the CALM Act 1984 in the combined EMBA are listed in **Table 9-3** and shown in **Figure 9-6**, **Figure 9-7** and **Figure 9-8** for the north, north-west and south of WA respectively. Protected lands in the NT are shown in Figure 9-5 as gazetted under the (NT) Crown Lands Act 1992. 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	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Reserves of Northern WA (see Figure 9-6)					
Ord River NR	-	1a	-	No [10]	North Kimberley Marine Park
Pelican Island NR	-	1a			
Lesueur Island NR	A	1a			
Low Rocks NR	A	1a			
Browse Island NR	A	1a	-	Yes [11]	-
Scott Reef NR	-	1a	-	Yes [11]	-
Adele Island NR	A	1a	-	Yes [11]	-
Tanner Island NR	A	1a	-	Yes [11]	-
Lacepede Islands NR		1a	-	Yes [11]	-

[10] Inferred as adjacent marine park boundary is the high water mark and dual tenure cannot exist.

[11] Conservatively inferred as no adjacent Marine Park.

Reserve name and type	Reserve class	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Coulomb Point NR	A	1a	-	Yes [11]	-
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 [11]	-
North Turtle Island NR	A	1a	-	Yes [11]	-
Reserves of North-West WA (see Figure 9-7)					
Unnamed (Dampier Archipelago) NR	A	1a	Dampier Achipelago Management Plan (CALM 1990). *Covers 25 of the islands*	Yes	-
Swan Island NR	A	1a	-	Yes[11]	Kimberly Marine Park
Unnamed NR		1a	-	Yes [11]	-
North Sandy Island NR	A	1a	-	Yes [11]	-
Montebello Islands CP	A	2	-	Partially [12]	Montebello Islands Marine Park
Lowendal Island NR		1a	-	No	Barrow Island Marine Management Area and Marine Park. Lowendal Island NR only partially bounded
Barrow Island NR	A	1a	Barrow Island Group Nature Reserves (DPAW 2015)	Yes	
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 [11]	-
Little Rocky Island NR	A	1a	-	Yes [11]	-
Airlie Island NR	-	1a	-	Yes [11]	-

[12] Reserve R42197 includes the inter-tidal zone and reserve R42196 does not.

Reserve name and type	Reserve class	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Thevenard Island Nature	-	1a	-	Yes [11]	-
Bessieres Island NR	A	1a	-	Yes [11]	-
Serrurier Island NR	-	1a	-	Yes [11]	-
Round Island NR	-	1a	-	Yes [11]	-
Locker Island NR	A	1a	-	Yes [11]	-
Rocky Island NR	-	1a	-	Yes [11]	-
Gnandaroo Island NR	A	1a	-	Yes [11]	-
Victor Island NR	-	1a	-	Yes [11]	-
Y Island NR	-	1a	-	Yes [11]	-
Tent Island NR	-	1a	-	Yes [11]	-
Burnside and Simpson Island NR	-	1a	-	Yes [11]	-
Whalebone Island NR		1a	-	Yes [11]	-
Whitmore, Roberts, Doole Islands & Sandalwood Landing NR	-	1a	-	Yes [11]	-
Muiron Islands NR	-	1a	Jarabi and Bundegi Coastal Parks and Muiron Islands (CALM 1999)	No [10]	Muiron Islands Marine Management Area
OneTree Point NR	A	1a	-	Yes [11]	
Reserves of Southern WA – (see Figure 9-8)					
Koks Island NR	A	1a	Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan (DPAW 2012)	Yes [11]	-
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
Zuytdorp NR	-	1a		Yes [11]	-
Beekeepers NR	-	1a	-	Yes [11]	-
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			

Reserve name and type	Reserve class	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
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 [11]	-
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	-
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[11]	-
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		Yes[11]	-

Reserve name and type	Reserve class	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Breaksea Island NR	A	1a	Albany coast draft management plan 2016 (DPAW 2016b)	Yes[11]	-
Bald Island NR	A	1a		Yes[11]	-
Eclipse Island NR	A	1a		Yes[11]	-
Michaelmas Island NR	A	1a		Yes[11]	-
Glasse Island NR	A	1a	-	Yes[11]	-
Arpenteur NR	-	1a	-	No	-
Figure 9-5					
Channel Point Coastal Reserve	-	5	-	Yes[11]	-
Casuarina Coastal Reserve	1 and 3	5	Casuarina Coastal Reserve Management Plan (PAWCNT, 2016)	Yes[11]	-
Shoal Bay Coastal Reserve	-	6	-	Yes[11]	-
Tree Point Conservation Area	-	5	-	Yes[11]	-

Further information is provided below in relation to Varanus Island and Airlie Island Nature Reserves. Santos' 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 combined 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).

9.7.4 Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)

The Lake Clifton thrombolite community is restricted to Lake Clifton, which occurs on the Swan Coastal Plain region of WA. Lake Clifton is situated within the Yalgorup National Park and is the northernmost lake in the Peel-Yalgorup Lakes System, which consists of several hypersaline and brackish lakes (Moore 1990). The Lake Clifton thrombolite community occurs on a relict foredune plain of Holocene age sands. The main known occurrence of the ecological community is a stretch, approximately 15 km long and up to 15 m wide, along the north-eastern shoreline of Lake Clifton. There are other small clusters of thrombolites within the Lake, also at the northern end. The thrombolites cover a total area of approximately four square kilometres (Moore 1990).

This structure is the largest known example of a living, non-marine microbialite reef in the southern hemisphere.

The Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton) is listed as critically endangered under the EPBC Act because it has a very restricted distribution and recent investigations indicate that *Scytonema*, a key cyanobacterium for thrombolite formation has gone from being a dominant species to no longer being found in Lake Clifton thrombolites.

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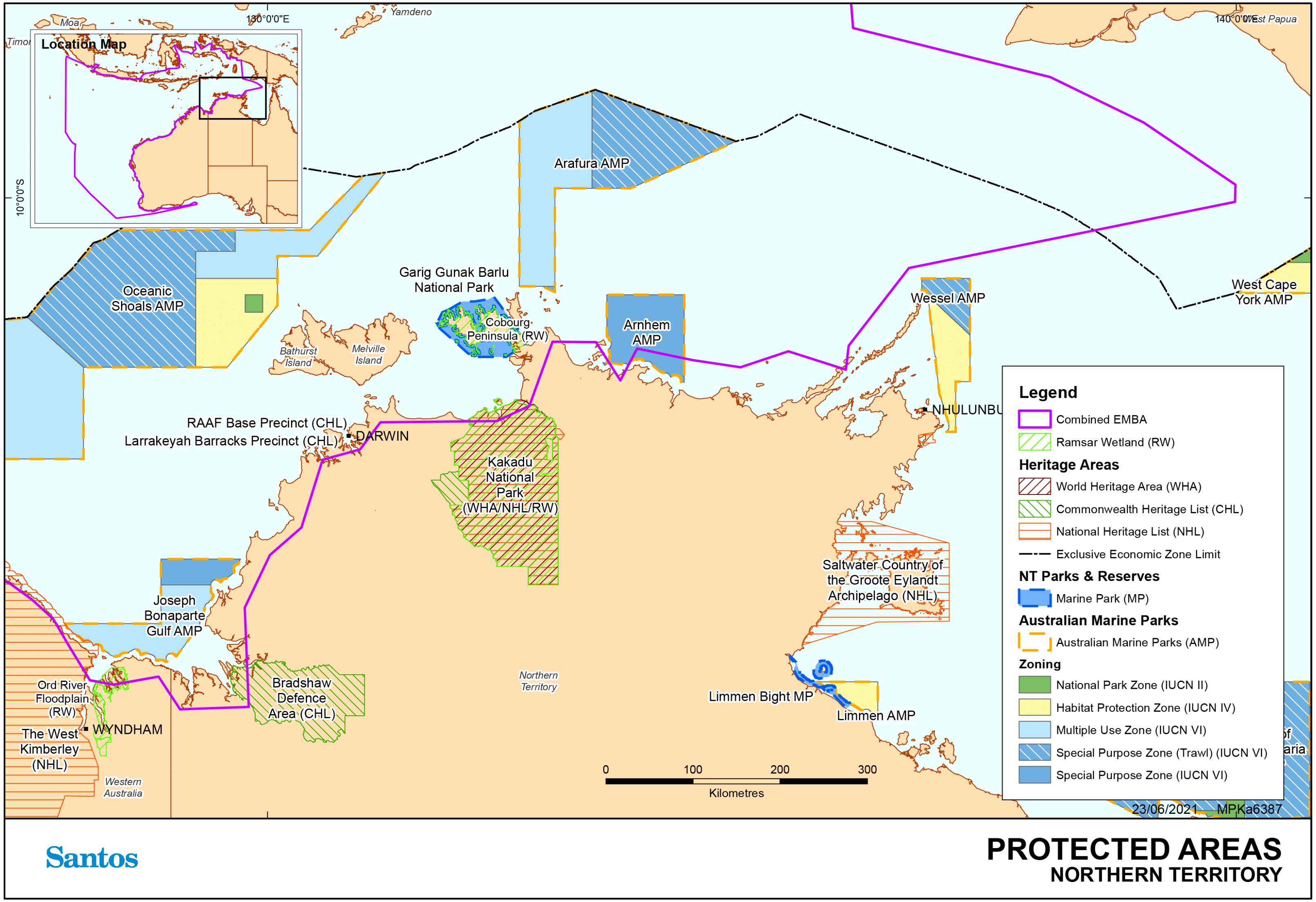

Figure 9-1: Protected areas in NT

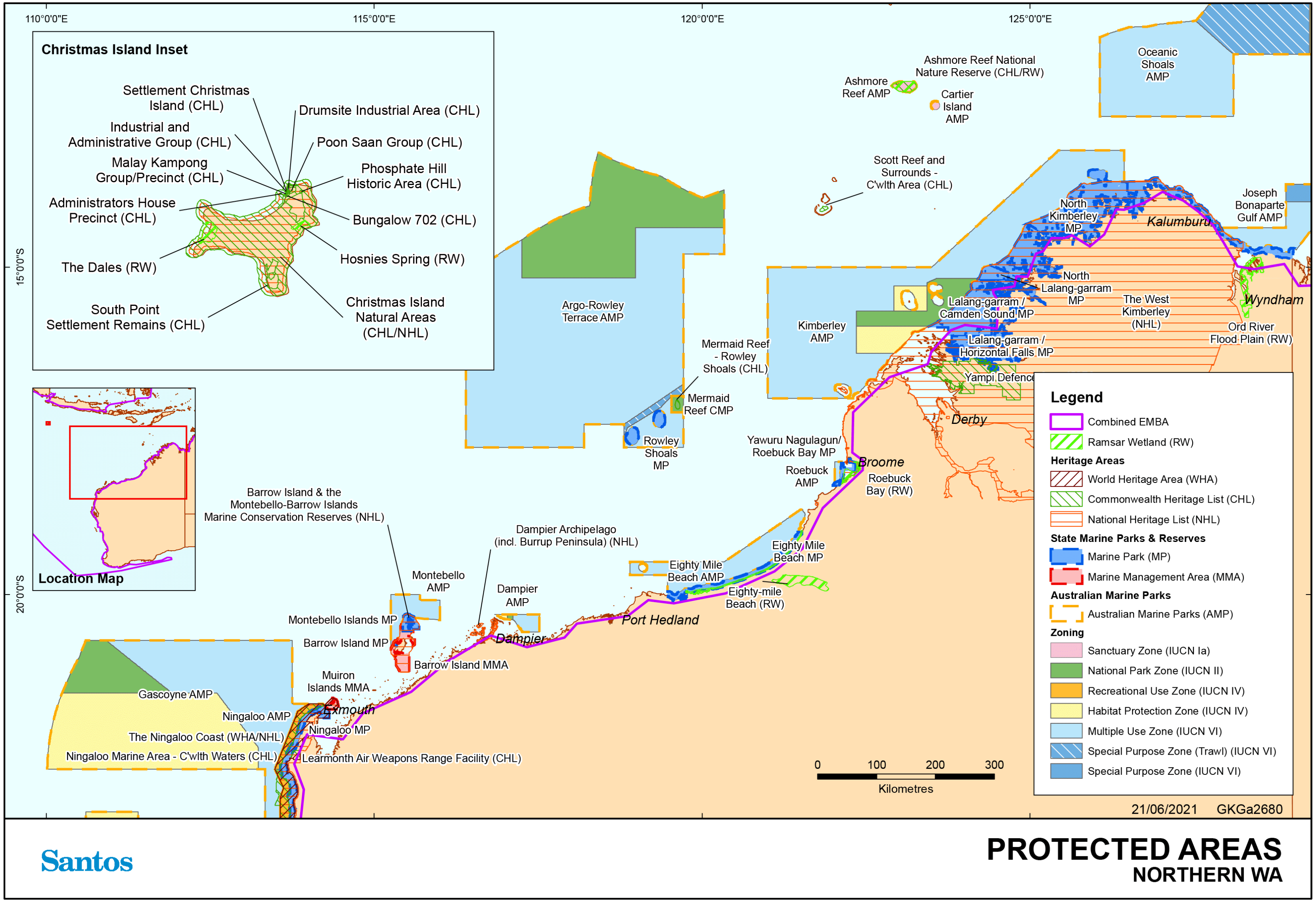

Figure 9-2: Protected areas in Northern WA

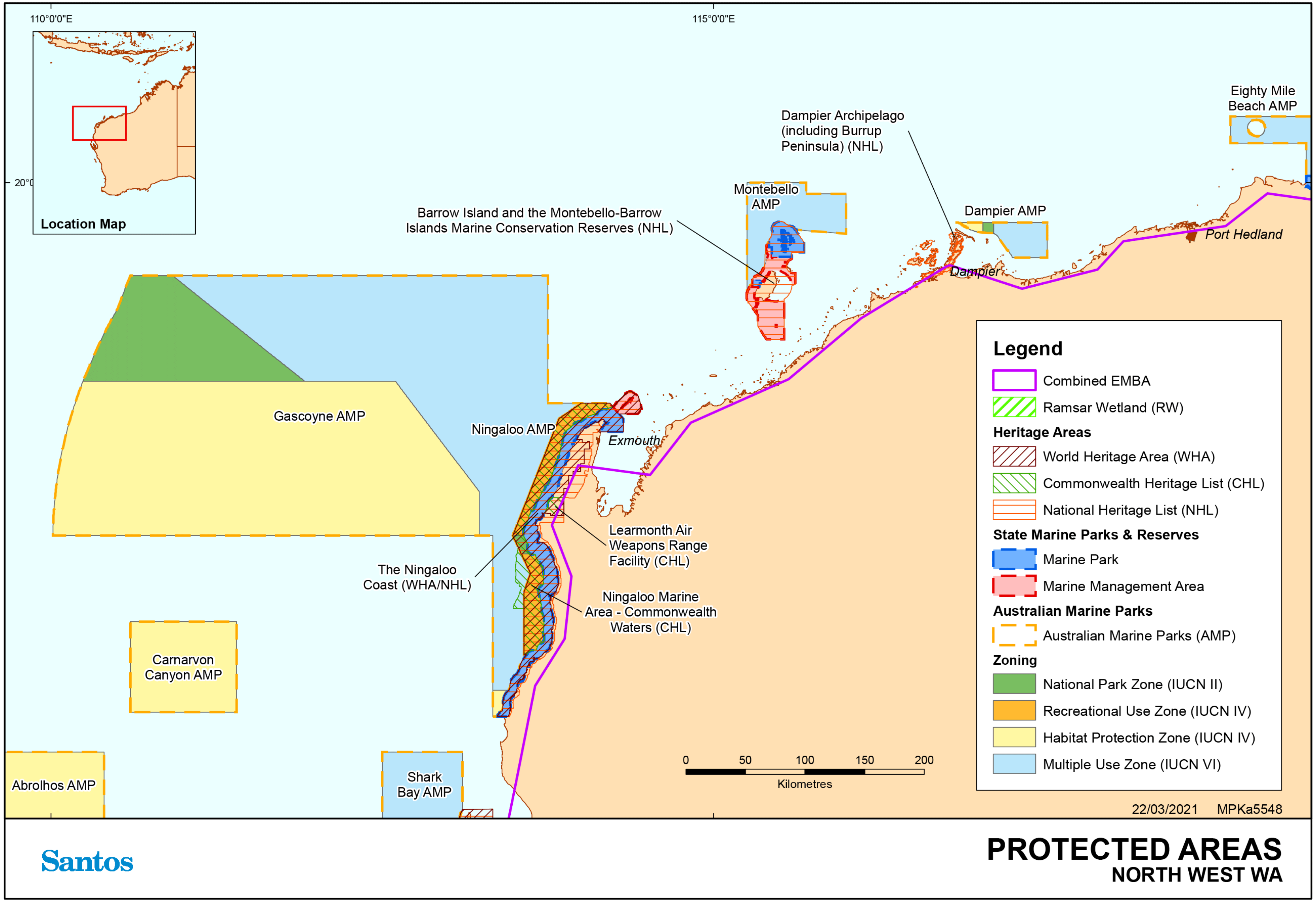

Figure 9-3: Protected areas in North West WA

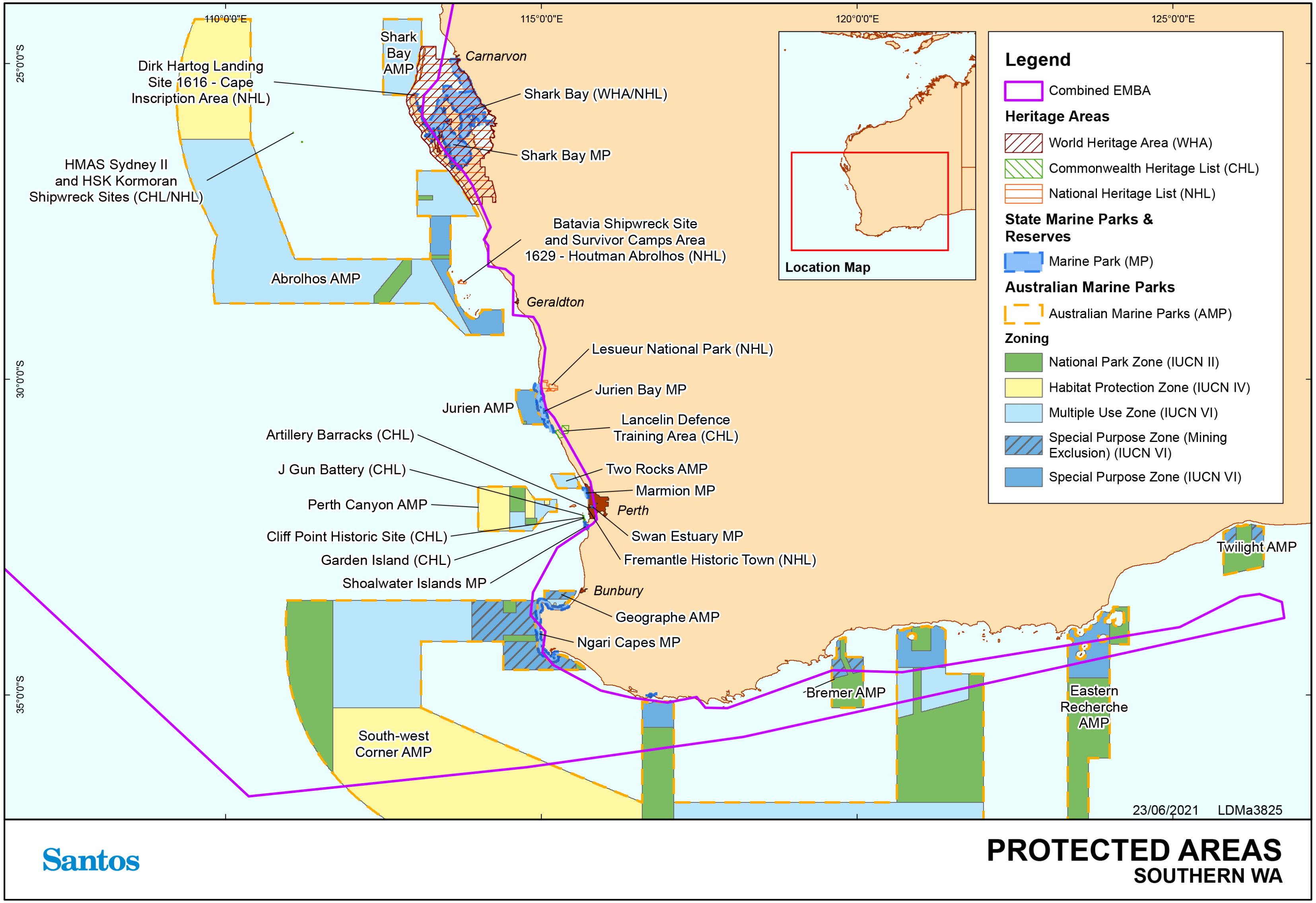

Figure 9-4: Protected areas in Southern WA

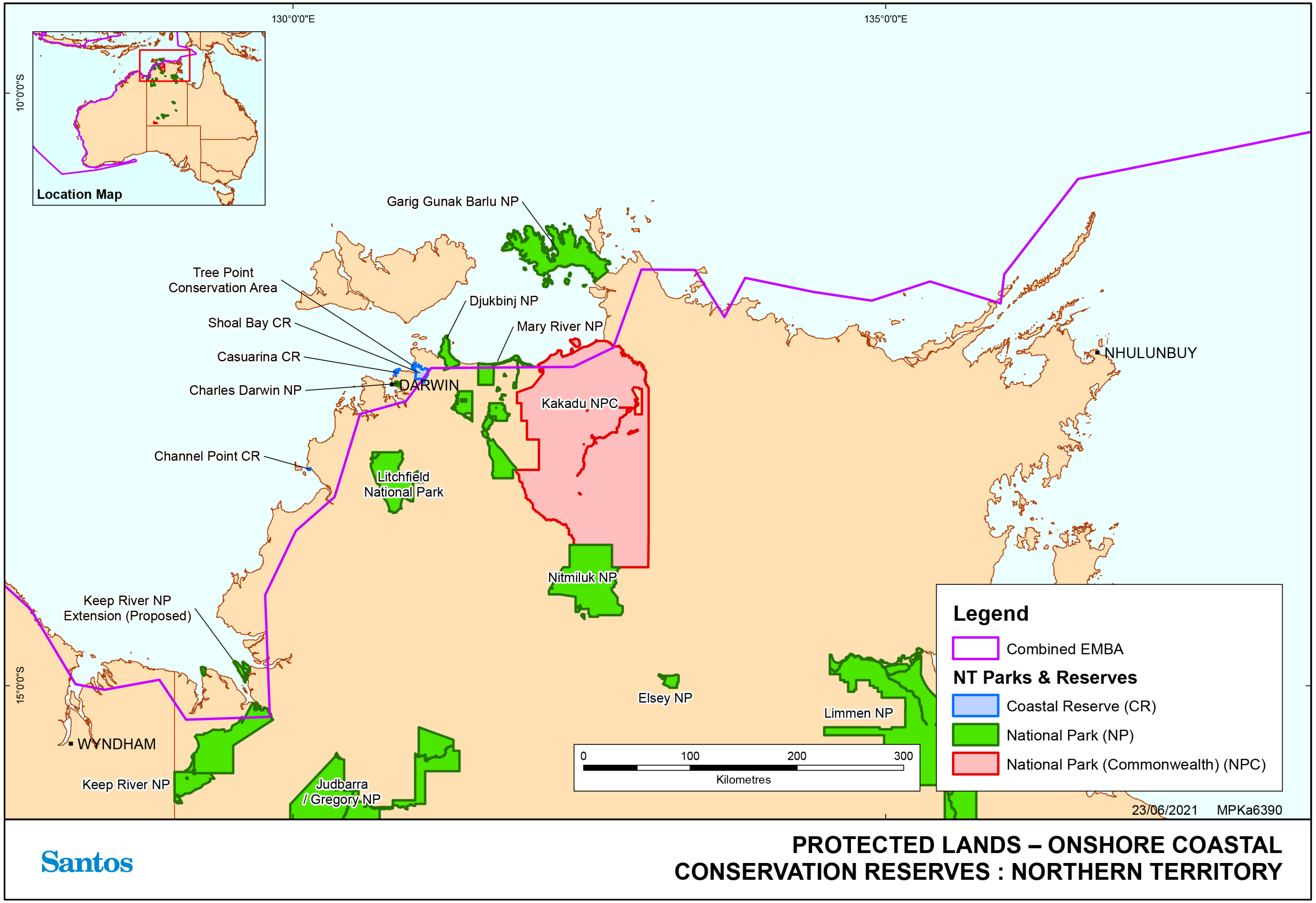

Figure 9-5: Protected Lands (CALM Act 1984) – terrestrial coastal reserves bounding marine waters in NT

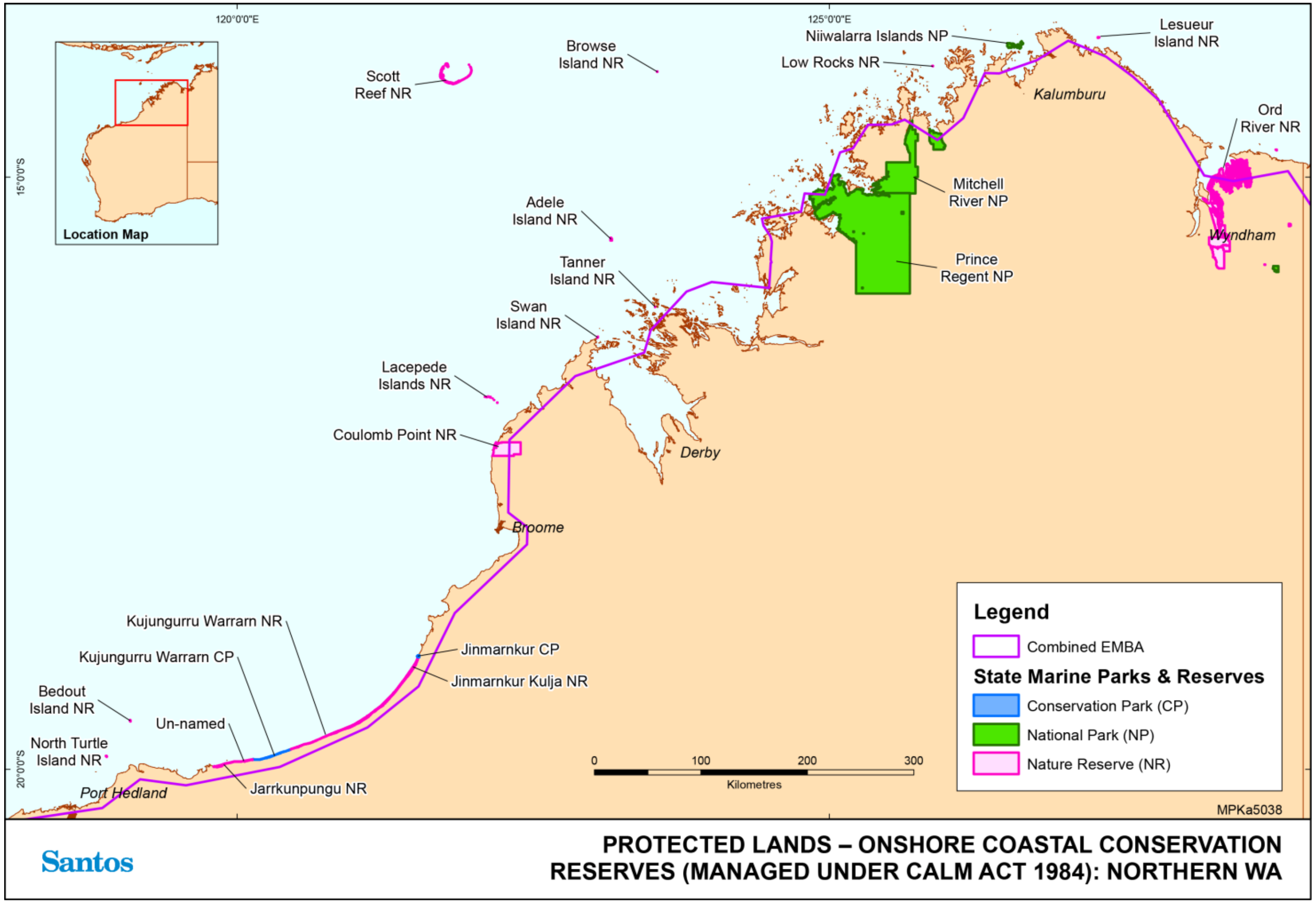

Figure 9-6: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in northern WA[13]

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[13] 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**).

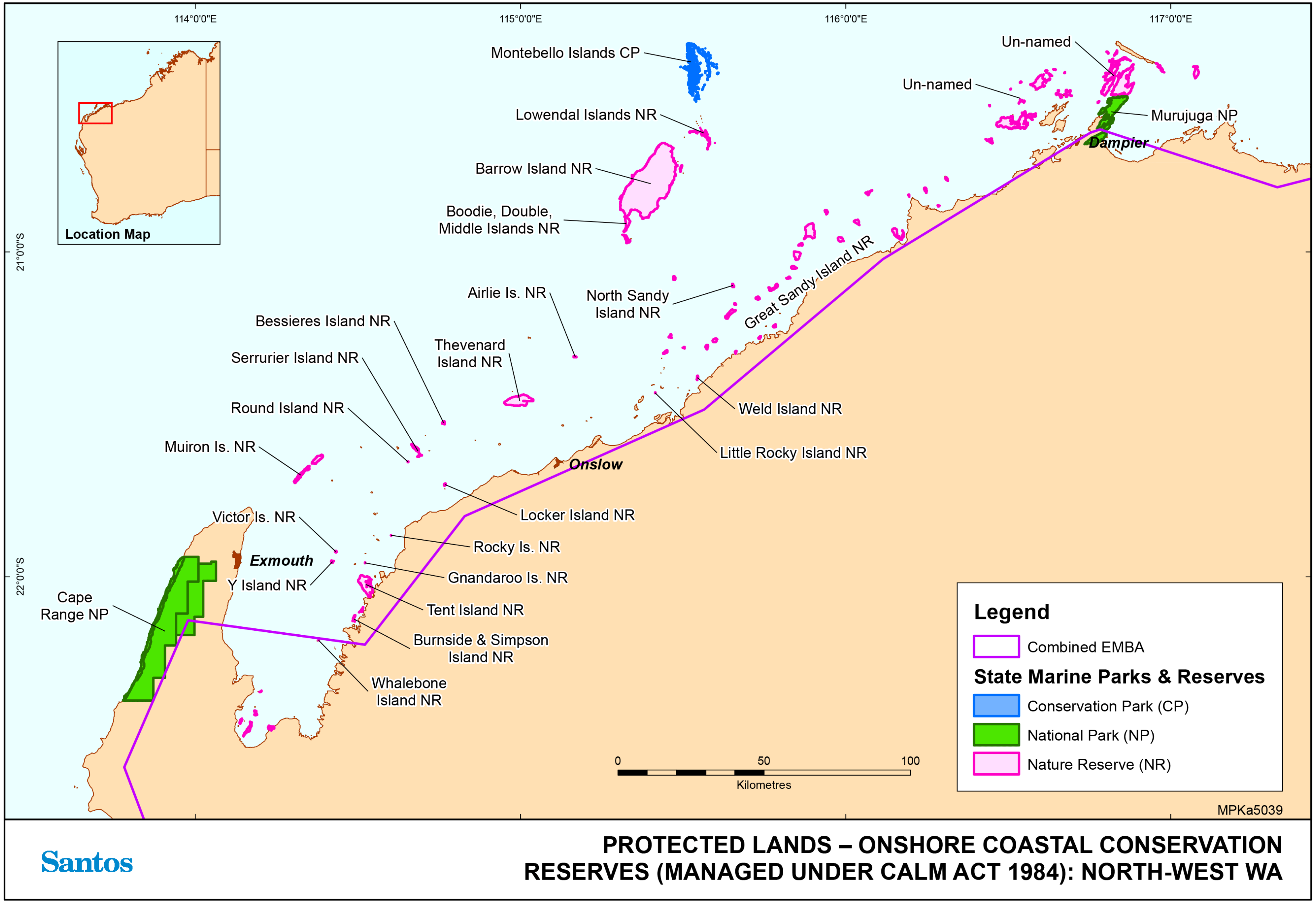
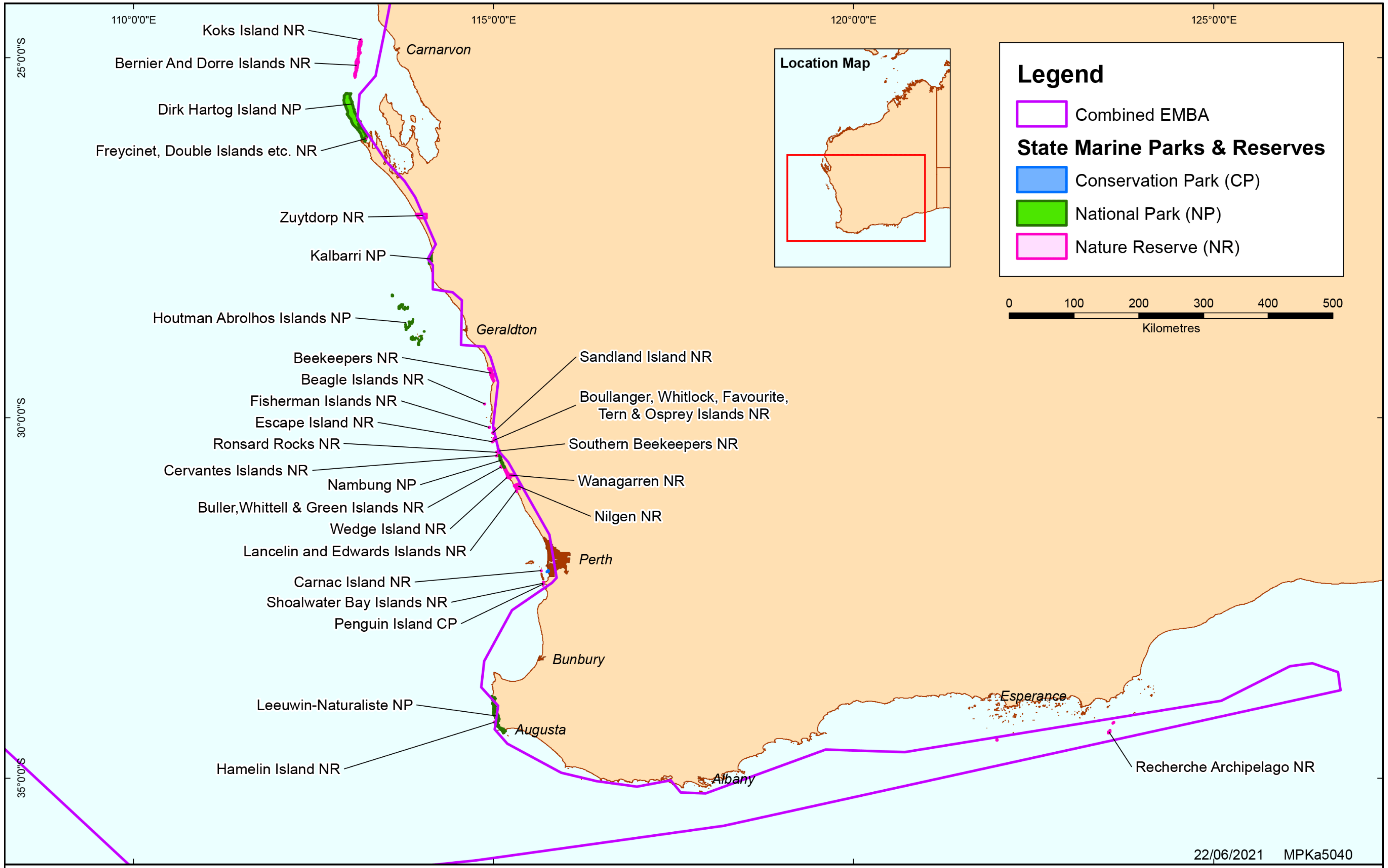


Figure 9-7: **Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in North-West WA**



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PROTECTED LANDS – ONSHORE COASTAL CONSERVATION RESERVES (MANAGED UNDER CALM ACT 1984): SOUTHERN WA

Figure 9-8: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in Southern WA[14]

9.8 International Protected Areas

There are 54 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). the combined EMBAA number of marine national parks, nature reserves and protected areas are overlapped by the combined EMBA. A summary of these is provided below. The waters and islands of these protected areas are frequented by tourists undertaking diving, snorkelling, sailing and other marine nature based tourism with many attractions such as shipwrecks and whale sharks as well as the extensive terrestrial ecosystems. Traditional fishing also occurs throughout the parks where allowed.

9.8.1 World Heritage and Protected Sites

9.8.1.1 Komodo

Komodo National park is located within the lesser Sunda Island between the provinces of East Nusa Tenggara and West Nusa Tenggara. Within the 1733km^2 site, three larger island (Komodo, Padar and Rincach) and 26 smaller ones are included. The marine fauna and flora are generally the same as that found throughout the Indo Pacific area, though species richness is very high, notable marine mammals include blue whale (*Balaenoptera musculus*) and sperm whale (*Physeter catodon*) as well as 10 species of dolphin, dugong (*Dugong dugon*) and five species of sea turtles (WHC, 2021). Fringing and patch coral reefs are extensive and most developed on the north-east side of Komodo (Indahnesia, 2011). The property is identified as a global conservation priority area, comprising unparalleled terrestrial and marine ecosystems (WHC, 2021).

The islands have an irregular coastline characterized by bays, beaches and inlets separated by headlands, often with sheer cliffs falling vertically into the surrounding seas.

9.8.1.2 Siberut

Siberut is located about 155km off the coast of West Sumatra across the Mentawaian strait and covers an area of 4050km^2. Sand beaches, lagoons, mangroves, and coral sea gardens create ecosystems within the site (Indahnesia, 2011).

9.8.1.3 Ujung Kulon

Ujung Kulon covers 1230km^2 of area. The coastline features various ecosystems such as sandy beaches, lagoons, rocky outcrops, as well as mangrove swamps. The water is an unusually warm 29 to 30 degrees Celsius and is home to multiple species of coral and fish (Indahnesia, 2011). The property includes the Ujung Kulon peninsula and several offshore islands that demonstrate on-going evolutionary processes (WHC, 2021).

9.8.2 Marine National Parks

9.8.2.1 Laut Sawu

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).

9.8.2.2 Kepulauan Seribu

Kepulauan Seribu, also known as Thousand Islands National Park, consists of a string of 105 islands within a reported area of 1074.89km^2. It is designated with an IUCN category II status. The closest island lies in Jakarta Bay, only a few kilometres from off mainland Jakarta with islands stretching as far as 45km north into the Java Sea (Indahnesia, 2011). Some islands are uninhabited, others have resorts or are privately owned. The coastlines are dominated by sandy beaches with some of the islands declared as protected historical sites to protect the artifacts and ruins on the islands dating back to the 19th century. Extensive coral reefs surround the islands. A Hawksbill turtle preservation program is in places in the park to protect the species that are found in the waters and nest on sandy beaches there (UNDP Indonesia, 2017). Mangroves are also found in the park, including plantations to increase the mangrove coverage.

9.8.2.3 Teluk Cenderawasih

Teluk Cenderawasih National Park is the largest marine park in Indonesia, with the reported area being 14535 km^2. It is designated with an IUCN category II status. The National Park is in Cenderawasih Bay, south-east of Bird's Head Peninsula, and includes the Islands of Misowaar, Nusrowi, Roon, Rumberpon and Yoop. The Park protects a rich marine ecosystem where over 150 coral species have been recorded. It is therefore considered to be a potential World Heritage Site (Indahnesia, 2011).

3.8% of the site consists of island tropical forest ecosystems, where some 46 species of plant have been recorded on the islands. 0.9% of the site is specifically mangrove ecosystems. Although only 5.5% of the site consists of coral reef ecosystems, 150 species of coral have been recorded. This coral reef ecosystem forms part of the Coral Triangle region. Within the remaining area of the site, over 200 fish species, various species of molluscs, whale sharks, four species of turtle as well as mammals such as the dugong, blue whale and dolphins inhabit the 89.8% of marine water ecosystems.

9.8.2.4 Taka Bonerate

Taka Bonerate National Park includes the Takabonerate Atoll Islands within a 5307 km^2 area within the Flores Sea. Taka Bone Rate consists of separate table reefs, enclosing a lagoon filled with massive reefs and is a site of major ecological importance (Indahnesia, 2011). According to the Indonesian Department of Forestry, the site has 261 species of coral, 295 species of coral fish, 244 species of molluscs as well as many other species such as turtles including green turtles that are known to nest on sandy beaches within the park (UNDP Indonesia, 2017).

9.8.2.5 Bunaken

Bunaken National Park is located in the north of the Sulawesi Islands, located near the centre of the Coral Triangle, it is designated with an IUCN category II status. This site typifies Indonesian tropical water ecosystems, consisting of seagrass plains, coral reefs and coastal ecosystems. 97% of the site is classified as marine habitat with the remaining being terrestrial, including 5 islands (Indahnesia, 2011). 390 species of coral, 90 fish species as well as mollusc, reptile, marine and mammal species have all been recorded.

9.8.2.6 Kapulauan Wakatobi

Kapulauan Wakatobi is located south of Sulawesi Island of Indonesia within a 13900km^2 area. It is designated with an IUCN category II status. Types of vegetation found in the National Park include mangrove forests, coastal forests, lowland swamp forests, riverbank vegetation, lowland rainforests, mountain rainforests and coral reefs (Indahnesia, 2011). There are 25 groups of coral reefs, including fringing reefs, barrier reefs and atolls. 396 species of coral belonging to 68 genera and 15 families populate the coral reef. Turtles are found nesting on the beaches and in the waters of the marine park.

9.8.2.7 Meru Betiri

Meru Betiri National Park lies within the province of East Java and extends over 580km^2. Of that area, 8.45 km^2 is marine (Indahnesia, 2011). The beaches of the park provide nesting grounds for endangered turtle species such as leatherback turtles, hawksbill turtles, green turtles, and olive ridley turtles (ADB 2014). The coastal vegetation is mostly found around Sukamade Bay and Meru Bay. Mangrove vegetation is largely found at the eastern side of the Rajegwesi Bay. The dominant genera are *Rhizophora, Avicennia* and *Bruguiera*. At the outlet of the Sukamade River, there is *Nypa fruticans*.

9.8.2.8 Togian Islands

The Togian Islands National Park, otherwise known as Kepulauan Togean, is a largely marine national park and provides habitat and breeding areas for hawksbill and green turtles and dugongs (Indahnesia, 2011). Mangroves forests are found within the marine park and extensive coral reefs.

9.8.3 Marine Nature Reserves and Conservation Areas

9.8.3.1 Karimunjawa

Karimunjawa is a national marine park in the Karimumjawa archipelago, 80km north of Jepara in the Java sea. The national park was formally declared a marine protected area in 2001 and has an IUCN category Ia status.

Karimunja has five types of ecosystems; coral reef, seagrass and seaweed, mangrove forest, coastal forest and low land tropical rainforest. The coral reefs of Karimunja are composed of fringing and barrier reefs along with several patch reefs. More than 90 species of coral biota is known to make up these ecosystems that creates a habitat for over 242 species of ornamental fish. Protected coral biota such as black coral, hornet helmet, titron trumpet, green shell and organ pipe coral, can be found here.

The 300 hectares of mangrove forests contain 32 species of mangroves and habitat many endemic species such as the dewadaru tree (*Fragraea elliptica*), setgi (*Pemphis acidula*) and kalimsada (*Cordia Subcordata*). Around 40 species of bird habitat this area as well as other terrestrial animals. Several species of turtles are known to use this national park as a breeding ground. Marine species within the area are particularly diverse, and in more abundance than the terrestrial populations.

9.8.3.2 Savu Sea National Marine Conservation Area

Savu Sea National Marine Conservation Area is located between the islands Sumba and Timor encompassing Pulau Roti and Sawu. The park includes coral reefs, mangroves, seagrass and deepwater habitats such as seamounts and deepwater canyons. Savu Sea NMCA is located within the Lesser Sunda seascape which is regarded as a high priority seascape for marine biodiversity conservation (Huffard et al. 2012). The Lesser Sundas is the main corridor between the Indian and Pacific Oceans including for migrating whales and commercially-important pelagic fishes (Huffard et al. 2012). Savu Sea NMCA covers ranges of species diversities and habitats within its region which includes:

- 532 corals species, 11 endemic and sub endemic species;
- 350 reef fish species;
- 15 mangrove species are recorded that represented nine families of mangrove;
- 10 sea grass species in two families;

- Deep-water habitats such as seamounts, deep-water canyons, straits (migratory corridors) and large persistent pelagic habitats were covered within Savu Sea NMP boundaries;
- Main migratory corridors and habitats for 14 whales species, seven dolphins species and one dugong species;
- Habitats for five sea turtles species (green, leatherback, olive ridley, loggerhead, and flat back), as well as for large marine fauna such as sharks, napoleon, parrotfish and groupers (Savu Sea Management Plan 2014).

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 eight key ecological features of the Commonwealth waters in the combined EMBA (covering the NMR, the NWMR and the SWMR) have been identified in the protected matters search (**Figure 10-2,Figure 10-3** and **Figure 10-1**) and are discussed in this section.

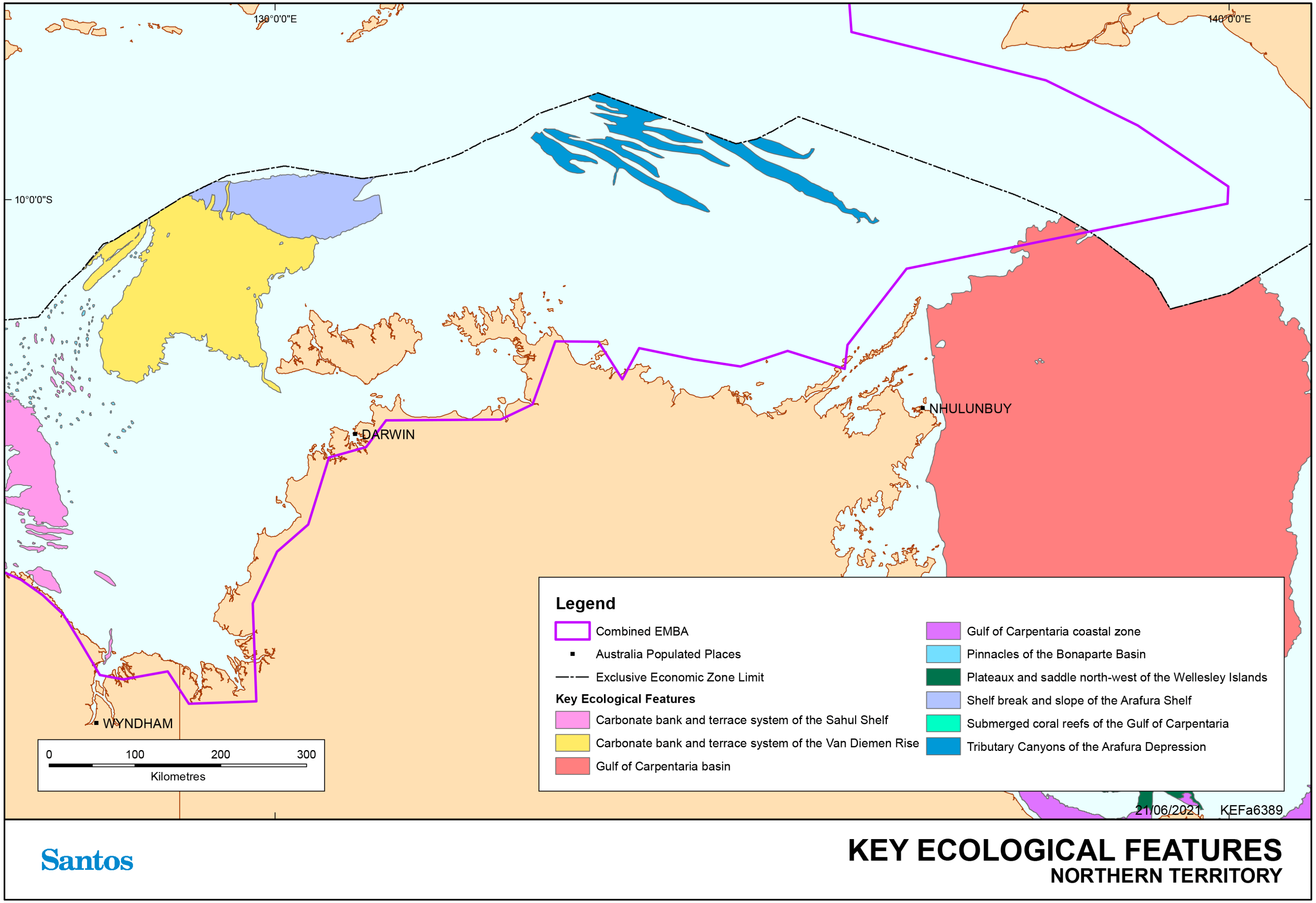

Figure 10-1: Key ecological features of NT

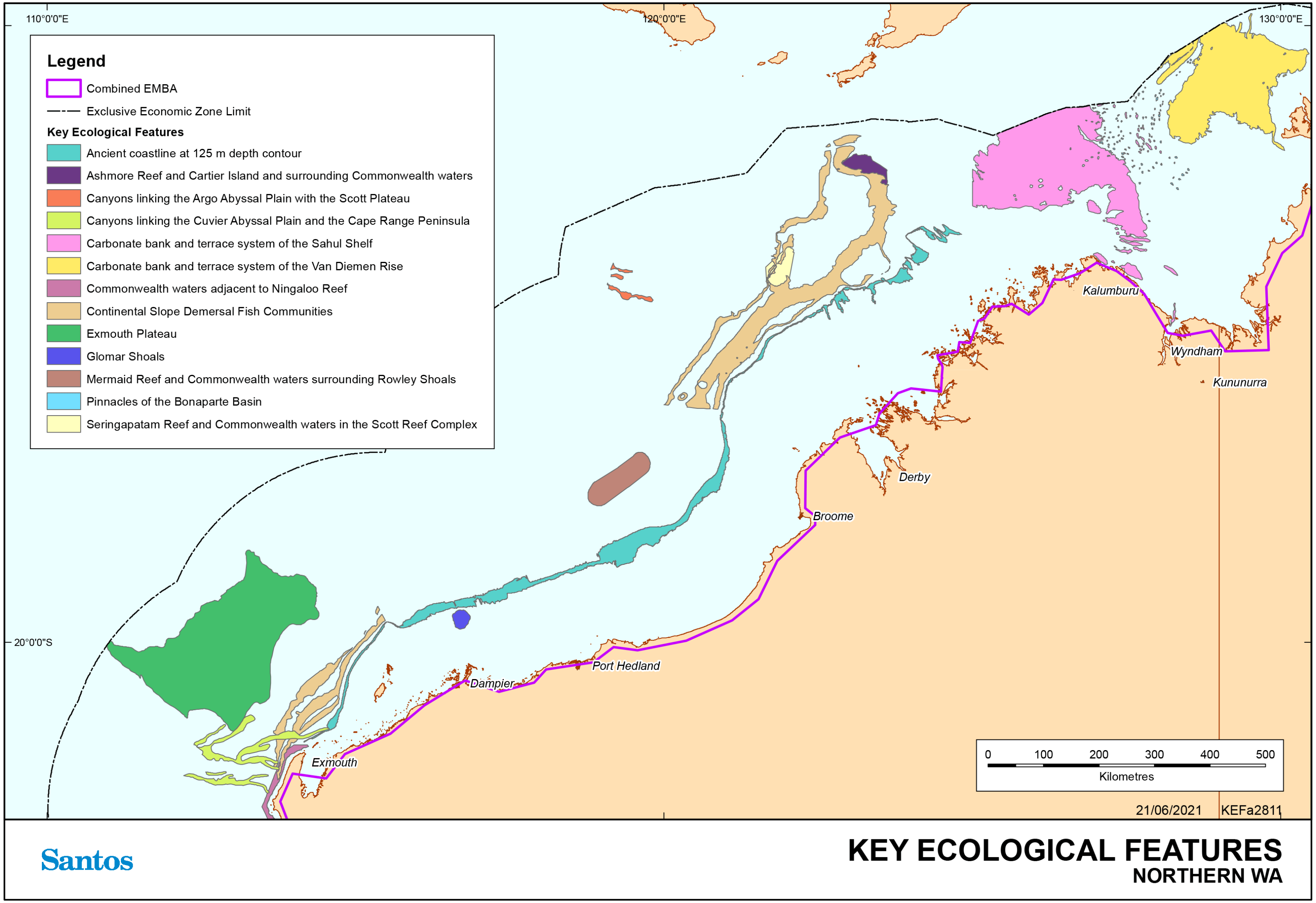

Figure 10-2: Key ecological features of Northern WA

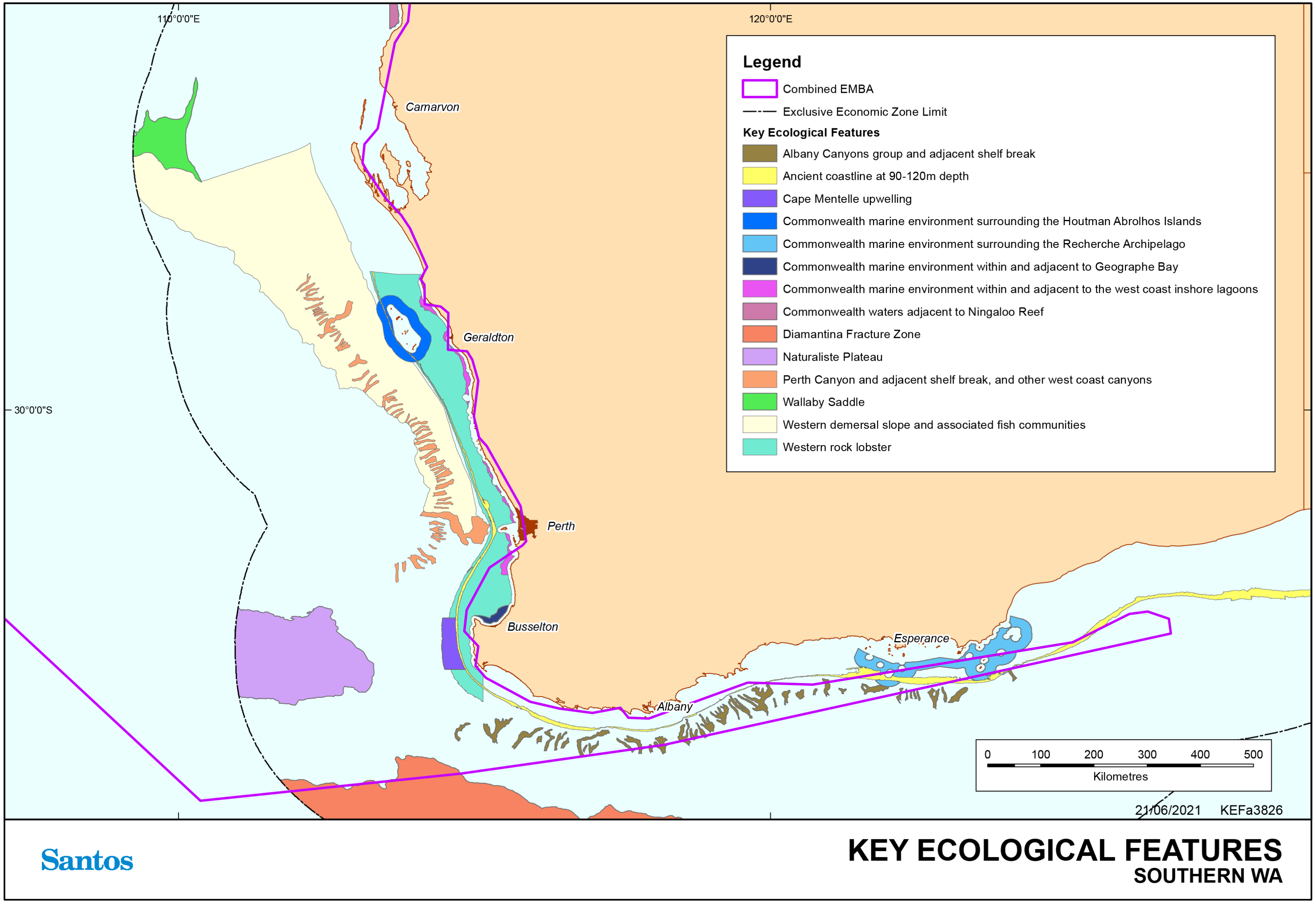

Figure 10-3: Key ecological features of Southern WA

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 Commonwealth Marine environment surrounding the Recherche Archipelago

The Recherche Archipelago is a chain of approximately 105 islands and 1 500 islets extending over 470 km of coastline near Esperance, Western Australia. This area is defined as a KEF as it is a region of high biodiversity, The Recherche Archipelago is the most extensive area of reef in the South-west Marine Region. Its reef and seagrass habitat support a high species diversity of warm temperate species, including 263 known species of fish, 347 known species of molluscs, 300 known species of sponges, and 242 known species of macroalgae. The islands also provide haul-out (resting areas) and breeding sites for Australian sea lions and New Zealand fur seals (DSEWPaC 2012)

10.1.3 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).

10.1.4 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.

10.1.5 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).

10.1.6 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.

10.1.7 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).

10.1.8 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. It 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 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, Williams *et al.* 2001). 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 (DoEE 2019a). 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).

10.1.9 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).

10.1.10 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).

10.1.11 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**.

10.1.12 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).

10.1.13 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).

10.1.14 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**).

10.1.15 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).

10.1.16 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).

10.1.17 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).

10.1.18 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).

10.1.19 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).

10.1.20 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**.

10.1.21 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).

10.1.22 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).

10.1.23 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.

10.1.24 Diamantina Fracture Zone

The Diamantina Fracture Zone is located south of the Naturaliste Plateau covering a range of more than 100,000 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.

10.1.25 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).

10.1.26 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).

10.1.27 Carbonate Bank and Terrace System of the Van Diemen Rise

The bank and terrace system of the Van Diemen Rise covers approximately 31,278 km^2 and forms part of the larger system associated with the Sahul Banks to the north and Londonderry Rise to the east. The feature is characterised by carbonate terrace, banks, channels and valleys, with variability in water depth and substrate composition considered to contribute to the presence of unique ecosystems in the channels. The variability in water depth and substrate composition across the feature may contribute to the presence of unique ecosystems in the channels. The carbonate banks and shoals found within the Van Diemen Rise make up 80% of the banks and shoals, 79% of the cannels and valleys, and 63% of the terrace found across the North Marine Region. The carbonate banks and shoals rise from depths of 100 m- 200 m to withing 10 m -40 m of the sea surface (Anderson et al. 2011).

The feature provides habitat for a high diversity of sponges, soft corals and other sessile filter feeders; epifauna and infauna; and olive ridley turtles, sea snakes and sharks. Rich sponge gardens and octocorals have been identified on the eastern Joseph Bonaparte Gulf along the banks, ridges and some terraces. Plains in deep hole/valleys are characterised by scattered epifauna and infauna that include polychaetes and ascidians. Epibenthic communities such as the sponges found in the channels are likely to support fish and second-order consumers. Pelagic fish such as mackerel, red snapper and a distinct gene pool of gold band snapper are found in the Van Diemen Rise.

10.1.28 Gulf of Carpentaria Basin

The Gulf of Carpentaria basin is defined as a key ecological feature for its regional importance for biodiversity, endemism and aggregations of marine life. These values apply to both the benthic and the pelagic habitats within the feature.

The Gulf of Carpentaria is believed to be one of the few remaining near-pristine marine environments in the world (Wightman et al. 2004). Primary productivity in the basin is mainly driven by cyanobacteria that fix nitrogen (Burford et al. 2009), but is also strongly influenced by seasonal processes. The soft sediments of the basin are characterised by moderately abundant and diverse communities of infauna and mobile epifauna dominated by polychaetes, crustaceans, molluscs and echinoderms.

The Gulf of Carpentaria basin also supports assemblages of pelagic fish species including planktivorous and schooling fish, and top predators such as shark, snapper, tuna and mackerel (Smith et al. 2006). The Gulf is also an important migratory route for seabirds, shore birds and marine turtles.

10.1.29 Shelf Break and Slope of the Arafura Shelf

The Shelf Break and Slope of the Arafura Shelf is an important ecological feature that creates a unique seafloor which enhances biological productivity on the edge of the shelf and attracts feeding aggregations of pelagic marine organisms. The productivity of this area has been recognised as nationally and/or regionally important (Last et al. 2005).

Although the ecosystem processes in this area are largely unknown it is thought that the oceanographic processes associated with the Indonesian Throughflow current and monsoonal winds are strong influence (DEWHA, 2007).

The physical characteristics of the Shelf Break and Slope of the Arafura Shelf comprise of continental slope, patch reefs and hard substrate pinnacles (Harris et al. 2005).

Phytoplankton and invertebrates have been sampled at this KEF and the primary production of phytoplankton is thought to be the basis for offshore food webs in the area (DEWHA, 2007). Records show approximately 284 demersal fish species in the area (Last et al. 2005) and other marine species that have been recorded include marine turtles, whale sharks and predatory fish species including sharks (DEWHA, 2008a).

10.1.30 Tributary Canyons of the Arafura Depression

The Tributary Canyons of the Arafura Depression is an important ecological feature characterised by high nutrients from upwellings of deep ocean water, which enhance productivity of the area (DEWHA, 2008a). This is thought to occur as a result of movements of water through the canyons and surface water circulating as a result of monsoonal winds (Wilson, 2005).

Surveys of the area identified around 245 macroscopic species including a variety of invertebrates and six small fish species (Wilson, 2005). The area also contains coral communities and attract aggregations of marine life (DEWHA, 2008a). Larger species found at this key ecological feature include predatory fish, whale sharks, sawfish and marine turtles (mostly olive ridley) (DEWHA, 2008a).

The national and/or regional importance of the Tributary Canyons of the Arafura Depression is associated with its high productivity, high levels of biodiversity and endemism.

11. State Marine Conservation Reserves

11.1 Introduction

Marine parks and reserves have been progressively established in Western Australia since 1987 and the Northern Territory since 1983. 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 25 marine parks within the combined EMBA (refer **Figure 9-2**, **Figure 9-3** **Figure 9-4** and **Figure 9-4**).

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 combined 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**).

Within the NT component of the combined EMBA, there are no marine based conservation reserves. There were three coastal reserves (Channel Point Coastal Reserve, Casuarina Coastal Reserve and Shoal Bay Coastal Reserve), one conservation area (Tree Point Conservation Area) and two national parks (Djukbinj National Park Garig Gunak Barlu National Park) identified in the PMST report as being situated adjacent to the combined EMBA. Three more were identified as being present (Mary River National Park, Keep River National Park, Charles Darwin National Park) in the combined EMBA from mapping. However, these are all terrestrial based reserves and have not been discussed in further detail.

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 km^2 of the bay. The 1,030 km^2 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 9-2, Figure 9-3** and **Figure 9-4**). 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 combined 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. Seven of these occur in West Australian waters in the combined 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
+ Eastern Recherche Marine Park

The North-West Marine Parks Network comprises 13 marine parks which all occur in West Australian waters pertinent to the combined 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. Four of these occur in Western Australian or Northern Territory waters within the combined EMBA:

- Oceanic Shoals Marine Park;
- Arafura Marine Park;
- Arnhem Marine Park; and
- Joseph Bonaparte Gulf Marine Park.

the combined EMBAThe 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 considers 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.

the combined EMBAThe 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).

Five types of zones are represented within the North Marine Parks Network:

- National Park Zone (IUCN Category II)
- Habitat protection zone (IUCN Category IV)
- Multiple use zone (IUCN Category VI)
- Special Purpose Zone (Trawl) (IUCN Category VI)
- Special Purpose Zone (IUCN Category VI)

A summary of the South-West, North-West and North 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 combined EMBA is provided below.

12.2.1 Abrolhos Marine Park

The Abrolhos Marine Park (including zones within the combined 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 an 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 combined EMBA): Marine National Park Zone -IUCN Category II – 31 km^2 Special Purpose Zone -IUCN Category VI – 1,820 km^2) covers an 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.

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 combined 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 combined 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 combined 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 combined 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 combined 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, Australian 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.

12.2.8 Eastern Recherche Marine Park

The Eastern Recherche Marine Park (Special Use Zone – IUCN Category V) is part of the South-West Marine Park Network. It lies adjacent to the Recherche Archipelago about 135km east of Esperance and includesimportant foraging areas for:

- Threatened white shark;
- Threatened Australian sea lion
- Pygmy blue whales are distributed across the marine park
- Southern right whales migrate through the region to important nursery areas in coastal waters.

The marine park does not contain any international, Commonwealth or National heritage listings (Director of National Parks 2018a) but it is adjacent to the Recherche Archipelago which is home to the only breeding population of great-winged petrels in Australia.

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 combined 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;
- 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).

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 km^2 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 Marine Parks 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) and is wholly contained within the combined 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).

12.4.2 Arafura Marine Park

The Arafura marine park covers 22,924 km^2 and is comprised of a Multiple Use Zone and Special Purpose Zone (Trawl). The marine park is wholly contained within the combined EMBA. It is located approximately 256 km from Darwin and extends to the outer edge of the Exclusive Economic Zone and the water depth ranges from 15 m to 500 m (Director of National Parks 2018c).

The Arafura Marine Park has been deemed significant because "*it contains habitats, species and ecological communities associated with the Northern Shelf Province and Timor Transition. It includes one key ecological feature: the tributary canyons of the Arafura Depression (valued as a unique seafloor feature with ecological properties of regional significance). It is near to important wetland systems including the Cobourg Peninsula Ramsar site, and provides important foraging habitat for seabirds"* (Director of National Parks, 2018c)

The Arafura Marine Park has both cultural and natural values.

The marine park protects the following natural values (Director of National Parks, 2018c):

- Ecosystems representative of the Northern Shelf Province
- Ecosystems representative of the Timor Transition
- BIAs for Marine Turtles
- BIAs for Seabirds
- Tributary canyons of the Arafura Depression key ecological features.

The sea country of the marine park is part of the responsibility of the Yuwurrumu members of the Mandilarri-Ilduji, the Mangalara, the Murran, the Gadura-Minaga and the Ngaynjaharr clans. Sea country is valued for Indigenous cultural identity and Indigenous people have been sustainably using and managing their sea country, including the sea country within the Arafura Marine Park for tens of thousands of years (Director of National Parks, 2018c).

12.4.3 Arnhem Marine Park

The Arnhem Marine Park covers an area of 7125 km^2 and water depth ranges from less than 15 m to 70 m. The marine park is entirely comprised of a Special Purpose Zone (VI) and the majorityof the marine park is contained within the combined EMBA. It is located approximately 100 km south-east of Croker Island and 60 km south-east of the Arafura Marine Park. It extends from Northern Territory waters surrounding the Goulburn Islands, to the waters north of Maningrida (Director of National Parks 2018c).

The Arnhem Marine Park has been deemed significant because "*it contains habitats, species and ecological communities associated with the Northern Shelf Province. It includes dynamic habitats due to gently sloping shelf topped with a number of pinnacles, at depths ranging from 5 m to 30 m. It is near to important wetland systems including the Blyth-Cadell Floodplain and Boucaut Bay Nationally Important Wetland and provides important foraging habitat for seabirds*" (Director of National Parks 2018c).

The Arnhem Marine Park has both cultural and natural values.

The marine park protects the following natural values (Director of National Parks, 2018c):

- Ecosystems representative of the Northern Shelf Province
- Nutrient-rich coastal water contributing to high biological biodiversity
- BIAs for Marine Turtles
- BIAs for Seabirds

The sea country of the marine park is part of the responsibility of the coastal Aboriginal people of West Arnhem land. Sea country is valued for Indigenous cultural identity and Indigenous people have been sustainably using and managing their sea country, including the sea country within the Arnhem Marine Park for tens of thousands of years (Director of National Parks, 2018c).

No heritage listings apply to the marine park. Commercial fishing, tourism and recreation are important socio-economic values for the park (Director of National Parks 2018c).

12.4.4 Joseph Bonaparte Marine Park

The Joseph Bonaparte Gulf Marine Park is located approximately 15 km west of Wadeye, Northern Territory, and approximately 90 km north of Wyndham, Western Australia, in the Joseph Bonaparte Gulf. It is adjacent to the Western Australian North Kimberley Marine Park. The marine park covers an area of 8597 km² and water depth ranges between less than 15 m and 100 m, and is wholly contained within the combined EMBA. The marine park is comprised of two zones; Special Purpose Zone (VI) and Multiple Use Zone (VI) (Director of National Parks, 2018c).

The Joseph Bonaparte Marine Park has been deemed significant because "*it contains habitats, species and ecological communities associated with the Northwest Shelf Transition bioregion. It includes one key ecological feature: the carbonate bank and terrace system of the Sahul Shelf (valued as a unique seafloor feature with ecological properties of regional significance). The Marine Park contains a number of prominent shallow seafloor features including an emergent reef system, shoals, and sand banks. It is near an important wetland systems including the Ord River floodplain Ramsar site and provides connectivity between the nearshore and sea environments. The Marine Park includes habitats connecting to and complementing the adjacent Western Australian North Kimberley Marine Park*" (Director of National Parks, 2018c).

The Joseph Bonaparte Marine Park has both cultural and natural values.

The marine park protects the following natural values (Director of National Parks, 2018c):

- Ecosystems representative of the Northwest Shelf Transition
- BIAs for Marine Turtles
- BIA for the Australian Snubfin Dolphin
- KEFs represented in the park are:
    - Carbonate bank and terrace system of the Sahul Shelf (unique sea-floor feature)

The sea country of the marine park is part of the responsibility of the Miriuwung, Gajerrong, Doolboong, Wardenybeng and Gija and Balangarra people. Sea country is valued for Indigenous cultural identify and

Indigenous people have been sustainably using and managing their sea country, including the sea country within the Arnhem Marine Park for tens of thousands of years (Director of National Parks, 2018c).

No heritage listings apply to the marine park, however the marine park is adjacent to the West Kimberly National Heritage Place. Tourism, commercial fishing, mining and recreation are important socio-economic values for the park (Director of National Parks 2018c).

Table 12-1 Summary of marine network values, pressures, management programs and actions applicable to the combined 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
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

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.

Table 13-1: Summary of EPBC Act recovery plans applicable to the combined 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 combined EMBA: + Asian dowitcher; + Bar-tailed godwit; + Black-tailed godwit; + Broad-billed sandpiper; + Common greenshank; + Common redshank; + Common sandpiper; + Curlew Sandpiper; + Double-banded plover; + Eastern Curlew; + 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;	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
	+ Red-necked stint; + Red knot; + Ruddy turnstone; + Ruff (reeve); + Sanderling; + Sharp-tailed sandpiper; + Streaked shearwater; + Terek sandpiper; + Whimbrel; and + Wood sandpiper.		
	Christmas Island frigatebird	Conservation Advice for the Christmas Island frigatebird *Fregata andrewsi* (2020a) Recovery Plan for the Christmas Island Frigatebird (*Fregeta andrewsi*) (2004)	Introduction of a new disease
			Disturbance of habitat
			Fisheries – prey depletion
			Illegal killing and hunting in south-east Asia
			Invasive weeds
			Fisheries - bycatch
			Drowning in artificial water bodies
			Heavy metal contamination
			Marine debris - plastics
	Australasian bittern	Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (2019)	habitat loss through water reductions and transition from ponded rice to other farming systems
			habitat degradation through increased salinity, siltation and pollution; grazing by livestock and feral animalsan d changes in abundance of plant species
			Climate change through changes in water availability; changes in fire regimes and salinisation of coastal wetlands
			Infrastructure through urban development

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Predation by introduced vertebrate pests such as foxes and cats
	Red knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and habitat degradation
			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)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Diseases
			Climate change impacts
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Climate change
			Intentional shooting/killing
			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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Intentional shooting/killing
			Feral pest species
			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

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
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Southern 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
	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		Ongoing human disturbance

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice *for Numenius madagascariensis* (eastern curlew) (2015)	Habitat loss and degradation from pollution
			Changes to the water regime
			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	Conservation Advice for the Abbott's booby *Papasula abbotti* (2020b)	Vegetation clearing – edge effects from previous clearing and new vegetation clearing
			Climate change – severe storm events and prey depletion
			Introduction of a new disease
			Invasive weeds
			Yellow crazy ants – habitat modification
			Fisheries – prey depletion
			Marine debris - plastics
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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	Commonwealth Conservation Advice on *Rostratula australis* (Australian painted snipe) (2013)	Loss and degradation of wetlands, through drainage and the diversion of water for agriculture and reservoirs
			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

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
	Shy albatross	Conservation Advice *Thalassarche cauta* Shy Albatross (2020c) National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Fisheries bycatch
			Disease
			Competition for nesting habitat
			Marine plastics
			Human disturbance
			Previous harvesting for feathers and eggs
			Climate change
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Campbell 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
	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		Climate and oceanographic variability and change

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015)	Anthropogenic noise and acoustic disturbance
			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

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

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)
			Fisheries bycatch – international (moderate), domestic (high)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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
			Predation on eggs by wild dogs, pigs and monitor lizards

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (moderate)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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)
			Noise interference – acute (low), chronic (low; unknown)
			Recreational activities (low)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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
			Public aquarium trade
			Pollution and disease
			Ecosystem effects - habitat modification and climate change

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	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
		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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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
			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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	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, Figure 14-2** and **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 combined EMBA. Existing petroleum infrastructure, permits and licences are shown in **Figure 14-1, Figure 14-2** and **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.

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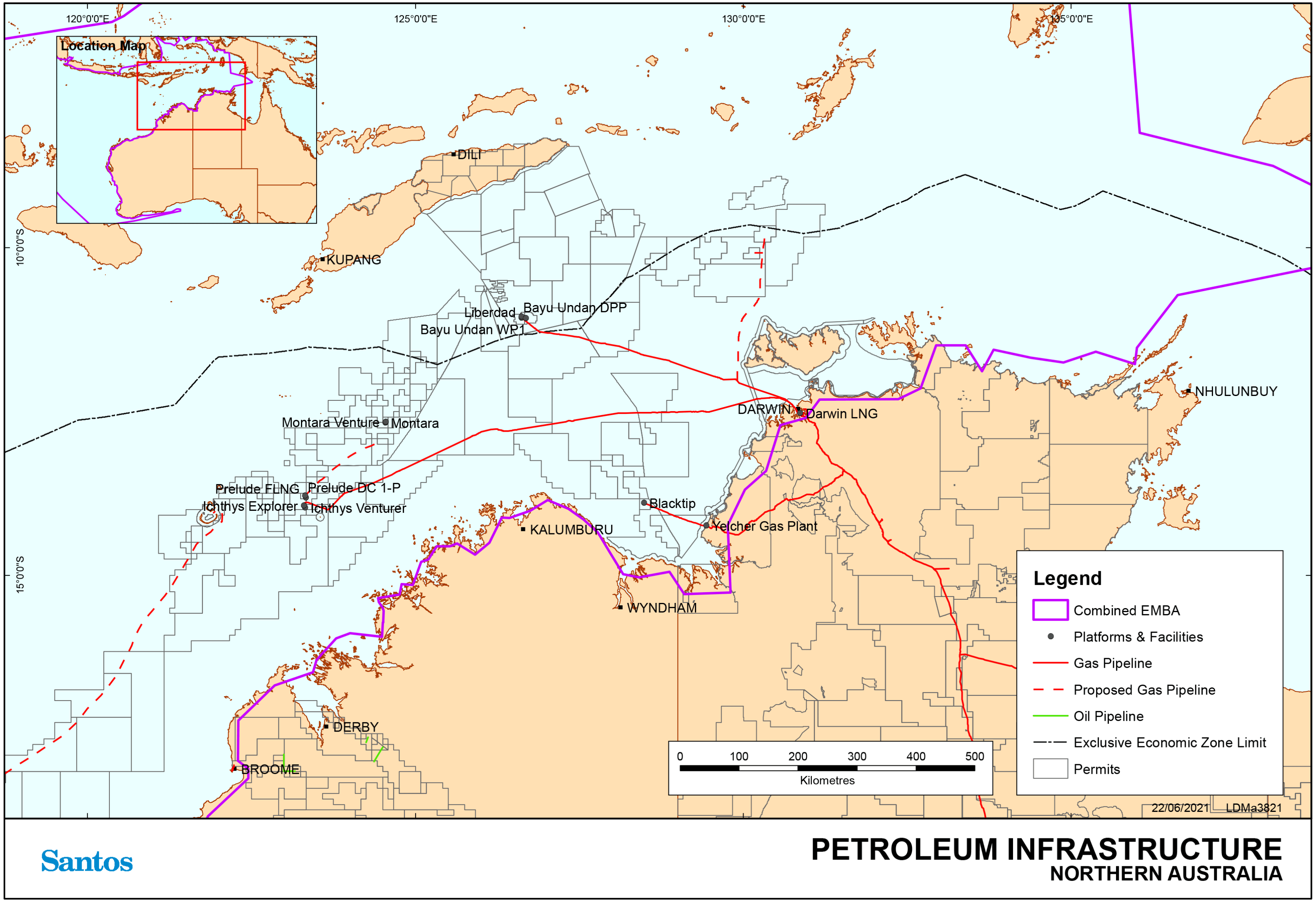

Figure 14-1: Existing petroleum infrastructure, permits and licences – Northern WA

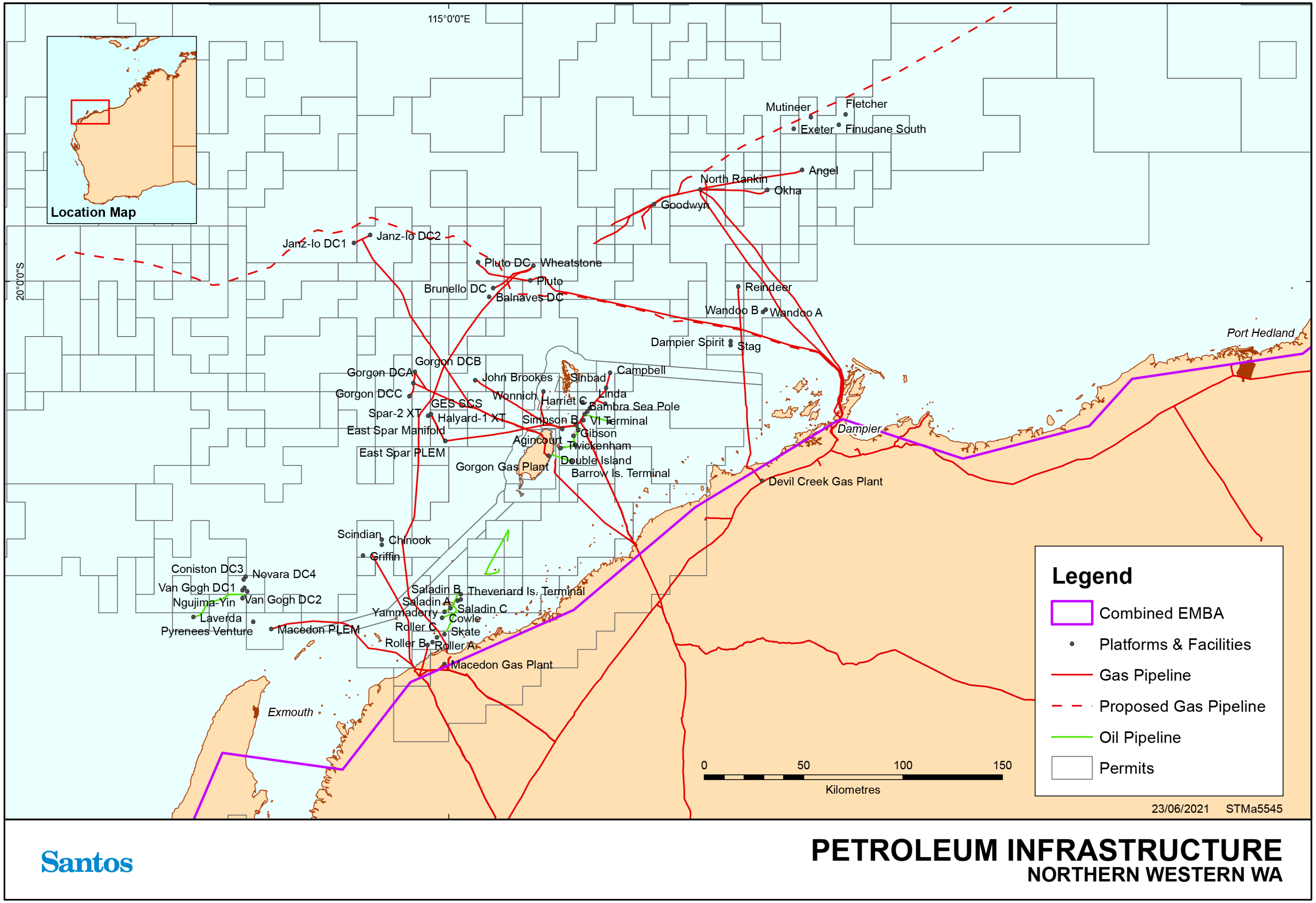

Figure 14-2: Existing petroleum infrastructure, permits and licences – Northern Western WA

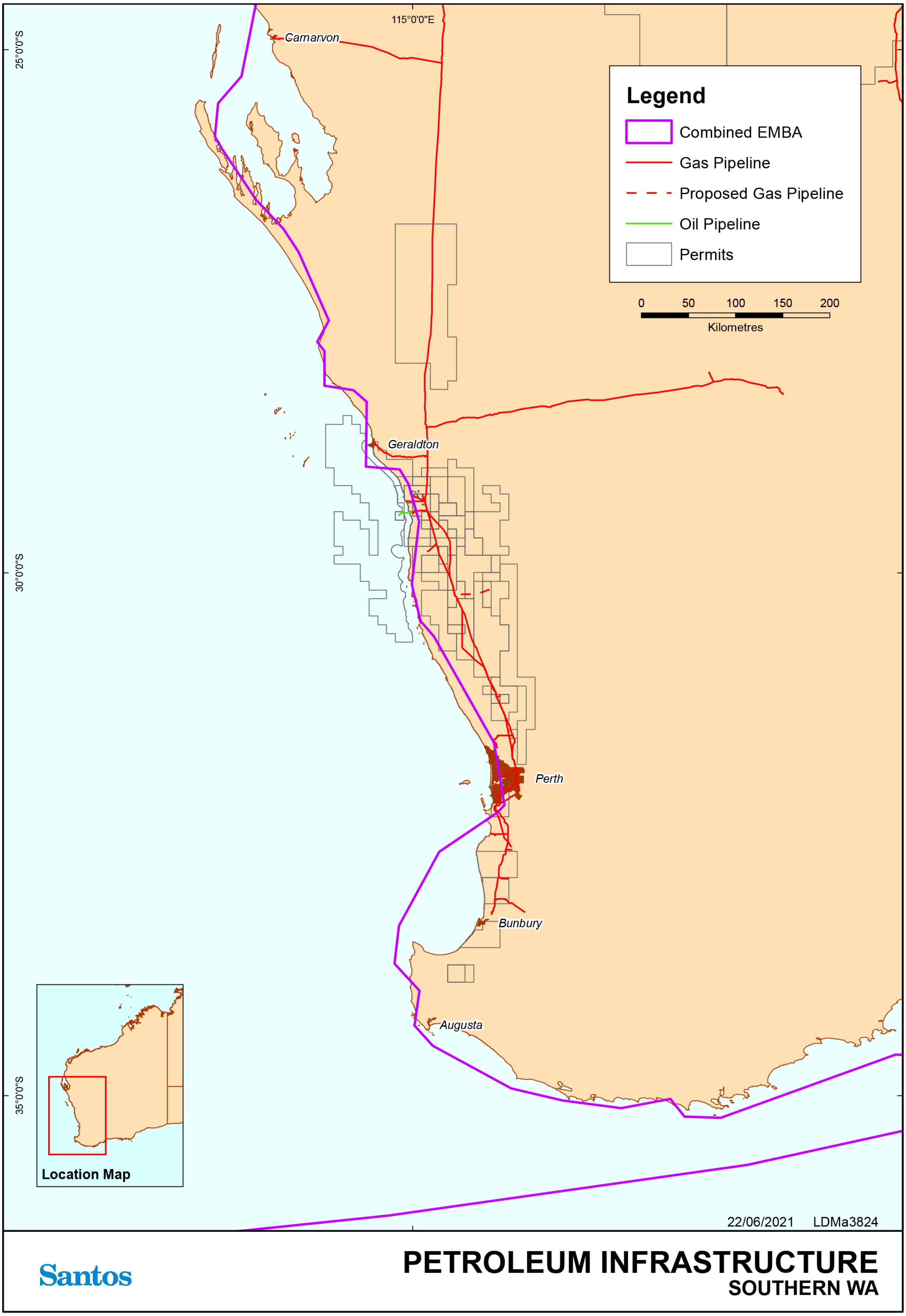

Figure 14-3: Existing petroleum infrastructure, permits and licences –Southern WA

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 combined EMBA through the AUSREP system in 2021 are shown in **Figure 14-4**.

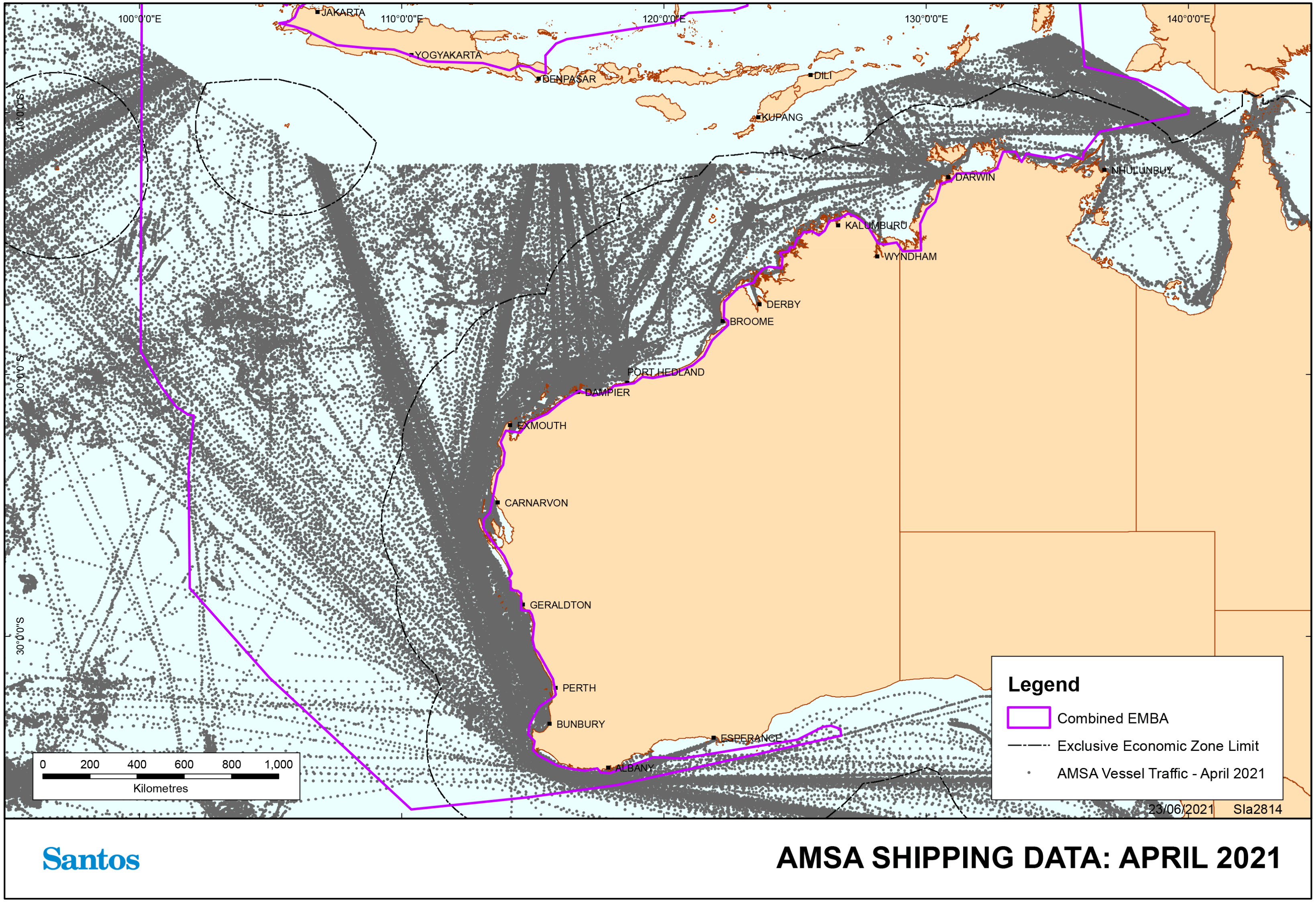

Figure 14-4:AMSA ship locations and shipping routes

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 combined 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.
+ Bradshaw Defence field training area
+ Artillery Barracks – Fremantle
+ Camble Barracks- Swanborne
+ Irwin Barracks – Karrakatta
+ Lancelin Training Area
+ Leeuwin Barracks- East Fremantle
+ Preston Point Training Depot
+ Rockingham – Navy CPSO
+ Swanbourne Rifle Range

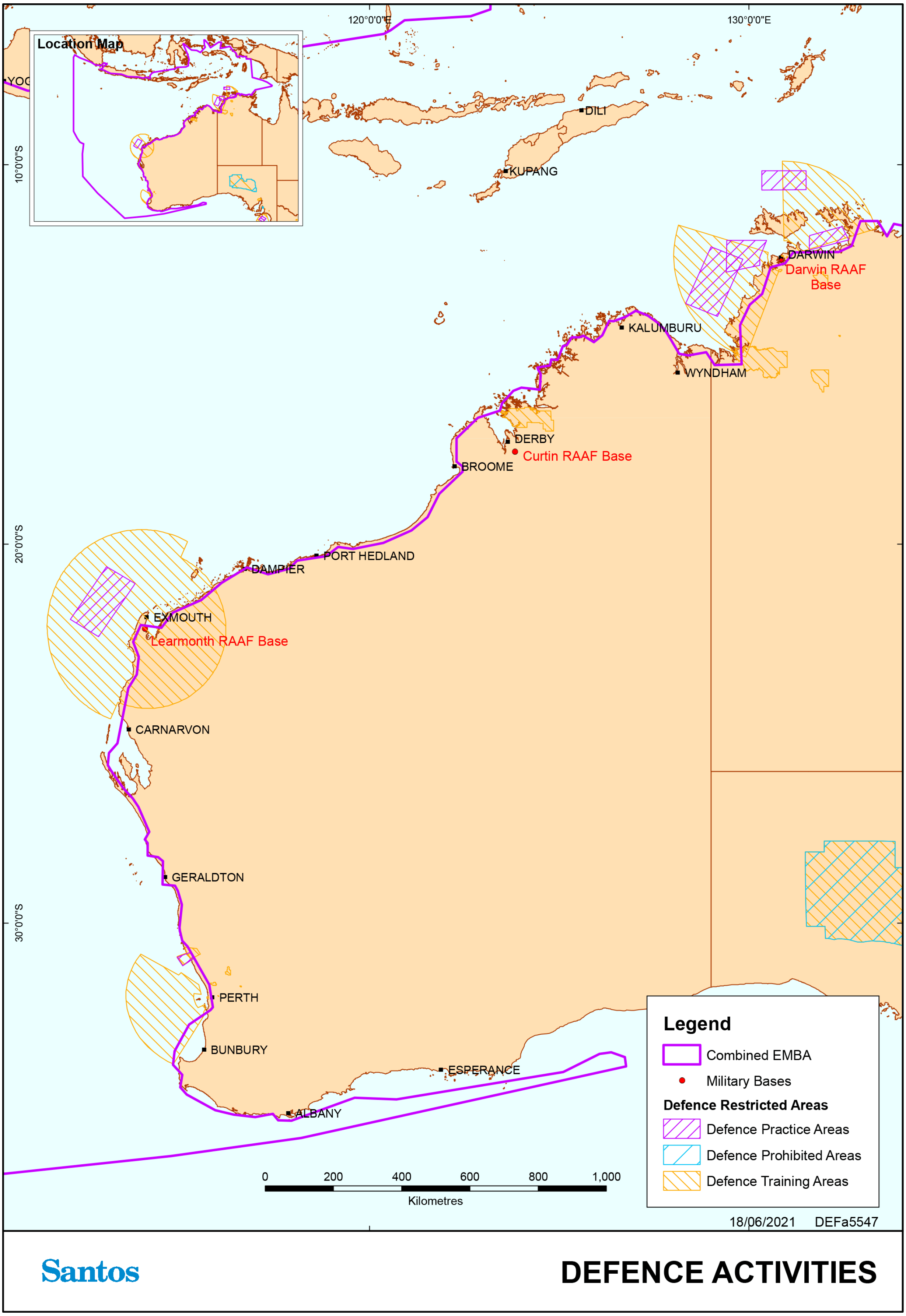

Figure 14-5: Defence activities

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. 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 combined 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). Within the combined 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).

In the Northern Territory there are a number of sacred and significant sites located on the Tiwi Islands. There are currently four registered sacred sites on the Tiwi Islands (Aboriginal Areas Protection Authority, 2016). Another 56 sites of significance to Tiwi Islanders have been recorded, including two sites on the NT mainland (Tiwi Land Council, 2003). The Tiwi Islands sites hold importance as they have high spiritual and cultural history value (Tiwi Land Council 2003).

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. the combined EMBA. Key shipwrecks in the North West Marine Region are shown in **Figure 14-10** to **Figure 14-6**, 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 combined EMBA, there are 1033 shipwrecks known to be in excess of 75 years old.

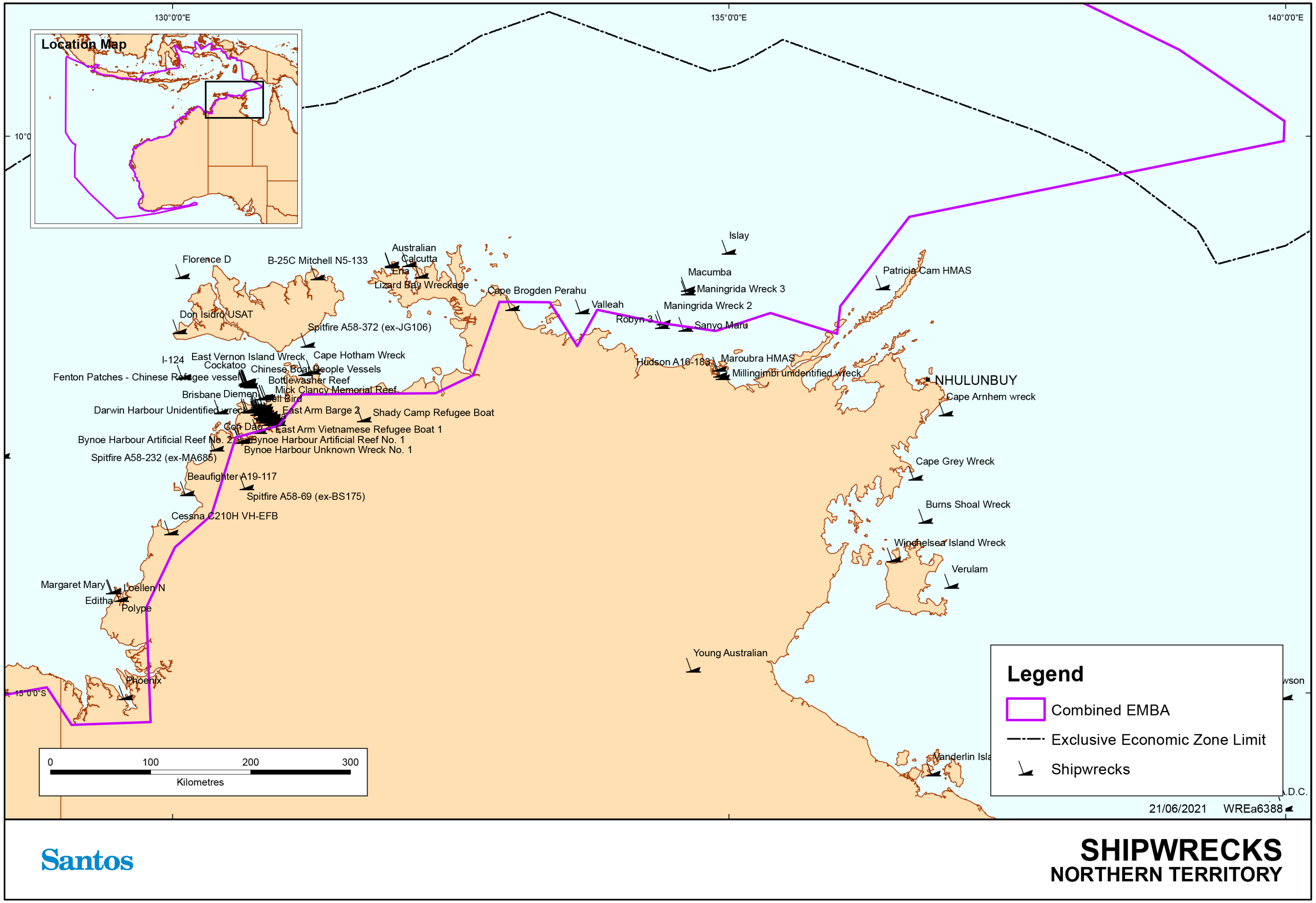

Figure 14-6: Shipwrecks –NT

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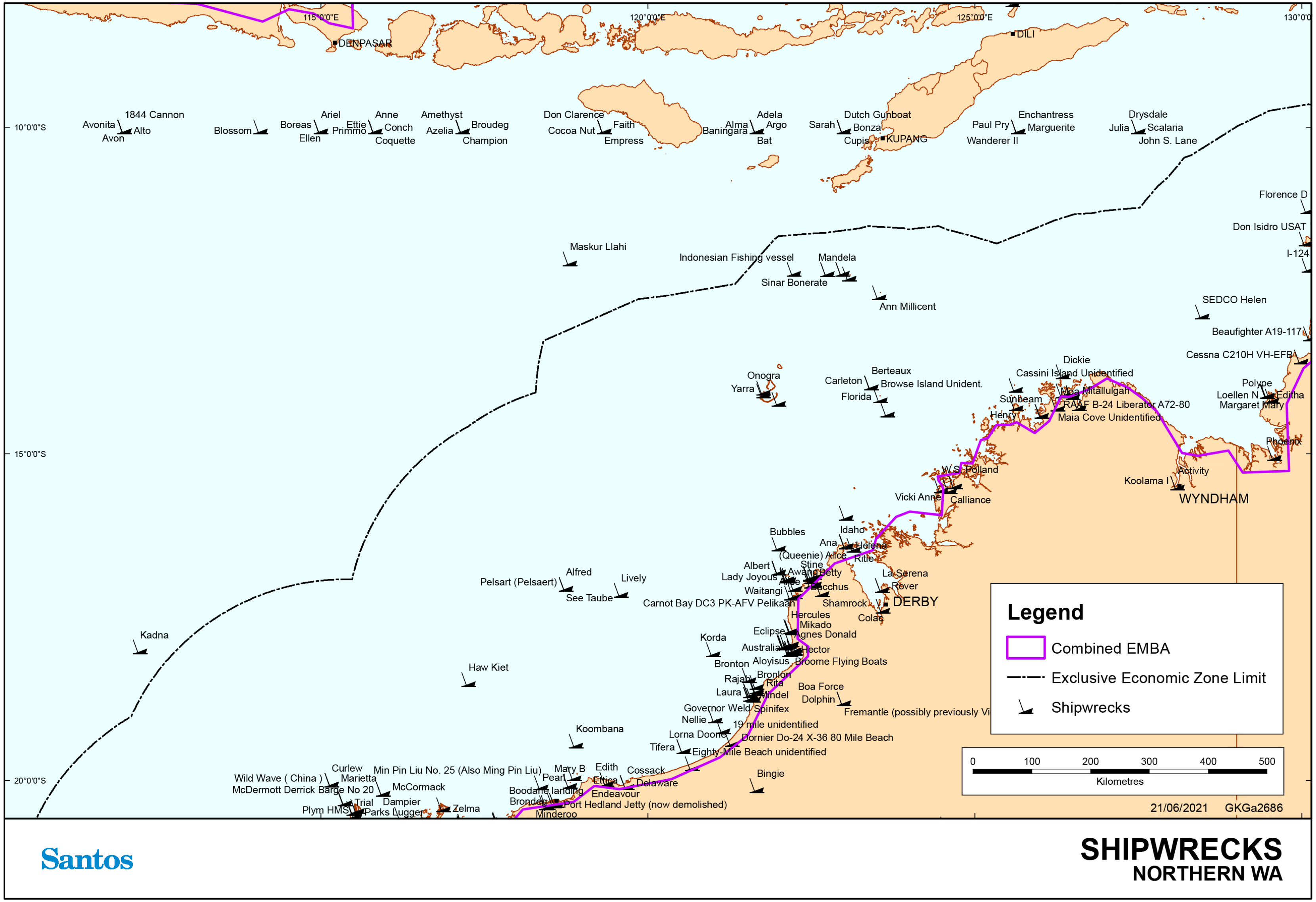

Figure 14-7: Shipwrecks – Northern WA

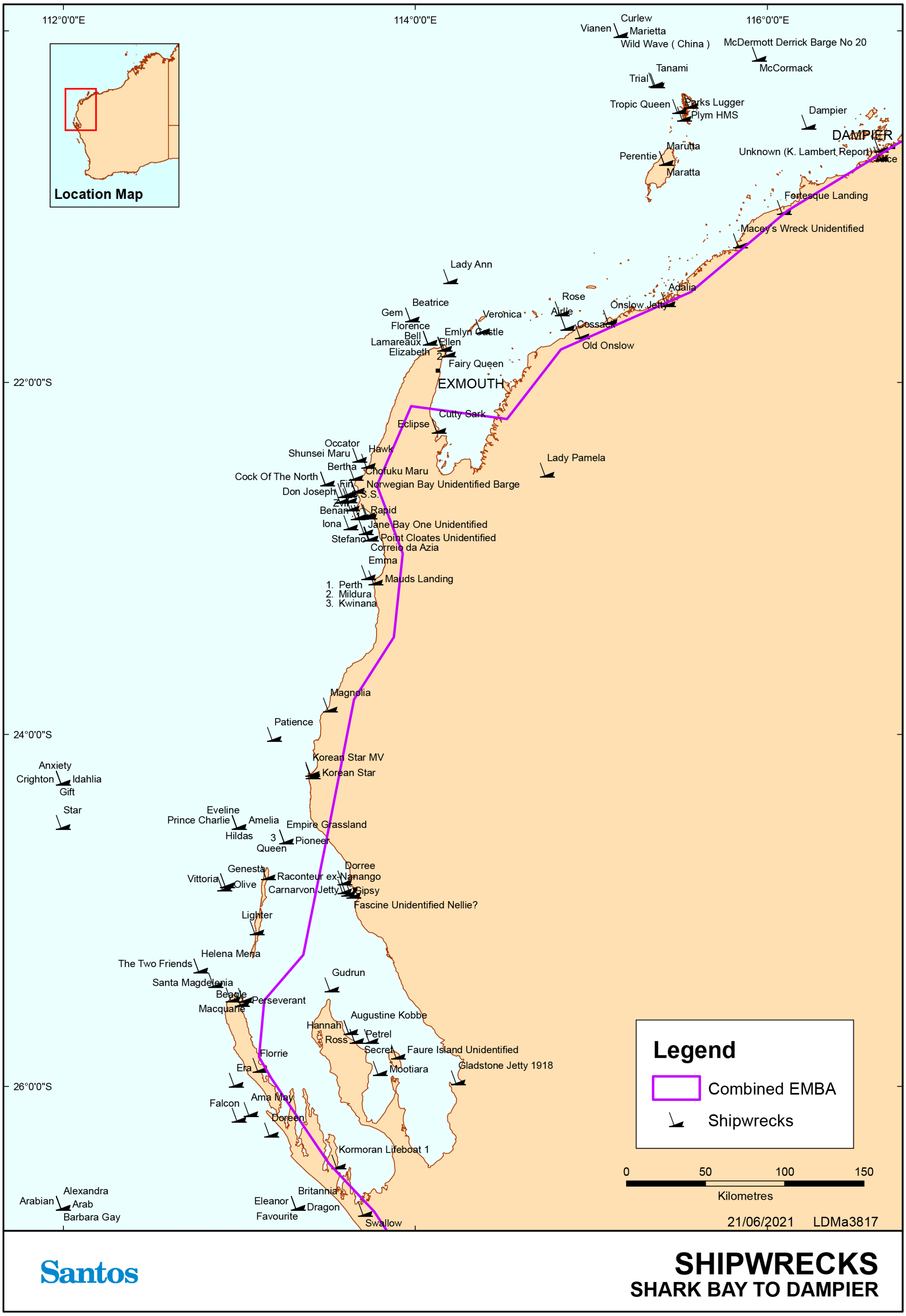

Figure 14-8: Shipwrecks – Shark Bay – Dampier

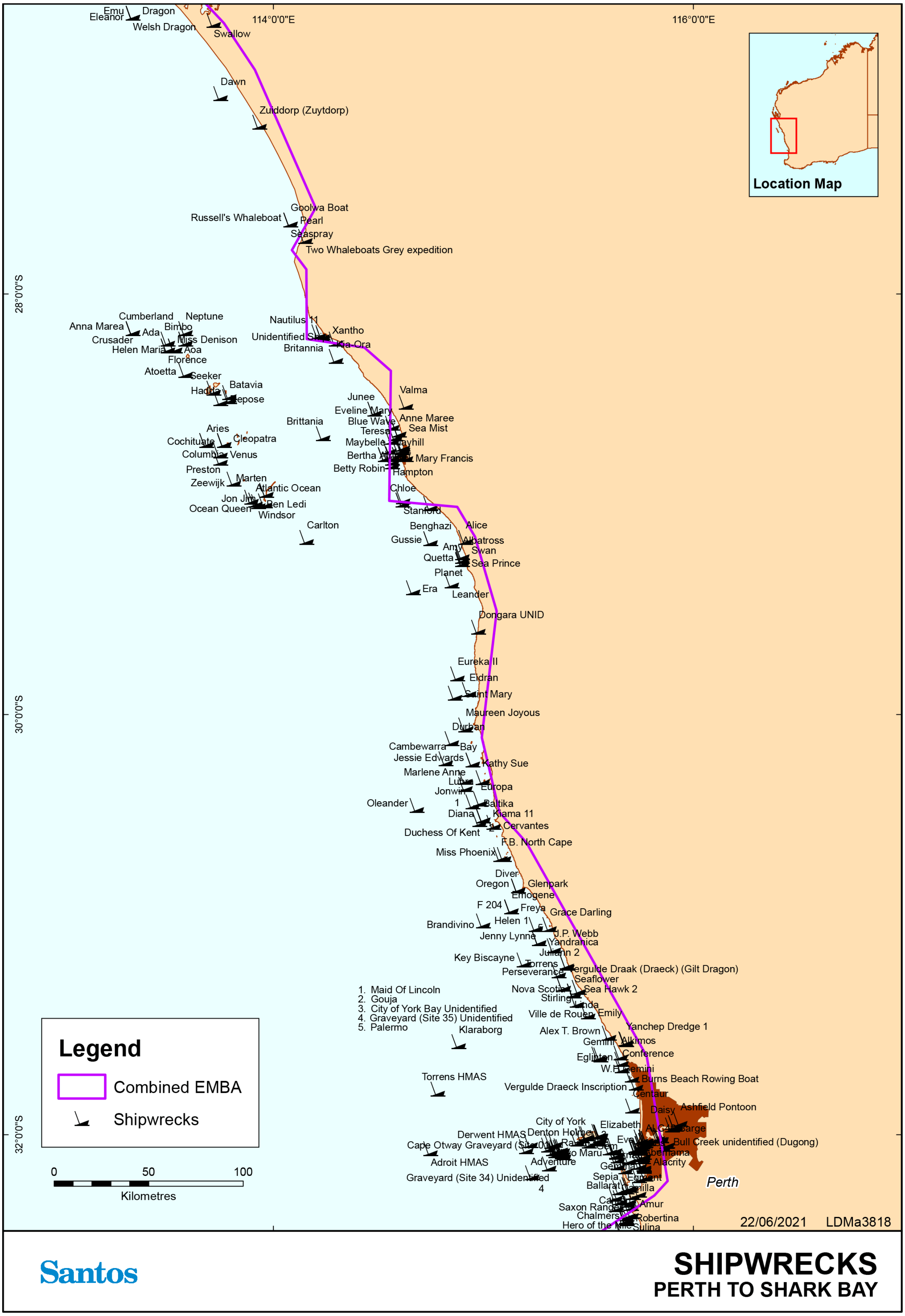

Figure 14-9: Shipwrecks – Perth – Shark Bay

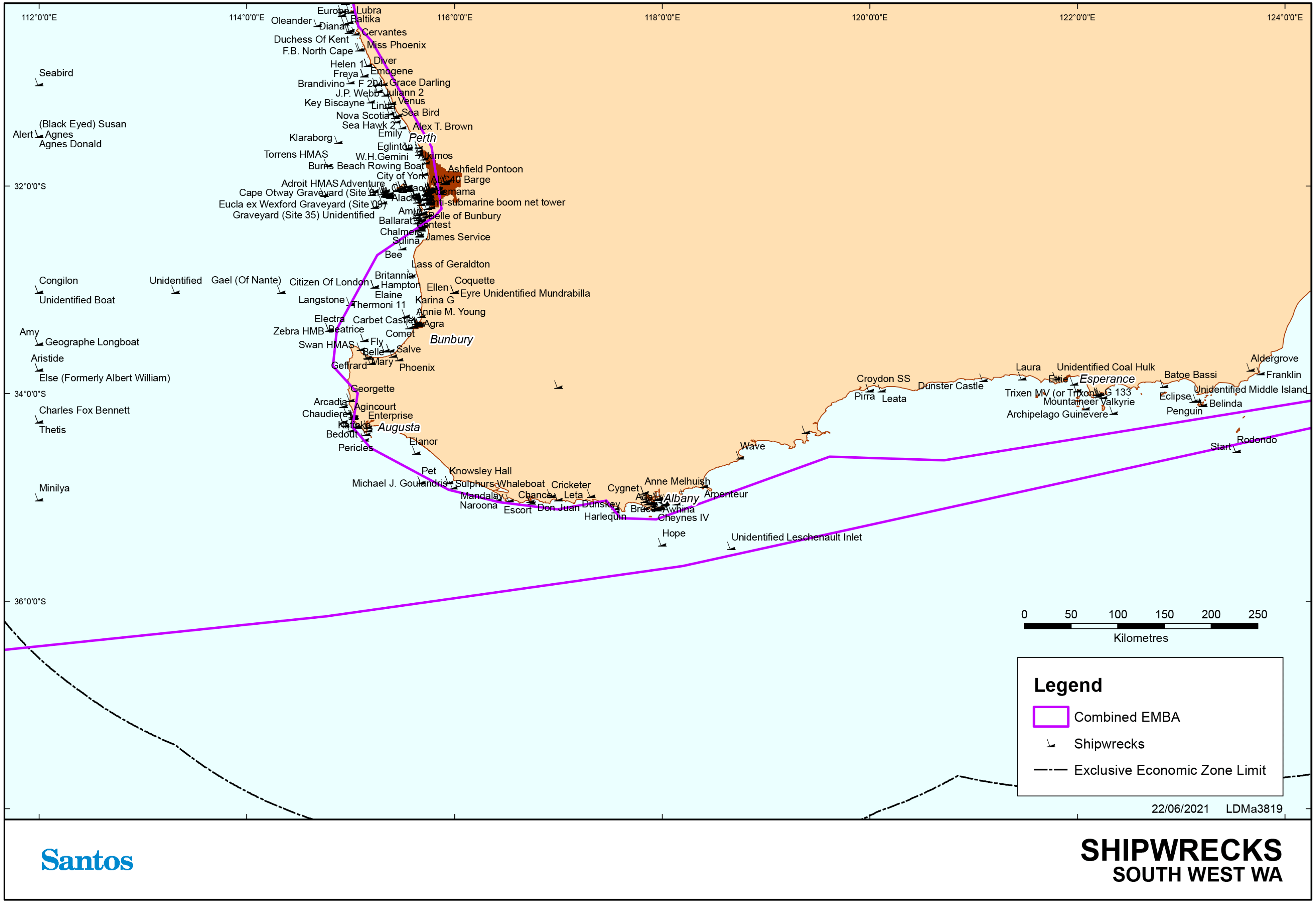

Figure 14-10: Shipwrecks – South West WA

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 2018/2019 (Gaughan *et al.* 2020) and direct consultation with DPIRD. Santos 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 14-12**. Fisheries in the Northern Territory are shown in **Figure 14-11**. A summary of all commercial fisheries in the area is also provided in **Table 14-1**. 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 14-12;**
+ Broome Prawn Managed Fishery (BPMF);
+ Kimberley Prawn Managed Fishery (KPMF);
+ Kimberley Gillnet & Barramundi Managed Fishery (KGBF);
+ Kimberley Developing Mud Crab Fishery[15]**;**
+ Northern Demersal Scalefish Managed Fishery (NDSF);
+ North Coast Traditional Trochus Fishery[15];
+ Pilbara Demersal Scalefish Fisheries[15]**;**
+ Pilbara Developing Crab Fishery[15]**;**
+ Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF);
+ Pilbara Trap Managed Fishery (PTMF);
+ Pilbara Line Fishery;
+ Western Australian Sea Cucumber Fishery;
+ Mackerel Managed Fishery (Area 1 – Kimberley and Area 2 – Pilbara);
+ Western Australian Pearl Oyster Fishery – referred to as Pearl Oyster Managed Fishery in **Figure 14-12;**
+ Northern Shark Fisheries (closed[15]**)** including:

[15] Not shown in **Figure 14-12**

- Western Australian North Coast Shark Fishery[15]; and
- Joint Authority Northern Shark Fishery[15]
- North Coast Trochus Fishery[15]; and
- Pilbara Developing Crab Fishery[15].

Northern Territory

- Coastal Line Fishery;
- Aquarium Fishery;
- Trepang Fishery;
- Development Small Pelagic Fishery;
- Coastal Net Fishery;
- Spanish Mackerel Fishery;
- Offshore Net and Line Fishery;
- Timor Reef Fishery;
- Demersal Fishery; and
- Barramundi Fishery.

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 14-12;**
- Shark Bay Prawn Managed Fishery – referred to as Shark Bay Prawn Limited Entry Fishery on **Figure 14-12;**
- Shark Bay Beach Seine and Mesh Net Managed Fishery[15]**;**
- Shark Bay Crab Interim Managed Fishery; and
- Mackerel Fishery (Area 3 – Gascoyne/West Coast).

West Coast Bioregion

- Roe's Abalone[15]**;**
- Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWRMF) (Closed) – referred to as Abrolhos Islands and Mid-West Trawl Limited Entry Fishery in **Figure 14-12;**
- West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF);
- South West Trawl Managed Fishery – referred to as South West Trawl Limited Entry Fishery in **Figure 14-12;**
- Mandurah to Bunbury Developing Crab Fishery[15]**;**
- Cockburn Sound Crab Managed Fishery[15]**;**
- Cockburn Sound Line and Pot Managed Fishery[15]**;**
- Cockburn Sound Mussel Managed Fishery[15]**;**

- Warnbro Sound Crab Managed Fishery (closed) [15];
- West Coast Nearshore and Estuarine Finfish Fisheries, including:
- Cockburn Sound Fish Net Managed Fishery[15];
- West Coast Beach Baited Managed Fishery[15];
- South West Beach Seine Fishery[15]; and
- West Coast Estuarine Managed Fishery[15];
- Temperate Demersal Gillnet and Demersal Longline Fisheries, including:
- West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (West Coast Bioregion) [15];
- West Coast Deep Sea Crab (Interim) Managed Fishery – referred to as West Coast Deep Sea Crustacean Managed Fishery in **Figure 14-12;**
- West Coast Nearshore Net Managed Fishery [15];
- Octopus Interim Managed Fishery [15];
- West Coast Rock Lobster Managed Fishery; and
- West Coast Purse Seine Fishery [15].

South Coast Bioregion

- Greenlip/Brownlip Abalone Fishery [15];
- South Coast Crustacean Managed Fishery [15];
- South Coast Deep-Sea Crab Fishery [15];
- South Coast Estuarine Managed Fishery[15];
- South Coast Open Access Netting Fishery [15]; and
- South West Coast Beach Net [15].
- South Coast Salmon Managed Fishery;
- South Coast Trawl Fishery;
- South West Coast Salmon Managed Fishery [15];
- 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 Coast Trawl Limited Entry Fishery in **Figure 14-12**; and
- Windy Harbour/Augusta Rock Lobster Managed Fishery [15].

Whole of State Fisheries

- Marine Aquarium Fish Managed Fishery (MAFMF);
- Specimen Shell Managed Fishery; and
- Hermit Crab Fishery (HCF) [15].

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 combined EMBA include as shown in **Figure 14-13**:

+ 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);
+ Small Pelagic Fishery (SPF);
+ Southern and Eastern Scalefish and Shark Fishery (SESSF) – not shown in **Figure 14-13**;
+ Skipjack Tuna Fishery (STF) (referred to as Western Skipjack Tuna Fishery in **Figure 14-13**)**;** and
+ Western Deepwater Trawl (WDTF) (referred to as Western Deepwater Trawl Fishery in **Figure 14-13**).

Commonwealth commercial fisheries between Kalbarri (WA) and the NT Border are shown **Figure 14-13** and summarised in **Table 14-1**.

14.7.3 Indonesian Commercial and Subsistence Fishing

Within the northern and north-western extent of the combined 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 14-13**) 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 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 such as sea cage farming.

Further invertebrate aquaculture operations are expected after recent funding to establish a South Coast Aquaculture Development Zone by DPIRD. An initial south coast aquaculture project aims to identify suitable areas for artificial farm structures to be constructed supporting shellfish production including abalone and edible oysters (Gaughan and Santoro 2020).

14.8.2 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).

Further aquaculture operations are expected following the establishment of the Mid-West Aquaculture Development Zone by DPIRD, which aims to provide a platform to stimulate aquaculture investment and development in the bioregion (Gaughan and Santoro 2020).

14.8.3 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.

14.8.4 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.

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 in this region mainly focuses on barramundi farming within Cone Bay, with two aquaculture licences granted in this area located about 200 km north-east of Broome (Gaughan and Santoro 2020).

Further aquaculture operations have expanded in the region with the establishment of the Kimberley Aquaculture Development zone, which encompasses almost 2,000 ha of coastal waters within Cone Bay supporting the production of up to 20,000 t of finfish annually (Gaughan and Santoro 2020).

14.8.5 Northern Territory

The Northern Territory boasts a diverse and vibrant aquaculture industry. An extensive range of commercial activity includes barramundi farming, trepang (sea cucumber), pearling and the collection of marine fish and coral for the tropical aquarium market. A pond-based barramundi farm on the Adelaide River produces more than 1,000 tonnes of Barramundi a year (Northern Territory Government, 2016). Giant clams are also farmed with trials on Groote Eylandt and Goulburn Island growing sea clams in sea-based cages. The silver-lipped pearl oyster is farmed in four main areas of the NT: Bynoe Harbour, Beagle Gulf, Cobourg Peninsula and Croker Island around the islands north west of Nhulunbuy.

14.8.6 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 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).

14.9.2 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).

14.9.3 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).

14.9.4 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).

14.9.5 Northern Territory

The most recent available data on recreational fishing in the Greater Darwin area indicates that line fishing (using bait, lures or flies) was the most common fishing method used, accounting for 72% of the total effort, followed by Mud Crab potting (23%). The use of cast nets and other fishing methods was far less common. Approximately 70% of all recreational fishing effort occurred in estuarine waters (Matthews et al, 2019). The Darwin Harbour region and its associated arms and creeks supported 40% of the total fishing effort, followed by Bynoe Harbour (14%) and Shoal Bay (6%). The offshore regions seaward of Bynoe Harbour and Dundee were the most popular sites for those fishers venturing beyond estuarine waters. Most of the catch (84%) comprised of fish species (i.e. bony fish and sharks/rays) with the bulk of the remaining catch consisting of crabs and prawns.

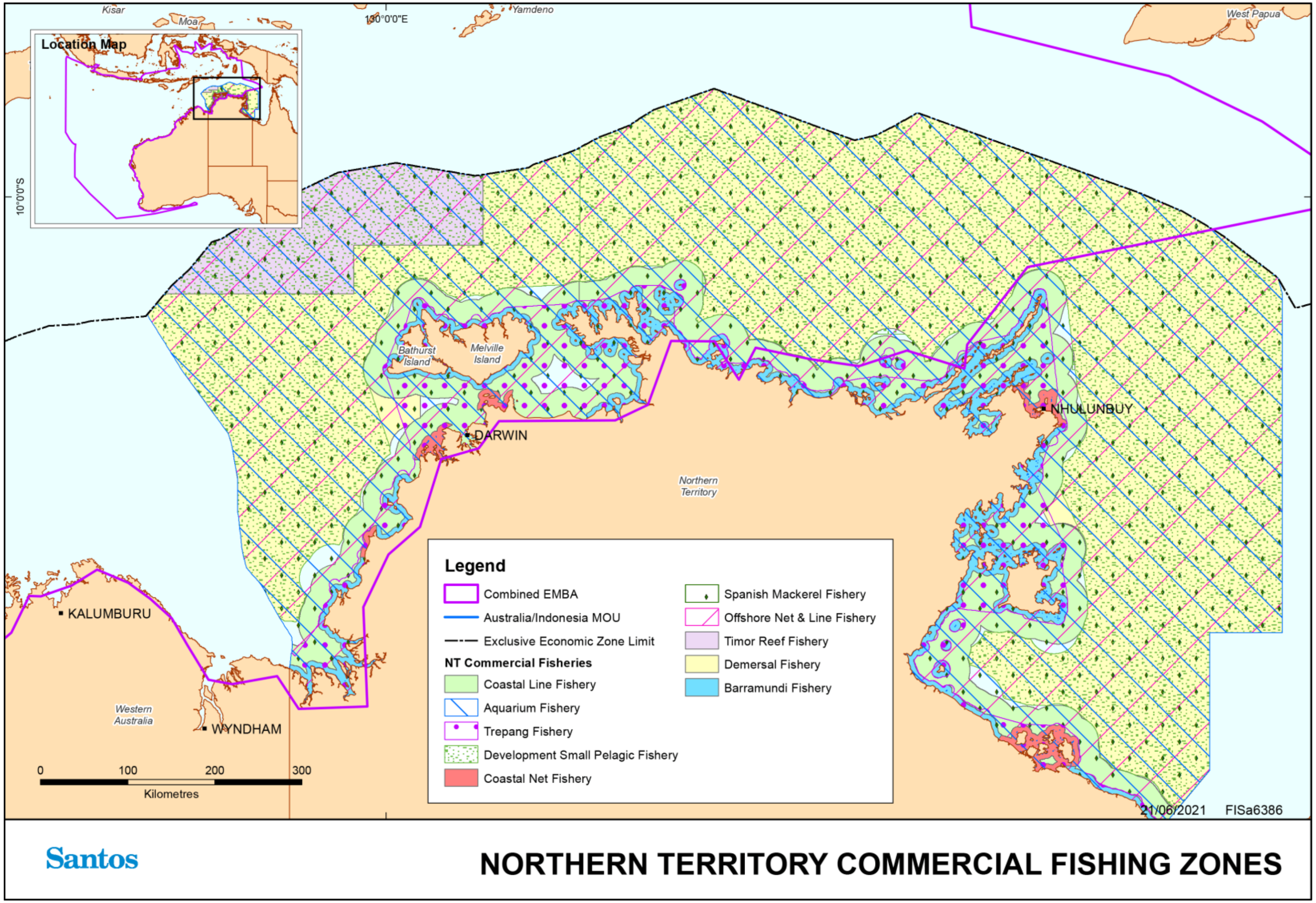

Figure 14-11:NT state commercial fishing zones

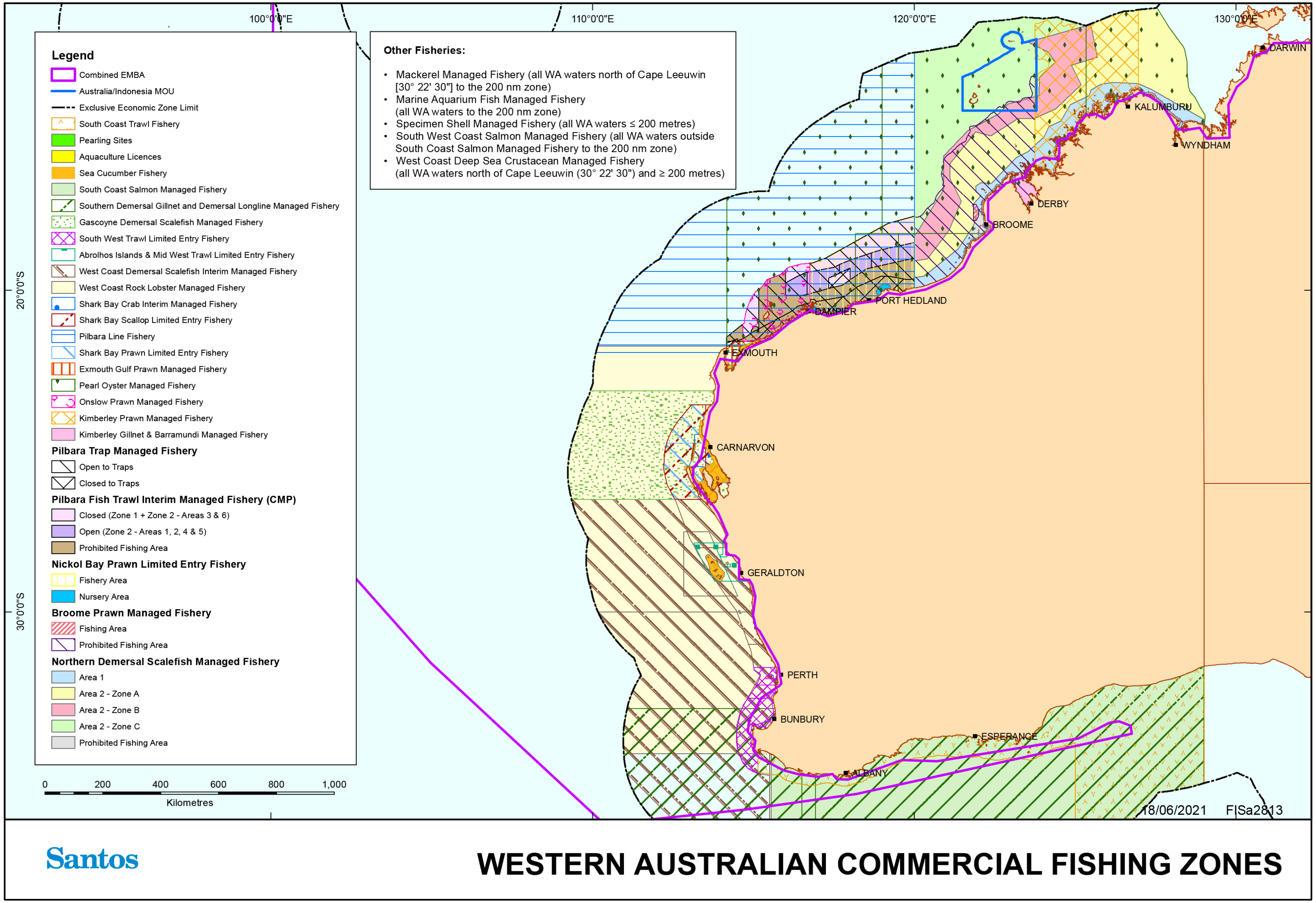

Figure 14-12:WA state commercial fishing zones

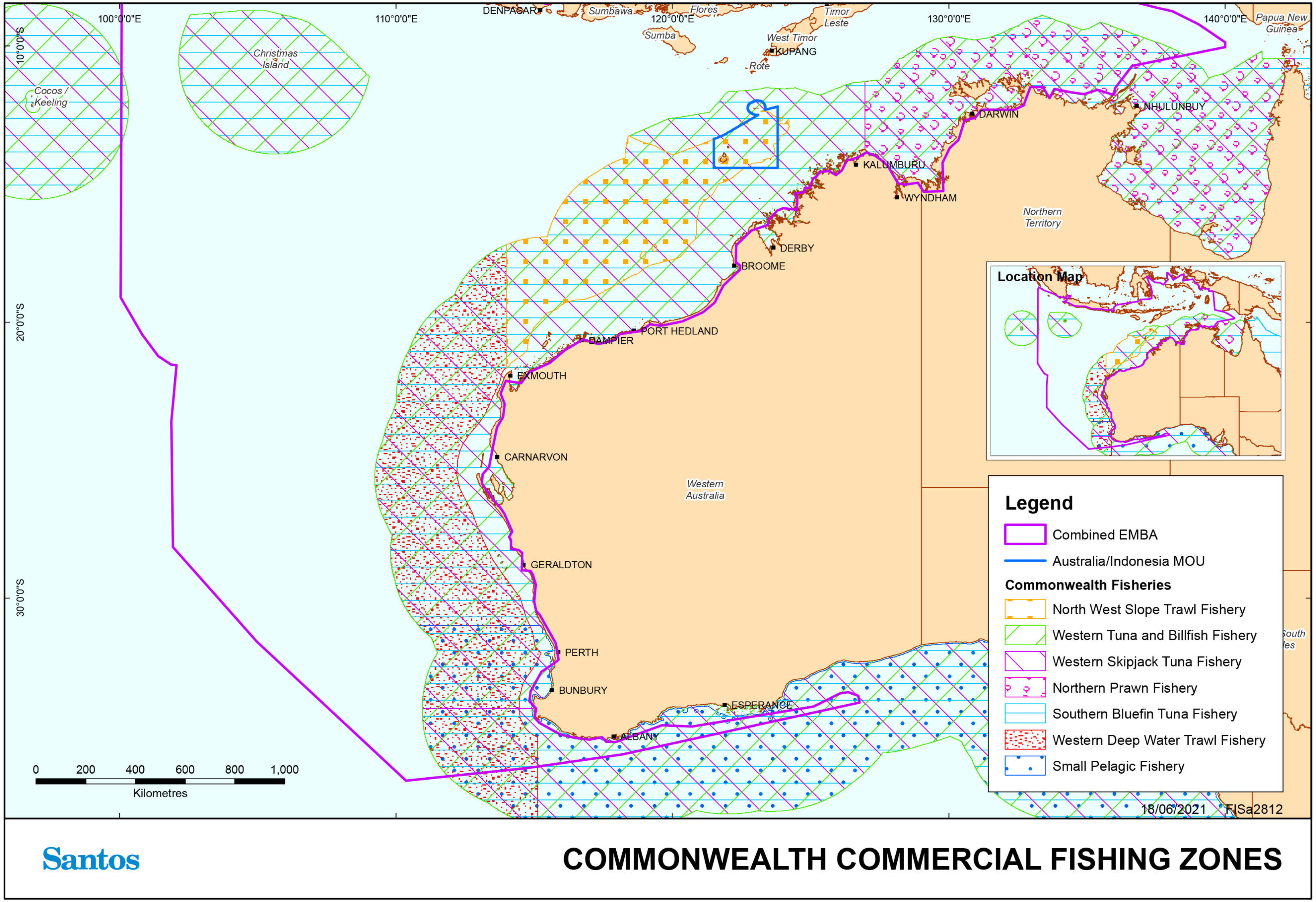

Figure 14-13: Commonwealth commercial fishing zones

Table 14-1: Commercial fisheries with permits to operate within the combined 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'.
Aquarium Fishery	Multi-species catch including; invertebtrates (hermit crabs, various snails, whelks and hard and soft corals) and finfish (rainbowfish, catfishes and scats).	Unknown	Dive-based method of collection, using barrier, cast, scoop, drag and skimmer nets, hand pumps, freshwater pumps and handheld instruments.	The Aquarium fishery is a small-scale, multi-species fishery that prospects freshwater, estuarine and marine habitats to the outer boundary of the AFZ. Most of the harvest occurs within 100km of Darwin, though one license holder does collect from two offshore locations; Evans Shoal and Lynedoch Bank. Fishing activities may occur year round.
Barramundi Fishery	Barramundi King threadfin	The fishery is restricted to 14 licences all of which are currently allocated to fishers.	Gill nets	The annual commercial barramundi fishing season in the NT is from 1 February to 30 September. Fishing is allowed from the high water mark to three nautical miles seaward of the low water mark. The area is restricted to waters seaward from the coast, river mouths and legislated closed lines
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.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Coastal Line Fishery	Black jewfish Golden snapper	Fishery is restricted to 52 licenses, with approximately one third of these being active in 2015.	Lines, nets and traps	Fishing occurs along the NT coast between high water marks and 15 nm from low water mark. Majority of activity is concentrated around rocky reefs along the coastline within 100km from Darwin. Fishing activities occur year-round.
Coastal Net Fishery	Mullet	This fishery is restricted to five licences, all of which are allocated.	Nets	The fishery extends from the high water mark to three nautical miles out from the low water mark. The fishery is divided into regions including: • Darwin – from Cape Hotham to Native Point and Cape Ford to Cape Dooley • Gove – between Cape Arnhem and Cape Wilberforce • Borroloola – from Bing Bong Creek and Pelican Spit.
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
Demersal Fishery	Red snappers Goldband snappers	There are currently 19 licenses issued for the fishery, with around 9 active.	Handline Dropline Fish traps Although, essentially trap-based since 2002	This fishery extends from waters 15nm from the coastal waters mark to the outer limit of the AFZ, excluding the area of the Timor Reef Fishery.
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	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
			'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.	greenlip/brownlip abalone is managed in three separate areas.
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.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Kimberley Prawn Managed Fishery (KPMF)	Banana prawns (*Penaeus merguiensis*) Tiger prawns (*Penaeus esculentus*) Endeavour prawns (*Metapenaeus endeavouri*) Western king prawns (*Penaeus latisulcatus*)	2017/2018: 269 tonnes	Otter trawl	The KPMF operates off the north of the state between Koolan Island and Cape Londonderry. 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).

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.
Octopus Interim Managed Fishery	*Octopus cf. tetricus*, with occasional bycatch of *O. ornatus* and *O. cyanea*	2017/2018:	Line and pots	Fishery in development phase. Four main categories in WA waters. Octopus are

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	in the northern parts of the fishery, and *O.maorum* in the southern and deeper sectors.	Commercial: 257 tonnes Recreational: 1 tonne	Trawl and trap (land Octopus as byproduct)	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.
Offshore Net and Line Fishery	Blacktip sharks Grey mackerel,	The number of licences for the fishery is restricted to 17 and only 10 boats operated in 2015. Limited effort was undertaken in the outer offshore area of the fishery during 2012.	Lines and nets	The fishery covers an area of over 522,000 km2 and extends from the NT high water mark to the boundary of the AFZ. Majority of the fishing effort is in the coastal zone (within 12 nm of the coast) and immediately offshore in the Gulf of Carpentaria.
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)	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
			Recreational fishers use drop nets or scoop nets, with diving for crabs becoming increasingly popular	recreational activity occurring in and around Nickol Bay.
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	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	(*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 snapper (*Argyrops spinifer*), Ruby snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus)*			isobath and seaward of a line generally following the 30 m isobath.
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	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
	endeavour prawns (*Metapenaeus* spp.) and coral prawns (various species).			
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

Santos

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
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.
Spanish Mackerel Fishery	Narrow-barred spanish Mackerel	In 2012, there were 16 fishery licences of which 12 were actively operating (DPIF 2014). The 2012 fishing effort was 719 boat-days; a decrease from 813 boat-days in 2011 but an increase from the 672 boat-days in 2010.	Near-surface trolling gear from vessels or handline.	The fishery extends from the NT waters seaward off the coast and river mouths to the outer limit of the AFZ. The majority of the fishing effort occurs coastal areas around reefs, shoals and headlands. The majority of the catch is taken in the Kimberley Area and north of Port Hedland.
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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				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.
Trepang Fishery	Sea cucumber (sandfish species)	The fishery is restricted to six licences, all of which are currently allocated.	Trepang are harvested by hand, either on foot or by diving.	Commercial fishing for sea cucumber is allowed from the high water mark to three nautical miles seaward from the territorial sea baseline. Most sea cucumbers are collected along the Arnhem Land coast, mainly around the Cobourg Peninsula and Groote Eylandt
Timor Reef Fishery	Goldband snapper	Consultation undertaken in 2016 confirmed there are only two active fishers currently operating in the fishery	Drop lines primarily in the 100 m–200 m depth range	Operates in remote offshore waters in the Timor Sea in a defined area approximately 370 km north-west of Darwin.
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.
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*).	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	West Coast Offshore Demersals: Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneios*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.			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	<u>Nearshore:</u> whitebait (*Hyperlophus vittatus*), western Australian salmon (*Arripis truttaceus*), Australian herring (*Arripis georgianus*), sourthern school whiting (*Sillago bassensis*), yellowfin whiting (*Sillago schomburgkii*), yelloweye mullet (*Aldrichetta forsteri*), tailor (*Pomatomus saltarix*), southern garfish (*Hyporhamphus melanochir*), silver trevally (*Pseudocaranx georgianus*) and King George whtiting (*Sillaginodes punctate*). <u>Estuarine:</u> sea mullet (*Mugil cephalus*), estuary cobbler (*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).	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. <u>Nearshore:</u> Cockburn Sound Fish Net Managed Fishery operating within in 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. <u>Estuarine:</u> 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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
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.
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).

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
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 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				

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
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. 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.	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
			Around 98% of Australia's SBT quota is taken by 5–10 purse seine vessels fishing for 13–25 kg southern bluefin tuna.	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 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.

15. Document review

This document is to be reviewed annually at a minimum. The review and revision will consider any changes to the spatial scope of the document, i.e. the Environment that May be Affected (EMBA), as well as any changes to EPBC Act Matters of National Environmental Significance (MNES) from one review year to the next, regardless of any changes to the spatial extent of the combined EMBA. A review of changes to MNES shall consider at a minimum any changes to EPBC Act species lists, species management/recovery plans and MNES spatial layers. Changes are to be recorded within the MNES review register (**Appendix B**).

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Appendix A: EPBC Act Protected Matters Reports

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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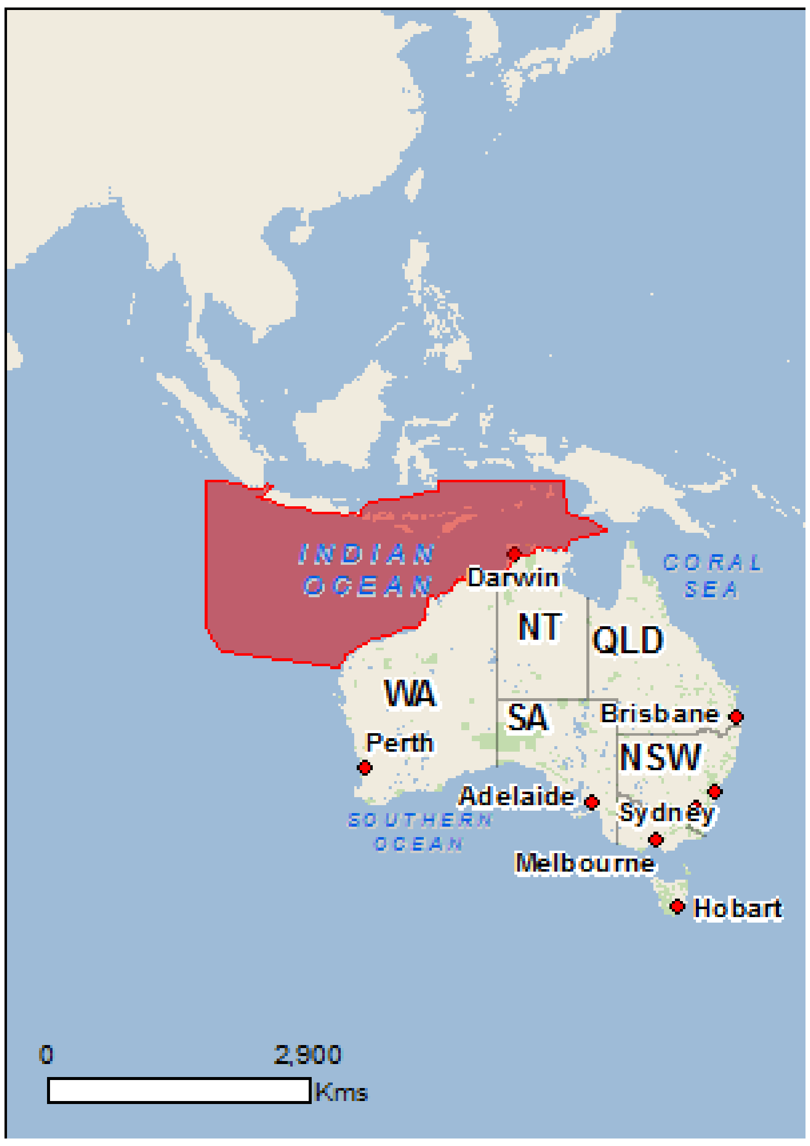

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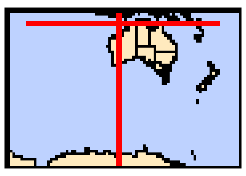

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	2
National Heritage Places:	3
Wetlands of International Importance:	6
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	103
Listed Migratory Species:	92

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:	33
Commonwealth Heritage Places:	23
Listed Marine Species:	164
Whales and Other Cetaceans:	32
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	2
Australian Marine Parks:	27

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	45
Regional Forest Agreements:	None
Invasive Species:	47
Nationally Important Wetlands:	17
Key Ecological Features (Marine)	17

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Kakadu National Park	NT	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Kakadu National Park	NT	Listed place
The Ningaloo Coast	WA	Listed place
The West Kimberley	WA	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Ashmore reef national nature reserve	Within Ramsar site
Cobourg peninsula	Within Ramsar site
Hosnies spring	Within Ramsar site
Kakadu national park	Within Ramsar site
Ord river floodplain	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

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Accipiter hiogaster natalis		
Christmas Island Goshawk [82408]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting 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
Epthianura crocea tunneyi Alligator Rivers Yellow Chat, Yellow Chat (Alligator Rivers) [67089]	Endangered	Species or species habitat known to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	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
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [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
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
Melanodryas cucullata melvillensis Tiwi Islands Hooded Robin, Hooded Robin (Tiwi	Critically Endangered	Species or species

Name	Status	Type of Presence
Islands) [67092]		habitat known to occur within area
Mirafra javanica melvillensis Horsfield's Bushlark (Tiwi Islands) [81011]	Vulnerable	Species or species habitat known to occur within area
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
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known 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
Pterodroma arminjoniana Round Island Petrel, Trinidade Petrel [89284]	Critically Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour 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
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Turdus poliocephalus erythropleurus Christmas Island Thrush [67122]	Endangered	Species or species habitat likely to occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat known to occur within area
Tyto novaehollandiae melvillensis Tiwi Masked Owl, Tiwi Islands Masked Owl [26049]	Endangered	Species or species habitat known to occur within area
Fish		
Milyeringa veritas Blind Gudgeon [66676]	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
Mammals		
Antechinus bellus Fawn Antechinus [344]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Status	Type of Presence
		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
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
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat known to occur within area
Crocidura trichura Christmas Island Shrew [86568]	Critically Endangered	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely 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
Macroderma gigas Ghost Bat [174]	Vulnerable	Breeding likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat may 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 known to occur within area
Mesembriomys gouldii melvillensis Black-footed Tree-rat (Melville Island) [87619]	Vulnerable	Species or species habitat 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
Petrogale concinna canescens Nabarlek (Top End) [87606]	Endangered	Species or species habitat likely to occur within area
Petrogale concinna concinna Nabarlek (Victoria River District) [87605]	Critically Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Petrogale concinna monastria Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Phascogale pirata Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat known to occur within area
Phascogale tapoatafa kimberleyensis Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat known to 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 known to occur within area
Sminthopsis butleri Butler's Dunnart [302]	Vulnerable	Species or species habitat known to occur within area
Trichosurus vulpecula arnhemensis Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat known to occur within area
Plants		
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Burmannia sp. Bathurst Island (R.Fensham 1021) [82017]	Endangered	Species or species habitat likely to occur within area
Hoya australis subsp. oramicola a vine [55436]	Vulnerable	Species or species habitat known to occur within area
Mitrella tiwiensis a vine [82029]	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
Stylidium ensatum a triggerplant [86366]	Endangered	Species or species habitat known to occur within area
Tectaria devexa [14767]	Endangered	Species or species habitat likely to occur within area
Typhonium jonesii a herb [62412]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Typhonium mirabile a herb [79227]	Endangered	Species or species habitat known to occur within area
Typhonium taylori a herb [65904]	Endangered	Species or species habitat likely to occur within area
Xylopia monosperma a shrub [82030]	Endangered	Species or species habitat known to occur within area
Reptiles		
Acanthophis hawkei Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area
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
Cryptoblepharus gurrmul Arafura Snake-eyed Skink [83106]	Endangered	Species or species habitat known to occur within area
Ctenotus zastictus Hamelin Ctenotus [25570]	Vulnerable	Species or species 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
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding 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
Lucasium occultum Yellow-snouted Gecko, Yellow-snouted Ground Gecko [82993]	Endangered	Species or species habitat likely 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		

Name	Status	Type of Presence
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 known to occur within area
Glyphis garricki		
Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding known to occur within area
Glyphis glyphis		
Speartooth Shark [82453]	Critically Endangered	Species or species habitat 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	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]		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]		Species or species habitat likely to occur within area
Ardenna pacifica		
Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata 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
Onychoprion anaethetus		
Bridled Tern [82845]		Breeding known to occur within area

Name	Threatened	Type of Presence
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may 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*	Species or species habitat likely 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
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	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
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
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
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding 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 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	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		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

Name	Threatened	Type of Presence
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 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]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		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

Name	Threatened	Type of Presence
		within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting known 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
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 Greater 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 incana Wandering Tattler [831]		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
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 - Australian Customs Service
Commonwealth Land - Australian Government Solicitor
Commonwealth Land - Christmas Island National Park
Commonwealth Land - Department of Administrative Services
Commonwealth Land - Department of Community Services & Health
Commonwealth Land - Department of Immigration Local Government & Ethnic Affairs
Commonwealth Land - Department of Transport & Regional Development
Commonwealth Land - Deputy Crown Solicitor
Commonwealth Land - Director of Property Services Defence Estate
Commonwealth Land - Kakadu National Park
Defence - AUSTRALIAN ARMY BAND - DARWIN
Defence - BERRIMAH ONE
Defence - BRADSHAW FIELD TRAINING AREA
Defence - DARWIN - AP10 RADAR SITE - LEE POINT
Defence - DARWIN - AP3 RECEIVING STATION - LEE POINT
Defence - DARWIN - TRANSMITTING STATION '11 MILE'
Defence - DARWIN RELOCATIONS CENTRE
Defence - DEFENCE FORCE CAREERS REFERENCE CENTRE
Defence - Esanda Builidng
Defence - HMAS COONAWARRA (Berrimah)
Defence - KOWANDI NORTH COMMUNICATION STATION
Defence - LARRAKEYAH BARRACKS
Defence - LEANYER BOMBING RANGE
Defence - MT GOODWIN RADAR SITE
Defence - Patrol Boat Base (DARWIN NAVAL BASE)
Defence - QUAIL ISLAND BOMBING RANGE
Defence - RAAF BASE DARWIN
Defence - ROBERTSON BARRACKS (Waler Barracks)
Defence - SHOAL BAY RECEIVING STATION
Defence - STOKES HILL OIL FUEL INSTALLATION
Defence - WINNELLIE ONE
Defence - WINNELLIE TWO

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ashmore Reef National Nature Reserve	EXT	Listed place
Bradshaw Defence Area	NT	Listed place
Christmas Island Natural Areas	EXT	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
Historic		
Administrators House Precinct	EXT	Listed place
Bungalow 702	EXT	Listed place
Drumsite Industrial Area	EXT	Listed place
Industrial and Administrative Group	EXT	Listed place
Larrakeyah Barracks Headquarters Building	NT	Listed place
Larrakeyah Barracks Precinct	NT	Listed place
Larrakeyah Barracks Sergeants Mess	NT	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
RAAF Base Commanding Officers Residence	NT	Listed place
RAAF Base Precinct	NT	Listed place
RAAF Base Tropical Housing Type 2	NT	Listed place
RAAF Base Tropical Housing Type 3	NT	Listed place

Name	State	Status
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 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]		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 dubius Little Ringed Plover [896]		Roosting known to occur

Name	Threatened	Type of Presence
		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
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 known 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
Heteroscelus incanus Wandering Tattler [59547]		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 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

Name	Threatened	Type of Presence
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
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius 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 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
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding 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 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

Name	Threatened	Type of Presence
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 impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may 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
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

Name	Threatened	Type of Presence
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
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 cinctus Girdled Pipefish [66214]		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

Name	Threatened	Type of Presence
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
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		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 parvicarinatus Short-keel Pipefish, Short-keeled Pipefish [66230]		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 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

Name	Threatened	Type of Presence
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		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
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within 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

Name	Threatened	Type of Presence
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 within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's 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

Name	Threatened	Type of Presence
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
Hydrophis pacificus Large-headed Seasnake, Pacific Seasnake [1112]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Parahydrophis mertoni Northern Mangrove Seasnake [1090]		Species or species habitat may 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 Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely 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

Name	Status	Type of Presence
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
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur

Name	Status	Type of Presence
		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)
Kakadu	NT	National Park (Commonwealth)

Australian Marine Parks [Resource Information]

Name	Label
Arafura	Multiple Use Zone (IUCN VI)
Arafura	Special Purpose Zone (IUCN VI)
Arafura	Special Purpose Zone (Trawl) (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)
Arnhem	Special Purpose Zone (IUCN VI)
Ashmore Reef	Recreational Use Zone (IUCN IV)
Ashmore Reef	Sanctuary Zone (IUCN Ia)
Cartier Island	Sanctuary Zone (IUCN Ia)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Joseph Bonaparte Gulf	Multiple Use Zone (IUCN VI)
Joseph Bonaparte Gulf	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	Habitat Protection Zone (IUCN IV)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Oceanic Shoals	National Park Zone (IUCN II)
Oceanic Shoals	Special Purpose Zone (Trawl) (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Adele Island	WA
Balanggarra	WA
Bardi Jawi	WA
Barrow Island	WA
Bedout Island	WA
Boodie, Double Middle Islands	WA
Browse Island	WA
Buffalo Creek	NT
Cape Range	WA
Casuarina	NT
Channel Point	NT
Charles Darwin	NT

Name	State
Dambimangari	WA
Djukbinj	NT
Garig Gunak Barlu	NT
George Brown Darwin	NT
Holmes Jungle	NT
Howard Springs	NT
Howard Springs	NT
Keep River	NT
Knuckey Lagoons	NT
Lawley River	WA
Lesueur Island	WA
Low Rocks	WA
Lowendal Islands	WA
Marri-Jabin (Thamurrurr - Stage 1)	NT
Marthakal	NT
Mary River	NT
Mijing	WA
Mitchell River	WA
Montebello Islands	WA
Niiwalarra Islands	WA
Ord River	WA
Pelican Island	WA
Shoal Bay	NT
Swan Island	WA
Tree Point Conservation Area	NT
Unnamed WA28968	WA
Unnamed WA40828	WA
Unnamed WA41080	WA
Unnamed WA41775	WA
Unnamed WA44672	WA
Unnamed WA44673	WA
Unnamed WA44677	WA
Uunguu	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
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
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Gallus gallus Red Junglefowl, Feral Chicken, 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

Name	Status	Type of Presence
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
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos javanicus Banteng, Bali Cattle [15]		Species or species habitat likely to occur within area
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Bubalus bubalis Water Buffalo, Swamp Buffalo [1]		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 within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
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 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

Name	Status	Type of Presence
		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
Annona glabra Pond Apple, Pond-apple Tree, Alligator Apple, Bullock's Heart, Cherimoya, Monkey Apple, Bobwood, Corkwood [6311]		Species or species habitat may occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Mimosa pigra Mimosa, Giant Mimosa, Giant Sensitive Plant, ThornySensitive Plant, Black Mimosa, Catclaw Mimosa, Bashful Plant [11223]		Species or species habitat likely to 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
Pennisetum polystachyon Mission Grass, Perennial Mission Grass, Missiongrass, Feathery Pennisetum, Feather Pennisetum, Thin Napier Grass, West Indian Pennisetum, Blue Buffel Grass [21194]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		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
Lepidodactylus lugubris Mourning Gecko [1712]		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 known to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
"The Dales", Christmas Island	EXT
Adelaide River Floodplain System	NT
Ashmore Reef	EXT
Cape Range Subterranean Waterways	WA
Cobourg Peninsula System	NT
Daly-Reynolds Floodplain-Estuary System	NT
Finniss Floodplain and Fog Bay Systems	NT
Hosine's Spring, Christmas Island	EXT
Kakadu National Park	NT
Legune Wetlands	NT
Mary Floodplain System	NT
Mermaid Reef	EXT
Moyle Floodplain and Hyland Bay System	NT
Murgenella-Cooper Floodplain System	NT
Ord Estuary System	WA
Port Darwin	NT
Shoal Bay - Micket Creek	NT

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
Carbonate bank and terrace system of the Van	North
Gulf of Carpentaria basin	North
Pinnacles of the Bonaparte Basin	North
Shelf break and slope of the Arafura Shelf	North
Tributary Canyons of the Arafura Depression	North
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
Pinnacles of the Bonaparte Basin	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

-7.36981 115.89261,-7.19135 116.29949,-6.55485 120.37194,-6.45848 120.55397,-6.19436 120.92517,-6.09044 122.66372,-5.91198 123.1872,-5.19516 123.20505,-5.0 123.30171,-5.0 135.75335,-8.24306 136.04424,-8.60962 137.51393,-8.75048 138.07868,-9.22161 139.04237,-9.86407 139.99177,-10.04253 139.98463,-10.72382 136.62178,-11.52618 135.99955,-11.77364 135.96981,-11.58685 135.37375,-11.74851 134.8812,-11.67712 134.38627,-11.55815 133.8152,-11.88652 133.63912,-11.48968 133.38979,-11.48677 132.93956,-12.14826 132.70162,-12.30784 132.365,-12.31736 131.16575,-12.59747 130.95403,-12.70638 130.56727,-13.40612 130.3488,-13.69213 130.02282,-14.23465 129.76584,-15.26257 129.80391,-15.28538 129.09681,-14.94928 128.87374,-15.03207 128.41037,-14.98497 128.16585,-14.62508 127.94872,-14.35212 127.78478,-14.14918 127.56355,-13.98357 127.33702,-13.84842 127.01722,-14.01273 126.7518,-14.12444 126.43663,-14.11902 126.31522,-14.49944 126.13206,-14.68485 125.91315,-14.51543 125.63714,-14.55422 125.52746,-14.55822 125.32684,-14.75504 125.19884,-14.81285 125.02928,-14.97063 124.91824,-15.02928 124.81225,-15.29304 124.7617,-15.34812 124.43249,-15.71938 124.51209,-15.84727 124.1046,-15.85025 123.58112,-16.31722 123.12308,-16.43833 122.97091,-16.30699 122.7639,-16.31841 122.51405,-16.58681 122.22566,-16.84665 122.02293,-18.11788 121.96844,-18.38967 121.84471,-18.49318 121.56274,-19.1856 121.16656,-19.32182 119.91259,-20.05946 118.11371,-20.23125 117.09824,-20.27051 116.58428,-20.6203 116.24164,-21.34484 115.08522,-21.58695 114.57006,-21.61586 114.38411,-21.70533 114.09667,-21.81336 113.98512,-21.90758 113.92516,-22.26736 113.89946,-22.41013 113.67246,-22.97204 113.32089,-21.53425 101.85645,-21.22968 101.3996,-20.44921 100.82852,-19.1072 100.04806,-5.0 100.09375,-5.0 101.31603,-5.13788 103.52417,-5.69943 104.43788,-5.75654 105.3516,-5.90168 105.61809,-5.59254 105.83277,-5.32348 106.26055,-5.43055 106.79236,-5.54834 106.78165,-5.99448 106.07852,-6.3514 105.92861,-6.52077 105.69911,-6.59054 105.32899,-6.71546 105.90363,-6.87964 106.41045,-6.99029 106.6139,-7.4293 107.52047,-7.52805 108.64596,-7.58515 109.71196,-8.04867 111.00163,-8.10578 113.10031,-8.38465 114.10801,-8.1943 114.5149,-8.25854 114.89323,-8.40488 115.12166,-8.48697 115.49286,-7.81953 115.47858,-7.36981 115.89261

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.

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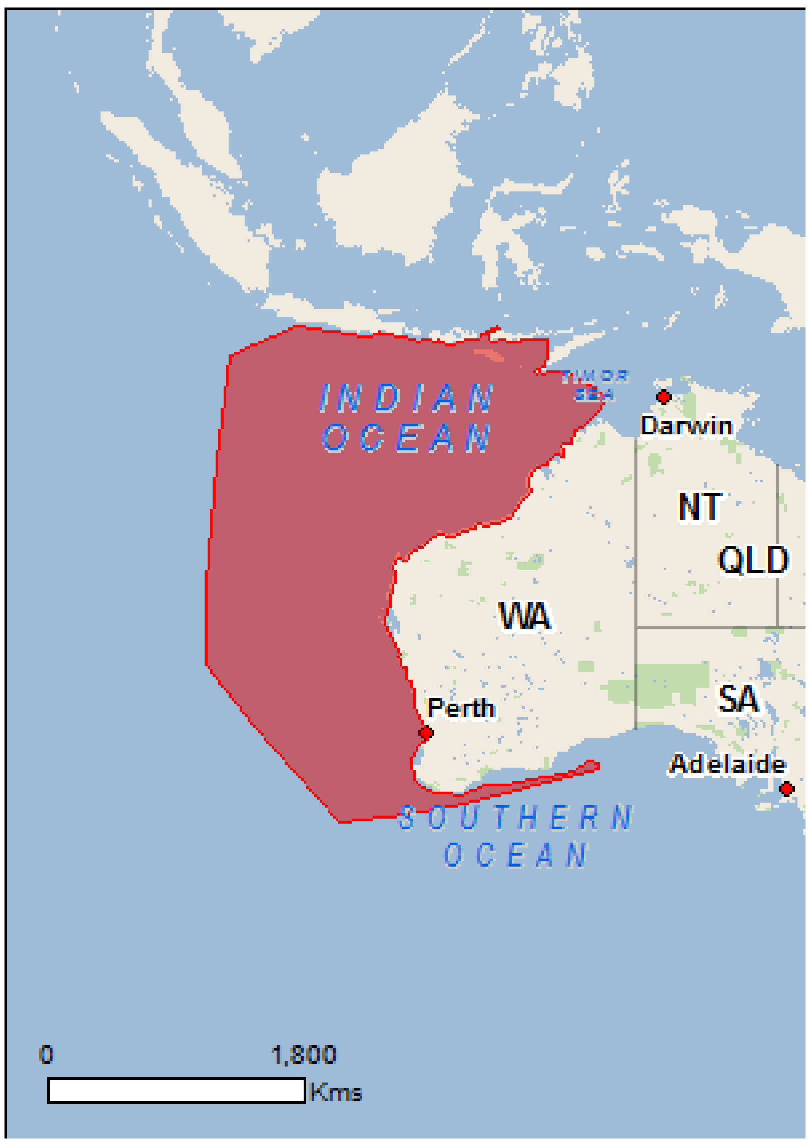
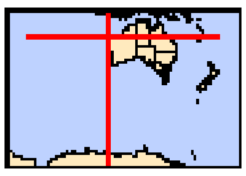


Coordinates
Buffer: 0.0Km



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:	4
National Heritage Places:	9
Wetlands of International Importance:	8
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	10
Listed Threatened Species:	175
Listed Migratory Species:	110

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:	18
Commonwealth Heritage Places:	24
Listed Marine Species:	215
Whales and Other Cetaceans:	44
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Australian Marine Parks:	44

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	144
Regional Forest Agreements:	1
Invasive Species:	65
Nationally Important Wetlands:	27
Key Ecological Features (Marine)	23

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Australian Convict Sites (Fremantle Prison Buffer Zone)	WA	Buffer zone
Australian Convict Sites (Fremantle Prison)	WA	Declared property
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
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
Fremantle Prison (former)	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
Forrestdale and thomsons lakes	Within Ramsar site
Hosnies spring	Within Ramsar site
Peel-yalgorup system	20 - 30km upstream
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-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
Aquatic Root Mat Community 3 in Caves of the	Endangered	Community known to

Name	Status	Type of Presence
Leeuwin Naturaliste Ridge		occur within area
Aquatic Root Mat Community 4 in Caves of the Leeuwin Naturaliste Ridge	Endangered	Community known to occur within area
Aquatic Root Mat Community in Caves of the Swan Coastal Plain	Endangered	Community known to occur within area
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area
Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	Community may occur within area
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Endangered	Community known to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Thrombolite (microbial) community of coastal freshwater lakes of the Swan Coastal Plain (Lake Richmond)	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
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	Breeding known to occur within area
Cereopsis novaehollandiae grisea		
Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat likely 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

Name	Status	Type of Presence
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
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	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 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),	Vulnerable	Species or species

Name	Status	Type of Presence
Dirk Hartog Black-and-White Fairy-wren [26004]		habitat likely to occur within area
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 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
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 Shy Albatross [89224]	Endangered	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
Turdus poliocephalus erythropleurus Christmas Island Thrush [67122]	Endangered	Species or species habitat likely to occur within area
Turnix varius scintillans Painted Button-quail (Houtman Abrolhos) [82451]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Crustaceans		
Cherax tenuimanus Hairy Marron, Margaret River Hairy Marron, Margaret River Marron [78931]	Critically Endangered	Species or species habitat may occur within area
Fish		
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 likely 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
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
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

Name	Status	Type of Presence
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
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
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
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Phascogale tapoatafa kimberleyensis Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat likely to occur within area
Pipistrellus murrayi Christmas Island Pipistrelle [64383]	Critically Endangered	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Pseudomys fieldi Shark Bay Mouse, Djoongari, Alice Springs Mouse [113]	Vulnerable	Species or species habitat likely to 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 known to occur within area
Kumonga exleyi Cape Range Remipede [86875]	Vulnerable	Species or species habitat known to occur within area
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Androcalva bivillosa Straggling Androcalva [87807]	Critically Endangered	Species or species habitat likely to occur within area
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat likely to occur within area
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Banksia nivea subsp. uliginosa Swamp Honeypot [82766]	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
Beyeria lepidopetala Small-petalled Beyeria, Short-petalled Beyeria [18362]	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

Name	Status	Type of Presence
		within area
Caladenia elegans Elegant Spider-orchid [56775]	Endangered	Species or species habitat known to occur within area
Caladenia excelsa Giant Spider-orchid [56717]	Endangered	Species or species habitat likely 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 known to occur within area
Caladenia lodgeana Lodge's Spider-orchid [68664]	Critically Endangered	Species or species habitat likely to occur within area
Calectasia cyanea Blue Tinsel Lily [7669]	Critically Endangered	Species or species habitat likely to occur within area
Chorizema varium Limestone Pea [16981]	Endangered	Species or species habitat known to occur within area
Conostylis dielsii subsp. teres Irwin's Conostylis [3614]	Endangered	Species or species habitat may occur within area
Conostylis micrantha Small-flowered Conostylis [17635]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat likely to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat known to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat likely to occur within area
Drakaea concolor Kneeling Hammer-orchid [56777]	Vulnerable	Species or species habitat likely to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat known 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 may occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Eucalyptus beardiana Beard's Mallee [18933]	Vulnerable	Species or species habitat may occur within area
Eucalyptus cuprea Mallee Box [56773]	Endangered	Species or species habitat likely 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 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 likely to occur within area
Kennedia glabrata Northcliffe Kennedia [16452]	Vulnerable	Species or species habitat likely to occur within area
Lambertia echinata subsp. occidentalis Western Prickly Honeysuckle [64528]	Endangered	Species or species habitat may occur within area
Lechenaultia chlorantha Kalbarri Leschenaultia [16763]	Vulnerable	Species or species habitat likely to occur within area
Leucopogon marginatus Thick-margined Leucopogon [12527]	Endangered	Species or species habitat likely to occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area
Macarthuria keigheryi Keighery's Macarthuria [64930]	Endangered	Species or species habitat likely to occur within area
Marianthus paralius [83925]	Endangered	Species or species habitat known to occur within area
Melaleuca sp. Wanneroo (G.J. Keighery 16705) [89456]	Endangered	Species or species habitat known to occur within area
Paracaleana dixonii Sandplain Duck Orchid [86882]	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

Name	Status	Type of Presence
Pterostylis sinuata Northampton Midget Greenhood, Western Swan Grrenhood [84991]	Endangered	Species or species habitat known to occur within area
Seringia exastia Fringed Fire-bush [88920]	Critically Endangered	Species or species habitat known to occur within area
Sphenotoma drummondii Mountain Paper-heath [21160]	Endangered	Species or species habitat may occur within area
Stachystemon nematophorus Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat may occur within area
Synaphea sp. Serpentine (G.R. Brand 103) [86879]	Critically Endangered	Species or species habitat may occur within area
Tectaria devexa [14767]	Endangered	Species or species habitat likely to occur within area
Tetratheca nephelioides [83217]	Critically Endangered	Species or species habitat may occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may 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 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-	Endangered	Species or species

Name	Status	Type of Presence
tailed Skink [64483]		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 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

Name	Threatened	Type of Presence
		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
Ardenna tenuirostris Short-tailed Shearwater [82652]		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
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

Name	Threatened	Type of Presence
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]	Endangered	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
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
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species

Name	Threatened	Type of Presence
		habitat 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 area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
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
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 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

Name	Threatened	Type of Presence
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 dubius Little Ringed Plover [896]		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
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
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur

Name	Threatened	Type of Presence
		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 - ARTILLERY BARRACKS - FREMANTLE
Defence - BROOME TRAINING DEPOT
Defence - CAMPBELL BARRACKS - SWANBOURNE
Defence - EAST FREMANTLE SMALL CRAFT BASE
Defence - EXMOUTH ADMIN & HF TRANSMITTING
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND
Defence - IRWIN BARRACKS - KARRAKATTA
Defence - LANCELIN TRAINING AREA
Defence - LEARMONTH - AIR WEAPONS RANGE
Defence - LEARMONTH RADAR SITE - TWIN TANKS EXMOUTH
Defence - LEARMONTH RADAR SITE - VLAMING HEAD EXMOUTH
Defence - LEEUWIN BARRACKS - EAST FREMANTLE
Defence - PRESTON POINT TRAINING DEPOT
Defence - ROCKINGHAM - NAVY CPSO
Defence - SWANBOURNE RIFLE RANGE

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
Historic		
Administrators House Precinct	EXT	Listed place
Army Magazine Buildings Irwin Barracks	WA	Listed place
Artillery Barracks	WA	Listed place
Bungalow 702	EXT	Listed place
Claremont Post Office	WA	Listed place

Name	State	Status
Cliff Point Historic Site	WA	Listed place
Drumsite Industrial Area	EXT	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Industrial and Administrative Group	EXT	Listed place
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

Name	Threatened	Type of Presence
		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
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 likely to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		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
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

Name	Threatened	Type of Presence
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
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 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

Name	Threatened	Type of Presence
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
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

Name	Threatened	Type of Presence
		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 within area
Puffinus tenuirostris Short-tailed Shearwater [1029]		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 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]	Endangered	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

Name	Threatened	Type of Presence
		related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat 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
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

Name	Threatened	Type of Presence
		habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
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

Name	Threatened	Type of Presence
		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
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

Name	Threatened	Type of Presence
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
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

Name	Threatened	Type of Presence
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
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

Name	Threatened	Type of Presence
		habitat may 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 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 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

Name	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

Name	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)
Eastern Recherche	National Park Zone (IUCN II)

Name	Label
Eastern Recherche	Special Purpose Zone (IUCN VI)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
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
Alfred Cove	WA
Bardi Jawi	WA
Barrow Island	WA
Bedout Island	WA
Beekeepers	WA
Bernier And Dorre Islands	WA
Bessieres Island	WA
Bold Park	WA
Boodie, Double Middle Islands	WA
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	WA
Broome Bird Observatory	WA
Broome Wildlife Centre	WA
Browse Island	WA
Bundegi Coastal Park	WA
Burnside And Simpson Island	WA
Cape Range	WA
Carnac Island	WA
Coulomb Point	WA
Dambimangari	WA
Dambimangari	WA
Dirk Hartog Island	WA
Dongara	WA
Escape Island	WA
Freycinet, Double Islands etc	WA
Gnandaroo Island	WA
Hamelin Island	WA
Harry Waring Marsupial Reserve	WA
Jarrkunpungu	WA
Jinmarnkur	WA
Jinmarnkur Kulja	WA
Jurabi Coastal Park	WA
Kalbarri	WA

Name	State
Karajarri	WA
Keanes Point Reserve	WA
Kings Park	WA
Koks Island	WA
Kujungurru Warrarn	WA
Kujungurru Warrarn	WA
Lacepede Islands	WA
Lake Joondalup	WA
Lancelin And Edwards Islands	WA
Leda	WA
Leeuwin-Naturaliste	WA
Lesueur	WA
Little Rocky Island	WA
Locker Island	WA
Lowendal Islands	WA
Matilda Bay Reserve	WA
Montebello Islands	WA
Muiron Islands	WA
Murujuga	WA
NTWA Bushland covenant (0144)	WA
Nambung	WA
Nanga Station	WA
Neerabup	WA
Neerabup	WA
Nilgen	WA
North Sandy Island	WA
North Turtle Island	WA
Nyangumarta Warrarn	WA
Part Murchison house	WA
Penguin Island	WA
Port Gregory	WA
Prince Regent	WA
Recherche Archipelago	WA
Rottnest Island	WA
Round Island	WA
Serrurier Island	WA
Southern Beekeepers	WA
Swan Island	WA
Swan River	WA
Tamala Pastoral Lease (Part)	WA
Tanner Island	WA
Tent Island	WA
Thomsons Lake	WA
Unnamed WA21176	WA
Unnamed WA26400	WA
Unnamed WA28968	WA
Unnamed WA31906	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 WA39584	WA
Unnamed WA39752	WA
Unnamed WA40322	WA
Unnamed WA40828	WA
Unnamed WA40877	WA
Unnamed WA41080	WA
Unnamed WA41775	WA
Unnamed WA42469	WA
Unnamed WA43290	WA

Name	State
Unnamed WA43903	WA
Unnamed WA44414	WA
Unnamed WA44665	WA
Unnamed WA44667	WA
Unnamed WA44669	WA
Unnamed WA44672	WA
Unnamed WA44673	WA
Unnamed WA44682	WA
Unnamed WA44688	WA
Unnamed WA45772	WA
Unnamed WA45773	WA
Unnamed WA46926	WA
Unnamed WA46982	WA
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Unnamed WA46984	WA
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Unnamed WA51658	WA
Unnamed WA51932	WA
Unnamed WA52237	WA
Unnamed WA52354	WA
Unnamed WA52366	WA
Unnamed WA53015	WA
Uunguu	WA
Victor Island	WA
Wanagarren	WA
Wandi	WA
Wedge Island	WA
Weld Island	WA
Woodvale	WA
Y Island	WA
Yanchep	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

Name	Status	Type of Presence
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Gallus gallus Red Junglefowl, Feral Chicken, 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 may 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

Name	Status	Type of Presence
		within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
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
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		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 plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur

Name	Status	Type of Presence
		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 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
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

Name	Status	Type of Presence
		within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		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 within area
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 known to occur within area

Nationally Important Wetlands

[Resource Information]

Name	State
"The Dales", Christmas Island	EXT
Ashmore Reef	EXT
Booragoon Swamp	WA
Bunda-Bunda Mound Springs	WA
Bundera Sinkhole	WA
Cape Range Subterranean Waterways	WA
De Grey River	WA
Eighty Mile Beach System	WA
Exmouth Gulf East	WA
Gibbs Road Swamp System	WA
Herdsman Lake	WA
Hosine's Spring, Christmas Island	EXT
Joondalup Lake	WA
Karakin Lakes	WA
Lake MacLeod	WA
Lake Thetis	WA
Learmonth Air Weapons Range - Saline Coastal Flats	WA
Leslie (Port Hedland) Saltfields System	WA
Loch McNess System	WA
Mermaid Reef	EXT
Roebuck Bay	WA
Rottnest Island Lakes	WA
Shark Bay East	WA
Spectacles Swamp	WA
Swan-Canning Estuary	WA
Thomsons Lake	WA
Willie Creek Wetlands	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
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 surrounding	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

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120.376181

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- -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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Appendix B: MNES Review Register

Santos

Table B-1: Review Register

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
Threatened Species			
Sharks	Speartooth shark *(Glyphis glyphis)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 5-1, Section 5.3, Section 5.3.5
Birds	Addition of *Territory Parks and Wildlife Conservation Act* 1976 conservation status	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-1, Section 8.2
Birds	Greater crested tern (*Thalasseus bergii)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-3
Birds	Little curlew (*Numenius minutus)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-3
Birds	Swinhoe's snipe (*Gallinago magala)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-3
Birds	Wandering Tattler (*Tringa glareola)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 8-3
Birds	Bar-tailed godwit	NT sites of international importance added	Table 8-5
Birds	Common greenshank	NT sites of international importance added	Table 8-5
Birds	Common sandpiper	NT sites of international importance added	Table 8-5
Birds	Fork-tailed swift	NT sites of international importance added	Table 8-5
Birds	Oriental pratincole	NT sites of international importance added	Table 8-5
Migratory Species-			
Reptiles	Salt-water crocodile *(Crocodylus porosus)*	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 6-1, Section 6.3

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
Provinces			
Provincial Bioregions	Timor Province	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 2.1
	Northwest Shelf Transition	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 2.1
	Timor Transition	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 2.1, 3.1, 3.3, 3.4, 4.1, 5.1
	Northern Shelf Province	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 2.1, 3.1, 3.2, 3.3, 3.4, 4.1, 4.2, 5.1
Protected Areas			
World Heritage Areas	Kakadu National Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.1.3
Wetlands of International Importance	Cobourg Peninsula	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.2.9
	Kakadu National Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.2.10
	Ord River Floodplain	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.2.11
Wetlands of National Importance	Adelaide River Floodplain System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.21

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
	Kakadu National Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.22
	Mary Floodplain System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.23
	Cobourg Peninsula System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.24
	Daly-Reynolds Floodplain-Estuary System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.25
	Finniss Floodplain and Fog Bay Systems	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.26
	Moyle Floodplain and Hyland Bay System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.27
	Murgenella-Cooper Floodplain System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.28
	Ord Estuary System	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.29
	Port Darwin	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.30
	Shoal Bay - Micket Creek	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, Section 9.3.31

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
National Heritage Place	Kakadu National Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, 9.4.10
Commonwealth Heritage Place	Bradshaw Defence Area	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-1, 9.5.10 Section 14.4
Coastal terrestrial Conservation Reserves	Five additional national parks included and four reserves	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 9-2 and 9-3
KEFs	Shelf Break and Slope of the Arafura Shelf	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 10.1.29
	Tributary Canyons of the Arafura Depression	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 10.1.30
Australian Marine Parks	Arafura Marine Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	12.4.2
	Arnhem Marine Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	12.4.3
	Joseph Bonaparte Marine Park	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	12.4.4
International Protected Areas	Additional international areas included	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 9.8
Social, Economic and Cultural Features			
Defence Activities	Bradshaw defence training area	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 14.4

Taxon	2021 Review (Rev 9 09/07/21)	Reason for Change	Sections Updated within this Document
Indigenous heritage	Tiwi Islands significant sites	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 14.6.1
Maritime heritage	Additional shipwrecks within EMBA, new figure provided	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 14.6.2
Fisheries	Additional NT fisheries	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Section 14.7.1 and 14.8
Legislation			
Conservation Status Legislation	Addition of *Territory Parks and Wildlife Conservation Act* 1976 conservation status to all species	Included with new PMST search for Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	Table 5-1, 6-1, 7-1, 8-1
Other edits			
-	Figures updated throughout to represent new EMBA	Included with revised EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	All figures in document
-	Text updated throughout to reflect new EMBA entering NT waters	Included with revised r Stairway EMBA based on Stairway TFN Rev 0 (SO-91-RZ-20027)	All text in document

Appendix D – EPBC Protected Matters Search Tool Results

D.1 – EPBC PMST Report for the operational area

D.2 – EPBC PMST Report for the light and noise boundaries

D.3 – EPBC PMST Report for the combined MEVA

D.4 – EPBC PMST Report for the combined EMBA

Australian Government
Department of Agriculture, Water and the Environment

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. Please see the caveat for interpretation of information provided here.

Report created: 02-Dec-2021

Summary

Matters of National Environment 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 (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	19
Listed Migratory Species:	34

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

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 Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	56
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	13
Key Ecological Features (Marine):	2
Biologically Important Areas:	4
Bioregional Assessments:	None
Geological and Bioregional Assessments:	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 a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
EEZ and Territorial Sea

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically 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
MAMMAL		
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

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
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
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
SHARK		
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 pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
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

Scientific Name	Threatened Category	Presence Text
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		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
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
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	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
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat likely to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	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
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

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		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

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
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 overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine 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
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
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
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 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

Scientific Name	Threatened Category	Presence Text
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
Reptile		
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

Scientific Name	Threatened Category	Presence Text
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
Chitulia ornata as Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [87377]		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	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
Enhydrina schistosa Beaked Seasnake [1126]		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

Scientific Name	Threatened Category	Presence Text
Hydrophis atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli Small-headed Seasnake [75601]		Species or species habitat may occur within area
Lapemis curtus as Lapemis hardwickii Spine-bellied Seasnake [83554]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat 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]

Current Scientific Name	Status	Type of Presence
Mammal		
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

Current Scientific Name	Status	Type of Presence
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Delphinus delphis Common Dolphin, 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 likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
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

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Bonaparte Liquified Natural Gas Project	2011/6141	Controlled Action	Post-Approval
Not controlled action			
2D Seismic Survey in Permit Areas WA-318-P & WA-319-P, near Cape Londonderry	2004/1687	Not Controlled Action	Completed
Not controlled action (particular manner)			
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey within permit area WA-318-P	2007/3879	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Fishburn2D Marine Seismic Survey	2012/6659	Not Controlled Action (Particular Manner)	Post-Approval
Floyd 3D and Chisel 3D Seismic Surveys	2011/6220	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Petrel MC2D Marine Seismic Survey	2010/5368	Not Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		(Particular Manner)	
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed

Key Ecological Features [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
Carbonate bank and terrace system of the Sahul Shelf	North-west
Pinnacles of the Bonaparte Basin	North-west

Biologically Important Areas

Scientific Name	Behaviour	Presence
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Known to occur
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and 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

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a 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 detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

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 Agriculture, Water and the Environment

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. Please see the caveat for interpretation of information provided here.

Report created: 02-Dec-2021

Summary

Matters of National Environment 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 (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	19
Listed Migratory Species:	34

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

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 Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	56
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	13
Key Ecological Features (Marine):	2
Biologically Important Areas:	4
Bioregional Assessments:	None
Geological and Bioregional Assessments:	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 a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
EEZ and Territorial Sea

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically 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
MAMMAL		
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

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
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
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
SHARK		
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 pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
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

Scientific Name	Threatened Category	Presence Text
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		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
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
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	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
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mobula alfredi as Manta alfredi		
Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat likely to occur within area
Mobula birostris as Manta birostris		
Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	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
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

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		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

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
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 overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine 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
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
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
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 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

Scientific Name	Threatened Category	Presence Text
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
Reptile		
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

Scientific Name	Threatened Category	Presence Text
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
Chitulia ornata as Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [87377]		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	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
Enhydrina schistosa Beaked Seasnake [1126]		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

Scientific Name	Threatened Category	Presence Text
Hydrophis atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli Small-headed Seasnake [75601]		Species or species habitat may occur within area
Lapemis curtus as Lapemis hardwickii Spine-bellied Seasnake [83554]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat 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]

Current Scientific Name	Status	Type of Presence
Mammal		
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

Current Scientific Name	Status	Type of Presence
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Delphinus delphis Common Dolphin, 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 likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
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

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Bonaparte Liquified Natural Gas Project	2011/6141	Controlled Action	Post-Approval
Not controlled action			
2D Seismic Survey in Permit Areas WA-318-P & WA-319-P, near Cape Londonderry	2004/1687	Not Controlled Action	Completed
Not controlled action (particular manner)			
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey within permit area WA-318-P	2007/3879	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Fishburn2D Marine Seismic Survey	2012/6659	Not Controlled Action (Particular Manner)	Post-Approval
Floyd 3D and Chisel 3D Seismic Surveys	2011/6220	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Petrel MC2D Marine Seismic Survey	2010/5368	Not Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		(Particular Manner)	
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed

Key Ecological Features [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
Carbonate bank and terrace system of the Sahul Shelf	North-west
Pinnacles of the Bonaparte Basin	North-west

Biologically Important Areas

Scientific Name	Behaviour	Presence
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Known to occur
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and 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

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a 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 detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

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. Please see the caveat for interpretation of information provided here.

Report created: 28-Apr-2022

Summary

Matters of National Environment 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 (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	18
Listed Migratory Species:	35

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

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 Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	65
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	17
Key Ecological Features (Marine):	2
Biologically Important Areas:	4
Bioregional Assessments:	None
Geological and Bioregional Assessments:	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 a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
EEZ and Territorial Sea

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically 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
MAMMAL		
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
REPTILE		

Scientific Name	Threatened Category	Presence Text
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 known 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
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
SHARK		
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 pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	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	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
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
Phaethon lepturus White-tailed Tropicbird [1014]		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

Scientific Name	Threatened Category	Presence Text
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		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
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 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	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
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat likely to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	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	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
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

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		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

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
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 overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine 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
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area
Fish		
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
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

Scientific Name	Threatened Category	Presence Text
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 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
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

Scientific Name	Threatened Category	Presence Text
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
Reptile		
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
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 known to occur within area
Chitulia inornata as Hydrophis inornatus		
Plain Seasnake [87379]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Chitulia ornata as Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [87377]		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	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
Enhydrina schistosa Beaked Seasnake [1126]		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 atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli Small-headed Seasnake [75601]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Lapemis curtus as Lapemis hardwickii		
Spine-bellied Seasnake [83554]		Species or species habitat may occur within area
Leioselasma coggeri as Hydrophis coggeri		
Black-headed Sea Snake, Slender-necked Seasnake [87373]		Species or species habitat may occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat 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]

Current Scientific Name	Status	Type of Presence
Mammal		
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 Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
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

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Bonaparte Liquified Natural Gas Project	2011/6141	Controlled Action	Post-Approval
Not controlled action			
2D Seismic Survey in Permit Areas WA-318-P & WA-319-P, near Cape Londonderry	2004/1687	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2009/5104	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2008/4133	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey within permit area WA-318-P	2007/3879	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Seismic and Bathymetric Survey	2012/6295	Not Controlled Action (Particular Manner)	Post-Approval
Fishburn2D Marine Seismic Survey	2012/6659	Not Controlled Action (Particular Manner)	Post-Approval
Floyd 3D and Chisel 3D Seismic Surveys	2011/6220	Not Controlled Action (Particular Manner)	Post-Approval
Gold 2D Marine Seismic Survey Permit Areas WA375P and WA376P	2009/4698	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Petrel MC2D Marine Seismic Survey	2010/5368	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed

Key Ecological Features [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
Carbonate bank and terrace system of the Sahul Shelf	North-west
Pinnacles of the Bonaparte Basin	North-west

Biologically Important Areas

Scientific Name	Behaviour	Presence
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Known to occur
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and 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

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a 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 detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

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. Please see the caveat for interpretation of information provided here.

Report created: 04-Jan-2022

Summary

Matters of National Environment 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 (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	20
Listed Migratory Species:	35

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

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 Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	65
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	17
Key Ecological Features (Marine):	2
Biologically Important Areas:	5
Bioregional Assessments:	None
Geological and Bioregional Assessments:	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 a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
EEZ and Territorial Sea

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically 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
MAMMAL		
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

Scientific Name	Threatened Category	Presence Text
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat known 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
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
SHARK		
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Glyphis garricki		
Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
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

Scientific Name	Threatened Category	Presence Text
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
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		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
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat 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	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

Scientific Name	Threatened Category	Presence Text
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat likely to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	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

Migratory Wetlands Species

Scientific Name	Threatened Category	Presence Text
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 ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		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

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
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

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine 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
Thalasseus bengalensis as Sterna bengalensis Lesser Crested Tern [66546]		Breeding known to occur within area
Fish		
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
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

Scientific Name	Threatened Category	Presence Text
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 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 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
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

Scientific Name	Threatened Category	Presence Text
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
Reptile		
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
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Chitulia inornata as Hydrophis inornatus Plain Seasnake [87379]		Species or species habitat may occur within area
Chitulia ornata as Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [87377]		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	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
Enhydrina schistosa Beaked Seasnake [1126]		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 atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli Small-headed Seasnake [75601]		Species or species habitat may occur within area
Lapemis curtus as Lapemis hardwickii Spine-bellied Seasnake [83554]		Species or species habitat may occur within area
Leioselasma coggeri as Hydrophis coggeri Black-headed Sea Snake, Slender-necked Seasnake [87373]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation 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]

Current Scientific Name	Status	Type of Presence
Mammal		
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

Current Scientific Name	Status	Type of Presence
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat may occur within area
Delphinus delphis Common Dolphin, 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 likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
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

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Bonaparte Liquified Natural Gas Project	2011/6141	Controlled Action	Post-Approval
Not controlled action			
2D Seismic Survey in Permit Areas WA-318-P & WA-319-P, near Cape Londonderry	2004/1687	Not Controlled Action	Completed
Not controlled action (particular manner)			
2D and 3D Seismic Survey	2011/6197	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2009/5104	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D Seismic Survey WA-405-P	2008/4133	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey	2009/4728	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey within permit area WA-318-P	2007/3879	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic survey	2009/5076	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte 2D & 3D marine seismic survey	2011/5962	Not Controlled Action (Particular Manner)	Post-Approval
Bonaparte Seismic and Bathymetric Survey	2012/6295	Not Controlled Action (Particular Manner)	Post-Approval
Fishburn2D Marine Seismic Survey	2012/6659	Not Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		(Particular Manner)	
Floyd 3D and Chisel 3D Seismic Surveys	2011/6220	Not Controlled Action (Particular Manner)	Post-Approval
Gold 2D Marine Seismic Survey Permit Areas WA375P and WA376P	2009/4698	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Petrel MC2D Marine Seismic Survey	2010/5368	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D Marine Seismic Survey	2008/4623	Referral Decision	Completed

Key Ecological Features [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
Carbonate bank and terrace system of the Sahul Shelf	North-west
Pinnacles of the Bonaparte Basin	North-west

Biologically Important Areas

Scientific Name	Behaviour	Presence
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Lepidochelys olivacea Olive Ridley Turtle [1767]	Foraging	Known to occur
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur
Seabirds		
Thalasseus bengalensis Lesser Crested Tern [66546]	Breeding	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and 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

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a 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 detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

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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Appendix E – Spill Modelling Results

Appendix E – Spill Modelling Results

The following tables provide the spill modelling results for a 60 m^3 surface MDO release at Frigate-1 (Xodus, 2022).

Modelling Results for Surface Release of MDO – Frigate-1:

Receptor	Receptor type	Minimum time to contact (Hours)							Maximum Hydrocarbon Concentration							Maximum oil ashore (m^3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values			Moderate Exposure Values				High Exposure Values				
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Dissolved aromatics (400 ppb)	Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2) *	Dissolved aromatics (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2) *	Dissolved aromatics (400 ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Joseph Bonaparte Gulf AMP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
JBG West Coast	Submerged	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Van Cloon/Deep Shoals	Submerged	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Kimberly Coast PMZ	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Gale Bank	Submerged	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Pinnacles of the Bonaparte Basin KEF	Submerged	NC	18	4	3	NC	4	NC	NC	69.2	101.8	103.5	NC	69.2	NC	NC	NC
Carbonate bank and terrace system of the Sahul Shelf KEF	Submerged	NC	23	20	NC	NC	NC	NC	NC	33.8	131.0	NC	NC	NC	NC	NC	NC

NC= No Contact

* This receptor is only emergent at lowest astronomical tide therefore accumulation is considered temporary only under these tidal conditions

Appendix F – Stakeholder Consultation

Frigate - 1

Stakeholder Consultation Appendix

From:	Consultation, Santos
To:	[redacted]
Subject:	SANTOS CONSULTATION | Frigate-1 Wellhead Survey Inspection Environment Plan
Date:	Friday, 21 January 2022 3:28:39 PM
Attachments:	Frigate-1 Consultation Information.pdf

Dear stakeholder

Santos is preparing to formalise the permanent abandonment of the Frigate-1 wellhead in Commonwealth Waters approximately 262 km north of Wyndham, Western Australia, commencing with a vessel-based well inspection survey to confirm the location and status of the wellhead.

The Frigate-1 exploration well was drilled in 1978 within petroleum permit WA-40-R but did not encounter any hydrocarbons. The well was permanently plugged and abandoned in the same year, and the wellhead was left in place.

The well inspection survey is planned to take place from Q3 2022, and Santos proposes to permanently leave the wellhead in situ if the survey confirms that the wellhead cannot be safely removed given the passage of time since the well was drilled.

Santos is seeking your feedback as a stakeholder relevant to the proposed activities to help inform planning for the Environment Plan (EP), which is required to be submitted and accepted by National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) before any activities can take place.

We are seeking your feedback by **25 February 2022**.

Activity Summary

An activity summary is provided below, and the attached information provides more detail on proposed activities, including a location map and a summary of risks, impacts and mitigation measures associated with leaving the wellhead on the seafloor.

Activity Name	WA-40-P Frigate-1 Wellhead Inspection Survey Environment Plan	
Activity Summary	A wellhead inspection survey to confirm the location and status of the wellhead. The inspection will be undertaken by a remotely operated vehicle controlled from a vessel at surface. Geophysical and hydrographic surveys maybe required to identify the well location.	
Estimated Start Date and Duration	The survey is planned to take place from Q3 2022 and take up to two weeks. The wellhead may be permanently left in situ if the survey confirms that the wellhead cannot be safely removed.	
Permit Number	WA-40-R	
Location	Approx. 262 km north of Wyndham, Western Australia. Please see attached Consultation Information for location map.	
Approximate Water Depth	Approx. 112 m	
Approximate well location (+/- 100 m)	**Latitude**	**Longitude**
	13° 10′ 48″ S	127° 55′ 25″ E
Exclusion Zone	There is no exclusion zone surrounding the wellhead and it is marked on nautical charts.	

Providing feedback

Commonwealth Environment Regulations require NOPSEMA to publish Environment Plans submitted by titleholders for assessment.

Correspondence between titleholders and stakeholders is summarised in Environment Plans, with a full transcript of correspondence provided in confidence to NOPSEMA to support the assessment process.

In providing feedback for this activity please make it known to Santos if you do not wish for your comments to be published in the Environment Plan or wish to provide your comments anonymously.

We look forward to hearing from you and please contact Santos at the earliest opportunity if you need more information about the proposed activity. Santos requests feedback on this activity by **25 February 2022.**

Regards

[redacted]

[redacted]
Stakeholder Adviser
As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
t: [redacted]

[redacted] [redacted] [redacted] https://www.santos.com/

[redacted]

From:	Consultation, Santos
To:	[redacted]
Subject:	SANTOS CONSULTATION | Frigate-1 Wellhead Survey Inspection Environment Plan
Date:	Friday, 21 January 2022 3:43:52 PM
Attachments:	Frigate-1 Consultation Information.pdf Frigate-1 - Northern Prawn Fishery.png

Dear [redacted]

Santos is preparing to formalise the permanent abandonment of the Frigate-1 wellhead in Commonwealth Waters approximately 262 km north of Wyndham, Western Australia, commencing with a vessel-based well inspection survey to confirm the location and status of the wellhead.

The Frigate-1 exploration well was drilled in 1978 within petroleum permit WA-40-R but did not encounter any hydrocarbons. The well was permanently plugged and abandoned in the same year, and the wellhead was left in place.

The well inspection survey is planned to take place from Q3 2022, and Santos proposes to permanently leave the wellhead in situ if the survey confirms that the wellhead cannot be safely removed given the passage of time since the well was drilled.

Santos is seeking your feedback as a stakeholder relevant to the proposed activities to help inform planning for the Environment Plan (EP), which is required to be submitted and accepted by National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) before any activities can take place.

We are seeking your feedback by **25 February 2022**.

Activity Summary

An activity summary is provided below, and the attached information provides more detail on proposed activities, including a location map and a summary of risks, impacts and mitigation measures associated with leaving the wellhead on the seafloor.

Activity Name	WA-40-P Frigate-1 Wellhead Inspection Survey Environment Plan	
Activity Summary	A wellhead inspection survey to confirm the location and status of the wellhead. The inspection will be undertaken by a remotely operated vehicle controlled from a vessel at surface. Geophysical and hydrographic surveys maybe required to identify the well location.	
Estimated Start Date and Duration	The survey is planned to take place from Q3 2022 and take up to two weeks. The wellhead may be permanently left in situ if the survey confirms that the wellhead cannot be safely removed.	
Permit Number	WA-40-R	
Location	Approx. 262 km north of Wyndham, Western Australia. Please see attached Consultation Information for location map.	
Approximate Water Depth	Approx. 112 m	
Approximate well location (+/- 100 m)	**Latitude**	**Longitude**
	13° 10' 48" S	127° 55' 25" E
Exclusion Zone	There is no exclusion zone surrounding the wellhead and it is marked on nautical charts.	

Commercial fishing implications

Santos has assessed implications for commercial fishers and has identified the following fishery as being relevant to the proposed activity, considering historical fishing catch in WA-40-R, as well as water depth, fishery target species and fishing methods:

Commonwealth managed Fisheries:

- *Northern Prawn Fishery*

State (WA) managed fisheries:

- *No relevant fisheries*

Licence holders in the Northern Prawn Fishery are being consulted for proposed activities, as well as relevant representative organisations and government departments. A map showing the location of the Frigate-1 wellhead respective to the Northern Prawn Fishery is also being provided relevant stakeholders.

Providing feedback

Commonwealth Environment Regulations require NOPSEMA to publish Environment Plans submitted by titleholders for assessment.

Correspondence between titleholders and stakeholders is summarised in Environment Plans, with a full transcript of correspondence provided in confidence to NOPSEMA to support the assessment process.

In providing feedback for this activity please make it known to Santos if you do not wish for your comments to be published in the Environment Plan or wish to provide your comments anonymously.

We look forward to hearing from you and please contact Santos at the earliest opportunity if you need more information about the proposed activity. Santos requests feedback on this activity by **25 February 2022.**

Regards

[redacted]

Santos

[redacted]
Stakeholder Adviser
As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
t: [redacted]

[redacted] [redacted] [redacted] https://www.santos.com/

From:	Consultation, Santos
Bcc:	[redacted]
Subject:	SANTOS CONSULTATION | Frigate-1 Wellhead Survey Inspection Environment Plan
Date:	Friday, 18 February 2022 4:44:38 PM
Attachments:	Frigate-1 Consultation Information.pdf

Dear Northern Prawn Fishery Licence Holder

Santos is sending this reminder email as your interests in commercial fishing are relevant to our proposed activities for the wellhead inspection survey and permanent abandonment of the Frigate-1 wellhead, in Commonwealth Waters approximately 262 km north of Wyndham, Western Australia.

As previously advised, the Frigate-1 exploration well was drilled in 1978 within petroleum permit WA-40-R but did not encounter any hydrocarbons. The well was permanently plugged and abandoned in the same year, and the wellhead was left in place.

Santos is seeking your feedback as a stakeholder relevant to the proposed activities to help inform planning for the Environment Plan (EP), which is required to be submitted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Your views on proposed activities are important as Santos proposes to permanently leave the wellhead in situ if the survey confirms this decommissioning option provides equal or better environmental and safety outcomes compared to complete removal.

An activity summary is provided below, and the attached information provides more detail on proposed activities, including a location map and a summary of risks, impacts and mitigation measures associated with leaving the wellhead on the seafloor.

Activity Name	WA-40-P Frigate-1 Wellhead Inspection Survey Environment Plan	
Activity Summary	A wellhead inspection survey to confirm the location and status of the wellhead. The inspection will be undertaken by a remotely operated vehicle controlled from a vessel at surface. Geophysical and hydrographic surveys maybe required to identify the well location.	
Estimated Start Date and Duration	The survey is planned to take place from Q3 2022 and take up to two weeks. The wellhead may be permanently left in situ if the survey confirms that the wellhead cannot be safely removed.	
Permit Number	WA-40-R	
Location	Approx. 262 km north of Wyndham, Western Australia. Please see attached Consultation Information for location map.	
Approximate Water Depth	Approx. 112 m	
Approximate well location (+/- 100 m)	**Latitude**	**Longitude**
	13° 10’ 48” S	127° 55’ 25” E
Exclusion Zone	There is no exclusion zone surrounding the wellhead and it is marked on nautical charts.	

We look forward to hearing from you and please contact Santos at the earliest opportunity if you need more information about the proposed activity.

Santos requests feedback on this activity by **25 February 2022.**

Regards

[redacted]

[redacted]
Stakeholder Adviser
As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
t: [redacted]

https://www.santos.com/

Consultation materials

STAKEHOLDER CONSULTATION

Santos

WA-40-P Frigate-1 Wellhead

Inspection Survey Environment Plan

Santos is preparing to formalise the permanent abandonment of the Frigate-1 wellhead in Commonwealth Waters approximately 262 km north of Wyndham, Western Australia, commencing with a vessel-based well inspection survey to confirm the location and status of the wellhead.

The Frigate-1 exploration well was drilled in 1978 within petroleum permit WA-40-R but did not encounter any hydrocarbons. The well was permanently plugged and abandoned in the same year, and the wellhead was left in place.

Santos plans to permanently leave the wellhead in situ if the survey confirms that the wellhead cannot be safely removed given the passage of time since the well was drilled.

Permanent abandonment of a wellhead requires approval under the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage Act 2006* and associated regulations. As such, an Environment Plan (EP) will be developed in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* for assessment by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Santos is seeking stakeholder feedback to prepare the EP for this activity.

Activity Description

Wellhead Inspection Survey

A Remote Operated Vehicle (ROV) wellhead inspection survey is required to locate and inspect the wellhead.

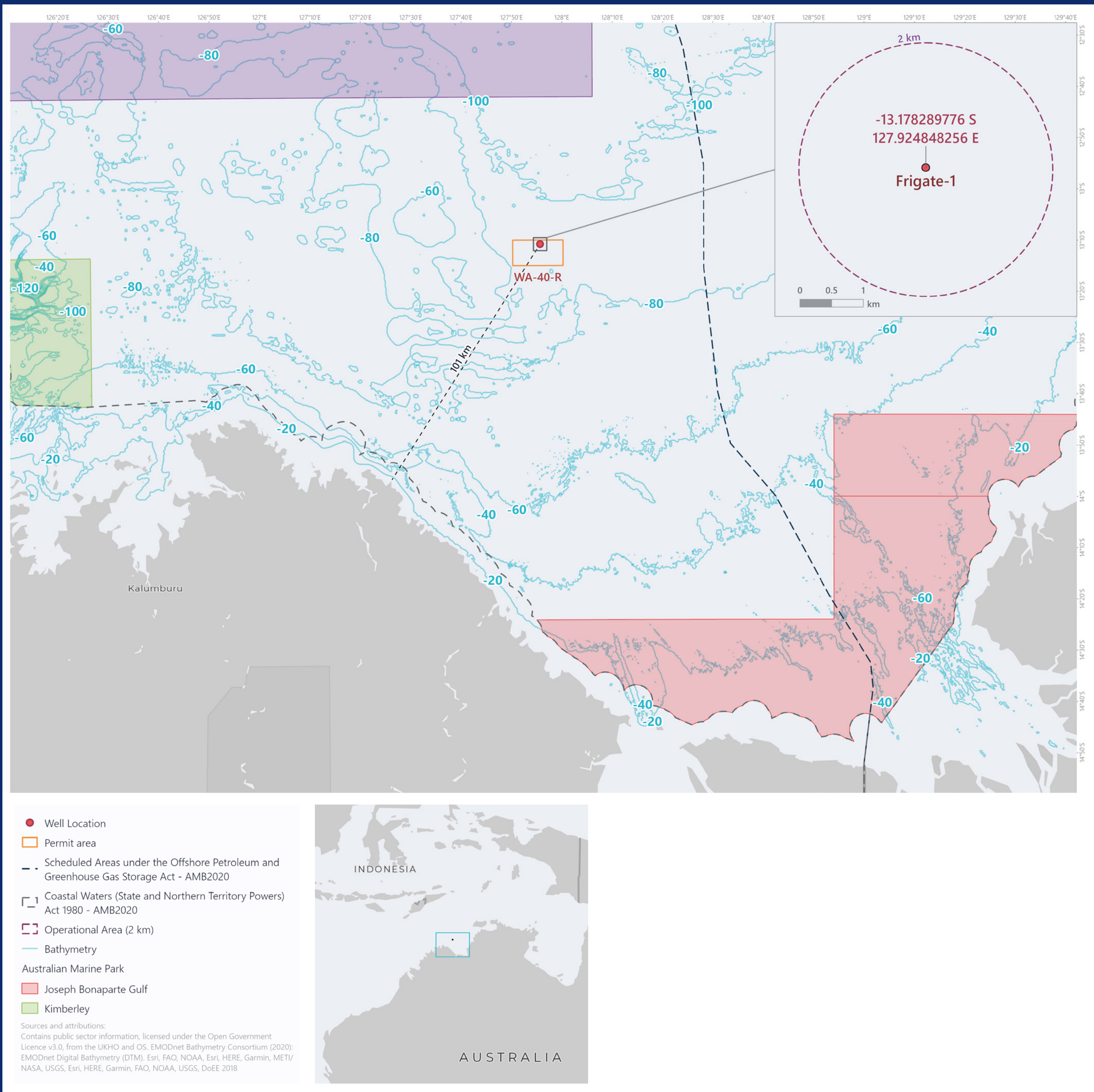
Santos plans to commence the wellhead inspection survey from Q3 2022, depending on the availability of vessels as well as the timing of neap tides. This timing of the survey has been identified as it is at the end of the dry season and provides the best possible visibility in the field. The activity will require the use of a small utility vessel.

Geophysical and hydrographic surveys may also be required to delineate seabed features at the well site and measure the physical features underwater to assist in locating the Frigate-1 wellhead.

There is no exclusion zone surrounding the wellhead and it is marked on nautical charts.

WELLHEAD DETAILS		
Permit number	WA-40-R	
Water depth	Approx. 112 meters	
Exclusion zone	There is no exclusion zone around the wellhead.	
Location (+/- 100 m)	Latitude: 13º 10' 48" S	Longitude: 127º 55' 25" E
Timing and duration	The wellhead inspection survey is planned to start from Q3 2022 and take up to two weeks. Santos plans to permanently leave the wellhead in situ if the survey confirms that the wellhead cannot be safely removed.	
Description of natural environment	Located within the Bonaparte Gulf mesoscale bioregion within the Northwest IMCRA Transition provincial bioregion.	
Proximity to key regional features	Regional Feature	Wellhead Location
	Oceanic Shoals Australian Marine Park	53 km N
	Joseph Bonaparte Gulf Australian Marine Park	122 km SE
	North Kimberly Marine Park	162 km W
	Darwin	466 km E
	Wyndham	262 km N
	Kalumburu	186 km SW
	Wadeye	209 km SE
Worst case hydrocarbon spill scenario	60 m^3 marine diesel spill resulting from a vessel collision. A loss of well control is not a credible scenario as no hydrocarbons were detected when the well was drilled in 1978.	

Figure 1: Frigate-1 Well Inspection Survey location map



Santos has conducted the following assessment of potential environmental risks and impacts from the wellhead inspection survey.

POTENTIAL RISKS AND/OR IMPACTS	MANAGEMENT MEASURES
Interaction with other commercial fishers and other marine users (e.g. potential for a snag risk to trawl fishers)	• Relevant stakeholders will be consulted during the preparation of the EP. • If requested, Santos will provide pre-start and activity completion notifications for the survey. • The wellhead is marked on nautical charts. • There is no exclusion zone around the wellhead.
Acoustic disturbance to marine fauna	• Monitoring of the surrounding environment for marine fauna is undertaken from the vessel bridge. • Survey vessel complies with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure.
Light emissions	• Survey vessel navigation lighting and equipment is compliant with SOLAS/AMSA Marine Orders.
Atmospheric emissions	• Survey vessel marine diesel (fuel oil) sulphur content is compliant with MARPOL/AMSA Marine Order.
Seabed disturbance	• No vessel anchoring, unless in an emergency. • Site survey to identify the location of the wellhead using the ROV. • 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) will meet legal requirements. • Deck cleaning products will not be harmful to the marine environment.
Biosecurity risk management	• Vessel is 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 Oil Pollution Emergency Plan requirements are implemented to mitigate environmental impacts.

Consultation

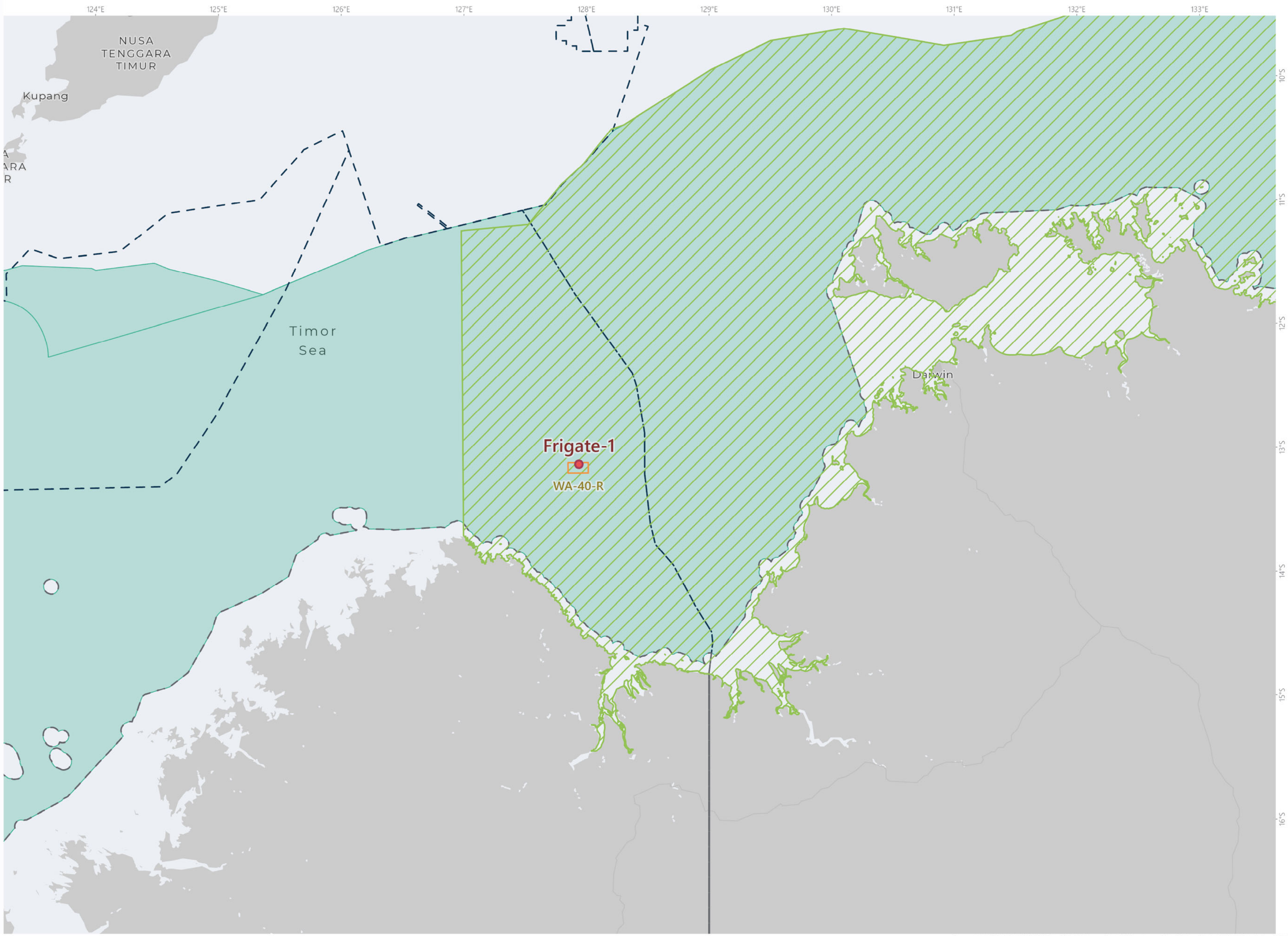
If you wish to comment on Santos' Frigate-1 Well Inspection Survey, or if you require additional information, please contact Santos on the contact details below. Santos would appreciate your feedback by **25 February 2022**.

Please also advise as part of this consultation process if you would like to be notified prior to the start and upon completion of the survey.

Santos
PO Box 5624, Perth, 6831
Telephone: 08 6218 7095
Email: Offshore.Consultation@Santos.com

Consultation maps

Well Location
Permit area
Coastal Waters (State and Northern Territory Powers) Act 1980 - AMB2020
Scheduled Areas under the Offshore Petroleum and Greenhouse Gas Storage Act - AMB2020
Northern Prawn Fishery
Draft Australian Fisheries Zone (2020)

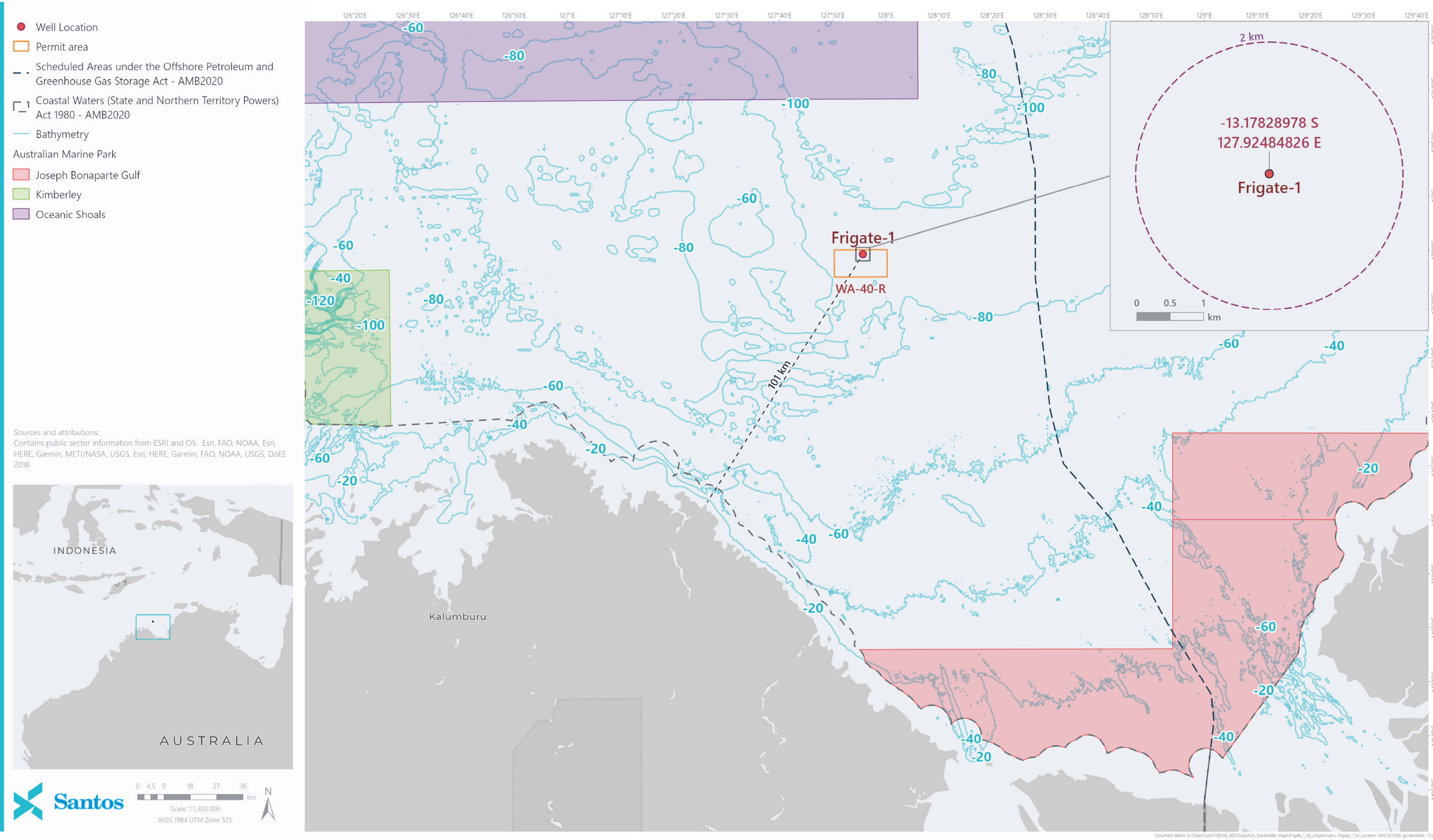


Sources and attributions:
Contains public sector information from ESRI and OS. Esri, FAO, NOAA, Esri, HERE, Garmin, FAO, NOAA, USGS, DoEE 2018

Santos

0 13 25 50 75 100 km
Scale: 1:3,862,381
WGS 1984 UTM Zone 52S
N

Document details: G:\CheckOuts\P100248_S00\Output\04_Stakeholder_maps\Frigate_1_SH_Location.aprx, Frigate_1_SH_PrawnFisheries, XWS-SCO108, gis.aberdeen, 18/01/2022

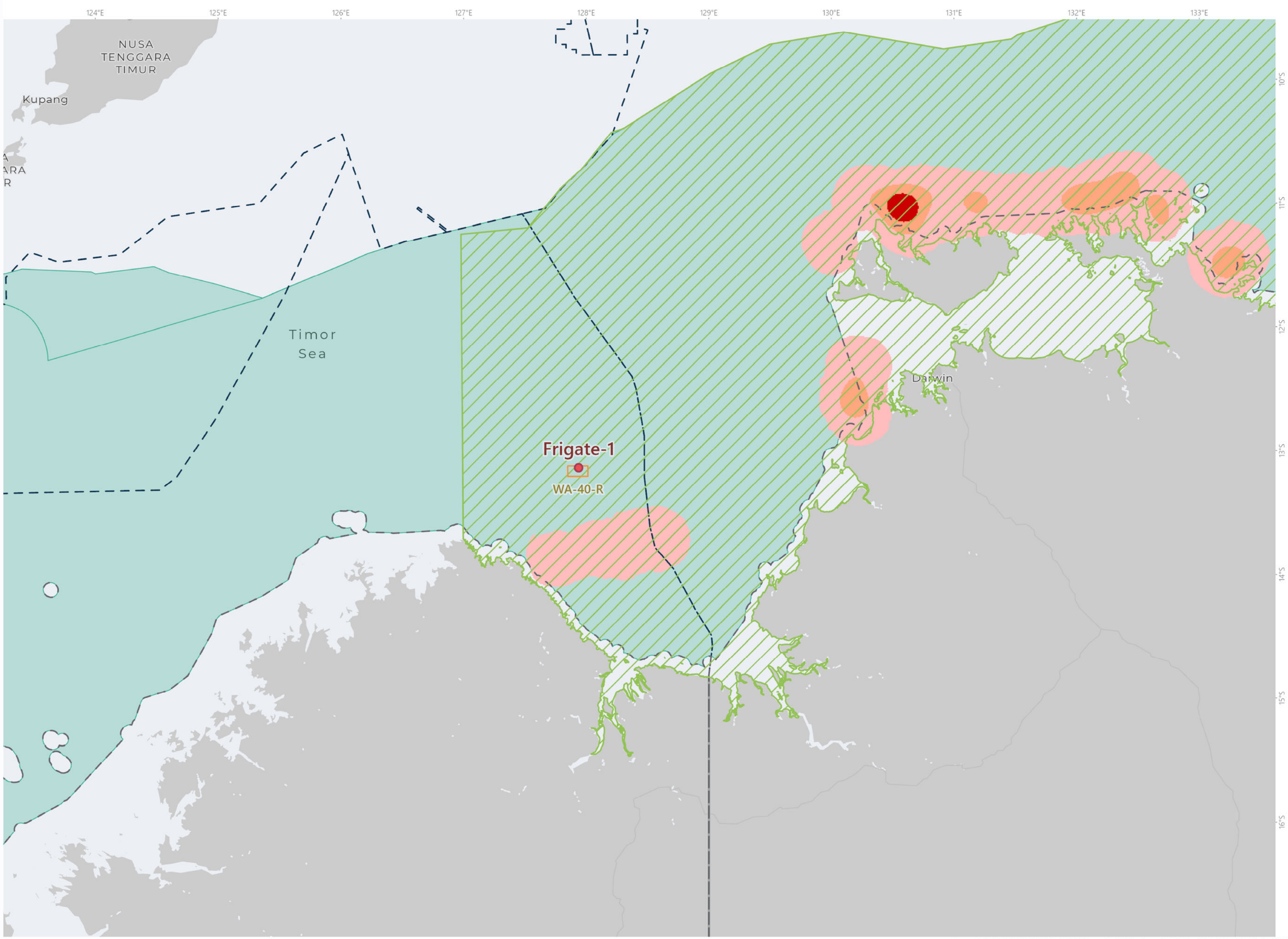


Well Location
Permit area
Scheduled Areas under the Offshore Petroleum and Greenhouse Gas Storage Act - AMB2020
Coastal Waters (State and Northern Territory Powers) Act 1980 - AMB2020
Bathymetry
Australian Marine Park
Joseph Bonaparte Gulf
Kimberley
Oceanic Shoals
Sources and attributions:
Contains public sector information from ESRI and OS. Esri, FAO, NOAA, Esri, HERE, Garmin, METI/NASA, USGS, Esri, HERE, Garmin, FAO, NOAA, USGS, DoEE 2018
INDONESIA
AUSTRALIA
Santos
0 4.5 9 18 27 36 km
Scale: 1:1,300,000
WGS 1984 UTM Zone 52S
N
Frigate-1
WA-40-R
101 km
Kalumburu
2 km
-13.17828978 S
127.92484826 E
Frigate-1
0 0.5 1 km

Well Location
Permit area
Coastal Waters (State and Northern Territory Powers) Act 1980 - AMB2020
Scheduled Areas under the Offshore Petroleum and Greenhouse Gas Storage Act - AMB2020
Northern Prawn Fishery
Draft Australian Fisheries Zone (2020)

Northern Prawn Fishery Effort (2020)

High
Medium
Low



Sources and attributions:
Contains public sector information from ESRI and OS. Esri, FAO, NOAA, Esri, HERE, Garmin, FAO, NOAA, USGS, DoEE 2018, ABARES (2021)

Santos

0 13 25 50 75 100
km
Scale: 1:3,862,381
WGS 1984 UTM Zone 52S
N

Document details: G:\CheckOuts\P100248_S00\Output\04_Stakeholder_maps\Frigate_1_SH_Location.aprx, Frigate_1_SH_PrawnFisheries, XWS-SCO108, gis.aberdeen, 17/01/2022

Appendix G – Santos Environment Consequence Descriptors

Consequence Level		I	II	III	IV	V	VI
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Severity Description		**Negligible** ***No impact or negligible impact.***	**Minor** ***Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect.***	**Moderate** ***Significant impact to local population, industry or ecosystem factors.***	**Major** ***Major long-term effect on local population, industry or ecosystem factors.***	**Severe** ***Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery.***	**Critical** ***Irreversible impact to regional population, industry or ecosystem factors.***
Environmental Receptors	**Fauna** In particular, EPBC Act listed threatened/migratory fauna or *WA Biodiversity Conservation Act 2016* 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. Widespread (regional) decline in population size or habitat critical to regional population.	Complete loss of regional population. Complete loss of habitat critical to survival of regional population.
Environmental Receptors	**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[1]; habitat within a protected area; habitats that include benthic primary producers[2] and/or epi-fauna[3]	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 approximately two years (two-season recovery).	Significant loss of area and/or function of local physical environment/habitat. Recovery over the medium term (two to ten years).	Major, large-scale loss of area and/or function of physical environment/local habitat. Slow recovery over decades.	Extensive destruction of local physical environment/habitat with no recovery. Long-term (decades) and widespread loss of area or function of primary producers on a regional scale.	Complete destruction of regional physical environment/habitat with no recovery. Complete loss of area or function of primary producers on a regional scale.

[1] As defined by the Department of Agriculture, Water and Environment (DAWE)
[2] Benthic photosynthetic organisms such as seagrass, algae, hard corals and mangroves
[3] Fauna attached to the substrate including sponges, soft corals and crinoids.

Consequence Level		I	II	III	IV	V	VI
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Severity Description		Negligible ***No impact or negligible impact.***	Minor ***Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect.***	Moderate ***Significant impact to local population, industry or ecosystem factors.***	Major ***Major long-term effect on local population, industry or ecosystem factors.***	Severe ***Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery.***	Critical ***Irreversible impact to regional population, industry or ecosystem factors.***
	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.	Extensive, long-term decline in threatened ecological community population size, diversity or function. Complete loss of threatened ecological community.	Complete loss of threatened ecological community with no recovery.
	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.	Extensive loss of one or more of protected area's values. Extensive loss of species population contained within protected area.	Complete loss of one or more of protected area's values with no recovery. Complete loss of species population contained within protected area with no recovery.
	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. Extensive loss of key natural features or populations supporting the local industry.	Permanent shutdown of local or regional industry. Permanent loss of key natural features or populations supporting the local or regional industry.

Appendix H – Decommissioning Options Assessment

Frigate-1 Wellhead Options Assessment

Wellhead Scenarios	Criteria	Sub-criteria	Description	Options							
				Option A: Removal (External cutting above the mudline)		Option B: Removal (Internal cutting below the mudline)		Option C: Install Cover/Cap		Option D: Leave the Wellhead In-situ	
				Justification	Score	Justification	Score	Justification	Score	Justification	Score
No wellhead remaining/found	Environment	Water quality and sediment quality	Assessment of water and sediment quality.	No action required							
		Ecological services	Assessment of biodiversity and habitat changes due to the physical presence of property, and seabed disturbance because of the petroleum activity.								
		Emissions	Emissions such as light, noise, air and marine discharges.								
		Waste	Volume and type of waste associated with offshore operations (e.g. landfill, recyclables).								
	Technical Feasibility	Engineering and execution complexity	The extent to which the option requires the use of proven technology. The ability to recover from unplanned excursions and complete the planned option.								
	Health and Safety	Risk to personnel (offshore and onshore)	Health and safety risks to company-related personnel both onshore (e.g. logistics) and offshore.								
		Residual risk to other marine users	Health and safety risks to marine users such as commercial vessels, fishers and members of the public.								
	Social	Effect on commercial fisheries	Displacing commercial fisheries or affecting their catch.								
		Other socio-economic effects	Effects on local communities, recreational users, commercial activities, etc.								
	Economic	Financial cost	Operational / capital costs to Santos.								
Casing only (no external obstructions)	Environment	Water quality and sediment quality	Assessment of water and sediment quality.	If part of the the wellhead is left in-situ as a result of external cutting it would slowly degrade overtime releasing corrosion material. The wellhead is comprised predominantly of mild steel, iron the primary component of steel (98%) is only toxic to marine organisms at extremely high concentrations (Grimwood and Dixon, 1997). All iron oxides are included on the OSPAR PLONOR list (Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment). Based on the low toxicity of iron, the slow release rate and rapid dilution of the open ocean environment, any impacts to sediments and water quality will be low and in the immediate vicinity of the wellhead. No risk of LOWC as the well did not encounter hydrocarbons. Vessel discharges and vessel MDO risk associated with the two campaigns.	-	Short-term local impact to water and sediment quality during the removal process. No risk of LOWC as the well did not encounter hydrocarbons. Vessel discharges and vessel MDO risk associated with the two campaigns.	-	If a cover/cap is installed it would slowly degrade overtime releasing corrosion material. The cover/cap is comprised predominantly of mild steel, iron the primary component of steel (98%) is only toxic to marine organisms at extremely high concentrations (Grimwood and Dixon, 1997). All iron oxides are included on the OSPAR PLONOR list (Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment). Based on the low toxicity of iron, the slow release rate and rapid dilution of the open ocean environment, any impacts to sediments and water quality will be low and in the immediate vicinity of the wellhead. No risk of LOWC as the well did not encounter hydrocarbons. Vessel discharges and vessel MDO risk associated with the single campaign.	-	If the wellhead is left in-situ it would slowly degrade overtime releasing corrosion material. The wellhead is comprised predominantly of mild steel, iron the primary component of steel (98%) is only toxic to marine organisms at extremely high concentrations (Grimwood and Dixon, 1997). All iron oxides are included on the OSPAR PLONOR list (Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment). Based on the low toxicity of iron, the slow release rate and rapid dilution of the open ocean environment, any impacts to sediments and water quality will be low and in the immediate vicinity of the wellhead. No risk of LOWC as the well did not encounter hydrocarbons. No vessel discharges or vessel MDO risk.	Most preferred
		Ecological services	Assessment of biodiversity and habitat changes due to the physical presence of property, and seabed disturbance because of the petroleum activity.	Most marine growth around/on the well will be removed. A portion of infrastrucure will remain above the seabed (marine growth on this piece will remain / re-grow). Over time itthe remaining infrastructure will deteroriate. Vessel and ROV activity with associated impacts and risks to the marine environment. No LOWC risk as the well did not encounter hydrocarbons.	-	Any marine growth around/on the well will be removed. Seabed disturbance will occur as a result of cutting below the mudline and lifting the infrastructure to remove from the ground. Vessel and ROV activity with associated impacts and risks to the marine environment. No LOWC risk as the well did not encounter hydrocarbons.	Least Preferred	Any marine growth around/on the well may not survive as a result of being trapped by the cover/cap. Installing a cover/cap will create a alrger seabed footprint and higher profile to cover the wellhead. Vessel and ROV activity with associated impacts and risks to the marine environment. No LOWC risk as the well did not encounter hydrocarbons.	Least Preferred	Retains marine growth around/on the well. No vessel or ROV activity, therefore no associated impacts or risks to the marine environment. No LOWC risk as the well did not encounter hydrocarbons.	Most preferred
		Emissions	Emissions such as light, noise, air and marine discharges.	Vessel and ROV activity creating light, noise and air (vessel) emissions, discharges, and MDO spill risk.	-	Vessel and ROV activity creating light, noise and air (vessel) emissions, discharges, and MDO spill risk.	-	Vessel and ROV activity creating light, noise and air (vessel) emissions, discharges, and MDO spill risk.	-	No vessel or ROV activity, therefore no associated emissions, discharges, or MDO spill risk.	Most preferred
		Waste	Volume and type of waste associated with offshore operations (e.g. landfill, recyclables).	General waste generated by the vessel operations. Onshore disposal required of retrieved well materials (concrete, steel, etc.).	-	General waste generated by the vessel operations. Onshore disposal required of retrieved well materials (concrete, steel, etc.).	-	General waste generated by the vessel operations.	-	No waste generated by the vessel operations. No need for onshore disposal of of well materials (concrete, steel, etc.)	Most preferred
	Technical Feasibility	Engineering and execution complexity	The extent to which the option requires the use of proven technology. The ability to recover from unplanned excursions and complete the planned option.	Cutting above the mudline using a cutting tool such as a diamond wire saw (DWS) The wellhead is located in 112 m of water, this exceeds max operating depth for air diving, consequently ROV operations are required for removal. Visibility in the region is poor due to the depth and high currents this poses a risk to effective ROV operations.	-	The wellhead type is unknown therefore the high-pressure housing and upper hub interface profile in unknown. This presents a risk to getting access to the wellbore for internal cutting. If stump is only present - costs $1mill+ to remove plus trips, for little improvement in environmental condition (only snag risk for fishers) Requires use of a non- heave compensated crane (or in-line compensator on the crane). The cap type and latching mechanism is also unknown, this presents a risk getting access to the wellbore for any internal cutting or pressure management options. The first of the two surveys includes a cleaning campaign to remove marine growth and to identify wellhead and temporary abandonment cap components. It may not be possible to identify the components due to the age and unknown condition of the wellhead. Visibility in the region is poor due to the depth (112 m) and high currents, this poses a risk to effective ROV operations.	Least Preferred	A larger vessel with crane capability required to maneuver the cover/cap.	-	Possibility that the old well infrastructure could have become brittle/weakened over time and may be difficult to remove/lift without sections breaking away. Leaving in-situ ensures the material remains in the one location and poses no technical risk. Therefore, the preference from a technical feasibility perspective is to leave the wellhead in place.	Most preferred
	Health and Safety	Risk to personnel (offshore and onshore)	Health and safety risks to company-related personnel both onshore (e.g. logistics) and offshore.	Complete removal would result in two campaigns and associated vessel hours, land logistics, supply needs, waste disposal health and safety risks.	-	Complete removal would result in two campaigns and associated vessel hours, land logistics, supply needs, waste disposal health and safety risks.	-	Installing a cover/cap would require one campaign and associated vessel hours, land logistics, supply needs, waste disposal health and safety risks. However, a second contignency campaign may be required, if sufficinet information can't be gathered durign the wellhead survey (e.g. due to poor visibility).	-	No health and safety risk to personnel as no removal camapign/s would be required.	Most preferred
		Residual risk to other marine	Health and safety risks to marine users such as	Given the remote offshore location of the wellhead and the water depth of 112		Given the remote offshore location of the wellhead and the water depth of 112 m,		Given the remote offshore location of the wellhead and the water depth of 112.2 m, no		Given the remote offshore location of the wellhead and the water depth of 112 m, no credible	
	Social	Effect on commercial fisheries	Displacing commercial fisheries or affecting their catch.	Well not able to be removed at/below the seabed with this method, therefore snag risk remains to trawl fishing operations, however, commercial fishing is not known to occur in the operational area (refer Section 3.3.2 of the EP). Vessel activity and associated impacts and risks for no additional benefit.	-	Complete removal of the well below the seabed. No snag risk to commercial fisheries if they operate in the region in the future.	Most preferred	Was thought to be a good option to reduce snag risk to fisheries, however previous consultation and feedback from fishery stakeholders determined this option would still present as a snag risk if used. However, commercial fishing is not known to occur in this area. Vessel activity and associated impacts and risks for no extra benefit.	-	Snag risk remains to trawl fishing operations, however, commercial fishing is not known to occur in this area.	Least Preferred
		Other socio-economic effects	Effects on local communities, recreational users, commercial activities, etc.	Reputational benefits as a responsible petroleum operator.	Most preferred	Reputational benefits as a responsible petroleum operator.	Most preferred	Potential reputational benefits as a responsible petroleum operator for attempting to address the legacy asset.	-	Possibility of reputational impacts.	Least Preferred
	Economic	Financial cost	Operational / capital costs to Santos.	< $3 million	-	> $3 million	Least Preferred	$1 million	-	No cost	Most preferred

External Obstructions (i.e. Guide Base (GB), concrete patio, drill cuttings)	Environment	Water quality and sediment quality	Assessment of water and sediment quality.	If the wellhead is supported by a GB and/or a cement patio is present, dredging of up to 15 m^3 of sediment would be required to remove the wellhead by external cutting. Dredging would impact water and sediment quality in the local area. If drill cuttings are present they will be disturbed to access the base of the well. However, according to the well report, WBM was used. If part of the the wellhead is left in-situ as a result of external cutting it would slowly degrade overtime releasing corrosion material. The wellhead is comprised predominantly of mild steel, iron the primary component of steel (98%) is only toxic to marine organisms at extremely high concentrations (Grimwood and Dixon, 1997). All iron oxides are included on the OSPAR PLONOR list (Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment). Based on the low toxicity of iron, the slow release rate and rapid dilution of the open ocean environment, any impacts to sediments and water quality will be low and in the immediate vicinity of the wellhead. No risk of LOWC as the well did not encounter hydrocarbons. Vessel discharges and vessel MDO risk associated with the two campaigns.	-	If the wellhead is supported by a GB and/or cement patio is present then the complete romval would involve lifting all parts from the seabed for removal thereby impacting the water and sediment quality in the local area. If drill cuttings are present they will be disturbed to access the base of the well. However, according to the well report, Water Based Muds was used. No risk of LOWC as the well did not encounter hydrocarbons. Vessel discharges and vessel MDO risk associated with the two campaigns.	-	If a cover/cap is installed it would slowly degrade overtime releasing corrosion material. The cover/cap is comprised predominantly of mild steel, iron the primary component of steel (98%) is only toxic to marine organisms at extremely high concentrations (Grimwood and Dixon, 1997). All iron oxides are included on the OSPAR PLONOR list (Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment). Based on the low toxicity of iron, the slow release rate and rapid dilution of the open ocean environment, any impacts to sediments and water quality will be low and in the immediate vicinity of the wellhead. No risk of LOWC as the well did not encounter hydrocarbons. Vessel discharges and vessel MDO risk associated with the single campaign.	-	If GB, cement patio and/or drill cuttings are present, they will not be disturbed. If the wellhead is left in-situ it would slowly degrade overtime releasing corrosion material. The wellhead is comprised predominantly of mild steel, iron the primary component of steel (98%) is only toxic to marine organisms at extremely high concentrations (Grimwood and Dixon, 1997). All iron oxides are included on the OSPAR PLONOR list (Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment). Based on the low toxicity of iron, the slow release rate and rapid dilution of the open ocean environment, any impacts to sediments and water quality will be low and in the immediate vicinity of the wellhead. No risk of LOWC as the well did not encounter hydrocarbons. No vessel discharges or vessel MDO risk.	Most preferred
		Ecological services	Assessment of biodiversity and habitat changes due to the physical presence of property, and seabed disturbance because of the petroleum activity.	Any marine growth around/on the well will be removed. A portion of infrastrucure will remain above the seabed. Vessel and ROV activity with associated impacts and risks to the marine environment. No LOWC risk as the well did not encounter hydrocarbons.	-	Any marine growth around/on the well will be removed. Seabed disturbance will occur as a result of cutting below the mudline and lifting the infrastructure to remove from the ground. Vessel and ROV activity with associated impacts and risks to the marine environment. No LOWC risk as the well did not encounter hydrocarbons.	-	Any marine growth around/on the well will die as a result of being trapped by the cover/cap. Installing a cover/cap will create a larger seabed footprint and higher profile to cover the wellhead. Vessel and ROV activity with associated impacts and risks to the marine environment. No LOWC risk as the well did not encounter hydrocarbons.	Least Preferred	Retains marine growth around/on the well. No vessel or ROV activity, therefore no associated impacts or risks to the marine environment. No LOWC risk as the well did not encounter hydrocarbons.	Most preferred
		Emissions	Emissions such as light, noise, air and marine discharges.	Vessel and ROV activity creating light, noise and air (vessel) emissions, discharges, and MDO spill risk over two campaigns.	Least Preferred	Vessel and ROV activity creating light, noise and air (vessel) emissions, discharges, and MDO spill risk. Over two campaigns.	Least Preferred	Vessel and ROV activity creating light, noise and air (vessel) emissions, discharges, and MDO spill risk for a single campaign.	-	No vessel activity and associated emissions, discharges, or MDO spill risk.	Most preferred
		Waste	Volume and type of waste associated with offshore operations (e.g. landfill, recyclables).	General waste generated by the vessel operations over two camapigns. Onshore disposal required of retrieved well materials (concrete, steel, etc.).	Least Preferred	General waste generated by the vessel operations over two campaigns. Onshore disposal required of retrieved well materials (concrete, steel, etc.).	Least Preferred	General waste generated by the vessel operations over single campaign.	-	No waste generated by the vessel operations No need for onshore disposal of of well materials (concrete, steel, etc.)	Most preferred
	Technical Feasibility	Engineering and execution complexity	The extent to which the option requires the use of proven technology. The ability to recover from unplanned excursions and complete the planned option.	Cutting above the mudline using a cutting tool such as a diamond wire saw (DWS). The wellhead is located in 112.2 m of water, this exceeds max operating depth for air diving, consequently ROV operations are required for removal. It is assumed the wellhead has a guide base (GB) installed which prevents direct access to the wellhead for external DWS mounting. Removal of GB would be required or dredging to access the conductor below the GB. The GB has minimal clearance above the sea-bed preventing access below the GB for any external cutting to the wellhead conductor without dredging sea-bed material from around the outside the external cut will leave stump protruding 100 mm from the mud-line. The extent of conductor cement at seabed level below GB is unknown. The cement 'porch' is likely to present a physical impediment and prevent dredging. Visibility in the region is poor due to the depth and high currents this poses a risk to effective ROV operations.	Least Preferred	The wellhead type is unknown therefore the high-pressure housing and upper hub interface profile in unknown. This presents a risk to getting access to the wellbore for internal cutting. If stump only present - costs $1mill+ to remove plus trips, for little improvement in environmental condition (only snag risk for fishers) Requires use of a non- heave compensated crane (or in-line compensator on the crane). The cap type and latching mechanism is also unknown, this presents a risk getting access to the wellbore for any internal cutting or pressure management options. The first of the two surveys includes a cleaning campaign to remove marine growth and to identify wellhead and temporary abandonment cap components. It may not be possible to identify the components due to the age and unknown condition of the wellhead. Visibility in the region is poor due to the depth (112 m) and high currents, this poses a risk to effective ROV operations.	Least Preferred	A larger vessel with crane capability required to maneuver the cover/cap. It may require a second campaign	-	Possibility that the old well infrastructure could have become brittle/weakened over time and may be difficult to remove/lift without sections breaking away. Leaving in-situ ensures the material remains in the one location and poses no technical risk. Two campaigns would be required to remove the wellhead, one to remove marine growth and inspect the wellhead (which would include a determination of well bore pressure) and the other to remove the well head if feasible. There are also risks associated with removal of the wellhead and include: External cutting • The presence of a GB around the wellhead which prevents direct access to the wellhead for external DWS mounting. Removal of GB would be required or dredging to access the conductor below the GB • The extent of cement at seabed level below GB is unknown (from conductor cementing) – a cement porch is likely to prevent a physical barrier to dredging • Conventional DWS options are not possible due to technical issues such as crane deployment (not being possible to access below the GB). Internal Cutting • The condition of the wellhead temporary cap, internal housing, and latching mechanism are unknown which presents a risk to internal cutting operations. • Based on the age of the wellheads and the uncertainty of the wellhead condition, removal by internal cutting is considered to have a high level of complexity and a low likelihood of success. Considering all potential wellhead removal options have a low likelihood of success, the preference from a technical feasibility perspective is to leave the wellhead in place.	Most preferred
	Health and Safety	Risk to personnel (offshore and onshore)	Health and safety risks to company-related personnel both onshore (e.g. logistics) and offshore.	Complete removal would result in two campaigns and associated vessel hours, land logistics, supply needs, waste disposal health and safety risks.	Least Preferred	Complete removal would result in two campaigns and associated vessel hours, land logistics, supply needs, waste disposal health and safety risks.	Least Preferred	Installing a cover/cap would require one campaign and associated vessel hours, land logistics, supply needs, waste disposal health and safety risks. However, depending on the quality of the information gathered in the wellhead survey, a second camapign may be required to do a follow-up survey before installing the cap.	-	No health and safety risk to personnel as no removal camapign/s required.	Most preferred
		Residual risk to other marine	Health and safety risks to marine users such as	Given the remote offshore location of the wellhead and the water depth of 112		Given the remote offshore location of the wellhead and the water depth of 112 m,		Given the remote offshore location of the wellhead and the water depth of 112.2 m, no		Given the remote offshore location of the wellhead and the water depth of 112.2 m, no credible	
	Social	Effect on commercial fisheries	Displacing commercial fisheries or affecting their catch.	Well and associated external obstructions not able to be removed at/below the seabed with this method, therefore snag risk remains to trawl fishing operations, however, commercial fishing is not known to occur in the operational area (refer Section 3.3.2 of the EP) Vessel activity and associated impacts and risks for no extra benefit.	Least Preferred	Complete removal of the well and associated external obstructions below the seabed. No snag risk to commercial fisheries if they operate in the region in the future.	Most preferred	Was thought to be a good option to reduce snag risk to fisheries, but previous consultation and feedback from fishery stakeholders determined this option would still present as a snag risk if used. The distance to the closest area of any fishing effort (low effort with <3 vessels) is approximately 48 km.	-	Snag risk remains to trawl fishing operations, however, commercial fishing is not known to occur in this area.	Least Preferred
		Other socio-economic effects	Effects on local communities, recreational users, commercial activities, etc.	Reputational benefits as a responsible petroleum operator.	Most preferred	Reputational benefits as a responsible petroleum operator.	Most preferred	Potential reputational benefits as a responsible petroleum operator for attempting to address the legacy asset.	-	Possibility of reputational impacts.	Least Preferred
	Economic	Financial cost	Operational / capital costs to Santos.	< $3 million	-	> $3 million	Least Preferred	$1 million	-	No cost for removal campaign/s	Most preferred
Scenarios considered as *Not Credible*											
Bubbles	Notes: LOWC is not considered likely as the well has not produced hydrocarbons Not found in other nearby wells of a similar era / same basin If found, would trigger the need for a new EP to P+A properly / manage with regular surveys as required for Petrel-1 well.										