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Yoorn-1 Geophysical Survey Environment Plan (State and Commonwealth Waters)

PROJECT / FACILITY	Drilling and Completions
REVIEW INTERVAL (MONTHS)	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s *Managerial/Technical/Site*	Approver
	Drilling Superintendent	HSE Team Lead – Offshore Drilling and Completions	Manager – Offshore Drilling and Completions
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List of Acronyms

Abbreviation	Description
AFMA	Australian Fisheries Management Authority
AHS	Australian Hydrographic Service
AIS	Automatic Identification System
ALARP	As low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre Pty Ltd
AMP	Australian Marine Park
AMSA	Australian Marine Safety Authority
APASA	Asia-Pacific Applied Sciences Associates
APPEA	Australian Petroleum Production & Exploration Association
API	American Petroleum Institute
AUV	Autonomous Underwater Vehicle
BIA	Biologically Important Area
CHARM	Chemical Hazard and Risk Management
CM	Control Measure
CMMS	Computerised Maintenance Management System
CPI	Corrugated Plate Interceptor
DAH	Dissolved Aromatic Hydrocarbons
DAWR	Department of Agriculture and Water Resources
DBCA	Department of Biodiversity, Conservation and Attractions
DoE	(Australian) Department of the Environment (now DoEE)
DoEE	(Australian) Department of the Environment and Energy (now DAWE)
DAWE	(Australian) Department of Agriculture, Water and Environment
DoF	Department of Fisheries
DoT	Department of Transport
DPaW	Department of Parks and Wildlife (now DBCA)
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environment Regulation
EMBA	Environment that May Be Affected
EP	Environment Plan
EPA	West Australian (WA) Environmental Protection Authority
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPO	Environmental performance outcome/objective
EPS	Environmental performance standard
ESD	Ecologically sustainable development

Abbreviation	Description
GHG	Greenhouse gases
HFC	Hydroflourocarbons
HFO	Heavy Fuel Oil
IFO	Intermediate Fuel Oil
IMMR	Inspection, Maintenance, Monitoring and Repair
IMS	Invasive Marine Species
KEF	Key Ecological Feature
LMS	Listed Migratory Species
LTS	Listed Threatened Species
MBES	Multi-beam echo sounding
MFO	Marine Fauna Observer
MNES	Matters of National Environmental Significance
MODU	Mobile Offshore Drilling Unit
MOU	Memorandum of Understanding
MP	Marine Park
NEBA	Net Environmental Benefit Analysis
NOPSEMA	National Offshore Petroleum Safety and Environment Management Authority
NWS	Western Australia's North West Shelf
ODS	Ozone depleting substances
OPEP	Oil Pollution Emergency Plan
OPGGS(E)(R)	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OSRL	Oil Spill Response Limited
P(SL)(E)R	State Petroleum (Submerged Lands) (Environment) Regulations 2012
PFC	Perflourocarbons
SBP	Sub-bottom profiling
SF_6	Sulphur hexaflouride
SSS	Side-scan sonar
WAFIC	Western Australian Fishing Industry Council
WAOWRP	WA Oiled Wildlife Response Plan

1 Introduction

1.1 EP Summary

OPGGS(E)R 2009 Requirements
Regulation 11(3)
Within 10 days after receiving notice that the Regulator has accepted an environment plan (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; and (ix) details of the titleholder's nominated liaison person for the activity. (b) must be to the satisfaction of the Regulator.

Environment Plan (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 **B**
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** and **Table 8-2**
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 8**
The response arrangements in the oil pollution emergency plan (OPEP)	**Section 6.7** and OPEP
Details of consultation already undertaken and plans for ongoing consultation	**Section 4**
Details of the titleholder's nominated liaison person for the activity	**Section 1.3.2**

PSL(E)R 2012 Requirements
Regulation 7
Within 10 days after receiving a notification that the Minister has approved an environment plan under subregulation (5)(a), the operator must submit to the Minister for public disclosure a summary of the plan.

Santos WA Northwest Pty Ltd (Santos WA) opts to submit this EP in full for public disclosure on the DMIRS website upon submission of the EP. The full EP is provided in lieu of providing an EP summary, as allowed for by the DMIRS *EP Summary Submission Process* guidance note (DMPMAY17_4757).

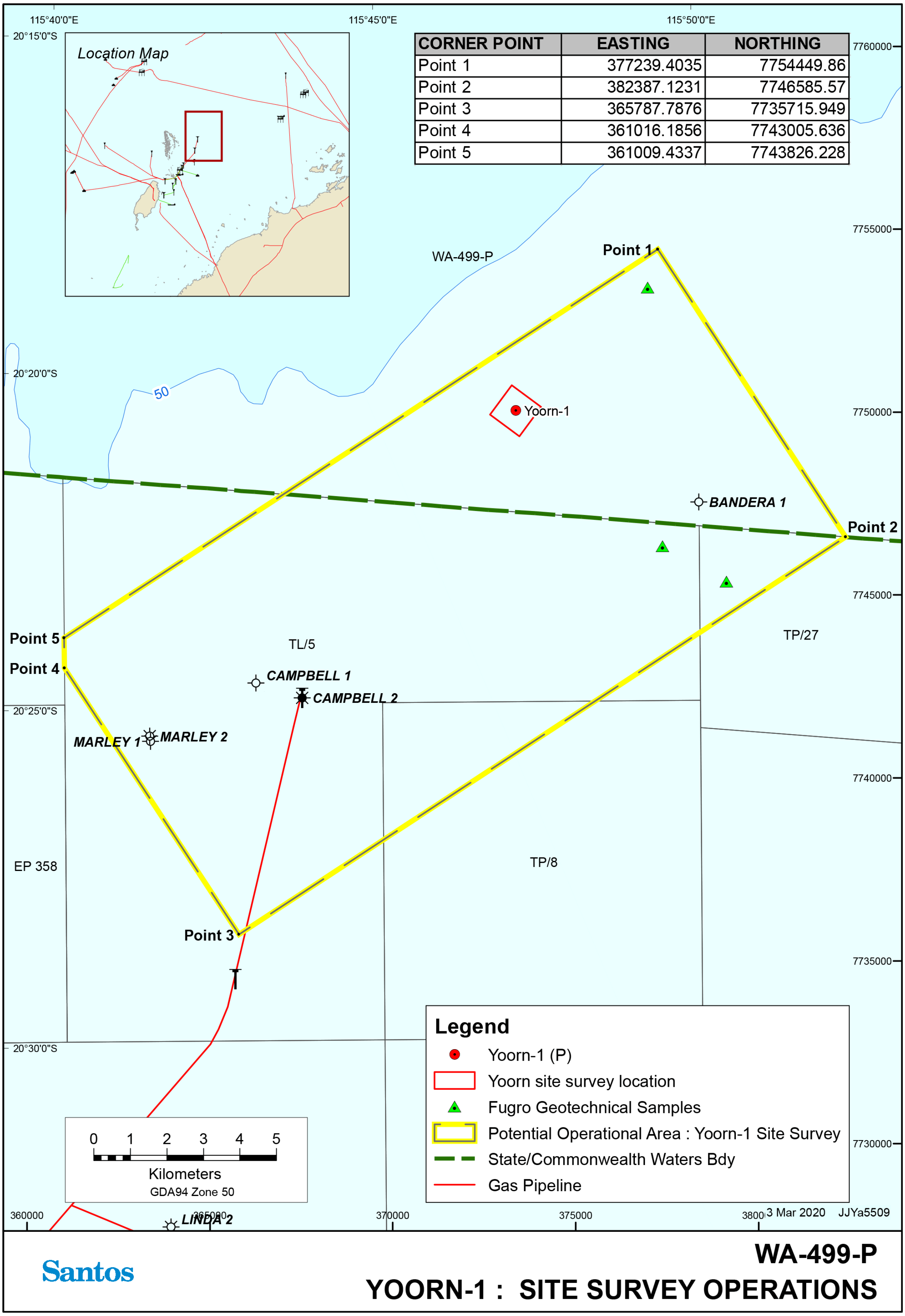
1.2 Activity overview

Santos WA Santos WA proposes to conduct exploration drilling in permit area WA-499-P, located in Commonwealth waters. As part of the drilling preparatory work, a vessel-based site survey will be undertaken involving geophysical survey techniques to assess the shallow seabed soils suitability to provide a safe foundation for a jack-up mobile offshore drilling unit (MODU). The survey activity ('the activity') which is the subject of this environment plan (EP) will involve surveying the planned drilling location and tie-in lines extending from the proposed drilling location to existing data points in the nearby area. The survey tie-in lines intersect both Commonwealth and state waters.

This EP has therefore been prepared to address the environmental requirements of activities undertaken in accordance with the following:

+ Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R), for acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA); and
+ WA State Petroleum (Submerged Lands) (Environment) Regulations 2012 (P(SL)(E)R) for acceptance by the Department of Mines, Industry Regulation and Safety (DMIRS).

The survey location is shown in **Figure 1-1**.



CORNER POINT	EASTING	NORTHING
Point 1	377239.4035	7754449.86
Point 2	382387.1231	7746585.57
Point 3	365787.7876	7735715.949
Point 4	361016.1856	7743005.636
Point 5	361009.4337	7743826.228

Figure 1-1: Survey Location

1.3 Purpose of the Environment Plan

In accordance with the OPGGS(E)R and P(SL)(E)R, this EP details the environmental impacts and risks associated with the activity and demonstrates how these will be reduced to as low as reasonably practicable (ALARP) and to an acceptable level. The EP provides an implementation strategy that will be used to measure and report on environmental performance during planned activities and unplanned events to ensure impacts and risks are continuously reduced to ALARP and are at an acceptable level. The environmental management of the activity described in the EP complies with the Santos WA Environmental Management Policy (**Appendix A1**) and with all relevant legislation (**Appendix A2**). This EP documents and considers all relevant stakeholder consultation performed during the planning of the activity.

1.3.1 Operator and Titleholder details

OPGGS(E)R 2009 Requirements
Regulation 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 ACN (within the meaning of the *Corporations Act 2001*)—ACN.
Regulation 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).

Table 1-1: Titleholder details for WA-499-P

Title	Titleholder (Operators in bold)	ABN	Interest (%)	Address
WA-499-P	**Santos WA Northwest Pty Ltd**	58 009 140 854	55	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
	Santos Offshore Pty Ltd	38 005 475 589	45	

1.3.2 Details of nominated liaison person

Details for Santos WA's nominated liaison person for the activity are as follows:

Name: Jason J. Young (Manager – Offshore Drilling and Completions)

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

Telephone number: (08) 6218 7100

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

1.3.3 Notification procedure in the event of changed details

In the event that there is a change in the nominated operator, the operator's nominated liaison person, or a change in the contact details for the operator or liaison person, Santos WA will notify NOPSEMA and DMIRS and provide the updated details.

1.4 Environmental management framework

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

P(SL)(E)R 2012 Requirements
Regulation 14 (6)
The environment plan must describe the requirements that — (a) apply to the petroleum activity under legislation (including conditions imposed under legislation), international conventions or agreements, or applicable codes of practice; and (b) are relevant to the environmental management of the petroleum activity.

1.4.1 Santos WA Environmental Management Policy

The activity will be conducted in accordance with the Santos WA Environmental Management Policy presented in **Appendix A1** and relevant legislative requirements presented in **Appendix A2**, inclusive of the relevant EP sections where the legislation may prescribe or control how an activity is undertaken.

Sections **6**, **7** and **8** of this EP reflect the Environmental Management Policy, detailing and evaluating impacts and risks from planned and unplanned events and providing control measures with set performance outcomes, standards, and measurement criteria to ensure environmental performance is achieved.

1.4.2 Relevant environmental legislation

Australia is a 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 operational activities are detailed in **Appendix A2**. As the activity will occur in both Commonwealth and WA State Waters, the activity will comply with applicable legislative requirements, also as detailed in **Appendix A2**.

2 Activity description

OPGGS(E)R 2009 Requirements
Regulation 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; and (d) any additional information relevant to consideration of environmental impacts and risks of the activity. Note: An environment plan will not be capable of being accepted by the Regulator if an activity or part of the activity, other than arrangements for environmental monitoring or for responding to an emergency, will be undertaken in any part of a declared World Heritage property – see regulation 10A.

P(SL)(E)R 2012
Regulation 14 (1)
The environment plan must include a comprehensive description of the petroleum activity including the following : (a) the location or locations of the petroleum activity; (b) details of the construction and layout of any facility; (c) a description of the operational details of the petroleum activity and proposed timetables; (d) any additional information relevant to consideration of the environmental impacts and environmental risks of the petroleum activity.

2.1 Activity overview

The activity will be undertaken using geophysical survey techniques and will include surveying an approximate 1 km x 1 km grid at the planned Yoorn-1 well location in Commonwealth waters, plus tie-in lines extending from the proposed drilling location to other existing data points within the operational area.

The survey will involve the following key activities and objectives:

+ Acquisition of multi-beam echo sounding (MBES) and side-scan sonar (SSS) data to define the bathymetry / seafloor morphology (e.g. depth, bedform character) and confirm the absence of debris or other anomalous seabed features within Commonwealth and State waters.
+ Identification of any hazards that may impact the location of a MODU through sub-bottom profiling (SBP), including shallow gas, lateral variability in layer properties, adverse near-seabed stratigraphy, anomalous layers of hard/soft formations, localised/regional outcrops or sub-crops, mobile bedforms and impediments to providing adequate foundations for supporting the rig when it is elevated above the water within Commonwealth and State waters.
+ Grab sampling or drop cores for ground-truthing the surficial geophysics and to support MODU spud-can penetration assessments within Commonwealth waters only.

Data acquired from the site survey will subsequently be processed to generate site survey reports for use in drilling the well. This data is required up to six months prior to drilling to inform planning for drilling the well.

2.2 Location and extent

The activity will be conducted entirely within a defined operational area as shown in **Figure 1-1**. The operational area overlaps permit areas WA-499-P in Commonwealth waters and TL/5, TP/8 and TP/27 in State waters. Water depth in the operational area ranges from approximately 40 m to 50 m.

A site survey at the proposed Yoorn-1 drilling location will be undertaken over an approximate 1 km x 1 km grid, as shown in **Figure 2-1**. Tie-in lines to nearby reference data points, for the purpose of enhancing understanding of the shallow geological conditions, will be surveyed along lines emanating from the Yoorn-1 drilling location, including to the following potential locations:

+ Campbell Field;
+ Marley Field; and
+ Previous geotechnical boreholes.

All of these potential data points and tie-in lines fall within the defined operational area (**Figure 1-1**). The approximate total linear distance of the tie-in lines is 25 km.

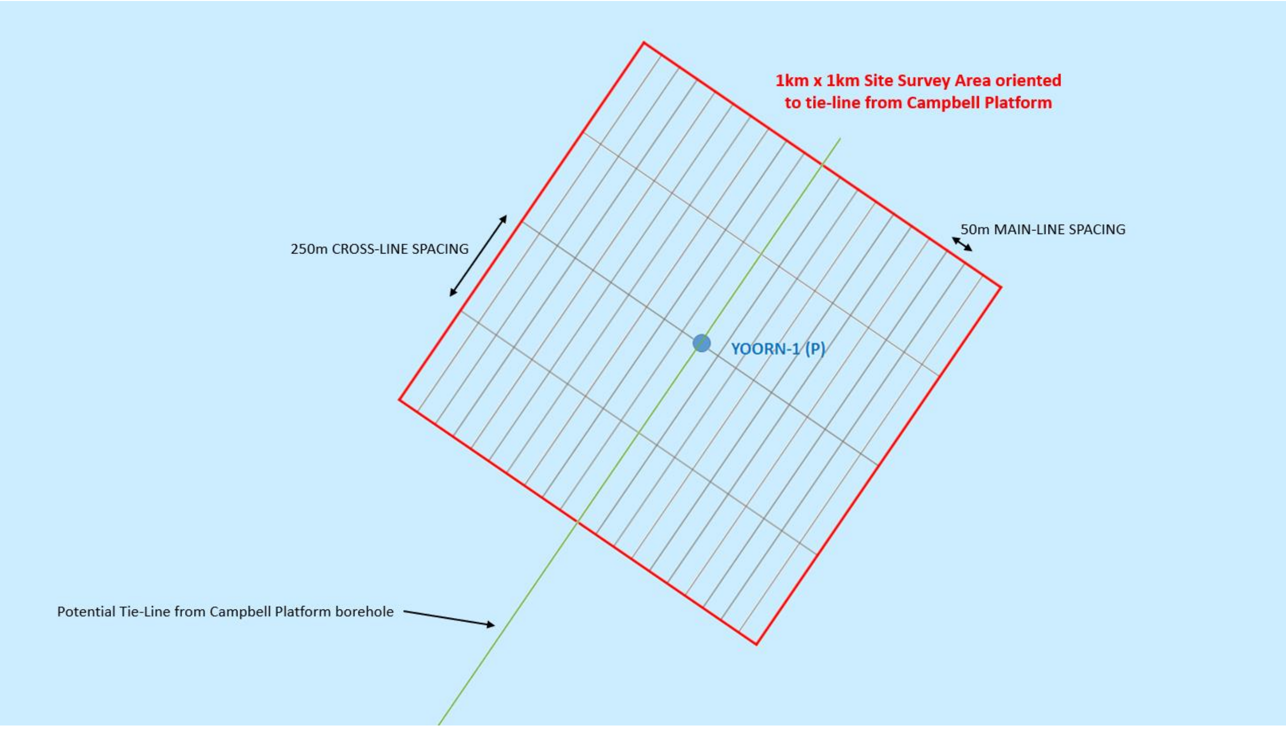


Figure 2-1: Site survey grid at Yoorn-1 proposed well location

2.3 Timing and duration

The activity will take place in 2020-2021. Allowing for potential down time, for example due to weather or vessel operability issues, the activity may extend to up to 10 days.

Activities will be undertaken up to 24 hours per day.

2.4 Survey vessel

A single survey vessel will be utilised to undertake the activity. The actual vessel will be determined in later planning stages. For environmental assessment purposes, a vessel such as the *Mermaid Searcher* has been considered, noting that the actual vessel to be used may be smaller; the intent being to assess impacts and risks of the largest typical vessel so that the assessment is conservative and allows for flexibility.

The Mermaid Searcher (see **Figure 2-2**) is a 54-m long, 950-tonne multi-purpose support vessel with accommodation for up to 34 people.

Figure 2-2: Indicative survey vessel – The Mermaid Searcher

Vessel speeds will be approximately 4 knots during geophysical surveying and the vessel will be temporarily stationary when taking seabed samples. No anchoring will take place unless in an emergency (e.g. loss of power).

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

2.5 Survey Equipment

Survey techniques will include equipment such as multibeam echo sounder (MBES), side-scan sonar (SSS), sub-bottom profiling (SBP) and seabed sampling as described below.

2.5.1 Multibeam echo sounder

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.

2.5.2 Side-scan sonar

SSS identifies any sea floor debris which may cause damage to the jack up MODU support legs. SSS involves towing a set of transducers mounted on either side of a 'tow fish' approximately 10-20 m above the seabed, producing pulses at high frequencies.

2.5.3 Sub-bottom profiling

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

2.5.4 Acoustic positioning system (Commonwealth waters only)

USBL (Ultra-short Base Line) acoustic positioning system will be utilised on board the survey vessel. This tool is used to locate the position of a single subsea transponder that will be placed temporarily on the seabed and subsequently recovered. The USBL system uses a vessel mounted transceiver to detect the range and bearing to a target using acoustic signals.

2.5.5 Sampling (Commonwealth waters only)

Seabed samples will be taken at points along the survey lines using a sampler lowered by a winch or crane from the survey vessel. Samples will extend up to 1.5 m deep into the seabed, with an areal disturbance of the seabed by each sample of approximately 1 m^2. Approximately four seabed samples are planned, and these will confirm the seafloor soil.

3 Description of the environment

OPGGS(E)R 2009 Requirements
Regulation 13(1)(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. Without limiting paragraph (1)(b), particular relevant values and sensitivities may include the following: (a) the world heritage values of a declared World Heritage property within the meaning of the EPBC Act; (b) the national heritage values of a National Heritage place within the meaning of that Act; (c) the ecological character of a declared Ramsar wetland within the meaning of that Act; (d) threatened; (e) migratory; (f) any values and sensitivities that exist in, or in relation to, part or all of: (i) a Commonwealth marine area within the meaning of that Act; or (ii) Commonwealth land within the meaning of that Act

P(SL)(E)R 2012 Requirements
Regulation 14 (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.

3.1 Environment that may be affected (EMBA)

This section the key physical, biological, socio-economic and cultural characteristics of the existing environment that may be affected by the activity, both from planned and unplanned events associated with the activity. The description of the environment applies to two areas:

+ The operational area, which is the area within which planned activities will occur; and
+ The environment that may be affected (EMBA), as shown in **Figure 3-1**.

A detailed and comprehensive description of the environment in the operational area and EMBA is provided in Section **3** and **Appendix B - Description of the Existing Environment**. Copies of the Department of the Environment and Energy (DoEE) Protected Matters Search Tool outputs for the operational area and the EMBA are also available in **Appendix B**.

The EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of a worst case oil spill. Most planned and unplanned events associated with the activity may affect the environment up to a few kilometres from the operational area e.g. from noise impacts (as identified in **Section 6**). A large unplanned hydrocarbon spill would extend substantially beyond this (**Section 7.4**).

3.1.1 Determining the Environment that May Be Affected

Stochastic hydrocarbon dispersion and fate modelling, applied to the worst case spill scenario identified as relevant to the activity (**Section 7.4**), was undertaken to inform the EMBA. Stochastic modelling is created by overlaying hundreds of individual hypothetical oil spill simulations from an oil spill into a single map, with each simulation subject to a different set of metocean conditions drawn from historical records. Stochastic modelling is completed to reduce uncertainty in risk assessment and spill response planning.

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 7-6 for the exposure values used and to **Section 7.4** 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 7-6). 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 are known as 'moderate' and 'high' are described within

Table 7-6 and further explained in **Section 7.4**.

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. Refer to **Section 7.4.1** for further information on the spill trajectory modelling thresholds that have been selected.

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 are relevant to the operational area and EMBA.

A summary of the information derived from the 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 14(2) of the P(SL)(E)R and regulation 13(1)(2) of the OPGGS(E)R is available in **Appendix B - Description of the Existing Environment**

The figures presented in this section of the EP have been zoomed to the extent of the data boundaries present 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, the operational area is within the Northwest Shelf Province and the EMBA overlaps the:

+ Northwest Province;
+ Northwest Shelf Province; and
+ Central Western Shelf Transition (**Figure 3-2**).

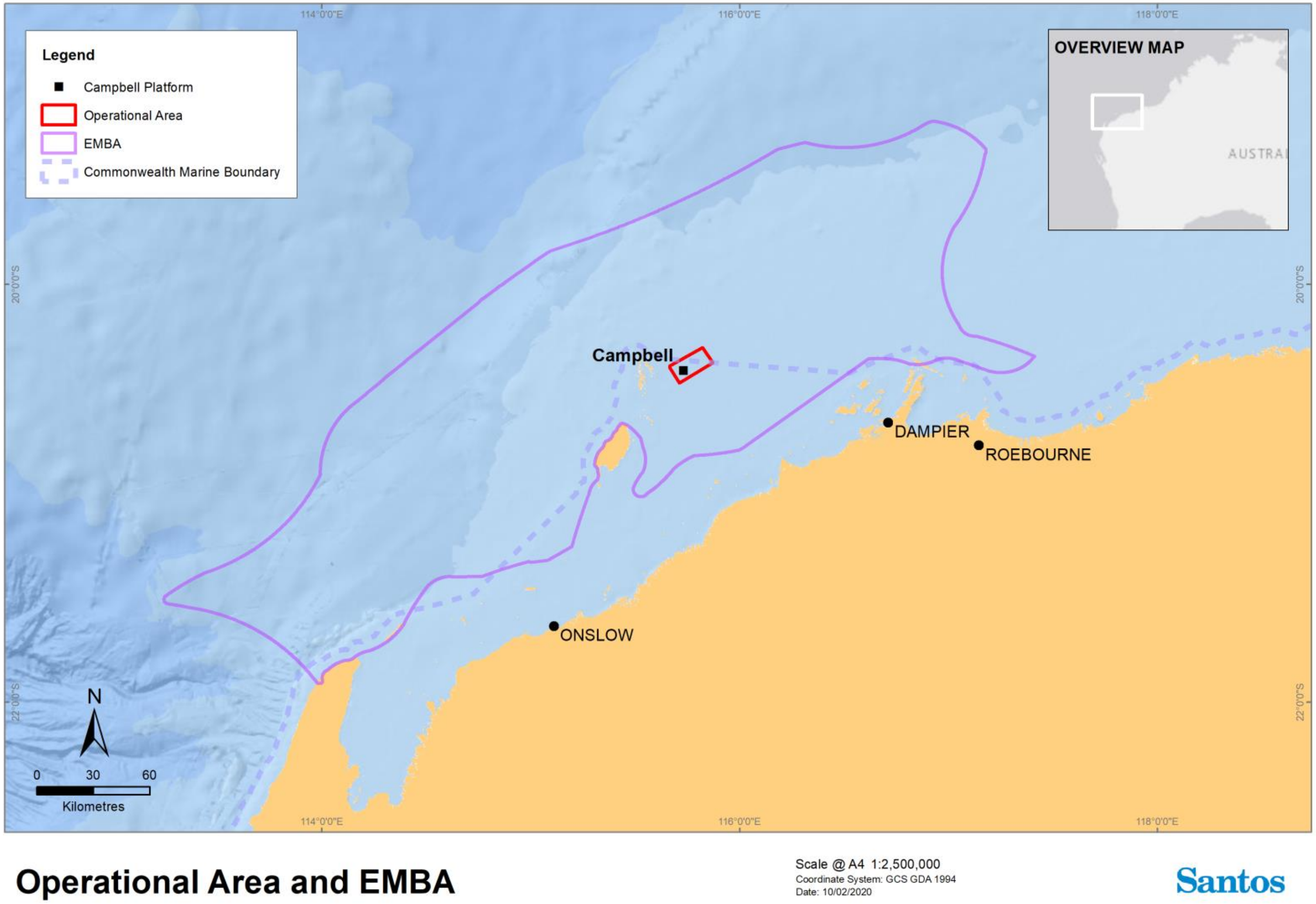


Figure 3-1: Operational area and EMBA (State and Commonwealth)

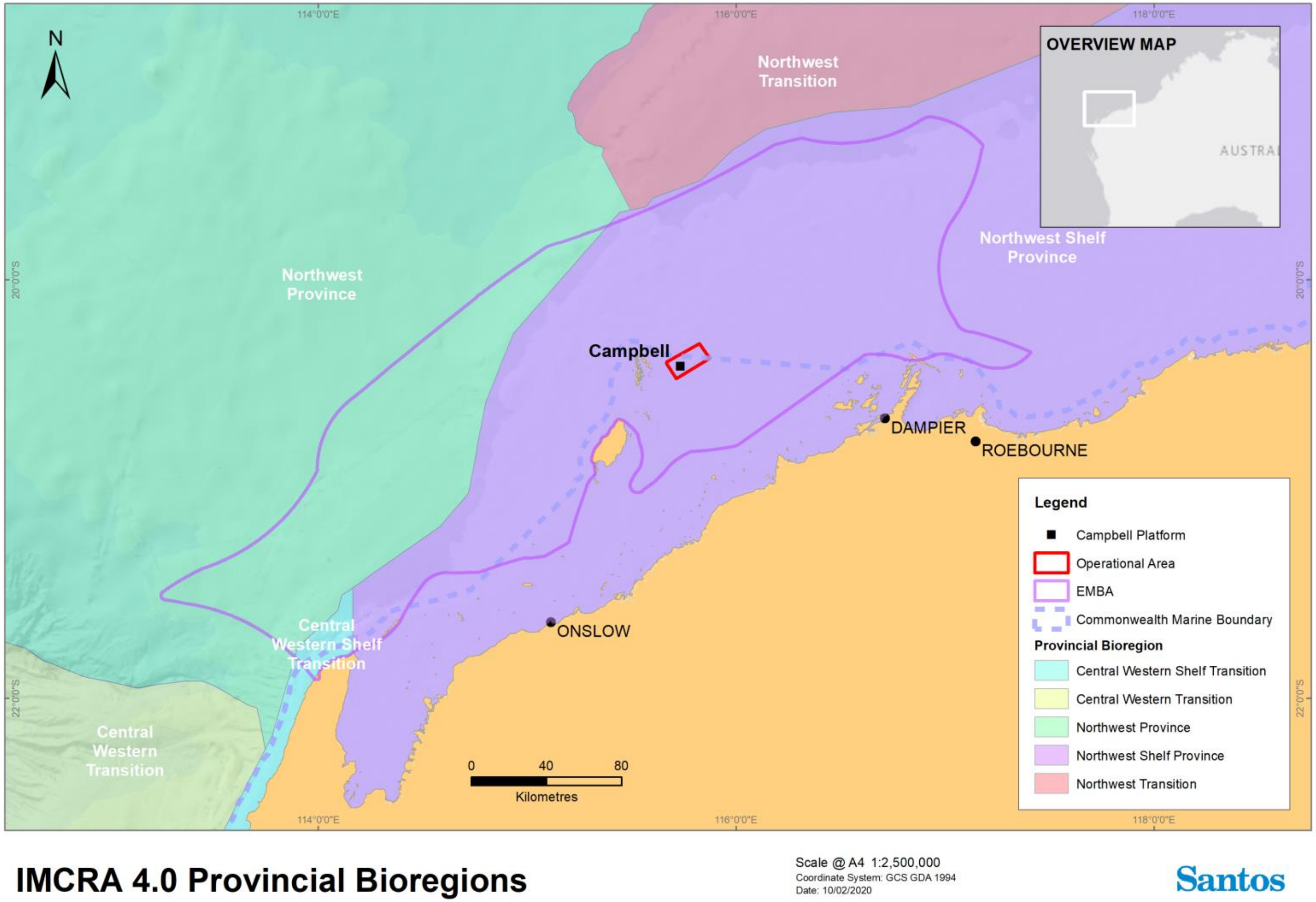


Figure 3-2: IMCRA 4.0 Provincial Bioregions within the EMBA and operational area

3.2.1.2 Benthic habitats

The presence of marine, coastal and terrestrial habitats within the operational area and EMBA are shown in **Figure 3-3**, and a detailed description of these habitats with reference to the IMCRA provincial bioregions is provided in **Appendix B - Description of the Existing Environment.**

The operational area does not contain any shoreline habitat; the nearest land is Trimouille, Lowendal and Barrow islands located approximately 22.3 km, 40.3 km and 50.2 km, respectively, from the Yoorn-1 well location.

According to the CAMRIS Marine Benthic Substrate Database – Marsed (IMAS, 2017) the benthic substrate within the operational area is made up of calcareous gravel, sand and silt. The subtidal benthic habitats in the NWS province include coral reefs, macroalgae, seagrasses, hard substrates and supported assemblages, and soft sediment and associated benthic fauna. Given the water depth within the operational area is approximately 40-50 m, benthic primary producers habitat (e.g., seagrass, macroalgae and hard corals) is unlikely to be present due to insufficient light availability, or if present will occur in low densities.

Benthic habitats within the EMBA are dominated by subtidal, bare reef; other habitats include coral reefs, seagrasses and macroalgae, which are associated with hard substrate around the Montebello and Lowendal Islands, as well as the mainland shore (Cardno 2011, Chevron 2005). The closest location to the operational area with a significant amount of benthic habitat biodiversity is the Montebello Islands. The subtidal coral reef community around the Montebello Islands are very diverse with over 150 species of hard corals recorded (DEC & MPRA 2007a). Seagrasses grow on soft substrates and sand veneers in the intertidal zone surrounding the Montebello/Barrow Islands, sparsely interspersed between macroalgae (DEC & MPRA 2007a).

Dominant shoreline habitats within the remainder of the EMBA include sandy beaches interspersed with hard substrate and intertidal platforms, which provide breeding and nesting grounds for marine turtles and seabirds (Astron 2012, Garnet and Crowley 2000).

Mangroves occur as discrete patches within the tidal and supratidal (immediately above the high tide mark) zone in communities throughout the Montebello Islands, and are found in lagoons of offshore islands (DEC 2007).

Benthic habitats that could potentially be impacted in a major spill event are shown in **Figure 3-1** and further detailed in **Table 3-1**.

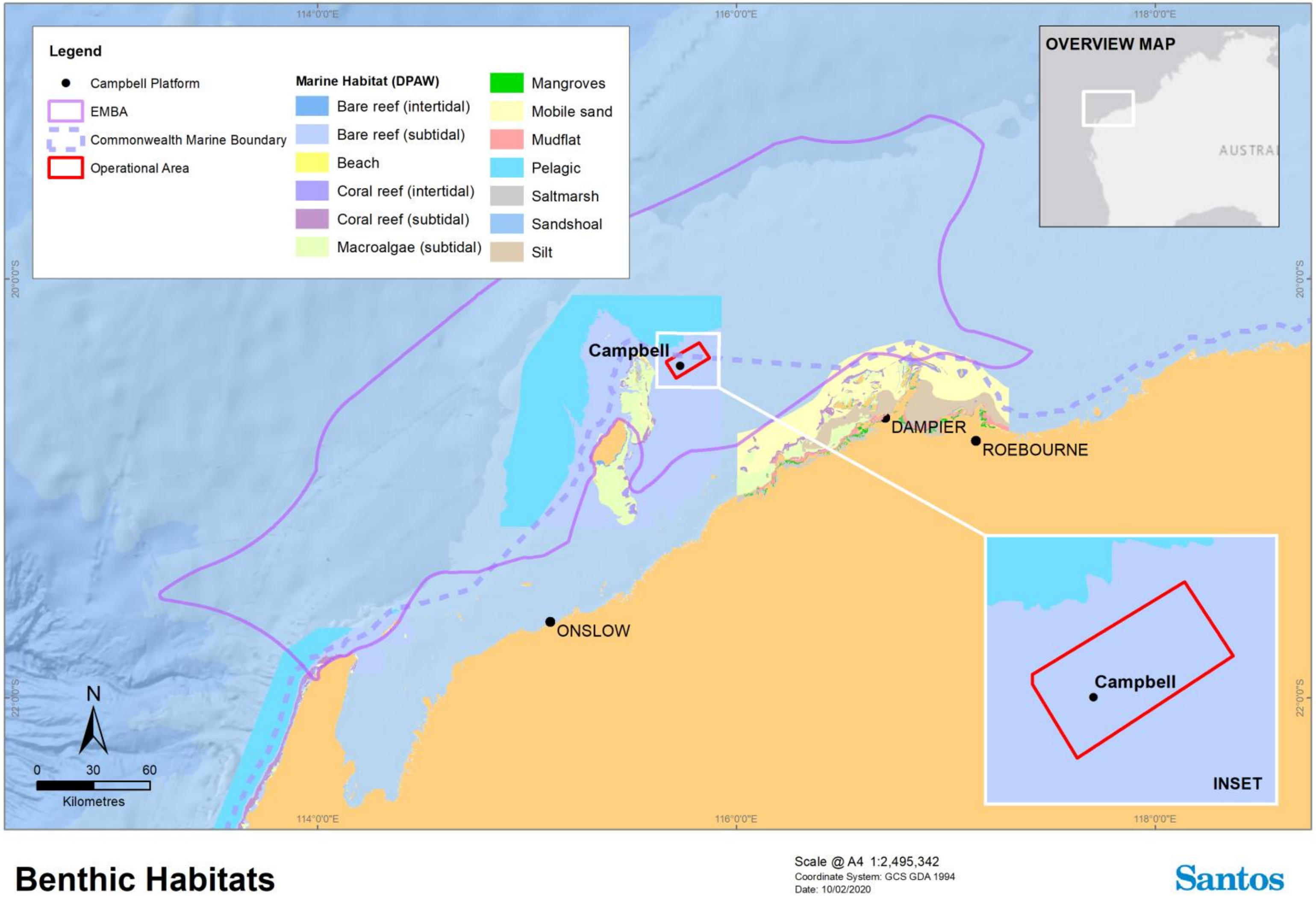


Figure 3-3: Benthic habitats within the EMBA and operational area

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Table 3-1: Habitats within the EMBA listed according to presence within the operational area and IMCRA Provincial Bioregions of Australia

Category	Receptor	Operational area presence	EMBA Presence				Relevant events that may impact on the receptors
			Northwest Province	Northwest Shelf Province	Northwest Transition	Central Western Shelf Transition	
Benthic habitats	Coral reefs	✗	✗	✓	✗	✓	Unplanned: Introduction of Invasive Marine Species (IMS) Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
	Seagrass	✗	✗	✓	✗	✓	Unplanned: Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
	Macroalgae	✗	✗	✓	✗	✓	Unplanned: Introduction of IMS Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
	Non-coral benthic invertebrates	✓	✓	✓	✓	✓	Planned: Seabed disturbance Planned operational discharges Unplanned:

Category	Receptor	Operational area presence	EMBA Presence				Relevant events that may impact on the receptors
			Northwest Province	Northwest Shelf Province	Northwest Transition	Central Western Shelf Transition	
							Introduction of IMS Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
Shoreline habitats	Mangroves	✗	✗	✓	✗	✓	Unplanned: Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel
	Intertidal platforms	✗	✗	✓	✗	✓	
	Sandy beaches	✗	✗	✓	✗	✓	
	Rocky shorelines	✗	✗	✓	✗	✓	
	Saline mudflats	✗	✗	✓	✗	✗	Unplanned: Hydrocarbon release from vessel collision Hydrocarbon release from survey vessel

3.2.2 Protected/significant areas

Protected/significant areas identified in the operational area and EMBA are detailed in **Table 3-2,** and shown in **Figure 3-4** and **Figure 3-5**. These areas are further discussed in **Appendix B - Description of the Existing Environment**. The management zones, associated with the Australian Marine Parks identified in the EMBA, and the relevant objectives are detailed in **Table 3-3.** Distances shown are from the closest point of the operational area to the nearest feature.

Table 3-2: Distance from operational area boundary to protected areas, key ecological features and threatened ecological communities within the EMBA

Value/sensitivity	Name	Within operational area	Distance to operational area	Protection classification/zone
Australian Marine Parks	Montebello Marine Park	✓	Intersects	Multiple Use Zone (IUCN VI) General Use Zone
	Dampier Marine Park	X	101 km	Marine National Park Zone (IUCN I) Habitat Protection Zone (IUCN IV) Special Purpose Zone (IUCN VI))
	Gascoyne Marine Park	X	215 km	Multiple Use Zone (IUCN VI)
State Marine Parks and Marine Management Areas	Montebello Islands Marine Park	X	1 km	Sanctuary Zones, Recreation Zones, Special Purpose Zones
	Barrow Island Marine Management Area	X	16 km	-
	Barrow Island Marine Park	X	47 km	Sanctuary Zone
	Muiron Islands Marine Management Area	X	184 km	-
	Ningaloo Marine Park	X	205 km	Recreational Use Zone (IUCN IV) General Use Zone Special Purpose Zone
World Heritage Areas	The Ningaloo Coast	X	184 km	-
National Heritage Areas	Barrow Island and the Montebello-Barrow Island Marine Conservation Reserves	X	1 km	-
	Dampier Archipelago (including Burrup Peninsula)	X	98 km	-
	The Ningaloo Coast	X	183 km	-
Key Ecological Features	Ancient Coastline at 125 m Depth Contour	X	58 km	-
	Commonwealth Waters adjacent to Ningaloo Reef	X	180 km	-
	Continental Slope Demersal Fish Communities	X	69 km	-

Value/sensitivity	Name	Within operational area	Distance to operational area	Protection classification/zone
	Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	X	16 km	-
	Glomar Shoals	X	103 km	-

Table 3-3: Management zones for the Australian and State Marine Parks found within the EMBA and the associated objectives

Management zones	**Objective**
Australian Marine Parks	
Multiple Use (IUCN VI)	Managed to allow ecologically sustainable use while conserving ecosystems, habitats and native species. The zone allows for a range of sustainable uses, including commercial fishing and mining where they are consistent with park values.
Recreational Use (IUCN IV)	Managed to allow recreational use while conserving ecosystems, habitats and native species in as natural a state as possible. The zone allows for recreational fishing, but not commercial fishing.
Habitat Species Management Area (IUCN IV)	Managed primarily, including (if necessary) through active intervention, to ensure the maintenance of habitats or to meet the requirements of specific species
State Marine Park	
Sanctuary Zone	The primary purpose of sanctuary zones is for the protection and conservation of marine biodiversity. Sanctuary zones are 'no-take' areas managed solely for nature conservation and low impact recreation and tourism.
Special Purpose Zone	*Special purpose (benthic protection) zone*: This zone has the priority purpose of conservation of benthic habitat *Special purpose (shore-based activities) zone*: Special purpose zones in marine parks are managed for a priority purpose or use, such as a seasonal event (e.g. wildlife breeding, whale watching) or a commercial activity (e.g. pearling).
Recreation Zone	Recreation zones have the primary purpose of providing opportunities for recreational activities, including fishing, for visitors and for commercial tourism operators, where these activities are compatible with the maintenance of the values of the zone
General Use Zone	Conservation of natural values is still the priority of general use zones, but activities such as sustainable commercial and recreational fishing, aquaculture, pearling and petroleum exploration and production may be permitted provided they do not compromise the ecological values of the marine park.

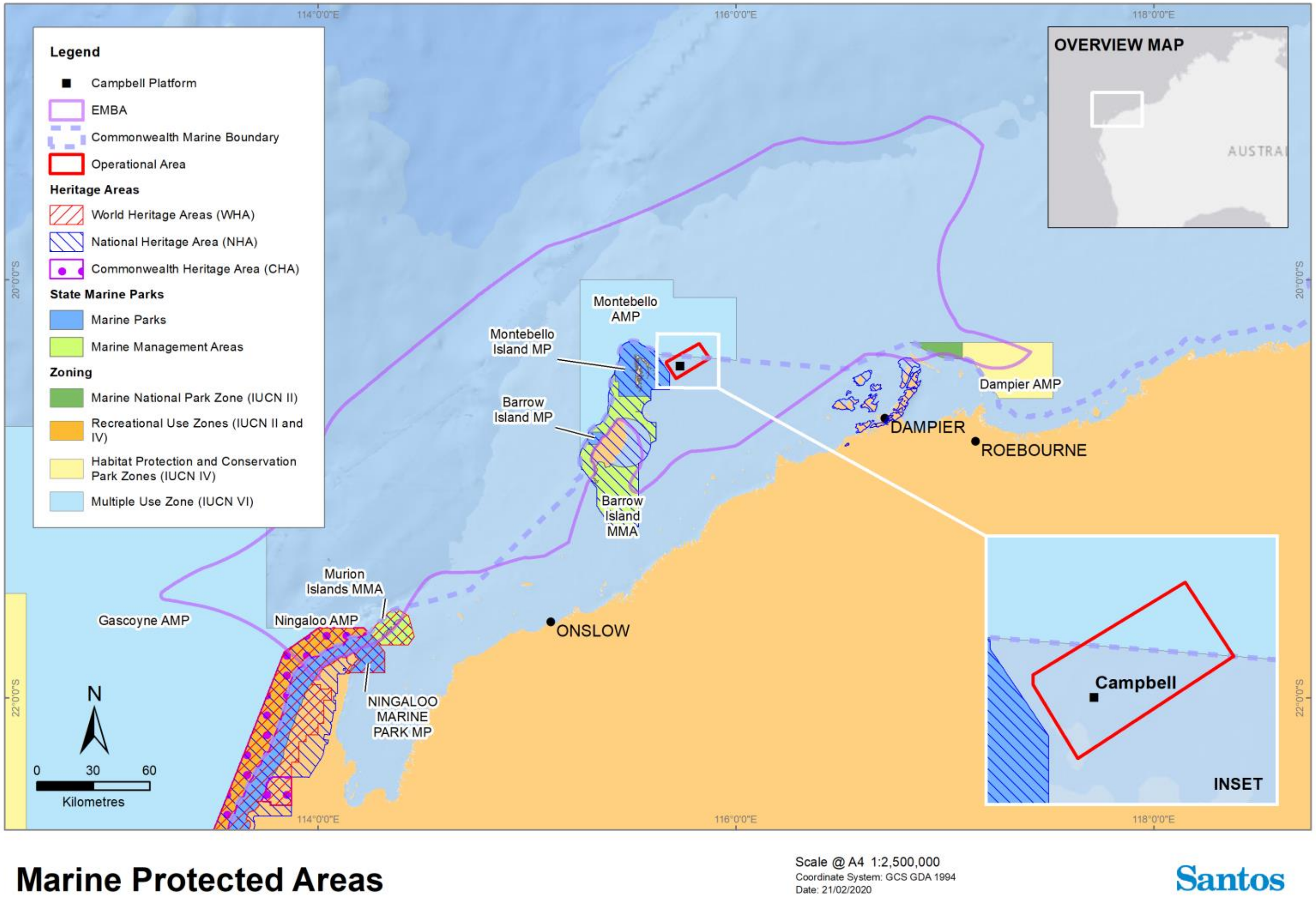


Figure 3-4: Protected areas within and near the EMBA and operational area

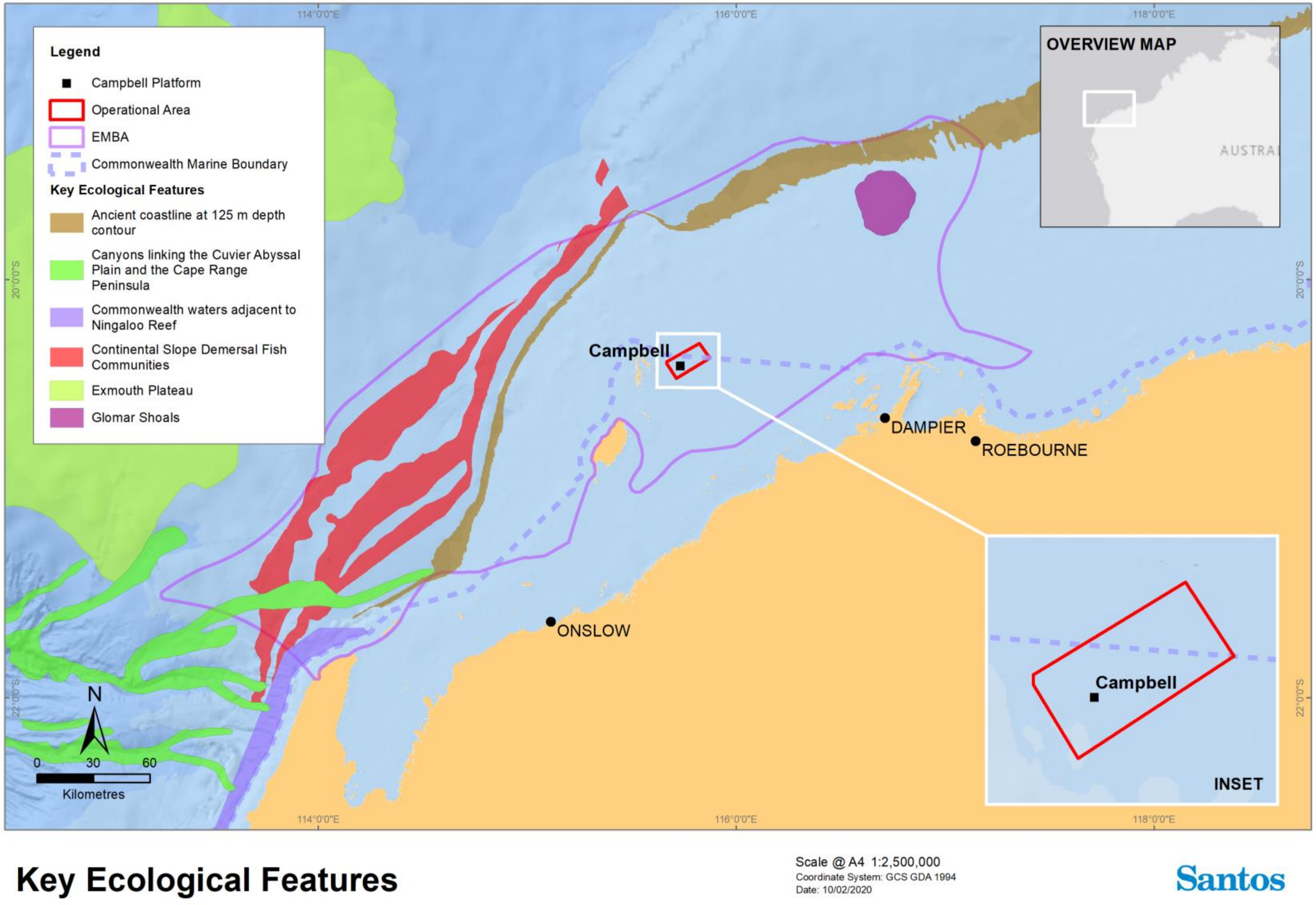


Figure 3-5: Key ecological features within and near the EMBA and operational area

3.2.3 Threatened and migratory fauna

3.2.3.1 Marine fauna

The PMST for the operational area identified 25 Listed Threatened Species (LTS) and 38 Listed Migratory Species (LMS).An additional 3 LTS and 11 LMS were identified as potentially occurring within the EMBA (**Table 3-4**).

An examination of the species profile and threats database showed that three LTS, identified within the EMBA, are not expected to occur in the marine and coastal environments due to their terrestrial and subterranean distribution. These species will not come into contact with any potential oil spill and therefore are not discussed further.

Those listed as threatened or migratory species groups and which have been identified as potentially being present within the operational area or EMBA, and the relevant planned and unplanned events that may impact them, are discussed in **Table 3-4**. Threatened and migratory species within these species' groups are further described in **Appendix B - Description of the Existing Environment**.

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 and EMBA are shown in **Figure 3-6** to **Figure 3-12** and are also described in **Appendix B - Description of the Existing Environment**. The relevant BIAs that occur within the operational area are listed below:

+ Internesting (internesting buffer) (loggerhead, green, hawksbill and flatback turtles);
+ Migration (humpback whale and pygmy blue whale); and
+ Breeding (wedge-tailed shearwater, Australian fairy tern, lesser crested tern and roseate tern).

Relevant conservation advices, recovery plans and management plans for marine fauna identified in the PMST are provided in **Section 3.2.3.3**.

Table 3-4: Environmental values and sensitivities within the EMBA and Operational Area – threatened and migratory marine fauna

Value/sensitivity: Common name	Value/sensitivity: Scientific name	EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Protected Species and Communities: Fish and Sharks						
Whale shark	*Rhincodon typus*	Vulnerable, Migratory	✓	Species or species habitat may occur within area.	Foraging, feeding or related behaviour known to occur within area. Overlap with foraging BIA.	Planned + Light emissions + Noise emissions + Seabed and benthic habitat disturbance + Planned vessel discharges + Spill response operations + Dropped objects Unplanned + Hydrocarbon releases + Marine fauna collisions + Introduction of invasive marine species (IMS)
Grey nurse shark (west coast population)	*Carcharias taurus (west coast population)*	Vulnerable	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Great white shark	*Carcharodon carcharias*	Vulnerable, Migratory	✓	Species or species habitat may occur within area.	Species or species habitat known to occur within area.	
Dwarf sawfish	*Pristis clavata*	Vulnerable, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Green sawfish	*Pristis zijsron*	Vulnerable, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Narrow sawfish	*Anoxypristis cuspidata*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat known to occur within area.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Reef manta ray	*Manta alfredi*	Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Giant manta ray	*Manta birostris*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat known to occur within area.	
Shortfin mako	*Isurus oxyrinchus*	Migratory	X	N/A	Species or species habitat likely to occur within area.	
Longfin mako	*Isurus paucus*	Migratory	X	N/A	Species or species habitat likely to occur within area.	
Protected Species and Communities: Marine Mammals						
Humpback whale	*Megaptera novaeangliae*	Vulnerable, Migratory	✓	Species or species habitat known to occur within area. Overlap with BIA for migration.	Congregation or aggregation known to occur within area. Overlap with BIA for migration.	Planned + Noise emissions + Planned vessel discharges + Spill response operations + Dropped objects Unplanned + Hydrocarbon releases
Blue whale	*Balaenoptera musculus*	Endangered, Migratory	✓	Species or species habitat likely to occur within area. Overlap with BIA for distribution.	Migration route known to occur within area. Overlap with BIA for migration.	
Bryde's whale	*Balaenoptera edeni*	Migratory	✓	Species or species habitat may occur within area.	Species or species habitat likely to occur within area.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Orca, killer whale	*Orcinus orca*	Migratory	✓	Species or species habitat may occur within area.	Species or species habitat may occur within area.	+ Marine fauna interaction
Spotted bottlenose dolphin	*Tursiops aduncus (Arafura/Timor Sea Populations)*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat likely to occur within area.	
Dugong	*Dugong dugon*	Migratory	✓	Species or species habitat known to occur within area.	Breeding known to occur within area. Overlap with BIA for foraging and breeding / calving / nursing.	
Indo-Pacific humpback dolphin	*Sousa chinensis*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat known to occur within area.	
Southern Right Whale	*Eubalaena australia*	Endangered	X	N/A	Species or species habitat likely to occur within area.	
Antarctic Minke Whale	*Balaenoptera bonaerensis*	Migratory	X	N/A	Species or species habitat likely to occur within area.	
Sei whale	*Balaenoptera borealis*	Vulnerable, Migratory	✓	Species or species habitat known to occur within area.	Foraging, feeding or related behaviour likely to occur within area.	
Fin whale	*Balaenoptera physalusk*	Vulnerable, Migratory	X	N/A	Foraging, feeding or related behaviour likely to occur within area.	
Sperm whale	*Physeter macrocephalus*	Migratory	X	N/A	Species or species habitat may occur within area.	
Protected Species and Communities: Marine Reptiles						

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Short-nosed seasnake	*Aipysurus apraefrontalis*	Critically Endangered	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	Planned + Light emissions + Noise emissions + Seabed and benthic habitat disturbance + Dropped objects + Planned vessel discharges + Spill response operations Unplanned + Hydrocarbon releases + Marine fauna interactions + Introduction of invasive marine species (IMS)
Loggerhead turtle	*Caretta caretta*	E, Migratory	✓	Foraging, feeding or related behaviour known to occur within area. Overlap with internesting BIA.	Breeding known to occur within area. Overlap with BIAs for nesting and internesting.	
Green turtle	*Chelonia mydas*	Vulnerable, Migratory	✓	Breeding known to occur within area. Overlap with BIAs for internesting. Overlap with critical nesting habitat.	Breeding known to occur within area. Overlap with BIAs for mating/nesting, foraging, basking, aggregation and internesting. Overlap with habitat critical to the survival of a species nesting habitat.	
Leatherback turtle	*Dermochelys coriacea*	Endangered, Migratory	✓	Breeding likely to occur within area.	Foraging, feeding or related behaviour known to occur within area.	
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable, Migratory	✓	Breeding known to occur within area. Overlap with BIAs for internesting. Overlap with critical nesting habitat.	Breeding known to occur within area. Overlap with BIAs for mating/nesting, foraging and internesting habitat. Overlap with habitat critical to the survival of a species nesting habitat.	
Flatback turtle	*Natator depressus*	Vulnerable, Migratory	✓	Breeding known to occur within area. Overlap with BIAs for internesting.	Breeding known to occur within area. Overlap with BIAs for mating/nesting, foraging, aggregation and internesting. Overlap with critical nesting habitat.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
				Overlap with critical nesting habitat.		
Protected Species and Communities: Marine Birds						
Roseate tern	*Stern dougallii*	Migratory	✓	Breeding known to occur within area. Overlap with breeding BIA.	Breeding known to occur within area. Overlap with breeding BIA.	Planned + Light emissions + Planned vessel discharges + Dropped objects + Spill response operations Unplanned + Hydrocarbon releases + Marine fauna interactions
Curlew sandpiper	*Calidris ferruginea*	Critically Endangered, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Red knot	*Calidris canutus*	E, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Southern giant petrel	*Macronectes giganteus*	Endangered, Migratory	✓	Species or species habitat may occur within area.	Species or species habitat may occur within area.	
Eastern curlew	*Numenius madagascariensis*	Critically Endangered, Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Common noddy	*Anous stolidus*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat likely to occur within area.	
Streaked shearwater	*Calonectris leucomelas*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat likely to occur within area.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Lesser frigatebird	*Fregata ariel*	Migratory	✓	Species or species habitat likely to occur within area.	Species or species habitat known to occur within area.	
Common sandpiper	*Actitis hypoleucos*	Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Sharp-tailed sandpiper	*Calidris acuminata*	Migratory	✓	Species or species habitat known to occur within area.	Species or species habitat known to occur within area.	
Pectoral sandpiper	*Calidris melanotos*	Migratory	✓	Species or species habitat may occur within area.	Species or species habitat may occur within area.	
Osprey	*Pandion haliaetus*	Migratory	✓	Breeding known to occur within area.	Breeding known to occur within area.	
Australian fairy tern	*Sternula nereis nereis*	Vulnerable	✓	Breeding known to occur within area. Overlap with breeding BIA.	Breeding known to occur within area. Overlap with breeding BIA.	
Fork-tailed swift	*Apus pacificus*	Migratory	X	N/A.	Species or species habitat likely to occur within area.	<u>Unplanned</u> + Hydrocarbon releases + Non-hydrocarbon releases
Bar-tailed godwit	*Limosa lapponica baueri*	Vulnerable, Migratory	X	N/A	Species or species habitat known to occur within area.	
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbierii*	Critically Endangered, Migratory	X	N/A	Species or species habitat may occur within area.	

Value/sensitivity		EPBC Act Status	Operational area presence	Particular values or sensitivities within operational area	Particular values or sensitivities within EMBA	Relevant events
Common name	Scientific name					
Wedge-tailed shearwater	*Ardenna pacifca*	Migratory	X	N/A	Breeding known to occur within area. Overlap with breeding BIA.	+ Introduction of non-indigenous flora and fauna.
Capsian tern	*Hydroprogne caspia*	Migratory	X	N/A	Breeding known to occur within area.	
Bridled tern	*Onychoprion anaethetus*	Migratory	X	N/A	Breeding known to occur within area.	
Oriental plover	*Charadrius plover*	Migratory	X	N/A	Species or species habitat may occur within area.	
Oriental pratincole	*Glareola maldivarum*	Migratory	X	N/A	Species or species habitat may occur within area.	
Crested tern	*Thalasseus bergii*	Migratory	X	N/A	Breeding known occur within area.	
Common greenshank	*Tringa nebularia*	Migratory	X	N/A	Species or species habitat likely to occur within area.	
Australian painted snipe	*Rostratula australis*	Endangered	X	N/A	Species or species habitat may occur within area.	
Greater frigatebird	*Fregata minor*	Migratory	X	N/A	Species or species habitat may occur within area.	
White-winged Fairy-wren (Barrow Island)	*Malurus leucopterus edouardi*	Vulnerable	X	N/A	Species or species habitat likely to occur within area.	
Soft-plumaged Petrel	*Pterodroma mollis*	Vulnerable	X	N/A	Foraging, feeding or related behaviour likely to occur within area.	
Flesh-footed Shearwater	*Ardenna carneipes*	Vulnerable	X	N/A	Species or species habitat likely to occur within area.	

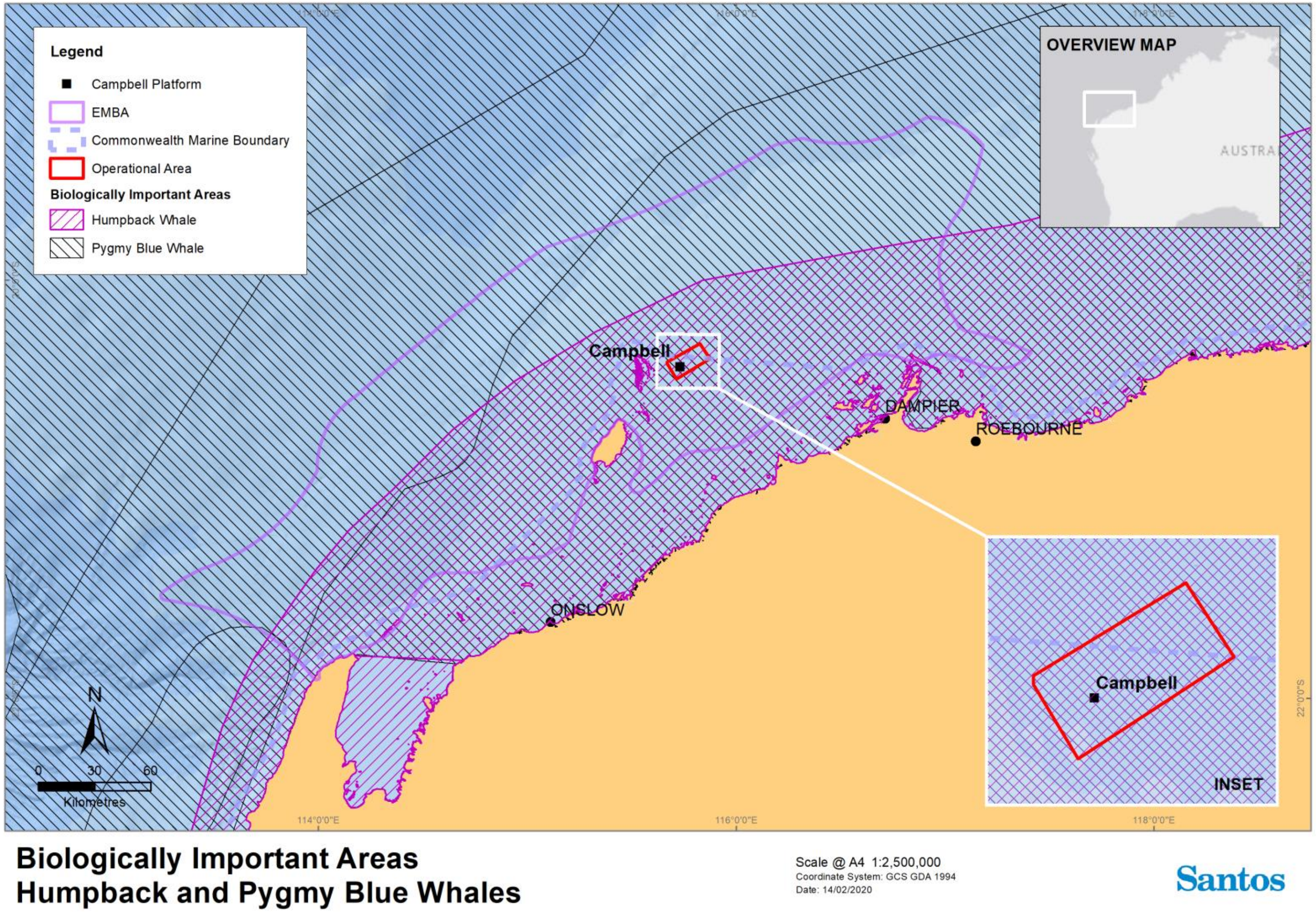


Figure 3-6: Biologically important areas for EPBC Protected whale species within the vicinity of the EMBA and operational area

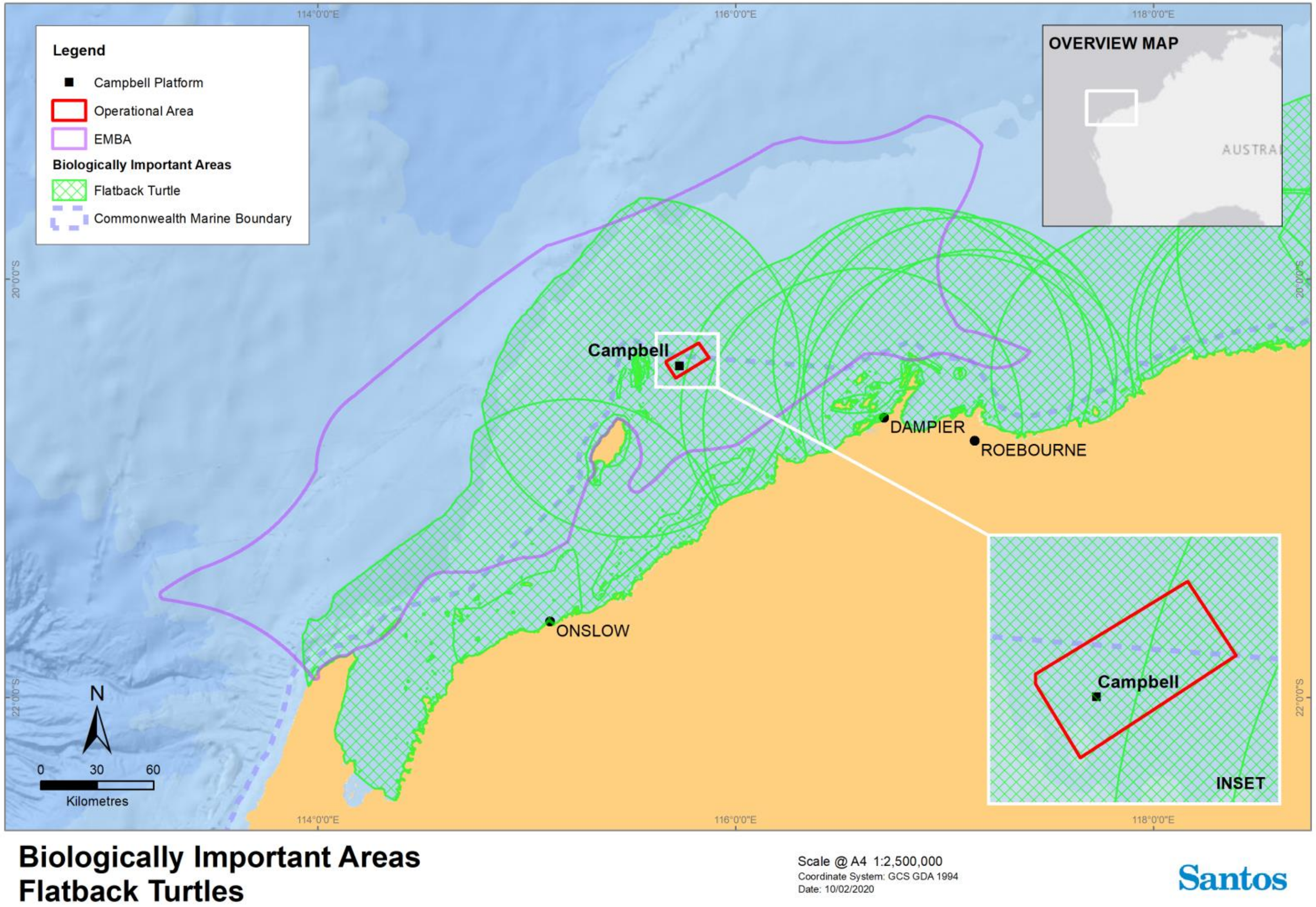


Figure 3-7: Biologically important areas for EPBC Protected flatback turtle within the vicinity of the EMBA and operational area

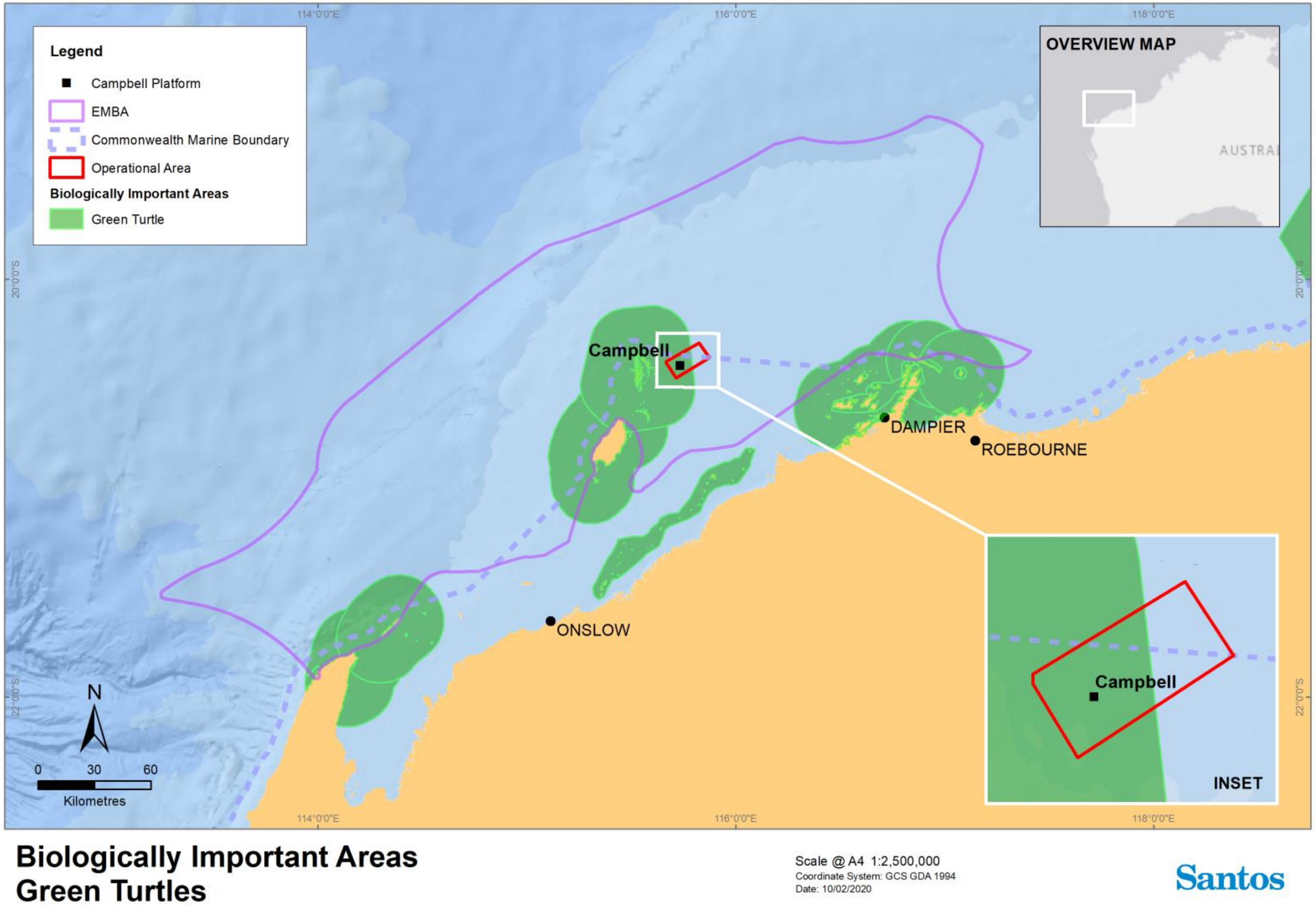


Figure 3-8: Biologically important areas for EPBC Protected green turtle within the vicinity of the EMBA and operational area

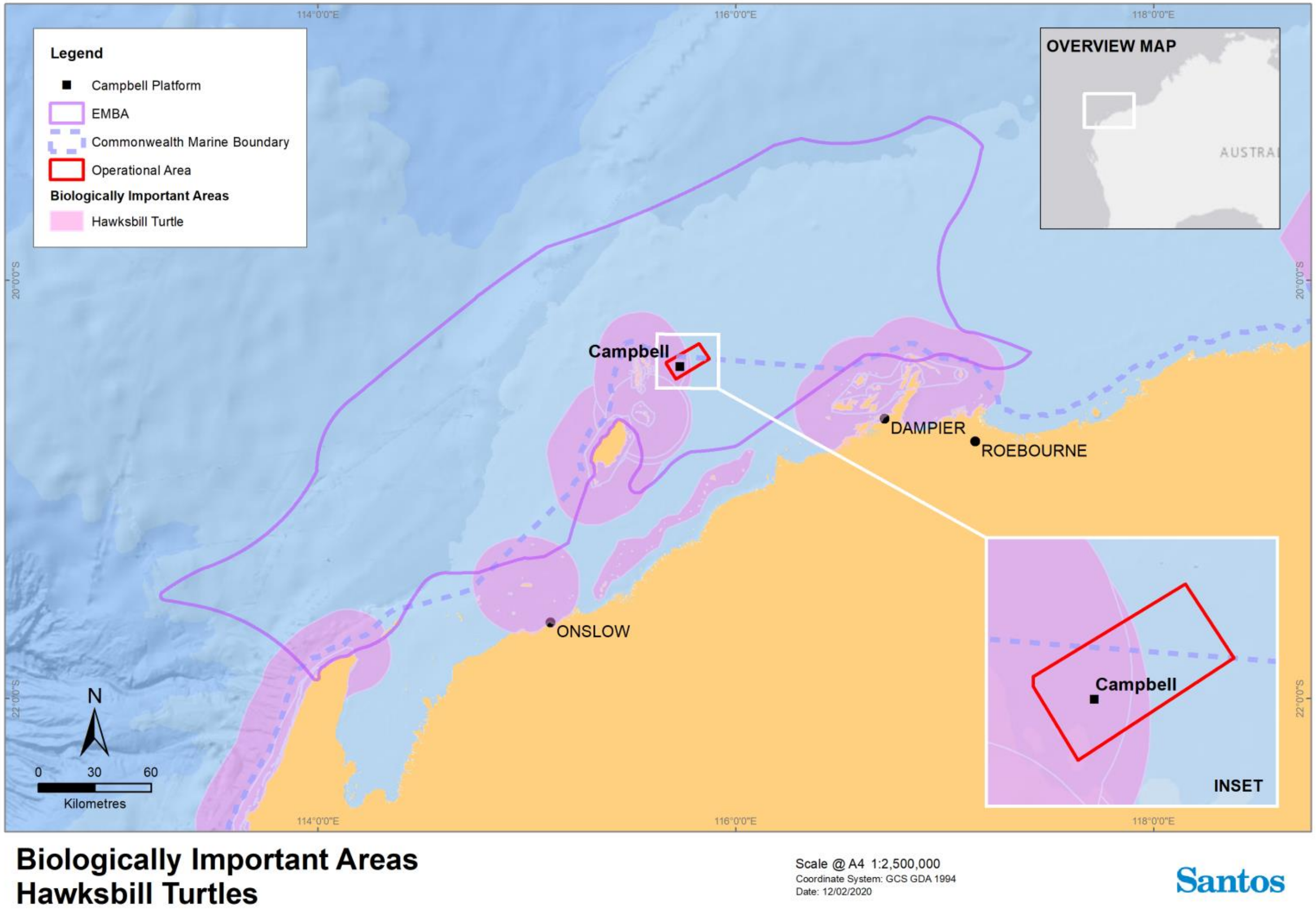


Figure 3-9: Biologically important areas for EPBC Protected hawksbill turtle within the vicinity of the EMBA and operational area

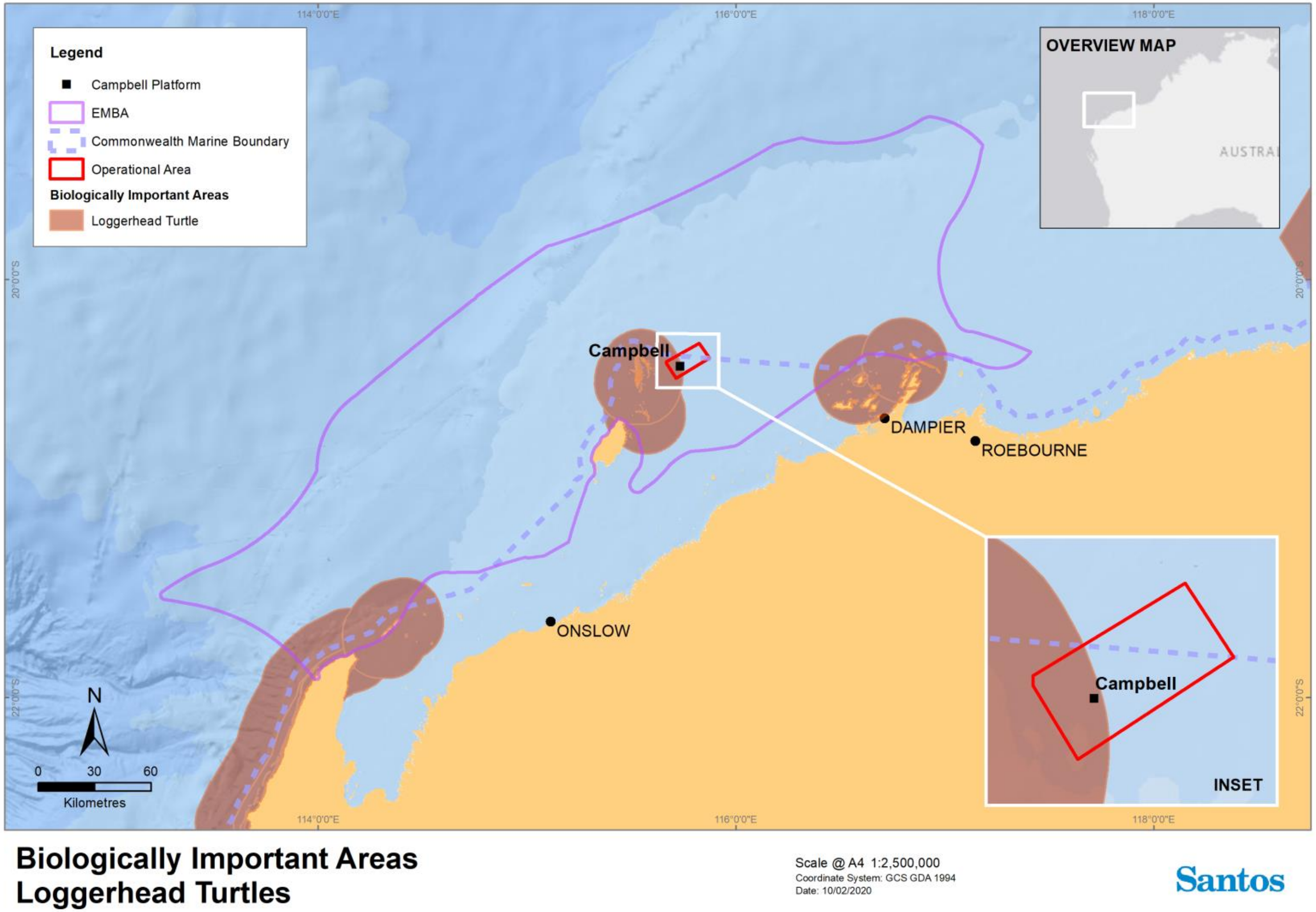


Figure 3-10: Biologically important areas for EPBC Protected loggerhead turtle within the vicinity of the EMBA and operational area

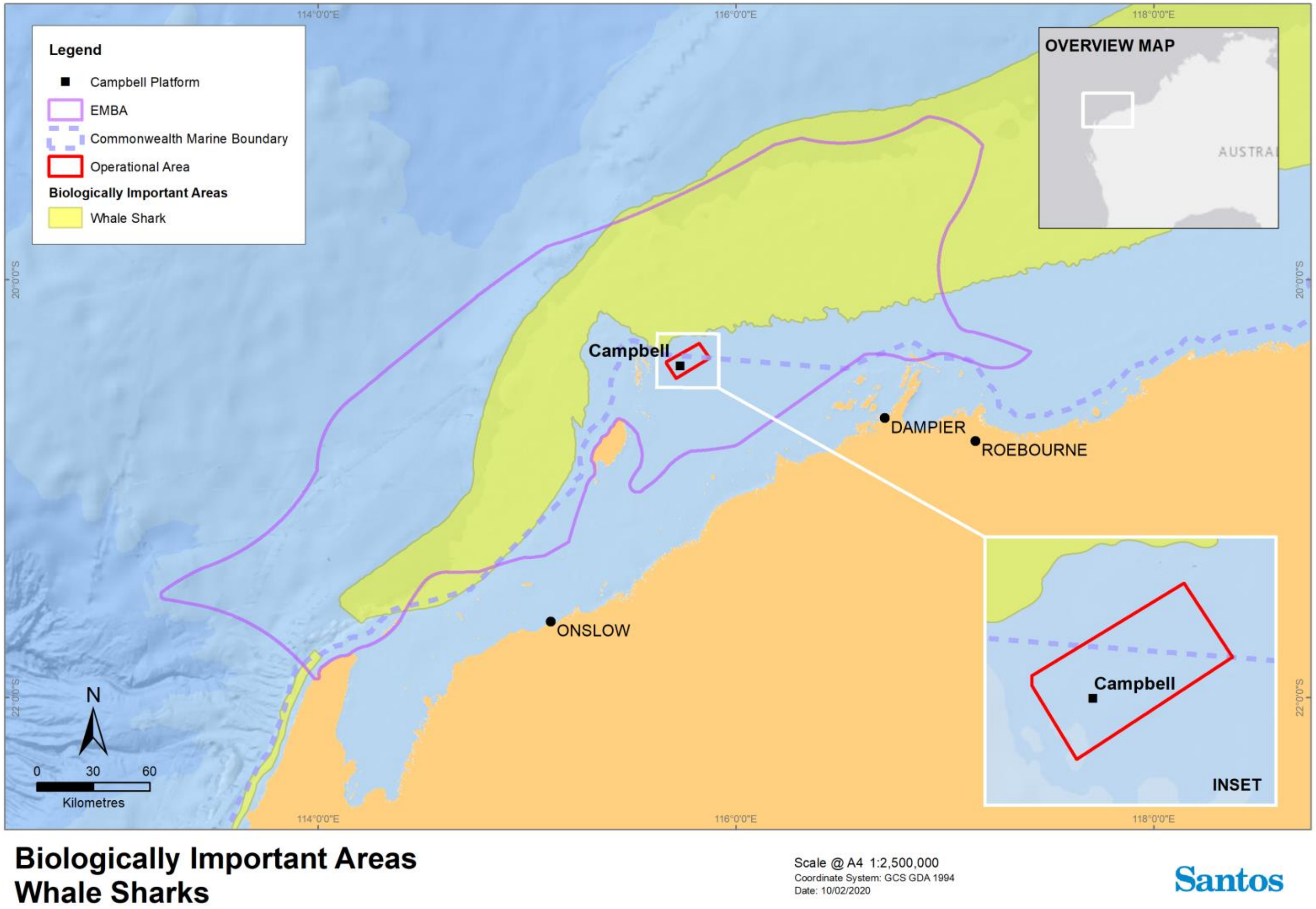


Figure 3-11: Biologically important areas for EPBC Protected whale sharks within the vicinity of the EMBA and operational area

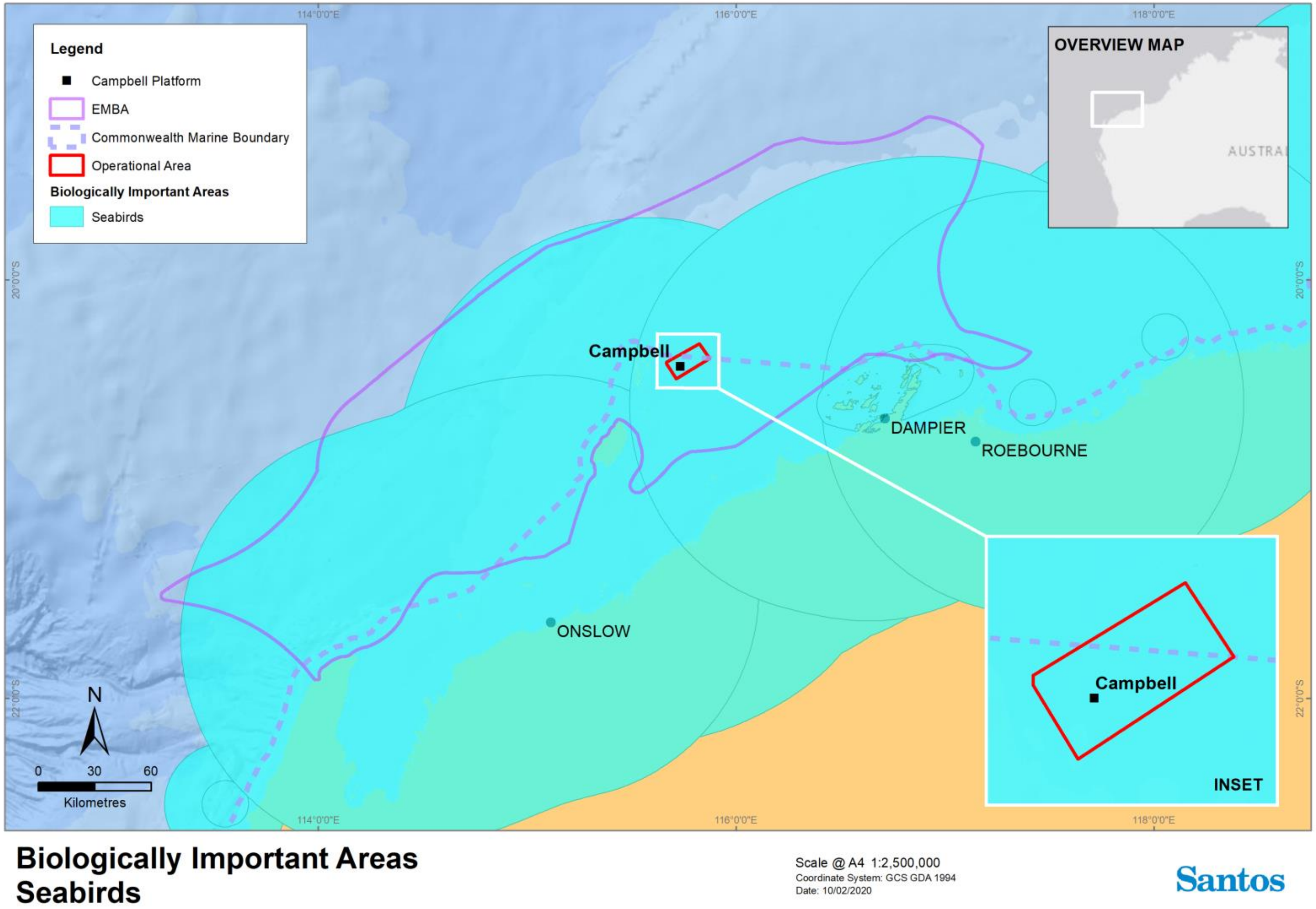


Figure 3-12: Biologically important areas for EPBC Protected seabird species within the vicinity of the EMBA and operational area

3.2.3.2 Terrestrial/subterranean fauna

The combined spill trajectory area for the worst-case accidental hydrocarbon release during the vessel survey encompasses offshore islands, however hydrocarbons will be limited to the contact margins of these islands. The PMST for the EMBA identified 11 terrestrial and two subterranean LTS as having the potential to occur within the EMBA, however these species are not expected to be impacted due to their terrestrial habitat and are therefore not discussed further.

3.2.3.3 Recovery Plans

Recovery Plans set out the research and management actions necessary to stop the decline of and support the recovery of LTS. **Table 3-5** summarises the actions relevant to the activity with more information on the specific requirements of the relevant plans of management (including Conservation Advices and Conservation Management Plans) that would be applicable to the installation activity and demonstrates where current management requirements have been considered.

Table 3-5: Threats and strategies from Recovery Plans, Conservation Advice and Management Plans relevant to the activity

Receptor	Name	Recovery Plan/Conservation Advice/Management Plan	Threats/strategies identified as relevant to the activity	Addressed (where relevant) in EP Section
All	All vertebrate fauna	Threat Abatement Plan for Impacts of Marine Debris on Vertebrate wildlife of Australia's coasts and oceans (DoEE, 2018)	Marine debris	7.1 and 7.3
Fish and Sharks	Dwarf sawfish	Sawfish and River Sharks Multispecies Recovery Plan (2015)	Habitat degradation and modification	6.4, 7.1 – 7.4
	Green sawfish	Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) (2008)	Habitat degradation and modification	6.4, 7.1 – 7.4
		Sawfish and River Sharks Multispecies Recovery Plan (2015)		
	Narrow Sawfish	Sawfish and River Sharks Multispecies Recovery Plan (2015)	Habitat degradation and modification	6.4, 7.1 – 7.4
	Great white shark	Recovery plan for the White Shark (*Carcharodon carcharias*) (2013)	Ecosystem effects as a result of habitat modification and climate change	6.4, 7.1 – 7.4
	Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (2014)	Pollution and disease	6.6
			Ecosystem effects - habitat modification and climate change	6.4, 7.1 – 7.4
	Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015)	Boat strike from large vessels	7.3
			Habitat disruption from mineral exploration, production and transportation	6.4, 7.1 – 7.4
Mammals	Blue whale	Blue Whale Conservation Management Plan 2015 - 2025 (2015)	Noise interference	6.1
			Habitat modification	6.4
			Vessel disturbance	6.5 and 7.3
	Southern right whale		Vessel disturbance	6.5 and 7.3

		Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012)	Habitat modification	7.4
			Noise interference	6.1
			Entanglement (marine debris)	7.3
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015)	Habitat degradation including pollution (increasing port expansion and coastal development)	6.4, 7.1 – 7.4
			Pollution (persistent toxic pollutants)	7.1 - 7.4
			Noise interference	6.1
			Vessel strike	7.3
	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015)	Habitat degradation including pollution (increasing port expansion and coastal development)	6.4, 7.1 – 7.4
			Pollution (persistent toxic pollutants)	7.1 - 7.4
			Vessel strike	7.3
	Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)	Noise interference	6.1
			Habitat degradation including coastal development and port expansion	6.7
Reptiles	All marine turtles	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020)	Light pollution	6.2
	Loggerhead turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017)	Marine debris	7.4
			Vessel disturbance	6.1 and 7.3
			Light Pollution	6.2
	Green turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017)	Deteriorating water quality	6.6
			Marine debris	7.4
			Vessel disturbance	6.1 and 7.3

Santos

			Light Pollution	6.2
	Leatherback turtle	Commonwealth Conservation Advice on *Dermochelys coriacea* (2008)	Boat strike	7.3
			Changes to breeding sites	7.1 - 7.4
		Recovery plan for marine turtles in Australia ((Commonwealth of Australia 2017)	Deteriorating water quality	6.6, 7.1 - 7.4
			Marine debris	7.4
			Loss of habitat	7.1 – 7.4
			Vessel disturbance	6.1 and 7.3
			Light Pollution	6.2
	Hawksbill turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017)	Deteriorating water quality	6.6
			Marine debris	7.4
			Loss of habitat	6.4, 7.1 – 7.4
			Vessel disturbance	6.1 and 7.3
			Light Pollution	6.2
	Flatback turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (Commonwealth of Australia 2017)	Deteriorating water quality	6.6
			Marine debris	7.4
			Loss of habitat	6.4, 7.1 – 7.4
			Vessel disturbance	6.1 and 7.3
			Light pollution	6.2
Birds	All seabirds and shorebirds	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020)	Light pollution	6.2
	Australian fairy tern	Commonwealth Conservation Advice on *Sternula nereis nereis* (Fairy Tern) (2011)	Oil spills, particularly in Victoria	7.1 – 7.4
	Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (2015)	Habitat loss and degradation from pollution	7.1 – 7.4

	Eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (2015)	Habitat loss and degradation from pollution	7.1 – 7.4
	Red knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (2016)	Pollution/contamination impacts	7.1 – 7.4
			Disturbance	6.1
			Habitat loss and degradation	7.1 – 7.4
	Southern giant-petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Marine pollution	7.1 – 7.4
	Soft-Plumaged Petrel	Approved Conservation Advice for *Pterodroma Mollis* (soft-plumaged Petrel) (2015)	Habitat loss disturbance and modifications	7.1 – 7.4
	Northern Siberian Bar-tailed Godwit	Conservation Advice *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian))	Habitat loss disturbance and modifications	7.1 – 7.4
	Australian Painted Snipe	Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (2013)	Habitat loss disturbance and modifications	7.1 – 7.4
Protected Areas	Montebello Islands Marine Park	Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007–2017.	Encourage a policy of zero discharge where alternatives to discharge exist	6.6
			Develop and enforce controls on the discharge of sewage from vessels in the reserves, including the prohibition of discharge in areas designated ‘Zone 1’	6.6
			Ensure relevant industry activities are undertaken at times and places that do not conflict with humpback whale migration through the reserves	6 and 7
			Maintain records of the incidence of entanglement, boat collisions and stranding of marine mammals in the reserves	8
			Maintain a database of turtle mortality and incidents of entanglement in the reserves	8

			Ensure that important seabird and shorebird breeding and feeding areas are not significantly affected by human activities	6 and 7

3.2.4 Socio-economic receptors

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 consideration are provided in **Appendix B - Description of the Existing Environment**.

Table 3-6: Summary of socio-economic activities that may occur within the operational area

Value/ sensitivity	Description	Operational area presence	Relevant events within operational area	Relevant events within EMBA
Commercial fisheries - Commonwealth	Three Commonwealth fisheries overlap the operational area: the Western Tuna and Billfish Fishery, Southern Bluefin Tuna Fishery, and the Western Skipjack Tuna Fishery (**Table 3-8**). Since 2005, there has been fewer than five vessels active in the Western Tuna and Billfish Fishery, down from 50 active vessels in 2000 (ABARES Fishery Status Reports, 2010). Southern Bluefin Tuna Fishery is only active in waters offshore South and South Eastern Australia, confirmed in consultation with the Australia Southern Bluefin Tuna Association for previous company offshore activities (ABARES Fishery Status Reports, 2018). There has been no fishing effort in the Skipjack Tuna Fishery since the 2009 season, and in that season, activity concentrated off South Australia (ABARES Fishery Status Reports, 2018).	✓	Planned Interaction with other marine users (**Section 6.5**)	Unplanned Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Commercial fisheries - State	State fisheries that intersect the operational area are the Pilbara Trap, Line, Developmental Crab and Fish Trawl Managed Fisheries; the Mackerel Managed Fishery Area 2; Western Australian Pearl Oyster Fishery; Marine Aquarium Fish Managed Fishery; Specimen Shell Managed Fishery; South West Coast Salmon Managed Fishery; Western Australian Abalone Managed Fishery; West Coast Deep Sea Crustacean Managed Fishery; and the Onslow Prawn Limited Entry Fishery (**Table 3-8**). A number of fisheries are open within the operational area and EMBA, but they do not have activity in	✓	Planned Interaction with other marine users (**Section 6.5**)	Unplanned Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)

Value/ sensitivity	Description	Operational area presence	Relevant events within operational area	Relevant events within EMBA
	this area. These are the Nickol Bay Prawn Managed Fishery, Exmouth Gulf Prawn Managed Fishery, WA Sea Cucumber Fishery and West Coast Rock Lobster Managed Fishery.			
Shipping	Shipping using North West Shelf (NWS) waters includes iron ore carriers, LNG and oil tankers and other vessels proceeding to or from the ports of Barrow Island, Varanus Island, Dampier, Port Walcott and Port Hedland. The proposed operational area does not overlap any major shipping lanes (>10 km away), although vessel traffic may be encountered throughout the operational area as commercial vessels transit around the Montebello Islands and support vessel(s) conduct operations with the offshore infrastructure (**Figure 3-16**).	✓	<u>Planned</u> Interaction with other marine users (**Section 6.5**)	<u>Unplanned</u> Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Recreational fishing	Within the operational area, there are no known natural seabed features that would aggregate fishes and which are typically targeted by recreational fishers. It is unlikely recreational fishing would occur in the operational area, but it may occur in around the nearby Montebello Islands. Recreational fishing does occur within the EMBA, and therefore could be impacted by a spill arising from a vessel collision.	X	N/A	<u>Unplanned</u> Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Defence	In consultation, Department of Defence has advised no concerns with this proposed activity.	X	N/A	N/A
Shipwrecks	Thirteen (19) historic shipwrecks (>75 years) old are found within the EMBA. One shipwreck intersects the operational area near the mainland coast: *Macey's Wreck Unidentified*. The year the shipwreck was stranded is not recorded.	X	<u>Planned</u> Interaction with other marine users (**Section 6.5**)	<u>Unplanned</u> Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Oil and gas	Various petroleum exploration and production activities have been undertaken within the northwest	X	<u>Planned</u>	<u>Unplanned</u> Unplanned hydrocarbon spills

Value/ sensitivity	Description	Operational area presence	Relevant events within operational area	Relevant events within EMBA
	shelf. Vessels servicing oil and gas operations in the region may pass through the area en route to facilities, which is discussed under 'Shipping' above. Oil and gas facilities and permits are present within the EMBA, operated by other titleholders. As such, oil and gas activities could be impacted by unplanned events.		Interaction with other marine users (**Section 6.5**)	(**Sections 7.1 – 7.4**)
Tourism	Aquatic recreational activities such as boating, diving and fishing occur near the coast and Montebello Islands. These activities are concentrated in the vicinity of the population centres such as Exmouth, Dampier and Onslow. Planned events are not predicted to have a significant impact on tourism given that the majority of operational activities occur at a greater water depth than aquatic recreational activities. The EMBA overlaps a portion with the Montebello Marine Park and also the Barrow Island Marine Park. As such, eco-tourism based on specific local values (whale sharks, game fish, nearshore reef snorkelling and diving) could be impacted by unplanned events.	X	N/A	<u>Unplanned</u> Unplanned hydrocarbon spills (**Sections 7.1 – 7.4**)
Cultural Heritage	No known sites of Aboriginal Heritage significance occur within the operational area. However, there are three known heritage sites that occur within the EMBA. A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Inquiry System was undertaken and indicated there are three registered sites recorded, including middens, burial, ceremonial, artefacts, rock shelters, mythological and engraving sites recorded on the Montebello and Legendre Islands. No known sites of Cultural Heritage significance or National Heritage places exist within the EMBA.	X	N/A	N/A

3.2.4.1 Commercial fisheries

Commonwealth and State fisheries overlapping with the operational area and the EMBA are illustrated in **Figure 3-13** and **Figure 3-14** respectively. **Table 3-7** describes each of these fisheries and indicates which events associated with the activity may impact on these.

Consultation with the Department of Primary Industries and Regional Development has previously identified commercial fishing interests that exist in, or in close proximity to, proposed activities under this EP. This includes commercial fisheries identified within **Table 3-7**. This consultation also identified key fish species that may be aggregating/spawning within the EMBA. This information is provided, together with other key periods of sensitivity for socio-economic receptors, in **Section 3.2.5.**

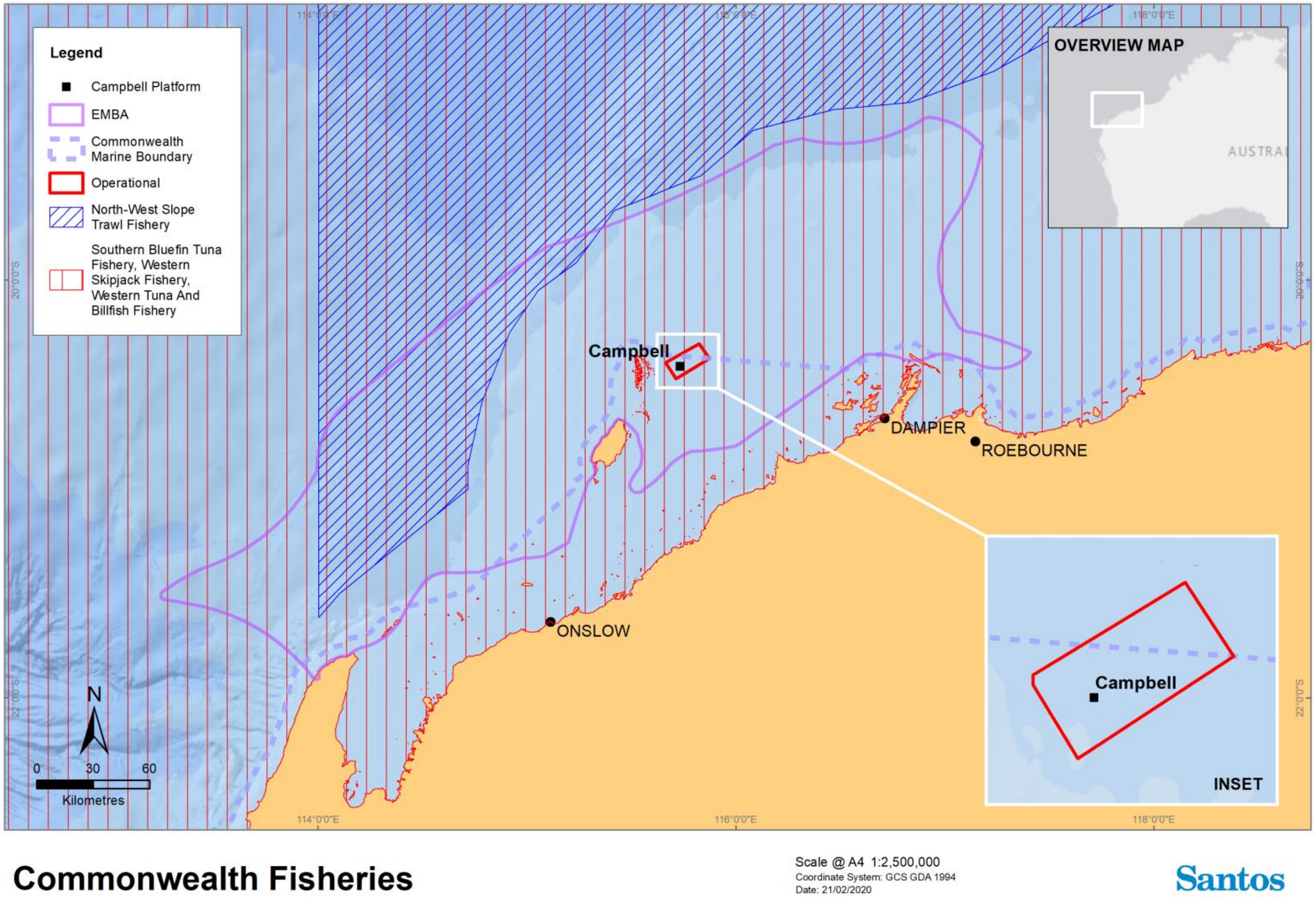


Figure 3-13: Commonwealth Commercial Fishing Zones within the EMBA and operational area

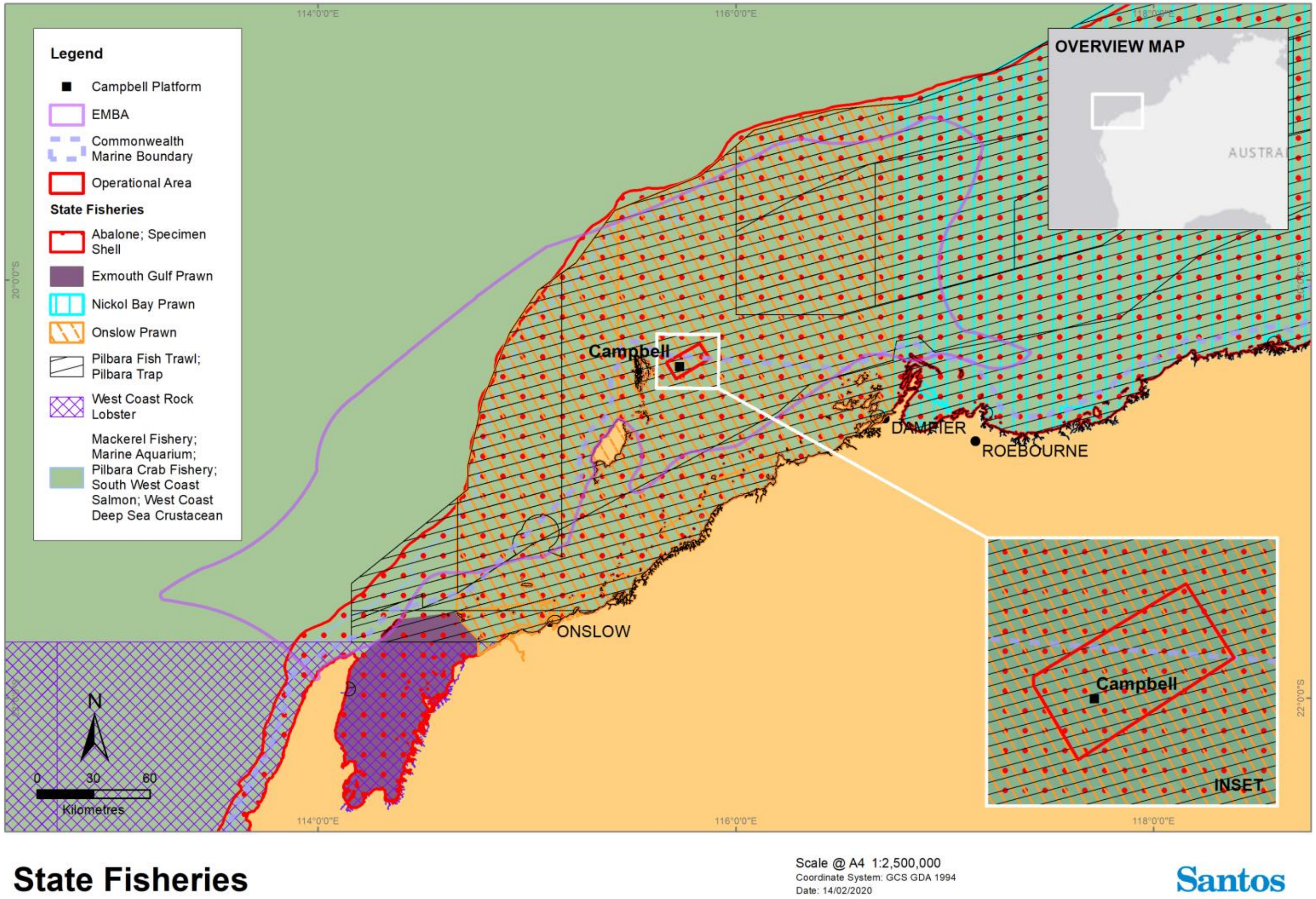


Figure 3-14: State Commercial Fishing Zones within the EMBA and operational area

Table 3-7: State and Commonwealth fisheries in the vicinity of the operational area and EMBA

Value/sensitivity	Description	Operational area overlaps Fishery boundary	EMBA overlaps Fishery boundary	Fishing activity within the operational area and EMBA
Commonwealth Managed Fisheries				
Western Tuna and Billfish Fishery	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. No current effort on NWS.	✓	✓	No active commercial fishing within the area in the past years. However, fishing vessels could be encountered in low density.
Western Skipjack Tuna Fishery	No current effort on NWS.	✓	✓	
Southern Bluefin Tuna	No current effort on NWS.	✓	✓	
Western Deepwater Trawl Fishery	Demersal trawl seaward of the 200 m isobaths. No recent fishing activity.	X	✓	
North West Slope Trawl	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).	X	✓	Historical effort within the EMBA, targeting scampi and prawns
State Managed Fisheries				
Onslow Prawn Limited Entry Fishery	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.	✓	✓	Significant disruption unlikely to occur due to vast area fished.
Pilbara Demersal Scalefish Fisheries (includes trap, trawl and line fisheries)	Use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The Trawl Fishery lands the largest component of the catch of demersal finfish in the Pilbara (and North Coast Bioregion), comprising more	✓	✓	Disruption to fishing activities is possible but not expected. Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, but the likelihood of these events is low.

Value/sensitivity	Description	Operational area overlaps Fishery boundary	EMBA overlaps Fishery boundary	Fishing activity within the operational area and EMBA
	than 50 scalefish species. In comparison, the trap fishery retains a subset of about 45 to 50 scalefish species, and while the Line Fishery catch comprises a similar number, it also includes some deeper offshore species. Line fishing for a variety of demersal scalefish between the 30 m isobath and 200 m isobath			
Pilbara Developmental Crab Fishery	Crabbing activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around Nickol Bay (DoF, 2015).	✓	✓	Disruption to fishing activities unlikely given fisheries operations are typically north of the operational area. Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.
Western Australian Pearl Oyster Fishery	Drift diving in depths up to 35 m	✓	✓	Disruption to fishing activities unlikely given water depths fisheries operate within. Nine aquaculture licences for pearl oysters occur within the EMBA, with 14 pearl farm leases occurring at the Montebello Islands. Unplanned events which may occur in the EMBA could disrupt fishing activities or aquaculture, but the likelihood of these events is low.
Exmouth Gulf Prawn Managed Fishery	Low opening otter trawls occurring in the sheltered waters of Exmouth Gulf, west to the Muiron Islands and north to Serrurier Island	X	✓	Disruption to fishing activities unlikely given boundaries that fisheries operate within. Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.

Value/sensitivity	Description	Operational area overlaps Fishery boundary	EMBA overlaps Fishery boundary	Fishing activity within the operational area and EMBA
West Coast Rock Lobster Managed Fishery	Baited traps, pots and diving (recreationally)	X	✓	Disruption to fishing activities unlikely given water depths fisheries operate within. Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.
State Managed Fisheries (Whole of State)				
Marine Aquarium Fish Fishery	All year. Effort within the operational area and EMBA is unknown, but is unlikely due to the depth and the dive-based method of collection	✓	✓	Disruption to fishing activities unlikely given water depths fisheries operate within. Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.
Specimen Shell Managed Fishery	All year. Effort within the operational area and EMBA is unknown, but it is unlikely due to the depth and the dive-based method of collection. Unlikely to occur.	✓	✓	
Western Australian Sea Cucumber Fishery (Beche-de-mer Fishery)	All year. Although permitted to fish within the operational area and EMBA, the fishery is restricted to shallow coastal waters suitable for diving and wading. Unlikely to occur.	X	✓	
Mackerel Managed Fishery	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands.	✓	✓	The majority of the catch is taken in the Kimberley Area and north of Port Headland, therefore disruption is unlikely.
South West Coast Salmon Managed Fishery	Beach Seine nets. Fishing on coastal beaches.	✓	✓	No fishing boats operate north of the Perth metropolitan area, so disruption is unlikely.
Western Australian Abalone Managed Fishery	All year. Although permitted to fish within the operational area and EMBA, the fishery is restricted to shallow coastal	✓	✓	Disruption to fishing activities unlikely given water depths fisheries operate within.

Value/sensitivity	Description	Operational area overlaps Fishery boundary	EMBA overlaps Fishery boundary	Fishing activity within the operational area and EMBA
	waters suitable for diving and wading. Unlikely to occur			Unplanned events which may occur in the EMBA could disrupt fishing activities, but the likelihood of these events is low.
West Coast Deep Sea Crustacean Managed Fishery	Baited pots on vessels in a longline formation on shelf edge waters that are greater than 150 m deep.	✓	✓	
Nickol Bay Prawn Managed Fishery	Vessels will target species in <45 water depth.	X	✓	Disruption to fishing activities is possible but not expected. Unplanned events which may occur in the operational area and EMBA could disrupt fishing activities, but the likelihood of these events is low.

3.2.4.2 Recreational fisheries

The operational area and EMBA are located within the North Coast Bioregion, which is a focal point for winter recreational fishing and is a key component of many tourist visits. The Dampier Archipelago, Lowendal Islands and Montebello Islands are popular offshore recreational fishing locations.

The predominant target species include the tropical species such as tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, cods and catfish, and invertebrate species including blue swimmer crabs, mud crabs and squid. The offshore islands, coral reefs and continental shelf waters contain other species such as tropical snappers, cod, mackerel, sharks and tunas for recreational fishing opportunities (WAFIC 2016). The operational area does not overlap any of these mentioned fishing locations.

3.2.4.3 Petroleum industry

Santos' Campbell platform is located within the operational area in 40 m water depth. The unmanned monopod structure has ceased production activity and production flowlines are disconnected and blanked, with no hazardous substance inventory on board. The similarly designed and disconnected Sinbad platform is located to the south of the operational area with further facilities of the Harriet Joint Venture to the south as shown in **Figure 3-15**. In the EMBA, there are several exploration and production permits and leases throughout the Western Australian and Commonwealth waters which include current exploration and production activities including platforms, floating, production, storage and offloading (FPSOs), pipelines, drilling and potentially seismic activities. There are also onshore production facilities on Varanus Island and Barrow Islands .

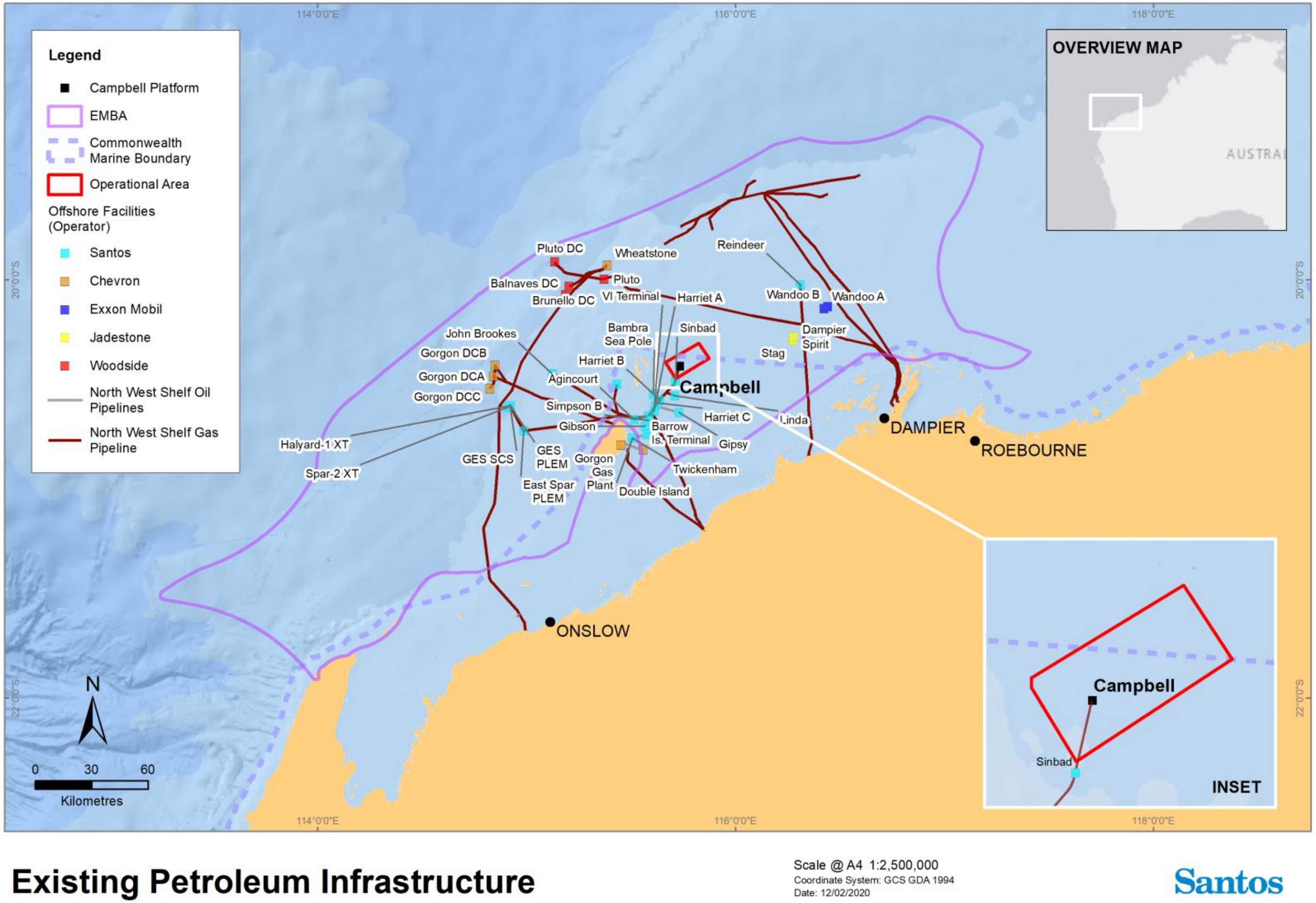


Figure 3-15: Existing petroleum infrastructure within the EMBA

3.2.4.4 Shipping

It is highly unlikely that shipping vessels will move through the operational area. However, large commercial vessels mostly associated with the oil and gas industry and Western Australian major ports move through the EMBA in transit.

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 2019). AMSA shipping routes within and in close proximity to the operational area and EMBA are shown in **Figure 3-16**.

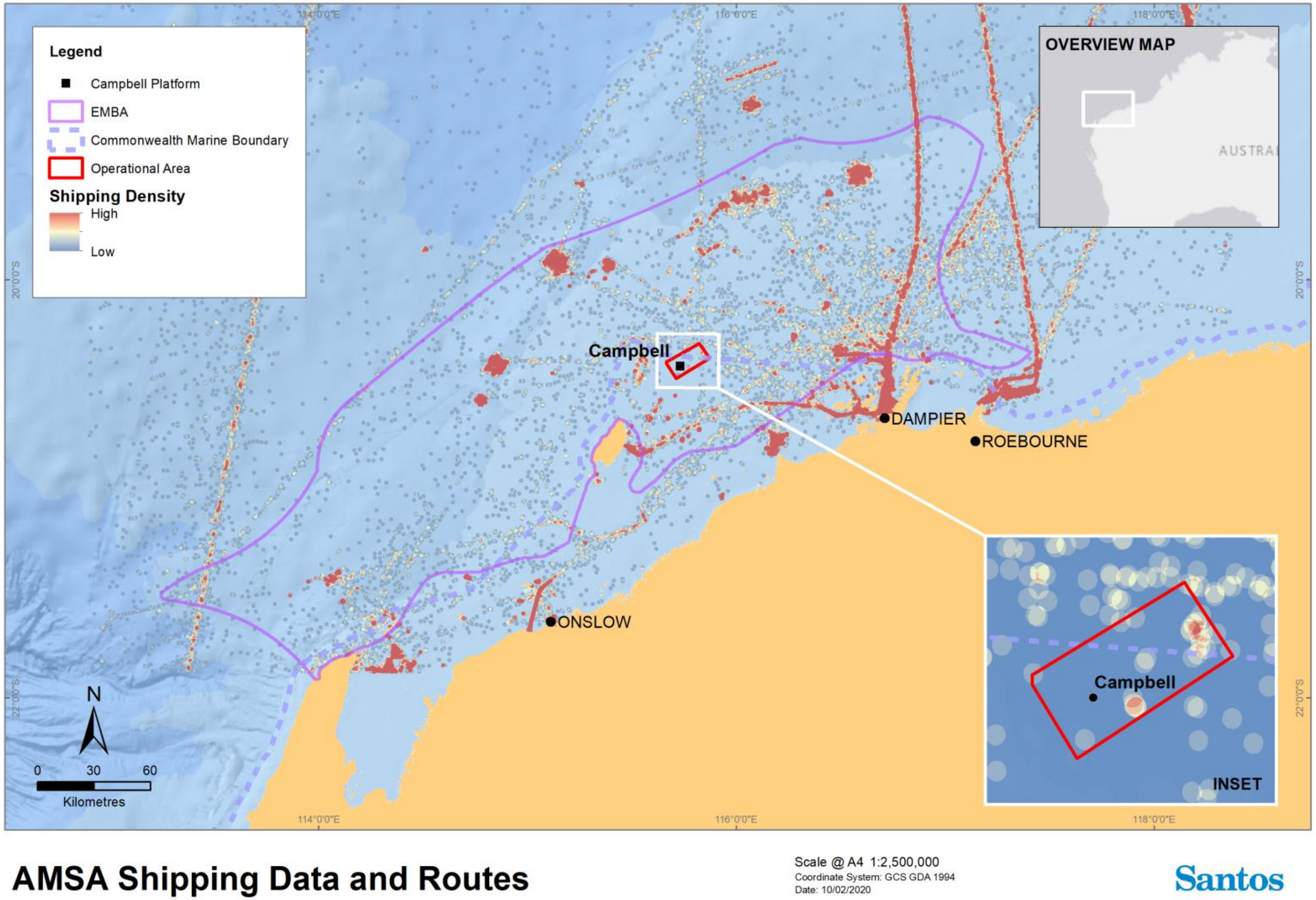


Figure *3-16*: AMSA ship locations and shipping routes within and close to the EMBA (September 2019)

3.2.4.5 Tourism

Tourism activities occur within the EMBA in areas such as Ningaloo Marine Park, North West Cape, Montebello Islands and the Dampier Archipelago. Popular water-based activities that may occur within the EMBA include fishing, swimming, snorkelling/diving, surfing/windsurfing/kiting and boating.

Seasonal nature-based tourism such as humpback whale watching, whale shark encounters and tours of turtle hatching mainly occurring around Ningaloo Reef and Cape Range National Park. 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 nearest area where recreation is likely to occur is the Montebello Islands, which are located approximately 7 km from the operational area. Given the water depths of the operational area and the lack of notable seabed features, there is unlikely to be any tourism-based activities in the surrounding waters of the operational area, however there could be seasonal tourism such as whale watching and fishing charters.

3.2.5 Windows of sensitivity

Timing of peak activity for threatened species and other relevant, significant sensitivities is given in **Table 3-8**.

Table 3-8: Windows of sensitivity in the vicinity of the EMBA

Receptors (critical life cycle stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
All shoreline habitats												
Coral (spawning periods)												
Macroalgae	growing				shedding fronds				growing			
Other benthic and terrestrial habitats												
Fish/Sharks and fisheries species												
Whale sharks			Aggregations at Ningaloo Coast									
Fisheries species spawning/aggregation times [1]												
Marine Mammals												
Dugong (breeding)	breeding								breeding			
Humpback whale (migration)						northern			southern			
Blue whale (migration)					northern						southern	
Marine Reptiles												
Hawksbill turtle's resident adult and juveniles[2]	Widespread throughout NWS waters, highest density of adults and juveniles over hard bottom habitat (coral reef, rocky reef, pipelines, etc.)											
Hawksbill turtle (mating aggregations[2])												
Hawksbill turtle (nesting and internesting[2])												
Hawksbill turtle (hatching[1])												
Flatback turtles (resident adult and juveniles[2])	Widespread throughout NWS waters, increased density over soft bottom habitat 10 – 60m deep, post hatchling age classes and juveniles spread across shelf waters											
Flatback turtle (mating aggregations[2])												
Flatback turtle (nesting and internesting[2])												

Receptors (critical life cycle stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Flatback turtle (hatching[2])												
Flatback turtle (nesting[2])												
Green turtles (resident adult and juveniles[2])	Widespread throughout the NWS waters, highest density associated with seagrass beds and macro algae communities, high density juveniles in shallow waters off beaches, amongst mangroves and in creeks											
Green turtle (mating aggregations[2])												
Green turtle nesting and internesting[2])												
Green turtle (hatching[2])												
Loggerhead turtles (resident adult and juveniles[2])	Widespread throughout the NWS waters, increased density associated with soft bottom habitat supporting their bivalve food source, juveniles associated with nearshore reef habitat											
Loggerhead turtle (mating aggregations[2])												
Loggerhead turtle (nesting and internesting[2])												
Loggerhead turtle (hatching[2])												
Leatherback turtles	Can occur at low density across the NWS year-round											
Short-nosed seasnake	Can occur at low density across the NWS year-round											
Seabirds												
Terns, shearwaters, petrels (nesting)												
Commercial Managed Fisheries												
Oil and gas												
Shipping												
Tourism/ recreational												
KEY / NOTES												
	Peak activity, presence reliable and predictable					[1] Information provided from Department of Fisheries consultation						

Receptors (critical life cycle stages)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

(yellow)	Lower level of abundance/activity/presence	[2] Information provided by K. Pendoley
(white)	Very low activity/presence	
(grey)	Activity can occur throughout year	
(green)	Proposed timing of activity	

Santos

4 Stakeholder consultation

OPGGS(E)R 2009 Requirements
Regulation 9AB
If the Regulator's provisional decision under regulation 9AA is that the environment plan includes material apparently addressing all the provisions of Division 2.3 (Contents of an environment plan), the Regulator must publish on the Regulator's website as soon as practicable: (a) the plan with the sensitive information part removed; and (b) the name of the titleholder who submitted the plan; and (c) a description of the activity or stage of the activity to which the plan relates; and (d) the location of the activity; and (e) a link or other reference to the place where the accepted offshore project proposal (if any) is published; and (f) details of the titleholder's nominated liaison person for the activity.
Regulation 14(9)
The implementation strategy must provide for appropriate consultation with: (a) relevant authorities of the Commonwealth, a State or Territory; and (b) other relevant interested persons or organisations.
Regulation 16
The environment plan must contain the following: (b) report on all consultations between the operator and any relevant person, for regulation 11A, that contains: (i) a summary of each response made by a relevant person; and (ii) an assessment of the merits of any objection or claim about the adverse impact of each activity to which the environment plan relates; and (iii) a statement of the operator's response, or proposed response, if any, to each objection or claim; and (iv) a copy of the full text of any response by a relevant person.

P(SL)(E)R 2012
Regulation 17 (1)
The environment plan must include the following — (b) a report on all consultations between the operator and relevant authorities and other relevant interested persons and organisations in the course of developing the environment plan.

4.1 Summary

Santos has been active in the Varanus Island Hub for many years and has a number of operating facilities in the region. With this history, Santos is familiar with local community stakeholders and other users of the marine environment in the region.

Stakeholders were informed of activities covered in this EP via several channels of engagement commencing in January 2020, including:

- Santos' *Quarterly Consultation Update* distributed to the company's wider stakeholder cohort;
- WA-499-P Exploration Drilling and Site Survey Program Consultation package distributed to identified stakeholders;
- Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package distributed to identified fishing licence holders.

Based on Santos' experience with the Corvus-2 exploration drilling program conducted in 2019, and from subsequent stakeholder feedback and regulator discussions, the primary stakeholder issues of concern for this activity are:

- baseline survey data on the important ecological values of these areas (addressed in **Section 3.2.1**); and
- interaction with other marine users and commercial fishers addressed i**n Section 3.2.4**).

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

Santos considers that consultation with relevant stakeholders has been adequate to inform the development of this EP. Notwithstanding this, Santos recognises the importance of ongoing stakeholder consultation and notification and these are described in **Table 8-2** and **Section 4.5.**

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 and specifically the Corvus-2 drilling program. The list of stakeholders was then reviewed and refined based on the defined operational area (refer to **Section 2.2**), the EMBA (refer to **Section 7.4.1**) 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.);
- Evaluation of Department of Primary Industries and Regional Development (DPIRD) Fish Cube data.
- Updated fishing licence holder contact details, from these identified fisheries, as provided by DPIRD;
- Utilisation of the WAFIC Oil and Gas consultation services to advise on 'relevant' commercial fisheries and fishers, and to review and distribute fishery-specific consultation material;
- Discussions with identified stakeholders to identify other potentially impacted persons;
- Active participation in industry bodies and collaborations (e.g., APPEA, AMOSC, NERA); and
- Records from previous consultation activities in the area.

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

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

Stakeholder	Relevant to Activity	Relevance/ Reason for Engagement
Commonwealth government departments/agencies		
Australian Hydrographic Office (AHO)	Considered relevant persons under Regulation 11A(1) (a)	The AHO is the part of the Commonwealth DoD responsible for maintaining and disseminating nautical charts, including the distribution of Notice to Mariners. The operational area is in commonwealth waters.
Australian Maritime Safety Authority (AMSA)	Considered relevant persons under Regulation 11A(1) (a)	AMSA is the statutory and control agency for maritime safety and vessel emergencies in Commonwealth Waters. AMSA is a relevant agency when proposed offshore activities may impact on the safe navigation of commercial shipping in Australian waters. The operational area is in commonwealth waters.
Department of Defence (DoD)	Considered relevant persons under Regulation 11A(1) (a)	DoD is a relevant agency where the proposed activity may impact operational requirements; encroach on known training areas and/or restricted airspace, or when nautical products or other maritime safety information is required to be updated. The operational area is in commonwealth waters.
Australian Fisheries Management Authority (AFMA)	Considered relevant persons under Regulation 11A(1) (a)	AFMA is responsible for managing Commonwealth fisheries and is a relevant agency where the activity has the potential to impact on fisheries resources in AFMA managed fisheries. The operational area intersects with commonwealth managed fisheries.
Department of Agriculture and Water Resources (DAWR) – Biosecurity (marine pests)	Considered relevant persons under Regulation 11A(1) (a)	The DAWR (marine pests) has primary policy and regulatory responsibility for managing biosecurity for incoming goods and conveyances, including biosecurity for marine pests. The Department is the relevant agency where an offshore activity has the potential to transfer marine pests between installations and mainland Australia. The operational area is in commonwealth waters.
Department of Agriculture and Water Resources (DAWR) – Fisheries	Considered relevant persons under Regulation 11A(1) (a)	DAWR (fisheries) has primary policy responsibility for promoting the biological, economic and social sustainability of Australian fisheries. The Department is the relevant agency where the activity has the potential to negatively impact fishing operations and / or fishing habitats in Commonwealth waters. The operational area intersects with commonwealth managed fisheries.
Department of Agriculture and Water Resources (DAWR) –Biosecurity (vessels, aircraft and personnel)	Considered relevant persons under Regulation 11A(1) (a)	DAWR (vessels and aircraft) has inspection and reporting requirements to ensure that all conveyances (vessels, installations and aircraft) arriving in Australian territory comply with international health regulations and that any biosecurity risk is managed. The department is the relevant agency where the titleholder's activity involves:

Stakeholder	Relevant to Activity	Relevance/ Reason for Engagement
Commonwealth government departments/agencies		
		• the movement of aircraft or vessels between Australia and offshore petroleum activities either inside or outside Australian territory • the exposure of an aircraft or vessel (which leaves Australian territory not subject to biosecurity control) to offshore petroleum activities.
Director of National Parks (DoNP)	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 activities proposed to occur outside a reserve may impact on the values within a Commonwealth marine reserve.
Department of Foreign Affairs and Trade (DFAT)	Considered relevant persons under Regulation 11A(1) (a	DFAT has no direct role in the management of commonwealth marine waters, but may be consulted where a proposed activity poses any oil spill or other environmental risks that could result in impacts to other international jurisdictions
State government departments/agencies		
Department of Transport (DoT)	Considered relevant persons under Regulation 11A(1) (b)	DoT is the control agency for marine pollution emergencies in State waters.
Department of Primary Industries and Regional Development (DPIRD)	Considered relevant persons under Regulation 11A(1) (b)	DPIRD is responsible for managed West Australian State fisheries. The operational area intersects with state managed fisheries.
Department of Biodiversity, Conservation and Attractions (DBCA)	Considered relevant persons under Regulation 11A(1) (b)	DBCA is a relevant State agency responsible for the management of State marine parks and reserves and protected marine fauna and flora. The operational area is adjacent to state marine reserves.
Department of Mines, Industry Regulation and Safety (DMIRS)	Considered relevant persons under Regulation 11A(1) (c)	Department responsible for the management of offshore petroleum in the adjacent State waters.
Neighbouring operators / exploration companies		
Chevron	Considered relevant persons under Regulation 11A(1) (e)	Chevron is listed as the titleholder of an adjacent petroleum permit.
Industry Bodies		
Western Australian Fishing Industry Council (WAFIC)	Considered relevant persons under Regulation 11A(1) (e)	WAFIC is the peak industry body representing the interests of the WA commercial fishing, pearling and aquaculture sector. The operational area intersects with several State-managed fisheries.
Commonwealth Fisheries Association (CFA)	Considered relevant persons under Regulation 11A(1) (e)	The CFA was engaged as a representative body for Commonwealth fisheries. The operational area intersects with a number of Commonwealth-managed fisheries. The CFA is also listed on the AFMA website

Stakeholder	Relevant to Activity	Relevance/ Reason for Engagement
Commonwealth government departments/agencies		
		as a contact for petroleum operators to use when consultation with fishing operators is required.
Marine Tourism WA (MTWA)	Considered relevant persons under Regulation 11A(1) (e)	MTWA represents the charter sector in WA. Charter fishing may occur within the proposed area of activity. MTWA is identified as being able to assist in reaching its membership to inform them of activity timing should this be requested.
Pearl Producers Association (PPA)	Considered relevant persons under Regulation 11A(1) (e)	The PPA is the peak representative organisation of The Australian South Sea Pearling Industry. PPA membership includes all *Pinctada maxima* pearl oyster licensees that operate within the Australian North-west Bioregion.
Recfishwest	Considered relevant persons under Regulation 11A(1) (e)	Recfishwest is the peak body representing recreational fishers in WA. Recfishwest is identified as being able to assist in reaching its membership to inform of activity timing should this be requested.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Considered relevant persons under Regulation 11A(1) (e)	ASBTIA represents the Australian SBT industry. ASBTIA is also listed on the AFMA website as a contact for petroleum operators to use when consultation with Commonwealth fishing operators is required.
Community		
Pilbara Port Authority	Considered relevant persons under Regulation 11A(1) (e)	Pilbara Ports Authority manages port land at Dampier, Port Hedland, Ashburton and Cape Preston East, and facilitates the development of land and leases to support port-related industries. Port Hedland is the nearest port to the activity.
Commercial Fisheries		
Mackerel Managed Fishery (Area 2)	Considered relevant persons under Regulation 11A(1) (d)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Mackerel Managed Fishery (Area 2) boundary overlaps the proposed activity area and is therefore potentially impacted by the activity.
Pilbara Line Fishery	Considered relevant persons under Regulation 11A(1) (d)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Pilbara Line Fishery boundary overlaps the proposed activity area and is therefore potentially impacted by the activity.
Pilbara Trap Managed Fishery	Considered relevant persons under Regulation 11A(1) (d)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Pilbara Trap Managed Fishery boundary overlaps the proposed activity area and is therefore potentially impacted by the activity.
Pilbara Crab Managed Fishery	Considered relevant persons under Regulation 11A(1) (e)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Pilbara Crab Managed Fishery boundary overlaps the proposed activity area and is therefore potentially impacted by the activity.
Onslow Prawn Managed Fishery	Considered relevant persons under Regulation 11A(1) (e)	Based on a review of DPIRD fishery information and consultation with WAFIC, the Onslow Prawn Managed Fishery boundary overlaps the proposed activity area

Stakeholder	Relevant to Activity	Relevance/ Reason for Engagement
Commonwealth government departments/agencies		
		and is therefore potentially impacted by the activity and should be consulted.
Developmental Octopus Fishery	Considered relevant persons under Regulation 11A(1) (e)	Based on consultation with WAFIC, the Developmental Octopus Fishery boundary overlaps the proposed activity area and is therefore potentially impacted by the activity and should be consulted.

4.3 Stakeholder Consultation

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

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

Key stakeholders were contacted by phone or meeting prior to providing the *WA-499-P Exploration Drilling and Site Survey Program Stakeholder Consultation* package to increase activity awareness and to encourage two-way communication. Stakeholders, wherever possible, were provided personal emails with information tailored to their functions, interests and activities, including outlining why they have been identified as a relevant stakeholder.

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

Individual fishing licence holders, as identified through DPIRD data and in consultation with WAFIC, were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and additional fisheries maps by email (and one by post).

Commercial fishers were provided additional information which included:

+ Maps and information relevant to a specific fishery;
+ Information about the timing and duration of the activity, and
+ Information on operational area access and concurrent operations.

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

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

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 and how each of these comments has been addressed in the EP, is outlined in **Table 4-2**. Full transcripts between Santos and stakeholders are provided in a confidential submission to NOPSEMA and DMIRS.

Santos adopted the following process to address any 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 stakeholders. This included assessing all reasonably available options for resolving or mitigating the degree to which a stakeholder may be affected, particularly through the application of control measures.
- Santos responded to all stakeholder objections and claims by email and advised the stakeholder how each of their issues would be addressed in the EP.
- Santos invited the stakeholder to provide additional feedback and comment.

- As soon as possible, or on publication of the EP on the NOPSEMA website, Santos will advise any stakeholders who had made an objection or claim, where their specific objections and claims are represented in the EP and provided the appropriate cross reference in the EP to each issue raised (**Table 4-2**).
- Santos commits to addressing any additional comments received from Stakeholders.

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

Santos

Table 4-2: Consultation summary for activity

<table>
<tr><th>Stakeholder</th><th>Summary of stakeholder and titleholder correspondence, and any objections and claims made</th><th>Assessment of stakeholder objections and claims</th></tr>
<tr><td colspan="3">Commonwealth departments/agencies</td></tr>
<tr><td>Australian Hydrographic Office (AHO)</td><td>AHO was provided the WA-499-P Exploration Drilling and Site Survey Program Consultation package via email on 13 January 2020.
AHO acknowledged receipt of information on 13 January 2020.
This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.
No further response received to date.</td><td>No response has been received by the AHO.
AHO has previously requested notification once activity commences.
Santos has addressed notification requirements in Table 8-2 and Table 8-4.
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>Australian Maritime Safety Authority (AMSA)</td><td>AMSA was provided the WA-499-P Exploration Drilling and Site Survey Program Consultation package via email on 13 January 2020.
AMSA responded on 14 January 2020 advising:
a. The Master should notify AMSA's Joint Rescue Coordination Centre (JRCC) for promulgation of radio-navigation warnings at least 24-48 hours before operations commence. JRCC will also need to be advised when operations start and end.
b. Santos should contact the AHO at no less than four working weeks before operations, with details relevant to the operations. The AHO will promulgate the appropriate Notice to Mariners (NTM), which will ensure other vessels are informed of activities.
c. To obtain a vessel traffic plot showing Automatic Identification System (AIS) traffic data for your area of interest, please visit AMSA's spatial data gateway and Spatial@AMSA portal to download digital data sets and maps.
This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.
Santos followed up with this stakeholder on 20th February 2020 advising their comments have been addressed in Section 8 of the EP, which will be available in full on the NOPSEMA website on submission</td><td>Santos accepts AMSA's request to provide notification to the AMSA's JRCC and AHO and in response to each comment confirms:
a. Santos will notify AMSA's JRCC at least 24–48 hours before operations commence for each survey and advise when operations start and end.
b. Santos will notify the AHO no less than four working weeks before operations commence.
c. Santos notes the information provided on traffic data.
Notification requirements are addressed in Table 8-2 (Control Measure CM-10) and Table 8-4.
Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.</td></tr>
</table>

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
Department of Defence (DoD)	DoD was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by the DoD. DoD has previously requested AHO notifications prior to activity commencement. Santos has addressed notification requirements in **Table 8-2** and **Table 8-4**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Australian Fisheries Management Authority (AFMA)	AFMA was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by AFMA. This stakeholder has previously advised it is important to consult with all fishers who have entitlements to fish within the proposed area. This can be done through the relevant fishing industry associations or directly with fishers who hold entitlements in the area. Santos has consulted directly with relevant fishers and fishing industry associations. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5.** Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Department of Agriculture and Water Resources (DAWR) – Biosecurity (vessels, aircraft and personnel)	The department was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. The department responded on 22 January 2020 providing advice on the Australian Government's biosecurity requirements. In summary, the department advised:	Santos accepts the biosecurity requirements outlined by DAWR and in response to each comment confirms: a. Santos notes Seaports comments regarding levels of risk and eligibility for exemptions.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	a. It is our understanding that your intended operating practices may expose domestic conveyances (support vessels and aircraft) to interactions with the survey vessel which may pose an unacceptable level of biosecurity risk. Where domestic conveyances become exposed through interactions with persons, goods or conveyances outside Australian territory they automatically become subject to biosecurity control upon their return. If the department concludes that the level of biosecurity risk associated with the survey vessel is low, within the meaning of the *Biosecurity (Exposed Conveyances – Exceptions from Biosecurity Control) Determination 2016* (the Determination), an exposed conveyance may be eligible for an exception from biosecurity control. b. In order for exposed conveyances to be assessed as low risk, the offshore installation must demonstrate that it meets the requirements set out in the Determination. To have risk status assessed, offshore installation projects must apply to the department at least one month prior to project commencement. The department will work with installation representatives to assess the biosecurity risk of the installation and associated support conveyances (vessels and aircraft). c. Please review the department's *Offshore Installations webpage and associated Offshore Installations Biosecurity Guide* which provides specific biosecurity information for operators of offshore installations and notify the department where your project which may have conveyance interactions with Australian territory, or to discuss a biosecurity assessment, email seaports@agriculture.gov.au. d. Please also review Australian ballast water and biofouling requirements and pre-arrival reporting using MARS. Santos responded to the department on 12 February 2020 confirming DAWR requirements on biosecurity will be taken into consideration in the drafting of the environment plan.	b. Santos will be applying to the department following confirmation of the vessel c. Santos will ensure consideration of the biosecurity information d. Santos will ensure consideration of the ballast water and biofouling Santos has addressed the Department's Biosecurity requirements through implementation of Santos' *Invasive Marine Species Management Plan* (EA-00-RI-10172) as provided for in **Table 8-2** (control measure CM-18). Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.
Department of Agriculture and Water Resources (DAWR) – Biosecurity (marine pests)	The department was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. No response received to date.	No response has been received by the Department. Biosecurity has been addressed in **Section 7.2** and in response to comments from Department of Agriculture and Water Resources (DAWR) – Biosecurity (vessels, aircraft and personnel).

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
		Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Department of Agriculture and Water Resources (DAWR) – Fisheries	The department was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. No response received to date.	No response has been received by the Department. Santos has consulted directly with relevant fishers and fishing industry associations. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5.** Santos considers the level of consultation to be adequate and Santos will address any comments from this stakeholder should they arise in the future.
Director of National Parks (DNP)	The DNP was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. No response received to date.	No response has been received by the DNP. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
State Government Departments		
Department of Transport (DoT)	DOT was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. DoT responded on 21 January 2020 advising if there is a risk of a spill impacting State waters from the proposed activities, please ensure that the department is consulted as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018). Santos responded on 12 February 2020 confirming the department's requirements will be taken into consideration in the drafting of the EP.	Santos accepts DoTs consultation requirements and has provided DoT information requested as per the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018), prior to submission of the EP. Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	Santos sent a follow-up email to DoT on 4 March 2020 and provided a copy of the Geophysical Survey Oil Pollution Emergency Plan for the WA-499-P Site Survey Activity and corresponding Consultation Package, as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (September 2018). Santos advised DoT the OPEP and consultation package for the WA-499-P Drilling Activity will be submitted separately. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.	
Department of Primary Industries & Regional Development (DPIRD)	DPIRD was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by DPIRD. This stakeholder has previously requested that: *a. Santos consult with affected fishers and industry representative bodies.* Santos has consulted directly with relevant fishers and fishing industry associations and assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5.** *b. if there is a biosecurity risk associated with the activity please act in accordance with the Fish Resources Management Regulations 1995 (FRMR) Regulation 176(1).* Biosecurity risk controls as required under the Fish Resources Management Regulations are addressed in **Section 7.2**. c. *the suspected or confirmed presence of any organism listed on the Western Australian Prevention List for Introduced Marine Pests, and any other organism that appears to have clear negative impacts or invasive characteristics, must*

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
		be reported within 24 hours to the department. This reporting requirement is captured in **Table 8-4** Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Department of Biodiversity and Conservation Attractions (DBCA)	The DBCA was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. DBCA responded on 10 February 2020 and provided the following comments: a. There are a number of ecologically important areas including marine and terrestrial conservation reserves located in the vicinity of the proposed operations, including the Montebello Islands Marine Park and Conservation Park, and Barrow Island Marine Park, Marine Management Area and Nature Reserve. Based on the information you have provided it appears that there is potential for these areas to be affected by Santos' operations if there is a substantial hydrocarbon release and subject to particular weather or other environmental conditions. b. Given the ecological importance of areas potentially affected by a hydrocarbon release from the proposed activities, it is considered important that the baseline values and state of the potentially affected environment are appropriately understood and documented prior to any operations commencing that pose a significant risk of impacting these areas. DBCA would like to have confidence that Santos has appropriate baseline survey data on the important ecological values of these areas and any current contamination if present within the area of potential impact of spills (as identified through Santos' modelling). Following desktop review and risk assessment, Santos should collect appropriate baseline abundance and distribution data for any threatened and specially protected marine fauna species in the area of potential impact, including information on the key habitats these species use for activities like foraging, breeding and aggregating. If baseline information is not available, Santos should thoroughly assess what baseline information is required commensurate with the level of risk associated with the proposed activities, and identify suitable sources/methods to attain that information such that Santos can ensure that any impacts on ecological values and recovery of these values can be monitored and remediated. DBCA undertakes monitoring in marine parks and	Santos accepts DBCA's requirements and confirms: a. Ecologically important areas that may be impacted by proposed operations, including a substantial hydrocarbon release have been identified and described in **Section 3** and **Appendix B - Description of the Existing Environment** b. Baseline values and data are addressed in Santos' Oil Spill Scientific Monitoring Plan which has been provided separately to DBCA and is discussed further in the OPEP. c. Impacts from light emissions is discussed further in **Section 6.2**. d. Reporting requirements in the event of a spill are detailed in the OPEP e. The OPEP reflects DoT's guidance and consultation with DoT has been undertaken. Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	reserves, and regularly publishes research which can be searched on the department's website. However, Santos should be aware that this monitoring is targeted to inform DBCA's values and objectives relating to marine park management and is not necessarily suitable to provide all baseline information required for oil spill risk assessment and management planning. DBCA encourages Santos to ensure it attains all information required to implement a Before-After, Control-Impact (BACI) framework in planning its management response. This may include independently monitoring and collecting data where required or identifying other data sources. c. In developing its Environmental Plan, DBCA also recommends that Santos refer to the Commonwealth Department of the Environment and Energy's *Draft National Light Pollution Guidelines for Wildlife* as a best-practice industry standard for managing potential impacts of light pollution on marine fauna. d. In the event of a hydrocarbon release, it is requested that Santos notify DBCA's Pilbara regional office as soon as practicable. Note however, that DBCA will not implement an oiled wildlife management response on behalf of a petroleum operator except as part of a whole of government response mandated by regulatory decision makers, and any advice or assistance from DBCA, at any scale, will occur on a full cost recovery basis. Santos should also commit to the monitoring and clean-up of any DBCA interests affected by an oil spill in consultation with DBCA. e. Santos should refer to the Department of Transport's (DoT) web content regarding marine pollution, and the Offshore Petroleum Industry Guidance Note of September 2018 titled *Marine Oil Pollution: Response and Consultation Arrangements*. These documents provide information on the Western Australian emergency management arrangements for marine oil pollution incidents in State waters, petroleum titleholders' obligations under those arrangements, and the DoT's expectations as the jurisdictional authority for such incidences. Santos responded on 17 February 2020 and provided the following comments: a. Santos has a long history of exploration drilling in this region and hydrocarbon production from the Varanus Island Hub. In recognition of the business operating risks and environmental sensitives of this region, Santos has dedicated resources to	

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	manage environmental monitoring programs and oil spill response preparedness and response planning. The Yoorn-1 Geophysical Oil Pollution Emergency Plan (OPEP) will contain the following information: b. Details of Santos' Oil Spill Scientific Monitoring Plan including relevant subplans for the monitoring key values and sensitivities in the region (including those of Montebello Islands Marine Park and Conservation Park, and Barrow Island Marine Park, Marine Management Area and Nature Reserve). These subplans include Marine Water and Sediment Quality, Shorelines and Coastal Habitats, Benthic Habitats, Seabirds and Shorebirds, Marine Megafauna and Marine Reptiles and detail initiation criteria, sampling methodologies, study design and use of baseline data. Santos' Oil Spill Scientific Monitoring Plan outlines the use of a BACI approach with pre-impact baseline data, as well as other study design approaches. The Oil Spill Scientific Monitoring Plan is reviewed annually to ensure the plan is fit for purpose and relevant to all key sensitivities that could be impacted from an oil spill. The OPEP will also contain detail of Santos' standby services arrangements with scientific monitoring providers to enable rapid baseline monitoring where required. The readiness and implementation arrangements with these providers are outlined in a standby and response services manual which is reviewed annually and tested regularly. Santos periodically reviews and documents the status, availability and suitability of existing baseline data sources related to high biodiversity value receptors potentially contacted by an oil spill from its operations. This baseline review includes data made available by industry and government through the Industry-Government Environmental Metadata (I-GEM) Project. Santos has determined areas/values that should be sampled as a priority based on the availability and quality of baseline data. Based on the arrangements and planning detailed above, Santos is of the view that any impacts on ecological values and recovery of these values can be determined and monitored over the long term. Santos looks to continuously improve its oil spill scientific monitoring arrangements and welcomes feedback on its Scientific Monitoring Plan and baseline data reviews from DBCA. These documents will be provided separately. c. Santos will consider the Commonwealth Department of the Environment and Energy's Draft National Light Pollution Guidelines for Wildlife as a best-practice industry standard for managing potential impacts of light pollution on marine fauna.	

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
	Such lighting management controls for marine fauna will need to be balanced against marine navigation and operational safety requirements. d. Santos will comply with DBCA's oil spill reporting and consultation requirements. e. The Yoorn-1 Geophysical Oil Pollution Emergency Plan (OPEP) will reflect Department of Transport's (DoT) marine pollution response arrangements as per the September 2018 Offshore Petroleum Industry Guidance Note. Santos will consult with DoT as per the Industry Guidance Note. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.	
Department of Mines, Industry Regulation and Safety (DMIRS)	DMIRS was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. DMIRS responded on 20 January 2020 acknowledging Santos' plan to: • Drill the Yoorn-1 well in Commonwealth waters and this activity will be regulated by NOPSEMA under the OPGGS(E)R. • Undertake site surveys in both State and Commonwealth waters and approvals documentation will be provided to both DMIRS and NOPSEMA for assessment. DMIRS advised they have recently requested clarification on the information on offshore geophysical surveys in the *Varanus Island Hub Operations Environment Plan* and the *Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations Environment Plan*. DMIRS requested Santos please ensure these assessment comments are considered when developing the Environment Plan for the Yoorn-1 site surveys. Santos responded on 12 February 2020 confirming DMIRS assessment comments on offshore geophysical surveys in the *Varanus Island Hub Operations Environment Plan* and the *Devil Creek Gas Supply Pipeline and Sales Gas Pipeline Operations Environment Plan* are considered when developing the Environment Plan for the Yoorn-1 site surveys. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.	Santos has incorporated the clarifications requested by DMIRS on other EPs recently assessed, within this EP. Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
Other operators		
Chevron	Chevron was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. No response received to date.	No response has been received by Chevron. Santos will address any comments from this stakeholder should they arise in the future.
Fishing bodies		
Western Australian Fishing Industry Council (WAFIC)	WAFIC was provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This included maps for the relevant commercial fisheries. WAFIC responded on 14 January 2020 advising it appreciates commercial fishing specific potential risks and or impacts information. WAFIC acknowledged Santos had addressed commercial fishing concerns including: a. the removal of the temporary exclusion zone around the drilling site as soon as the MODU departs; b. fisher access to these sites whilst the work is in progress – Santos commitment to concurrent operations; c. avoiding active commercial fishing and schooling fish in the vicinity of commercial fishing activities; d. confirming that site, support vessel and survey personnel will be prohibited from recreational fishing activities; and e. activity notifications. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program.	Santos has addressed the matters raised by WAFIC in the following sections of the EP: a. the removal of the temporary exclusion zone around the drilling site as soon as the MODU departs (through communication of NTM. Refer **Table 8-2** control measure CM-10); b. fisher access to these sites whilst the work is in progress – Adherence to standard navigational requirements, and including through communication of NTM. Refer **Table 8-2** control measure CM-10; c. avoiding active commercial fishing and schooling fish in the vicinity of commercial fishing activities. Refer **Table 8-2** control measure CM-10; d. confirming that site, support vessel and survey personnel will be prohibited from recreational fishing activities. Refer **Table 8-2** control measure CM-11; and e. activity notifications. Refer **Table 8-2** control measure CM-10. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5.**

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
		Commitments relating to fisher access, recreational fishing and notifications are addressed in **Table 8-2.** Santos considers the level of consultation to be adequate and will address any additional comments from this stakeholder should they arise in the future. Santos acknowledges WAFICs guidance in the identification of relevant and potentially affected commercial fishers.
Commonwealth Fisheries Association (CFA)	The CFA was provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and commonwealth fisheries map via WAFIC email on behalf of Santos on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by the CFA. Santos has consulted directly with relevant fishers and representative bodies. Santos has assessed the impact fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Pearl Producers Association (PPA)	The PPA was provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Pearl Oyster Managed Fishery map via WAFIC email on behalf of Santos on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by the PPA. Santos has consulted directly with relevant fishers and representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	ASBTIA was provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Commonwealth Fisheries map via WAFIC email on behalf of Santos on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by ASBTIA. Santos has consulted directly with relevant fishers and representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Recfishwest	Recfishwest was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by Recfishwest. Santos considers the level of consultation to be adequate. Santos will address any comments from this stakeholder should they arise in the future.
Marine Tourism WA (MTWA)	MTWA was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by MTWA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Community		
Pilbara Ports Authority	The Pilbara Ports Authority was provided the *WA-499-P Exploration Drilling and Site Survey Program Consultation package* via email on 13 January 2020. This stakeholder also receives Santos' Quarterly Consultation Update for WA. The January 2020 update provided information on the WA-499-P Exploration Drilling and Site Survey Program. No response received to date.	No response has been received by the Pilbara Ports Authority. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
Commercial Fisheries		
Mackerel Managed Fishery (Area 2) (Ten identified relevant fishers)	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Mackerel Managed Fishery (Area 2) map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.
Pilbara Line Fishery (Nine identified relevant fishers).	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Pilbara Line Fishery map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.
Pilbara Trap Managed Fishery (Three identified relevant fishers).	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Pilbara Trap Managed Fishery map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.

Stakeholder	Summary of stakeholder and titleholder correspondence, and any objections and claims made	Assessment of stakeholder objections and claims
Pilbara Crab Managed Fishery (One identified relevant fisher)	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Pilbara Crab Managed Fishery map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.
Onslow Prawn Managed Fishery (Ten identified relevant fishers)	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* and Onslow Prawn Fishery map via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.
Development Octopus Fishery (Eight identified relevant fishers)	These licence holders were provided the *Commercial Fishers WA-499-P Exploration Drilling and Site Survey Program Consultation package* via WAFIC email on behalf of Santos on 13 January 2020. Refer to WAFIC comments received. No comments received to date from individual fishers in this fishery.	No response has been received from individual fishers in this fishery. Santos has also consulted directly with relevant representative bodies. Santos has assessed the impact to fish in **Section 6**, including interaction with other users in **Section 6.5**. Santos considers the level of consultation to be adequate and will address any comments from these stakeholders should they arise in the future.

4.5 Ongoing consultation

Stakeholder consultation for this activity will be ongoing and Santos will work with stakeholders before, during and after the activity. Should new stakeholders be identified (**Section 4.1**), they will be added to the stakeholder database and included in all future correspondence as required, including activity-specific notifications.

Santos, as a marine user, understands there will be the need to interact and communicate with other marine users to ensure mutual and individual stakeholder goals are met. Santos has identified the need for ongoing engagement with the fishing industry, as committed to in **Table 4-2.**

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

+ Prior to commencement of the activity, Santos will notify all relevant stakeholders listed, or as revised, in **Table 4-2.** The notification will include information on activity timing, vessel movements and vessel details.
+ Upon completion of the activity, Santos will provide a cessation notification to the relevant stakeholders listed, or as revised, in Table 4.2. The final cessation notification will advise stakeholders that the activity has ended.
+ Santos' Quarterly Consultation Update (see **Section 4.6**) will also contain relevant details of this activity until cessation.
+ Up to date knowledge of stakeholders will be managed as described in **Section 4.2.**

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

4.6 Quarterly Consultation Update

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

The *WA-499-P Exploration Drilling and Site Survey activities were* included in Santos' Quarterly Consultation Update distributed in January 2020. No comment regarding the proposed activities was received in response to this consultation. This document is provided in **Appendix C - Stakeholder Consultation**.

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

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

4.7 Addressing Consultation Feedback

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

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

4.8 Stakeholder-related Control Measures, Performance Outcomes and Standards

Control measures and performance outcomes and standards for stakeholder consultation are included in **Section 8.4.1**.

If, in stakeholder consultation, a change to any control measure or activity outlined in this EP is required, Santos will undertake an internal assessment using the management of change process (**Section 8.10.2**).

5 Environmental impact and risk assessment

OPGGS(E)R 2009 Requirements
Regulation 13(5)
The environment plan must include — (a) details of the environmental impacts and risks of the activity; and (b) an evaluation of those 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.

P(SL)(E)R 2012 Requirements
Regulation 14 (3) & (4)
(3) The environment plan must include — (a) details of all environmental impacts and environmental risks of the petroleum activity; and (b) an evaluation of those impacts and risks; and (c) a description of the environmental risk assessment process used to evaluate those impacts and risks, including the terms used in that process to categorise the levels of seriousness of those impacts and risks. (4) For the avoidance of doubt, the evaluation mentioned in subregulation (3)(b) must evaluate all the environmental impacts and environmental risks arising directly or indirectly from — (a) all aspects of the pipeline activity; and (b) potential emergency conditions, whether resulting from accident or any other cause.

Environmental impact and risk assessment refers to a process whereby planned and unplanned events that may or will 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 based on their likelihood of occurrence which contributes to their level of risk.

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

Provided in this section of the EP is the following information relating to the environmental impact and risk assessment approach:

+ 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 WA's *Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004).

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 *Environmental Hazard Identification and Assessment Procedure* (EA-91-IG-00004).

Table 5-1: Impact and risk assessment terms and definitions

Term	Definition
Acceptability	Determined for both impacts and risks. Acceptability of a planned impact is in part determined by the severity (consequence) of the impact after control measures have been implemented. Acceptability of an unplanned impact is in part determined by its risk ranking after control measures have been implemented. For both impacts and risks, acceptability is also determined by a demonstration of the ALARP principle (see next table row), consistency with Santos WA's Environmental Management Policy (QE-91-IQ-00047), consistency with all applicable legislation, and consideration of relevant stakeholder consultation when determining control measures.
ALARP Principle	The ALARP principle is that the residual impacts and risks shall be 'as low as reasonably practicable'. It has particular connotations as a route to reduce risks when considering law, regulation and standards. For an impact or risk to be ALARP, it must be possible to demonstrate that the cost involved in reducing the impact or risk further would be grossly disproportionate to the benefit gained. The ALARP principle arises from the fact that infinite time, effort and money could be spent on the attempt to reduce risk to zero. It should not be understood as simply a quantitative measure of benefit against detriment. It is more a best common practice of judgement of the balance of impact or risk and societal benefit.
EMBA	Environment that may be affected by planned or unplanned events.
Environment	The environment (physical, biological and socio-economic) within the spatial extent over which the planned activity will occur.
Environmental consequence	The severity of an impact in terms of its adverse effects on the environment.
Environmental impact	Any change to the environment, whether adverse or beneficial, wholly or partly resulting from the planned activity.
Environmental risk	Applies to unplanned events. Risk is a function of the likelihood of the unplanned event occurring and the severity (consequence) of the environmental impact that arises from that event.
Grossly disproportionate	Where the sacrifice (cost and effort) of implementing a control measure to reduce impact or risk grossly exceeds the environmental benefit to be gained.
Likelihood of impact	Probability of an impact occurring (used for risk assessment only).
Non-routine planned event	An attribute of the planned activity that results in some level of environmental impact and may occur or will occur infrequently during the planned activity.
Planned activity	The activity to be undertaken under an environmental plan or oil pollution emergency plan, including the services, equipment, products, assets, personnel, timing, duration and location.
Planned event	An attribute of the planned activity that results in some level of environmental impact and will occur continuously or frequently throughout the duration of the planned activity.
Receptor	A feature of the environment that may have environmental, social and/or economic values.
Unplanned event	An event that results in some level of environmental impact and may occur despite preventative safeguards in place. An unplanned event is not intended to occur during the activity.

5.2 Summary of the environmental impact and risk assessment approach

5.2.1 Overview

Santos WA operates under an overarching Risk Management Policy (QE-91-IF-10050). Santos WA’s Risk Management Framework (QE-91-IF-10051) underpins the Risk Management Policy and is consistent with the requirements of Australian Standard/New Zealand Standard International Standards Organization 31000:2019 Risk Management – Guidelines (ISO, 2018).

The key steps to risk management are illustrated in **Figure 5-1**.

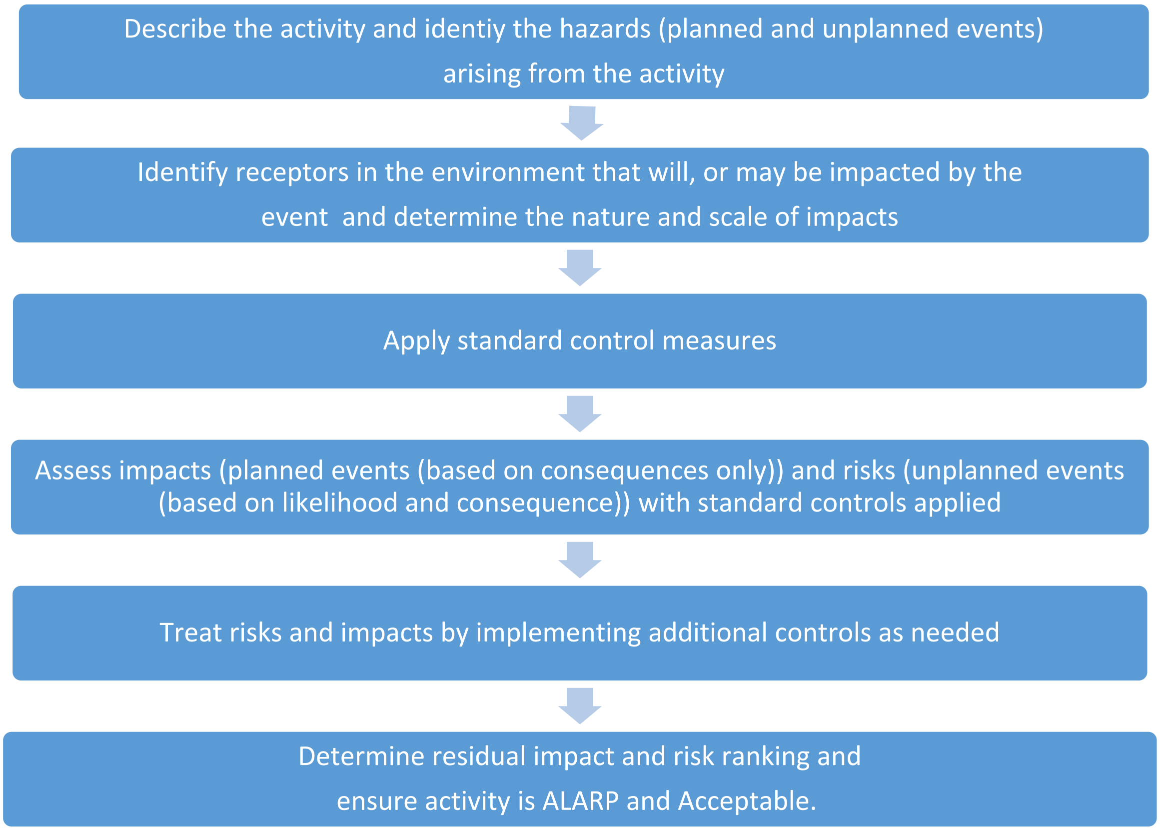


Figure 5-1: Environmental risk and impact assessment process

Santos WA’s *Environmental Hazard Identification and Assessment Procedure* (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 WA’s Environmental Management Policy;
- Principles of ecologically sustainable development (ESD); and
- Santos WA-defined acceptable levels of impact and risk.

These factors were considered in environmental impact and risk assessment workshops. The risk workshops involved participants from Santos WA as well as specialist environmental consultants with knowledge of the existing environment and the proposed activity.

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

5.2.2 Describe the activity and Associated Planned and Unplanned Events

The petroleum activity is described in **Section 2** of this plan. An assessment against the activity was undertaken and the planned and unplanned events were identified. The outcome of this assessment is detailed in the relevant subsections of **Section 6** and **7**.

5.2.3 Determine the nature and scale of impacts and identify receptors that have the potential to be impacted

The extent of actual or potential impacts from each planned or unplanned event is assessed using, where required, modelling (e.g., hydrocarbon spills) and scientific reports. The duration of the event is also described, including the potential duration of any impacts should they occur. Receptors identified as potentially occurring within an impacted area or areas are detailed **Section 3**.

5.2.4 Describe the Control Measures, Environmental Performance Objectives, Standards and Measurement Criteria

For each planned and unplanned event, a set of control measures, environmental performance objectives, environmental performance standards and measurement criteria is identified. The definitions of these terms are consistent with the OPGGS(E)R and P(SL)(E)R. Note that where the P(SL)(E)R uses the term environmental performance objectives, the term environmental performance outcomes is used in this document to address both outcomes and objectives (collectively abbreviated to EPO).

5.2.5 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 event and the identified receptor. Impact mechanisms and any thresholds for impacts are determined and described, using scientific literature and modelling where required. Impact thresholds for different critical life stages are also identified where relevant.

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

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

The level of information required to determine 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.

A description of the consequence levels is provided in **Table 5-2**.

Table 5-2: Consequence level description

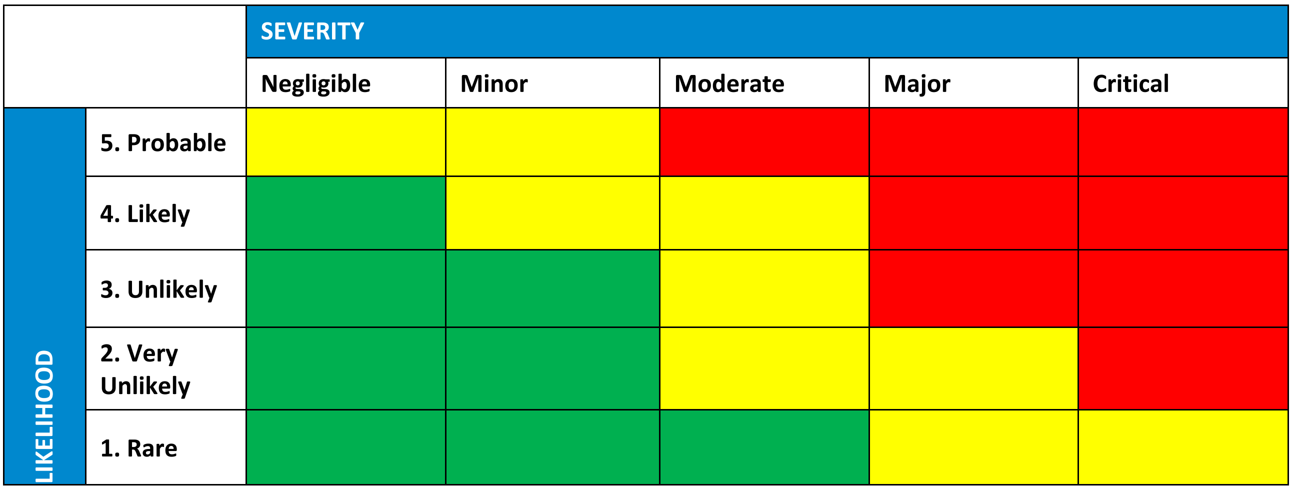
Consequence level		Consequence level description
A	Negligible	No impact or negligible impact. Environmental impact lasting days up to 1 week.
B	Minor	Detectable but insignificant change to local population, industry or ecosystem factors. Environmental impact lasting weeks up to 12 months.
C	Moderate	Significant impact to local population, industry or ecosystem factors. Environmental impact lasting 1 to 10 years.
D	Major	Major long-term effect on local population, industry or ecosystem factors. Environmental impact lasting 10 to 20 years.
E	Critical	Complete loss of local population, industry or ecosystem factors AND/OR major wide-spread regional impacts with slow recovery to no full recovery. Environmental impact lasting more than 20 years to no recovery.

Note: Injury or mortality to a protected species is included as a moderate consequence level (**Appendix D - Environment Consequence Descriptors**).

For unplanned events, in addition to the consequence level of the impact, a risk ranking is also determined using an assessment of the likelihood (likelihood ranking) of the impact occurring from an unplanned event. For oil spill events, potential impacts to environmental receptors are assessed where they occur within the EMBA using results from modelling. The risk matrix is provided in **Figure 5-2**.

Table 5-3: Likelihood description

No.	Matrix	Description
5	Probable	1. Event has occurred frequently within the Company. 2. Between 1 and 10 incidents every 10 years (i.e. up to a frequency of 1/year).
4	Likely	1. Event has occurred frequently within the Industry. 2. Between 1 and 10 incidents every 100 years (i.e. up to a frequency of 10^{-1}/year).
3	Unlikely	1. Event has occurred occasionally within the Company. 2. Between 1 and 10 incidents every 1000 years (i.e. up to a frequency of 10^{-2}/year).
2	Very Unlikely	1. Event has occasionally occurred within the Industry. 2. Between 1 and 10 incidents every 10,000 years (i.e. up to a frequency of 10^{-3}/year).
1	Rare	1. Event could happen under exceptional circumstances only. 2. Between 1 and 10 incidents every 100,000 years (i.e. up to a frequency of 10^{-4}/year).



High Risk	Reduction of risk required
Medium Risk	Reduction of risk required based on ALARP principle
Low Risk	Deemed acceptable based on standard risk controls in place

Figure 5-2: Santos WA risk matrix

5.2.6 Evaluating whether 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 as low as reasonably practicable. This process relies on demonstrating that further potential control measures would require a disproportionate level of cost or effort in reduce the level of impact or risk. If this cannot be demonstrated, then further control measures are adopted. The level of detail included in the ALARP assessment is based on the nature and scale of the potential impact or risk. For example, more detail is required for a risk ranked as Medium compared to a risk ranked as Low.

5.2.7 Evaluating impact and risk acceptability

Santos WA 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 A or B; or a risk of impact from an unplanned event is ranked Low to Medium;
+ 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 have addressed the principles of ecologically sustainable development;
+ Demonstration 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 Santos WA's Environmental Management Policy;
+ Performance standards are consistent with industry standards and best practice guidance (e.g., National Biofouling Management Guidelines for the Petroleum Production and Exploration Industry) (Marine Pest Sectoral Committee, 2018);
+ Performance objectives and standards are consistent with stakeholder expectations; and
+ 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(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.
Regulation 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.
Regulation 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.

P(SL)(E)R 2012 Requirements
Regulation 14(3)
The environment plan must include: (a) details of all environmental impacts and environmental risks of the petroleum activity; and (b) an evaluation of those impacts and risks; and (c) a description of the environmental risk assessment process used to evaluate those impacts and risks, including the terms used in that process to categorise the levels of seriousness of those impacts and risks.
Regulation 14(4)
For the avoidance of doubt, the evaluation mentioned in subregulation (3)(b) must evaluate all the environmental impacts and environmental risks arising directly or indirectly from: (a) all aspects of the petroleum activity; and (b) potential emergency conditions, whether resulting from accident or any other cause

Santos WA's environment assessment identified seven potential sources of environmental impact associated with the planned activities to be undertaken in the operational area. The results of the impact assessments are summarised in **Table 6-1.** Given 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 5.2**). The potential impact assessment for each planned event and the subsequent control and management measures proposed by Santos WA 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	Planned event	Residual consequence level
6.1	Acoustic disturbance to marine fauna	A - Negligible
6.2	Light emissions	A - Negligible
6.3	Atmospheric emissions	A - Negligible
6.4	Seabed and benthic habitat disturbance	A - Negligible
6.5	Interaction with other marine users	A - Negligible
6.6	Operational discharges	A - Negligible
6.7	Spill response operations	B - Minor

6.1 Acoustic disturbance to marine fauna

6.1.1 Description of event

Event	Underwater noise emissions will be generated by: + the survey vessel activities (**Section 2.4**); + the geophysical survey equipment, including MES, SSS, and a boomer SBP (**Section 2.5**); and + underwater acoustical positioning equipment (**Section 2.5**). Noise originating from these sources could potentially have the following effects on marine fauna: + Masking of vocalisations / signals from predators / prey; + Modification of fauna behaviour (avoidance / attraction / disruption of normal behaviour); and + Physical injury to fauna from exposure to excessive noise (barotrauma, hearing loss).
Extent	Localised: A representative survey vessel will have sound levels which do not exceed the marine mammal behavioural disturbance threshold beyond 1200 m. Localised: A conservative estimate for the use of geophysical equipment (MBESs, SSS and boomer SBP) is within a few hundred metres radius depending on the activity characteristics. Localised: A conservative estimate for the use of underwater positioning equipment (USBL) is within hundreds of metres of the source
Duration	Survey vessel noise for the duration of the activity, with intermittent survey equipment noise.

6.1.1.1 Noise generated from survey vessel

Noise associated with vessel activity that could impact marine fauna includes noise generated by vessel thrusters, engines and propellers, as well as noise emitted onboard which is converted to underwater noise through the hull (e.g. from heavy machinery). The main source of vessel noise will be from propellers or DP thrusters.

Noise will be generated during transit, towing of geophysical sources and seafloor sampling. The sound levels from the representative vessel are likely to be less than those from *R/V Ocean Pioneer*, a 62-m long 5600 HP (4175 kW) vessel. The *R/V Ocean Pioneer* was measured during transit at 10 knots and found to have a monopole source level of 166.3 dB re 1 µPa @ 1m (Chorney *et al*. 2011). In this study, in the Arctic in 46 m of water, the maximum distance to 120 dB re 1 µPa was found to be 1600 m. To place this in context with other studies, McCauley (1998) measured underwater sound levels from the *Pacific Ariki*, a 64 m long support vessel with 8000 HP (6000 kW) main engines during calm conditions in the Timor Sea in 110 m of water while transiting at 11 knots, and found the distance to 120 dB re 1 µPa to be approximately 1 km.

The 54-m long 3200 HP (2386 kW) *Mermaid Searcher* representative survey vessel is likely over-estimated when considering either the *Ocean Pioneer* or the *Pacific Ariki*, due to the higher speeds and more powerful engines, although the work-rate of the engines, and thus output power and noise, will depend upon speed and sea-state, and the propagation will depend upon the location. Practical spreading loss, $15\log_{10}$(Range) (Urick 1983), is a reasonably conservative approach to take in waters on the continental shelf, representing a balance between spherical and cylindrical spreading. If practical spreading loss is applied with the monopole source level of the *Ocean Pioneer* under transit, 166.3 dB re 1 µPa @ 1m, the distance to 120 dB re 1 µPa (SPL) will be less than 1200 m.

The thrusters on the *Mermaid Searcher* are significantly smaller than the main engines (only 600 kW total installed thruster power, compared to 2386 kW), therefore the 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 survey vessel, the *Mermaid Searcher*, 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 $10*\log_{10}$(Time in seconds) to sound levels. This approach can be used to calculate the unweighted Sound Exposure Level (SEL), which can be used in a conservative comparison against relevant SEL impact assessment thresholds.

6.1.1.2 Underwater acoustic positioning

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

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

6.1.1.3 Multibeam Echo Sounder

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.

6.1.1.4 Side Scan Sonar

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.

6.1.1.5 Boomer Sub Bottom Profiler

The representative boomer SBP considered for this survey is an Applied Acoustics S-Boom Boomer SBP being used with a CSP-D 2400 Joule power source, but only operating at 300 Joules. The output from boomer SBP systems is highly dependent on the model and operational power levels. A measurement of a very similar SBP, also operating at lower power levels, is the Applied Acoustics AP3000 boomer SBP operating at both 750 and 1000 J reported in Martin *et al*. (2012). This boomer had a primary frequency range of 100 to 1000 Hz. During the study, the acoustic data were collected as close as 8 m to the source and directly below it. The data showed that the broadband source level for the system was 203.3 dB 1 µPa @ 1 m SPL over 0.2 ms window length and 172.6 dB re 1 µPa2·s @ 1 m SEL. They found that even with the closest measurement at 8 m, SPL values never exceeded 175 dB re 1 µPa, with the distance to 160 dB re 1 µPa calculated to be 12 m, and the unweighted accumulated SEL over an entire measurement track (525 impulses) in 28 m of water which passed directly over the recorder while operating at 1000 J was 161.5 dB re 1 µPa^{2}s.

6.1.2 Nature and scale of environmental impacts

Potential Receptors: Threatened/migratory fauna (marine mammals (particularly cetaceans), marine turtles (particularly flatback, green and hawksbill turtles), sharks, rays and fish.

The operational area overlaps several internesting buffer BIAs for loggerhead, green, hawksbill and flatback turtles. The operational area also overlaps with a migration BIA for the humpback and blue whales, dugong BIA, foraging BIA for whale sharks, and breeding BIAs for the wedge-tailed shearwater, Australian fairy tern and roseate tern. The only marine protected area that overlaps the operational area is the Montebello Australian Marine Park.

The use of sound in the underwater environment is important for marine animals, particularly cetaceans, to navigate, communicate and forage effectively, along with reptiles, sharks/rays and other fish, for a range of functions such as social interaction, foraging and orientation. Underwater noise may impact on marine fauna in the following ways:

+ Attraction;
+ Increased stress levels;
+ Disruption to underwater acoustic cues;
+ Localised avoidance;
+ Disturbance, leading to behavioural changes or displacement from areas;
+ Masking or interference with other biologically important sounds such as communication or echolocation (used by certain cetaceans for location of prey and other objects);
+ Physical injury to hearing or other organs; and
+ Indirectly by inducing behavioural and physiological changes in predator or prey species.

The nature and scale of impacts must be considered in the context of the ambient noise environment. Ambient underwater noise levels are dependent on location, and are often dominated by local wind noise, waves, biological noise and ship traffic. Wind speed and seabed conditions have a clear influence on the ambient noise level. Coral reefs are one of the noisiest habitats in the ocean, with sources such as breaking swells, snapping shrimp and fish choruses (Amoser and Ladich, 2005). Broadband levels on reefs are typically 95–110 dB re 1 µPa with a high proportion of low frequency noise (Tolimieri *et al*., 2000). Fish choruses are capable of raising background noise levels to 120–130 dB re 1 µPa (McCauley, 2011). Baseline noise levels in the Otway Basin, Victoria, were measured to oscillate between 94–99 dB re 1 µPa. Anthropogenic underwater noise sources in the region comprise shipping and small vessel traffic, petroleum-production and exploration-drilling activities and sporadic petroleum seismic surveys.

The survey will involve the vessel, acoustic positioning through USBL, MBES, SSS and a boomer SBP, as detailed in **Section 2.5**. These sound sources are both non-impulsive (vessel) and impulsive (USBL, MBES, SSS and a boomer SBP), and thus require the consideration of different criteria to assess their potential impact.

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

+ acoustic masking – anthropogenic sounds may interfere with, or mask, biological signals, therefore reducing the communication and perceptual space of an individual. Auditory masking impacts may occur when there is a reduction in audibility for one sound (signal) caused by the presence of another sound (noise). For this to occur the noise must be loud enough and have a similar frequency to the signal and both signal and noise must occur at the same time.
+ behavioural response – behavioural impacts will depend on the audible frequency range of each potential receptor in relation to the frequency of the noise, as marine animals will only respond to acoustic signals they can detect, as well as the intensity of the noise. The intensity of behavioural responses of marine mammals to sound exposure ranges from subtle responses, which may be difficult to observe and have little implications for the affected animal, to obvious responses, such as avoidance or panic reactions. The context in which the sound is received by an animal affects the nature and extent of responses to a stimulus. The threshold for elicitation of behavioural responses depends on received sound level, as well as multiple contextual factors such as the activity state of animals exposed to different sounds, the nature and novelty of a sound, spatial relations between a sound source and receiving animals, and the gender, age, and reproductive status of the receiving animal.
+ physiological impacts – auditory threshold shift (temporary and permanent hearing loss) – marine fauna exposed to intense sound may experience a loss of hearing sensitivity, or even potentially mortal injury. Hearing loss may be in the form of a 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 2013; Popper *et al* 2014). These criteria have been compared with measured and predicted sound levels for different sound sources to assess potential impacts.

6.1.2.1 Marine mammals

No known aggregation, resting, breeding or feeding areas for cetaceans lie in close proximity to the operational area. However, cetaceans may travel through the area, with the operational area being within the migration BIA for the humpback whale and blue whale and dugongs. The relevant species are described in **Section 3.2.3**, and includes both low and mid-frequency cetaceans.

Table 6-2 and **Table 6-3** detail receptor noise impact and behavioural thresholds for continuous noise (vessels) and impulsive noises (survey equipment).

Table 6-2: Continuous Noise: Acoustic effects of continuous noise on marine mammals: Unweighted SPL and SEL_{24h} thresholds

Hearing Group	NMFS (2014)	NMFS (2018)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)

Low-frequency cetaceans	120	199	179
Mid-frequency cetaceans		198	178
Sirenians (dugong)		206	186

Table 6-3: Impulsive Noise: unweighted SPL, SEL_{24h}, and PK thresholds for acoustic effects on marine mammals

Hearing Group	NMFS (2014)	NMFS (2018)			
	Behaviour	PTS onset thresholds (received level)		TTS onset thresholds (received level)	
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency cetaceans	160	183	219	168	213
Mid-frequency cetaceans		185	230	170	224
Sirenians (dugong)		190	226	175	220

Potential impacts from survey vessel

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

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

The estimated distances to behavioural and physiological thresholds (as listed in **Table 6-2**) for marine mammals are provided in **Table 6-4**.

Table 6-4: Estimated distances to behavioural and physiological thresholds (as listed in Table 6-2) for marine mammals from vessels

Potential Marine Fauna Receptor	Estimated Distance	Justification
PTS		
Low-Frequency (LF) cetaceans	12 m	Based upon accumulation of unweighted SEL over 24 h for a vessel with a source level of 166.3 dB re 1 µPa (SPL), and applying practical spreading loss, see Section 6.1.1.
Mid-Frequency (MF) cetaceans and dugongs	Not predicted to occur	Not predicted to occur for vessels with a significantly greater power output (McPherson *et al*. 2019)
TTS		

Low-Frequency (LF) cetaceans	266 m	Based upon accumulation of unweighted SEL over 24 h for a vessel with a source level of 166.3 dB re 1 µPa (SPL), and applying practical spreading loss, see Section 6.1.1.
Mid-Frequency (MF) cetaceans and dugongs	Not predicted to occur	Not predicted to occur for vessels with a significantly greater power output (McPherson *et al*. 2019)
Behaviour		
Low-Frequency (LF) cetaceans	Within 1200 m	Considering a vessel with a source level of 166.3 dB re 1 µPa (SPL), and applying practical spreading loss, see Section 6.1.1.
Mid-Frequency (MF) cetaceans		

Potential impacts from survey equipment and positioning equipment

The sound levels from positioning equipment are described in **Section 6.1.1**. The proposed equipment has sound levels which could reach the threshold for behavioural disturbance (**Table 6-4**) within 36 m. A nominal accumulation scenario for 1000 impulses (**Section 6.1.3**) results in an unweighted accumulated SEL significantly below thresholds for PTS and TTS in marine mammals. The measured PK at 30 m was 170 dB re 1 µPa, therefore considering both SEL and PK metrics within the criteria (**Table 6-4**), PTS and TTS are not predicted to occur from the positioning equipment.

The sound levels from MBES are described in **Section 6.1.1**. The measurement study from Martin *et al*. (2012) indicates that the threshold for behavioural disturbance (**Table 6-4**) could be exceeded within less than 10 m. PTS and TTS due to SEL is not predicted to occur, considering that a measurement of along a trackline with a closest point of approach of 4 m didn't result in accumulated unweighted levels higher than 121.5 dB re 1 $\mu Pa^2 s$. PTS and TTS considering PK is unlikely to occur given the measurement of 170 dB re 1 µPa PK at 40 m. Therefore, considering both SEL and PK metrics within the criteria (**Table 6-4**), PTS and TTS due to the MBES are not predicted to occur.

The sound levels from SSS are described in **Section 6.1.1**. The measurement study Austin *et al*. (2013) indicates that the threshold for behavioural disturbance (**Table 6-4**) could be exceeded within less than 130 m for in-beam marine mammals. The reported per-pulse sound levels at 40 m are similar to those from the MBES, and as it isn't predicted to exceed either the PTS or TTS criteria considering both SEL and PK metrics (**Table 6-4**), neither is the SSS.

The sound levels from the boomer SBP are described in **Section 6.1.1**. The measurement study from Martin *et al*. (2012) indicates that the threshold for behavioural disturbance (**Table 6-4**) could be exceeded within less than 12 m. PTS and TTS due to SEL is not predicted to occur, considering that a measurement along a survey line in shallow water directly over the recorder didn't result in accumulated unweighted levels higher than 161.5 dB re 1 $\mu Pa^2 s$. The study didn't report PK measurements, however, as the source level is lower than either the MBES or SSS, and as they didn't cause exceedance of the PK thresholds, neither will this boomer SBP. Therefore, considering both SEL and PK metrics within the criteria (**Table 6-4**), PTS and TTS due to the boomer SBP are not predicted to occur.

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

Given the transient and mobile nature of the survey, the operating frequencies and noise maxima of the survey equipment (detailed in **Section 2.5**), effects of noise on marine mammals is expected to be limited to behavioural responses within up to a few kilometres of the survey vessel depending on the heading range of the receptors.

6.1.2.2 Marine reptiles

Turtles utilise shallow waters and beaches of the Montebello Islands, particularly flatback, green and hawksbill turtles for feeding, nesting, breeding and internesting. BIAs within the operational area include the loggerhead turtle (internesting and nesting), green, flatback and hawksbill turtles (internesting and critical nesting habitat). However, internesting activities typically occur within shallower waters.

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

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

Turtles have been recorded successfully breeding on VI over the last 20 years with an estimated survival probability of over 94% (Prince and Chaloupka, 2011). This would indicate that the industrial uses on VI, inclusive of the operational noise emissions, have had little to no measurable impact on adult turtles nesting on VI and, to date, have not shown to have led to a long-term decrease in the size of the adult marine turtle nesting population.

No numerical thresholds have been developed for impacts of continuous sources (e.g. vessel noise) on marine turtles. However, Popper *et al*. (2014) have developed risk-based criteria, and these are presented in Table 6-5. Survey equipment and positioning equipment are considered impulsive sources for this assessment, therefore the criteria from Popper *et al*. (2014) for seismic airguns, an impulsive source, has been adopted (**Table 6-6**).

Table 6-5: Continuous Noise: Criteria for vessel noise exposure for turtles, adapted from Popper *et al*. (2014)

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

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

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

Potential Marine Fauna Receptor	Masking	Behaviour	TTS	Recoverable injury	Mortality and Potential mortal injury
Marine Turtle	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	> 210 dB SEL24h or > 207 dB PK

Potential impacts from survey vessel

Based on the criteria detailed within **Table 6-5** there is a low risk of any injury to marine turtles from vessel noise (**Section 6.1.1**). Behavioural changes, e.g. avoidance and diving, are only predicted for individuals in close proximity to the activity vessels (high risk of behavioural impacts within tens of metres of a vessel and moderate risk of behavioural impacts within hundreds of metres of a vessel). There is a high risk of masking within hundreds of meters of the vessel, and a moderate risk of masking within thousands of metres from the vessel. Turtles have not been shown to have a reliance on sound for finding food or avoiding predators. Sounds potentially could be used by turtles in a social manner to synchronise activities during the nesting season (Ferrara *et al*. 2014), however this has not been demonstrated for sea turtles. The noises are relatively quiet (Ferrara *et al*. 2014), and thus would only have a limited range of detection by turtles even in ideal conditions, with masking from natural sounds likely. The impacts from masking are expected to be low.

Potential impacts from survey equipment and positioning equipment

The sound levels of the survey equipment and positioning equipment (**Section 6.1.1)** are below those associated with the PK criteria for injury (**Table 6-6**) beyond a few metres , and due to the low per-pulse SEL, the SEL criteria will also not be exceeded. Recoverable injury and TTS could occur within tens of metres applying the relative risk criteria from Popper *et al*, (2014) (**Table 6-6**). Behavioural changes, e.g. avoidance and diving, are only predicted for individuals in close proximity to the survey vessel (high risk of behavioural impacts within tens of metres of source and moderate risk of behavioural impacts within hundreds of metres of the source).

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

Sea snakes

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

6.1.2.3 Sharks, fish and rays

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

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

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

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

The criteria defined in Popper *et al*. (2014) for continuous (**Table 6-7**) and impulsive (**Table 6-8**) noise sources has been adopted.

Table 6-7: Continuous noise: Criteria for noise exposure for fish, adapted from Popper *et al*. (2014)

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

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

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

Potential Marine Fauna Receptor	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	> 219 dB SEL_{24h} or > 213 dB PK	> 216 dB SEL_{24h} or > 213 dB PK	>> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	>> 186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or > 207 dB PK	203 dB SEL_{24h} or > 207 dB PK	186 dB SEL_{24h}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Fish eggs and fish larvae	> 210 dB SEL_{24h} or > 207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

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

Potential impacts from survey vessel

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.

Potential impacts from survey equipment and positioning equipment

Based on available criteria from Popper *et al* (2014), potential impacts of survey and positioning equipment on fish have been assessed. Impulsive noises from survey equipment could result in physiological impacts to fish located within metres of the sound source considering the results presented in **Section 6.1.1.** 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. The only survey equipment with energy below 1 kHz is the boomer SBP, all other equipment which operates at higher frequencies is unable to be heard by most fish, which further reduces the risk of impact (Ladich and Fay 2013).

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

Protected and significant areas

The operational area intersects the Montebello Australian Marine Park (Multiple Use Zone - IUCN Category VI). No recognised breeding or resting area for cetaceans, shark or fish species are known to occur in the operational area, however the operational area does overlap several internesting buffer BIAs for loggerhead, green, hawksbill and flatback turtles. The conservation values of the marine park (as described in **Section 3.2.2**) include foraging areas for marine turtles which are adjacent to important nesting sites. Impacts to turtles from noise are discussed above and due to the short term duration of the activity are not expected to significantly impact the conservation values of the Montebello Australian Marine Park (AMP).

Socio-economic

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

6.1.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed fauna during activities (EPO-1).

The control measures considered for this activity are shown in **Table 6-9** with EPSs and measurement criteria for the EPOs described in **Section 8**.

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

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

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

Table 6-9: Control measures – noise emissions

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-01	Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from vessel and survey equipment, because if they are sighted, then activity can cease and/or vessels can slow down or move away	Operational costs to adhere to marine fauna interaction restrictions, such as vessel speed and direction, are based on legislated requirements and must be adopted.	**Adopted** – Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos WA. Control drives compliance with EPBC Regulations (Part 8).
CM-02	Constant bridge watch on survey vessel	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost – industry practice	**Adopted** – industry practice, benefits outweigh cost.
N/A	Undertake site specific acoustic modelling as per Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015))	Increase the knowledge of potential impacts. However, noise emissions from geophysical surveys are already well documented	Additional cost to undertake site specific acoustic modelling.	**Rejected** – Cost is disproportionate to increase in environmental benefit.
N/A	Develop a noise management plan as per approved Conservation Advice for Megaptera novaeangliae (humpback whale) (2015)).	Potential reduction in impacts to marine fauna	Additional cost to develop a noise management plan for a short duration activity (i.e. a few days) that is low risk to marine fauna.	**Rejected** – Cost is disproportionate to increase in environmental benefit.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Dedicated Marine Fauna Observer (MFO)	Improved ability to spot and identify marine fauna at risk of impact from vessel and survey noise.	Additional cost of contracting specialist MFO.	**Rejected** – Risk of animals being encountered is too low to justify additional cost of MFO, i.e. cost is disproportionate to environmental benefit.
N/A	Schedule activities to avoid coinciding with sensitive periods for marine fauna present in the operational area	Potential reduction in impact of noise to some sensitive receptors	Impracticable to schedule activities to avoid all listed marine fauna due to variability in timing of environmentally sensitive periods and the constant or unpredictable presence of some species. Short duration activity (i.e. a few days) that is low risk to marine fauna.	**Rejected** – Cost is disproportionate to increase in environmental benefit

6.1.4 Environmental Impact Assessment

Underwater noise emissions	
Key receptors	**Consequence level**
Noise from operation of equipment and vessels	
Threatened/ migratory fauna	Noise emitted by vessels and the survey activity will be short in duration and is likely to be reduced to background levels within a few kilometres. As such, any potential related marine fauna behavioural impacts are expected to be temporary and short ranged and are not expected to lead to long-term changes in individual behaviour (e.g. migration) or lead to changes at the population level.
Physical environment/ habitat	Not applicable – noise will not impact the physical environment itself, only the species mentioned above utilising it.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which noise emissions are expected.
Protected areas	Noise emissions will impact a very small portion of the Montebello Islands Marine Park with any impacts expected be restricted to localised and temporary impacts to marine fauna as they transit through the area.
Socio-economic	Noise levels are not expected to impact on socio-economic receptors due to their low activity level within the vicinity of the operational area. Impacts to fish may result in indirect impacts to fisheries in the area. However, considering the noise emissions are localised, the available catch area for commercial fishermen and the area over which commercial species spawn, impacts to fisheries are considered acceptable.
Overall worst case consequence	A - Negligible

6.1.5 Demonstration of ALARP

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

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

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

Additional controls were identified and considered but rejected, as detailed in **Section 6.1.3**. Therefore, the risks to marine fauna from noise associated with the project activities are considered to be ALARP.

6.1.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence from underwater noise emissions is A (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 ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – strategic objectives of the State Montebello Islands Marine Park met. Controls implemented during the activity will minimise the potential impacts to species identified in Recovery Plans as having the potential to be impacted by noise emissions. Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017), and Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale).
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management 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.

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

Minimal behavioural changes are expected from all marine fauna in the operational area, and therefore the negligible impacts expected from these noise sources are considered environmentally acceptable. No long-term harm is expected to result to EPBC listed marine fauna during operational activities. Through adherence to Santos WA's *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003), which drives compliance with EPBC Policy Statement Part 8, the activity is considered acceptable to undertake in the area. In addition, no concerns from stakeholders (including fisheries) have been raised to indicate that the activity will have any unacceptable impacts to socio-economic receptors, nor did DWER highlight any concerns with acoustic disturbance form the activity.

Santos

6.2 Light emissions

6.2.1 Description of event

Event	A minimum level of lighting is required for safety and navigational purposes on the survey vessel. Navigational and safety lighting cannot be eliminated.
Extent	Localised, limited light 'spill' or 'glow' onto waters surrounding the survey vessel.
Duration	Navigational and task lighting on vessels will be required on a 24-hour basis.

6.2.2 Nature and scale of environmental impacts

Potential Receptors: Threatened/migratory fauna (marine mammals, marine reptiles - marine turtles (particularly hatchlings), sharks, rays and fish and zooplankton and birds (sea).

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:

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

National Light Pollution Guidelines for Wildlife have also been published in draft (Commonwealth of Australia 2019). According to the draft National Light Pollution Guidelines for Wildlife, a 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15-18 km and fledgling seabirds grounded in response to artificial light 15 km away. The effect of light glow may occur at distances greater than 20 km for some species and under certain environmental conditions (Commonwealth of Australia 2019).

Threatened/migratory fauna

Marine mammals

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

Marine reptiles

The operational area is located within the flatback, loggerhead, hawksbill and green turtle internesting buffer BIA, and therefore individuals are likely to occur in the operational area. All four species nesting on the Montebello and nearby islands are classified as threatened under the EPBC Act 1999 and the WA *Biodiversity Conservation Act 2016.*

The Recovery Plan for Marine Turtles in Australia: 2017-2027 (Commonwealth of Australia, 2017) 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;
+ Disrupting hatchling orientation and sea finding behaviour; and
+ Creating pools of light that attract swimming hatchlings and increase their risk of predation.

The internesting area are defined as a 60 km radius around Barrow Island between October and March for flatback turtles (Oct-Mar), a 20 km radius around Barrow Island between November and March for green turtles (Nov-Mar) and a 20 km radius around Montebello Island for hawksbill turtles (Oct-Feb).

Light pollution reaching marine turtle nesting beaches is widely considered detrimental owing to its ability to alter important nocturnal activities, including choice of nesting sites and orientation/navigation to the sea by post-nesting females and hatchlings (Witherington and Martin, 2003). Light pollution is also highlighted in the Recovery Plan for Marine Turtles in Australia: 2017-2027 as a factor requiring management for successful marine turtle nesting (Commonwealth of Australia, 2017). The most significant risk posed to marine turtles from artificial lighting is the potential disorientation of hatchlings following their emergence from nests, although breeding adult turtles can also be disoriented (Rich and Longcore, 2006 in EPA 2010). 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). According to the Recovery Plan for Marine Turtles in Australia: 2017-2027 (Commonwealth of Australia, 2017), the operational area intersects internesting areas identified as habitat critical to the survival of the species for flatback, loggerhead, green and hawksbill turtles.

The North-west Marine Bioregion supports globally significant breeding populations of green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and flatback (*Natator depressus*) turtles (DSEWPaC, 2012). The Montebello Islands are the closest significant nesting location to the operational area. The most common species of turtle nesting on the Montebello Islands is the green and flatback turtles. Hawksbill turtles are also seen frequently, whilst Leatherback turtles are the least common. The Recovery Plan for Marine Turtles in Australia: 2017-2027 states that light pollution is of high risk to hawksbill (WA genetic stock) turtles, flatback (Pilbara genetic stock) turtles and green (North West Shelf genetic stock) turtles (Commonwealth of Australia, 2017). Physical habitat modification is of high risk to flatback (Pilbara genetic stock) and green turtles (Scott Reef-Browse Island genetic stock) (Commonwealth of Australia, 2017).

The Montebello Islands are the closest significant nesting location to the operational area.

For marine turtle (and seabird) species, light pollution along, or adjacent to, nesting beaches or rookeries may cause alterations to critical behaviours, such as foraging at sea, the selection of nesting sites and the passage of emerging turtle hatchlings from the beach to the sea (Limpus, 2008). The impacts of these changes include a decrease in nesting success, beach avoidance by nesting females and disorientation, leading to increased mortality through predation, road kill or dehydration (Limpus, 2008; Witherington & Martin, 2000 as cited in DSEWPaC, 2012).

Generally, marine turtles are most sensitive to the shorter wavelengths (< 600 nm), meaning they perceive the violet, blue and green end of the light spectrum more so than the yellow, orange or red end. Typically, the lights used in industrial and offshore applications are fluorescent and halogen lights, falling within the wavelength range that is visible to marine turtles.

Based on published scientific studies and experimental work carried out on turtle hatchling emergence and attraction to lights on Barrow Island, low wattage, low pressure sodium vapour lights are the least "attractive" to turtles, followed by a low wattage light with a yellow filter. High pressure sodium vapour lights and fluorescent white light were the most attractive and therefore the least desirable in terms of reducing impact on turtle behaviour (Pendoley, 2011).

BIAs for marine turtles overlapping the operational area, include the green, flatback and hawksbill turtles (internesting buffer, including for critical habitat).These internesting areas are around Montebello Islands (for all turtles) and Dampier Archipelago (for flatback turtles). 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). Given the proposed Yoorn-1 well is located approximately 22 km away from the nearest turtle nesting beach (Trimouille Island), light emissions will not be visible from turtle nesting beaches. Experienced nesting females are unlikely to be disturbed by light, and first time nesters are likely to be disturbed by light when they are selecting their first nesting beach (Pendoley, 2014). Given that the closest beach is >20 km from the well location, nesting females should not be disorientated by light emissions. Furthermore, once in the water, turtle hatchlings orientate by wave fronts and do not appear to rely on visual cues (Pendoley, 2014); therefore light emissions should not cause disorientation at that distance from land (i.e., >20 km).

Marine turtles have been recorded successfully breeding on VI over the last 20 years with an estimated survival probability of over 94% (Prince and Chaloupka, 2011). This would indicate that the industrial uses on VI, inclusive of the introduction of artificial light sources, have had little to no measurable impact on adult turtles nesting on VI and, to date, have not shown to have led to a long-term decrease in the size of the adult marine turtle nesting population.

The potential impacts of light emissions to flatback, loggerhead, hawksbill and green turtles from the activity are expected to be restricted to localised attraction and temporary disorientation but with no long-term or residual impact due to the short duration of the activity (up to 10 days) . Due to overlap with the BIAs, it is likely that marine turtles will be encountered in the operational area during the nesting and internesting seasons presented. However, it is acknowledged that marine turtles may face multiple threats simultaneously across their lifecycle, including background noise increases and vessel strike. Light emissions may act as a contributor to stock level decline when considering cumulative impacts of threats.

Sharks, fish and rays

The response of fish to light emissions varies according to species and habitat. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan *et al*., 2001), with traps drawing catches from up to 90 m (Milicich *et al.,* 1992). Lindquist *et al*. (2005) concluded from a study that artificial lighting associated with offshore oil and gas activities resulted in an increased abundance of clupeids (herring and sardines) and engraulids (anchovies); these species are known to be highly photopositive. Lighting impacts may increase the risk of predation to these fish species. Shaw *et al.* (2002), in a similar light trap study, noted that juvenile tunas (Scombridae) and jacks (Carangidae), which are highly predatory, may have been preying upon concentrations of zooplankton attracted to the light field of the platforms. This could potentially lead to increased predation rates compared to unlit areas.

However, the low level of light emitted from a vessel is unlikely to lead to large scale changes in species abundance or distribution. Impacts to transient fish will therefore be limited to short-term behavioural effects with no decrease in local population size or area of occupancy of species, nor loss or disruption of critical habitat or disruption to the breeding cycle.

A localised increase in fish activity as a result of vessel lighting is expected to occur as a result of the activity.

Birds (seabirds/shorebirds)

Lighting from the survey vessel may result in behavioural impacts to seabirds including terns and shearwaters. However, as they will be for a short duration, the consequence is considered negligible.

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) and that lighting can attract birds from large catchment areas (Wiese *et al*., 2001). 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 trophic levels, creating food sources and shelter for seabirds (Surman, 2002). The light from offshore platforms and vessels may also provide enhanced capability for seabirds to forage at night.

Light potentially impacts breeding seabirds in the operational area in much the same way as it does marine turtles. A study into light impacts upon nocturnally migrating birds on the North Sea found that birds were disoriented and attracted by red and white light (containing visible long-wavelength radiation), whereas they were clearly less disoriented by blue and green light (containing less or no visible long wavelength radiation) (Poot *et al*., 2008). In addition, disoriented adult birds may not be able to return to their burrows to relieve their mates or feed their young. Fledglings are particularly vulnerable to light through misorientation and disorientation when departing the colony for the first time.

The operational area overlaps BIAs for the Roseate tern and the Australian fairy tern. The proposed Yoorn-1 well is located ~ 22 km from the nearest land mass (Trimouille Island) that may provide seabird roosting or breeding habitat. As this is greater than the 20 km buffer suggested by the National Light Pollution Guidelines, breeding behaviour should not be interrupted. The location of the Yoorn-1 well should not significantly impact foraging behaviour, given the large distances typically covered by breeding individuals

6.2.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ Reduce impacts to marine fauna from lighting on support vessels through limiting lighting to that required by safety and navigational lighting requirements (EPO-2).

The control measures for this activity are shown in **Table 6-10** with EPS and measurement criteria for the EPOs described in **Section 8.**

Table 6-10: Control measures – light emissions

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-03	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.
N/A	Do not use lighting at night time	Reduce risk of impacts from light emissions during environmentally sensitive periods for listed marine fauna (e.g. turtle nesting/hatching).	Vessel lighting is required for safe operations; therefore this control would restrict activity to daylight hours only, causing delays in scheduled activities, which in turn will have time and cost implications.	**Rejected** – Cost is disproportionate to increase in environmental benefit
N/A	Exclude offshore lighting during key periods for fauna	Reduce risk of impacts from light emissions during environmentally sensitive periods for fauna	Delays in scheduled activities, including future activities that are relying on this survey information, which in turn will may have time and cost implications.	**Rejected** – Cost is disproportionate to increase in environmental benefit

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Reduce light intensity and/or frequencies which may attract turtles.	Reduce risk of impacts from the intensity of light emissions for fauna (e.g. turtle nesting/hatching, cetacean and bird migration).	Delays in scheduled activities and cost involved with changing lighting may have significant implications on future activities.	**Rejected** – Cost is disproportionate to increase in environmental benefit given the short duration of the activity

6.2.4 Environmental Impact Assessment

Light emissions	
Key receptors	**Consequence level**
Light emissions	
Disturbance to marine fauna from artificial lighting	
Threatened/migratory fauna	Due to management controls and conclusions of ecological studies undertaken on VI, the artificial lighting associated with the vessel survey is considered unlikely to significantly impact on fauna, including the breeding success of seabird and marine turtle populations.
Physical environment/ habitat	Not applicable – light will not impact the physical environment itself, only the species mentioned above utilising it.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which light emissions are expected.
Protected areas	Light glow may impact sensitive receptors within the Montebello Commonwealth Marine Park, but will be restricted to localised and temporary impacts mentioned to marine fauna above.
Socio-economic receptors	Not applicable – lighting is not expected to cause an impact to socio economic receptors other than as a visual cue for avoidance of the area.
Overall worst-case consequence level	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 or area of occupancy of species, nor loss or disruption of critical habitat, disruption to the breeding cycle or introduction of disease.

6.2.5 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.

There are no safe alternatives to the use of artificial lighting on the survey vessel. Artificial lighting is required on a 24-hour basis for navigational safety in the area, and additional light is required to allow operational activities to proceed safely on a 24-hour basis for occupational health and safety reasons. Therefore, the risks of using 24-hour artificial lighting at an intensity to allow work to proceed are ALARP.

6.2.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence from light emissions is A (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 ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with the intent of the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) and EAG (13) Guidelines for Protecting Marine Turtles from Light Impacts.

Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no stakeholder concerns have been raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) specifies the following priority actions for the Pilbara genetic stock of flatback turtles and NWS genetic stock of green 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.

Based on the range of controls implemented to manage light emissions associated with operational activities, potential impacts to light-sensitive conservation significant fauna is considered to be minimal and will not cause turtles to be displaced from these habitats. Therefore, the negligible impacts expected from light emissions are considered consistent with the management plan and environmentally acceptable.

6.3 Atmospheric emissions

6.3.1 Description of event

Event	Potential atmospheric emissions include greenhouse gases (GHG), such as carbon dioxide (CO_2) and nitrous oxide (N_2O), non-GHGs such as sulphur oxides (SO_X), oxides of nitrogen (NO_X) and ozone depleting substances (ODS) resulting from: + Use of fuel to power vessel engines, generators and equipment; + Incineration generating point source emissions including CO_2, carbon monoxide (CO), NO_X, sulphur dioxide (SO_2) and particulates; and + ODS should leaks occur from refrigeration and chiller systems on survey vessel.
Extent	Localised within the vicinity of the operational area
Duration	Atmospheric emissions generated during the survey, up to 10 days.

6.3.2 Nature and scale of environmental impacts

Potential Receptors: Physical environment (Air quality).

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

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

Physical environment

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

Ozone is a naturally occurring molecule that forms a gaseous layer mostly in the upper atmosphere (the stratosphere) 15-30 km above the surface of the earth and protects life on earth by absorbing ultra-violet radiation from the sun. Scientific evidence indicates that the balance of stratospheric ozone has been upset by the production and release into the atmosphere of ODS, including chlorofluorocarbons, halons, CH_3CCl_3 (Methyl chloroform), carbon tetrachloride, hydrochlorofluorocarbons (a synthetic greenhouse gas) and methyl bromide. ODS and synthetic GHG (HFCs, PFCs and SF_6) are widely used, e.g. in refrigerators, air conditioners and fire extinguishers. These gases deplete the ozone layer by releasing chlorine and bromine atoms into the stratosphere, which destroy ozone molecules. These and other ozone-depleting substances also contribute to varying extents to the enhanced greenhouse effect.

ODS will not be deliberately released during the course the activity. ODS air emissions would only occur in the event of damaged or faulty refrigeration equipment.

Based on the information available, the atmospheric emissions that are a key focus in terms of potential environmental impacts are:

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

6.3.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ Reduce impacts to air and water quality from planned discharges and emissions from the activities (EPO-03).

The control measures for this activity are shown in **Table 6-11** with EPS and measurement criteria for the EPOs described in **Section 8**.

Table 6-11: Control measures – atmospheric emissions

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-04	Vessel planned maintenance system	Reduces emissions from vessels because equipment operating within its parameters	Operational costs and labour/access requirements of undertaking vessels maintenance	**Adopted** – benefits of operating equipment within operational parameters will help maintain vessel fuel efficiency.
CM-05	Fuel oil management	Reduces emissions through use of low sulphur fuel in accordance with Marine Order 97	Operational costs of refuelling	**Adopted** – environmental benefit outweighs the costs.
CM-06	International Air Pollution Prevention Certificate	Reduces probability of potential impacts to air quality due to ODS emissions, high NOx, SOx and incineration emissions	Vessel has current International Air Pollution Prevention Certificate as per vessel class, during vessel contracting procedure and in pre-mobilisation audits / inspections	**Adopted** – under Marine Orders, the vessel must be compliant to operate in Australian waters.
CM-07	Waste incineration management	Reduce potential impacts to air quality due to waste incineration	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).	**Adopted** – environmental benefit outweighs the costs associated with transporting waste to shore for landfill.
N/A	No incineration during vessel-based operations activities	Eliminate the potential for emissions due to waste incineration to impact air quality	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 and/or incineration outweighs on-board incineration.
N/A	Removal of all ODS-containing equipment	Eliminates potential of ODS emissions occurring, impacting on air quality	Lack of refrigeration systems on-board the vessels would lead to unacceptable workplace conditions. It is noted that ODS is rarely found on vessels.	**Rejected** – based on unacceptable workplace conditions (health and safety)
N/A	Alternative fuel type (non-hydrocarbon	Could reduce level of pollutants released	Practical and reliable alternative fuel types	**Rejected** – not feasible

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
	based) selected for the vessel	to the environment during fuel combustion	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.	
N/A	Use incinerators and engines with higher environmental efficiency	Improves air quality by more efficient burning or fuel combustion	Significant cost in changing unknown vessel equipment	**Rejected** – cost grossly disproportionate to low environmental benefit (impact rated negligible)

6.3.4 Environment Impact Assessment

Atmospheric emissions	
Key receptors	**Consequence level**
Atmospheric emissions	
Threatened/migratory fauna	Emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere. Therefore, any potential impacts are not expected to result in a decrease in local population size or disruption to the breeding cycle (A - negligible).
Physical environment/ habitat	The activity may result in the deterioration of local and regional air quality. Gaseous and particulate emissions will, under normal circumstances, quickly dissipate into the surrounding atmosphere.
Threatened ecological communities	Not applicable – no threatened ecological communities identified in the area over which air emissions are expected.
Protected areas	The operational area intersects the State Montebello Islands Marine Park. The values of the marine park are not expected to be impacted given the relatively small volume of emissions produced by a vessel.
Socio-economic receptors	As the activity occurs in offshore waters, the combustion of fuels in such remote locations will not impact on air quality in coastal towns or large human settlements. The emissions 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.
Overall worst-case consequence level	A - Negligible

6.3.5 Demonstration of ALARP

Power generation through combustion of fossil fuels is essential to undertaking the operational activities either by vessel or power generation. Given the routine maintenance of these systems by suitably qualified personnel, all practicable management measures are considered to have been implemented, and the likelihood of significant impacts occurring have been reduced to ALARP.

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

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. It is considered therefore that the impact of the activities conducted is ALARP.

6.3.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence from atmospheric emissions is A (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 ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – pursuant to *Protection of the Sea (Prevention of Pollution from Ships) Act* 1983 and Marine Order 97. In line with the Clean Energy Act, Santos WA identifies opportunities to reduce GHG emissions and implements those deemed viable. Examples include the use of waste heat recovery on some power generators and the conversion of power generation on the String of Pearls platforms to instrument air compressor packages.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are the activities and their risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are risks and impacts consistent with stakeholder expectations?	Yes – no stakeholder concerns have been raised regarding this aspect.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

Atmospheric emissions from vessels are permissible under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, which reflect Marine Order 97 requirements. The fuel oil utilised during the activity will be compliant with Marine Order 97 in order to control emission quality. As an internationally accepted standard that is utilised industry wide, compliance with MARPOL (Marine Order) standards are considered to be an appropriate control measure.

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

6.4 Seabed and benthic habitat disturbance (Commonwealth waters only)

6.4.1 Description of event

Event	Disturbance to the seabed and benthic habitats could potentially occur in Commonwealth waters only: + during the collection of sediment samples which is expected to disturb approximately 1.5 m deep and 1m^2 area per sample with a total seabed disturbance of approximately 4 m^2. + From the placement of a single transponder which will be weighted onto the seafloor using sand bags, with a total disturbance of approximately 1 m^2. This may result in minor seabed disturbance, sedimentation or water quality impacts (i.e. increased turbidity).
Extent	**Localised**: within the operational area.
Duration	For operational life of the activity.

6.4.2 Nature and scale of environmental impacts

Potential Receptors: Physical environment (water quality and benthic habitats), threatened/migratory fauna (marine reptiles, sharks, fish and rays), protected and significant areas (marine parks).

Operational activities described above may cause the following impacts:

Direct physical disturbance of benthic and seabed habitat, including benthic fauna by equipment during grab sampling and the temporary placement of the transponder weighted with sandbags for the acoustic positioning system.

Physical environment

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

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

The benthic biota around the operational area is very similar to that of the wider region, with a low species abundance and high species richness. No significant seabed features or biota have been found in the immediate region surrounding this operational area.

The scale of potential habitat loss and seabed disturbance from localised vessel survey activities is small in comparison to the vast size of soft substrata habitats spanning the NWS and limestone pavement habitats in the region of operations. The relatively small disturbance area (5 m^2) from these planned activities will therefore not have a significant impact on benthic biota or habitat.

Indirect impacts associated with a temporary (several hours) and localised (within tens of 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 (i.e. turbidity) to nearby shoals and banks, offshore reefs or islands given their distance from the activity.

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 3-5**). 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.

BIAs for marine turtles occur within the operational area, including the loggerhead turtle (internesting and nesting), green, flatback and hawksbill turtles (internesting and critical nesting habitat). However, internesting activities typically occur within shallower waters. The habitat present within the operational area is representative of habitats within the broader BIA and the 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 (5 m^2) and the regional availability of habitat, seabed and benthic habitat disturbance is not expected to affect these species.

Protected and significant areas

The operational area intersects the Montebello Australian Marine Park (Multiple Use Zone - IUCN Category VI). Therefore, seabed and benthic habitat disturbance may occur within the marine park. The conservation values of the marine park (as described in **Section 3.2.2**) that may be directly impacted include:

+ Foraging areas for marine turtles which are adjacent to important nesting sites; and
+ Seafloor habitats and communities of the NWS.

Impacts to these values from seabed disturbance are discussed above, are very localised and not expected to significantly impact the conservation values of the Montebello Australian Marine Park (AMP).

6.4.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ Seabed disturbance is limited to the extent required for sampling (EPO-04).

The control measures considered for this activity are shown in **Table 6-12**. EPSs and measurement criteria for the EPOs are described in **Section 8.**

Table 6-12: Control measures – seabed and benthic habitat disturbance

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-08	No anchoring (unless in emergency)	Avoids potential multiple and repeat disturbances to the seabed.	no additional cost due to the nature of the activity	**Adopted** – the environmental benefits outweigh the costs of implementing measure.
N/A	Take fewer samples	Impacts to the seabed are reduced	Substantial cost to the quality of survey data obtained	**Rejected** – cost outweighs the benefit

6.4.4 Environmental Impact Assessment

Seabed and benthic habitat disturbance	
Key receptors	**Consequence level**
Seabed disturbance	
Threatened/migratory fauna	Given the small scale of the activity, minor and short-term nature of indirect impacts and the regional availability of the habitats present, seabed and benthic habitat disturbance is not expected to impact threatened/migratory species. The consequence level is therefore assessed as negligible (A).
Physical environment/ habitat	Impacts from seabed disturbance are expected to be localised, and indirect impacts may result in short-term increases in turbidity to the immediate vicinity of grab samples and placement of the transponder. Given the nature of the habitats within the operational areas that are representative of those within the region, and the localised nature of disturbance, impacts to the physical environment/habitat are assessed as negligible (A).
Threatened ecological communities	Not applicable – no threatened ecological communities are identified in the area where seabed disturbance could occur.
Protected areas	The operational area intersects the Montebello Marine Park (Multiple Use Zone - IUCN Category VI). The relevant values of the marine park are not anticipated to be significantly affected by seabed distance activities, and therefore the consequence has been assessed as negligible (A).
Socio-economic	Not applicable – disturbance of the seabed and benthic habitat within the operational area will not 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. No stakeholder concerns have been raised regarding this aspect.
Worst case consequence level	A - Negligible

6.4.5 Demonstration of ALARP

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

The activities within the operational area occur in benthic habitats (i.e. primarily soft sediments with little epifauna) that are widely represented at a regional scale on the NWS (RPS, 2010). Impacts will be localised within the operational area and in the immediate vicinity of the grab samples and transponder. The placement of equipment may leave indentations on the seabed and cause a temporary increase in water column turbidity, but this will be limited to the top layer of sediment.

Given the localised nature of activities which may cause seabed and benthic habitat disturbance, and expected rapid recovery time, environmental impacts are expected to be negligible.

The proposed management controls for seabed disturbance are considered appropriate to manage the risk to ALARP.

6.4.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum consequence to seabed and benthic habitats is A (Negligible).
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 ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – strategic objectives of the State Montebello Islands Marine Park met. Consistent with Santos procedures and industry standards.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are performance standards consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

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

6.5 Interaction with other marine users

6.5.1 Description of event

Event	Sources of impact to other marine users may occur as a result of, but not limited to: + The survey vessel moving through the operational area posing collision risk and potential inconvenience; and + Towed equipment. The presence of the activity could potentially inhibit marine user groups, tourism, commercial shipping, fishing and other oil and gas activities.
Extent	Operational area
Duration	Temporary and intermittent interaction with vessels when transiting the operational area

6.5.2 Nature and scale of environmental impacts

Potential Receptors: Socio-economic (commercial fishers, tourism, shipping traffic and other oil and gas activities).

Potential impacts to tourism and recreational fisheries include displacement from the area while the survey vessel is in the operational area.

Socio-economic

There are three Commonwealth and eleven State fisheries that overlap the operational area and are actively fished (**Section 3.2.4**).

An analysis of the current fishery closures, depth range of activity, historical fishing effort data, fishing methods and consultation feedback (refer to **Section 4**) has revealed that there is a low potential for interaction with commercial fisheries. None of the Commonwealth fisheries identified in **Section 3.2.4** are likely to be active in the operational area. For state-managed fisheries, the Pilbara Trap Managed Fishery and the Pilbara Line Fishery of the Pilbara Demersal Scalefish Fishery may access the operational area. The Pilbara Trap Managed Fishery is seaward of the 30 m isobath and landward of the 200 m isobaths; there are six licenses with the allocation consolidated onto three vessels (DoF, 2012). The Pilbara Line Fishery licensees are permitted to operate anywhere in Pilbara waters over a restricted season; there are nine licences in this fishery.

To avoid impacts to commercial fisheries, the activity will avoid commercial fishing vessels and schooling fish in the vicinity of commercial fishing activities. Therefore, there are no impacts expected to commercial fisheries.

The nearest recognised shipping route is approximately 10 km outside of the operational area (**Figure 3-16**). Analysis of historical AUSREP shipping data indicates that commercial vessels do use the general area, however this is most likely vessels in the oil and gas industry as activity is mostly located around oil and gas fields with transit to and from ports. Should commercial vessels need to deviate from planned routes to avoid the activity vessel, this may slightly increase transit times and fuel consumption. No concerns have been raised by the shipping industry through consultation or in the past five years relating to disturbance to shipping routes as a result of activities within the region.

Tourism activities are expected to occur infrequently in the operational area. Activities such as snorkelling, diving, surfing and fishing activities are most likely to occur around the Islands, banks and shoals, as is traditional or subsistence fishing. Interaction with tourism and the survey vessel are unlikely to occur, potentially resulting in minor deviations from their planned route, which may slightly increase transit times and fuel consumption.

AMSA requires a high level of communication during the activity, and inclusion of the activity on a notice to mariners, therefore reducing the likelihood of interaction with other sea users.

6.5.3 Environmental performance outcomes and control measures

EPOs relating to this hazard 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 (EPO-05).

The control measures for this activity are shown in **Table 6-13**. EPSs and measurement criteria for the EPOs are described in **Section 8.**

Table 6-13: Control measures – interaction with other marine users

Reference No	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-03	Lighting will be used as required for safe work conditions and navigational purposes.	Reduces 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 operating navigational equipment. Costs associated with vessel fit-out with navigational equipment.	**Adopted** – The safety benefits (and thus environmental benefits) outweigh the cost. Compliance with Marine Orders are a legislated requirement.
CM-09	Seafarer competency and certification	Requires appropriately trained and competent personnel to navigate vessels to reduce interaction with other marine users.	Costs associated with personnel time in obtaining qualifications.	**Adopted** – Benefits considered to outweigh costs and is a legislated requirement
CM-02	Constant bridge watch on survey vessel	Minimises risk of collision through visual identification and avoidance of other vessels and Reduce impacts to commercial fisheries by actively avoiding their activities and schooling fish in their vicinity	Negligible costs	**Adopted - -** Benefits considered to outweigh costs
CM-10	Stakeholder consultation	Santos WA will update relevant stakeholders on a quarterly basis and prior to the activity commencing	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 WA
CM-11	No fishing from vessel	Reduce potential impacts to fisheries in the vicinity of the activity	Negligible costs.	**Adopted** – Benefits considered to outweigh negligible costs to Santos WA

Reference No	Control measure	Environmental benefit	Potential cost/issues	Evaluation
N/A	Eliminate the use of the survey vessel	Would eliminate potential impacts to other marine users	Not considered feasible as a vessel is the only form of transport that can undertake the survey activity	**Rejected** – Not feasible
N/A	Manage the timing of the survey to avoid peak marine user periods (e.g. tourism and recreational fishing)	Would eliminate potential impacts to other marine users	Not considered feasible as marine users could potentially be in the area all year round when operational activities are required all year round. The area that stakeholders are excluded from is small when compared to the area available to other marine users, and there is low fishing activity in the area as evidenced through consultation.	**Rejected** – Stakeholders in the area all year round

6.5.4 Environmental Impact Assessment

Interaction with other marine users	
Key receptors	**Consequence Level**
Interaction with other marine users	
Threatened/migratory fauna	Not applicable – related to socio-economic receptors only.
Physical environment/ habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	Commercial fishing, shipping and tourism in the area is expected to be low. Santos WA has committed to avoiding active commercial fishing and schooling fish in the vicinity of commercial fishing activities to negate any impacts to commercial fisheries. Other marine users currently plan their activities in consideration of other petroleum activities and other marine users (shipping) in the region. AMSA requires a high level of communication during the activity, therefore reducing the likelihood of interaction with other sea users.
Overall worst case consequence	A - Negligible

6.5.5 Demonstration of ALARP

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

Stakeholders have been informed of the proposed installation activity as detailed in **Section 4**. Throughout the duration of EP preparation, details of the activity have been communicated to relevant stakeholders as appropriate. In consultation, stakeholders are made aware of the proposed area from which other marine users may be excluded for the duration of the activity and the potential schedule.

No concerns have been raised by stakeholders regarding the potential exclusion from the proposed operational area.

The proposed management controls for marine user interaction are considered appropriate to manage the risk to ALARP.

6.5.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum interaction with other marine users consequence is A (Negligible).
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 ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with Safety of Life at Sea (SOLAS) 1974 and *Navigation Act 2012* and Marine Orders.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management 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 presence of the survey vessels is not expected to significantly affect tourism, commercial fishing operations or shipping traffic given the amount of similar habitat available in the surrounding areas and the various routes that can be taken. If third party operations avoid the operational area, there should be no additional risk of collision, and this risk is therefore acceptable.

The risk level of inhibiting tourism, commercial fishing or shipping operations is therefore considered acceptable in this case, as the vessel will have a collision radar to allow communication between vessels and notifications are issued through Australia Hydrographic Office (AHO) and AMSA. In addition, no concerns have been raised by other sea users regarding the proposed activity (**Section 4**).

6.6 Vessel discharges

6.6.1 Description of event

Event	Planned discharges from the survey vessel to the marine environment include: + Deck drainage/run off; + Sewage and grey water; + Food wastes; + Cooling water; + Bilge water; and + Brine (if a reverse osmosis unit is used for water treatment). **Deck drainage/run off** 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. **Sewage and greywater** The volume of sewage and food waste is directly proportional to the number of persons on-board the vessels. Depending on waste production rates and the specifications of sewage systems available, the total volume of this waste stream generated typically ranges between 0.04 and 0.45 m^3 per day per person. Treated sewage/greywater will be disposed in accordance with Marine Order 96. **Food waste** Putrescible waste is estimated to consist of approximately 1 L of food waste per person per day. The vessel will dispose food waste in accordance with AMSA and Marine Order 95, and MARPOL Annex V. **Cooling water** Seawater is used as a heat exchange medium for the cooling of machinery engines. Cooling water temperatures vary dependent upon the vessel's engines' work load and activity. **Bilge water** While in the operational area, the vessel may discharge oily water after treatment at a concentration of up to 15 ppm through an approved oily water filter system required by Marine Order 91. **Brine** If a reverse osmosis unit is used for water treatment, waste brine generated 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 demand based on the number of people on-board.
Extent	Localised: within the area around the discharge points and in the direction of the prevailing current in surface waters. The discharges are expected to be dispersed and diluted rapidly, with concentrations of wastes significantly dropping with distance from the discharge point. Changes to ambient water quality outside of the operational area are not expected to occur.
Duration	During the period of the activity, localised impacts to water quality will occur.

6.6.2 Nature and scale of environmental impacts

Potential Receptors: Physical environment (water quality, benthic habitats), threatened/migratory fauna (marine mammals, marine turtles, sharks, rays and fish (pelagic) and seabirds).

Physical environment

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

Eutrophication impacts from sewage, greywater and putrescible food wastes

Sewage liquids and grey water discharges to the ocean from the vessel can cause water discolouration, localised nutrient enrichment, increase in water column productivity of phytoplankton and bacteria, or oxygen depletion from increased biological oxygen demand around the discharge. 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 which could transmit disease to marine fauna and humans.

Dispersion and dilution of discharges is expected to be rapid in the open ocean environment as the discharges are of low volume and short duration, from a vessel that will be moving for the majority of the activity. The discharges will be subject to biodegradation of organics through bacterial action, oxidation and evaporation.

Salinity increases

The desalination of seawater results in a discharge of brine with a slightly elevated salinity (around 10% higher than seawater). On discharge to the sea, the desalination brine, being of greater density than seawater, will sink and disperse in the currents. On average, seawater has a salt concentration of 35,000 ppm. 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 way (e.g. 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 organism. 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, temporary and intermittent nature of brine discharges from the survey vessel, the impact on water quality in the operational area is expected to be low. There is no relationship between the level of salinity and biological or chemical oxygen demand of the discharged concentrate – over 80% of the minerals that encompass concentrate salinity are sodium and chloride, and they are not food sources or nutrients for aquatic organisms.

Changes in water temperature

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.

Temperature dispersion modelling shows that the water temperature of discharged water will decrease rapidly as it mixes with the receiving waters, with discharge waters being less than 1°C above background levels within less than 100 m (horizontally) of the discharge point. Vertically, the discharge will be within background levels within 10 m (Woodside, 2008).

Several studies have been carried out in order to determine how the distribution and abundance of marine flora and fauna species react to a change in temperature. Temperature can have an influence on 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.

Cooling water discharge points vary between vessels. However, they all adopt the same discharge design that permits cooling water to be discharged above the water line, in order to facilitate cooling and oxygenation of this wastewater stream before mixing with the surrounding marine environment. Given the relatively low volume of cooling water, the temperature differential and the open ocean water surrounding the vessel, the impact on water quality is expected to be low and short-term.

<u>Contamination from releases of bilge water and deck drainage</u>

Discharges of oily bilge water could result in a localised reduction in water quality with impacts on protected marine fauna and plankton. However, oily water discharged from vessels will be treated to a concentration (<15 ppm) in accordance with Marine Order 91: Marine Pollution Prevention - Oil requirements that will unlikely lead to any impacts to the receiving environment. Given the concentration and dosage of exposed receptors within surface waters (e.g. plankton, fish) is expected to be very low and toxic, impacts to organisms would be on a negligible scale.

Given that oil and grease residues in oily water drainage will be in low concentrations, the potential for impact is low and would be further reduced due to the strong tidal movements experienced in the region and the naturally turbid environment. Dispersion and biodegradation of potentially contaminated oily water drainage is expected to be rapid and highly localised resulting in no long-term or adverse effects on water quality or marine ecology. An initial dilution of 100:1 is expected to occur from within metres to 10s of metres from the discharge location.

Threatened/migratory fauna

As discussed in the sections above, the discharge extent for planned discharges is localised, and rapid dilution is predicted to occur within the open ocean environment. Marine fauna within the operational area are 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 exposure time may not be of sufficient duration to cause a toxic effect.

Discharges may cause changes to behaviour in marine fauna (i.e. avoidance or attraction). Fishes and oceanic seabirds may be attracted to the discharge of food scraps. However, such discharges would be isolated occurrences and not in any one location, so no prolonged influence on faunal behaviour is expected. Discharges of cooling water and brine may cause avoidance behaviour in marine fauna. Given the nature of the discharges (localised, rapid dilution, intermittent), any behavioural impacts are expected to be short-term and minimal.

Protected and significant areas

The operational area intersects the Montebello Australian Marine Park (Multiple Use Zone - IUCN Category VI). All conservation values of the marine park (as outlined in **Section 3.2.2**) have the potential to be impacted by planned operational discharges through impacts to the physical environment and marine fauna as discussed in the sections above. Therefore, planned operational discharges are not expected to significantly impact the conservation values of the Montebello AMP.

6.6.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ Reduce impacts to air and water quality from planned discharges and emissions from operational activities (EPO-03).

The control measures considered for this activity are shown in **Table 6-14**. EPSs and measurement criteria for the EPOs are described in **Section 8**.

Table 6-14: Control measures evaluation for operational discharges

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-12	Vessel sewage system	Reduces potential impacts of inappropriate discharge of sewage. Drives compliance with MARPOL requirements.	Personnel cost in ensuring vessel 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.
CM-13	Vessel oily mixtures system	Reduces potential impacts of planned discharge of oily water to the environment Provides compliance with Marine Order 91 Marine Pollution Prevention – Oil.	Additional time and personnel costs in maintaining oil record book.	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time and is a legislated requirement.
CM-14	Waste (garbage) management plan	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations. Drives compliance with MARPOL requirements and prohibits the discharge of food within 3nm of land (i.e. within State waters).	Personnel cost of pre-mobilisation audits and inspections, and in reporting discharge levels	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time
CM-15	Deck cleaning product selection procedure	Deck cleaning materials are selected based on MARPOL requirements - Marine Order 95	Costs minimal	**Adopted** – Benefits outweigh costs
N/A	Scupper plugs on survey 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
N/A	Mandatory closed drain system on survey vessel to prevent deck drainage discharged overboard.		Increased cost due to treatment system required, modifications to vessels, storage space required for containment of drained liquids,	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer.

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
			increase in transfers to vessels resulting in increased potential impacts and risks. Increased transfers result in increased fuel usage, increased safety risks to personnel during transfer (e.g. crushing between skips), increase in crane movements.	
N/A	Storage of some wastes on-board survey vessel (e.g. oily water, food waste and sewage) for disposal onshore.	Would eliminate discharge to sea, reducing potential impacts to the marine environment	Storage space required for containment of waste, increase in transfers to vessels resulting in increased potential impacts and risks. Increased transfers results in increased fuel usage, increased safety risks to personnel during transfer (e.g. crushing between skips), increase in crane movements.	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and high potential impacts from risk transfer. Noting that vessels will adhere to Marine Order 95 to ensure waste disposal is undertaken correctly in State/Commonwealth waters.

6.6.4 Environmental Impact Assessment

Planned operational discharges	
Key receptors	**Consequence level**
Operational discharges	
Physical environment/ habitat	As the activity is located in an open oceanic environment where tides and currents would quickly dilute and disperse the planned discharges, and the activity is short-term (days) and transient, it is not expected that impacts to the physical environment or fauna will occur. 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. As such, only short-term behavioural impacts are expected with no decrease in local population size or area of occupancy of species, nor loss or disruption of critical habitat, disruption to the breeding cycle or introduction of disease.
Threatened/migratory fauna	
Threatened ecological communities	Not applicable – no threatened ecological communities are identified in the area where operational discharges are expected to disperse.
Protected areas	The operational area intersects the Montebello Marine Park (Multiple Use Zone - IUCN Category VI). The relevant values of the marine park are not anticipated to be

Planned operational discharges	
Key receptors	**Consequence level**
	significantly affected by vessel discharges, and therefore the consequence has been assessed as negligible (A).
Socio-economic	Not applicable – no planned operational discharges will occur within areas known to be utilised by third party operators or for tourism and recreation. No impacts to fish stocks are expected to occur. Therefore, there is no conceivable impact to commercial, traditional or recreational fisheries.
Overall worst case consequence	A - Negligible

6.6.5 Demonstration of ALARP

Vessels are required to undertake operational activities. On-board 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. The proposed management controls for planned operational discharges are considered appropriate to manage the risk to ALARP. Additional controls considered but rejected are in **Section 6.6.3**.

6.6.6 Acceptability evaluation

Is the consequence ranked as A or B?	Yes – maximum planned operational discharge consequence is rated A (negligible).
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 ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes - management consistent with Marine Orders, and Santos WA procedures. Strategic objectives of the North-West Marine Parks Network met.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management 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 reflects MARPOL Annex IV, V and I requirements respectively and is enacted by:

+ Marine Order 91: Marine Pollution Prevention – Oil;
+ Marine Order 96: Marine Pollution Prevention – Sewage; and
+ Marine Order 95: Marine Pollution Prevention – Garbage.

The operational discharges are not expected to significantly impact the receiving environment with management controls proposed, including compliance with all MARPOL requirements. The MARPOL standard is considered to be the most appropriate standard given the nature and scale of the activities. These standards are internationally accepted and utilised industry wide. Therefore, compliance with the relevant and appropriate MARPOL requirements and standards is expected to reduce the potential for environmental impacts to a level which is considered environmentally acceptable.

Deteriorating water quality is identified as a potential threat to turtles in the marine turtle recovery plan and some bird and shark species. However, the operational discharges are not expected to significantly impact the receiving environment with management controls proposed. Therefore, the activities will be conducted in a manner that is considered acceptable.

6.7 Spill response operations

The spill response strategies that may be adopted in the event of a hydrocarbon spill have been identified in **Section 7.4**. Potential impacts arising from the implementation of the following spill response operations/actions have been assessed as planned events in this section.

6.7.1 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 the OPEP. Spill response will be under the direction of the relevant Controlling Agency, as defined within the OPEP (Section 2.2), which may be Santos WA and/or another agency. In all instances, Santos WA 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 **Section 7.4.3** and comprise: + Source control; + Monitoring and evaluate; + Mechanical dispersion; + Shoreline protection and deflection; + Shoreline clean-up; + Waste management; + Oiled wildlife response; and + 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 disturbance and handling of wildlife may be undertaken intentionally.
Extent	Extent of spill.
Duration	As required.

6.7.2 Nature and Scale of environmental impacts

Potential Receptors: Physical environment, Threatened/migratory fauna, Protected areas (Marine Parks, KEFs, Commonwealth Heritage Place) and 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 6-15**.

Table 6-15: 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:	Threatened/ Migratory Fauna Protected Areas Socio-Economic
Lighting may cause behavioural changes to fish, birds and marine turtles which can have a heightened consequence during key life-cycle activities, for example turtle nesting and hatching. Turtles and birds, which includes threatened and migratory fauna, have been identified as key fauna susceptible to lighting impacts; **Section 6.2** provides further detail on the nature of impacts to fish, birds and marine turtles. Spill response activities which require lighting may take place in protected areas important to turtles and birds, for example, shoreline locations of Barrow Island and the Montebello Islands are seasonally important for turtles, including BIAs and critical habitats. This could result in, indirect impacts on the values of the protected areas. As a consequence of impacts to fauna, lighting has the potential to impact supported industries such as tourism.	
Noise:	
Spill response activities will involve the use of aircraft and vessels which will generate noise both offshore and in proximity to sensitive receptors in coastal areas. Spill response activities will also involve the use of equipment on coastal areas during clean-up of shorelines (e.g. pumps and vehicles), for accessing shoreline areas (e.g. vehicles) and for supporting temporary camps (e.g. diesel generators).	
Potential receptors:	Threatened/ Migratory Fauna Protected Areas Socio-Economic
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** provides further detail on these impacts from vessels. Cetaceans have been identified as the key concern for vessel noise within the EMBA. The humpback migration BIA is within the EMBA. Spill response activities using vessels have the potential to impact fauna in protected areas, this includes the Ningaloo World Heritage Area/Commonwealth Heritage Place. Noise and vibration from terrestrial activities on shorelines has the potential to cause behavioural disturbance to coastal fauna including protected seabirds and turtles. Shoreline activities involving the use of noise generating equipment may take place in important nesting areas for turtles and/or roosting/feeding areas for shorebirds. As a consequence of impacts to fauna (including shorebirds, marine mammals and fish), noise has the potential to impact supported industries such as tourism and commercial fishing. Noise from aircraft used for surveillance purposes is not expected to cause disturbance to fauna as the aircraft will remain airborne, however, there may be a resulting loss of amenity value through the presence of and noise from aircraft.	
Atmospheric emissions:	

The use of fuels to power vessel and aircraft engines, generators and mobile equipment used during spill response activities will result in emissions of greenhouse gases (GHG) such as carbon dioxide (CO_2) 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 Threatened/Migratory Fauna Protected Areas

Atmospheric emissions from spill response equipment will be localised (apart from aircraft emissions which will rapidly dissipate) and while there is potential for fauna and flora impacts, the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted. Emissions may occur in protected areas, however, the scale of the impact relative to potential oil spill impacts is not considered great.
Operational discharges and waste:
Operational discharges include those routine discharges from vessels used during spill response which may include: + Bilge water; + Deck drainage; + Putrescible waste and sewage; + Cooling water from operation of engines; and + Brine. In addition, there are specific spill response discharges and waste creation that may occur, including: + Cleaning of oily equipment/vessels and vehicles; + Flushing water for the cleaning of shoreline habitats; + Decanting and disposal of oily water from storage tanks during offshore containment and recovery; + Sewage/putrescible and municipal waste at camp areas; and + Creation, storage and transport of oily waste and contaminated organics.

Potential receptors:	Threatened/Migratory Fauna Physical Environment/habitat Protected Areas Socio-Economic

Operational discharges from vessels, including decanting and disposal of oily water to free storage during offshore containment and recovery operations, 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 6.6**. 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. Cleaning of oil contaminated equipment, vehicles and vessels, has the potential to spread oil from contaminated areas to those areas not impacted by a spill, potentially spreading the impact area and moving oil into a more sensitive environment. Flushing of oil from shoreline habitats is a clean-up technique designed to remove oil from the receptor that has been oiled and remobilise back into the marine environment and result in further dispersion of the oil. The process of flushing has the potential to physically damage shoreline receptors such as mangroves and rocky shoreline communities, increase levels of erosion, and create an additional, and potentially higher, level of impact than if the habitat was left to bio-remediate. Sewage, putrescible and municipal waste will be generated from onshore activities at temporary camps which may include toilet and washing facilities. These wastes have the potential to attract fauna, impact habitats, flora and fauna and reduce the aesthetic value of the environment, which may be within protected areas. The creation,

storage and transport of oily waste and contaminated organics has the potential to spread impacts of oil to areas, habitats and fauna not previously contaminated.

Physical presence and disturbance:

The movement and operation of vessels, aircraft, vehicles, personnel and equipment, undertaking of clean-up activities and the set-up of temporary camp areas during spill response activities has the potential to disturb the physical environment and marine/coastal habitats and fauna, which may include those habitats and fauna within protected areas. Disturbance may also impact cultural and amenity 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:	Threatened/Migratory Fauna Physical Environment/habitat Protected Areas Socio-Economic

The use of vessels may disturb benthic habitats in coastal waters including corals, seagrass, macroalgae and mangroves. Impacts to habitats from vessels include damage through the deployment of anchor/chain, nearshore booms and grounding. Vessel use in shallow coastal waters also increases the chance of contact or physical disturbance with marine megafauna such as turtles and dugongs. Booms create a physical barrier on the surface waters that has the potential to injure or entangle passing marine fauna that are either surface breathing or feeding.

The presence of and noise from surveillance aircraft may result in a temporary loss of amenity value.

Vehicles, equipment, personnel presence and cleaning activities during shoreline response activities have the potential to damage coastal habitats such as dune vegetation, mangroves and habitats important to threatened and migratory fauna including nests of turtles and birds and bird roosting/feeding areas. Shoreline clean-up may involve the physical removal of substrates that could cause impact to habitats and coastal hydrodynamics and alter erosion/accretion rates. As with vessel use, an assessment of appropriate vehicles and equipment to reduce habitat damage, along with the establishment of access routes/demarcation zones, and operational restrictions on equipment/vehicles use will limit sensitive habitat damage and damage to important fauna areas.

The presence of camp areas, although relatively short-term, may disrupt normal behaviour of coastal species such as shorebirds and turtles, and could potentially interfere with nesting and feeding behaviours. The establishment of temporary camp areas will be carried out under direction of DoT and DBCA with suitable advice sought if access is needed to culturally significant areas.

Oiled wildlife response may include the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling such as birds and marine turtles. While oiled wildlife response is aimed at having a net benefit, poor responses can potentially create additional stress and exacerbate impacts from oiling, interfering with life-cycle processes, hampering recovery and in the worst instance increasing levels of mortality.

Impacts from invasive marine species released from vessel biofouling include out-competition, predation and interference with other ecosystem processes. The ability for a non-native species to establish is generally mitigated in deeper offshore waters where the depth, temperature, light availability and habitat diversity is not generally conducive to supporting reproduction and persistence of the invasive species. However, in shallow coastal areas, such as areas where vessel-based spill response activities may take place, conditions are likely to be more favourable.

Impacts from invasive terrestrial species are similar in that the invasive species can out-compete local species (e.g. weeds) and interfere with ecosystem processes. Non-native species may be transported attached to equipment, vehicles and clothing. Such an introduction would be especially detrimental to wilderness areas or protected terrestrial reserves which may have a relatively undisturbed flora and fauna community.

The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow on impacts to socio-economic values and industry (e.g. tourism, fisheries).

Disruption to other users of marine and coastal areas and townships:

Spill response activities may involve the use of vessels, aircraft, equipment and vehicles, and the establishment of temporary camps, in areas used by the general public or industry. The mobilisation of spill response personnel into an affected area may also place increased demands on local accommodation and other businesses.	
Potential receptors:	Socio-Economic Receptors (commercial, recreational and traditional fishing, tourism and recreation, other oil and gas operators)
The use of vessels in the nearshore and offshore environment and the undertaking of spill response activities at shoreline locations may exclude the general public and industry use of the affected environment. As well as impacting leisure activities of the general public, this may impact on revenue with respect to industries such as tourism and commercial fishing. The mobilisation of personnel to small communities has the potential to affect the local community through demands on local accommodation and business, reducing the availability of services to members of the public.	

6.7.3 Environmental performance outcomes and control measures – spill response operations

EPOs, control measures, EPSs and measurement criteria for oil spill preparedness and response activities are outlined in the relevant strategy sections of the OPEP. Control Measures relevant to reducing the potential impacts from spill response operations are shown in **Table 6-16**.

Table 6-16: Control measures for reducing potential impacts from 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.
Acoustic Disturbance			
Vessels and aircraft compliant with Santos WA's 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			
Select temporary base camps in consultation with DoT and DBCA.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.
Atmospheric Emissions			
Where required under MARPOL, vessels will maintain a current 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
Operational Discharges and waste			
Vessel sewage system	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Oily mixtures system	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			(regulatory requirement).
Approved oily water decanting	Reduces impact from discharge of oily water from storage. Frees up space in liquid waste containers to allow further waste collection.	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).
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 WA's 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).
Use of shallow draft vessels for shoreline and nearshore operations.	Reduce seabed and shoreline disturbance.	Operational costs associated with operating shallow draft vessels for shoreline and nearshore operations.	**Adopted –** Considered a standard control.
OSR Team Leader assesses and selects vehicles appropriate to shoreline conditions.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Conduct shoreline, nearshore habitat, bathymetry assessment.	Reduce shoreline habitat disturbance.	Operational costs associated with conducting shoreline nearshore habitat assessment.	**Adopted –** Considered a standard control.
Establish demarcation zones for vehicle and personnel movement considering sensitive vegetation, bird nesting and roosting areas and turtle nesting habitat.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Operational restriction of vehicle and personnel movement	Reduce coastal habitat erosion and compaction.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
to limit erosion and compaction.			
Prioritise use of existing roads and tracks.	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Soil profile assessment prior to earthworks.	Reduce habitat disruption and erosion.	Operational costs associated with soil profile assessment.	**Adopted –** Considered a standard control.
Use of Heritage Advisor if spill response activities overlap with potential areas of cultural significance.	Reduce disturbance to culturally significant sites.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.
Pre-cleaning and inspection of equipment (quarantine)	Reduces potential for invasive species to offshore islands	Cost/effort in inspecting equipment	**Adopted –** Considered a standard control.

6.7.4 Environmental Impact Assessment

Spill Response Operations	
Key Receptor	**Consequence Level**
Spill Response Operations – Light Emissions	
Threatened, migratory, or local fauna	The receptors considered most sensitive to lighting from vessel and shoreline 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. Temporary camps will be positioned at the direction of DoT or DBCA; therefore, the consequence of shoreline lighting is considered *Negligible*. These species are likely to be values of the protected area they occur in (e.g., Montebello Islands, Ningaloo), and the impact to the protected area from light is also considered *Negligible*. As a consequence of impacts to fauna, lighting has the potential to impact supported industries, such as tourism; however, as impacts to fauna are considered negligible, any indirect impacts on tourism will also be *Negligible*.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Acoustic Disturbance	
Threatened, migratory, or local fauna	The receptor considered most sensitive to vessel noise disturbance is the humpback whale during migration season, when these whales come close to the Montebello Islands and Barrow Island during their peak migration (July to October), as well as populations of marine turtles, whale sharks and pygmy blue whales. However, following the adoption of control measures to limit close interaction with protected fauna (i.e., Protected Marine Fauna Interaction and Sighting Procedure (EA-91-II-00003)), a temporary behavioural disturbance is expected only with a consequence of *Negligible*. With respect to noise from onshore operations (mobile equipment and vehicles), nesting, roosting or feeding birds are considered to be the most sensitive to noise, in particular shorebirds that may be aggregating at Montebello Islands, Barrow Island and the Ningaloo coast. The equipment used is not considered to have excessive sound levels and, following direction by DoT and DBCA on the location of temporary camp areas, the consequence to birds from noise is expected to be *Negligible*. Shorebirds may be official values of the protected area they occur in, and the impact to the protected area from noise is also considered *Negligible*.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	A – *Negligible*
Spill Response Operations – Atmospheric Emissions	
Threatened, migratory, or local fauna	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 emissions will be localised and low level, impacts to protected area values, physical environment and socio-economic receptors are predicted to be *Negligible*.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	

<table>
<tr><th colspan="2">Spill Response Operations</th></tr>
<tr><th>Key Receptor</th><th>Consequence Level</th></tr>
<tr><td>Overall worst-case consequence level</td><td>A – Negligible</td></tr>
<tr><th colspan="2">Spill Response Operations – Operational Discharges and Waste</th></tr>
<tr><td>Threatened, migratory, or local fauna</td><td rowspan="5">Operational discharges from vessels may create a localised and temporary reduction in marine water quality, which has the potential to impact shallow coastal habitats in particular; however, following the adoption of regulatory requirements for vessel discharges, which prevent discharges close to shorelines, discharges will have a Negligible impact to habitats, fauna or protected area values. Furthermore, washing of vessels and equipment will take place only in defined offshore hot zones preventing impacts to shallow coastal habitats.

As a consequence of impacts to fauna, operational discharges from vessels has the potential to impact supported industries, such as tourism and commercial fishing; however, as impacts to fauna are considered Negligible, any indirect impacts on socio-economic receptors will also be Negligible.

Onshore, the use of flushing water has the potential to damage sensitive shoreline and intertidal habitats, e.g., mangroves; however, low-pressure flushing only will be used, preventing further damage to habitats or erosion of sediments. For sensitive habitats, the deployment of booms will be considered to retain flushed hydrocarbons, if this presents a net benefit. Following these control measures, the use of flushing to clean shorelines and intertidal habitats is seen to have a Negligible additional impact to habitats, fauna or protected area values.

The cleaning of contaminated vehicles and equipment onshore has the potential to spread oily waste and damage habitats if not contained. Decontamination units will be in used during the spill response, thus containing waste and preventing any secondary contamination. The consequence of cleaning discharges is therefore ranked as Negligible in terms of impacts to habitats, fauna or protected area values.

Sewage, putrescible waste and municipal waste generated onshore will be stored and disposed of at approved locations. The storage, transport and disposal of hydrocarbon-contaminated waste arising from spill response operation actions, such as containment and recovery and shoreline clean up, will be managed by Santos WA's appointed waste management contractor; and dedicated waste containment areas will prevent the spreading or leaching of hydrocarbon contamination. The consequence of sewerage discharges is therefore ranked as Negligible in terms of impacts to habitats, fauna or protected area values.</td></tr>
<tr><td>Physical environment or habitat</td></tr>
<tr><td>Threatened ecological communities</td></tr>
<tr><td>Protected areas</td></tr>
<tr><td>Socio-economic receptors</td></tr>
<tr><td>Overall worst-case consequence level</td><td>A – Negligible</td></tr>
<tr><th colspan="2">Spill Response Operations – Physical Presence and Disturbance</th></tr>
<tr><td>Threatened, migratory, or local fauna</td><td rowspan="3">The use of vessels and nearshore booms has the potential to disturb benthic habitats, including sensitive habitats in coastal waters, such as corals, seagrass, macroalgae and mangroves. A review of shoreline and shallow water habitats and of bathymetry and the establishment of demarcated areas for access and anchoring will reduce the level of impact to Negligible.

The use and movement of vehicles, equipment and personnel during shoreline response activities has the potential to disturb coastal habitats, such as dune</td></tr>
<tr><td>Physical environment or habitat</td></tr>
<tr><td>Threatened ecological communities</td></tr>
</table>

Spill Response Operations	
Key Receptor	**Consequence Level**
Protected areas	vegetation, samphire and mangroves, and important habitats of threatened and migratory fauna, including nests of turtles and birds and bird roosting areas. Furthermore, clean-up can involve physical removal of substrates that could impact habitats and fauna and alter coastal hydrodynamics. As with vessel use, an assessment of appropriate vehicles and equipment to reduce habitat damage, along with the establishment of access routes, demarcation zones, and operational restrictions on equipment and vehicle use, will limit sensitive habitat damage and damage to important fauna areas. The establishment of temporary camp areas will be done under direction of DoT and DBCA with suitable advice sought if access is needed to culturally significant areas. Following these and other control measures, the resultant consequence to the physical environment and habitat is assessed as *Minor*, indicating that there may be a detectable reduction in habitat area from response activities (as separate from spill impacts), but recovery will be relatively rapid once spill response activities cease. As with all spill response activities, this disturbance will only occur if there is a net benefit to accessing and cleaning shoreline areas. The main direct disturbance to fauna would be the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling impacts, such as birds and marine turtles. This would only be done if this intervention were to deliver a net benefit to the species, but it may result in a *Minor* consequence. These habitats or environments are likely to be values of the protected area they occur in, and the impact to the protected areas from physical disturbance is therefore also considered *Minor*. The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow-on impacts to socio-economic values and industry (e.g., tourism, fisheries). This impact is considered *Minor.*
Socio-economic receptors	
Overall worst-case consequence level	B – *Minor*
Spill Response Operations – Disruption to Other Users of Marine and Coastal Areas and Townships	
Threatened, migratory, or local fauna	The use of vessels in the nearshore and offshore environment and spill response activities at shoreline locations and within townships may exclude general public and industry use. Note 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*.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	B – *Minor*

6.7.5 Demonstration of ALARP

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

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

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

Santos WA considers the actions prescribed in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) and Approved Conservation Advice for other threatened fauna (**Table 3-5**) relevant to spill responses for the activities to minimise noise and light impacts on marine cetaceans, fish and marine turtles. The proposed activity will not result in significant impacts on these species and implementation of identified control measures is in line with the relevant Conservation Advice and Recovery Plans. Pollution events (such as hydrocarbon spills) could impact on fauna (as described in **Section 7.4**), 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 as provided in **Section 6.7.3** will reduce potential impacts to marine fauna and these are consistent with current conservation advice. The assessed residual consequence for this impact is minor and cannot be reduced further without disproportionate costs. It is considered therefore that the impact of the activities conducted are acceptable and ALARP.

6.7.6 Acceptability evaluation

Is the consequence ranked as A or B? Is the risk ranked between Low to Medium?	Yes – maximum consequence is a B (Minor) from planned events and maximum risk is Medium.
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 ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with EPBC Act Regulations (Part 8), Marine Orders (91, 96 and 97) and Australian Ballast Water Requirements.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management Policy.
Are risks and impacts 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. Wildlife response will be conducted in accordance with the WA Oiled Wildlife Response Plan (WA OWRP) and Pilbara Regional Oiled Wildlife Response Plan.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

7 Unplanned activities risk assessment

OPGGS(E)R 2009 Requirements
Regulation 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.
Regulation 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.
Regulation (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.

P(SL)(E)R 2012 Requirements
Regulation 14(3)
The environment plan must include: (a) details of all environmental impacts and environmental risks of the petroleum activity; and (b) an evaluation of those impacts and risks; and (c) a description of the environmental risk assessment process used to evaluate those impacts and risks, including the terms used in that process to categorise the levels of seriousness of those impacts and risks.
Regulation 14(4)
For the avoidance of doubt, the evaluation mentioned in subregulation (3)(b) must evaluate all the environmental impacts and environmental risks arising directly or indirectly from: (a) all aspects of the petroleum activity; and (b) potential emergency conditions, whether resulting from accident or any other cause

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

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

EP Section	Unplanned event	Likelihood	Consequence	Residual consequence level
7.1	Dropped objects	2 – Very Unlikely	A – Negligible	Low
7.2	Introduction of invasive marine species	1 – Rare	D – Major	Medium
7.3	Marine fauna Interaction	2 – Very unlikely	B – Minor	Medium
7.4	Accidental release of hydrocarbons	2 – Very unlikely	D – Major	Medium

Unplanned releases of small quantities (e.g. from 5 litre containers) of hazardous materials to the marine environment such as lubricating and hydraulic oils were considered not a credible event during the risk assessment. Such materials would only be found below deck (e.g. in engine room) during the activity, with no feasible release pathway to the environment.

7.1 Dropped objects

7.1.1 Description of event

Event	Solid wastes such as containers, cardboard, plastic and polythene packaging may be blown or dropped accidentally in to the sea, potentially impacting sensitive receptors. Release of these waste items may occur as a result of overfull and/or uncovered bins or the loss of survey or personal protective equipment overboard which could result in seabed disturbance or floating debris.
Extent	Localised (seabed and water column within the operational area) to widespread if successfully translocated to new areas via ocean currents or project equipment transit.
Duration	Temporary (or until solid waste degrades or is retrieved).

7.1.2 Nature and scale of environmental impacts

Potential Receptors: Physical environment (water quality and benthic habitats), threatened/migratory fauna (marine reptiles, sharks, fish and rays), socio-economic receptors (fisheries, tourism and recreation).

Non-hazardous solids such as sampling survey equipment and plastics have the potential to smother benthic environments and harm marine fauna through compression, 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 fatality. Marine debris has been highlighted as a threat to marine turtles, humpback whales and whale sharks in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017), Conservation Management Plan for the Blue Whale (Recovery Plan) (DoEE, 2015), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) and Approved Conservation Advice for *Rhincodon typus* (whale shark). The Recovery Plans and Approved Conservation Advices have specified a number of recovery actions to help combat this threat. Of relevance to this activity is the legislation for the prevention of garbage disposal from vessels, which Santos implements through adherence to MARPOL.

Release of any hazardous components such as oily residues may result in the pollution of the immediate receiving environment, which may lead to impacts to marine flora and fauna. Physiological damage, through ingestion or absorption may occur to individual fish, sharks, cetaceans, marine reptiles or seabirds.

Impacts to socioeconomic receptors could occur should debris interfere with other marine users or their equipment (e.g. fishing nets).

The area of potential disturbance due to a non-buoyant dropped object would be restricted to the operational area. The seabed within the operational area is made up of calcareous gravel, sand and silt. The operational area does not overlap any KEFs. Damage to hard substrates, and associated fauna, may occur, however such impact is expected to be restricted to the size of the dropped object, and since the survey vessel will operate over a very short period of time, overall impacts will be negligible.

7.1.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ No unplanned objects, emissions or discharges to sea or air (EPO-6).

The Control Measures for this activity are shown in **Table 7-3**. EPSs and measurement criteria for the EPOs are described in **Section 8**.

Table 7-2: Dropped objects – Control Measures Evaluation

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-14	Waste (garbage) management plan.	Reduces probability of waste being discharged to sea, reducing potential impacts to marine fauna. Ensures food waste is discharged in manner that does not pose risk to the environment. Ensures compliance with Marine Orders (94 and 95) and MARPOL (Annex III and V) requirements as appropriate for vessel class.	Personnel cost of vessel audits and inspections, and in recording and reporting waste management.	**Adopted -** benefits of ensuring vessel is compliant outweighs the costs.
CM-16	Dropped object recovery	Avoids leaving debris on seabed	May delay survey	**Adopted –** where feasible
CM-17	Dropped object prevention procedure.	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects where possible.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted -** benefits of ensuring procedures are followed and measures implemented outweighs the costs of personnel time.

7.1.4 Environmental Impact Assessment

Hazardous and Non-Hazardous Unplanned Discharges – Solid	
Key Receptors	Physical environment (benthic habitats), threatened/migratory fauna (marine mammals, marine reptiles, sharks, fish and rays), socio-economic receptors (fisheries, tourism and recreation)
Consequence	A – Negligible
	Lost equipment, dropped objects, and hazardous/non-hazardous waste could result in localised damage to the seabed, impacts to water quality and the benthic environment. The overall consequence level was assessed as **negligible**.
Likelihood	2 – Very Unlikely
	A set of control measures and checks have been proposed to ensure that the risks of dropped objects, lost equipment or release of hazardous/ non-hazardous solid waste to the environment has been minimised. The likelihood of dropped objects in the operational area is limited and given the controls in place, the likelihood of releasing hazardous and non-hazardous solids to the environment resulting in a negligible consequence is considered very unlikely (assumes potential for a single loss dropped object incident during the activity).

Hazardous and Non-Hazardous Unplanned Discharges – Solid	
Residual Risk	The residual risk associated with this hazard is Low.

7.1.5 Demonstration of ALARP

Wastes generated and equipment used during the activity and managed through the proposed control measures. The control measures proposed are considered sufficient to reduce the risk of solid releases to a level that is ALARP. No further feasible control measures were identified.

7.1.6 Acceptability evaluation

Is the risk ranked between Low to Medium?	Yes –residual risk is ranked 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 ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – Management consistent with MARPOL Annex V. Controls implemented will minimise the potential impacts from the Activity to species identified in relevant Recovery Plans and Approved Conservation Advice (**Table 3-5**) as having the potential to be impacted by marine debris (solid hazardous/ non-hazardous releases).
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management 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 accidental release of hazardous/ non-hazardous solid waste or a dropped object, and the negligible impacts predicted, the risk to the marine environment is considered low and reduced to a level that is considered acceptable. The Activity undertaken with the controls, will be conducted in a manner that is acceptable under the relevant Recovery Plans and Approved Conservation Advice to prevent accidental release of hazardous/ non-hazardous solid (marine debris) (**Table 3-5**).

7.2 Introduction of invasive marine species

7.2.1 Description of event

Event	Introduction of invasive marine species (IMS) may occur due to: + Biofouling on vessels and external/internal niches (e.g. sea chests, seawater systems, etc); + Biofouling on equipment that is routinely submerged in water (e.g. survey equipment); Once established, IMS have the potential to out-compete indigenous species and affect overall native ecosystem function.
Extent	Localised (seabed and water column 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).

7.2.2 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 flora and fauna that have been introduced into a region that is beyond their natural range but have the ability to survive, and possibly thrive (DAFF, 2011). The majority of climatically compatible IMS to the NWS are found in south-east Asian countries.

Some IMS pose a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (DAFF, 2011; 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;
+ out-competing of native flora and fauna for food;
+ human illness through released toxins;
+ depletion of viable fishing areas and aquaculture stock;
+ reduction of coastal aesthetics; and
+ damage to marine and industrial equipment and infrastructure.

The above impacts can result in flow on detrimental effects to marine parks, tourism and recreation.

IMS species of concern are those that are not native to the region; are likely to survive and establish in the region; and are able to spread by human mediated or natural means. Species of concern vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities. IMS, if they successfully establish, can out-compete native species for food or space, preying on native species or changing the nature of the environment and can subsequently impact on fisheries (commercial and recreational) or aquaculture. This is primarily through altering benthic habitats which in turn may result in changes to biological assemblages and a reduction in biodiversity.

It is recognised that artificial, disturbed and/or polluted habitats in tropical regions are susceptible to introductions which is why ports are often areas of higher IMS risk (Neil *et al*., 2005). 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. For this reason, increased management requirements have been implemented in recent years by Commonwealth and State regulatory agencies.

Biofouling on vessel hulls and other external niche areas, biofouling on internal niches and biofouling on equipment routinely immersed in water all pose a potential risk of introducing IMS into Australia. The potential biofouling risk presented by the survey vessel will relate to the length of time that the vessel has already been operating in Australian waters or, if it has been operating outside Australian waters, the location/s of the operations it has been undertaking, the length of time spent at these location/s, and whether the vessel has undergone hull inspections, cleaning and application of new anti-foulant coating prior to returning to operate in Australia.

7.2.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ No introduction of marine pest species (EPO-7).

The Control Measures for this activity are shown in **Table 7-3**. EPSs and measurement criteria for the EPOs are described in **Section 8**.

Table 7-3: Introduction of IMS – Control Measures Evaluation

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-18	Invasive marine species management plan	The risk of introducing IMS is reduced due to assessment procedure	Personnel costs involved in risk assessing vessels in accordance with the IMSMP. Costs associating with reducing the vessel risk to 'low' e.g. dry docking, hull cleaning or additional costs due to inspections. Could lead to potential delays and therefore costs, in vessel contracting process due to availability of vessels.	**Adopted** – minimal personnel costs and potential delays or costs to project are considered outweighed by the benefits of reducing the risk of IMS.
CM-19	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.
N/A	Restrict vessel operations to using vessels and equipment that have operated in local, State or National waters to reduce potential for IMS.	Reduce potential for IMS to be transported into area since vessels would not have originated elsewhere.	Vessels and equipment suitable for the activity may not be available in State/National waters therefore work could not be completed.	**Rejected** – not feasible without significant impact on survey objectives / schedule.
N/A	Mandatory dry docking of vessels prior to entering field to clean vessel and/or equipment and remove biofouling.	Demonstrates that no IMS were 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. Given other controls in place already reducing the

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
				risk, cost outweighs benefit.

7.2.4 Environmental Impact Assessment

Invasive Marine Species	
Key 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)
Consequence	D – Major
	IMS could result in reduction in diversity or health of the ecosystem, which may result in economic losses with long-term effects on industry. The overall consequence level was assessed as **major**.
Likelihood	1 – Rare
	The pathways for IMS introduction are well known, and subsequently standard preventative measures are proposed. It is unlikely that an IMS would be able to successfully translocate from the operational area to surrounding shallower habitats. With controls in place to reduce the risk, introduction of IMS is considered unlikely.
Residual Risk	The residual risk associated with this hazard is Medium.

7.2.5 Demonstration of ALARP

The proposed management controls for IMS are considered appropriate to manage the risk of pest introduction in this case and bring the chance of pest introduction to ALARP. Additional controls considered but rejected are detailed below.

Ballast water exchange will be managed in accordance with the IMSMP and legislative requirements, to demonstrate vessels are low risk so that marine pest species are not introduced.

Santos WA has adopted a risk-based approach to managing biofouling given it is not practicable or reasonable to inspect and/or clean every vessel before each voyage. Such an approach is consistent with other petroleum operators on the NWS and is beyond that enforced on the majority of commercial and recreation vessels that regularly transit the same bioregion. International vessels are given the highest priority to prevent the introduction of marine pest species into Australian waters. However, domestic vessels (Interstate and locally sourced) are also risk-assessed to reduce the likelihood of spreading marine pest species already established in Australian waters. Through the biofouling risk assessment approach, Santos WA is confident that the *Fish Resources Management Act 1994* and associated regulations prohibiting the introduction of non-endemic fish species will be met.

With adherence to the proposed management controls, the risk to the environment from these waste streams is considered to have been reduced to ALARP.

7.2.6 Acceptability evaluation

Is the risk ranked between Low to Medium?	Yes – introduction of invasive marine species residual risk ranking is Medium.
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 ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with *Biosecurity Act* (2015) and National Biofouling Guidance for the Petroleum Industry.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management 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).

All vessels and in-sea equipment that are internationally mobilised will meet the requirements of the Santos IMSMP which addresses all applicable State and Commonwealth regulatory requirements. Application of the proposed management and adherence to regulations reduces the likelihood of introducing IMS into the operational area. While the potential exists for IMS to be translocated to the area, with the application of rigorous preventative measures and controls, the risk is deemed acceptable in this case.

7.3 Marine fauna interaction

7.3.1 Description of event

Event	There is the potential for vessels or equipment 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 survey vessel.
Duration	During the Activity.

7.3.2 Nature and scale of environmental impacts

Potential receptors: Threatened/migratory fauna (marine mammals, marine turtles, whale sharks, seabirds).

Cetaceans are naturally inquisitive marine mammals that are often attracted to vessels underway; for example, dolphins commonly 'bow ride' with vessels.

Marine fauna in surface waters that would be most at risk from vessel collision include marine mammals, marine turtles and whale sharks. As summarised in **Figure 3-6** to **Figure 3-12**, the operational area overlaps with a number of BIA's including breeding BIA's for five seabird species, internesting BIAs for four turtle species, a migration BIA for the humpback whale and a distribution BIA for the pygmy blue whale. Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) indicates that humpback whales are one of the most frequently reported whale species involved in vessel strikes worldwide (Laist *et al*., 2001; Jensen & Silber, 2003). The increase in vessel numbers (Silber & Bettridge, 2012) is not only a threat to humpback whales in relation to vessel strikes but also in disturbance and displacement from key habitats. Similarly, boat strike is also recognised by the Approved Conservation Advice for *Rhincodon typus* (whale shark) as one of the threats to the recovery of whale sharks.

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, 2004). There have been recorded instances of cetacean deaths as a result of vessel collisions in Australian waters (e.g. a Bryde's whale in Bass Strait in 1992) (WDCS, 2004), though the data indicate this is likely to be associated with container ships and fast ferries. Whale and Dolphin Conservation Society (WDCS) (2004) also indicates that some cetacean species, such as humpback whales, can detect and change course in order to avoid a vessel.

The most commonly sighted whale in continental shelf waters of the region is the humpback whale. The humpback whale migrates between calving grounds in the Kimberley region of WA to feeding grounds in Antarctica; with the northbound migration from early June to early August (BHPB, 2005), and the peak of the northbound migration between Exmouth Gulf and the Dampier Archipelago occurring around July, concentrated inshore of the 200 m depth contour (Jenner *et al.*, 2001). The southern migration, which peaks around early September, with pods travelling in shallower waters, typically at 30 - 100 m and passing to the west of Barrow Island and north of the Montebello islands. Higher numbers may be encountered in the operational area during humpback whale southern migration, however significant numbers may be expected given the water depths at the operational area are approximately 40 – 50 m.

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).

It is likely that individual loggerhead, green, hawksbill and flatback turtles may be encountered in the operational area, particularly due to overlap with BIAs and proximity to known nesting beaches.

Marine turtle mortality due to boat strike has been identified as an issue in Queensland waters in the Marine Turtle Recovery Plan (Commonwealth of Australia, 2017). However, turtles appear to be more vulnerable to boat strike in areas of high urban population where incidents of pleasure crafts are higher. WA turtle populations have not been highlighted as those most affected by boat strike, possibly due to the relatively low human population density of the NWS coast line.

7.3.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ No injury or mortality to EPBC Act and WA Biodiversity Conservation Act 2016 listed marine fauna during activities (EPO- 01).

The Control Measures for this activity are shown in **Table 7-4**. EPSs and measurement criteria for the EPOs are described in **Section 8.**

Table 7-4: Marine Fauna Interaction – Control Measure Evaluation

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-01	Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from vessels because if they are 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 WA.
CM-02	Constant bridge watch on survey vessel	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost – industry practice	**Adopted** – industry practice, benefits outweigh cost.
CM-15	Deck cleaning product selection procedure	Ensures products meet the criteria for not being harmful to the marine environment	No additional cost – industry practice	**Adopted** – industry practice, benefits outweigh cost.
CM-23	Vessel chemical management procedures	Ensures any chemicals are managed appropriately to reduce the likelihood of unplanned discharges	Negligible costs of following procedure	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant, outweighs the costs. Regulatory requirement must be adopted.
N/A	Restrict the timing of activities to operate outside of	Reduce risk of collisions (causing harm) during environmentally	Protected Marine Fauna species are present year-round meaning there are no	**Rejected** – Grossly disproportionate to the environmental benefit and would severely limit

CM Reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
	sensitive periods only	sensitive periods for listed marine fauna.	non-sensitive periods to operate in.	operations which are required to occur 24 hours a day, 7 days a week.
N/A	Dedicated Marine Fauna Observer on survey vessel	Improved ability to spot and identify marine fauna at risk of collision (that may cause harm)	Additional cost of contracting MFO.	**Rejected** – Risk of animals being encountered is too low to justify additional cost of MFO, i.e. cost is disproportionate to environmental benefit.
N/A	Activities will only occur during daylight hours.	Potential for a vessel-fauna collision occurring is decreased due to vessel being stationary when visibility is lower at night.	Lengthens time of the activity – approximately double. Increased cost due to increased operation time (more than double the cost and therefore grossly disproportionate).	**Rejected** – Substantial additional cost due to doubling of operation duration.

7.3.4 Environmental Impact Assessment

Marine Fauna Interaction	
Key Receptors	Threatened/migratory fauna (marine mammals, marine reptiles, sharks and seabirds).
Consequence	B - Minor
	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 is expected to be limited to a small number of transient individuals. There are multiple BIAs that occur in the operational area; such as internesting areas for marine turtles, migration paths for the humpback whale and breeding locations for a number of seabirds. As such there is the potential for death or injury of EPBC listed individual species, however as they would represent a small proportion of the local population it is not expected that it would result in a decreased population size over what would usually occur due to natural variation, at a local or regional scale. It is expected that the loss of an individual would be a minor consequence.
Likelihood	2 – Very unlikely
	Marine fauna interaction is considered very unlikely given the small operational area and short timeframe, slow moving vessels (typically <5 knots), open ocean environment and the ability for fauna to move away. The Australian National Marine Safety Committee (NMSC) reports that during 2009, there was one report of a vessel collision with a marine animal (species not defined) (NMSC, 2010). No known aggregation areas occur within the operational area and therefore concentrations of milling individuals are unlikely. The noise generated from vessel operations will deter marine fauna from coming in close proximity to vessels.

Marine Fauna Interaction	
	Consequently the likelihood of a collision with marine fauna resulting in a minor consequence is considered to be very unlikely.
Residual Risk	The residual risk associated with this hazard is Medium

7.3.5 Demonstration of ALARP

No alternative options to the use of a vessel are possible in order to undertake the activity. If the management controls are adhered to then the risk of marine fauna collisions will have been reduced to ALARP.

The proposed management controls for marine fauna collision are considered appropriate to manage the risk to ALARP. Additional controls considered but rejected are detailed below.

7.3.6 Acceptability evaluation

Is the risk ranked between Low to Medium?	Yes – maximum marine fauna collisions residual risk ranking is Low.
Is further information required in the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are risks and impacts consistent with the principles of ESD?	Yes – activity evaluated in accordance with Santos WA's Environmental Hazard Identification and Assessment Procedure which considers principles of ESD.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with Part 8 of the EPBC Regulations. Controls implemented will minimise the potential impacts from the activity to species identified in Recovery Plans and conservation advice as having the potential to be impacted by boat strike.
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management 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).

Application of the proposed management and adherence to applicable regulations in line with relevant actions prescribed in the Recovery Plans and Approved Conservation Advices, reduces the likelihood of vessel interactions with marine fauna. While the potential exists for a collision to occur, it is considered a rare scenario. Vessels will be travelling at low speeds within the operational area, also reducing the likelihood of fauna strike. In the unlikely event that an impact did occur, it would be highly probable that only a single individual would be contacted. It is thought that owing to the rare likelihood of a collision occurring, coupled with the potential impact being limited to a single individual, the risk is deemed acceptable in this case.

7.4 Accidental release of hydrocarbons

7.4.1 Description of event

There is the potential for loss of containment of marine diesel as a result of a vessel collision event occurring during the activity, as discussed below. Diesel spill trajectory modelling was utilised to predict the potential extent of a spill event.

Event	It is considered credible that a release of diesel to the marine environment could occur from a collision between the survey vessel and a third party vessel. Such events could have sufficient impact to result in the rupture of a diesel tank (loss of integrity). This is considered credible given the diesel tanks may not be protected or double-hulledm], and fuel tank ruptures resulting in a hydrocarbon release have occurred before. The AMSA (2015) Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities recommend that the spill scenario for modelling and impact assessment should be based on the largest single fuel tank volume. The specific vessel to undertake the survey is yet to be confirmed; a review of available survey vessels indicated that the largest single fuel tank is likely to be up to 250 m^3 in capacity. Although the likely survey vessel's largest fuel tank will be smaller, a conservative modelled spill volume of 329 m^3 has been used for this EP.
Extent	Diesel spill trajectory modelling (GHD 2019) indicated that there was some probability of a 329 m^3 diesel spill extending as follows: + Shoreline loading at low exposure (10 g/m^2) may occur between Ningaloo Coast North, approximately 300 km to the southwest of the release location, and Dampier Archipelago, approximately 150 km to the east. The potential for shoreline contact at the medium (100 g/m^2) and high (1,000 g/m^2) exposure values was confined to the proximal locations of Montebello Islands, Lowendal Islands and Barrow Island. + The maximum potential accumulated oil ashore across all shorelines was modelled as ~222 tonnes, occurring entirely at the Montebello Islands. + Other shoreline receptors that were predicted to receive shoreline oiling during other stochastic realisations included Barrow Island (maximum of ~130 tonnes), Lowendal Islands (maximum of ~11 tonnes) and Dampier Archipelago, Muiron Islands and Ningaloo Coast North (each receiving <0.3 tonnes). + The surface slick exceeding the low exposure value of 1 g/m^2 (visible sheen) was modelled to extend a maximum distance of ~350 km to the southwest and ~200 km to the northeast of the spill location, with a similar predicted spatial extent for the low total entrained oil exposure value (10 ppb). + The low dissolved hydrocarbon exposure value (10 ppb) was predicted to extend a maximum distance of ~220 km to the southwest and ~160 km to the northeast.
Duration	329 m^3 release of diesel was modelled for a release over 0.5 hour, replicating the potential duration of a spill arising from a significant collision. Effects of a worst case spill may involve 10-20 year recovery period.

7.4.1.1 Spill modelling information

Diesel

A surface release of 329 m^3 of diesel was modelled from the survey vessel. Upon release, the diesel is forecast to spread rapidly out to a thin film on the sea surface, and evaporation is forecast to remove approximately 50% of the released volume within several days of release. The diesel will also become increasingly subject to entrainment into the water column as the density increases after losing the lighter components through evaporation (APASA 2013).

7.4.1.2 Diesel characteristics

A summary of the representative characteristics of diesel, as assessed in this EP, is provided in **Table 7-5**.

Table 7-5: Summary of diesel characteristics

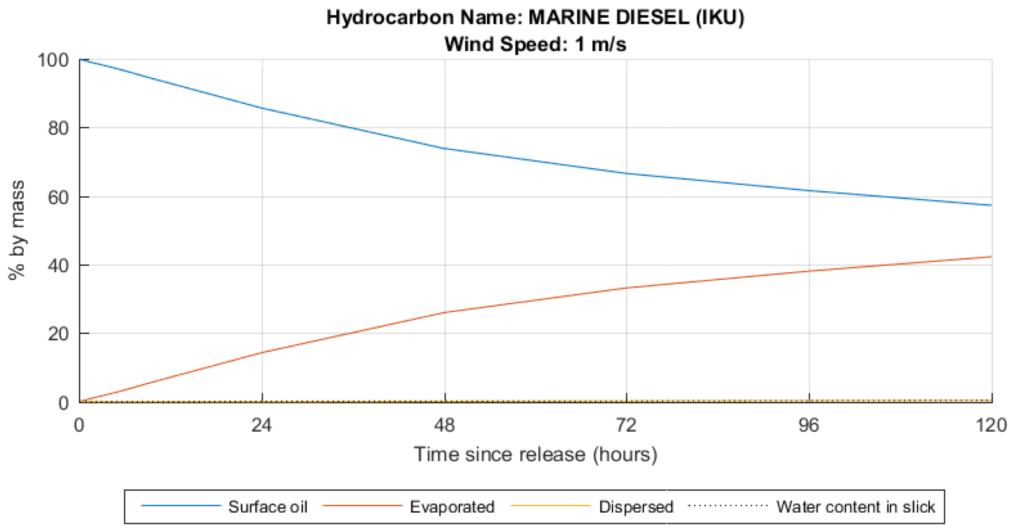
Oil Name	Initial density (g/cm³) (25°C)	Viscosity (cP) (25 °C)	Component	Volatiles (%)	Semi-volatiles (%)	Low Volatility (%)	Residual (%)	Aromatics (%)
			Boiling Points (°C)	<180 C4 to C10	180-265 C11 to C15	265 – 380 C16 to C20	>380 > C20	Of whole oil < 380 °C BP
				NON-PERSISTENT			PERSISTENT	
Diesel	0.8368 @15°C	3.9 @20°C	% of total	6	34.6	54.4	<5	3.0

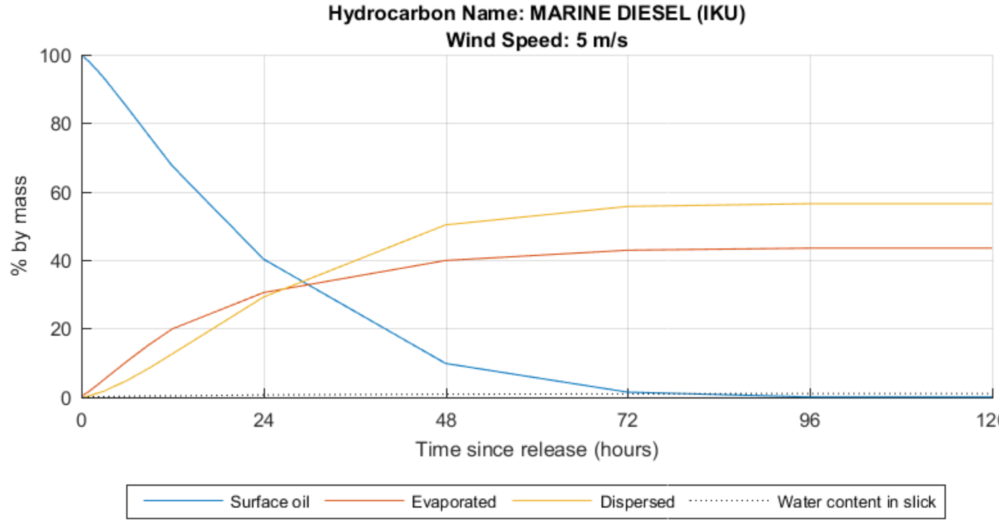
Source: APASA (2014a)

7.4.1.3 Marine Diesel Weathering

A preliminary analysis of hydrocarbon weathering for Marine Diesel was undertaken with the SINTEF Oil Weathering Model (OWM) (GHD, 2019). The OWM predicts the fate of spilled 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 OWM simulations are based on 100 m3 of hydrocarbon released instantaneously onto the sea surface.

The results of the weathering analyses are presented in **Figure 7-1**. Marine diesel is a moderate weight and moderately persistent oil in the marine environment. Under low winds (1 m/s), 60% of the surface slick is predicted to remain after 120 hours (5 days). Under moderate winds (5 m/s), 40% of the initial surface slick is predicted to remain after 24 hours, decreasing further to ~10% after 48 hours and ~1% after 72 hours. With high winds (10 m/s), the surface slick is predicted to be almost entirely evaporated and dispersed after 12 hours. Marine diesel has a very low tendency for emulsion formation with only ~1% water content entrained into the surface slick after 120 hours across the three constant wind assessment conditions.





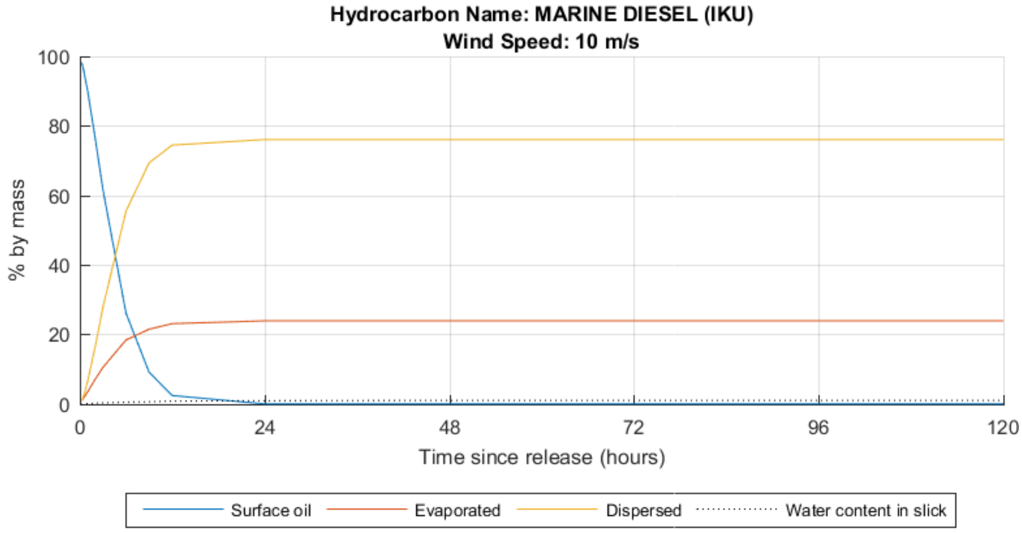


Figure 7-1: Simulated weathering of the SINTEF Marine Diesel (IKU) hydrocarbon for constant wind speeds of 1 m/s (top), 5 m/s (middle) and 10 m/s (bottom)

7.4.1.4 Exposure Values

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

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

Exposure values applied for surface hydrocarbons, total water accommodated fraction (WAF) hydrocarbons (entrained), dissolved WAF and accumulated hydrocarbons ashore used in the modelling study are summarised in

Table 7-6. The adopted exposure values are based primarily on the exposure values defined in NOPSEMA Bulletin #1 Oil Spill Modelling (April 2019).

Table 7-6: Summary of the exposure values applied in the GHD (2019) modelling

Exposure Values			Description
Surface hydrocarbons (floating) (g/m^2)	Low	1	**Risk Evaluation (EMBA)** It is recognised that a lower floating 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 threshold 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 floating oil. **Response Planning** 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.
	Moderate	10	**Risk Evaluation** There is a paucity of data on floating 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 floating oil on birds is better understood than on other receptors. A conservative threshold of 10 g/m^2 has been applied for when ecological impacts would commence from surface hydrocarbons (floating oil) in this EP. Although based on birds, this hydrocarbon threshold is also considered appropriate for turtles, sea snakes and marine mammals (NRDAMCME, 1997). **Response Planning** Contact at 10 g/m^2 is estimated minimum threshold for commencing operational and/or scientific monitoring components.
	High	50	**Risk Evaluation** At greater thicknesses the potential for impact of floating oil to wildlife increases. Studies have indicated that a concentration of surface oil 25 g/m^2 or greater would be harmful for all birds that contacted the hydrocarbon slick (Scholten et al. 1996; Koops et al. 2004). This was chosen as a conservative threshold for high impacts due to the foraging (sooty tern), breeding and foraging (lesser frigatebird); and breeding (wedge-tailed shearwater, Australian fairy tern, lesser crested tern, white-tailed tropicbird and roseate tern) that overlap the operational area. **Response Planning** Contact at 25 g/m^2 is not specifically used for spill response planning.
	Low	10	**Risk Evaluation (EMBA)**

Shoreline Hydrocarbons (g/m²)			An accumulated concentration of oil above 10 g/m² on shorelines is considered to represent a level of socio-economic effect (NOPSEMA, 2019), e.g. reduction in visual amentity 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 accumulations at this concentration cannot be effectively cleaned.
	Moderate	100	**Risk Evaluation** The impact threshold 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 reefs) and coating of marine fauna. Environmental risk assessment studies (French-McCay, 2009) report that an oil thickness of 0.1 mm (100 g/m²) on shorelines is assumed as the lethal threshold for invertebrates on hard substrates (rocky, artificial or man-made) and sediments (mud, silt, sand or gravel) in intertidal habitats. Therefore, a conservative exposure value for impacts of 100 g/m² has been applied to impacts from shoreline accumulation of hydrocarbons. **Response Planning** A shoreline concentration of 100 g/m², 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 threshold equates to approximately ½ a cup of oil per square metre of shoreline contacted.
	High	1000	**Risk Evaluation** At greater thicknesses the potential for impact of accumulated oil to shoreline receptors increases. All other things being equal, accumulation of oil above 1000 g/m² is expected to result in a greater impact. **Response Planning** 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.
Total water accommodated fraction	Low	10	**Risk Evaluation (EMBA)** Entrained hydrocarbons, as opposed to DAHs, 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

(entrained) (ppb)			exposed tissues and ingestion (NRC, 2005) however the level of exposure causing effects is considered to be considerably higher than for DAHs. 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 and dissolved)) may account for much of the observed wide variation in reported threshold 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 threshold represents the very lowest concentration and corresponds generally with the lowest trigger levels for chronic exposure for entrained hydrocarbons in the ANZECC (2019) 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).
	Moderate[1]	100	**Risk Evaluation** The 100 ppb exposure value is considered to be more 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 oil in toxicity tests using water accommodated fractions (WAFs). Given entrained oil is expected to have lower toxicity than dissolved

[1] The NOPSEMA Bulletin (April 2019) lists 'High' exposure values for entrained and dissolved aromatic hydrocarbons of, 100 ppb and 400 ppb, respectively. Santos considers it inconsistent with the mechanisms of oil toxicity to have a High exposure for DAHs greater than that for entrained oil. For that reason, Santos has used 100 ppb as the 'Moderate' exposure value for entrained oil. This is more aligned with the Moderate exposure value for DAHs of 50 ppb – i.e. it is consistent with the mechanism of toxic effect that a Moderate exposure value for entrained oil would be greater than a Moderate exposure value for DAHs.

			aromatics, especially over time periods where these soluble fractions have dissoluted from entrained oil, the higher Moderate exposure value for entrained oil over dissolved aromatic hydrocarbons (100 vs 50 ppb) is considered appropriate. **Response Planning** Encompassed by response to 10 ppb. There is nothing different for higher exposure values
	High	-	No high exposure value for entrained.
Dissolved water accommodated fraction (ppb) [1]	Low	10	**Risk Evaluation (EMBA)** Dissolved Aromatic Hydrocarbons 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 DAHs 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 obtained under turbulent conditions (this includes fine oil droplets) was 6 ppb to 410 ppb with an average of 50 ppb (French-McCay, 2002). Further research by Woodside (Woodside 2019) for Balnaves-3 crude undertook laboratory-based ecotoxicology tests across a range of water accommodated fraction to determine the point of “No observed effect Concentrations (NOECs). The lowest NOEC reported is 123 ppb, from the amphipod acute toxicity tests. All other toxicity tests indicated NOECs ranging from 610 to 6640 ppb, with a median value of 2695 ppb. Based on these ecotoxicology tests, the selected dissolved aromatic hydrocarbon threshold of 6 ppb is considered highly conservative. The DAH modelling results used to inform the EMBA and risk assessment outlined within this EP considers instantaneous exposure and therefore applying the literature concentration data for PAH exposure over 96 hours is considered highly conservative. Nevertheless, a threshold of 10 ppb to inform the EMBA as the lowest concentration documented in research that could have some potential negative effect on marine organisms. This is considered to be sub lethal, with most marine organisms a concentration of between 50 and 400 ppb is considered to be more appropriate for risk assessment. **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).
	Moderate	50	**Risk Evaluation** Approximates potential toxic effects, particularly sublethal effects to sensitive species (refer to above text). Consistent with NOPSEMA (2019). **Response Planning** Encompassed by response to 6ppb. There is nothing different for higher exposure values.
	High	400	**Risk Evaluation** Approximates toxic effects including lethal effects to sensitive species (NOPSEMA, 2019). **Response Planning** Encompassed by response to 6 ppb. There is nothing different for higher exposure values.

7.4.1.5 Exposure values in relation to EMBA

Hydrocarbon exposure values for surface oil, entrained oil, dissolved aromatic hydrocarbons and hydrocarbons ashore have been used to define the spatial extent of the Environment that May Be Affected (EMBA) (see also **Section 3.1**), as shown in **Table 7-7**.

Table 7-7: Summary of EMBA contact thresholds

Hydrocarbon component	Surface oil concentration (g/m^2)	Entrained oil concentration (ppb)	Dissolved aromatic hydrocarbon concentration (ppb)	Hydrocarbons ashore (g/m^2)
Exposure value	Low	Low	Low	Low
EMBA	1	10	10	10

7.4.1.6 Spill modelling results discussion

Floating oil

A surface slick (> $1g/m^2$) was predicted to extend up to approximately 350 km from the release location. Contact by the surface slick at the > $1g/m^2$ exposure value was predicted at the Montebello Australian Marine Park (99% probability with a minimum arrival time of 0.1 days), Barrow-Montebello Surrounds (21% probability and minimum arrival time of 0.3 days) and Montebello Islands (14% probability and minimum arrival time 0.3 days).

Entrained oil (total water-accommodated fraction (total WAF))

Entrained diesel above 10 ppb was primarily confined within 200 km of the release site with some isolated exceedances up to ~350 km to the southwest. Exceedances of the high exposure value (100 ppb) were predicted up to a maximum of ~160 km to the southwest of the spill location and ~140 km to the northeast.

Exposure to entrained oil above the 100 ppb exposure value was forecasted at a number of receptors including the Montebello AMP (95% probability). Lower contacted probabilities were predicted at Montebello Islands (16% probability) and Barrow-Montebello Surrounds (20% probability).

Dissolved oil (dissolved WAF)

Dissolved diesel above 10 ppb was predicted to occur a maximum distance of ~220 km to the southwest and ~160 km to the northeast. Exceedances at the medium exposure (50 ppb) were predicted up to ~150 km to the southwest and ~110 km to the northeast. Concentrations above the high exposure (400 ppb) value were only predicted in sparse patches within ~50 km of the release location.

Contact above the 50ppb exposure value was predicted at a number of receptors, including Montebello AMP (98% probability), Montebello Islands (16% probability) and Barrow-Montebello Surrounds (22% probability).

Shoreline accumulated oil

Oil accumulation on shorelines above the 10 g/m^2 exposure value was predicted to occur at Montebello Islands at a 24% probability. Lower contact probabilities of 1-6 % were predicted for Dampier Archipelago, Lowendal Islands, Barrow Island, Murion Islands and Ningaloo Coast. Minimum times to shoreline accumulation at these receptors ranged from 0.5 days (Montebello Islands) to 6.1 days (Dampier Archipelago). The average maximum volumes of oil accumulated ashore (exceeding the exposure value) were predicted to be 222 tonnes at the Montebello Islands, 130 tonnes at Barrow Island, 11 tonnes for Lowendal Islands and <0.3 tonnes at Dampier Archipelago, Murion Islands and Ningaloo Coast North.

7.4.1.7 Spill risk assessment approach

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

+ Identify the spatial extent of the environment that may be affected (the EMBA);
+ Identify areas of high environmental value (HEV) within the EMBA;
+ Risk assess areas of HEV with a high probability and level of oil contact (Hotspots); and
+ Identifies priorities for protection.

7.4.1.8 Areas of high environmental value (HEV)

Santos WA 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 LTS – These are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour, such as breeding, feeding, resting or migration. Each one of these within the predefined areas contributes to the score.

Further input to determine areas of HEV included:

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

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

7.4.1.9 Hotspots

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); and
+ The greatest potential concentration or volume of oil arriving at the area.

These areas are termed 'Hotspots'. Defining Hotspots is typically the first step in undertaking detailed spill risk assessment and spill response planning. Hotspots 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; and
+ Receive the greatest concentration or volume of oil, either floating or stranded oil, entrained oil or dissolved aromatic hydrocarbons above exposure values described in **Section 7.4.1**

7.4.1.10 Priorities for protection

For the purposes of a spill response preparedness strategy, it is not necessary for all Hotspots to have detailed planning. For example, wholly submerged Hotspots may only be contacted by entrained oil, and the response would be largely to implement scientific monitoring to determine impact and recovery. Hotspots 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, to inform the oil spill response strategy, is based on the worst-case estimate of floating oil concentration, shoreline loading and minimum contact time at exposure value concentrations. 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 is done through a strategic NEBA approach outlined in the OPEP.

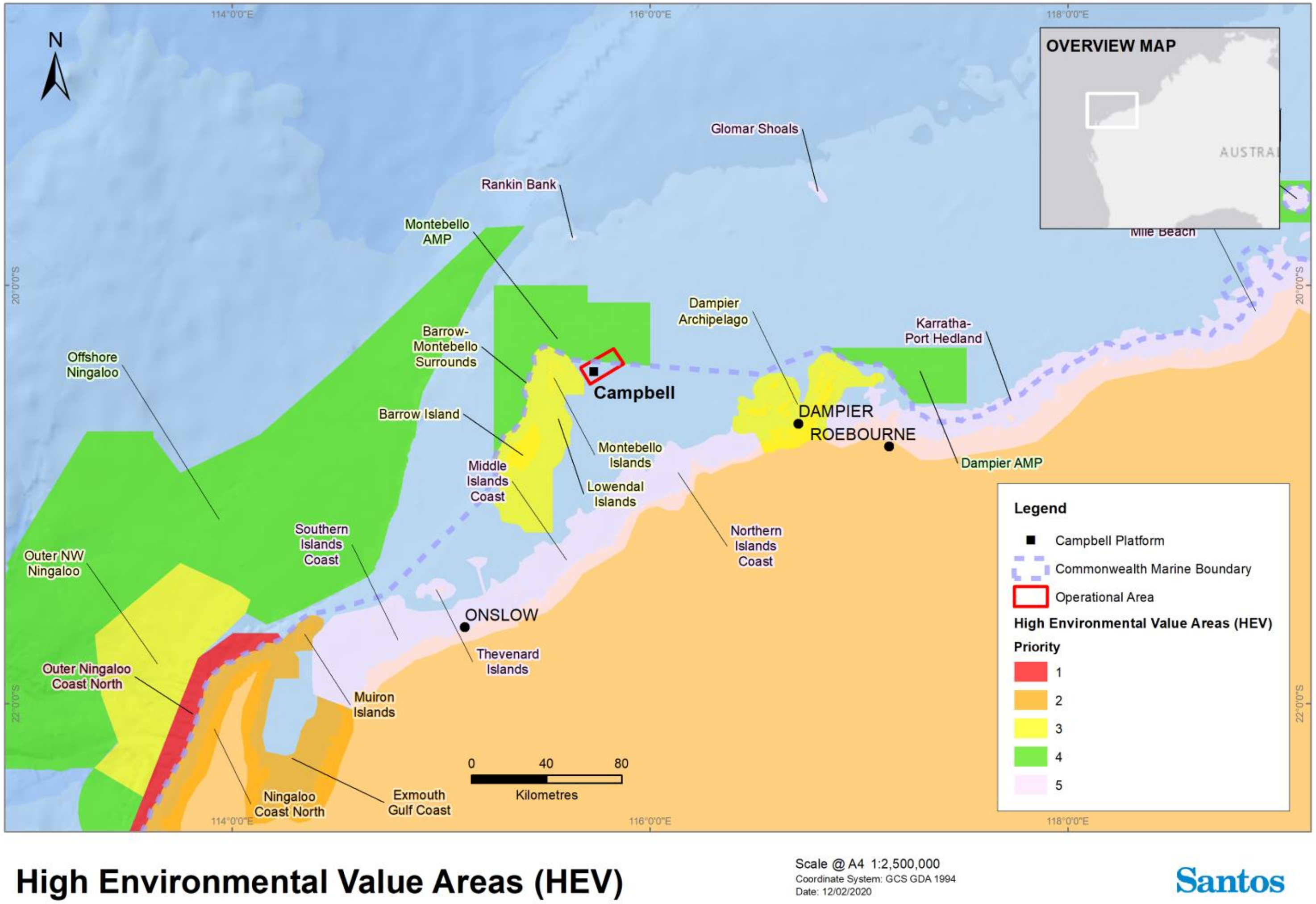


Figure 7-2: HEVs within the EMBA

7.4.2 Nature and scale of environmental impacts

Potential Receptors: Physical environment (Water quality, Shallow benthic, intertidal and shoreline habitats), Threatened/migratory fauna (plankton, invertebrates, marine mammals, marine reptiles, sharks, rays and fish, birds (seabirds and shorebirds), Protected Areas (KEFs, Marine Parks and Commonwealth Heritage Areas) and Socio-economic (commercial, recreational and traditional fisheries, recreation and tourism, oil and gas industry).

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

Unplanned hydrocarbon releases to the marine environment, as a result of a vessel collision (diesel) would result in a localised reduction in water quality in the upper surface waters of the water column near the location of the spill. A worst-case surface release from a vessel collision (diesel) would result in a surface slick, above the exposure value of 1 g/m^2 thickness, potentially extending up to 350 km from the release location. Shorelines in which oil accumulation was predicted (above the 10 g/m^2 exposure value) included the Montebello Islands, Lowendal Islands and Barrow Island, with the average maximum volumes ashore ranging from 220 to <0.3 tonnes. The greatest predicted exposure to entrained oil concentrations (> 10 ppb exposure value) and Dissolved WAF (> 10 ppb) resulted from the release of diesel with exposure forecast at the Montebello AMP, Montebello Islands, and Barrow-Montebello Surrounds at worst-case concentrations ranging from 344 ppb to 1,154 ppb for entrained oils, and 290 ppb to 545 ppb for Dissolved WAF.

The potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors and habitats are summarised in **Table 7-8**. Potential impacts to receptors found within the EMBA are further described in **Table 7-9** with respect to an unplanned spill of all hydrocarbons associated with this EP (diesel). A summary is provided below.

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Table 7-8: Physical and chemical pathways for hydrocarbon exposure and potential impacts to receptors

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Rocky shorelines	Shoreline loading and attachment may result in thin and sporadic coating of hydrocarbon residues. Degree of oil coating is dependent upon the energy of the shoreline area, the type of the rock formation and continual biodegradation of the oil.	Impacts to flora (mangroves) and fauna further described below.	Chemical pathway to fauna and flora via adsorption through cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Impacts to flora (mangroves) and fauna further described below.
Sandy beaches	Shoreline loading and water movement may allow hydrocarbon residue to filter down into sediments, continue to biodegrade on the surface or remobilise into surf zone. Degree of loading is dependent upon the energy and tidal reach of the shoreline, the type of the sandy shore and continual weathering of the oil.	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts to infauna.	Chemical pathway to fauna and flora via adsorption through cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts (mortality) to infauna through toxic effects and smothering.
Intertidal platforms	Shoreline loading and water movement may allow hydrocarbon residue to filter down into sediments, or continue to biodegrade on the surface or remobilise into surf zone. Degree of loading is dependent upon the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the oil.	Indirect impacts to foraging habitats for birds and turtles. Direct impacts to infauna.	Chemical pathway to fauna and flora via adsorption through cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Indirect impacts to foraging habitats for birds. Direct impacts (mortality) to infauna through toxic effects and smothering.
Shallow sub-tidal soft sediments	Hydrocarbon residue in the shallow waters adjacent to shorelines may settle to filter down into sediments. Degree of loading is dependent upon the energy and tidal reach of the shoreline, the type of	Indirect impacts to foraging habitats for turtles and fish. Direct impacts to infauna.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Indirect impacts to foraging habitats for turtles and fish. Direct impacts (mortality) to infauna through toxic effects and smothering.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
	the substrate and continual weathering of the oil.			
Mangroves	Coating of root system reducing air and salt exchange. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the oil.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output. Reduced seed viability.	External contact by oil and adsorption across cellular membranes.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output. Reduced seed viability. Growth abnormalities.
Seagrasses and macroalgae	Coating of leaves/thalli reducing light availability and gas exchange. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the 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.
Hard corals (coral reefs)	Coating of polyps, shading resulting in reduction on light availability. Degree of coating is dependent upon the metocean conditions, dilution, if corals are emergent at all and continual weathering of the oil.	Bleaching. Increased mucous production. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
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 dissolved aromatic hydrocarbons across cellular membranes. Reduced mobility and capacity for oxygen exchange.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.
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 dissolved aromatic hydrocarbons across cellular membranes (e.g. gills).	Mortality. Cell damage. Flesh taint. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.
Birds (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.	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.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
				Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
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.	Behavioural disruption particularly during turtle nesting periods.	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 (i.e. baleen whales).	Behavioural disruption such as deviation from migration pathways and commonly frequented feeding grounds. For smooth skinned marine mammals more susceptible to chemical pathways than physical pathways.	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.
Plankton	Coating of feeding apparatus.	Mortality.	Inhalation. Ingestion.	Mortality.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
	Reduced mobility and capacity for oxygen exchange.	Behavioural disruption (e.g. reduced mobility).	External contact.	Impairment of biological activities (e.g. 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.
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.

Table 7-9: Impacts of a diesel spill on receptors found within the EMBA

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of hydrocarbon spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td colspan="3">Threatened/Migratory fauna</td></tr>
<tr><td rowspan="2">Plankton (including zooplankton; fish and coral larvae)</td><td>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.</td><td>Plankton utilising the sea surface layer could be impacted by floating oil.</td></tr>
<tr><td colspan="2">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 at Montebello Islands. Plankton utilising 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.</td></tr>
<tr><td rowspan="2">Marine mammals</td><td>Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.</td><td>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. Potential impact to feeding apparatus of some species i.e. baleen whales.</td></tr>
<tr><td colspan="2">Nine migratory marine mammal species were identified by the PMST. Of these, two are listed as endangered (blue whale and southern right whale) and three as vulnerable (humpback whale, fin whale and sei whale). The operational area and EMBA overlap with blue whale and humpback whale BIAs (Figure 3-6). For further information on environmental impacts to marine mammals from hydrocarbon exposure and increased toxicity, refer to Table 7-8.

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 between the Pilbara offshore islands and the mainland and have been observed in the shallow waters along the east coast of Barrow Island and</td></tr>
</table>

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	**Surface hydrocarbons**
	over the Lowendal Shelf. The closest BIA (foraging and nursing) is at Exmouth Gulf and the Ningaloo Coast located approximately 182 km from the operational area. Aerial surveys of dugong distribution have found that the animals occur around Barrow Island, Airlie Island, Lowendal Islands and the Montebello Islands further offshore (Prince, 2001).	
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 reptile were identified as possibly being impacted by a spill. Short-nosed seasnake, flatback, hawksbill, leatherback, green and loggerhead turtles are widely dispersed across the 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. The EMBA overlaps with BIAs and critical habitat for four turtle species (flatback, green, hawksbill and loggerhead) as shown in **Figure 3-7** to **Figure 3-10.** Significant green turtle and flatback turtle rookeries are located on the western side of Barrow Island and on the Montebello Islands respectively. Nesting green turtles have also been observed on Varanus Island. Hawksbill turtles are known to nest in greater numbers of the eastern beaches of Varanus Island. Critical habitat including important nesting beaches for other turtle species are present within the EMBA, including locations where spill modelling indicated the accumulation of hydrocarbons on shorelines. The highest average shoreline accumulations, above the 100 g/m^2 exposure value, were predicted at the Montebello Islands, Lowendal Islands, Barrow Island, Barrow-Montebello Surrounds and the Montebello Australian Marine Park. In the event of a spill, the presence of hydrocarbons on beaches would disrupt behaviour and potentially threaten turtle populations. For further detailed environmental impacts to marine reptiles from hydrocarbon exposure and increased toxicity, refer to **Table 7-8**.	
Birds (seabirds and shorebirds)	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.	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

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of hydrocarbon spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td rowspan="2"></td><td></td><td>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">Five threatened species of seabirds and six threatened species of shorebirds were identified within the EMBA by the PMST (Table 3-4). Of these, only 4 species of seabird and 3 species of shorebird were identified within the operational area. The Australian fairy tern (vulnerable status) has foraging habitat intersecting the operational area and a BIA for breeding within the EMBA. Therefore, the species may be impacted by surface and entrained hydrocarbons while foraging (dive and skim feeding) with higher numbers expected during the breeding period of August to February. Other migratory seabird BIAs for breeding and foraging include lesser crested tern, roseate tern and wedge-tailed shearwater, and white-tailed tropicbird (Figure 3-12).

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 slick (diesel spill) could extend up to 350 km from the release location at the 1 g/m^2 exposure value, impacts to birds may include coating by oil when floating in open water, diving into open and coastal waters to feed on fish, wading and foraging on shallow intertidal mud/sand flats or roosting on oil affected sandy beaches. Other impacts could include behavioural impacts whereby birds avoid important nesting and migratory stop-over areas or reduced food availability if important foraging areas are impacted. For further information on environmental impacts to seabirds/shorebirds through hydrocarbon exposure and toxicity effects, refer to Table 7-8.</td></tr>
</table>

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of hydrocarbon spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td rowspan="2">Sharks, Rays and Fish</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 Continental Slope Demersal Fish Communities KEF located approximately 69 km from the operational area) may be exposed. For further information on environmental impacts to fish/sharks/rays from hydrocarbon exposure and toxicity effects, refer to Table 7-8.</td><td>While fish, sharks and rays do not generally break the sea surface, individuals may feed at the surface. For condensate/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 up to 350 km from the release location at the 1 g/m^2 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 supports a diverse assemblage of fish, including 456 species of finfish, particularly in shallower water near the mainland and islands. Threatened species identified by the PMST include the white shark, whale shark, grey nurse shark, sawfishes (dwarf, green, narrow), giant manta ray and reef manta ray 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. Grey nurse sharks, white sharks, sawfishes and manta rays could be present at low densities all year round within the operational area and EMBA, however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted if an unplanned release were to occur.

The whale shark foraging BIA is presented in Figure 3-11 and the main whale shark aggregation location (Ningaloo Marine Park) is 4 km northwest of the operational area. The EPBC Act-listed whale shark may occur in EMBA, particularly off the Ningaloo coastline between March and June and is known to feed in surface waters. There is, therefore, the potential for this species to ingest oil from surface slicks with resultant damage to gills, other tissues and organs. For further information on environmental impacts to fish/sharks/rays from hydrocarbon exposure and toxicity effects, refer to Table 7-8.</td></tr>
</table>

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	**Surface hydrocarbons**
Socio-economic		
Commercial, Recreational and Traditional 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.
	A number of commercial fisheries operate within the EMBA (**Section 3.2.4**). Impacts to these fisheries from a spill may range from disruption of fishing activities caused by the physical presence of the slick, loss of (or loss of function of) coastal intertidal habitat (e.g. seagrass meadows, mangrove communities, intertidal mudflats) which may provide nursery habitat for fishery species (e.g. fish and crustaceans) and contact of surface and entrained hydrocarbons with the eggs and larvae of commercially important species. Exposure to entrained and DAHs could result in the accumulation of oil in fish tissues to the extent that could result in hydrocarbon taint of fish flesh. Connell and Miller (1981) compiled a summary of studies listing the exposure value concentrations at which tainting occurred for hydrocarbons. The results contained in their review indicate that tainting of fish occurs when fish are exposed to ambient concentrations of 4–300 ppm (4,000-300,000 ppb) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest. Given that entrained hydrocarbons are predicted to exceed >1,338 ppb in the scenario of a surface release of marine diesel oil as a result of a vessel collision; **Section7.4.1**), hydrocarbon taint is possible in fish flesh although it is difficult to assess how long fish might be exposed for; small less mobile fishes would be more susceptible. Given the large volume of oil that could potentially be released, it is possible that impacts could be detected to fisheries on a stock level although it is more likely that natural variation in fish abundance would be on a greater scale than any impacts attributable to a hydrocarbon spill. This would most likely be the case for fisheries species that utilise shallow waters around the Barrow and Montebello Islands and could occur through direct impacts to fish or to fish habitats (e.g. seagrass, coral reef, mangrove habitats). The same negative impacts could also occur to important recreational fish species and the recreational fisheries they support although impacts to commercial fisheries could result in the additional impact of loss of income for commercial fishers. Entrained oil >100 ppb could reach pearl farming activities at the Montebello Islands. Pearl oysters are filter feeders, therefore entrained oil droplets could create negative impacts through ingestion and accumulation of hydrocarbon compounds in oyster tissues or interference with respiratory structures. Ecotox (2009) reported NOEC levels of a comparable oyster species from weathered condensates ranged from approximately 9,000 to 28,000 ppm. Such impacts could lead to sub-lethal (e.g. reduced oyster growth rates, reduced reproductive success) or at worst lethal impacts. Given that dissolved hydrocarbons could reach acutely toxic levels, mortality could occur. Significant impacts on aquaculture would be unlikely as predictive modelling reported that the maximum entrained hydrocarbon concentration for the worst replicate as 864 ppb at Barrow-Montebello Surrounds. Additionally, pearling leases identified in the region are currently inactive and no stakeholder concerns have been raised. However, if these leases were to become active within the life of this EP, then some loss of value to the local industry could occur in the event of a loss of well control/vessel collision resulting in a spill.	

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	**Surface hydrocarbons**
Recreation and Tourism	A number of tourism destinations occur within the EMBA, including Ningaloo Reef (which is within a World Heritage Area, National Heritage Place and a Commonwealth Heritage Place) and offshore islands such as the Montebello Islands. A number of areas with high diversity or which have unique ecological values are protected within AMPs. As well as reducing the visual amenity of these areas, a surface slick could impact the habitats and marine fauna of these areas thereby impacting the environmental values of these tourism areas. Depending upon the extent of impact, loss of revenue to coastal towns and communities could also occur.	
Shipping	Multiple shipping fairways intersect the EMBA (**Table 3-6**). Hydrocarbons in the water column will have no effect on shipping.	Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable); vessel may have to take large detours leading to potential delays and increased costs.
Defence	The level of defence activities carried out in the vicinity of operational area is low, and therefore interference of defence activities due to a hydrocarbon spill is expected to be minimal.	
Shipwrecks	As described in **Section 3.2.4**, a number of shipwreck sites have been recorded in the EMBA with the closest located approximately 10 km west of the operational area and on the north-eastern side of the Montebello Islands (*Plym HMS*). Shipwrecks may be of important heritage value and/or act as dive sites. Surface hydrocarbons will have no impact on shipwrecks. 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 and/or dispersant may alter bacterial community composition (biofilms) inhabiting shipwrecks possibly altering corrosion potential (Salerno *et al* 2016).	
Indigenous users	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. The level of activities undertaken by indigenous users is expected to be low given that no native title claims, ethnographic or archaeological sites or records of aboriginal occupation are listed for the Montebello Islands or the surrounding marine waters of the nearby islands (**Section 3**). Therefore, interference due to a hydrocarbon spill are expected to be minimal.	
Existing oil and gas activity	A number of oil and gas operators operate within the EMBA with existing projects and infrastructure in place as well as continuing drilling and exploration programs. A surface slick has the potential to disrupt activity potentially halting production or exploration with associated economic impact. Exclusion zones surrounding spills will reduce access potentially resulting in delays to work schedules with possible subsequent financial implications. Chevron's Gorgon and WA Oil operations on Barrow Island, and Santos' other activities may be impacted in the event of an unplanned spill event through exclusion or access restrictions in the event of spill response/clean-up activities (if applicable).	

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of hydrocarbon spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td colspan="3">Protected Areas</td></tr>
<tr><td rowspan="2">Marine Parks and Commonwealth Heritage Areas</td><td colspan="2">Protected areas are described in Section 3.1, and are summarised below. These areas provide key habitats that support an array of marine flora and fauna along with unique natural phenomena.
<u>Ningaloo Coast World Heritage Area and National Heritage Place</u>
Includes important and significant natural habitats for in situ conservation of biological diversity including threatened species. Significant geomorphic features, natural phenomena and areas of exceptional natural beauty.
<u>Dampier Archipelago (including the Burrup Peninsula) Commonwealth Heritage Area</u>
Contains a diverse array of Aboriginal heritage including dreaming sites, ceremonial sites, rock engravings and archaeological sites. It is of exceptional heritage interest for its diverse array of rock engravings and stone arrangements and the importance of these within the Aboriginal traditions of Ngarda-Ngarli peoples.
<u>Australian Marine Parks (AMPs): Montebello, Ningaloo, Gascoyne, Argo-Rowley Terrace, Dampier, Carnarvon Canyon, Shark Bay, Eighty Mile Beach AMPs</u>
Includes habitat for foraging and migratory seabirds, foraging/breeding area for marine turtles, migrating humpback whales and blue whales, foraging sharks, sea floor habitats.
<u>State Marine Parks and Marine Management Areas: Barrow Island Marine Park, Barrow Island Marine Management Area, Montebello Islands Marine Park and Muiron Islands Marine Management Area</u>
Includes foraging and nesting areas for marine turtles, and feeding/resting/breeding areas for seabirds and migratory shorebirds.
Includes shallow water and shoreline habitats that support a range of marine fauna and flora species, including those of conservation significance.</td></tr>
<tr><td colspan="2">These parks support all the habitats and faunal groups described above and support unique/protected habitats/marine fauna or ecological features. Impacts to the habitat/fauna receptors described above therefore have an impact on the values of these reserves which could have flow-on effects to tourism revenue for coastal communities that provide access to these marine reserves. The protected areas listed above may also support nursery/feeding/aggregation areas for fisheries species and therefore may assist in maintaining healthy fish stocks and commercial/recreational fisheries.</td></tr>
<tr><td>KEFs</td><td colspan="2">KEFs overlapping the EMBA are described in Section 3, and are summarised below:
<u>Ancient Coastline at 125m Depth Contour</u>
Contributes to higher diversity and enhanced species richness relative to soft sediment habitat.
Attracts opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish.
<u>Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula</u></td></tr>
</table>

Receptor	Impacts of hydrocarbon spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
	Supports the productivity and species richness of Ningaloo Reef. Continental Slope Demersal Fish Communities Provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Glomar Shoal Provides important habitats for a number of commercial and recreational fish species.	
	While the features associated with the KEFs are subtidal and will not be directly contacted by a surface slick, they all may support increased productivity or abundance of marine fauna that use surface waters above the features (including plankton, pelagic invertebrates and fish, marine mammals, marine reptiles and seabirds) which may be impacted by floating oil. Impacts to these marine fauna are described above. In the case of Continental Slope Demersal Fish Communities, the planktonic eggs and larvae of these demersal fish communities may be impacted by a spill.	

7.4.3 Environmental performance outcomes and control measures

EPOs relating to this hazard include:

+ No loss of containment of hydrocarbon to the marine environment (EPO-8).

Control measures applied to prevent an oil spill are shown in **Table 7-10** and corresponding EPSs and measurement criteria are described in **Section 8.4**.

Selection of oil spill response strategies and associated performance outcomes, control measures and performance standards, including those required to maintain preparedness and for response, are detailed within the OPEP. The OPEP contains an evaluation of oil spill preparedness arrangements to demonstrate that oil spills will be mitigated to ALARP.

Table 7-10: Accidental release of hydrocarbons – Control Measure Evaluation

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-02	Constant bridge watch on survey vessel	Minimises risk of collision through visual identification and avoidance of other vessels	Negligible costs	**Adopted -** - Benefits considered to outweigh costs
CM-03	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 considered to outweigh costs.
CM-09	Seafarer Competency and Certification	Requires appropriately trained and competent personnel, in accordance with Marine Order 70, to navigate vessels to reduce interaction with other marine users. Requires appropriately trained and competent personnel to navigate vessels.	Costs associated with personnel time in obtaining qualifications.	**Adopted** – Benefits considered to outweigh costs.

CM reference	Control measure	Environmental benefit	Potential cost/issues	Evaluation
CM-20	Vessel spill response plans (SOPEP)	Implements response plans on board vessels to deal with unplanned hydrocarbon releases and spills quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents. Generally undertaken by vessel contractor so time for Santos WA personal to confirm and check SOPEP in place.	**Adopted** – Benefits considered to outweigh costs.
CM-21	Accepted Oil pollution emergency plan (OPEP)	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant, outweighs the costs. Regulatory requirement must be adopted.
CM-22	Marine assurance standard	Ensures vessels meet Marine assurance standards to reduce the likelihood of unplanned discharges	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.
CM-23	Vessel chemical management procedures	Ensures any chemicals are managed appropriately to reduce the likelihood of unplanned discharges	Negligible costs of following procedure	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant, outweighs the costs. Regulatory requirement must be adopted.

7.4.4 Environmental Impact Assessment

Description	
Key Receptors	Physical environment - water quality, Shallow benthic, intertidal and shoreline habitats Threatened/migratory fauna - plankton, invertebrates, marine mammals, marine reptiles, sharks, rays and fish, birds (seabirds and shorebirds) Protected Areas - KEFs, Marine Parks and Commonwealth Heritage Areas Socio-economic - commercial, recreational and traditional fisheries, recreation and tourism, oil and gas industry).

Description	
Consequence	D - Major

A summary of the consequence assessment for each receptor category is presented below.

Physical environment and habitats

Exposure of nearshore environments to entrained oils and DAHs has the potential to impact intertidal habitats including benthic coral reefs and mangrove areas which may result in a long-term decrease in ecological values given toxicity impacts associated with hydrocarbon exposure (**Table 7-8** and **Table 7-9**). Additionally, emergent features may also be impacted by the presence of floating oil at the sea surface resulting in impacts due to coating or smothering.

The consequence assessment undertaken at selected Hotspot areas (refer **Section 7.4.4**) revealed that the worst-case consequence to the physical environment and habitats from a vessel collision resulting in a worst-case accidental hydrocarbon release was ranked as a D – Major.

Threatened/migratory fauna

Habitat modification/degradation/disruption/loss, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-5**). Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-8**, and potential impacts to receptors found within the EMBA are further described in **Table 7-9**.

The potential pathways and impacts to marine fauna through hydrocarbon exposure and potential toxicity effects are summarised in **Table 7-8**. Transient fauna traversing the area may also be potentially impacted by a spill through exposure to floating oil, entrained or DAHs. The potential impacts to transient receptors due to the presence of surface and water column hydrocarbons are summarised in **Table 7-9**.

The potential impacts of a hydrocarbon release on seabird breeding and feeding areas are discussed in **Table 7-9**.

The consequence assessment undertaken at selected Hotspot areas (refer **Section 7.4.4**) revealed that the worst-case consequence to threatened/migratory fauna from a vessel collision was ranked as a D – Major.

Protected areas

The EMBA intersects several Marine Parks, AMPs, Commonwealth Heritage Areas and marine management areas (**Section 3.1**). Combined, these areas support all the habitats and faunal groups described above. Impacts to the habitat/fauna receptors described above therefore have an impact on the values of these reserves which could have flow-on effects to tourism revenue of coastal communities that provide access to these marine reserves.

The consequence assessment undertaken at selected Hotspot areas (refer **Section 7.4.4**) revealed that the worst-case consequence to protected areas from a vessel collision resulting in a worst-case accidental hydrocarbon release was ranked as a D – Major.

Socio-economic receptors

There is the potential temporary disruption to fishing activities if the surface slick or entrained oil and DAH plume moves through fishing areas (**Table 3-7**).

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. Connell and Miller (1981) compiled a summary of studies listing the exposure value concentrations at which tainting occurred for hydrocarbons. The results contained in their review indicate that tainting of fish occurs when fish are exposed to ambient concentrations of 4–300 ppm (4,000-300,000 ppb) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest.

Given the large volume of oil that could potentially be released, it is possible that impacts could be detected to fisheries on a stock level although it is more likely that natural variation in fish abundance would be on a greater scale than any impacts attributable to a hydrocarbon spill. This would most likely be the case for fisheries species that utilise shallow waters around the Lowendal, Barrow and Montebello Islands and could occur through direct impacts to fish or to fish habitats (e.g. seagrass, coral reef, mangrove habitats).

Description	
Entrained and surface oil could impact pearl farming activities at the Montebello Islands. Given that pearl oysters are filter feeders, entrained oil droplets could create negative impacts through ingestion and accumulation of hydrocarbon compounds in oyster tissues or interference with respiratory structures. Such impacts could lead to sub-lethal (e.g. reduced oyster growth rates, reduced reproductive success) or at worst lethal impacts. Given that dissolved hydrocarbons could reach acutely toxic levels, mortality could occur. A number of oil and gas operators operate within the EMBA with existing projects and infrastructure in place as well as continuing drilling and exploration programs (**Table 3-7**). An unplanned hydrocarbon release has the potential to disrupt these activities, with associated economic impact, albeit on a temporary basis. Tourism could also be affected by a spill, either from reduced water quality/shoreline oiling preventing recreational activities or reducing aesthetic appeal or from impacts to habitats and marine fauna as described in **Table 7-8** and **Table 7-9**. The consequence assessment undertaken at selected Hotspot areas (refer **Section 7.4.4**) revealed that the worst-case consequence to socio-economic receptors from a vessel collision resulting in a worst-case accidental hydrocarbon release, was ranked as a D – Major.	
Likelihood	2 – Very Unlikely
A worst-case hydrocarbon release resulting from a vessel collision could result in major disruption and long-term effects on the receiving environment. Impacts could decrease local populations and result in loss of critical habitats; however recovery would be expected within 10 to 20 years. With the proposed control measures in place to prevent releases, any decline in local populations or degradation of habitats is considered very likely and therefore the activity will be conducted in a manner that is considered acceptable. The likelihood of a hydrocarbon release occurring due to a vessel collision/bunkering is limited given the set of mitigation and management controls in place. Subsequently the likelihood of a vessel collision releasing hydrocarbons to the environment resulting in a major consequence is considered to be Very Unlikely.	
Residual Risk	The residual risk associated with this hazard is Medium.

7.4.4.1 Hotspot Consequence Assessment

Using the process described in **Section7.4.1**, areas of High Environmental Value within the EMBA were identified, as listed below.

+ Barrow Island
+ Barrow-Montebello Surrounds
+ Dampier AMP
+ Dampier Archipelago
+ Glomar Shoals
+ Lowendal Islands
+ Montebello AMP
+ Montebello Islands
+ Muiron Islands
+ Ningaloo Coast North
+ Offshore Ningaloo
+ Outer Ningaloo Coast North
+ Outer NW Ningaloo

The values and sensitivities associated with these HEVs have been described in **Appendix B - Description of the Existing Environment.**

The process (from **Section 7.4.1**) identified the following Hotspots:

- Montebello Islands;
- Barrow Island;
- Lowendal Islands
- Barrow-Montebello Surrounds

Table 7-11 provides a summary of the consequence assessment results for each of the Hotspot areas. The consequence assessment was based on predicted contact and concentration of floating oil, accumulated oil, entrained oil and dissolved aromatic hydrocarbons (DAHs). For each Hotspot area the consequence to the key values were assessed using the methodology described in **Section 7.4.4**.

Table 7-11: Hotspot consequence assessment results from worst case vessel collision spills

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m^3	Consequence Category	Consequence Ranking	Total
Montebello Islands	3	<u>Habitats</u> Reefs - coral spawning: Mar & Oct Algae (40%) Mangroves (globally unique as offshore) Fish habitat Intertidal sand flat communities Mangroves are considered globally unique <u>Turtles</u> Loggerhead and green (significant rookery), hawksbill, flatback turtles - Loggerhead turtle nesting: Dec-Jan, Green turtle nesting: Nov- to Apr. Peak period from Jan-Feb, Flatback turtle nesting: Dec-Jan, Hawksbill turtle nesting: Oct-Jan Northwest and Eastern Trimouille Islands (hawksbill) Western Reef and Southern Bay at Northwest Island (green) <u>Seabirds</u> Migratory and threatened seabirds – 14 species Significant nesting (Sept-Feb), foraging and resting areas <u>Whales</u> Humpback (Jun-Jul) / Pygmy blue (Apr-Aug) whale migration <u>Socio-Economic</u> Pearling (inactive/pearling zones)	*Probability of contact by floating oil at 10 g/m²*	*(%)*	14.2	+ Threatened / Migratory Fauna + Physical Environment/ Habitat + Protected Areas + Socio-Economic Receptors	D D D D	D
			Minimum time to contact by floating oil 10 g/m²	*Time (days)*	0.3			
			Maximum oil loading on shorelines >10g/m²	*tonnes*	221.7			
			Maximum accumulated concentration >100g/m²	*g/m²*	18,935.2			
			Maximum length of shoreline oiled (>100 g/m²)	*(km)*	14.1			
			Maximum concentration of entrained oil >100 ppb	*(ppb)*	344.2			
			Maximum concentration of dissolved	*(ppb)*	260.2			

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m^3	Consequence Category	Consequence Ranking	Total
		Very significant for recreational fishing and charter boat tourism Social amenities and other tourism Nominated place (National heritage)	*hydrocarbon >10 ppb*					
Barrow Island	3	<u>Habitats</u> Bandicoot Bay - conservation area Fisheries Act (benthic fauna/seabird protection), mudflats, rock platforms, mangroves, clay pans Mangroves are in Bandicoot Bay (considered globally unique) Coral reefs (eastern side) - Biggada Reef (Coral spawning: Mar & Oct) Biggada Creek <u>Turtles</u> Regionally and nationally significant green turtle (western side) and flatback turtle (eastern side) nesting beaches Turtle Bay north beach North and west coasts - John Wayne Beach also loggerhead and hawksbill turtles. Peak turtle nesting periods - Loggerhead turtle nesting: Dec-Jan, Green turtle nesting: Nov- to Apr. Peak period from Jan-Feb, Flatback turtle nesting: Dec-Jan, Hawksbill turtle nesting: Oct-Jan <u>Seabirds</u> Migratory birds (important habitat) (important bird area) 10th of top 147 bird sites.	*Probability of contact by floating oil at 10 g/m^2*	*(%)*	3.3	+ Threatened / Migratory Fauna + Physical Environment/ Habitat + Protected Areas + Socio-Economic Receptors	D D D C	D
			Minimum time to contact by floating oil 10 g/m^2	*Time (days)*	2.4			
			Maximum oil loading on shorelines >10 g/m^2	*tonnes*	130.8			
			Maximum accumulated concentration >100g/m^2	*m^2*	18,890.3			
			Maximum length of shoreline oiled <u>(>100 g/m^2)</u>	*(km)*	11			

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m^3	Consequence Category	Consequence Ranking	Total
		Highest population of migratory birds in BI Nature reserve (south-south east island). Double island important bird nesting (shearwaters, sea eagles). <u>Whales</u> Pygmy blue whale northern migration (Apr -Aug) <u>Cultural Heritage</u> Important Aboriginal cultural 13 listed sites incl. (pearling camps) <u>Socio-Economic</u> Significant for recreational fishing and charter boat tourism Nominated place (National heritage)	*Maximum concentration of entrained oil >100 ppb* *Maximum concentration of dissolved hydrocarbon >10 ppb*	*(ppb)* *(ppb)*	340.7 86.8			
Lowendal Islands	3	<u>Habitats</u> Important shallow lagoons with seagrass for dugongs Deep water benthic (soft sediment) habitats Dugong and batman reef Mangroves are considered globally unique as they are offshore Macro algal reefs (40%) <u>Turtles</u> Important hawksbill (Beacon, Parakeelya, Kaia and Pipeline), Loggerhead and green turtle nesting (minor) Nesting is reported to occur throughout the year in WA, peaking between October and January	*Probability of contact by floating oil at 10 g/m^2* *Minimum time to contact by floating oil 10 g/m^2* *Maximum oil loading on shorelines >10 g/m^2* *Maximum accumulated concentration >100g/m^2*	*(%)* *Time (days)* *tonnes* m^2	2.5 1.3 10.6 3,743.8	+ Threatened / Migratory Fauna + Physical Environment/ Habitat + Protected Areas + Socio-Economic Receptors	D D D C	

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m³	Consequence Category	Consequence Ranking	Total
		Significant Flatback rookery , nesting season for Flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March Seabirds Approximately 89 species of avifauna, 12 -14 species of migratory and seabirds Marine mammals Seagrass beds around the Lowendal islands thought to provide valuable food source for dugongs Protected Areas The Barrow Island Marine Management Area most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park. Socio-economic and Heritage values Social amenities and other tourism, Very significant for recreational fishing and charter boat tourism	*Maximum length of shoreline oiled (>100 g/m²)*	*(km)*	2.8			
			Maximum concentration of entrained oil >100 ppb	*(ppb)*	293.2			
			Maximum concentration of dissolved aromatic hydrocarbon >10 ppb	*(ppb)*	176.8			
	3	Habitats Coral reefs habitat Seabirds Migratory birds Whales Humpback/ pygmy blue whale migration Socio-economic Significant for recreational fishing and charter boat tourism	*Probability of contact by floating oil at 10 g/m²*	*(%)*	20.8	+ Threatened / Migratory Fauna + Physical Habitat + Protected Areas + Socio-economic Receptors	C D D	D
			Minimum time to contact by floating oil 10 g/m²	*Time (days)*	0.3			
			Maximum oil loading on	*tonnes*	N/A			

Receptor (Hotspot) Name	HEV Ranking	Values	Oil Spill Modelling Parameter		Diesel 359 m^3	Consequence Category	Consequence Ranking	Total
Barrow – Montebello Surrounds[2]			*shorelines >10g/m²*				B	
			Maximum accumulated concentration >100g/m²	*g/m²*	NA			
			Maximum length of shoreline oiled (>100 g/m²)	*(km)*	NA			
			Maximum concentration of entrained oil >100 ppb	*(ppb)*	864.3			
			Maximum concentration of dissolved hydrocarbon >10 ppb	*(ppb)*	354.4			

[2] Barrow Island Shoals, within the Barrow-Montebello Surrounds is only emergent at lowest astronomical tide. Therefore, this receptor is considered a submerged feature.

7.4.5 Demonstration of ALARP

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

Given the short duration of the survey, offshore refuelling will not be undertaken.

The combination of the standard prevention control measures (**Section 7.4.3**) (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 medium 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 WA 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 control measures is presented in the OPEP (SO-91-RI-20058.02).

7.4.6 Acceptability evaluation

Is the risk ranked between Low to Medium?	Yes – residual risk is ranked as Medium.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the activities and their risks and impacts consistent with the principles of ESD?	Yes – aligns with the principles of ecologically sustainable development where these natural resources are used in a sustainable manner with environmental and economic considerations factored into decision making.
Are performance standards consistent with industry standards, legal and regulatory requirements, including protected matters?	Yes – management consistent with the OPGGS(E)R and the P(SL)(E)R. Santos WA has considered the values and sensitivities of the receiving environment including, but not limited to: + Conservation values of the Montebello Australian Marine Park, the Barrow Island Marine Park and Management Area and Montebello Marine Park; + Relevant species Recovery Plans, Conservation Management Plans and management actions including but not limited to: Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017), Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) and Approved Conservation Advice for *Rhincodon typus* (whale shark).
Are risks and impacts consistent with Santos WA Environmental Management Policy?	Yes – aligns with Santos WA Environmental Management 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 assessment above.

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.

P(SL) (E) Regs 2012 Requirements
Regulation 15(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.

The specific measures and arrangements that will be implemented in the event of an oil pollution emergency are detailed within the oil pollution emergency plan (OPEP).

Stakeholder engagement is assessed separately for the requirements of the Reindeer activities. Ongoing stakeholder management strategies are discussed in **Section 4**.

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.

P(SL)(E)R 2012 Requirements
Regulation 15(3)
The implementation strategy must identify the specific systems, practices and procedures to be used to ensure that: (a) The environmental impacts and environmental risks of the petroleum activity are continuously reduced to as low as is reasonably practicable; and (b) The environmental performance objectives and environmental performance standards in the environment plan are met.

The Santos WA management system exists to support its ethical, 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, result in these outcomes:

A common HSE approach is followed across the organisation;

+ HSE is proactively managed and maintained;
+ The mandatory requirements of HSE management are implemented and are auditable;
+ HSE management performance is measured and corrective actions are taken;
+ Opportunities for improvement are recognised and implemented; and
+ Workforce commitments are understood and demonstrated.

This implementation strategy is designed to meet the requirements of the EP to ensure that:

+ Environmental impacts and risks continue to be identified for the duration of the activity and reduced to ALARP;
+ Control measures are effective in reducing environmental impacts and risks to ALARP and acceptable levels;
+ Environmental performance outcomes and standards set out in this EP are met; and
+ Stakeholder consultation is maintained throughout the activity as appropriate.

8.2 Environmental Management Policy

Santos WA's Environmental Management Policy (**Appendix A1**) clearly sets out Santos WA's 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 WA, 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 EPSs that will be implemented to manage the identified risks and impacts, and the EPOs that will be achieved, are detailed in **Section 8.4**.

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 MoC procedure (**Section 8.10.2**).

Oil spill response control measures and EPSs and EPOs are listed in the OPEP.

8.4 Environmental performance

To ensure environmental risks and impacts will be of an acceptable level, EPOs have been defined and are listed in **Table 8-1** for planned activities, those relating to oil spill response are listed in the OPEP.

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 is limited to the extent required for sampling
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

8.4.1 Control measures and environmental performance

OPGGS(E)R 2009 Requirements
Regulation 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.

P(SL)(E)R 2012 Requirements
Regulation 14(5)
The environment plan must include – (a) environmental performance standards — (i) that state the performance required of persons, equipment and procedures for the purposes of managing the environmental impacts and environmental risks of the petroleum activity; and (ii) against which the performance of the operator in meeting the environmental performance objectives in the environment plan, can be measured; (b) measurement criteria for the purposes of determining whether — (i) the environmental performance objectives and environmental performance standards in the environment plan have been met; and (ii) the implementation strategy in the environment plan has been complied with.

The control measures that will be used to manage identified environmental impacts and risks and the associated statements of performance required of the control measure (i.e., EPSs) 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 and EPS and associated measurement criteria relating to preparedness and response operations are contained within the Yoorn-1 Geophysical Survey Oil Pollution Emergency Plan (SO-91-RI-20058.02).

Table 8-2: Control measures and environmental performance standards for the proposed activity

Control Measures	CM Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	Performance Objective Reference	Section
Procedure for interacting with marine fauna	CM-01	Survey vessel complies with Santos WA's Protected Marine Fauna Interaction and Sighting Procedure (EA-91-II-00003) which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 which include controls for minimising the risk of collision with marine fauna	CM-01-EPS-01	Statement of conformance, which demonstrates that the contractor is aware of the requirements of the Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003) and commits to meeting them during the activity. Marine fauna observation records are maintained.	EPO-1	Section 6.1 Section 7.3
Constant bridge watch on survey vessel	CM-02	Monitoring of surrounding marine environment is undertaken from vessel bridge.	CM-02-EPS-01	Records show that 24 hour bridge watch was maintained	EPO-1 EPO-5	Section 6.1 Section 6.5 Section 7.3
		Avoid active commercial fishing vessels and schooling fish in the vicinity of commercial fishing activities	CM-02-EPS-02	Vessel log documents changes to vessel survey as applicable	EPO-5	Section 6.5
Lighting will be used as required for safe work conditions and navigational purposes.	CM-03	Survey vessel navigation lighting and equipment is compliant with COLREGS / Marine Orders Part 30: Prevention of Collisions, and with Marine Orders Part 21: Safety of Navigation and Emergency Procedures.	CM-03-EPS-01	Vessel certification confirms compliance with applicable regulations	EPO-2	Section 6.2 Section 6.3 Section 6.5 Section 7.4
		Premobilisation review of lighting on vessel is undertaken prior to activities commencing to only confirm necessary lighting for safety and navigation.	CM-03-EPS-02	Documented premobilisation review confirms lighting restricted to that necessary for safety and navigation.	EPO-2	Section 6.2
Vessel planned maintenance system	CM-04	Documented maintenance program is in place for equipment that provides a status on the maintenance of equipment.	CM-04-EPS-01	Vessels have records that demonstrate maintenance is performed as per the vessel's planned maintenance system requirements.	EPO-3	Section 6.3
Fuel oil management	CM-05	MARPOL-compliant (Marine Order 97) fuel oil (diesel) will be used during the activity	CM-05-EPS-01	Fuel bunkering records and/or relevant purchase records show that compliant fuel oil was used	EPO-3	Section 6.3
		IFO or HFO will not be used during the activity	CM-05-EPS-02	Fuel bunkering records and/or relevant purchase records show that compliant fuel oil was used	EPO-3	
		No vessel-to-vessel refuelling within the operational area.	CM-05-EPS-03	Fuel bunkering records confirms no vessel to vessel refuelling undertaken during the activity	EPO-3	
International Air Pollution Prevention Certificate	CM-06	Pursuant to Marine Order 97, the vessel will maintain a current International Air Pollution Prevention Certificate, which certifies that measures to prevent ozone-depleting substance (ODS) emissions, and reduce NOx, SOx, and incineration emissions during the activity are in place.	CM-06-EPS-01	Current International Air Pollution Prevention Certificate (if required for the vessel class under Marine Order 97)	EPO-3	Section 6.3
Waste incineration management	CM-07	Waste incineration on the vessel is managed in accordance with Marine Order 97.	CM-07-EPS-01	Completed waste record book or recording system confirms compliance with requirements during the activity	EPO-3	Section 6.3 Section 7.4
No anchoring, unless in an emergency	CM-08	No anchoring, unless in an emergency.	CM-08-EPS-01	Vessel log and incident reports confirm no anchoring, or detail the emergency situation that lead to the requirement for anchoring (where relevant).	EPO-4	Section 6.4 Section 7.3

Control Measures	CM Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	Performance Objective Reference	Section
Seafarer competency and certification	CM-09	Vessel crew are trained and competent, in accordance with Flag State regulations, to navigate vessels and reduce interaction with other marine users.	CM-09-EPS-01	Training records confirm vessel crew with responsibilities for navigation hold current seafarer competency and certification.	EPO-5	Section 6.5
Stakeholder consultation	CM-10	Santos WA provided a *Quarterly Consultation Update* to relevant stakeholders and all stakeholder correspondence recorded in stakeholder database.	CM-10-EPS-01	Records of transmittal for quarterly consultation update to relevant stakeholders. Stakeholder communications database is maintained	EPO-5	Section 6.5
		Santos WA notifies AHO and AMSA's JRCC prior to commencement of the activity.	CM-10-EPS-02	Transmittal records demonstrate notification of activity prior to the activity commencing.	EPO-5	
		Santos will notify all relevant stakeholders listed, or as revised, in Table 4 2 of relevant activity details prior to commencement, including activity timing, vessel movements, proposed cessation date and vessel details.	CM-10-EPS-03	Transmittal records demonstrate notification of activity prior to the activity commencing.	EPO-5	
No fishing from vessel	CM-11	Personnel are prohibited from recreational fishing activities on the vessel	CM-11-EPS-01	Induction records confirm no fishing prohibition is communicated to all personnel	EPO-5	Section 6.5
Vessel sewage system	CM-12	Pursuant to Marine Order 96, the survey vessel will have a current International Sewage Pollution Prevention (ISPP) Certificate which certifies that required measures to reduce impacts from sewage disposal are in place.	CM-12-EPS-01	Current International Sewage Pollution Prevention Certificate	EPO-3	Section 6.6
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	CM-12-EPS-02	Vessels have records that demonstrate that maintenance is performed as per the vessel's planned maintenance system requirements.		
		Sewage from vessels is discharged or retained, in accordance with Marine Order 96.	CM-12-EPS-03	Records demonstrate that sewage was appropriately discharged or retained.		
Vessel oily mixtures system	CM-13	Oily mixtures (bilge water) only discharged to sea in accordance with Marine Order 91.	CM-13-EPS-01	Oil record book is maintained.	EPO-3	Section 6.6
		Preventive maintenance on oil filtering equipment completed as scheduled.	CM-13-EPS-02	Vessels have records that demonstrate that maintenance is performed as per the vessel's planned maintenance system requirements.		
		Pursuant to Marine Order 91, (support vessels larger than 400 t) will have an International Oil Pollution Prevention Certificate, which certifies that required measures to reduce impacts of planned oil discharges are in place.	CM-13-EPS-03	Current International Oil Pollution Prevention Certificate		
Waste (garbage) management plan.	CM-14	Garbage management plan implemented to reduce the risk of waste released to sea, in accordance with Marine Order 95. The plan includes detail for: + Bin types; + Lids and covers; + Waste segregation; + Bin storage; and + Food waste	CM-14-EPS-01	Records show that garbage management plan is implemented Inspection records show that garbage management plan is implemented Vessel's garbage record book maintained to record quantities and types of waste in accordance with Marine Order 95	EPO-6	Section 7.1
Deck cleaning product selection procedure	CM-15	Deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to Marine Order 94.	CM-15-EPS-01	Safety Data Sheet (SDS) and product supplier supplementary data for any deck cleaning products are retained as required.	EPO-3	Section 6.6

Control Measures	CM Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	Performance Objective Reference	Section
Dropped object recovery	CM-16	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.	CM-16-EPS-01	Incident records shows the fate of dropped objects and the associated risk assessment.	EPO-6	Section 7.1
Dropped object prevention procedures.	CM-17	Vessel lifting procedures include the following control measures to reduce the risk of objects entering the marine environment: + Lifting equipment certification and inspection. + Lifting crew competencies. + Heavy lift procedures. + Preventative maintenance on cranes.	CM-17-EPS-01	Records demonstrate implementation of lifting procedures.	EPO-6	
Invasive marine species management	CM-18	Vessels are managed to low risk in accordance with the Santos WA Invasive Marine Species Management Plan (EA-00-RI-10172) prior to movement or transit into or within the invasive marine species management zone, which requires: + Assessment of applicable vessels using the IMSMP risk assessment; and + The management of immersible equipment to low risk.	CM-18-EPS-01	Completed risk assessment demonstrating vessel and equipment is low risk of translocating IMS	EPO-7	Section 7.2
		Pursuant to the Biosecurity Act 2015 and Australian Ballast Water Management Requirements 2017, support vessels carrying ballast water and engaged in international voyages shall manage ballast water so that marine pest species are not introduced.	CM-18-EPS-02	Records show Ballast Water Management is implemented. Completed ballast water record book or log is maintained.	EPO-7	Section 7.2
Anti-foulant system	CM-19	Vessel anti-foulant system maintained in compliance with *International Convention on the Control of Harmful Anti-fouling Systems on Ships*	CM-19-EPS-01	Current International Anti-Fouling System Certificate.	EPO-7	Section 7.2
Vessel spill response plans (SOPEP)	CM-20	Survey vessel has a shipboard oil pollution emergency plan (SOPEP) which outlines steps taken to combat spills.	CM-20-EPS-01	Records demonstrate compliance with the SOPEP Inspection records demonstrate implementation of the SOPEP	EPO-8	Section 7.4
Accepted Oil pollution emergency plan (OPEP)	CM-21	In the event of a hydrocarbon spill to sea, the Santos WA OPEP requirements are implemented to mitigate environmental impacts.	CM-21-EPS-01	Incident database records show that oil spill to see are responded to in accordance with the OPEP.	EPO-8	Section 7.4
Marine assurance standard	CM-22	Vessels selected and on-boarded in accordance with the *Marine Assurance Standard* (QE-91-ZH-10001) to ensure contracted vessels are operated, maintained and manned in accordance with industry standards and regulatory requirements.	CM-22-EPS-01	Completed inspection checklist and premobilisation documentation demonstrates that requirements have been met.	EPO 8	Section 7.4
Vessel chemical management procedures	CM-23	Safety data sheets (SDS) available for chemicals to aid in the process of hazard identification and chemical management.	CM-23-EPS-01	Records show that SDS are retained on the vessel	EPO 8	Section 7.4
		Chemicals managed in accordance with the safety data sheet in relation to safe handling and storage, spill-response and emergency procedures, and disposal considerations.	CM-23-EPS-02	Inspection records demonstrate compliance with SDS		

8.5 Leadership, accountability and responsibility

OPGGS(E)R 2009 Requirements
Regulations 14(4)
The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan including during emergencies or potential emergencies.

P(SL) (E) Regs 2012 Requirements
Regulations 15(4)
The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan.

While Santos WA's Chief Executive Officer has the overall accountability for the implementation of the Santos WA Management System and Environmental Management Policy, Santos WA's 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 amongst Santos WA 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
Perth office based roles	
Manager – Offshore D&C	+ 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 Management of Change (MoC) documents, if acceptable and ALARP; and + Ensures annual HSE improvement plan is completed.
Company Site Representative	Has responsibility for: + Implementation of EP commitments; + Ensuring personnel competency; + Ensuring compliance with procedures and work instructions; + Site focal point for onshore/offshore communications; + Reporting of all incidents and potential hazards; + Leading site-based incident response; and + Implementation of corrective actions from environmental incidents and audits.

Role	Responsibilities
Survey Vessel Master	Has overall responsibility for: + Implementation and compliance with relevant environmental legislative requirements, EP commitments and operational procedures on the vessel; + Maintaining clear communication with personnel on board; + Communicating hazards and risks to the workforce; + Monitoring daily activities on the vessel to ensure that the relevant environmental legislative requirements, EP commitments and operational procedures are being followed; + Maintaining vessels to all regulatory and class requirements; + Maintaining their vessel in a state of preparedness for emergency response; and + Reporting environmental incidents to PIC and ensuring follow-up actions are carried out.
Santos HSE Manager	Has overall responsibility for: + Ensuring incident preparedness and response arrangements meet Santos WA and regulatory requirements; + Approving the OPEP; and + Providing ongoing resources to maintain compliance with the OPEP and other Santos WA incident response requirements.
Santos HSE Coordinator(s)	+ Ensures the EP is managed and reviewed: monitors conformance with EPOs and EPSs, and the implementation strategy in the EP; + Prepares, maintains and distributes the environmental compliance register; + Completes regular HSE reports, inspections and audits; + Completes HSE inductions and promotes general awareness; + Collates HSE data and records; + Contributes to HSE incident management and investigations; + Provides operational HSE oversight and advice; + Facilitates the development and implementation of MoC documents; + Provides incident reports, compliance reports and notifications to NOPSEMA; + Ensures stakeholder consultation and communication requirements have been fulfilled; and + Ensures subcontractors are communicated the EP requirements.
HSE Team Lead – Security Emergency Response	Has overall responsibility for: + Overarching incident and crisis management responsibility; + Managing the CMT and IMT personnel training program; + Reviewing and assessing competencies for CMT, IMT, and field-based IRT members; + Managing the Duty roster system for CMT and IMT personnel; and + Managing the maintenance and readiness of incident response resources and equipment.

Role	Responsibilities
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 3rd-parties; + Developing and defining objectives, strategies and tactical plans for response preparedness defined in this OPEP and IRP; and + Undertaking assurance activities on arrangements outlined within the OPEP.
All personnel	+ Adhere to HSE obligations; + Carry out duties in accordance with defined work systems and procedures; + Report sightings of marine fauna and marine pollution; + Identify HSE improvement opportunities wherever possible; + Report HSE incidents, hazards or non-conformances to supervisors in a timely manner; and + Understand their obligation to 'stop-the-job' due to HSE concerns.

8.6 Workforce training and competency

OPGGS(E)R 2009 Requirements
Regulations 15(5)
The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment plan including during emergencies or potential emergencies, and has the appropriate competencies and training.

P(SL) (E) Regs 2012 Requirements
Regulations 15(5)
The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the petroleum activity is aware of his or her responsibilities in relation to the environment plan and has appropriate competencies and training.

8.6.1 Inductions

All personnel on the vessel will complete an induction which will include a component addressing their EP responsibilities. Induction attendance records for all personnel will be maintained. Inductions will include information on:

+ Environmental Management Policy;
+ Regulatory regime (State and Commonwealth);
+ Operating environment (e.g. nearby protected marine areas);
+ Activities with highest risk;
+ EP commitments (e.g. **Table 8-2**);
+ Incident reporting and notifications
+ Regulatory compliance reporting;
+ Management of change process for changes to EP activities; and

+ Oil pollution emergency response (e.g. OPEP requirements).

8.6.2 Training and competency

All members of the workforce on the survey vessel will complete relevant training and/or hold relevant qualifications and certificates for their roles.

Santos WA 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, staff on boarding process and training departments.

Personnel qualification and training records will be sampled at various times such as during the procurement process, inductions, crew change, and operational inspections and audits.

8.6.3 Workforce involvement and communication

Daily operational meetings will be held 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 or pre-shift meetings will be held to plan jobs and discuss work tasks, including HSE risks and their 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).

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.

P(SL) (E)R 2012 Requirements
Regulation 15(10) P(SL)(E)R 2012
The implementation strategy must include an oil spill contingency plan that — (a) sets out details of the following — (i) preparations to be made for the possibility of an oil spill; (ii) emergency response arrangements to be implemented if an oil spill occurs; (iii) recovery arrangements to be implemented if an oil spill occurs; and (iv) current oil spill trajectory modelling that applies to the petroleum activity; (b) requires the operator to conduct tests of the emergency response arrangements set out in the oil spill contingency plan at specified intervals; and (c) describes the tests mentioned in paragraph (b).

Vessels are required to have and implement incident response plans, such as an emergency response plan and SOPEP. Regular incident response drills and exercises (e.g., as defined in an emergency response plan or SOPEP) are carried out to refresh the crew in using equipment and implementing incident response procedures.

Santos WA will implement the activity OPEP (SO-91-RI-20058.02) in the event of a hydrocarbon spill. The OPEP details how Santos WA will prepare and respond to a spill event and meets the requirement of the OPGGS(E)R 2009 and P(SL)(E)R 2012.

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.

P(SL)(E)R 2012 Requirements
Regulation 17(1)
The environment plan must include the following: (c) A list of all incidents that are classified as reportable incidents in relation to the petroleum activity.
Regulation 17(2)
The environment plan must classify an incident as a reportable incident if: (a) It could arise from the petroleum activity; and (b) It has the potential to cause an environmental impact that is classified, under the environmental risk assessment process described in the environment plan, as moderate or more serious than moderate.

All personnel will be informed through inductions and daily operational meetings of their duty to report HSE incidents and hazards. Reported HSE incidents and hazards will be shared during daily operational meetings and will be documented in the incident management systems as appropriate. HSE incidents will be investigated in accordance with the Santos WA Incident Reporting and Investigation Procedure (QE-91-IF-00002) or vessel contractor procedures.

Environmental recordable and reportable incidents will be reported to NOPSEMA and DMIRS as required, in accordance with **Section 8.9**. 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) and P(SL)(E) Regulations:

+ A recordable incident, for an operator of a petroleum activity, means an incident arising from the petroleum activity that –
  - breaches an EPO or EPS in the EP for the petroleum activity; and
  - is not a reportable incident.
+ A reportable incident, for an operator of a petroleum activity, means —
  - an incident that is classified as a reportable incident under the environment plan for the petroleum activity; or

- an incident arising from the petroleum activity if —
- the incident has caused, or has the potential to cause, an adverse environmental impact; and
- under the environmental risk assessment process described in the environment plan for the petroleum activity, that environmental impact is categorised as moderate or more serious than moderate. in accordance with **Table 5-2**.

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. Note: Regulation 26C requires a titleholder to report on environmental performance in accordance with the timetable set out in the environment plan.
Regulation 14(7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

P(SL) (E)R 2012 Requirements
Regulation 16
The environment plan must include arrangements for — (a) monitoring, and recording information about, the petroleum activity that are sufficient to enable the Minister to determine whether — (i) the environmental performance objectives and environmental performance standards in the environment plan have been met; and (ii) the implementation strategy in the environment plan has been complied with; and (b) reporting to the Minister on the information recorded under paragraph (a) at intervals agreed with the Minister, but not less often than annually.

8.9.1 Notifications 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				
Consultation with AMSA (Refer **Table 4-2**)	Notification of proposed start and end dates and any other relevant information for the NTM to be issued	At least 24–48 hours before operations commence	Written	AMSA's JRCC
		No less than four working weeks before operations	Written	AHO
Consultation	Prior to commencement of the activity, Santos will notify all relevant stakeholders of information on activity timing, vessel movements and vessel details.	At least one week prior	Written	All relevant stakeholders listed, or as revised, in Table 4 2
Consultation with Department of Agriculture and Water Resources (DAWR) – Biosecurity (vessels, aircraft and personnel) (Refer **Table 4-2**)	Prior to commencement of the activity application to the department for assessment of biosecurity risk of vessel as applicable.	At least 1 month prior to activity commencement	Written	DAWR Biosecurity (vessels, aircraft and personnel)
<u>OPGGS(E) Regulation 29 & 30 – Notifications</u> NOPSEMA and DMIRS must be notified that the activity is to commence.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form for both notifications. DMIRS can also be notified using NOPSEMA's notification form.	At least 10 days before the activity commences.	Written	NOPSEMA DMIRS
During the activity				

Initiation	Required Information	Timing	Type	Recipient
<u>OPGGS(E) Regulation 26B and P(SL)(E) Regulation 30 - Recordable Incident</u> NOPSEMA and DMIRS 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 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 DMIRS
<u>OPGGS(E) Regulation 26 & 26A and P(SL)(E) Regulation 28 & 29 - Reportable Incident</u> NOPSEMA and DMIRS must be notified of any reportable incidents. A reportable incident is defined as: An incident relating to the activity that has caused, or has the potential to cause,	The oral notification must contain: + All material facts and circumstances concerning the reportable incident known, or that by reasonable search or enquiry could be found out; and + Any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident; and + 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 2 hours after the first occurrence of a reportable incident; <u>or</u> if the incident was not detected at the time of the first occurrence, at the time of becoming aware of the reportable incident.	Oral	NOPSEMA DMIRS
	A written record of the oral notification must be submitted. The written record is not required to include anything that was not included in the oral notification.	As soon as practicable after the oral notification.	Written	NOPSEMA NOPTA DMIRS

Initiation	Required Information	Timing	Type	Recipient
moderate to significant environmental damage.	A written report must contain: + All material facts and circumstances concerning the reportable incident known, or that 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; and + The action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future. Consider reporting using NOPSEMA's Report of an Accident, Dangerous Occurrence or Environmental Incident form.	Must be submitted as soon as practicable, and in any case not later than 3 days after the first occurrence of the reportable incident. Same report to be submitted to NOPTA within 7 days after giving the written report to NOPSEMA.	Written	NOPSEMA NOPTA DMIRS
AMSA Reporting Under the MoU between Santos WA and AMSA	Titleholder agrees to notify AMSA of any marine pollution incident[3].	Within 2 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

[3] For clarity and consistency across Santos WA regulatory reporting requirements Santos WA 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 WA's environmental impact and risk assessment process outlined in **Section 5**.

Initiation	Required Information	Timing	Type	Recipient
Director of National Parks Reporting Notification of the event of oil pollution within a marine park or where an oil spill response action must be taken within a marine park.	Not specified, however should include details of event and response actions being undertaken with the marine park.	So far as reasonably practicable prior to response action being written.	Not defined	Director of National Parks
DPIRD Reporting If marine pests or disease are suspected this must be reported to DPIRD.	Notification of any suspected marine pests or diseases including any organism listed in the Western Australian Prevention List for Introduced Marine Pests and any other non-endemic organism that demonstrates invasive characteristics.	Within 24 hours.	Oral	DPIRD FishWatch
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 7 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 3 months after the end of the activity.	Written	DAWE
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 7 days to fauna@dbca.wa.gov.au	Written	DBCA
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

Initiation	Required Information	Timing	Type	Recipient
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 as detailed in the Management Plan for the Montebello/Barrow Islands Marine Conservation 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 2 hours.	Oral	DoT
	WA DoT POLREP and SITREP available online (refer OPEP).	As requested by DoT following verbal notification.	Written	DoT
End of activity				
OPGGS(E) Regulation 14 (2) & 26C and P(SL)(E) Regulation 16 & 34 - Reporting Environmental Performance Performance should be recorded and reported to the regulators.	Report must contain sufficient information to determine whether or not EPOs and EPSs in the EP have been met and in accordance with P(SL)(E) Regulation 34, will also include Volumes and details of all emissions and discharges to any land, air, marine, seabed, sub-seabed, groundwater, sub-surface or inland waters environment as provided in **Table 8-5**..	An environmental performance report will be submitted within three months of completion of the activity.	Written	NOPSEMA DMIRS
OPGGS(E) Regulation 29 – Notifications NOPSEMA and DMIRS must be notified that the activity is completed.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form for both notifications. DMIRS can also be notified using NOPSEMA's notification form.	Within 10 days after finishing.	Written	NOPSEMA DMIRS

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 6 months of the final Regulation 29 (2) notification.	Written	NOPSEMA
Consultation requirement	Upon completion of the activity, Santos will provide a cessation notification to the relevant stakeholders listed, or as revised, in **Table 4-1**. The final cessation notification will advise stakeholders that the activity has ended	Within 10 days after finishing.	Written	relevant stakeholders listed, or as revised, in **Table 4-1**

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.

P(SL) (E)R 2012 Requirements
Regulations 15(7) (and 34)
The implementation strategy must provide for — (a) specified emissions and discharges (whether occurring during normal operations or otherwise) to any air, marine, seabed and sub-seabed environment to be monitored and recorded in a way that — (i) is accurate; and (ii) can be audited against the environmental performance standards and measurement criteria in the environment plan; and (b) the monitoring mentioned in paragraph (a) to be done either continuously or at specified intervals; and (c) tests to assess the performance of the monitoring equipment used for the purposes of paragraph (a) to be conducted at specified intervals.

Vessel-based discharges to the marine environment, associated with this activity will be recorded and controlled in accordance with requirements under relevant marine orders.

In addition to the reporting requirements of **Table 8-4**, Regulation 14(7) of the OPGGS(E) Regulations and 34 of the Petroleum (Submerged Lands) (Environment) Regulations 2012 has specific monitoring and reporting requirements to NOPSEMA and DMIRS which will include those outlined in **Table 8-5**. Given the short-term nature of the activity, the report of emissions and discharges will be provided in the end of activity report discussed in **Table 8-4**.

Table 8-5: Monitoring methods for emissions and discharges

Emission/discharge	Method of monitoring
Air emissions (N_2O, NOx, SOx, CO_2, ODS) from vessel	Based on NPI calculations / estimates based on vessel fuel use
Oily water discharges	From vessel oil record book
Sewage discharges	Estimated from personnel on board numbers
ODS	Leakage reports (if any)
Discharges to seabed	Dropped object reports (if any)

8.10 Document management

8.10.1 Information Management and Document Control

This EP and the associated OPEP, as well as any approved MoC documents, are controlled documents and current versions will be available on the Santos WA intranet. Vessel contractors are also required to maintain current versions of these documents.

EPOs and EPSs will be measured based on the measurement criteria listed in **Table 8-3.** 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

Proposed changes to this EP and OPEP will be managed in accordance with the Santos WA Environment Management of Change Procedure (EA-91-IQ-10001). 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 18 of P(SL)(E)R 2012 and determines whether and in what manner a proposed change can proceed. The MoC procedure will determine whether a revision of the EP is required and whether that revision is to be submitted to DMIRS. If a revision of the EP is not required, the MoC form will detail the basis for the decision and if a bridging document or written notification is required for submission and acceptance to DMIRS prior to the activity commencing. For a change to proceed, the associated environmental impacts and risks must be demonstrated to be ALARP and acceptable. Additional stakeholder consultation may be required depending on the nature and scale of the change. Additional information on the MoC process is provided in **Figure 8-2** and **Figure 8-2**.

The MoC procedure also allows the assessment of new information that may become available post EP acceptance. For example, new management plans for marine reserves, recovery plans or conservation advice for species and changes to the EPBC Act Protected Matters Search results. If review identifies new information, this is treated as 'Change that has an impact on Environment Plan' in **Figure 8-2** and **Figure 8-2**Figure 8-2, and the MoC procedure is followed accordingly.

Accepted MoCs become part of the in force EP or OPEP, are tracked on a register and are made available on Santos WA's intranet. Where appropriate, the EP compliance register will be updated so that control measure or environmental performance standard changes are communicated to the workforce and implemented. Any MoC will be distributed to the management people identified in **Table 8-3**; 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.

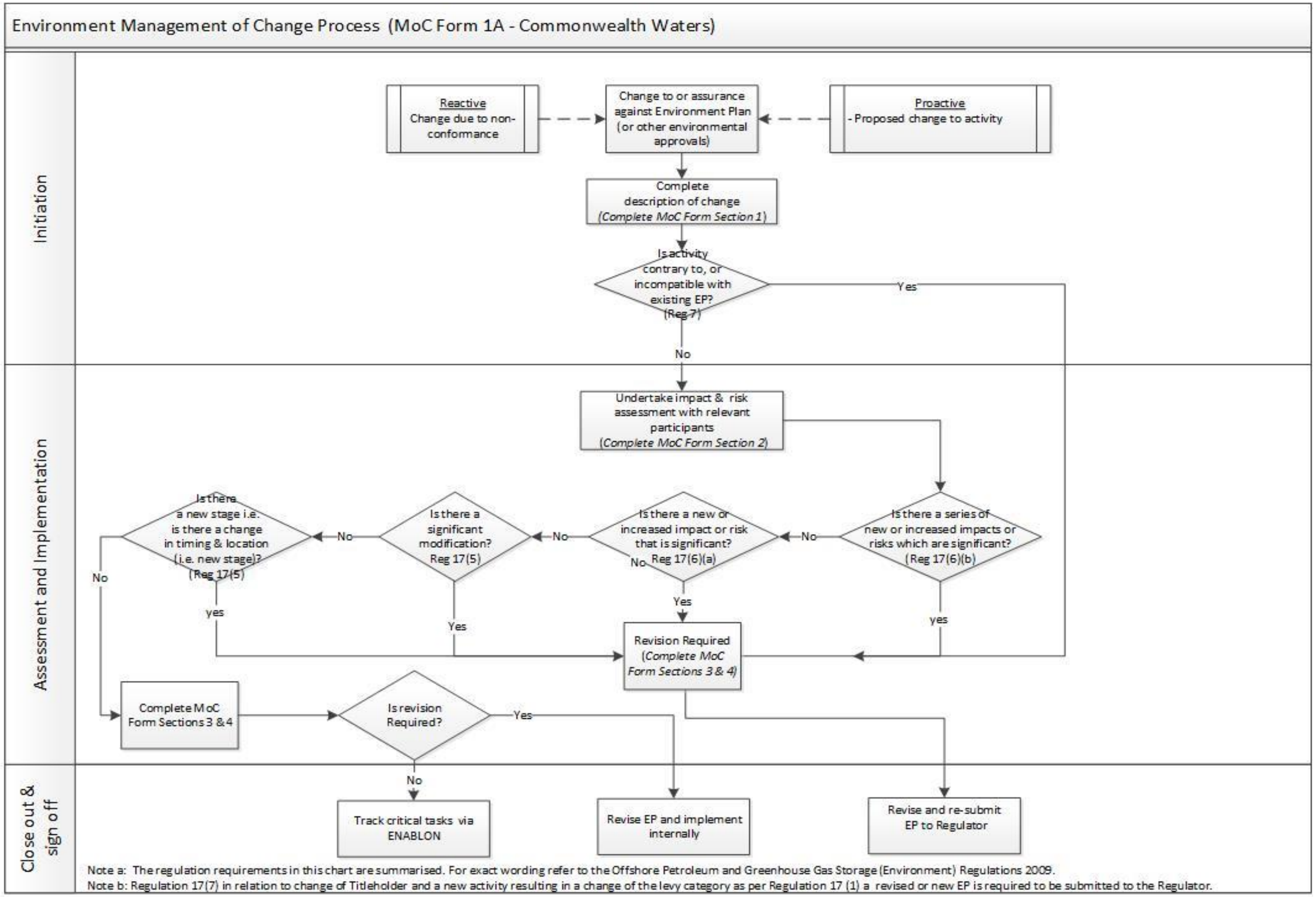

Figure 8-1: Environment management of change process (Commonwealth Waters)

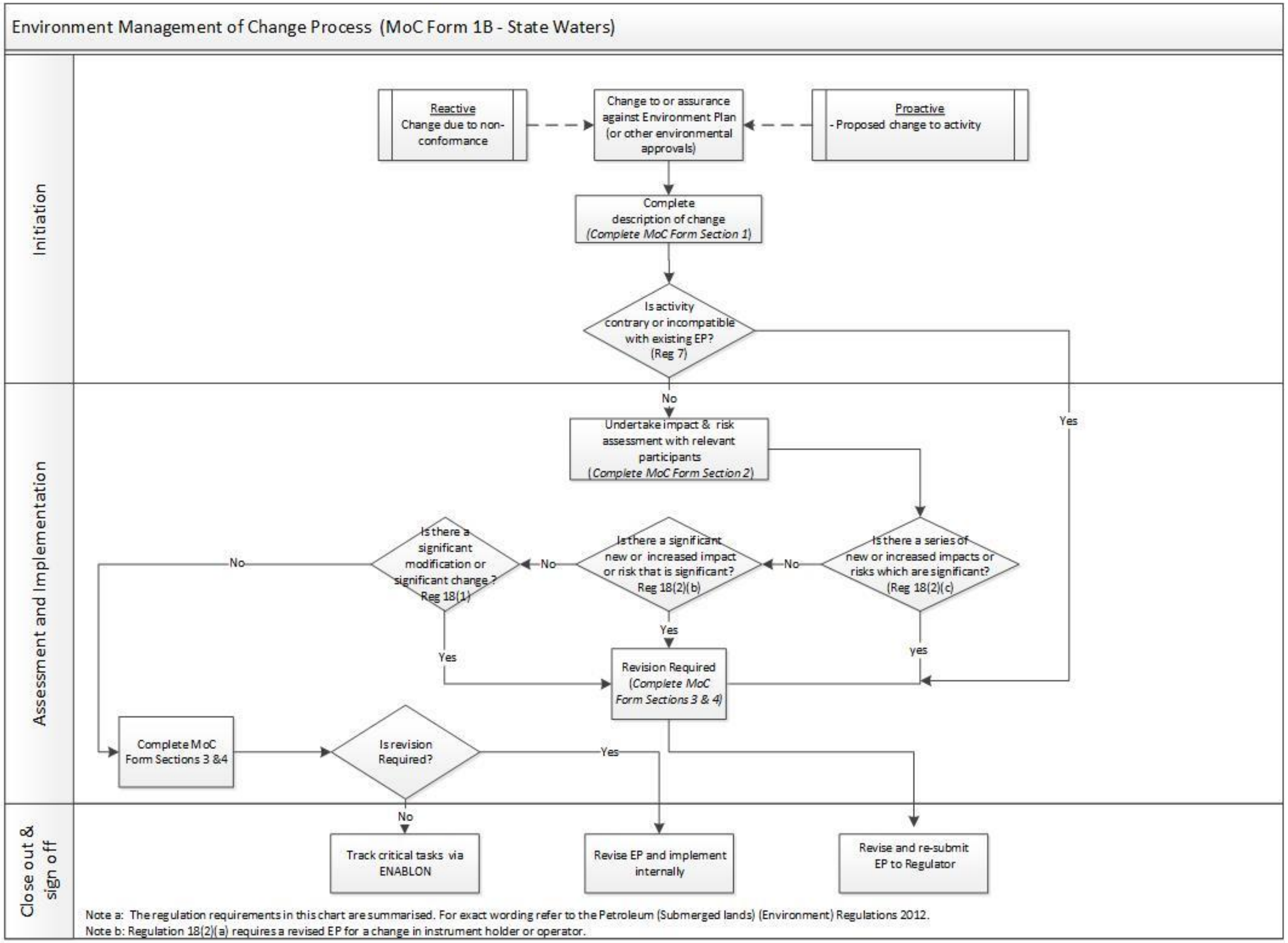

Figure 8-2: Environment management of change process (State Waters)

8.10.3 Reviews

This EP includes an assessment of impacts and risks across the entire operational area, during any time of the year for planned and unplanned events given the nature of the 24/7 operations.

It is recognised that the following may change over the validity of the EP:

+ Legislation;
+ Businesses conditions, activities, systems, processes and people;
+ Industry practices;
+ Science and technology; and
+ Societal and stakeholder expectations.

To ensure that Santos WA maintains up to date knowledge of the industry, legislation and conservation advice the following tasks are undertaken:

+ Maintaining membership of APPEA, 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 WA;
+ Undertaking annual spill response exercises to check spill response arrangements and capability are adequate;
+ Identifying stakeholders prior to the activity commencing under this EP via the mechanisms outlined in **Section 4**.
+ Undertaking annual review of Values and Sensitivities of the Western Australian Marine Environment (EA-00-RI-10062) which includes completing a new EPBC PMST, review of **Appendix A2 - Regulatory Framework of Relevant Legislation** against relevant legislation to capture and review any relevant updates, and incorporate as required, as well as a review of any recently known published relevant scientific papers;
+ Subscriptions to various regulator updates; and
+ 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 WA's MoC procedure (**Section 8.10.2**).

8.11 Audits and inspections

P(SL)(E)R 2012 Requirements
Regulation 15(6)
The implementation strategy must provide for the monitoring of, audit of, management of non-compliance with, and review of, the operator's environmental performance and the implementation strategy.

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.

Santos WA audit plans and schedules are reviewed and updated at the beginning of each calendar year and cover all Santos WA facilities and activities. Santos WA's audit schedule may be amended to accommodate operational priorities, activity risk, personnel availability or high audit demand during certain periods (e.g., regulatory audits, contractor audits). Santos WA will determine if a survey vessel audit is required following contract award and vessel confirmation.

Audits will be undertaken in a manner consistent with Santos WA's Assurance Standard (QE-91-ZF-100073).

Audit scope typically includes a selection of control measures 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 8.11.2**.

8.11.1 Inspections

During an activity, frequent HSE inspections (desktop or vessel based) will be conducted to identify hazards, incidents and EP non-conformances to check compliance against all the environmental performance objectives and standards of this EP (**Table 8-3**). Any in-field opportunities for improvement or corrective actions will be discussed during the inspection with the Vessel Master.

8.11.2 Non-conformance management

EP non-conformances will be addressed and resolved by a systematic corrective action process as outlined in Santos WA's Assurance Standard (QE-91-ZF-10007). Non-conformances arising from audits and inspections will be entered into Santos WA's incident and action tracking management system (i.e., 'Enablon'). Once entered, corrective actions, time frames and responsible persons will be assigned. Corrective action 'close out' will be monitored using a management escalation process.

8.11.3 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 WA 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;
+ Stakeholder engagement that may be undertaken during the course of the EP; and
+ Actions taken to address concerns and issues raised during the ongoing stakeholder management process (**Section 4**).

Identified continuous improvement opportunities will be assessed in accordance with the MoC process (**Section 8.10.2**) to ensure any potential changes to this EP or the OPEP are managed in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and in a controlled manner

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Appendix A1 - Santos WA Environment Management Policy

Environmental Management

Policy

Our commitment

We share the community's concern for the proper care and custody of our environment for present and future generations. At Santos protecting the environment and valuing cultural heritage are an integral part of the way we do business.

Our objective is to implement best environmental practices wherever practical to do so. We are committed to demonstrating leadership in environmental management and ensuring that our actions are performed in a manner which has acceptable impact on the land, sea and air.

We will comply with all applicable environmental legislation and regulations relevant to our business.

We will promote continuous improvement in energy efficiency, greenhouse gas emission reduction and innovation to reduce our carbon footprint and energy use.

Our actions

Wherever we operate we will:

+ Maintain open community and government consultation regarding our activities and our environmental performance
+ Educate, train and encourage our workforce to conduct activities in an environmentally responsible manner
+ Identify, assess and control risks to the environment and the surrounding community in order to manage the potential for unacceptable pollution and impacts
+ Develop and implement systems to manage all activities which have the potential to affect the surrounding natural environment
+ Measure our environmental performance and set targets for continual improvement; and
+ Conduct monitoring of the surrounding natural environment thereby contributing to knowledge of natural systems and enabling any impacts to be detected.

Governance

This policy has been reviewed and endorsed by the Santos WA Energy Holdings Board of Directors and management who foresee benefits in, and take responsibility for, its successful implementation.

By accepting employment with Santos, each employee and contractor acknowledges that they are responsible for the application of this policy.

K. T. Gallagher

Kevin Gallagher
Managing Director & CEO

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Appendix A2 - Regulatory Framework of Relevant Legislation

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	This Act provides for the preservation and protection from injury or desecration areas and objects that are of significance to Aboriginal people, under which the Minister may make a declaration to protect such areas and objects. The Act also requires the discovery of Aboriginal remains to be reported to the Minister.	No	Commonwealth – Department of Agriculture, Water and the Environment	There are no known sites of Aboriginal Heritage Significance within the operational area or EMBA.	N/A
Australian Ballast Water Requirements, Version 7	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 and Water Resources	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange.	**Section 7.1** – Introduction of IMS
Australian Heritage Council Act 2003	This Act identifies areas of heritage value listed on the Register of the National Estate and sets up the Australian Heritage Council and its functions.	Yes	Australian Heritage Council	There is one national heritage places found on the National Heritage List, within the EMBA, as identified by the Act.	**Section 7.4 -** hydrocarbon release
Australian Maritime Safety Authority Act 1990 (AMSA Act)	This Act specifies that the Australian Maritime Safety Authority's (AMSA) role includes protection of the marine environment from pollution from ships and other environmental damage caused by shipping. AMSA is responsible for administering the Marine Orders in Commonwealth waters. AMSA is the spill	Yes	AMSA	This Act applies to the use of any vessel associated with operations and is relevant to the activity in regards to the unplanned pollution from vessels.	**Section 7.4 -** hydrocarbon release

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	control agency for shipping sourced spill in Commonwealth waters. Facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are given effect through AMSA. AMSA is the lead agency for responding to oil spills in the marine environment and is responsible for the Australian National Plan for Maritime Environmental Emergencies.				
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 –** Planned activities **Section 7 –** Unplanned activities
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,	Yes	Department of Primary Industries and Regional Development	Vessel movements have the potential to introduce IMS	**Section 7.1**

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	however, this has been deferred while an amendment to the Act is progressed.				
Maritime Powers Act 2013	Protects the heritage values of shipwrecks and relics for shipwrecks over 75 years. It is an offence to interfere with a shipwreck covered by this Act. Available historic shipwreck locations covered by international conventions enacted by this legislation have been identified and assessed (as applicable) within this EP.	No	The Department of Immigration and Border Protection	This Act applies to the shipwrecks (over 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.	N/A
Biosecurity Act 2015 *Biosecurity Regulations 2016*	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia's native flora and fauna or natural environment. The Commonwealth's powers include powers of entry, seizure, detention and disposal. This Act includes mandatory controls on the use of seawater as ballast in ships and the declaration of sea vessels voyaging out of and into Commonwealth waters. The Regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the quarantine officers.	Yes	Commonwealth – Department of Agriculture and Water Resources	Potential internationally-sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange	**Section 7.1** – Introduction of IMS
Environment Protection and	The Act aims to: + Protect MNES;	Yes	Commonwealth – Department of	The activity involves potential impacts to MNES	**Section 6.2** – Light emissions

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Biodiversity Conservation Act 1999 *Environment Protection and Biodiversity Conservation Amendment Regulations 2006*	+ Provide for Commonwealth environmental assessment and approval processes; and + Provide an integrated system for biodiversity conservation and management of protected areas.		Agriculture, Water and the Environment	which are threatened and migratory species;	**Section 6** – Underwater Noise emissions **Section 6.6** – Planned operational discharges **Section 7.4 -** hydrocarbon release
Environment Protection and Biodiversity Conservation Act *1999 - Proclamation – Ningaloo Marine Park (Commonwealth Waters)*	The Declaration of Ningaloo Marine Park in Commonwealth Waters.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	Unplanned hydrocarbon/chemical release	**Section 7.4 -** hydrocarbon release
Historic Shipwrecks Act 1976 *Historic Shipwrecks Regulations 2018*	This Act protects shipwrecks that have lain in territorial waters for 75 years or more. It is an offence to interfere with any shipwreck covered by the Act. *Note Act and Regulations planned to be repealed on commencement of Underwater Cultural Heritage Act 2018*	No	Commonwealth – Department of Agriculture, Water and the Environment	This Act applies to the shipwrecks (over 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.	N/A
Underwater Cultural Heritage Act 2018	This Act extends protection provided under the *Historic Shipwrecks Act 1976* to other wrecks such as submerged aircraft and human remains. It also increases penalties applicable to damaged sites.	No	Commonwealth – Department of Agriculture, Water	This Act applies to the shipwrecks (over 75 years old) within the EMBA.	N/A

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	Commencement date of Act to be proclaimed, but will commence at latest on 24 August 2019.		and the Environment	There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters.	
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; and 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 6.3** – 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, Regional Development and Cities	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	**Section 6.3** – Atmospheric emissions

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
				Order Part 97: Marine Pollution Prevention – Air Pollution), and require the use of low sulphur fuel.	
Navigation Act 2012	An act regulating navigation and shipping including Safety of Life at Sea (SOLAS). A number of Marine Orders enacted under this Act apply directly to offshore petroleum exploration and production activities: + Marine Orders - Part 17: Liquefied gas carriers and chemical tankers + Marine Orders - Part 21: Safety of navigation and emergency procedures + Marine Orders - Part 30: Prevention of collisions + Marine Orders - Part 47: Mobile Offshore Drilling Units + Marine Orders - Part 50: Special purpose ships + Marine Orders - Part 57: Helicopter Operations + Marine Order - Part 59: Off-shore industry vessel operations + Marine Orders - Part 60: Floating Offshore facilities	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	All vessel movements associated with the activity will be governed by marine safety regulations and marine orders under the Act.	**Section 7.4 -** hydrocarbon release

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Offshore Petroleum and Greenhouse Gas Storage Act 2006 *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009*	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements specified in the OPGGS Act and associated Regulations. The OPGGS Act contains a broad requirement for titleholders to operate in accordance with "good oil-field practice". 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.	No	NOPSEMA	N/A	N/A
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Regulates the manufacture, importation and use of ozone depleting substances (typically used in fire-fighting equipment and refrigerants). Applicable to the handling of any ODS.	Yes	Commonwealth - Department of Agriculture, Water and the Environment	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 6.3** – Atmospheric emissions
Protection of the Sea (Powers of Intervention) Act 1981 *Protection of the Sea (Powers of*	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, Regional Development and Cities	Potential impacts to commonwealth waters in the event of an unplanned hydrocarbon spill.	**Section 7.6- 7.8** – Unplanned hydrocarbon spills

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Intervention) Regulations 1983					
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 *Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994* *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*	This Act relates to the protection of the sea from pollution by oil and other harmful substances discharged from ships. This Act disallows any harmful discharge of sewage, oil and noxious substances into the sea and sets the requirements for a shipboard waste management plan. The following Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Orders - Part 91: Marine Pollution Prevention - Oil + Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances + Marine Orders - Part 94: Marine Pollution Prevention - Harmful Substances in Packaged Forms + Marine Orders - Part 95: Marine Pollution Prevention – Garbage + Marine Orders - Part 96: Marine Pollution Prevention – Sewage + Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	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 relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78:	**Section 6.6** – Planned operational discharges **Section 7 –** Unplanned activities risk assessment

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	+ Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems				
Protection of the Sea (Civil Liability of Bunker Oil Pollution Damage) Act 2008	This Act implements the requirements for the International Convention on Civil Liability for Bunker Oil Pollution Damage.	Yes	Commonwealth, Department of Infrastructure, Regional Development and Cities	This Act applies to diesel refueling which will be undertaken at sea as part of the activity. Compliance with the Act reduces the risk of bunker oil pollution.	**Section 7.4 -** hydrocarbon release
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, Regional Development and Cities	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 7.1** – Introduction of IMS

State legislation

State legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
Conservation and Land Management Act 1984	DBCA is responsible for the day to day management of marine parks vested with Marine Parks and Reserves Authority (MPRA) and provide administrative support to the MPRA. Marine nature reserves, marine parks and marine management areas are the three reserve categories vested in the MPRA. Offshore operations must comply with specific marine park conditions when navigating or conducting activities in or near areas designated as marine sanctuaries for conservation, recreational, ecological, historical, research, educational, or aesthetic qualities.	Yes	Department of Biodiversity, Conservation and Attractions (DBCA)	Unplanned hydrocarbon/chemical release	**Section 6 –** Planned activities risk assessment **Section 7 –** Unplanned activities risk assessment
Environmental Protection Act 1986 *Environmental Protection Regulations 1987*	The Environment Protection Act 1986 (EP Act) requires all petroleum activities with the potential to cause significant environment harm to be referred to OEPA	Yes	The Environment Protection Agency		**Section 6 –** Planned activities risk assessment **Section 7 –** Unplanned activities risk assessment
Environmental Protection (Unauthorised Discharges) Regulations 2004	The purpose of the Regulations is to cover discharges into the environment from business or commercial activity which are not serious enough to cause pollution or environmental harm and breach the provisions of the Environmental Protection Act 1986 (EP Act).	Yes	Department of Water and Environment Regulation	Unplanned hydrocarbon/chemical release (Response Actions – OPEP)	**Section 7 –** Unplanned activities risk assessment

State legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
Environment Protection (Controlled Waste) Regulations 2004	Regulates the transportation of controlled waste on roads in Western Australia (storage, handling, labelling, transport, tracking etc)	Yes	Department of Water and Environment Regulation (DWER)	Unplanned hydrocarbon/chemical release (Response Actions – OPEP)	**Section 7 –** Unplanned activities risk assessment
Fish Resources Management Act 1994 *Fish Resources Management Regulations 1995*	This Act establishes a framework for management of fishery resources and is the nominated lead agency responsible for implementing Western Australian marine biosecurity management requirements through implementation of the *Fish Resources Management Act 1994* (FRMA 1994) and associated regulations.	Yes	Department of Primary Industries and Regional Development (DPIRD)	Introduction of IMS.	**Section 7.1**– Introduction of invasive species
Petroleum (Submerged Lands) Act 1982 *Petroleum (Submerged Lands) (Environment) Regulations 2012*	The environment plan must include: (a) details of all environmental impacts and environmental risks of the activity; and (b) an evaluation of those impacts and risks; and (c) a description of the environmental risk assessment process used to evaluate those impacts and risks, including the terms used in that process to categorise the levels of seriousness of those impacts and risks.	Yes	Department of Mines, Industry Regulation and Safety	Environmental impacts and environmental risks of the activity due to: + Artificial light; + Noise emissions; + Atmospheric emissions; + Seabed and benthic habitat disturbance; + Operational discharges; + Introduction of invasive marine species; + Marine fauna interaction; + Dropped objects; + Hydrocarbon releases (surface and subsea); and	**Section 5** – Environmental impact and risk assessment **Section 6** – Planned events **Section 7** – Unplanned events

State legislation	Summary	Relevant to activity?	Administering authority	Relevant aspects of the activity	EP section
				+ Spill response operations.	
West Australian Maritime Archaeology Act 1973	Protects maritime archaeological sites on state land and in State waters, such as bays, harbours and rivers. Other than shipwrecks, it includes single relics, such as an anchor, and land sites associated with exploration, early settlements, whaling and pearling camps and shipwreck survivor camps	No	West Australian Museum	No archaeological relics identified within operational area or EMBA.	N/A

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*.	No	Planned operational discharges occur as parted of operations.	**Section 6.6** – Planned 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 7.4 -**hydrocarbon release
Agreement Between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and Their Environment 1986 (commonly referred to as the China Australia Migratory Bird Agreement or CAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and China. Implemented in EPBC Act 1999.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging or nesting in area.	**Section 7.4 -**hydrocarbon release
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	**Section 6** – Underwater noise emissions

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
			migratory species) protected under the EPBC Act.	**Section 7.1**- Introduction of IMS **Section 7.4 -**hydrocarbon release
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 7.4 -**hydrocarbon release
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 7.4 -**hydrocarbon release
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 five Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged substances, sewage and garbage.	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
	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 1912 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 7.4 -**hydrocarbon release
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 IMS in ships' 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 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	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 7.1 – Introduction of IMS

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
	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 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.	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 Orders - Part 91: Marine Pollution Prevention - Oil + Marine Orders - Part 93: Marine Pollution Prevention - Noxious Liquid Substances + Marine Orders - Part 95: Marine Pollution Prevention – Garbage + Marine Orders - Part 96: Marine Pollution Prevention – Sewage + Marine Orders - Part 97: Marine Pollution Prevention - Air Pollution + Marine Orders - Part 98: Marine Pollution - Anti-fouling Systems	**Section 6.6** – Planned operational discharges **Section 7.1**- Introduction of IMS **Section 7.4** -hydrocarbon release

International agreements and conventions	Summary	Relevant to activity?	Relevant aspects	EP section
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 in 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.	**Section 6.3** – Atmospheric emissions

Appendix B - Description of the Existing Environment

Appendix B1 Description of the Existing Environment

Appendix B2 PMST Searches

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Values and Sensitivities of the Marine and Coastal Environment

PROJECT / FACILITY	All
REVIEW INTERVAL (MONTHS)	12 Months
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s *Managerial/Technical/Site*	Approver
	HSE Government Approvals	HSE	Principal Environment Advisor
6	Nick Phillips	Sonja Mavrick Annette McGovern	Libby Howitt

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Rev	Rev Date	Author / Editor	Amendment
A	13/05/14	Oceanica	Technical review
B	13/05/14	Oceanica	Editorial review
0	30/07/14	EG/GG	Final
1	30/12/14	GG	Updated
2	28/07/2016	Jacobs	Updated
3	28/11/17	Jacobs	Updated
3.1	11/12/2018	Jacobs	Issued for technical review
4	17/12/2018	Jacobs	Issued for use
4.1	09/01/2019	Jacobs	Issued for technical review
5	14/02/2019	Santos	Issued for use
5.1	15/01/2020	CDM Smith	Issued for technical review
6	03/03/2020	CDM Smith	Issued for use

Contents

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Appendices

1. Introduction

Santos WA Energy Limited (Santos WA) is the titleholder of multiple petroleum titles for exploration, development and operational activities located in marine waters off north-western Western Australia. This document describes the existing environment that may be affected (EMBA) by these petroleum activities and includes details of the relevant values and sensitivities of that environment as required by the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* and State *Western Australian Petroleum (Submerged Lands) (Environment) Regulations 2012.*

The EMBA represents the largest possible spatial extent that could be contacted by the worst-case spill event modelled for Santos activities to date (loss of well control event from drilling an exploration well at Phoenix South). The EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of a worst case oil spill from Santos's activities. The low hydrocarbon exposure values as defined in NOPSEMA's '*Environmental Bulletin – Oil Spill Modelling*' (April 2019), are used as a predictive tool to set the outer boundaries of the EMBA.

This document describes the values and sensitivities of the marine environment based on the modelling results for the low hydrocarbon exposure values for the surface hydrocarbons and the entrained hydrocarbons from a loss of well control event at Phoenix South 2.

This document is informed by a search of the protected matters search tool (PMST) provided by the Department of Agriculture, Water and the Environment (DAWE) (previously the Department of the Environment and Energy (DoEE) (dated 25/11/2019 and provided in **Appendix A**), as well as published scientific literature and studies where applicable. Descriptions of all fauna are provided, with a focus on protected species that are threatened and migratory.

1.1 Geographical Extent

The EMBA, includes the coastal waters and shoreline habitats of Western Australia (WA), encompassing the south of WA and the Northern Territory (NT) border in the north (**Appendix A**). This area largely approximates the Commonwealth North-West Marine Region (NWMR), the South-West Marine Region (SWMR) and the North Marine Region (NMR). Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, there are 14 bioregions that occur within the EMBA. These bioregions are based on fish, benthic habitat and oceanographic data (IMCRA v. 4.0). Where relevant, the physical, biological and social environments within the EMBA are discussed with reference to the IMCRA Provincial Bioregions. The provinces of most relevance (**Figure 1-1**) are:

North-west Marine Region

+ Northwest Shelf Transition;
+ Timor Province;
+ Northwest Transition;
+ Northwest Province;
+ Northwest Shelf Province;
+ Central Western Transition;
+ Central Western Shelf Transition; and
+ Central Western Shelf Province.

South-west Marine Region

+ Central Western Province;
+ Southwest Shelf Transition;

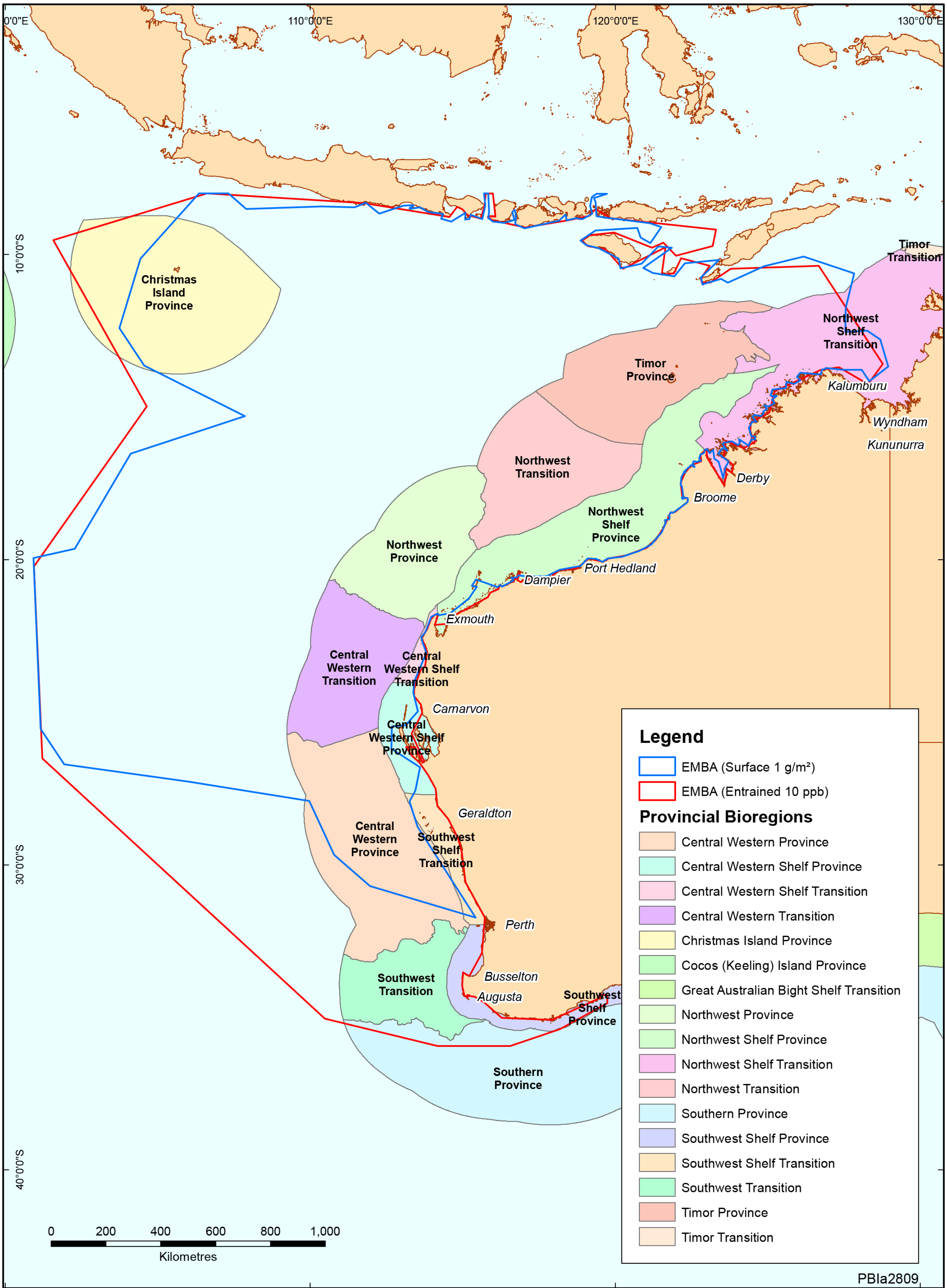
- Southwest Transition; and
- Southwest Shelf Province; and
- Southern Province,

North Marine Region

- Northwest Shelf Transition (as above).

Other IMCRA 4.0 bioregions of interest include: Christmas Island Province.

The international waters of south west Indonesia and Timor-Leste (in part) are also included in the EMBA and described where relevant throughout this document.



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PROVINCIAL BIOREGIONS

Figure 1-1: EMBA within IMCRA 4.0 Provincial Bioregions

2. Physical Environment

2.1 Geomorphology

2.1.1 Formation History

Approximately 550–160 million years ago, northern and western parts of Australia formed part of the northern margin of Gondwana. About 300 million years ago, crustal stretching, rifting and breakup initiated development of an extensive basin that became the site for deposition of sediments (Baker *et al*. 2008 in Department of the Environment, Heritage, Water and the Arts (DEWHA) 2008a). Approximately 135 million years ago the continent broke up resulting in the separation of greater India and Australia. Ocean spreading associated with the continental break-up resulted in the creation of the Argo and Cuvier abyssal plains. Subsidence of the rifted margin resulted in the formation of the Exmouth and Scott plateaux and the Rowley Terrace. The narrow shelf south of North West Cape was formed approximately 130 million years ago as a result of the separation of India and seafloor spreading (Baker *et al*. 2008 in DEWHA 2008a).

The South-west region has been relatively stable throughout its recent geological past. This has shaped a continental shelf that has high wave exposure and is punctuated with coastal features such as island groups and fringing coastal reefs providing sheltered habitats for marine communities (2008a).

2.1.2 Present Day Geological Features

The EMBA consists of five major landform features: continental shelf, continental slope, continental rise, Exmouth plateau and abyssal plain. The majority of the area consists of either continental shelf or continental slope (DEWHA 2008a).

Limited surveys have shown that the continental slope in the EMBA comprises diverse geological features such as canyons, plateaux, terraces, ridges, reefs, banks and shoals (DEWHA (2008)) (**Figure 2-1** and **Figure 2-2**). These features are significant in that over half of the total area of banks and shoals across Australia's entire marine jurisdiction occurs in the Commonwealth waters from the South Australian border to the Northern Territory border, as well as 39% of terraces and 56% of deeps, holes and valleys (DEWHA 2008a).

An important characteristic of the EMBA is the significant narrowing of the continental shelf around North West Cape from the broad continental shelf in the north (**Figure 2-3**). For example, in the Joseph Bonaparte Gulf (at the NT boundary), the continental shelf is around 400 km wide, whereas at North West Cape the shelf is only 7 km wide – the narrowest of anywhere on the Australian continental margin (DEWHA 2008a). Shelf width affects oceanography with flow on effects to productivity and ecosystem functioning.

The continental shelf north of Cape Leveque is characterised by a rimmed ramp where the waters over the outer margins of the shelf (approximately 50 to 100 m waters depth) are shallower than the middle portions (up to 150 m water depth). The rim at its outer edge is the site of a number of coral reefs including Ashmore, Cartier, Scott and Seringapatam (DEWHA 2008a).

The Indonesian archipelago lies between the Pacific and Indian oceans, and bridges the continents of Asia and Australia. The archipelago is divided into several shallow shelves and deep-sea basins.

2.1.3 Southwest Shelf Province

The Southwest Shelf Province consists of an area of narrow continental shelf from Rottnest to Point Dempster. For the purposes of this document (EMBA), the northern and western limits of the bioregion are the main focus because it is this portion that falls within the EMBA, which are an extension of the seafloor described in the Southwest Shelf Transition (below). It includes features such as limestone ridges, depressions defining an inshore lagoon and a relatively smooth inner shelf plain that meets the South Bank Ridge on the outer shelf, and islands providing important habitat, such as Rottnest Island. The shelf progressively broadens to form the relatively sheltered waters of Geographe Bay before narrowing once again at Cape Mentelle.

2.1.4 Southwest Shelf Transition

The Southwest Shelf Transition is a nearshore bioregion that covers the area of continental shelf from Perth to Busselton, and extends out to the edge of the shelf. This bioregion consists of a narrow continental shelf, ranging from approximately 40–80 km wide. It includes a series of complex nearshore ridges and depressions that form inshore lagoons, a smooth inner shelf plain, a series of offshore ridges and a steep, narrow outer shelf. The near-shore ridges are formed by eroded limestone reefs and pinnacles that stand 10–20 m above the seafloor. The edge of the inner shelf plain is marked by a series of broken offshore ridges that extend north to the northern limits of the bioregion, where they emerge to support the tropical carbonate reef growth of the Houtman Abrolhos Islands.

2.1.5 Southwest Transition

The Southwest Transition is an offshore deep-water bioregion with a submerged continental fragment as its dominant seafloor feature – the Naturaliste Plateau. The Plateau extends across an area of 90,000 km^2 of which only 29,825 km^2 is within Commonwealth waters. It is located west of Cape Leeuwin and Cape Naturaliste in water depths ranging from 2,000–5,000 m. It is relatively flat with a slight northward dip, and has steep southern and western sides and a more gently sloping northern side. The Plateau is separated from the Australian continent by the Naturaliste Trough and two offshore terraces on the continental slope (average depth 780 m). Submarine canyons incise the northern parts of the slope and parts of the Naturaliste Plateau.

2.1.6 Southern Province

The Southern Province is the largest bioregion within Australia's waters stretching from the shelf break south of Kangaroo Island to the southern edge of the Naturaliste Plateau. The bioregion includes the deepest ocean areas within the Australian Exclusive Economic Zone (approximately 5,900 m maximum water depth) and consists of a long continental slope incised by numerous well-developed submarine canyons. Several key ecological features are present within the EMBA and include the Albany Canyons Group, the Ceduna and Eyre Terraces (covering approximately 147,150 km^2) and the Diamantina Fracture Zone.

2.1.7 Sediments

Terrestrial environments are not a major source of sediment in the area and terrigenous sediments tend to be confined to the inner shelf (generally less than 100 m water depth), particularly in areas adjacent to rivers. Sediments in the area generally become finer with increasing water depth, ranging from sand and gravels on the shelf to mud on the slope and abyssal plain. Joseph Bonaparte Gulf is an exception to this pattern, as sediments with high mud content extend across the inner and mid shelf within the Gulf, graduating to sands and gravels in the Bonaparte Depression.

The distribution and resuspension of sediments on the inner shelf is strongly influenced by the strength of tides across the continental shelf as well as episodic events such as cyclones. Further offshore, on the mid to outer shelf and on the slope itself, sediment movement is primarily influenced by ocean currents and internal tides. Internal tides describe the tidal movement across a slope of water stratified by marked differences in density. Internal tides cause resuspension and net down-slope deposition of sediments on the North West Shelf (DEWHA 2008a).

Surveys conducted over the North West Shelf indicate that similar sediments occur extensively over this geographic region, but with spatial variation in the grain size and origin of the surface sediments.

The ecology of the southwest is also greatly influenced by the lack of river discharge into the Region. The few significant rivers adjacent to the Region flow intermittently and their overall discharge is low. The low discharge of rivers and the generally low rate of biological productivity also results in low turbidity (suspended sediments), making the waters of the Region relatively clear (McLoughlin & Young 1985). Surface sediments in the area are predominantly composed of skeletal remains of marine fauna, with lenses of weathered sands (McLoughlin & Young 1985).

Several geomorphic formations have been associated with Key Ecological Features (DEWHA 2008a) and these are discussed in **Section 10**.

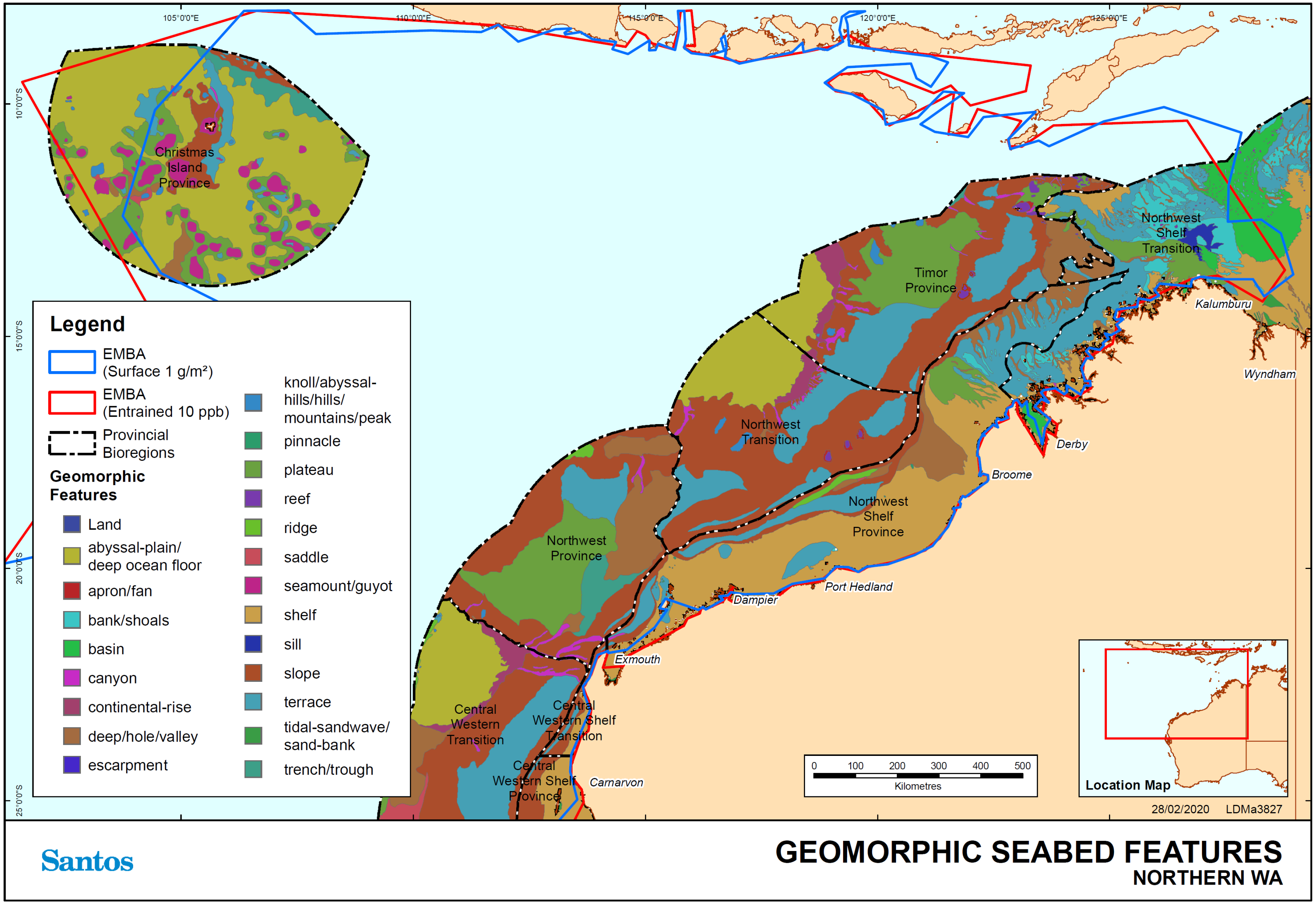


Figure 2-1: Geomorphic/seafloor features of Northern WA

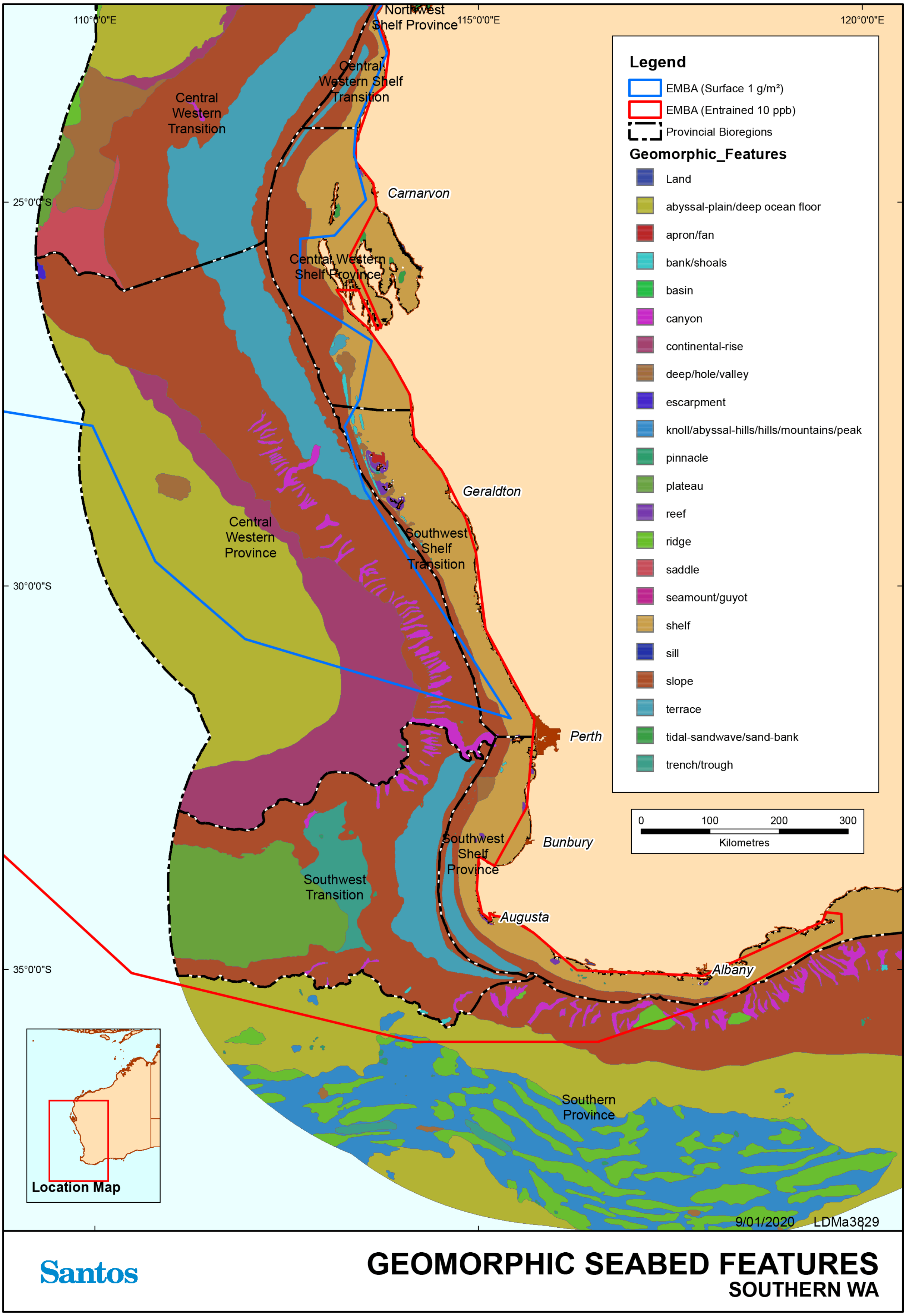


Figure 2-2: Geomorphic/seafloor features of Southern WA

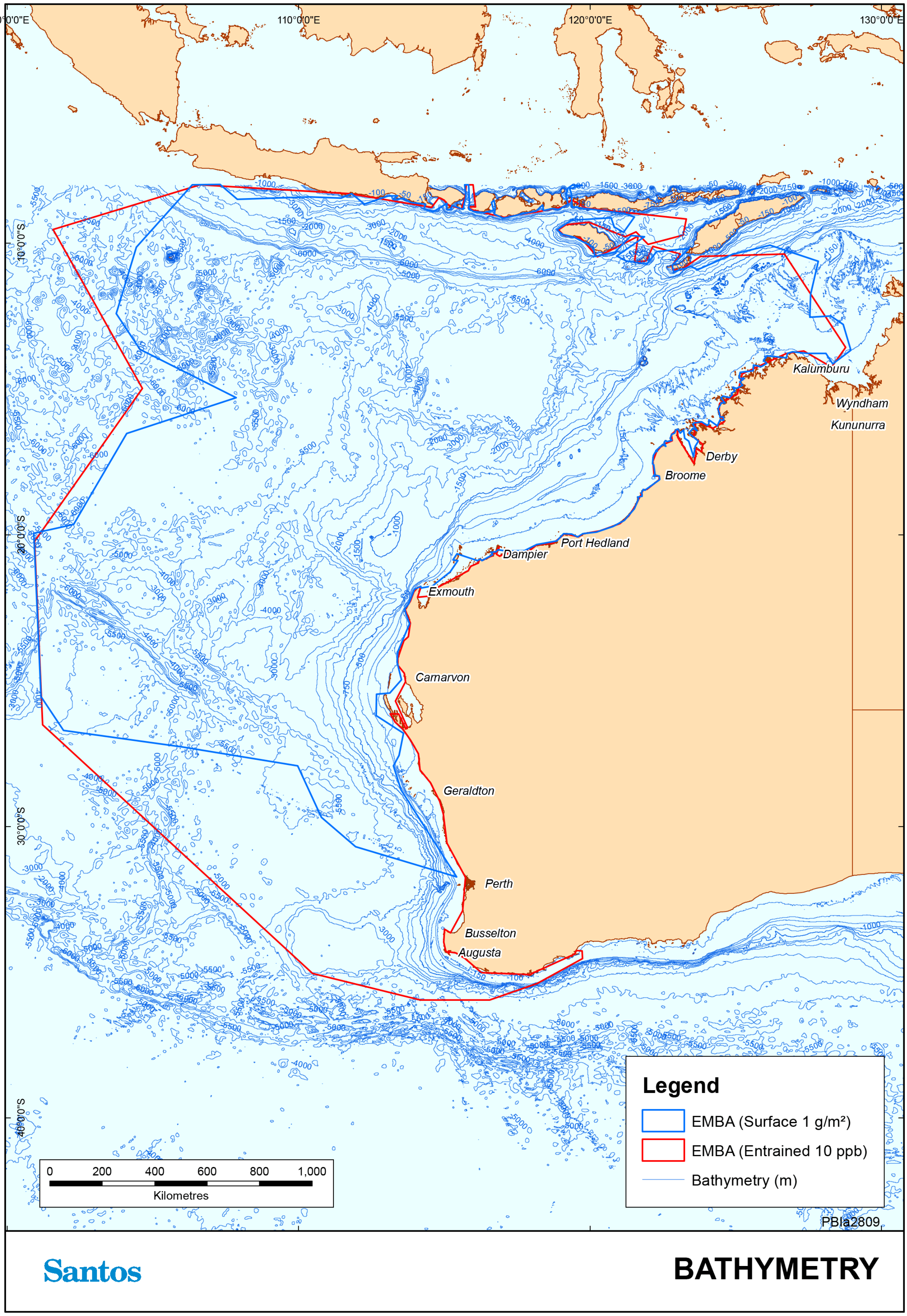


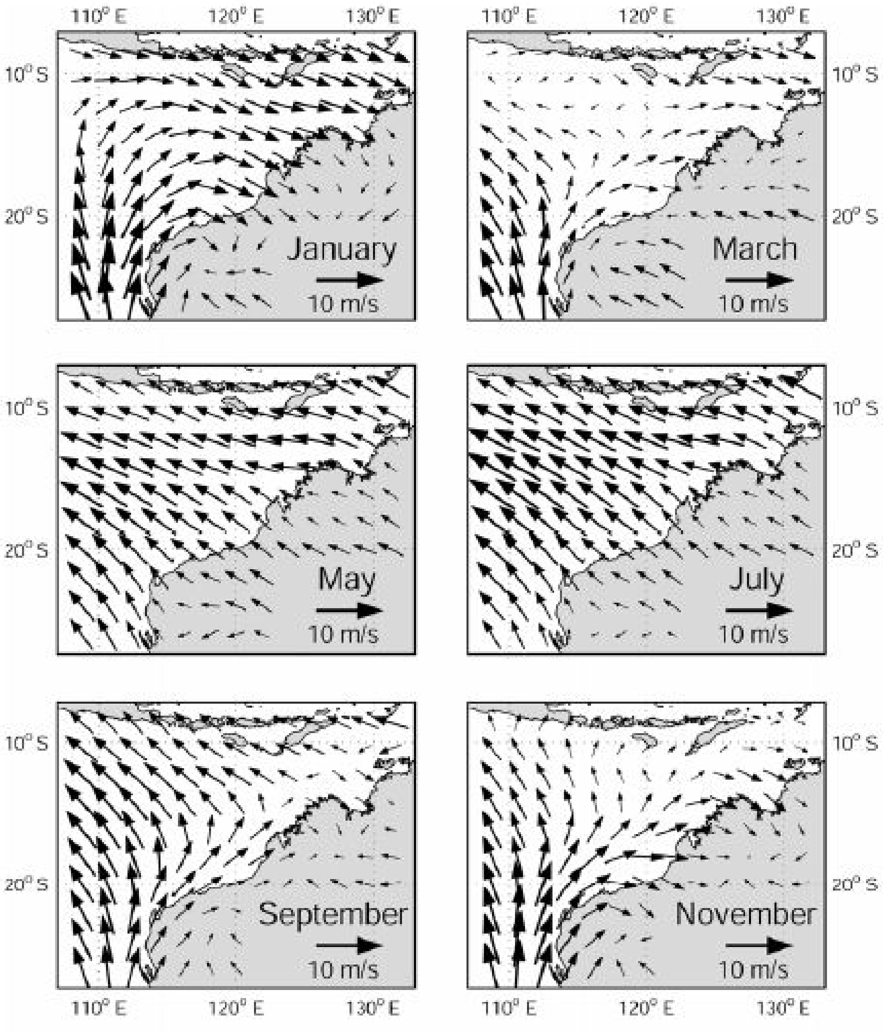
Figure 2-3: Bathymetry of the EMBA

2.2 Climate

Waters in northern Western Australia predominantly lie in the arid tropics, experiencing high summer temperatures and periodic tropical cyclones in summer. Rainfall in the region is low, although intense rainfall may occur during the passage of summer tropical cyclones and thunderstorms (Condie *et al.* 2006). Mean air temperatures range from a minimum of 11°C in winter to a maximum of 36°C in summer (Condie *et al.* 2006). Due to the arid climate, daytime visibility in the area is generally greater than 5 nautical miles (SSE 1991).

The summer and winter seasons fall into the periods September–March and May–July, respectively. Winters are characterised by clear skies, fine weather, predominantly strong east to southeast winds and infrequent rain (calculated from NCEP-NCAR dataset measured from 1982 to1999; Condie *et al.* 2006; **Figure 2-4**).

Summer winds are more variable, with strong south-westerlies dominating. Transitional wind periods, during which either pattern may predominate, can be experienced in April–May and September of each year.



Calculated from NCEP-NCAR dataset measured from 1982 to 1999. Source: Condie *et al*. (2006)

Figure 2-4: Seasonally averaged winds at 10 m above mean sea level

Tropical cyclones generate the most significant storm conditions in the area (SSE 1993). These clockwise-spiralling storms have generated wind speeds 50–120 knots (SSE 1991). Tropical cyclones develop in the eastern Indian Ocean, and the Timor and Arafura Seas during the summer months. Three to four cyclones per year are typical, with the official cyclone season being November through to April (Bureau of Meteorology

(BoM) 2013). In Indonesia, the main variable in climate is not temperature or pressure, but rainfall, which varies greatly by month and place, ranging from 997 millimetres (mm) to 4,927 mm.

Waters in the southwest and southern Western Australia experience a Mediterranean style climate that is characterised by cool, wet winters and hot, dry summers. In winter, wind patterns are characterised by a prevailing westerly wind stream. This enables winter cold fronts and strong westerly winds to regularly penetrate the south-west, with cold fronts crossing the coast every week or so. Apart from the passage of storms, typically lasting one day or less, the weather is otherwise mild in winter with winds variable and relatively weak. In summer, cold fronts rarely penetrate into the south of the state with any strength and hot easterly winds prevail.

2.3 Oceanography

Major drivers of marine ecosystems include ocean currents, tides, waves, temperature and salinity. The dominant offshore sea surface current is the Leeuwin Current (**Figure 2-5**), which carries warm tropical water south along the edge of Western Australia's continental shelf, reaching its peak strength in winter and becoming weaker and more variable in summer (Condie *et al.* 2006). The current is typically located seaward of the shelf break (200 m isobath) and is a narrow, surface current, extending to a depth of 150 m (BHPB 2005, Woodside 2005) and a width of 50–100 km (DEWHA 2008a). The formation of meanders and eddies are also a feature of the Leeuwin Current and a number of eddies occur south of Shark Bay (DEWHA 2008a). The strength of the Leeuwin Current is influenced by seasonal variability in the pressure gradient (DEWHA 2008a). The Holloway Current is the prevailing seasonal current, travelling south-west along the north West Australian coast in winter and north-east in summer (Brewer et al. 2007).

The Indonesian Throughflow is the other important current influencing the upper 200 m of the outer North West Shelf (Woodside 2005). This current brings warm and relatively fresh water to the region from the western Pacific via the Indonesian Archipelago (**Figure 2-5**). Modelling undertaken by Woodside and Commonwealth Scientific and Industrial Research Organisation (CSIRO) Marine and Atmospheric Research indicates that significant east–west flows occur across the North West Shelf to the north of the North West Cape, possibly linking water masses in the area (Woodside 2005, Condie *et al.* 2006).

Currents in the coastal zone and over the inner to mid-shelf are largely driven by tides and winds, whereas offshore, over the continental shelf, slope and rise are influenced by large scale regional circulation (DEWHA 2008a).

The nearshore Ningaloo Current flows northwards opposite to the Leeuwin Current, along the outside of the Ningaloo Reef and across the inner shelf from September to mid-April (BHPB 2005, Woodside 2005). The nearshore Capes Current, which is to the south of the Ningaloo Current, is a seasonal current that appears strongest between Cape Leeuwin and Cape Naturaliste, in the southwest of Western Australia (Pearce and Pattiaratchi 1999). Strong northwards winds between November and March slow the Leeuwin Current and increase the strength of the Capes Current. Localised upwelling is also known to occur in the area (Pearce and Pattiaratchi 1999).

Tides increase in amplitude from south to north, corresponding with the increasing width of the shelf (Holloway 1983). Tides in the area are generally semi-diurnal (i.e. two high tides and two low tides per day) with a spring/neap cycle. The northern area experiences some of the largest tides in the world. In the Kimberley, the daily tidal range is up to 10 m during spring tides and less than 3 m during some neap tides. Mid-shelf tidal currents are predicted to have average speeds of approximately 0.25 knots during neap tides and up to 0.5 knots during spring tides (NSR 1995, WNI 1995).

The wave climate in the northwest is composed of locally-generated wind waves (seas) and swells that are propagated from distant areas (WNI 1995). In summer the seas typically approach from the west and southwest, while in winter the seas typically approach from the south and east. Mean sea wave heights are typically less than 1 m and peak heights of less than 2 m are experienced in all months of the year (WNI 1995).

Indonesian waters, especially the eastern part of the archipelago, play an important role in the global water mass transport system, in which warm water at the surface conveys heat to the deeper cold water in what is known as the great ocean conveyor belt (refer **Figure 2-5**). The eastern archipelago is the only place in the

Pacific Ocean that connects with the Indian Ocean at lower latitudes. The water mass transport from the Pacific to the Indian Ocean through various channels in Indonesia is called Arlindo (Arus Lintas Indonesia), also known as the Indonesian Throughflow (ADB 2014). Surface currents in Indonesian waters are more strongly influenced by circulation from the Pacific Ocean than from the Indian Ocean. The currents are also greatly influenced by the winds of the prevailing monsoon.

Average swell heights are low, around 0.4–0.6 m in all months. The greatest exposure to swells is from the west (SSE 1993). Tropical cyclones have generated significant swell heights of up to 5 m in this area, although the predicted frequency of swells exceeding 2 m is less than 5% (WNI 1996). In the open ocean, sustained winds result in wind-forced currents of approximately 3% of the wind speed (Holloway & Nye 1985).

Tides in the South West Capes area are mixed (i.e. diurnal and semi-diurnal) and generally less than one metre, with a typical daily range of about 0.7 m during spring tides and about 0.5 m during neap tides. Tides of this magnitude produce weak currents compared to wind and wave driven flows (Hill & Ryan 2002 cited in Department of Environment and Conservation (DEC) 2013).

Waters on the continental shelf are usually thermally-stratified, with a marked change in water density at approximately 20 m (SSE 1993). Surface temperatures vary annually, being warmest in March (32°C) and coolest in August (19°C). Vertical gradients are related to the seasonality of sea surface temperatures, and are greatest during the warm-water season (SSE 1991). Near-bottom water temperature on the North West Shelf is approximately 23°C, with no discernible seasonal variation.

Salinity is relatively uniform at 34–35 ppt throughout the water column and across the North West Shelf. Due to the low rainfall there is little freshwater run-off from the adjacent mainland (Blaber *et al*. 1985).

Pronounced shifts in water column characteristics can occur following the passage of tropical cyclones (McKinnon *et al*. 2003). Changes in water temperature and salinity characteristics can result from changes in local heating and evaporation following the southward movement of warmer water due to southward-moving cyclones, and can have flow-on effects to primary and secondary productivity (McKinnon *et al*. 2003).

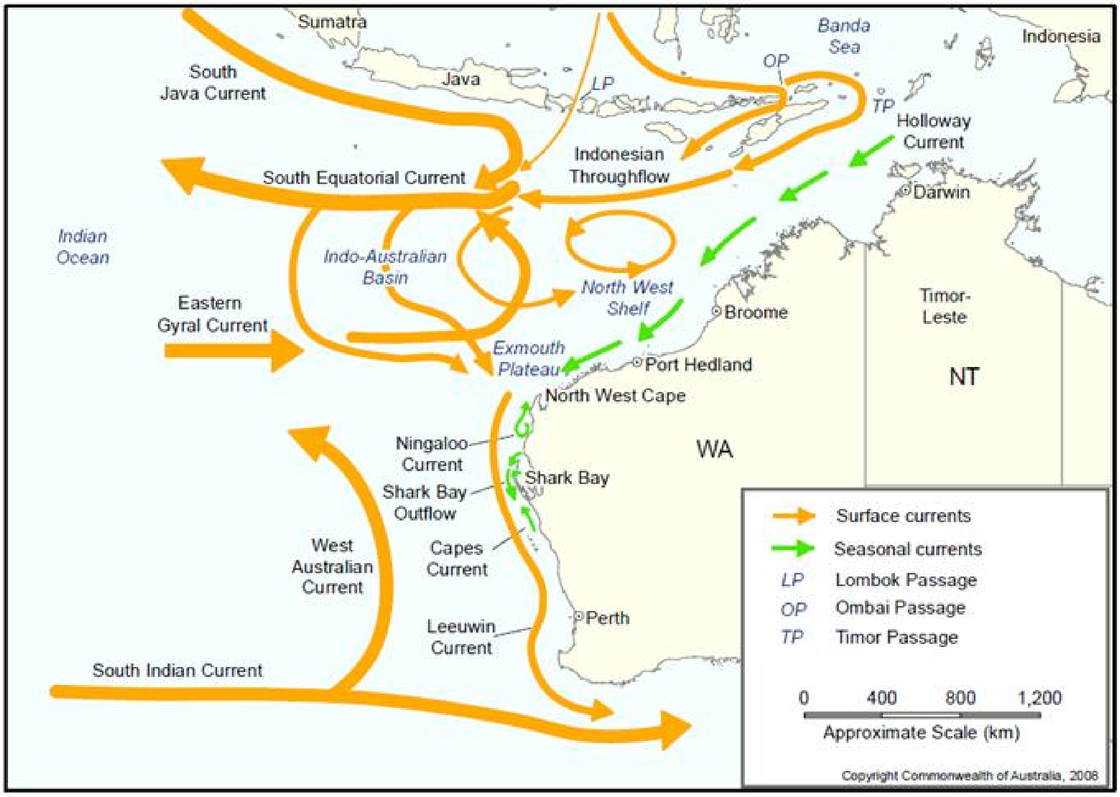


Figure 2-5: Surface currents in WA

Source: DEWHA (2008b)

3. Benthic and Pelagic Habitats

Benthic habitats are defined as those subtidal habitats lying below the lowest astronomical tide (LAT). The benthic habitats within waters in the EMBA lie at depths ranging from LAT down to more than 6,000 m at Argo and Cuvier abyssal plains (DEWHA 2008a, 2008b).

Benthic habitats are partially driven by light availability. Primary producers (photosynthetic corals, seagrasses and macroalgae) are limited to the photic zone, whereas benthic invertebrates including filter feeding communities may be found in deeper waters. The depth of the photic zone varies spatially and temporally and is predominantly dependent on the volumes of suspended material in the water column. The photic zone in the offshore Pilbara is approximately 70 m whereas in oceanic waters in the northwest and coastal waters of the southwest the photic zone may extend to 120 m (DEWHA 2008b).

The following section broadly categorises benthic habitats as four biological communities; coral, seagrasses, macroalgae and non-coral benthic invertebrates. These communities are discussed in terms of the 14 IMCRA v. 4.0 bioregions. Some broad scale benthic habitat mapping exists for the Northwest and Central Western Shelf Provinces and this is shown in **Figure 3-1**.

3.1 Coral Reefs

Corals are both primary producers and filter feeders and thus play a role in the provision of food to marine fauna and in nutrient recycling to support ecosystem functioning (Conservation and Land Management (CALM) & Marine Parks and Reserves Authority (MPRA) 2005a).

Corals create settlement substrate and shelter for marine flora and fauna. Studies have shown that declines in the abundance, or even marked changes in species composition of corals, has a marked impact on the biodiversity and productivity of coral reef habitats (Pratchett *et al*. 2008). As part of the reef building process, scleractinian corals are also important for protection of coastlines through accumulation and cementation of sediments and dissipation of wave energy (CALM & MPRA 2005a).

The waters in the EMBA contain extensive coral communities. Coral reefs in the area fall into two general groups: the fringing reefs around coastal islands and the mainland shore; and large platform reefs, banks and shelf-edge atolls offshore (Woodside 2011). The distribution of corals in area is governed by the availability of hard substrate for attachment and light availability.

Coral reefs are dynamic environments that regularly undergo cycles of disturbance and recovery. Depending on how frequent and severe the disturbances are, recovery can take a few years or more than a decade. Disturbances can include bleaching, cyclones and disease outbreaks (Australian Institute of Marine Science (AIMS) 2011).

Corals in the northwest and central provinces have experienced bleaching events and subsequent recovery. Bleaching is the process where symbiotic algae are expelled from the coral tissue, often leading to the death of the colony. Causes of bleaching include high temperatures (Scott Reef; 1998), anoxic conditions (Bill's Bay; 2008) or smothering (Waples & Hollander 2008, Gilmour et al. 2013). Coral susceptibility to bleaching and their ability to recover is an important consideration in the context of potential anthropogenic impacts.

Four bioregions (Northwest Province, Northwest Transition, Central Western Province and Central Western Shelf Transition) lie in deep waters below the photic zone. Two bioregions (Southwest Transition and Southwest Shelf Province) occur in waters that are too cold to support tropical coral reefs species. Photosynthetic corals are not present in either of these locations and hence these bioregions are not discussed further.

3.1.1 Southwest Shelf Transition

The coral reefs of the Houtman Abrolhos Islands are the most southern extensive coral community along the west coast. Smaller localised pockets do occur as far south as Rottnest Island and even extend to Cape Naturaliste in the Southwest Shelf Province. The reefs around the Abrolhos Islands comprise 211 known species of corals and all but two of the coral species are tropical (Department of Fisheries (DoF) 2012). The greatest diversity and density of corals is found on the reef slopes, shallow reef perimeters and lagoon patch reefs in the more sheltered northern and eastern sides of each of the three limestone platforms that support the island groups (DoF 2012).

3.1.2 Central Western Shelf Province

The Central Western Shelf Province occurs on the continental shelf between Coral Bay and Busselton and is generally flat with depths ranging from 0–100 m. The province includes Shark Bay and Bernier, Dorre and Dirk Hartog Islands.

Studies at Shark Bay recorded 80 species of coral (Marsh 1990). The study determined that salinity and seasonal temperature gradients restrict the distribution of corals to areas that have normal salinity in the western half of the Bay, a few species occur in the metahaline waters but none in the hyper saline areas (Marsh 1990). The eastern shores of Bernier, Dorre and Dirk Hartog Islands provide the most favourable habitats for coral growth due to shelter, and water with relatively small salinity and temperature fluctuations. Some sections of these islands support prolific coral growth (up to 100% cover) both in the sheltered leeward and exposed areas. This bioregion is a transitional zone between the predominantly tropical flora and fauna of the north and temperate flora and fauna further south (CALM & NPNCA 1996).

3.1.3 Central Western Shelf Transition

A significant proportion of this bioregion is covered by the Ningaloo Reef. The Ningaloo Reef is unique in that it is the largest fringing reef in Australia and is the only large reef found on the western side of a continent in the southern hemisphere.

A 300 km section of the coast, from Red Bluff to North West Cape and extending to Bundegi in Exmouth Gulf, is included in the Ningaloo Marine Park. Ningaloo Reef supports variable lagoonal, intertidal and subtidal coral communities along its length. Ningaloo Reef is characterised by a high diversity of hard corals with at least 217 species representing 54 genera of hermatypic (reef building) corals recorded to date (Veron & Marsh 1988). The most diverse coral communities are found in the shallow relatively clear water, high energy environment of the fringing barrier reef and low energy lagoonal areas to the west of North West Cape (CALM & MPRA 2005a).

Coral diversity reduces with increasing depth, and corals are uncommon at depths greater than 40 m (Waples & Hollander 2008). At depths between 20 and 30 m hard corals have been found to be more dominant in the northern areas of the Ningaloo Marine Park, whereas in southern areas other sessile invertebrates such as sponges, as more prevalent (Waples & Hollander 2008).

3.1.4 Northwest Transition

This bioregion lies mostly over the continental slope and the abyssal plain in deep waters that preclude photosynthetic coral growth (DEWHA 2008a). However, in contrast with the surrounding area, the Rowley Shoals are three distinct reef systems (Mermaid, Clerke and Imperieuse Reefs) approximately 30–40 km apart that rise vertically to the surface from depths of between 500 and 700 m. The marine reef fauna of the Rowley Shoals is considered to be exceptionally rich and diverse, including species typical of the oceanic coral reef communities of the Indo-West Pacific. As many of these species are not found in the inshore tropical waters of northern Australia, such populations are of regional significance (DEWHA 2008a).

A 1993 survey at Mermaid Reef recorded 214 species of scleractinian corals (Done *et al*. 1994). The survey found that coral assemblages of the Rowley Shoals are broadly comparable to those found on the reefs of the outer Great Barrier Reef and in the Coral Sea. While the coral fauna is similar to Scott Reef, it differs considerably from that of north-western Australia (Veron 1986). Veron (1986) notes that the clear water of the Rowley Shoals allows coral communities to exist over a great range of depths, while the strong wave action on the outer coral slopes and the wide tidal range result in distinct patterns of zonation.

3.1.5 Northwest Shelf Province

This province contains numerous small coastal islands in addition to larger archipelago and offshore island groups. Many of these features are surrounded by shallow waters with small barrier and fringing reefs that support coral communities. Key areas recognised for coral communities in this bioregion are discussed below.

The Dampier Archipelago supports coral reefs in shallow waters near islands and submerged pinnacles. The most significant coral reefs have formed along the seaward slopes of Delambre Island, Hamersley Shoal, Sailfish Reef, Kendrew Island and north-west Enderby Island (CALM & MPRA 2005). Field trips in the Dampier Archipelago between 1972 and 1998 recorded 229 species of corals from 57 genera (Griffith 2004). Surveys of the Dampier Port and inner Mermaid Sound recorded approximately 120 coral species from 43 genera (Blakeway & Radford 2005) with coral reefs dominated by acroporids and pocilloporids. The greatest coral cover (up to 70%) was recorded in the eastern half of the archipelago (Wells *et al*. 2003).

The Montebello, Lowendal and Barrow Islands include 315 islands associated with extensive coral reefs, the most significant of which occur in the sheltered waters on the eastern side of the islands. Examples of these significant reefs include Dugong Reef, Batman Reef and reefs along the Lowendal Shelf (DEC & MPRA 2007a). Dominant corals include acroporids and poritids, with greater than 70% cover recorded for some areas (Chevron 2010). Subtidal coral reef communities around the islands are highly diverse, with at least 150 species of hard corals recorded from fringing and patch coral reef areas (DEC & MPRA 2007a).

Coral distribution near the mainland is restricted by lack of light due to natural turbidity. Corals may exist as sparse coral colonies in some locations, rather than extensive coral communities. Within Exmouth Gulf, coral communities are less common but are present on fringing reefs surrounding islands, as solitary corals distributed across areas of hard substrate, or on larger isolated patch reefs.

An epibenthic dredge survey of nearshore areas north of Broome identified 14 species of hard corals from six families (Keesing *et al*. 2011). Limited coral surveys conducted at Broome (15 species) and the Lacepede Islands (ten species) (Veron & Marsh 1988) suggest the species diversity in this locality may be low. However, low species diversity observed during the dredge survey may reflect the limited sampling frequency, limited depth range (11–23 m) or inadequate sampling in habitats considered favourable for the proliferation of hard corals (hard substrate). In contrast, other surveys of nearshore locations in the region have recorded much higher levels of species diversity. Veron and Marsh (1988) stated that 102 species of hard corals have been recorded from the Kimberley coast and nearshore reefs and Cairns (1998) recorded 87 species of azooxanthellate hard coral species from north-western Australian waters.

3.1.6 Timor Province

Although water depths in this province are generally deep (200 m to almost 6,000 m) there are several reefs and islands that are regarded as biodiversity hotspots (DEWHA 2008a).

Ashmore Reef, Cartier Island, Hibernia, Scott and Seringapatam Reefs are areas of enhanced local biological productivity, within an area of relatively unproductive waters. Ashmore Reef National Nature Reserve supports one of the greatest number of coral species of any reef off the West Australian coast, with 255 species of reef-building corals in 56 genera (Veron 1993). Taxonomic revisions and additional surveys have resulted in a net increase in species numbers to 275 (Griffith 1997, Ceccarelli *et al*. 2011). Species are typical of the Indo-pacific region and none are unique or considered endemic. However, 41 species (15% of the total hard coral species at the site) are listed as vulnerable on the IUCN Red List (IUCN 2019). In 1998, hard coral covered an area of around 717 ha at Ashmore Reef. The majority of hard corals occur in the deep lagoon (265 ha) and shallow reef top (315 ha) with small areas in the shallow lagoons, and reef edge/slope habitats (Skewes *et al*. 1999a). The soft, non-reef building corals are less well studied at Ashmore Reef than the hard corals (Hale & Butcher 2013). In 1986, 39 soft coral taxa were recorded within the Ashmore Reef, including the vulnerable blue coral (*Heliopora coerulea*) which was moderately common on the reef flats (Marsh 1993). In 1998, the total cover of soft coral at Ashmore Reef was 323 ha and *Sarcophyton* spp. was the dominant taxa covering around 19 ha in total (Skewes *et al*. 1999b, Hale & Butcher 2013).

The species composition of all the hard coral reefs in the bioregion is very similar and reflects strong links with Indo-West Pacific fauna, largely as a result of the dispersal of coral spawn via regional currents. The reefs and islands in this bioregion are thought to be important biological stepping-stones between centres of biodiversity in the Indo–Pacific and reef ecosystems further south (DEWHA 2008a).

Seringapatam Reef is a regionally important scleractinian coral reef as it has a high biodiversity, which is comparable to Ningaloo Reef. Results from the Western Australian Museum (WAM) survey in 2006 noted 159 species of scleractinian corals with a hard coral cover of approximately 16% (WAM 2009). The dominant benthic habitats of the reef were observed to include hard and soft corals (Heyward et al. 2013 cited in ConocoPhillips 2018).

Scott Reef consists of two reefs, North Scott Reef and South Scott Reef, which are separated by a deep (400–700 m) channel. North Scott Reef is an annular reef which encloses a lagoon that is connected to the ocean. South Scott Reef is a crescent-shaped reef which forms an arc and partially encloses another lagoon. Light penetration at Scott reef is high due to low turbidity. Light penetration depths to the deeper part of South Reef Lagoon are in excess of 50m with corals able to survive at depths of up to 70 m (Woodside Energy Limited *et al.* 2010).

Hibernia Reef consists of an approximately oval-shaped reef, with large areas of the reef becoming exposed at low tide. Hibernia Reef is also characterised by a deep central lagoon and drying sand flats.

There are a number of shoals and banks in the NMR and NWMR. Relatively few studies have been undertaken of these features with the majority of the understanding derived from the Big Bank Shoals study (Heyward *et al*. 1997), PTTEP surveys initiated in response to the Montara incident (Heyward *et al*. 2010; Heyward *et al.* 2011) and ConocoPhillips baseline surveys undertaken to support the Barossa Area Development (Heyward *et al.* 2017). The PTTEP surveys completed at Ashmore, Cartier and Seringapatam Reefs were undertaken during a coral bleaching disturbance likely to be attributed to regional thermal stress indicated by both *in situ* and satellite based data for the region. The condition of the reefs communities was consistent with previous surveys within the area and did not indicate any disturbance from the Montara incident (Heyward *et al*. 2010; Heyward *et al.* 2012).

In general, the submerged features are characterised by abrupt bathymetry, rising steeply from the surrounding outer continental shelf at depths of 100 m–200 m. The shoals and banks tend to flatten at depths of 40-50 m, with horizontal plateau areas of several square kilometres generally present at 20-30 m depths (Heyward *et al*. 2010). The shoals and banks support a diverse and varied range of benthic communities, including algae, reef-building soft corals, hard corals and filter-feeders (Heyward *et al.* 1997, Heyward *et al.* 2012). The plateau areas were dominated by benthic primary producer habitat, with interspersed areas of sand and rubble patches (Heyward *et al*. 2012).

3.1.7 Northwest Shelf Transition

Coral communities of the Northwest Shelf Transition have historically not been well studied. However, based on the scale of reef development and the diversity of coral species recorded through limited surveys, it is highly likely that further surveys will demonstrate that the Kimberley contains a coral reef province of global significance (Masini *et al*. 2009).

Coral reefs in the province include fringing reefs around coastal islands and some mainland shores. Development of coral communities in inshore areas is limited due to persistent high turbidity. Known examples of coral reefs in the bioregion are given below, however further mapping is required.

Benthic habitat surveys at Adele and Long Islands in 2009 and 2010 revealed extensive development of hard and soft coral communities (Richards *et al*. 2013). Scleractinian coral communities at Adele Island were diverse, supporting 176 species in intertidal and subtidal areas up to 14 m depth. At Long Island approximately 200 species of scleractinian corals were recorded in intertidal and subtidal areas. These surveys also identified two significant and unique habitats; a zone of mixed corallith and rhodolith habitat at Adele Island and an Organ Pipe Coral habitat zone with unusually high benthic cover at Long Island (Richards *et al*. 2013).

Studies by DBCA and the LNG industry indicate that fringing and emergent coral reefs are well developed in the Heyward island group, around islands in the Bonaparte Archipelago, and off mainland shores of Cape Voltaire and Cape Bougainville. Surveys by INPEX of Maret, Bethier and Montalivet islands, which were largely restricted to the intertidal zone, have recorded 280 species of coral from at least 55 genera, making the Kimberley Bioregion the most coral-diverse area in WA (INPEX 2008).

Montgomery Reef has been identified as a key feature in the area. Montgomery Reef is a huge submerged rock platform covering approximately 400 km^2. Corals occur in the subtidal area around Montgomery Reef, and in the many rock pools on the platform where there is shaded from the sun by algae or rock ledges

(DEWHA 2008a). A survey of benthic habitats at Montgomery Reef was conducted in 2009 by AIMS but a literature search found no published results from this survey (AIMS 2014).

Browse Island is surrounded by a minor fringing coral reef. Assemblages at Browse Island are characteristic of coral platform reefs throughout the Indo-West Pacific region, particularly Cartier Island. Coral diversity was greatest on the reef faces and shallow lagoons but these areas were of very limited extent (URS 2010a).

Hard corals have been recorded at Echuca Shoals but the community was low in both species richness and abundance (URS 2010a). The presence of occasional large outcrops suggests that larger coral structures have occurred previously and may still occur elsewhere on the shoal (RPS Environmental 2008).

3.1.8 International Waters

Important areas outside of the IMCRA bioregions include:

Christmas Island

Fringing coral reefs around Christmas Island are relatively simple with 88 coral species previously identified which are identified to support and over 600 fish species (Director of National Parks 2012).

Indonesia (west)

Indonesia has an estimated 75,000 km^2 coral reef ecosystem distributed throughout the archipelago (Tomascik et al. 1997 cited in Hutumo & Moosa 2005). Fringing reefs are the most common reef types with scleractinian corals as being the most dominant and important group. 452 species of hermatypic scleractinian coral were collected from Indonesian waters by Tomascik et al. (1997 cited in Hutumo & Moosa 2005), a study presented by Suharsono (2004 cited in Hutumo & Moosa 2005), indicated that 590 species of scleractinian corals exist in Indonesian waters. Acropora, Montipora and Porites are the most important reef building corals in Indonesia.

The Lesser Sunda Ecoregion encompasses the chain of islands and surrounding waters from Bali, Indonesia to Timor-Leste. This region contains suitable habitat for corals on shallow water substrates formed by limestone and lava flows and is thought to contain more than 500 species of scleractinian reef-building corals (DeVantier *et al.* 2008). Coral species composition is influenced by regional and local scale seasonal upwellings that typically occur from April to May each year on the southern side of the islands. The ecoregion is considered important for coral endemism, particularly the areas of Bali-Lombok, Komodo and East Flores. Fringing coral reefs tend to be less developed on the southern, more exposed shorelines (Wilson *et al.* 2011).

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

3.2 Seagrasses

Seagrasses are biologically important for four reasons:

1. As sources of primary production;
2. As habitat for juvenile and adult fauna such as invertebrates and fish;
3. As a food resource; and
4. For their ability to attenuate water movement and trap sediment (Masini *et al*. 2009).

Twenty-five species of seagrass have been recorded in WA, the highest diversity in the world (Masini *et al*. 2009). Waters extending from Busselton to the NT border support predominantly tropical species although temperate species are also found, particularly between Busselton and Exmouth (Walker 1987). One species, *Cymodocea angustata*, is endemic to WA (Department of Parks and Wildlife (DPAW) 2013).

The main seagrasses of the region are small, ephemeral species that grow on soft sediments and have a seed bank in the surficial sediments that allows them to recover quickly from disturbance (Walker 1989). Small, ephemeral species of seagrass tend to form mixed associations with macroalgae (CALM & MPRA 2005, DEC & MPRA 2007a, BHPBIO 2011) and usually covers less than 5% of the substrate (BHPBIO 2011, van Keulen & Langdon 2011).

Areas occupied by seagrass vary markedly both seasonally and interannually and it is not clear why some areas of suitable substrate will support seagrass in one year but not the next. It appears that recruitment to what may otherwise be suitable substrate is haphazard, lending weight to the descriptions of these seagrass communities as ephemeral (CALM & MPRA 2005, DEC & MPRA 2007a).

Two bioregions (Northwest Province and Central Western Transition) lie entirely in deep waters below the photic zone. Seagrasses are not present hence these bioregions are not discussed further.

3.2.1 Southwest Shelf Province

Geographe Bay is a large relatively sheltered area with that supports extensive beds of tropical and temperate seagrass that have a high diversity of species and endemism (DEWHA 2008a). They are thought to account for about 80% of benthic primary production in the area. These seagrass beds provide important nursery habitat for many shelf species that use the shallow seagrass habitat as nursery grounds for several years before moving out over the shelf to their adult feeding grounds along the shelf break.

The Geographe Bay seagrass meadows are among the most extensive temperate seagrass communities on the west coast (MPRSWG 1994 cited in DEC 2013), and include 10 species from five genera (*Amphibolis, Posidonia, Halophila, Heterozostera* and *Thalassodendron*). Geographe Bay is dominated by stands of the narrowleaf tape-weed (*Posidonia sinuosa*) that covers approximately 70% of Geographe Bay. It has smaller areas of *Posidonia angustifolia*, *Amphibolis griffithii*, *A. antarctica* and minor species, which have irregular distributions both spatially and temporally (Lord 1995 cited in DEC 2013). *Thalassodendron pachyrhizum*, *Posidonia* spp. and *Amphibolis* spp. are also found in depths of between 27 and 45 m (Walker *et al*. 1994 cited in DEC 2013).

3.2.2 Southwest Shelf Transition

Species diversity of seagrasses in this bioregion is the highest in the world, with 14 species occurring (DEWHA 2008a). In total, 10 seagrass species have been recorded at the Abrolhos ranging from small, delicate species to larger, more robust types that grow in large meadows (DoF 2012). Small paddle-weeds grow in protected lagoon areas or deep waters between the islands, such as Goss Passage and the larger species may be found growing on reef as well as in sandy areas (DoF 2012). *Thalassodendron pachyrhizum*, which is encountered growing on the exposed reef crest area, has been recorded at a number of the island groups. There are also two species of wire-weed (*Amphibolis* species), endemic to southern Australia, found at the Abrolhos (DoF 2012). The most abundant seagrass is *Amphibolis antarctica*, while *Amphibolis griffithii* appears to be restricted to bays such as Turtle Bay in the Wallabi Group.

The larger ribbon-weeds (*Posidonia* species) grow in sheltered bays and lagoons where the sand cover is deeper and more stable (e.g. Turtle Bay, the Gap, East Wallabi Island, the lagoon on the west side of West Wallabi Islands and around North Island) (DoF 2012).

Nine species of seagrass are found in the Perth region, including at Rottnest Island where *Amphibolis* thrives in clear waters overlying limestone rock (Amalfi 2006). Seagrasses are a major component of the ecosystem on the Rottnest Shelf, thriving in waters ranging in depth from intertidal to 45m (Amalfi 2006). All of the seagrass species identified with the exception of *Syringodium isoetifolium* and *H. ovalis* are endemic to temperate areas of southern Australia (Amalfi 2006). At Rocky Bay, on the north side of the island where it is protected from big swells and strong south to south-westerly winds, a mix of dense seagrass meadow consisting of *Amphibolis* and *Posidonia* thrive. The meadows around Rottnest Island serve as nurseries for juveniles of many fish species, and are home to species such as the cobbler and long-headed flathead (Amalfi 2006).

3.2.3 Central Western Shelf Province

Shark Bay contains the largest reported seagrass meadows in the world (approximately 4,000 km^2), as well as some of the most species-rich seagrass assemblages (Walker *et al.* 1989). Twelve species of seagrass are found in the Bay with the dominant species being *Amphibolis antarctica*. Seagrass is a fundamental component of biological processes in Shark Bay; it has modified the physical, chemical and biological characteristics of the Bay and provides food, habitat and nursery grounds for many species (CALM & National Parks and Nature Conservation Authority (NPNCA) 1996).

An inshore survey of benthic habitats near Busselton recorded dense coverage of *Amphibolis* spp. on limestone pavement. *Halophila* spp., *Heterozostera* spp. and *Syringodium isoetifolium* were recorded on sandy substrates (DoF 2007).

3.2.4 Central Western Shelf Transition

Nine species of seagrasses have been found throughout Ningaloo Reef (van Keulen & Langdon 2011). Some delineation of temperate and tropical species exists; however, several species were found throughout the Ningaloo Reef. Halophila ovalis was the most commonly found seagrass at Ningaloo and was generally found growing in sandy patches between coral bomboras. *Amphibolis antarctica* is a large meadow forming species that has been found growing in large clumps in Bateman Bay, north of Coral Bay (van Keulen & Langdon 2011).

3.2.5 Northwest Transition

The Rowley Shoals provide the only suitable shallow substrate for seagrasses in this predominantly deep bioregion. Sparse seagrass is found within subtidal coral reef communities of the Rowley Shoals but is not a major habitat type. Two species of seagrass, *Thalassia hemprichii* and *Halophila ovalis*, have been recorded at Mermaid Reef (Huisman *et al*. 2009). Earlier studies at Mermaid and Imperieuse Reef recorded the above two species and a third species; *Thalassodendron ciliatum* (Walker & Prince 1987).

3.2.6 Northwest Shelf Province

In the Northwest Shelf Province, seagrasses are present but sparsely distributed to depths of approximately 30 m (LEC & Astron 1993, URS 2009, CALM 2005a). The abundance and distribution of tropical (and subtropical) seagrass species can vary greatly due to seasonal changes in water quality (turbidity, light penetration) and conditions (wave action, temperature), with biomass tending to peak in summer (Lanyon & March 1995).

Studies between Quondong and Coulomb Points north of Broome identified seagrass communities of *Halophila* spp. patchily distributed across large areas, from the lower intertidal and out to a depth of approximately 20 m (DEC 2008, Fry *et al*. 2008). Similarly, *Halophila decipiens* was the only seagrass collected from epibenthic dredge studies at five localities near Broome from Gourdon Bay to Packer Island (Keesing *et al.* 2011).

Roebuck Bay is located south of Broome and includes large areas of intertidal mudflats. Extensive seagrass meadows occur in the northern regions of Roebuck Bay and are dominated by *Halophila ovalis* and *Halodule uninervis*. *Halophila minor* and *Halodule pinifolia* have also been reported at this location (Prince 1986, Walker & Prince 1987, Seagrass-Watch 2019).

In the Dampier Archipelago seagrass occurs in the larger bays and sheltered flats of the area (CALM & MPRA 2005). Six species of seagrass, including three Halophila species, have been recorded on the subtidal soft sediment habitats (CALM & MPRA 2005). Seagrasses do not form extensive meadows within the proposed reserves, but rather form interspersed seagrass/macroalgal beds. The largest areas of seagrass are found between Keast and Legendre islands, and between West Intercourse Island and Cape Preston (CALM & MPRA 2005).

Surveys near Onslow found that *Halophila* spp. were the most widespread of the seagrasses in that region. Seagrasses were found to be generally sparsely distributed (<10% cover), occurring in small patches within larger areas of suitable substrate. Small areas of higher (>50%) seagrass cover occurred in shallow clear water areas but were not common (URS 2009, URS 2010b, Chevron 2010).

Similarly, in the Montebello/Barrow Islands Marine Conservation Reserves, seagrasses appear not to form extensive meadows but are sparsely interspersed between macroalgae. Seven seagrass species have been recorded in the Reserves (DEC & MPRA 2007a) with *Halophila* spp. the most common seagrass species on shallow soft substrates and sand veneers. Distributions of these species extend from the intertidal zone to approximately 15m water depth (DEC & MPRA 2007a). Surveys to the northwest and southeast of Barrow Island from 2002 to 2004 did not identify any significant seagrass meadows but confirmed the presence of sparse coverage of *Halophila* and *Halodule* spp. in shallow areas east of Barrow Island (RPS BBG 2005).

A significant meadow of large seagrasses at Mary Anne Reef east of Onslow was identified almost 30 years ago and its presence today is unconfirmed. The meadow was several hundred hectares of *Cymodocea angustata* at 30–50% cover, occurring primarily at a depth of 2–3 m (Walker & Prince 1987).

3.2.7 Timor Province

Seagrass has been reported on the reef flats of offshore reefs of this bioregion (Whiting 1999, Hale & Butcher 2013). Five species of seagrass were reported at Ashmore Reef with *Thalassia hemprichii* being the dominant species (Pike & Leach 1997, Skewes *et al*. 1999b, Brown & Skewes 2005). The total area of seagrass at Ashmore Reef in 1999 was estimated to be 470 ha (Skewes *et al*. 1999b). However, much of this was very sparse cover and there were only 220 ha of seagrass with a greater than 10% cover (Brown & Skewes 2005). Seagrass grew in a sparse, patchy distribution across the sand flats, but had a higher coverage on the reef flat area, where it extended to within 100 m of the reef crest. The area of greatest cover and diversity was in the west and south-west areas of the reef on the inner reef flat (Brown & Skewes 2005). These seagrass meadows support a small but significant population of dugongs estimated at around 100 individuals comprising all age classes from calves to adults (Hale & Butcher 2005).

Similarly, Scott Reef supports five species of seagrass (URS 2006), with *Thalassia hemprichii* most abundant (Skewes *et al*. 1999a, URS 2006). The area of seagrass at Scott Reef is significantly less than that recorded for Ashmore Reef (approximately 100 ha) (Woodside 2011). The highly energetic environment and significant tidal exposure of Scott Reef restricts the area of habitats potentially suitable for seagrass establishment to a small proportion of the total area, resulting in low abundance (Skewes *et al*. 1999a, URS 2006).

Seringapatam Reef was found to have a seagrass cover of 2 ha out of 5,519 ha (0.04%) composed of *Thalassia hemprichii* and *Halophila ovalis* in approximately equal quantities (Skewes *et al*. 1999a). This finding contrasts with a more recent survey where only one species of seagrass (*Halophila decipiens*) was recorded at Seringapatam (Huisman *et al*. 2009).

Skewes *et al*. (1999a) did not observe any seagrass communities at Hibernia Reef.

3.2.8 Northwest Shelf Transition

Extensive and diverse intertidal seagrass meadows are known from islands in the southern Kimberley, particularly in the Sunday Island One Arm Point area (Walker 1995, Walker & Prince 1987). Ten species of seagrasses have been recorded at One Arm Point, with the majority of meadows low to moderate in abundance and dominated by *Thalassia hemprichii* with *Halophila ovalis*, *Halodule uninervis* and *Enhalus acoroides* (Seagrass-Watch 2019).

While some seagrasses have been collected from intertidal sites in the central and north Kimberley (Walker *et al*. 1996, Walker 1997), these areas were not found to be species rich and did not support extensive seagrass meadows like those found in the southern Kimberley.

Subtidal seagrass meadows in the Northwest Shelf Transition are not well mapped, although dugongs are known to feed on seagrass communities in coastal waters of the Joseph Bonaparte Gulf (DEWHA 2008a).

3.2.9 International Waters

Important areas outside of the IMCRA bioregions include:

Indonesia (west)

Within Indonesian waters, the lower intertidal and upper subtidal zones are considered important areas for the growth of seagrass (Hutumo and Moosa 2005). Pioneering vegetation in the intertidal zone is dominated by *Halophila ovalis* and *Halodule pinifolia* while *Thalassodendron ciliatum* dominate the lower subtidal zones. Wide areas of the Indonesian coastal waters are covered by dense beds of seagrass.

Seagrass habitats are widely distributed across the Lesser Sunda Ecoregion. Preliminary data from the United Nations Environment Program's (UNEP) World Conservation Monitoring Centre (WCMC) has identified the following areas as potential areas of importance for seagrass, many of which are outside the EMBA (DeVantier *et al.* 2008):

- North-west Bali;
- South-west and west Lombok;
- North-east Sumbawa;
- Komodo Islands;
- Savu; and
- South coast of Timor-Leste.

The Kepulauan Seribu National Park is also known for its rich diversity of seagrasses (refer to **Section 9.8**).

3.3 Macroalgae

Macroalgae are important contributors to primary production and nutrient cycling in the region, providing food and habitat for vertebrate and invertebrate fauna. Macroalgae are also recognised for their role in spatial subsidies; the movement of nutrients or energy between neighbouring habitats. Spatial subsidies involving macroalgae include the movement of wrack from macroalgal beds to bare substrates and shorelines (Orr 2004).

Macroalgae are primarily associated with hard substrates. They occur in moderate to high cover on exposed hard substrates, but typically have lower cover on hard substrates that are covered with a veneer of sediment (SKM 2009, BHPBIO 2011). Macroalgae exhibit very high seasonal and interannual variation in biomass (Heyward *et al*. 2006) and distribution, abundance and biodiversity (Rio Tinto 2009, BHPBIO 2011). The distribution of hard substrates therefore indicates areas that may support macroalgal communities, although abundance and diversity may fluctuate annually.

Macroalgae are susceptible to disturbance from factors such as sedimentation, scouring and turbidity but the marked seasonality in biomass, abundance, diversity and distribution suggests macroalgae are likely to be resilient to acute, short-term disturbance acting at local scales. Macroalgae may be more susceptible to impacts acting over longer time scales (years) and at certain times of the year, where recruitment at a regional scale could be affected. Indirect impacts affecting the numbers, distribution and community structure of herbivorous fish can also be expected to have impacts (either positive or negative) on macroalgal habitats (Vergès *et al*. 2011).

Two bioregions (Northwest Province and Central Western Transition) lie entirely in deep waters below the photic zone. Benthic macroalgae are not present hence these bioregions are not discussed further.

3.3.1 Southwest Shelf Province

Species diversity of macroalgae is very high. The south coast of the bioregion is characterised by a relatively higher diversity of temperate macro-algal species compared with the Southwest Shelf Transition. These colonise the exposed rocky shorelines and rocky reefs (DEWHA 2008a).

3.3.2 Southwest Shelf Transition

The Houtman Abrolhos have known species of benthic algae with macroalgae communities considered important in supporting a diversity of marine life.

More than 340 species of macroalgae (including 54 species of green algae, 71 species of brown algae, and 222 species of red algae) have been recorded from rock platforms around Rottnest Island (Amalfi 2006).

3.3.3 Central Western Shelf Province

Although seagrasses are the most visually dominant organisms found in Shark Bay (Walker *et al*. 1989) macroalgae are also a significant component within the system, with 161 taxa of benthic macroalgae reported from the location (Kendrick *et al*. 1990). The seagrass meadows host a large number of epiphytic algal species (Harlin *et al*. 1985, Kendrick *et al*. 1990), which numerically dominate the algal flora of the area. Eighty algal species were epiphytic on the seagrass *Amphibolis antarctica*, and of these, over half have been reported both as epiphytes and benthic algae. Benthic macroalgae can be found in growing on occasional subtidal rock (limestone–sandstone) platforms and extensive sand flats that occur throughout Shark Bay, and as drift within seagrass meadows (Kendrick *et al*. 1990).

The benthic algae of Shark Bay are not predominantly temperate as is the case with the seagrasses (Walker *et al*. 1989) and seagrass epiphytes (Kendrick *et al*. 1990). The majority of taxa are either of tropical or cosmopolitan distribution. Their local distribution within Shark Bay is correlated with salinity, with benthic algal species richness lower in areas of high salinity (Kendrick *et al*. 1990).

Limestone platforms occur along the bioregion's coastline and high energy environments are likely to be dominated by large brown algae including *Ecklonia radiata* and *Sargassum* spp. with articulated coralline algae making up the understorey. More diverse algae assemblages may be observed in sheltered locations such as potholes and ledges (DoF 2007).

3.3.4 Central Western Shelf Transition

Macroalgal beds along the Ningaloo coastline are generally found on the shallow limestone lagoonal platforms and occupy about 2,200 ha of the Ningaloo Marine Park and Muiron Islands Marine Management Area (CALM & MPRA 2005a). Macroalgal communities within the area have been broadly described (Bancroft & Davidson 2000). The dominant genera are the brown algae *Sargassum*, *Padina*, *Dictyota* and *Hydroclathrus* spp. (McCook et al. 1995).

3.3.5 Northwest Transition

Although macroalgae is present at the Rowley Shoals, it is not recognised as a key habitat component in the Mermaid Reef Marine National Nature Reserve Plan of Management (EA 2000) or the Rowley Shoals Marine Park Management Plan (DEC & MPRA 2007b).

There is nothing to suggest that the algal flora of the Rowley Shoals is unique within the Indo-Pacific (Huisman *et al*. 2009). A study of macroalgae at 16 locations at Mermaid Reef recorded over 100 species (Huisman *et al*. 2009). The algal flora recorded at the Rowley Shoals represents a small portion of the highly diverse Indo-Pacific flora. The majority of species that were recorded at Mermaid Reef had been previously recorded from mainland north-western Australia or from Indonesia (Huisman *et al*. 2009).

3.3.6 Northwest Shelf Province

Macroalgae are diverse and widespread throughout the Northwest Shelf Province. They are restricted to depths where sufficient light penetrates to the substrate and therefore tend to be most common in shallow subtidal waters down to approximately 20 m depth.

In the nearshore regions of the Pilbara, macroalgae are often a dominant component of the mosaic of benthic organisms found on hard substrates in shallow water. In these shallow waters, regular disturbance to reef habitats from seasonal changes in sedimentation/ erosion patterns and the less frequent impacts of cyclones and storms through sedimentation and scouring may substantially alter the distribution and composition of the benthic communities associated with reefs, including macroalgal habitats (BHPBIO 2011).

Macroalgae dominate shallow (<10 m) submerged limestone reefs and also grow on stable rubble and boulder surfaces in the Dampier Archipelago (CALM & MPRA 2005). Huisman and Borowitzka (2003) reported approximately 200 species of macroalgae from the Dampier Archipelago. Low relief limestone reefs that are dominated by macroalgae, account for 17% (approximately 35,460 ha) of the marine habitats within the proposed Marine Management Area (CALM 2005a).

Epibenthic dredge surveys along the coastline north of Broome identified 43 species of algae from 22 families (Keesing *et al*. 2011). The lower species diversity collected by this study is attributed to the method of collection and limited depth range (11–23 m) (Keesing *et al*. 2011).

Macroalgae occur around the numerous small offshore islands within this bioregion (including Thevenard Island, Airlie Island and Serrurier Island) associated with limestone pavement and protected areas of soft sediments. Dominant species are consistent with those described for the Dampier Archipelago (Woodside 2011).

In the shallow offshore waters of the Pilbara region, macroalgae are the dominant benthic habitat on hard substrates in both the Montebello and Barrow Islands Marine Parks and are the main primary producers (DEC & MPRA 2007a, Chevron 2010). Shallow water habitats outside these marine parks are also likely to support substantial areas of macroalgal habitat wherever conditions are suitable.

Macroalgae occupy approximately 40% of the benthic habitat area in the Montebello/ Lowendal/ Barrow Island region (CALM 2005b). At least 132 macroalgal taxa occur around Barrow Island, with most thought to be widely distributed in the tropical Indo-Pacific region (Chevron 2005).

Macroalgae monitoring around the Lowendal and Montebello Islands since 1996 (The Ecology Lab 1997, IRCE 2002 2003 2004 2006 2007, URS 2009) has found macroalgal cover and biomass to be naturally spatially and temporally variable. *Sargassum* spp. represented 70% of the macroalgal assemblage in 2009, compared to 96% in 2002 (URS 2009). Sargassum spp. cover as a percentage of total macroalgae cover was significantly lower in 2009 than in previous years, primarily due to an increase in filamentous algae at a number of sites (URS 2009).

3.3.7 Timor Province

Macroalgae at Ashmore Reef are estimated to cover over 2,000 ha, mostly on the reef slope and crest areas (Hale & Butcher 2013). The algal community is dominated by turf and coralline algae, with fleshy macroalgae comprising typically less than 10% of total algal cover (Skewes *et al*. 1999b).

Surveys at Scott and Seringapatam Reefs recorded over 100 species of marine algae (Huisman *et al*. 2009). The marine algal community was similar between reefs and also similar to the Rowley Shoals. Algae found at these offshore atolls forms a small subset of the Indo-Pacific algal flora, with virtually all of the species identified thus far having been previously collected from north-western Australia or from localities further north. Although further research is necessary, at present there is nothing to suggest that the macroalgae communities of these offshore atolls are unique within the Indo-Pacific (Huisman *et al*. 2009).

3.3.8 Northwest Shelf Transition

There is a lack of information regarding the marine benthic flora of north-west Western Australia and no comprehensive marine flora list exists for the region (Huisman 2004). However, about 70 algae species were collected during a survey of intertidal reefs on the central Kimberley coast in 1997 (Walker 1997).

Tropical macroalgae species are typically associated with areas of hard substrate and various types of macroalgae occur on rock platforms intermingled with coral and sponge. Abundance and biomass typically exhibit strong seasonal trends (Heyward *et al*. 2006).

The diversity and abundance of algae in the Kimberley is probably linked to the region's extreme tidal exposure and highly turbid waters, reducing light penetration and resulting in deposition of fine sediments (Walker 1997). However, the role of algae appears crucial to the growth of reefs in the highly turbid waters of the Kimberley coast and islands (Brooke 1997). *Sargassum* spp. and coralline algae may be dominant (DPAW 2013).

3.3.9 International Waters

No information on macroalgae in international waters has been identified other than for Timor-Leste waters.

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

3.4 Non-Coral Benthic Invertebrates

The offshore marine environment from Busselton to the Northern Territory border is overwhelmingly dominated by soft sediment seabeds; sandy and muddy substrates, occasionally interspersed with hard substrates covered with sand veneers, and rarely, exposed hard substrate. In shallow waters, non-coral benthic invertebrates may form part of the mosaic of benthic organisms found on hard substrates, alongside macrophytes and coral colonies. As light reduces with water depth, non-coral benthic invertebrates are the dominant community, albeit at low densities.

Non coral benthic invertebrates feed by filtering small particles from seawater, typically by passing the water over a specialised filtering structure. Examples of filter feeders are sponges, soft and whip corals and sea squirts.

3.4.1 Southwest Transition

There is little available information on benthic biological communities of this bioregion however deep sea crabs, such as the champagne crab and crystal crab are known to inhabit the seafloor of the slope (DEWHA 2008b).

3.4.2 Southern Province

There is little information available on the benthic biological communities within the bioregion, however it is described as a unique region of deep-sea habitats that includes the Diamantina Fracture Zone Key Ecological Feature. The Diamantina Fracture Zone is described as structurally complex deep water environment of seamounts and numerous closely spaced troughs and ridges, which represents a unique region of deep-sea habitats including 26 endemic species of demersal fish (DSEWPaC) 2012b).

3.4.3 Central Western Province

The understanding of marine life in this bioregion is mostly confined to the demersal fish on the continental slope. The exception to this is the Perth Canyon which, although poorly understood, is known to have unique seafloor features with ecological properties of regional significance.

3.4.4 Western Shelf Province

The Central Western Shelf Province occurs on the continental shelf in water depths from 0 to 100 m. Biological communities of the shelf are likely to include a sparse invertebrate assemblage of sea cucumbers, urchins, crabs and polychaetes on sand substrates. Hard substrates are likely to contain sessile invertebrates such as sponges and gorgonians. The biological communities of this bioregion share many similarities with the adjoining temperate region (DEWHA 2008a).

Stromatolites occur in Shark Bay. Although they are a microbial colony (prokaryote), and not an invertebrate (eukaryote), they are described here as a unique benthic biological community. Stromatolites are rock-like structures built by cyanobacteria. Shark Bay’s stromatolites are 2,000 to 3,000 years old and are similar to life forms found on Earth up to 3.5 billion years ago. Until about 500 million years ago, stromatolites were the only macroscopic evidence of life on the planet; hence they provide a unique insight into early life forms and evolution. The stromatolites are located in the hypersaline environment of Hamelin Pool and are one of the reasons for the area’s World Heritage Listing (DPAW 2009).

3.4.5 Central Western Transition

The Central Western Transition extends from the shelf break to the continental slope with some parts of the bioregion occurring on the abyssal plain. Water depths range from 80 m to almost 6,000 m. Sediments are dominated by muds and sands that decrease in grain size with increasing depth. The present level of understanding of the marine environment in this bioregion is generally poor. The harder substrate of the slope in waters of 200–2,000 m deep is likely to support populations of epibenthic fauna including bryozoans and sponges. These support larger infauna and benthic animals such as crabs, cephalopods, echinoderms and other filter feeding epibenthic organisms. In the deeper waters of the abyss, the benthic communities are likely to be sparse (DEWHA 2008a).

3.4.6 Central Western Shelf Transition

The Central Western Shelf Transition is located entirely on the continental shelf and is comprised mainly of sandy sediments in depths between 0 and 80 m (DEWHA 2008a).

Some sponge species and filter-feeding communities found in deeper waters offshore from the Ningaloo Reef appear to be significantly different to those of the Dampier Archipelago and Abrolhos Islands, indicating that the Commonwealth waters have some areas of potentially high and unique sponge biodiversity (Rees *et al.* 2004).

3.4.7 Northwest Province

The Northwest Province is located entirely on the continental slope in water depths of predominantly between 1,000–3,000 m and is comprised of muddy sediments. Despite the present poor knowledge of the benthic communities on the Exmouth Plateau, information on sediments in the bioregion indicates that benthic communities are likely to include filter feeders and epifauna. Soft-bottom environments are likely to support patchy distributions of mobile epibenthos, such as sea cucumbers, ophiuroids, echinoderms, polychaetes and sea pens.

3.4.8 Northwest Transition

The Northwest Transition is located from the shelf break (200 m water depth) over the continental slope to depths of more than 1,000 m at the Argo Abyssal Plain. Benthic habitat mapping surveys and epibenthic sampling conducted by CSIRO at the continental slope (approximately 400 m water depth) showed that all survey sites predominantly comprised soft muddy sediment, which was often riffled. Gravel, boulders and small outcrops were occasionally recorded. Epifaunal abundance was similar all sites, with epifauna limited to sparsely distributed isolated individuals. Epifauna included isolated scattered sessile crinoids, anemones, glass sponges and seapens. Occasional non-sessile fauna included urchins, prawns and other decapods, holothurians and sea stars. Modelling indicated a 1 km long beam trawl across the continental shelf (approximately 400 m water depth) would be expected to yield sparse (<20 individuals) and low diversity (<10 species) of epibenthic fauna (≥1 cm body size) (Williams *et al*. 2010). Deeper on the continental slope at approximately 700 m and approximately 1,000 m, habitats were similar to those observed at 400 m (Williams *et al*. 2010).

Although soft sediment habitat may appear monotonous and featureless, there is likely to be some marked differences in terms of ecological functioning and faunal composition between shelf and deep-sea areas, with the 200 m isobath widely believed to represent a key boundary (Wilson 2013, Brewer *et al*. 2007, Gage & Tyler 1992). Beyond the 200 m isobath, deep-sea benthic communities rely exclusively on the settling of organic detritus from the overlying water column as a food source. The spatial and temporal distribution of benthic fauna depends on factors such as sediment characteristics, depth and season (Wilson 2013).

Due to contrasting depths, the Rowley Shoals supports a diverse marine invertebrate community including a number of endemic species. Invertebrate species (excluding corals) at the Rowley Shoals include sponges, cnidarians (jellyfish, anemones), worms, bryozoans (sea mosses), crustaceans (crabs, lobsters, etc.), molluscs (cuttlefish, baler shells, giant clams, etc.), echinoderms (starfish, sea urchins) and sea squirts (DEC & MPRA 2007b).

3.4.9 Northwest Shelf Province

This bioregion is located primarily on the continental shelf in water depths from 0 to 200 m (DEWHA 2008a). The sandy substrates on the shelf within this bioregion are thought to support low density benthic communities of bryozoans, molluscs and echinoids (DEWHA 2008a). Sponge communities are also sparsely distributed on the shelf, but are found only in areas of hard substrate. The region between Dampier and Port Hedland has been described as a hotspot for sponge biodiversity (Hooper & Ekins 2004).

Epibenthic dredge surveys in nearshore areas around Broome covered 1,350 m^2 of seabed in depths between 11 and 23 m. The survey recorded 357 taxa comprising 52 sponges, 30 ascidians, 10 hydroids, 52 cnidarians (not including scleractinian corals), 69 crustaceans, 73 molluscs and 71 echinoderms. The most important species on soft bottom habitats in terms of biomass was the heart urchin *(Breynia desorii)*, whilst sponges were the dominant fauna by biomass on hard bottom habitats. The biomass of other filter feeders, especially ascidians, soft corals, gorgonians was also high, indicating the importance of these groups in characterising hard bottom habitats.

In 2007, CSIRO conducted extensive benthic habitat mapping surveys and epibenthic fauna (living on the surface and ≥1 cm body size) sampling in deep waters (100–1,000 m) spanning thirteen sites between Barrow Island and Ashmore Reef running along the continental shelf and across the continental slope of the North West Shelf (Williams *et al*. 2010). At the continental shelf margin (approximately 100 m water depth) Williams *et al*. (2010) reported that similar benthic habitats occurred at each survey site across the breadth of the North

West Shelf. Benthic habitats at this depth comprised a mix of riffled muddy sand (sometimes as a veneer over rocky subcrops) together with gravel to pebble-sized rubble, cobbles, boulders and some rock outcrops. Typical epifauna found at these depths included scattered isolated hydroids, sea fans and soft corals and often small sponges. Other fauna observed at some of the sites included scattered isolated sea whips, crinoids, sea pens, urchins and anemones. Epibenthic fauna along the continental shelf margin were quantified as sparse and low diversity (Williams *et al*. 2010). Modelling indicated that a trawl sample of 1 km length would generally be expected to yield approximately 80 individuals represented by 15 species (Williams *et al*. 2010) in 100 m depth waters.

At the shelf edge (approximately 200 m water depth), two sites were surveyed. Both sites were similar to the continental shelf margin, except the northern site mainly comprised coarse material. Epifauna observed at the northern site was similar at 200 m as at 100 m. At the southern site, epifauna included sparse and scattered individual soft corals, anemones, glass sponges and stalked crinoids (Williams *et al.* 2010). Modelling indicated epibenthic fauna were sparse and had low diversity, numbering approximately 20–40 individuals in a 1 km long trawl sample represented by approximately 5–10 species (Williams *et al*. 2010).

Baseline studies undertaken in nearshore areas of the Pilbara (SKM 2009, Rio Tinto 2009, BHPBIO 2011) and offshore areas around Barrow Island (Chevron 2010) have shown that filter feeder communities are a dominant component of benthic habitats in depths >10 m where reduced light appears to inhibit extensive development of hard corals and macroalgae. The pavement habitats between Barrow Island and the mainland are covered by a sediment veneer that appears to periodically move, exposing areas of pavement reef. Sessile benthic organisms that require hard substrates for attachment, such as gorgonians, are frequently seen emerging through a shallow veneer of sand. This type of substrate (sediment veneer) with sparse filter feeder communities is common throughout this area (SKM 2009, Rio Tinto 2009, BHPBIO 2011).

3.4.10 Timor Province

The Timor Province is located on the continental slope and abyssal plain and water depths range from 200 m to almost 6,000 m. Benthic studies in this bioregion are scarce, however data from the North West Slope Trawl Fishery suggests that muddy sediments in the Timor Province support significant populations of crustaceans (Brewer *et al*. 2007). Additionally, research into the demersal fish communities of the continental slope has identified the Timor Province as an important bioregion. This is due to the presence of a number of endemic fish species, and two distinct demersal community types associated with the upper slope (water depths of 225–500 m) and mid-slope (water depths of 750–1,000 m) (Last *et al*. 2005). The current understanding of the relationship between demersal fish communities and benthic environments on the continental slope is rudimentary (DEWHA 2008a).

Over 130 species of sponges have been recorded at the Ashmore Reef National Nature Reserve (Russell & Hanley 1993).

Studies of Seringapatam Reef have observed the dominant benthic habitats to include filter feeders, such as sponges, gorgonians, hydroids and seapens (Heyward et al. 2013 cited in ConocoPhillips 2018).

3.4.11 Northwest Shelf Transition

The Northwest Shelf Transition is located on the continental shelf with a small area extending onto the continental slope, with water depths ranging from 0–330 m. Nearshore areas may support significant filter feeding communities but these have not yet been described (Masini *et al*. 2009).

Pipeline route surveys north of the Kimberley in water depths from 10–250 m recorded a seabed largely devoid of hard substrate, with only sparse epibenthic fauna noted on the predominantly sandy substrate. Occasional epibenthic fauna (featherstars, gorgonians, bryozoans, sea urchins, hydroids and sponges) were recorded in areas where rocky substrate or outcrops were present (URS 2010a).

In contrast, benthic surveys at Echuca Shoals identified broad areas of hard substrate with substantial epibenthic fauna. The shallow shoal areas were dominated by a flat 'reef' platform with crinoids, sea whips, soft corals and low densities of hard corals. With increasing depth (25–80 m) soft corals and sponges became increasingly dominant. At greater depths (80–100 m) the density of epibenthic fauna decreased substantially with sea whips and sea fans became dominant (URS 2010a).

3.4.12 International Waters

No information on non-coral benthic invertebrates in international waters has been identified other than for Timor-Leste waters.

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

3.5 Plankton

Plankton abundance and distribution is patchy, dynamic and strongly linked to localised and seasonal productivity (Evans *et al.* 2016). Fluctuations in abundance and distribution occur both vertically and horizontally in response to tidal cycles, seasonal variation (light, water temperature and chemistry, currents and nutrients) and cyclonic events. As a key indicator for ecosystem health and change, Plankton distribution and abundance has been measured for over a century in Australia (Richardson *et al.* 2015). The compilation of this data has been made publicly available through the Australian Ocean Data Network (Australian Ocean Data Network 2017) and has been used in the Australia State of the Environment 2016 report (Jackson *et al.* 2017) to nationally assess marine ecosystem health. According to their findings, warming ocean temperatures has extended the distribution of tropical phytoplankton species (which have a lower productivity), further south resulting in a decline in primary productivity in oceanic waters north of 35°C, especially the North West Shelf (Evans *et al.* 2016). Trends of primary productivity across Australia are however variable with the South West of Australia experiencing an increase in productivity and northern Australia experiencing no change between 2002-2016 (Evans *et al.* 2016).

Within the EMBA, peak primary productivity varies on a local and regional scale. For example, peak phytoplankton biomass in waters surrounding Broome has been observed in May with a high variability recorded in August, whereas recorded phytoplankton biomass in waters surrounding Geographe Bay has been found to peak during winter and is localised close to the coast (Bloundeau-Patissier *et al.* 2011). In general, these peaks are linked to mass coral spawning events, peaks in zooplankton and fish larvae abundance and periodic upwelling. Regional upwelling is most common close to the coast and where surface waters diverge. Despite the suppression of major upwelling along the WA coast by the Leeuwin Current, known key upwelling regions include the Ningaloo region (Hanson & McKinnon 2009) and Cape Mentelle (Pattiaratchi 2007). It is also expected that a high abundance of plankton will occur within areas of localised upwelling in the EMBA where the seabed disrupts the current flow.

In waters surrounding Indonesia, seasonal peaks in phytoplankton biomass is linked to monsoon related changes in wind. When the winds reverse direction (offshore vs. onshore), nutrient concentrations decrease/increase because of the suppression/enhancement of upwelling (National Aeronautics and Space Administration (NASA) 2017). Annual variability of phytoplankton productivity in waters surrounding Indonesia is heavily influenced by the El Niño-Southern Oscillation climate pattern (NASA 2017). For example, phytoplankton productivity around Indonesia increases during El Niño events.

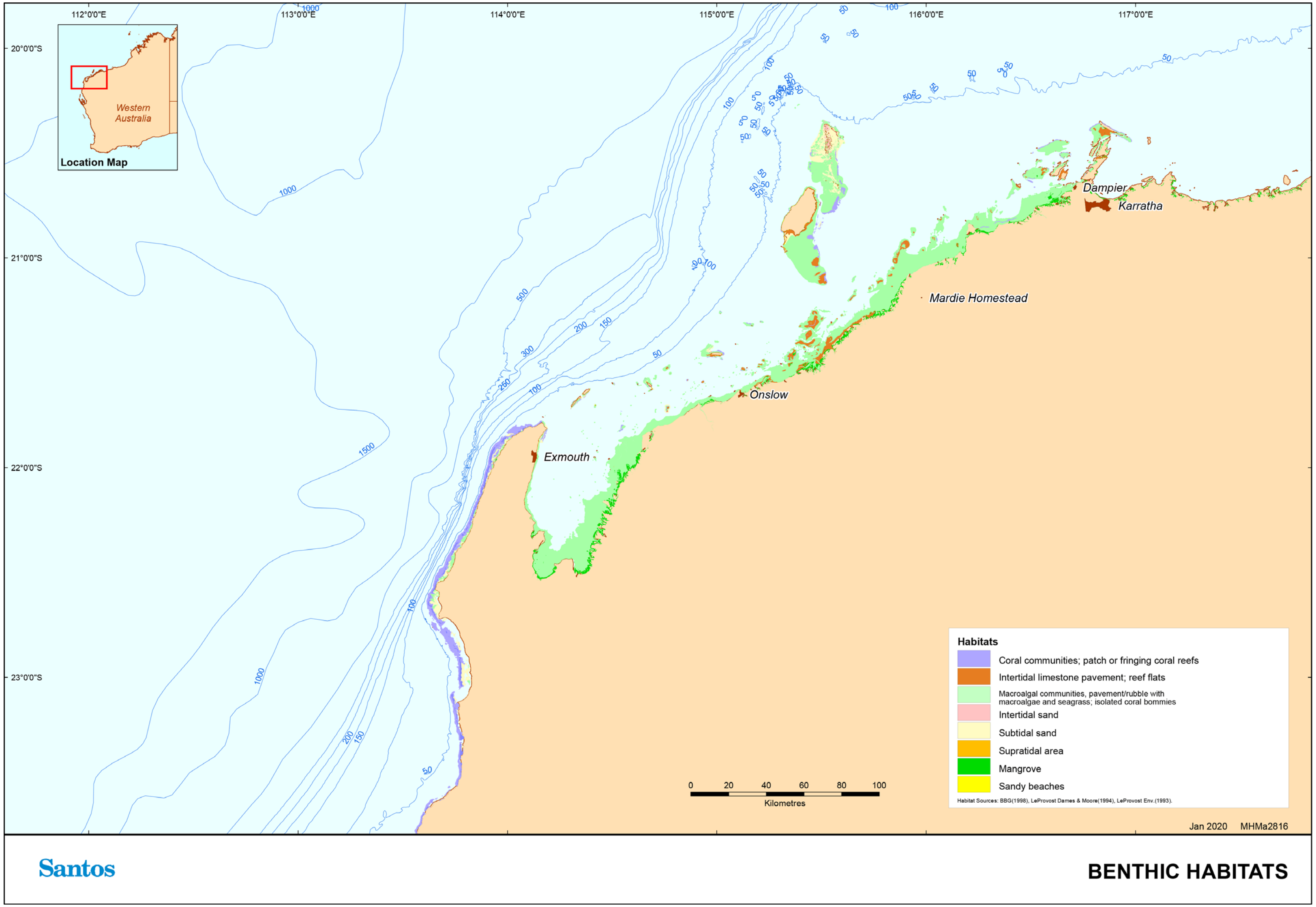


Figure 3-1: Benthic habitats from Coral Bay to Dampier

4. Shoreline Habitats

Shoreline habitats are defined as those habitats that are adjacent to the water along the mainland and of islands that occur above the LAT and most often in the intertidal zone.

The following section broadly categorises shoreline habitats as the following biological communities; mangroves, intertidal mud/sand banks, beaches, and rocky shores. These communities are discussed in **Sections 4.1- 4.5**, in terms of the 14 IMCRA v. 4.0 bioregions where relevant and where information is available.

Figure 3-1 broadly illustrate these habitats within the Northwest Shelf Province and Central Western Shelf Transition.

4.1 Mangroves

Mangroves commonly occur in sheltered coastal areas in tropical and sub-tropical latitudes (Kathiresan and Bingham 2001). Up to eight species of mangroves are found further north in the Central Western Shelf Transition region, but at most locations the dominant mangrove (in terms of area of intertidal zone occupied) is *Avicennia marina*, with the stilt rooted mangrove *Rhizophora stylosa* often occurring as thin zones of dense thickets within the broad zone of *A. marina*. Mangroves are found wherever suitable conditions are present including wave dominated settings of deltas, beach/dune coasts, limestone barrier islands and ria/archipelago shores (Semeniuk 1993). Mangrove plants have evolved to adapt to fluctuating salinity, tidal inundation and fine, anaerobic, hydrogen sulfide rich sediment (Duke *et al.* 1998).

Mangroves are important primary producers and have a number of ecological and economic values. For example, they play a key role in reducing coastal erosion by stabilising sediment with their complex root systems (Kathiresan and Bingham 2001). They are also recognised for their capacity to help protect coastal areas from the damaging effects of erosion during storms and storm surge. Mangroves are also important in the filtration of run-off from the land which helps maintain water clarity for coral reefs which are often found offshore in tropical locations (National Oceanic and Atmospheric Administration (NOAA) 2010). The intricate matrix of fine roots within the soil also binds sediments together.

Mangroves play an important role in connecting the terrestrial and marine environments (Alongi 2009). Numerous studies (e.g. Nagelkerken *et al.* 2000, Alongi 2002, Alongi 2009, Kathiresan and Bingham 2001) have shown mangroves to be highly productive and an important breeding and nursery areas for juvenile fish and crustaceans, including commercially important species (Kenyon *et al*. 2004). They also provide habitat for many juvenile reef fish species.

Mangroves also play an important ecosystem role in nutrient cycling and carbon fixing (NOAA 2010). The trees absorb carbon dioxide from the atmosphere and the organic matter such as fallen leaves forms nutrient rich sediments creating a peat layer that stores organic carbon (Alongi 2009, Ayukai 1998).

The muddy sediments that occur in mangrove forests are home to a variety of epibenthic, infaunal and meiofaunal invertebrates (Kathiresan and Bingham 2001). Crustaceans known to inhabit the mud in mangrove systems include fiddler crabs, mud crabs, shrimps and barnacles. Within the water channels of the estuary, various finfish are found from the smaller fish such as gobies and mudskippers (which are restricted to life in the mangroves) through to larger fish such as barramundi (*Lates calcarifer*) and the mangrove jack (*Lutjanus argentimaculatus).* Mangroves and their associated invertebrate-rich mudflats are also an important habitat for migratory shorebirds from the northern hemisphere, as well as some avifauna that are restricted to mangroves as their sole habitat (Garnet and Crowley 2000).

The two key State regulatory documents relevant to the protection and management of mangroves in WA are:

+ EPA (2001) Guidance Statement for Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline. Guidance Statement No. 1; and
+ EPA (2016) Technical Guidance – Protection of Benthic Communities and Habitats.

4.1.1 Central Western Shelf Province

Shark Bay (in the Central Western Shelf Province) supports the southern-most area of substantial mangrove habitat in Western Australia (Rule *et al*. 2012). The mangroves of Shark Bay comprise only one species, the white mangrove *Avicennia marina*, and these trees occur around the coastline in widely dispersed and often isolated stands of varying size.

4.1.2 Central Western Shelf Transition

The regional mangroves from Exmouth to Broome (within the Central Western Shelf Transition and southern part of the Northwest Shelf Province) represent Australia's only 'tropical-arid' mangroves. The most significant stand of mangroves in the Central Western Shelf Transition is Mangrove Bay on the western side of the Cape Range Peninsula in the Ningaloo Marine Park. This small area of mangrove (37 ha) represents the largest area of mangrove habitat within the Ningaloo Marine Park and is considered extremely important from a biodiversity conservation perspective (CALM 2005).

4.1.3 Northwest Shelf Province

In the Pilbara region, the coast is a complex of deltas, limestone barrier islands and lagoons, with a variable suite of substrates. As a result, mangroves in this region form relatively diverse fringing stands, albeit often stunted in stature but at times quite extensive in area. The mangroves along the Pilbara coastline are the largest single unit of relatively undisturbed tropical arid zone habitats in the world. The area has nine mangrove taxa and a total of 632 km^2 mangroves (MangroveWatch 2014). As with most arid zone mangroves, Pilbara mangroves are characterised by open woodlands and shrublands that are of relatively lower productivity than the mangrove communities of the wet tropics because of the extreme water and salinity stresses that affect the intertidal zone in the Pilbara (EPA 2001). Significant stands of mangroves in the Pilbara include:

+ Exmouth Gulf: mangrove assemblages within the Bay of Rest on the western shore of the Gulf and the extensive mangrove system on the eastern shore of the Gulf that extends as a series of tidal flats and creek channels from Giralia Bay to Yanrey Flats (Astron 2014). These areas of mangrove are also designated as 'regionally significant' by the EPA (2001). The importance of these mangroves to the Exmouth Prawn Fishery is discussed in Kangas et al. (2006);
+ Mainland coast and nearshore islands: mangrove assemblages at Ashburton River Delta, Coolgra Point, Robe River Delta, Yardie Landing, Yammadery Island and the Mangrove Islands are all designated as 'regionally significant' by the WA EPA (2001) and the EPA will give these mangrove formations the highest degree of protection with respect to geographical distribution, biodiversity, productivity and ecological function; and
+ Montebello, Barrow and Lowendal Islands: mangrove assemblages all lay within designated reserves. The mangrove communities of the Montebello Islands are considered globally unique as they occur in lagoons of offshore islands (DEC 2007). Mangrove stands identified on Varanus Island occur on the west coast in discrete patches within the tidal and supratidal zones, at South Mangrove Beach and a small embayment (Astron 2016). Mangrove stands on Varanus Island have been identified as healthy, with similar stands also identified as present on Bridled Island to the north of Varanus Island (Astron 2016).

The mangroves of the Kimberley are particularly diverse and relatively untouched. They occupy a variety of coastal settings including rocky shores, beaches and tidal flats (Cresswell and Semeniuk 2011). They belong to the Indo-Malaysian group of Old World Mangroves centred in the Indian-Pacific area (Cresswell and Semeniuk 2011). Of the eighteen species of mangrove plants known to Australia all are represented in the Kimberley including *Avicennia marina, Aegialitis annulata, Aegiceras corniculatum, Rhizophora stylosa, Ceriops tagal, Osbornia octodonta, Bruguiera exaristata, Camptostemon schultzii, Excoecaria agallocha, Sonneratia alba,* and *Xylocarpus australasicus* (Pendretti and Paling, 2001; Waples, 2007). Of these, ten occur only in the Kimberley (Waples 2007). *Rhizophora stylosa* and *Avicennia marina* are the most common mangrove species along the WA Coast.

Mangroves line much of the coastal area within the western Kimberley (and within the proposed Horizontal Falls Marine Park area). They are known to line the shore in the upper reaches of Talbot Bay and to fringe many of the islands of the Buccaneer Archipelago. There are large stands in the southern section of Dugong Bay. Kingfisher Islands has been noted to exhibit extensive mangroves where 10 species of mangrove have been recorded (Wilson 2013). Mangroves line the shores of the southern coast of Collier Bay and large tracts are found in Walcott Inlet and Secure Bay (Duke *et al.* 2010). The mangroves on the eastern side of the inlet extend about 30 km inland (Gueho 2007, Pendretti and Paling 2001, Zell 2007). Further along the coast mangroves have been identified lining much of the shores of Doubtful Bay. Mangroves are also known to line the shores of the Sale River and have been identified in George Water. For detailed maps of mangrove distribution refer to Pendretti and Paling (2001).

4.1.4 Northwest Shelf Transition

Mangroves are also a prominent feature of the North Kimberley. Fringing mangroves have developed around the edge of Prince Frederick Harbour and to the east of Cape Voltaire extending along the shores of Walmesly Bay and Port Warrender (Zell 2007). This region is humid and *Xylocarpus granatum* is localised here (Cresswell and Semeniuk 2011). The rocky coastline between Cape Pond and Cape Voltaire does not lend itself to mangrove development; instead coastal woodland grows on the shores above high water mark. Mangroves are interspersed with rocky outcrops and beaches around much of the Admiralty Gulf, Vansittart Bay and Napier Broome Bay (with extensive stands around the Drysdale estuary). Cape Londonderry marks the westerly limit of *Scyphiphora hydrophylacea* (Duke *et al.* 2010).

Between Cape Londonderry and Cape Dussejour mangrove communities are sparse, and limited to a few small stands in the bays as this part of the coastline is dominated by high relief rocky shores which are exposed to the prevailing easterly winds (Wilson 1994). Extensive mangroves do however line the shores of the islands and rivers in the Cambridge Gulf, where 12 mangrove species have been recorded (Wilson 2013). The mangroves of the Ord River are notable in terms of their structural complexity and diversity. Fourteen species of mangrove have been recorded in the boundaries (Pedretti and Paling 2001). The mangroves of the Cambridge Gulf are important for saltwater crocodiles and mangrove bird communities. A unique type of flycatcher which is an intermediate between *Microcea flavigater* and *Microeca tormenti* has been identified in the mangroves of the Cambridge Gulf (Johnstone 1984). Additionally, the area is important for maintaining stocks of the commercially exploited species of the Red-Legged Banana Prawns (*Penaeus indicus)* (Kenyon *et al.* 2004).

4.1.5 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.1.6 International Waters

Subawa's south coast in Indonesia is thought to contain the most significant stand of mangroves in the Lesser Sunda Ecoregion (DeVantier 2008). Other significant stands have been mapped at the following locations (DeVantier 2008):

+ North-west and south east Bali;
+ North coast of Nusa Lembongan;
+ North-east and east Sumba;
+ South-west, north-west, north and east Flores and Maumere;
+ Komodo Island, and nearby islands; and
+ South west, south, central and north Timor-Leste.

Several Indonesian National Parks, including Karimunjawa National Park, Kepulauan Seribu National Park, Meru Betiri National Park, Bali Barat National Park and Komodo National Park contain mangrove forest (refer to **Section 9.8**).

4.2 Intertidal Mud/Sand Flats

Intertidal mudflats form when fine sediment carried by rivers and the ocean is deposited in a low energy environment. Tidal mudflats are highly productive components of shelf ecosystems responsible for recycling organic matter and nutrients through microbial activity. This microbial activity helps stabilise organic fluxes by reducing seasonal variation in primary productivity which ensures a more constant food supply (Robertson 1988). Intertidal sand and mudflats support a wide range of benthic infauna and epifauna which graze on microscopic algae and microbenthos, such as bivalves, molluscs, polycheate worms and crustaceans (Zell 2007).

The high abundance of invertebrates found in intertidal sand and mudflats provides an important food source for finfish and shellfish which swim over the area at high tide. Mudflats have also been shown to be significant nursery areas for flatfish. During low tide, these intertidal areas are also important foraging areas for indigenous and migratory shorebirds. Mudflats also play a vital role in protecting shorelines from erosion (Wade and Hickey 2008).

4.2.1 Central Western Shelf Province

Shark Bay in the Central Western Shelf Province has an protected intertidal ecological community 'Subtropical and Temperate Coastal Saltmarsh', as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is the northerly limit for this community and there is a transition zone for many saltmarsh species (CALM 1996). The EPBC 'Listed Advice' (DSEWPaC 2013a) reports that sediments associated with these communities generally consist of poorly-sorted anoxic sandy silts and clays, and may have salinity levels that are much higher than seawater due to evaporation. The drainage characteristics of coastal soils, along with tidal patterns and elevation, can strongly influence the distribution of flora and fauna within the Coastal Saltmarsh ecological community (DSEWPaC 2013a).

4.2.2 Northwest Shelf Province

Within Northwest Shelf Province both Roebuck Bay and Eighty Mile beach are areas with significant intertidal mudflats that are used by birds in spring and summer including species listed as threatened under the *Biodiversity Conservation Act 2016* (BC Act) or EPBC Act, or listed on the IUCN Red List of Threatened Species (IUCN 2019). Intertidal mudflats are also an important feature of the Kimberley coast forming in many bays and inlets of the region (Waples 2007). The sediments that dominate these flats are generally of terrigenous origin (Wilson 2013).

The mudflats of the Kimberley coast have been shown to be important for migratory birds of the East Asian-Australasian Flyway, which is estimated to support more than five million migratory shorebirds (Barter 2002, Bennelongia Pty Ltd 2010, Wade and Hickey 2008). The migratory birds visit the mudflats of the Kimberley coast to feed on benthic organisms prior to embarking on a 10,000–15,000 km migration to their breeding grounds in the Artic (Wade and Hickey 2008).

4.2.3 Northwest Shelf Transition

Extensive mud flats are located in Collier Bay, where the highest tidal range in Australia is found. (Wilson 2013, Zell 2007). A study by (Duke *et al*. 2010, Masini *et al*. 2009) also identified fringing mudflats around Walcott Inlet, and Doubtful Bay. The tidal mudflats of Walcott Inlet are up to 5 km wide and support a rich intertidal invertebrate community (Gibson and Wellbelove 2010). These invertebrate communities in turn also support large numbers of waterbirds (Wilson 1994).

Extensive intertidal mudflats occur in Prince Frederick Harbour and are generally backed by mangroves. The mudskipper is known to feed on these mudflats at low tide. Intertidal flats are also a feature of the estuary of the Mitchell River. The mudflats of Port Warrender are known to support 20 shorebird species and tern species and it is likely the other mudflats in the region also support high numbers of birds. The ecological significance of the wetlands of the Mitchell River has been recognised in *A Directory of Important Wetlands in Australia*. Mud and sand flats are also known to surround much of Deep Bay and Napier Broome Bay.

Intertidal sand and mudflats are a common feature of the East Kimberley. Large sand bars are present on the river mouths of the King George River, Berkeley River and Lyne River and intertidal mudflats are extensive along the edges of the Cambridge Gulf. The estuary is wide and very shallow in some sections, and the silt and clay is continually picked up and redeposited by strong tidal currents (Robson *et al.* 2008). The tidal flats of the Ord River in the Cambridge Gulf have been listed as a wetland of international importance for the conservation of waterbirds under the Ramsar convention. The area supports a variety of fauna including shorebirds and mudskippers. Tidal mudflats are also extensive along the coast between the Cambridge Gulf and the WA-NT Border.

4.2.4 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.2.5 International Waters

Although no specific areas of intertidal mud or sand flats have been identified for international waters, the southern coasts of the islands that make up the Lesser Sunda Ecoregion of Indonesia and Timor-Leste do contain numerous estuarine habitats. These estuaries are likely to contain intertidal and tidal sand and mud flats that support a range of benthic invertebrate species that in turn attract other species such as birds and fish. Such estuaries in the Lesser Sunda Ecoregion are typically mangrove lined. Within the Lesser Sunda Ecoregion, the following areas are recognised as containing estuarine habitat (Wilson et al. 2011):

+ Lombok;
+ Sumba;
+ Central south and central north coasts of Sumbawa;
+ North-east coast of Flores; and
+ South-west coast of Timor-Leste.

The Irebere Estuary, located on the south-eastern coast, Tilomar located on the southern coast and Nino Konis Santana located on the eastern coast of Timor-Leste has been recognised as an Important Bird Area (Birdlife International 2018).

Several National Parks in the Ecoregion also contain estuarine habitats (likely to include intertidal sand and mud flats), including Karimunjawa National Park (refer to **Section 9.8**).

4.3 Intertidal Platforms

Intertidal platforms are areas of hard bedrock and/or limestone with or without a sediment veneer of varying thickness. These platforms can vary from low to high relief and provide a habitat for a diverse range of intertidal organisms (Morton and Britton in Jones 2004, SKM 2009, 2011, Hanley and Morrison 2012) and some species of shore birds (Garnet and Crowley 2000). They are common within each of the coastal bioregions within the EMBA.

4.3.1 Southwest Shelf Province and Southwest Shelf Transition

Intertidal platforms within the Northwest and Southwest bioregions support a mosaic of fauna and flora that typically exhibits strong variability in percent cover, community composition, abundance and diversity both between and within reefs at varying spatial and temporal scales (SKM 2009, 2011). Reef platforms typically exhibit zonation of fauna and flora from upper to lower levels on the intertidal zone, with increasing diversity, abundance and biomass lower in the intertidal (Morton and Britton in Jones 2004, SKM 2009, 2010, 2011, Hanley and Morrison 2012).

On the south coast of the Southwest Shelf Province, the coastal geomorphology changes from the predominant limestone reefs to eroded Precambrian rocks. Intertidal platforms are also common along the Southwest Shelf Transition. Shark Bay in the Central Western Shelf Province has a high diversity of intertidal marine habitats as a result of the diversity of benthic substrate, salinity and the broad geographical features which influence depth, water movement and turbidity (CALM 1996, DSEWPaC 2013b). This includes extensive, limestone platforms (as well as sand flats, mud flats, salt marsh and mangroves and beaches (CALM 1996).

4.3.2 Central Western Shelf Province and Transition

Limestone pavements extend out from the beach into subtidal zones, e.g. along the Ningaloo Coast and North West Cape; and higher relief platforms (>0.5 m off high water mark) are also present at a number of headlands along the North West Cape.

4.3.3 Northwest Shelf Province and Northwest Shelf Transition

Large tidal regimes are likely to be the defining environmental factor influencing the distribution of intertidal flora and fauna in the Northwest Shelf Province and Northwest Shelf Transition. The intertidal area of the Kimberley has an extreme tidal range (hypertidal) which creates unique environmental conditions and habitats not seen else anywhere else in the world. As a remote area many of the habitats are untouched and they are recognised as having significant conservation value (DPaW 2013). DPaW (2013) reports that as a result of the monsoonal influxes of freshwater and land-derived nutrients distinctive tropical marine ecosystems have occurred.

4.3.4 International Waters

While no significant areas of intertidal platforms have been identified in international waters, the high energy southern coastlines of the islands of the Lesser Sunda Ecoregion of Indonesia (and also including Timor-Leste) are likely to have areas of exposed pavements consisting of limestone and remnant lava flows (Wilson *et al*. 2011).

4.4 Sandy Beaches

Sandy beaches are those areas within the intertidal zone where unconsolidated sediment has been deposited (and eroded) by wave and tidal action. Sandy beaches can vary from low to high energy zones; the energy experienced influences the beach profile due to varying rates of erosion and accretion. Sandy beaches are found across the EMBA and vary in length, width and gradient. They are interspersed among areas of hard substrate (e.g. sandstone) that form intertidal platforms and rocky outcrops. There is a wide range of variation in sediment type, composition, and grain size along the EMBA.

Sandy beaches provide habitat to a variety of burrowing invertebrates and subsequently provide foraging grounds for shorebirds (Garnet and Crowley 2000). The number of species and densities of benthic macroinvertebrates that occur in the sand are typically inversely correlated with sediment grain-size and exposure to wave action, and positively correlated with sedimentary organic content and the amount of detached and attached macrophytes (Wildsmith *et al.* 2005). However, the distributions of these faunas among habitats will also reflect differences in the suite of environmental variables that characterize those habitats (Wildsmith *et al.* 2005).

Sandy habitats are important for both resident and migratory seabirds and shorebirds (refer **Section 8**). While sand flats and beaches generally support fewer species and numbers of birds than mudflats of similar size; some species such as the beach thick knee (*Esacus giganteus*) a crab eater, are commonly associated with sandy beaches (Garnet and Crowley 2000). Sandy beaches can also provide an important habitat for turtle nesting and breeding (see marine turtles **Section 6.1**).

Sandy beaches also provide important nesting habitat for the six species of marine turtles that nest within WA (refer **Section 6.1**).

4.4.1 Southwest Shelf Province

The hooded plover (*Thinornis rubricollis*) is a shorebird found on several beaches within the South West capes. Hooded plovers live on sandy surf beaches and prefer beaches backed by dunes rather than cliffs (DEC 2013). In addition to this, beaches in the South West province provide a variety of socio economic values including tourism, commercial and recreational fishing, and support other recreational activities.

4.4.2 Southwest Shelf Transition

Sandy beaches throughout the Abrolhos host breeding populations of the Australian sea lion. The Abrolhos represent the northernmost breeding population of Australian sea lions. The current population at the Abrolhos is estimated to be approximately 90 individuals (DoF 2012).

In addition to this, beaches in the South West province provide a variety of socio-economic values including tourism, commercial and recreational fishing, and support of other recreational activities.

4.4.3 Northwest Shelf Province

Eighty Mile Beach Marine Park is one of the Australia's largest uninterrupted sandy beaches (stretching 220 km) and is an important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DEC 2012a). It is also a listed Ramsar wetland (see **Section 9** on Protected Areas).

4.4.4 Northwest Shelf Transition

Sand habitat within the Camden Marine Park is mainly associated with shorelines and inlets on both mainland and island shores. Some beach deposits on islands in the Kimberley are composed of skeletal carbonate sand, while they may also consist of sediments from inland areas carried to the sea by rivers and gullies (DPaW 2013). The sediment coarseness of the sand may vary, and may also be littered with dead shell, rock and/or coral material. Sea cucumbers that ingest sand and filter out microscopic food are often common in this habitat DPaW 2013).

Generally, in this region, sand habitat is adjacent to either dense mangrove stands or rocky cliffs (DPaW 2013). Beaches can be highly influenced by tide and weather conditions. Those that overlie rock are likely to shift and be ephemeral in nature.

4.4.5 International Waters

No significant areas of sandy beaches in international waters have been identified. However, the southern coastlines of the islands of the Lesser Sunda Ecoregion of Indonesia and Timor-Leste are known to contain sandy beaches consisting of soft black sand, formed by volcanic activity. Within this region, a number of National Parks are considered important sites for turtle nesting beaches, including the Meru Betiri National Park (refer to **Section 9.8**).

4.5 Rocky Shorelines

Rocky shorelines are found across the EMBA and are often indicative of high energy areas (wave action) where sand deposition is limited or restricted (perhaps seasonally or during a cyclone). They are formed from limestone pavement extending out from the beach into subtidal zones, for example along the Ningaloo Coast and North West Cape; higher relief platforms (>0.5 m off high water mark) are also present at a number of headlands along the North West Cape. This habitat is also widespread heading south towards Perth.

Rocky shores can include pebble/ cobble, boulders, and rocky limestone cliffs (often at the landward edge of reef platforms). Rocky outcrops typically consist of hard bedrock, but some of the coastline has characteristic limestone karsted cliffs with an undercut notch. Rocky shorelines can vary from habitats where there is bedrock protruding from soft sediments to cliff like structures that form headlands. Rocky shorelines are an important foraging area for seabirds and habitat for invertebrates found in the intertidal splash zone (Morton and Britton cited in Jones 2004). For example, oyster catchers and ruddy turnstones feed along beaches and rocky shorelines (see seabirds in **Section 8.2.2**).

4.5.1 International Waters

The Lesser Sunda Ecoregion contains numerous rocky shores, particularly on the exposed southern coastlines of the islands that make up the ecoregion. Areas of rocky shores include the following (DeVantier 2008):

+ The Bukit Peninsula and Nusa Penida areas of Bali;
+ South Lombok;

- South-east Sumbawa;
- Nusa Tengara;
- Sumba; and
- Timor-Leste, including Roti Island, Fatu and Atapupu.

Santos

5. Fish and Sharks

Fish distributions in the EMBA are discussed with respect to the IMCRA Provincial Bioregions which were defined using CSIRO's 1996 regionalisation of demersal fish on the continental shelf to the shelf break, and their 2005 regionalisation of demersal fish on the continental slope to approximately 1,200 m depth (DEH 2006). The EPBC species listed as threatened and migratory found in the EMBA, according to the Protected Matters search (**Appendix A**), are shown in **Table 5-1** along with their WA conservation listing (as applicable) and discussed in **Section 5.2** below.

The following WA conservation codes apply to WA conservation significant fauna:

- Threatened Species (listed under BC Act):
  - Critically Endangered
  - Endangered
  - Vulnerable
- Specially protected species (listed under BC Act):
  - Migratory
  - Species of special conservation interest (conservation dependant fauna)
  - Other specially protected species
- Priority species (non-statutory state based administrative process):
  - Priority 1, 2 and 3: poorly-known species – possible threatened species that do not meet survey criteria or are otherwise data deficient. Ranked in order of priority. In urgent need of further survey.
  - Priority 4: species that are adequately known, are either: rare but not threatened; meet criteria for near threatened; or delisted as threatened species within last five years for reasons other than taxonomy. Requiring regular monitoring.

A detailed account of commercial and recreational fisheries that operate in the region is provided in in the Commercial Fisheries **Section 14.7** and detailed in *The State of the Fisheries Report* 2017/2018 (Gaughan *et al.*, 2019).

Table 5-1: EPBC listed fish and shark species in the EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Blind gudgeon (*Milyeringa veritas*)	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - No BIA defined
Balstons pygmy perch (*Nannatherina balstoni*)	Vulnerable	Vulnerable	-	Species or species habitat likely to occur within area.	None - No BIA defined

[1] The Wildlife Conservation (Specially Protected Fauna) Notice 2018 has been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the BC Act.

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Blind cave eel (*Ophisternon candidum)*	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - No BIA defined
Black-stripe minnow (*Galaxiella nigrostriatal*)	Endangered	Endangered	-	Species or species habitat known to occur within area.	None - No BIA defined
Grey nurse shark (*Carcharias taurus*)	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - BIA not found in EMBA
Great white shark (*Carcharodon carcharias*)	Vulnerable & Migratory	Vulnerable	-	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to **Table 5-3**
Whale shark (*Rhincodon typus*)	Vulnerable & Migratory	Specially protected (species otherwise in need of special protection)	-	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to **Table 5-3**
Northern river shark (*Glyphis garricki)*	Endangered		Priority 1	Breeding likely to occur within the area.	None - BIA not found in EMBA
Dwarf sawfish (*Pristis clavata)*	Vulnerable & Migratory		Priority 1	Breeding known to occur within area.	Yes – Refer to **Table 5-3**
Freshwater sawfish (*Pristis pristis)*	Vulnerable & Migratory		Priority 3	Species or species habitat known to occur within area.	Yes – Refer to **Table 5-3**
Narrow sawfish (*Anoxypristis cuspidate)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Green sawfish (*Pristis zijsron)*	Vulnerable & Migratory	Vulnerable	-	Breeding known to occur within area.	Yes – Refer to **Table 5-3**
Shortfin mako *(Isurus oxyrinchus)*	Migratory	-	-	Species or species habitat likely to occur within area .	None - No BIA defined
Longfin mako *(Isurus paucus)*	Migratory	-	-	Species or species habitat likely to occur within area.	None - No BIA defined
Reef manta ray *(Manta alfredi)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Giant manta ray *(Manta birostris)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Porbeagle *(Lamna nasus)*	Migratory	-	-	Species or species habitat may occur within area.	None - No BIA defined

In addition a review of conservation dependent species[2] identified five species of fish / sharks that may occur in the EMBA:

- Orange roughy (*Hoplostethus atlanticus*);
- Southern blue fin tuna (*Thunnus maccoyii*);
- Southern dogfish (*Centrophorus zeehaani*);
- School shark (*Galeorhinus galeus*); and
- Scalloped hammerhead (*Sphyrna lewini*).

5.1 Regional Surveys

Within the EMBA a number of important geographical areas for fish exist, including Ningaloo Marine Park, Montebellos/Barrow Island Marine Park, Abrolhos Australian Marine Park and the Rowley Shoals.

5.1.1 Southwest Shelf Province

At least 150 species have been identified within the capes region as being reef-associated (Hutchins 1994 cited in DEC 2013). Of these, 77% are warm temperate species, 18% are subtropical species and 5% are tropical (DEC 2013).

The most abundant finfish species across the region identified during surveys were the Maori wrasse (*Opthalmolepis lineolatus*), red banded wrasse (*Pseudolabrus biserialis*), McCulloch scalyfin (*Parma mccullochi*), and western king wrasse (*Coris auricularis*). The yellow headed hulafish (*Trachinops noarlungae*), black headed puller (*Chromis klunzingeri*), rough bullseye and common bullseye (*Pempheris multiradiata* and *P. klunzingeri*) were also common at Eagle Bay and Geographe Bay (Westera *et al.* 2007 cited in DEC 2013).

5.1.2 Southwest Shelf Transition

A total of 389 finfish species have been recorded at the Abrolhos (DoF 2012). The Abrolhos and their surrounding coral and limestone reef systems consist of a combination of abundant temperate macroalgae with coral reefs, supporting substantial populations of large species such as baldchin groper and coral trout. Some of the species occurring in the Abrolhos are dependent on larvae carried southward by the Leeuwin Current from areas further north, such as Shark Bay or Ningaloo Reef. Similarly, populations of some of the species occurring at Rottnest Island are dependent on larvae generated from breeding populations at the Abrolhos (DoF 2012).

More than 20 species of sharks have been identified at the Abrolhos (DoF 2012). These sharks include:

- Port Jackson sharks (*Heterodontus portusjacksoni*);

[2] Conservation dependent species are listed species under the EPBC Act and are considered as part of the Commonwealth marine area.

- Tiger shark (*Galeocerdo cuvier*);
- Whaler sharks (*Carcharhinus brachyurus*); and
- Wobbegongs (*Orectolobus maculatus*).

Abrolhos waters are considered to be an important food source for sharks, due to the resident fish populations. Various species of rays have been recorded at the Abrolhos. These include the manta ray and the white spotted eagle ray (DoF 2012).

5.1.3 Central Western Province

The Perth Canyon appears to be an important ecological feature attracting krill and fish aggregations that in turn attract larger species such as predatory fish and pygmy blue whales (DSEWPaC 2012). Demersal slope fish assemblages in this bioregion are characterised by high species diversity. Scientists have described 480 species of demersal fish that inhabit the slope of this bioregion and 31 of these are considered endemic to the bioregion. Demersal fish on the slope in this bioregion in particular have high species diversity compared with other more intensively sampled oceanic regions of the world. Below 400 m water depth demersal fish communities are characterised by a diverse assemblage where relatively small, benthic species (grenadiers, dogfish and cucumber fish) dominate.

5.1.4 Central Western Shelf Province

The Central Western Shelf Province is located near Shark Bay and is the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay, 83% are tropical species with 11% warm temperate and 6% cool temperate species (CALM 1996).

5.1.5 Central Western Shelf Transition

Ningaloo is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that provides habitat for many fish species. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). Ningaloo Reef is a well known biodiversity hotspot, supported by the direct link between the reef and the ancient reef systems found closer to the equator by the Leeuwin Current (Kemps 2010). Approximately 500 species of fish have been reported to inhabit the reef (Kemps 2010). The Piercam project from inception in 2005 to 2013, identified 165 fish species from 50 families at the Point Murat Navy Pier alone, located within the Ningaloo Marine Park (Whisson & Hoschke 2013).

Seasonal aggregations of whale sharks occur at Ningaloo each year (CALM 2005). There is limited data available on species diversity and distribution of sharks in the Ningaloo area as chondrichthyan biodiversity for the area has not been specifically recorded. Despite this, it is possible that the Ningaloo Reef Marine Park contains the largest and most diverse collection of sharks on the Australian coastline (Stevens *et al.* 2009). It was estimated in 2009 by Last and Stevens (cited in Stevens *et al.* 2009), that there are likely to be 118 species of chondrichthyan fishes occurring in the park. Of these species, 59 are shark species predicted to be found at depths of less than 200 m (Stevens *et al.* 2009).

The lagoon at Ningaloo Reef appears to provide a juvenile habitat and nursery area for shark species such as the grey nurse shark (*C. Taurus*), black-tipped reef shark (*Carcharhinus melanopterus*) and other reef sharks (Carcharhinidiae) (Stevens *et al.* 2009). A study conducted on the distribution and abundance of elasmobranches in the Ningaloo Marine Park, in 2009, tracked the movements of six key shark species. Species such as *Galeocerdo cuvier* (tiger shark) and *Sphyrna mokarran* (great hammerhead) were found to remain for brief time periods in the park, in contrast to other species found to re-visit the Ningaloo area (Stevens *et al.* 2009). Several species of sharks within Ningaloo have been identified as key indicator species for the health of the system (Stevens *et al.* 2009).

Barrow Island includes Biggada Reef, an ecologically significant fringing reef, and the Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops; providing fish habitat (DEC 2007a). Within the Barrow/Montebello region, at least 380 fish species have been recorded (de Lestang & Jankowski 2017). Most species exhibit wide distributions, with local species composition closely resembling that of the Dampier Archipelgao. Coral habitats support the most diverse fish community in this region, comprising, among others, many species of damselfish (*Pomacentridae*), parrotfish (*Scaridae*), snappers (*Lutijanidae*) and groupers (*Serranidae*) (de Lestang & Jankowski 2017). The region's macroalgal habitats are considered important nursery areas for a diverse range of fish species, such as emperor (*Lethrinidae*), threadfin bream (*Nemipteridae*), tuskfish (*Labridae*) and trevally (*Carangidae*) (de Lestang & Jankowski 2017).

Ramsar wetlands within the area (e.g. Eighty Mile Beach and Ashmore Reef National Nature Reserve) can also provide important habitat for fish (see **Section 9.2**).

5.1.6 Central Western Transition

The biological communities of the Central Western Transition are thought to be distinctive owing to the proximity of deep oceans areas to the continental slope and shelf, resulting in close interaction between pelagic species of the Cuvier Abyssal Plain and those of the slope and shelf (DEWHA 2008a).

The present level of understanding of the marine environment in this bioregion is generally poor. The diversity of fish and cephalopod species changes with depth, generally decreasing species numbers with increasing depth. The demersal slope fish bioregionalisation identified some endemism in communities in this bioregion (Last *et al*. 2005), however, it is lower than other areas of the North-west Marine Region (DEWHA 2008a).

Bentho-pelagic fish, such as deep-water snappers (e.g. *Paracaesio* spp, and *Eletis* spp.), hatchetfish (*Argyropelecus* spp.), dragonfish (*Melacosteus* spp.), viperfish (*Chauliodus* spp.) and a number of eels species migrate between the benthic and pelagic systems, forming an important link between these systems (DEWHA 2008a).

Transient fish species through the Central Western Transition bioregion include southern bluefin tuna (migrating to and from spawning grounds), broadbill swordfish (*Xiphius gladius*), bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*) and striped marlin (*Tetrapturus audax*). Pelagic sharks also range across the bioregion following schools of pelagic fish (DEWHA 2008a).

5.1.7 Northwest Shelf Province and Northwest Province

The demersal zone of the North West Shelf (which includes the Northwest Province and Northwest Shelf Province) hosts a diverse assemblage of fish of tropical Indo-west Pacific affinity, with up to 1,400 species known to occur, with a great proportion of these occurring in shallow coastal waters (Allen *et al*. 1988). Last *et al*. (2005) and Fox and Beckley (2005) described the North-west Province as being characterised by a high level of endemism and species diversity. Certain areas of increased biological activity (e.g. Glomar Shoals) attract demersal fish species such as Rankin cod, red emperor, crimson snapper and spangled emperor that are exploited by commercial trawl and trap fisheries (Sainsbury *et al.* 1992, Fletcher and Santoro 2013).

The shallow waters (<30 m) of the Dampier Archipelago, in the Northwest Shelf Province, support a characteristic and rich fish fauna of 650 species from a variety of habitats including coral and rocky reefs, mangroves, sand and silty bottoms and sponge gardens (Hutchins 2003 & 2004). The majority of these species are found over hard substrate, but significant numbers are also found from soft bottom and mangrove areas. The outer islands of the Archipelago are inhabited predominantly by coral reef fishes whereas inner areas close to the mainland are occupied by mangrove and silty-bottom dwellers. The inter-island passages have a relatively rich soft bottom fauna. EPBC Act protected fish species within the Dampier Archipelago include the dwarf sawfish (*Pristis clavata*), freshwater sawfish (*Pristis pristis*) and narrow sawfish (*Anoxypristis cuspidate*).

The fish fauna of the archipelago is less diverse than the islands of the West Pilbara to the south, but are closely related to the fauna at the offshore Montebello Islands (Hutchins 2004). The fish fauna of Barrow/ Lowendal/ Montebello Islands are widespread throughout the Indo-west Pacific region.

Within the southern portion of the Northwest and Northwest Shelf Province, small pelagic fish (e.g. lantern fishes) comprise a third of the total fish biomass (Bulman 2006) and inhabit a range of marine environments, including inshore and continental shelf waters. These small pelagic fish play an important ecological role, not only for this particular area but for the entire NWMR. They feed on pelagic phytoplankton and zooplankton and provide a food source for a wide variety of predators such as marine mammals, sharks, large pelagic fish and seabirds, thus providing a vital link between many of the region's trophic systems (Mackie *et al*. 2007).

Pelagic fish in the Northwest and Northwest Shelf Province include tuna, mackerel, herring, pilchard and sardine, and game fish such as marlin and sailfish (BBG 1994, Brewer *et al*. 2007), some of which are targeted by both commercial and recreational fishers. In particular, adult and juvenile southern bluefin tuna are thought to migrate through the North West Shelf on their way to and from spawning grounds in the north-eastern Indian Ocean. However, the timing of these migrations and the use of regional currents to assist their migration is still unclear. The oceanic waters of the North West Shelf are also believed to provide important spawning and nursery grounds for a number of large pelagic fish species. **Table 5-2** provides a summary of the key fish species and likely timing of their spawning in the region (DoF correspondence).

5.1.8 Northwest Shelf Transition

Creek systems, mangroves and rivers, and ocean beaches within this region provide habitat for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin and cods (Fletcher and Santoro 2013). The offshore atolls and the continental shelf waters in the Northwest Shelf Transition are also geographically important for fish species. They support species of recreational and commercial interest, including saddle-tail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish (Gaughan et al. 2019).

The Rowley Shoals within the Northwest Shelf Transition comprise three oceanic reef systems approximately 30–40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant (DEC 2007b). See **Section 11** on State Marine Parks and Nature Reserves for further details on important geographical areas for fish.

5.1.9 Northwest Transition

The Northwest Transition bioregion may support sparse populations of bentho-pelagic fish and cephalopods in low densities. Pelagic fish species likely to be present include grenadiers and hatchetfish (*Argyropelecus* spp.) as well as transient populations of highly mobile pelagic fish. Adult and juvenile southern bluefin tuna are through to migrate through this bioregion on their way to and from spawning grounds in the north-eastern Indian Ocean (DEWHA 2008a).

The slope habitat of this bioregion is associated with important populations of demersal fish species and supports the second richest demersal fish assemblage nationally (Last *et al*. 2005). Over 508 fish species have been identified on the slope in this area and 64 of these species are endemic. The high diversity and endemism of the demersal fish fauna indicates important interactions between physical processes and trophic structures in this bioregion. For more information on the slope habitat for fish and sharks, refer to **Section 10.1.18**.

The Rowley Shoals within the Northwest Transition comprise three oceanic reef systems approximately 30–40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant (DEC 2007b).

5.1.10 Timor Province

The diversity of demersal fish assemblages on the continental slope in the Timor Province (as well as the Northwest Transition and the Northwest Province) is high compared to elsewhere along the Australian continental slope (DSEWPaC 2012). Elements of the Timor Province are not well known, due to limited survey data in the northern limits of the region. The province is geographically extensive and includes 418 fish species, 64 of which are endemic to the region (Last *et al.* 2009). Key indicator species include *Bembrops nelsoni*, *Bythaelurus* sp., *Halicmetus* sp., *Malthopsis* spp, *Neobythites australiensis*, *Nobythites bimaculatus*, *Neobythites macrops*, *Neobythites soelae*, *Parapterygotrigla* sp., *Physiculus roseus* (Last *et al.* 2005).

Scott and Seringapatam Reefs are regionally important for the diversity of their fauna, including 558 fish species (Department of the Environment (DoE) 2014). Scott Reef has enormous habitat diversity and is considered a hot spot for fish, with five endemic species (DoE 2014). Scott Reef has biogeographic significance due to the presence of species which are at or close to the limits of their geographic ranges, including fish known previously only from Indonesian waters such as cardinalfish, azure damselfish (*Chrysoptera hemicyanea*), comb-tooth blenny (*Escnius schroederi*) and several Gobiids (DoE 2014).

The diversity of fish at Ashmore Reef is also higher than other comparable reefs in the bioregion with over 760 species recorded (Russell *et al.* 2005, Kospartov *et al.* 2006. The majority of fish species are shallow water, benthic taxa that typically inhabit depths down to 100 m and are widely distributed throughout the Indo-West Pacific (Russell *et al.* 2005). The most species rich groups are gobies (*Gobiidae*), damselfishes (*Pomacentridae*), wrasses (*Labridae*), cardinal fishes (*Apogonidae*), moray eels (*Muraenidae*), butterflyfishes (*Chaetodontidae*), and rockcods and groupers (*Serranidae*) (Allen 1989, Russell *et al*. 2005).

5.1.11 Christmas Island Province

The Christmas Island Province is in deep, offshore waters (2,200 m – 6,000 m depth range). These waters provide habitat for pelagic finfish species including tuna (*Thunnus* sp.) and wahoo (*Acanthocybium solandri*), and some demersal species such as ruby snapper (*Etelis carbunculus*).

Table 5-2: Spawning and aggregation times of key commercially caught fish species within the North West Shelf

Species		Month											
Species Common Name	**Species Latin Name**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Blacktip shark	*Carcharhinus tilstoni* and *C. limbatus*												
Goldband snapper	*Pristipomoides multidens*												
Rankin cod	*Epinephelus multinotatus*												
Red emperor	*Lutjanus sebae*												
Sandbar shark	*Carcharhinus plumbeus*												
Spanish mackerel	*Scomberomorus commerson*												
Pink snapper	*Pagrus auratus*												
Baldchin groper	*Choerodon rubescens*												
Crystal (snow) crab	*Chaceon spp.*												
King George whiting	*Sillaginodes punctate*												
Spangled emperor	*Lethrinus nebulosus*												
Pearl oyster	*Pinctada maxima*												
Blue-spotted emperor	*Charaxes cithaeron*												
Dusky whaler	*Carcharhinus obscurus*	May occur throughout the year											
Whiskery shark	*Furgaleus macki*												
Gummy shark	*Mustelus antarcticus*	Peak pupping periods unknown											
Fish	other species	Timing of spawning activity varies between species											

5.2 Fish Species

Four species of fish listed as threatened under the EPBC Act (**Table 5-1**) were identified in the Protected Matters search (**Appendix A**):

- Balston's pygmy perch (*Nannatherina balstoni*);
- Black-stripe minnow (*Galaxiella nigrostriata*);

- Blind gudgeon (*Milyeringa veritas*); and
- Blind cave eel (*Ophisternon candidum*).

In addition the Barrow cave gudgeon *(Milyeringa justitia*) has been identified as relevant threatened species under the BC Act. This species is not listed under the EPBC Act.

5.2.1 Blind Gudgeon, Balston's Pygmy Perch and Blind Cave Eel

Both the blind gudgeon (*Milyeringa veritas*) and blind cave eel (*Ophisternon candidum*) are known to occur on the Cape Range Peninsula (in the Central Western Shelf Transition) (Humphreys and Feinberg 1995), and a related species of the genus Milyeringa, the Barrow cave gudgeon *(Milyeringa justitia*) has also been noted at Barrow Island (Humphreys 1999). The Barrow cave gudgeon is listed as Vulnerable under the WA BC Act. They have been recorded in waters ranging from fresh to seawater at depths of up to 33 m in caves and 50 m in wells and bores. Both species are restricted to either caves or groundwater (Humphreys and Blyth 1994) and are the only two vertebrate animals known from Australia for this (DoE 2014a).

The Balston's pygmy perch distribution ranges from Moore River (75 km north of Perth) at the northern extent to Two Peoples Bay near Albany. This freshwater species is typically associated with shallow waters near riparian vegetation and is considered to have low salinity tolerance, making it unlikely to occur in estuarine conditions (DoEE, 2016).

5.2.2 Black-stripe minnow

The black-stripe minnow inhabits coastal wetlands of south-west WA between Augusta and Albany. During summer when ephemeral pools dry out, individuals burrow into the moist soil below to aestivate until the rains return in autumn (Bray and Gomon 2017).

5.2.3 Syngnathids

The EPBC Protected Matters search also identified 72 'listed marine species of fish which are largely from the family Syngnathidae (**Appendix A**). Syngnathids are a group of bony fishes that include seahorses, pipefishes, pipehorses and sea dragons, although taxonomic uncertainty still surrounds a number of these (DEWHA 2012a). Knowledge about the distribution, abundance and ecology of syngnathids is limited.

5.3 Sharks, Rays and Sawfishes

The diversity of marine environments in the waters within the NWMR has led to a rich fauna of cartilaginous fish (sharks and rays). Of the approximately 500 shark species found worldwide, 19% (94) are found in the region (DEWHA 2008a). The EPBC Act Protected Matters search (**Appendix A**) identified four species of shark, and three species of sawfishes listed as threatened within the search area between south west WA and NT border (**Table 5-1**), including:

- Grey nurse shark (*Carcharias taurus*);
- Great white shark (*Carcharodon carcharias*);
- Northern river shark (*Glyphis garricki*);
- Whale shark (*Rhincodon typus*);
- Dwarf sawfish (*Pristis clavata*);
- Freshwater sawfish (*Pristis pristis*); and
- Green sawfish (*Pristis zijsron*).

In addition, the narrow sawfish (*Anoxypristis cuspidate*), two species of ray, the reef manta ray (*Manta alfredi*) and giant manta ray (*Manta birostris*), the porbeagle (*Lamna nasus*) and the longfin (*Isurus paucus*) and shortfin (*Isurus oxyrinchus*) mako sharks are listed as migratory within the search area (**Table 5-1).**

The Biologically Important Areas (BIAs) for relevant species detailed above are illustrated in **Figure 5-1, Figure 5-2** and **Figure 5-3**.

5.3.1 Grey Nurse Shark

The grey nurse shark (*Carcharias taurus*) is listed as vulnerable under the EPBC Act and the BC Act, and may be found within the EMBA. In Australia, the grey nurse shark is now restricted to two populations, one on the east coast from southern Queensland to southern NSW and the other is predominantly found around the southwest coast of WA, but has been recorded on the North West Shelf (DEWHA 2012b, Pogonoski *et al*. 2002). It is believed that the east and west coast populations do not interact and ongoing research will probably confirm that the populations are genetically different (Last and Stevens 2009).

While it is thought that grey nurse sharks have a high degree of site fidelity, some studies (McCauley 2004) suggest that grey nurse sharks move between different habitats and localities, exhibiting some migratory characteristics. In certain areas grey nurse sharks are vulnerable to localised pressure due to high endemism. The status of the west coast population is poorly understood although they are reported to remain widely distributed along the WA coast and are still regularly encountered, albeit with low and indeterminate frequency (Chidlow *et al*. 2006).

Grey nurse sharks are often observed hovering motionless just above the seabed, in or near deep sandy-bottomed gutters or rocky caves, and in the vicinity of inshore rocky reefs and islands (Pollard *et al*. 1996). The species has been recorded at varying depths, but is generally found between 15–40 m (Otway & Parker 2000). Grey nurse sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 m on the continental shelf (Pollard *et al*. 1996). Grey nurse sharks feed primarily on a variety of teleost and elasmobranch fishes and some cephalopods (Gelsleichter *et al*. 1999, Smale 2005).

No grey nurse shark BIAs were identified in the EMBA.

5.3.2 Great White Shark

The great white shark (*Carcharodon carcharias*) is listed as vulnerable and migratory under the EPBC Act and is listed as vulnerable under the BC Act. In Australia, great white sharks have been recorded from central Queensland around the south coast to northwest WA, but may occur further north on both coasts (Last and Stevens 2009). There are no known aggregation sites for white sharks in the North-west marine region, but the species has been recorded in North West Shelf waters during humpback migrations (DEWHA 2012b). They are widely but not evenly distributed in Australian waters and are considered uncommon to rare compared to most other large sharks (CITES 2004).

Study into great white shark populations is difficult (Cailliet 1996) given the uncertainty about their movements, emigration, immigration and difficulty in estimating the rates of natural or fishing mortality.

Great white sharks can be found from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas (Pogonoski *et al*. 2002). They also make open ocean excursions and can cross ocean basins (for instance from South Africa to the western coast of Australia and from the eastern coast of Australia to New Zealand). Great white sharks are often found in regions with high prey density, such as pinniped colonies (DEWHA 2009). The relevant great white shark BIAs in the EMBA are detailed in **Table 5-3** and is shown on **Figure 5-1** (DoEE 2019b).

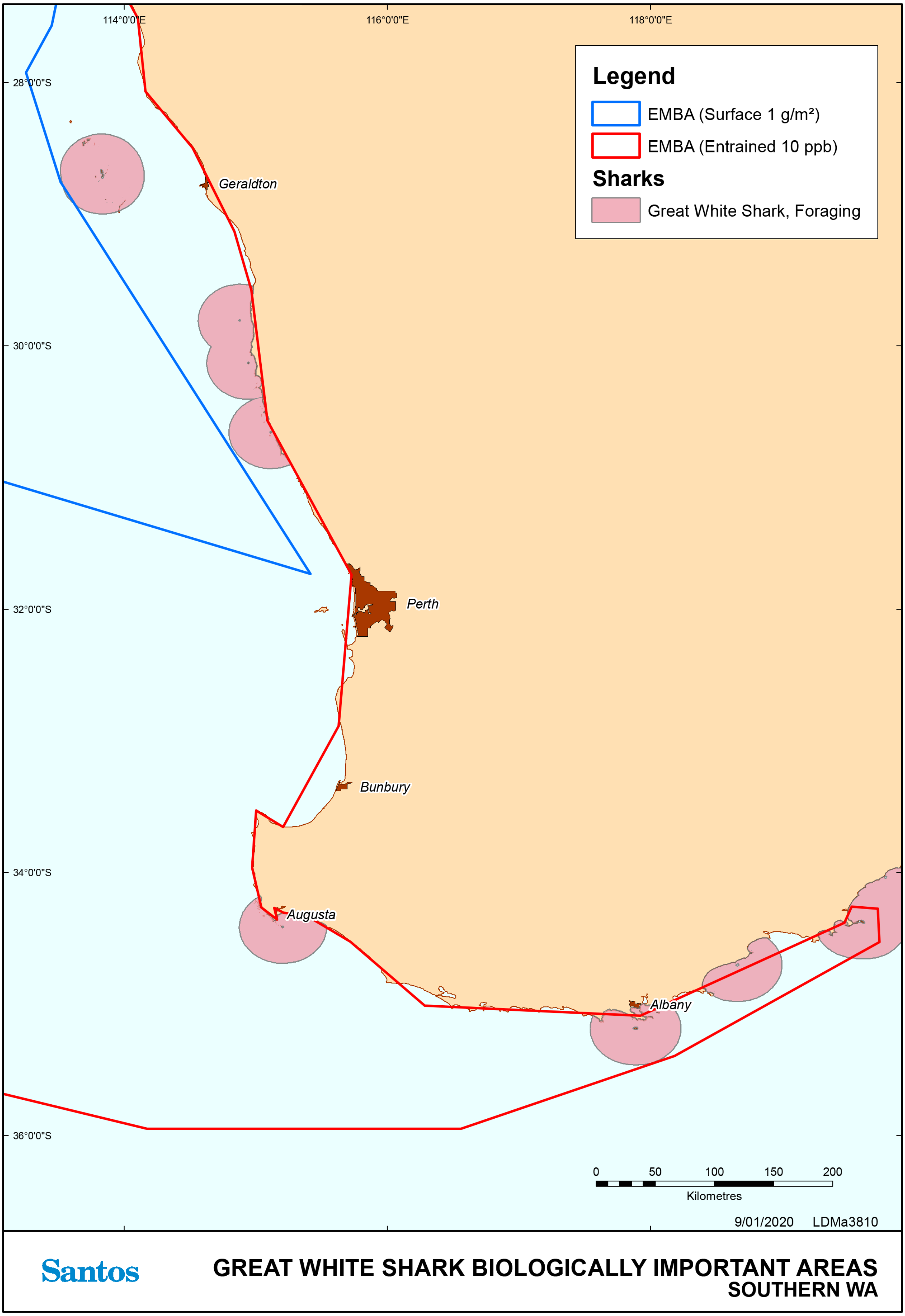


Figure 5-1: Biologically important area – great white shark

5.3.3 Northern River Shark

The northern river shark (*Glyphis garricki*) is listed as endangered under the EPBC Act and is one of the rarest species of shark in the world. Adults only recorded in marine habitats, whereas neonates, juveniles and subadults recorded in freshwater, estuarine and marine environments. It is also listed as a Priority 1 conservation species in WA.

The associated recovery plan (Sawfish and River Sharks Multispecies Recovery Plan, Commonwealth of Australia 2015) identifies adults and juveniles are being known in WA marine waters north of Derby. Pupping and juvenile sharks are identified as known to occur in Cambridge Gulf and pupping is also identified as likely to occur in King Sound. Under the associated recovery plan all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

5.3.4 Whale Shark

The whale shark (*Rhincodon typus*) is listed as vulnerable and migratory under the EPBC Act and is also listed as a specially protected species under the BC Act as a species of special conservation interest (conservation dependent fauna). The species is also classified as vulnerable on the World Conservation Union's Red List of Threatened Species (Norman 2005) and are protected under the WA *Conservation and Land Management Act 1984* and WA *Fish Resources Management Act 1994*.

The whale shark is the largest of all fish (>18 m; Borrell *et al*. 2011; Chen *et al*. 1997, Compagno 2001) and is a migratory species with worldwide geographical ranges between 30º N and 35º S (Last and Stevens 2009). There is a general lack of knowledge on many aspects of whale shark biology, including definitive migration patterns. The species is oceanic but often forms aggregations in coastal waters at sites throughout the tropics. Typically, these aggregations are seasonal and often coincide with specific productivity events that are a focus of feeding for the animals. For example, whale sharks aggregate to feed on dense swarms of copepods in Baja California (Clark and Nelson 1997), fish spawn off Belize (Heyman *et al*. 2001) and red crab larvae at Christmas Island (Meekan *et al*. 2009).

One of the best known aggregation sites for whale sharks occurs along the central and NW coast of Western Australia from March to July and is focused at Ningaloo Reef, within the Exmouth region. The small size and general absence of female whale sharks from Ningaloo Reef suggests that the region may be important for feeding rather than breeding (Norman and Stevens 2007). The timing of this aggregation coincides with a pulse in seasonal productivity that results in large abundances of tropical krill on which these filter feeding sharks feed (Meekan *et al*. 2006, Jarman and Wilson 2004). At Ningaloo Reef, whale sharks are often found swimming close to the reef front, within a few kilometres of the shore and in water of less than 50 m deep. A tourist industry based on snorkelling with the sharks in this area has developed over the last 15 years and is now estimated to be worth over $4 million annually to the local economy of the Ningaloo region.

Estimates of the size of the population participating in the Ningaloo aggregation are between 300 and 500 individuals (Meekan *et al*. 2006), but research indicates that the Ningaloo population of whale sharks is declining (Bradshaw *et al*. 2007).

Whale sharks are known to be highly migratory with migrations of 13,000 km being recorded (Eckert and Stewart 2001). Research on the migration patterns of whale sharks in the western Indian Ocean, and isolated and infrequent observations of individuals, indicate that a small number of the Western Australian population migrate through the North West Shelf. Wilson *et al*. (2006) tagged 19 whale sharks in 2003 and 2004, with long term movements patterns successfully recorded from six individuals. All travelled northeast into the Indian Ocean after departing Ningaloo Reef, with one tracked to Ashmore Reef and another to Scott Reef. Whale sharks are occasionally observed from Santos WA's offshore oil and gas facilities on the North West Shelf (Harriet Alpha and Stag platforms). In general, migration along the northern WA coastline broadly follows the 200 m isobath and typically occurs between July and November (DoE 2015).

A biologically important area for whale sharks is located in northern WA, offshore of the Pilbara and Kimberley coastline, and broadly follows the 200 m isobath The relevant whale shark BIAs in the EMBA are detailed in **Table 5-3** and is shown on **Figure 5-2**.

DBCA has a wildlife management program to manage whale shark interactions in reserves - *Whale shark management with particular reference to Ningaloo Marine Park, Wildlife Management Program no. 57 (2013).*

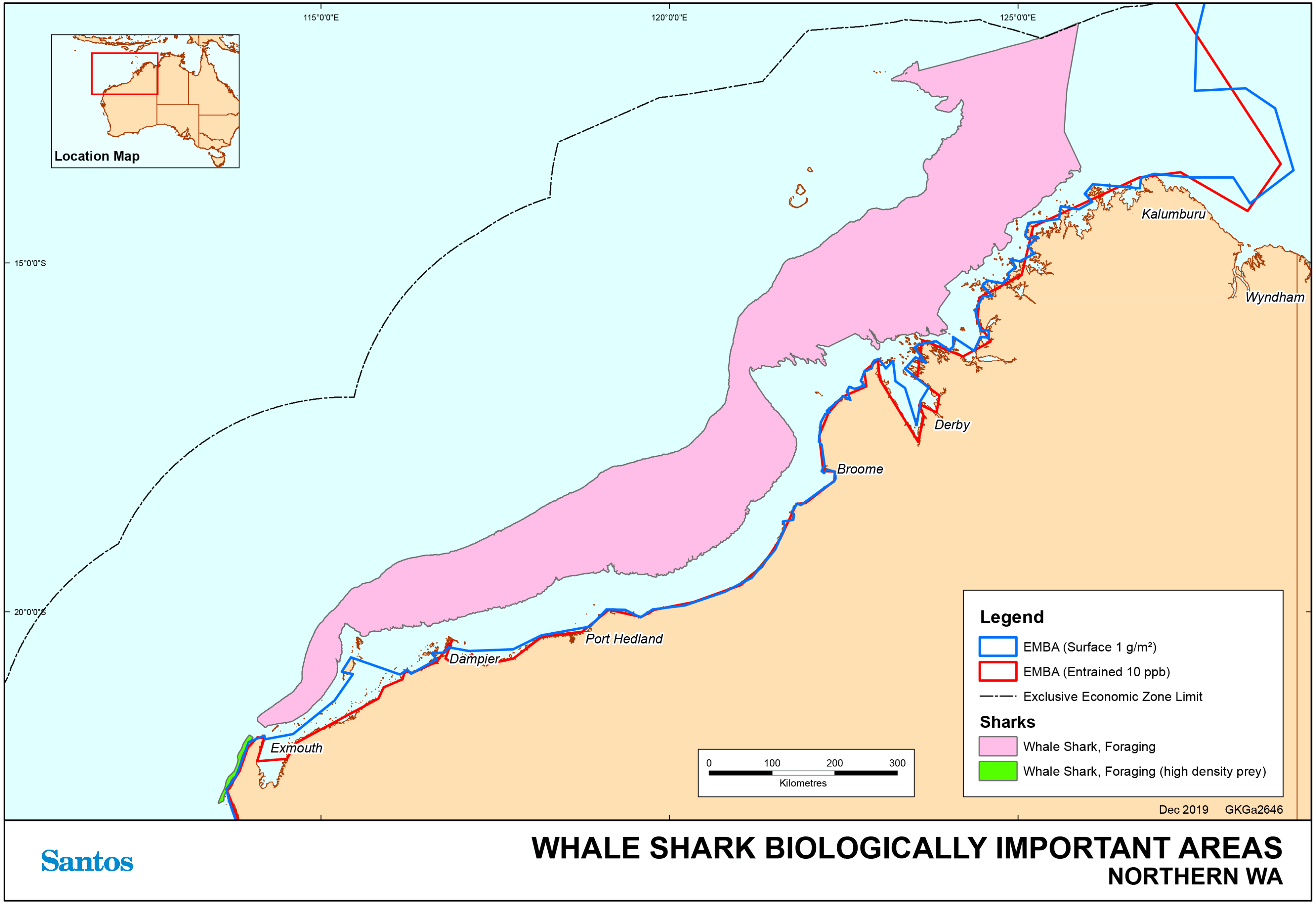


Figure 5-2: Biologically important area – whale shark

5.3.5 Dwarf Sawfish

The dwarf sawfish (*Pristis clavata*) is listed as vulnerable under the EPBC Act and thought to be restricted to Australia (DoE 2014b). It is also listed as a Priority 1 conservation species in WA. The Australian distribution of the dwarf sawfish is considered to extend across northern Australia and along the Kimberley and Pilbara coasts (Last and Stevens 2009, Stevens *et al*. 2005). However, the majority of records of dwarf sawfish in WA have come from shallow estuarine waters of the Kimberley region which are believed to be nursery (pupping) areas, with immature juveniles remaining in these areas up until three years of age (Thorburn *et al*. 2004). Adults are known to seasonally migrate back into inshore waters (Peverell 2007); although it is unclear how far offshore the adults travel as captures in offshore surveys are very uncommon. The species' range is restricted to brackish and salt water (Thorburn *et al*. 2007).

The recovery plan identifies pupping as known to occur in the King Sound, the Cambridge Gulf and 80 Mile Beach, with pupping likely to occur identified at a number of locations along the Pilbara and Kimberly Plan (Commonwealth of Australia, 2015). Under the associated recovery plan all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

The relevant sawfish BIAs in the EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

5.3.6 Freshwater and Green Sawfish

The freshwater sawfish (*Pristis pristis)* and green sawfish (*Pristis zijsron)* are both listed as Vulnerable under the EPBC Act. The freshwater sawfish is listed as a Priority 1 conservation species in WA, while the green sawfish is listed as Vulnerable under the BC Act.

Both species are wider-ranging than the dwarf sawfish and are also found in the Indo-west Pacific (DoE 2014c, DoE 2014d). Important areas for sawfishes include King Sound, and the Fitzroy, Durack, Robinson and Ord rivers for the freshwater sawfish; and Cape Keraudren for the green sawfish (Stevens *et al*. 2008, Thorburn *et al*. 2007, 2008).

Sawfishes generally inhabit inshore coastal, estuarine and riverine environments. The freshwater sawfish has been recorded in north-west Australia from rivers (including isolated water holes), estuaries and marine environments (Stevens *et al*. 2005). Newborns and juveniles primarily occur in the freshwater reaches of rivers and in estuaries, while most adult freshwater sawfish have been recorded in marine and estuarine environments (Peverell 2005, Thorburn *et al*. 2007). It is believed that mature freshwater sawfish enter less saline waters during the wet season to give birth (Peverell 2005) and freshwater river reaches play an important role as nursery areas (DoE 2014c).

The green sawfish has predominantly been recorded in inshore coastal areas, including estuaries and river mouths with a soft substrate, although there have been records of sawfish offshore in depths up to 70 m (Stevens *et al*. 2005). This species does not occupy freshwater habitats (DoE 2014d).

Short-term tracking has shown that green sawfish appear to have limited movements that are tidally influenced, and they are likely to occupy a restricted range of only a few square kilometres within the coastal fringe, with a strong association with mangroves and adjacent mudflats (Stevens et al. 2008). Sawfishes feed close to the benthos on a variety of teleost fishes and benthic invertebrates, including cephalopods, crustaceans and molluscs (Compagno & Last 1999, Last & Stevens 2009, Pogonoski *et al*. 2002, Thorburn *et al*. 2007, 2008).

Baseline surveys undertaken for Chevron's Wheatstone project identified green sawfish habitat and nursery area for juveniles within the north-eastern lagoon of the Ashburton Delta and in Hooley Creek near Onslow. Distribution of sawfish in these creeks is spatially and seasonally variable due to changing tidal and environmental conditions. However, they typically return to inshore waters to breed and pup during the wet season (i.e. January) (Chevron 2011).

The relevant sawfish BIAs in the EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

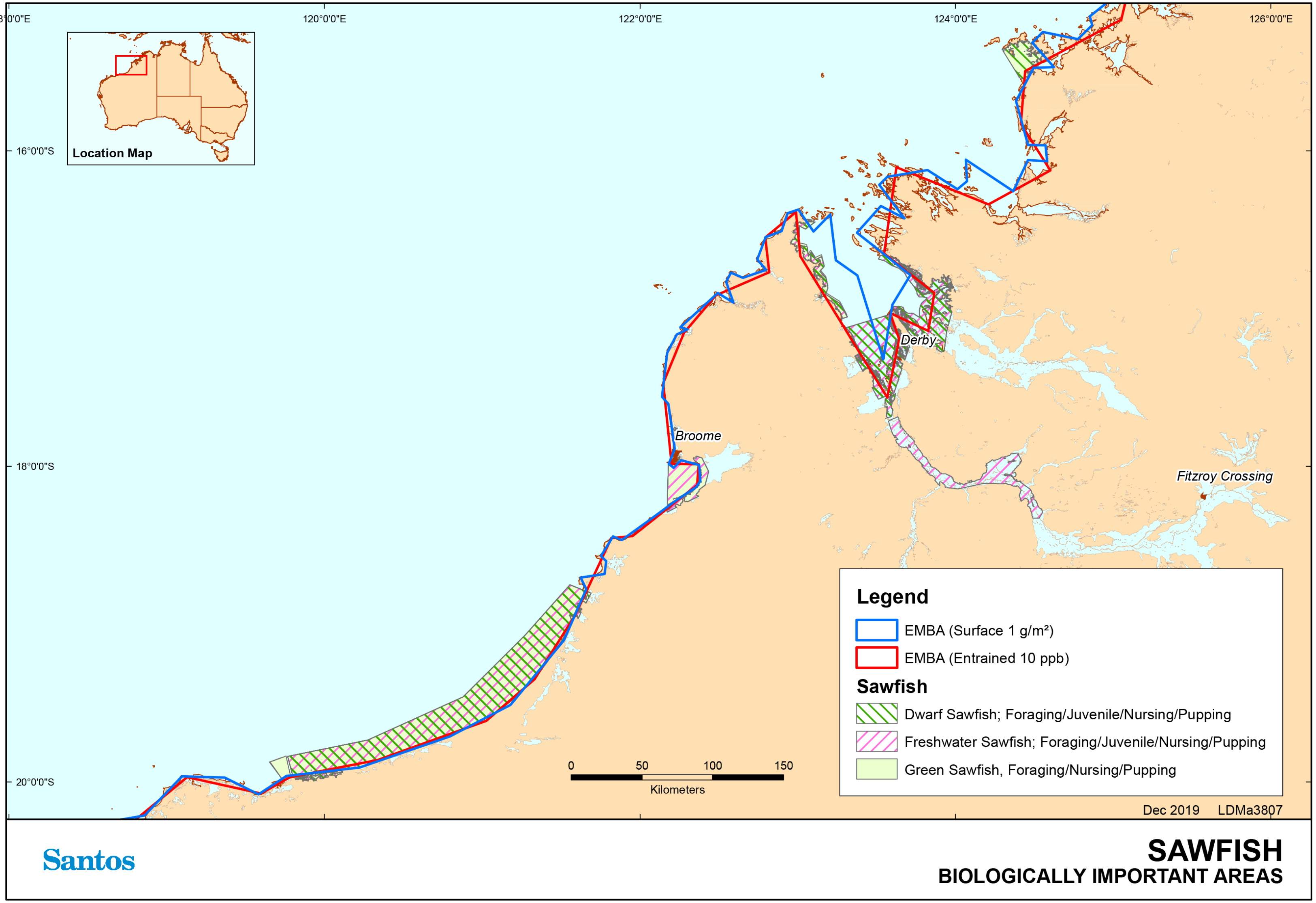


Figure 5-3: Biologically important areas – sawfish

5.3.7 Narrow Sawfish

The narrow sawfish (*Anoxypristis cuspidate*) is listed as Migratory under the EPBC Act. It is a marine or marginal (brackish water) species found from inshore waters to a depth of 40 m (Compagno *et al.* 2006). Though details of its ecology are not precisely known, it probably spends most of its time on or near the bottom in shallow coastal waters and estuaries. A study showed the narrow sawfish to be the most abundant amongst the sawfish sampled in the Gulf of Carpentaria (Peverell, 2005) which holds some consistency with the offshore distribution of the species as shown by a study of Northern Prawn Fishery by-catch. Peverell (2005) also used catch data of offshore surface net fisheries to conclude that narrow sawfish also inhabit the mid-water column and can thus be described as a benthopelagic animal. The narrow sawfish is known to form aggregations of mature females during the months of October to November. Its Australian distribution is unclear though it is most common in the Gulf of Carpentaria with southward ranges extending to Broad Sound in Queensland and the Pilbara Coast (circa 116°E), Western Australia (Last & Stevens 2009).

5.3.8 Giant Manta Ray / Reef Manta Ray

The giant manta ray appears to be a seasonal visitor to coastal or offshore sites. Giant manta rays are often seen aggregating in large numbers to feed, mate, or clean. Sightings of these giant rays are often seasonal or sporadic but in a few locations their presence is a more common occurrence. This species is not regularly encountered in large numbers and, unlike some other rays do not often appear in large schools (>30 individuals) when feeding. Overall, they are encountered with far less frequency than the smaller manta species, despite having a larger distribution across the globe (IUCN 2019).

The giant manta ray occurs in tropical, sub-tropical and temperate waters of the Atlantic, Pacific and Indian Oceans. They are commonly sighted along productive coastlines with regular upwelling, oceanic island groups and particularly offshore pinnacles and seamounts. The giant manta ray is commonly encountered on shallow reefs while being cleaned or is sighted feeding at the surface inshore and offshore. It is also occasionally observed in sandy bottom areas and seagrass beds (IUCN 2019).

The reef manta ray has a circumtropical and sub-tropical distribution, existing in the Pacific, Atlantic and Indian Oceans. Within this broad range, however, actual populations appear to be sparsely distributed and highly fragmented. This is likely due to the specific resource and habitat needs of this species.

Overall population size is unknown, but subpopulations appear, in most cases, to be small (about 100–2,000 individuals). A proportion of the individuals in some populations undertake significant coastal migrations (IUCN 2019). Since the species is migratory it is possible that individuals may be encountered in the operational area, however, given that they generally do not aggregate in large groups, high numbers are not expected to be encountered during the activities.

5.3.9 Shortfin Mako and Longfin Mako Sharks

The shortfin mako and longfin mako sharks are listed as migratory under the EPBC Act. The longfin mako is widely distributed but rarely encountered oceanic shark that ranges from Geraldton around the north coast to at least Port Stephens in New South Wales (DSEWPaC 2012). The shortfin mako is an oceanic and pelagic species, although they are occasionally seen inshore. They are found throughout temperate seas but are rarely found in waters colder than 16°C.

5.3.10 Porbeagle (Mackerel Shark)

The porbeagle (mackerel shark) (*Lamna nasus*) are listed as Migratory under the EPBC Act. The porbeagle is wide-ranging, typically occurring in oceanic waters off the continental shelf, although they occasionally enter coastal waters (Francis *et al*. 2002 cited in DoE 2014e). The porbeagle is known to undertake seasonal migrations, although the timing and details of these migratory movements are not well understood (Saunders *et al.* 2011 cited in DoE 2014e).

5.4 Biologically Important Areas / Critical Habitat – Fish

BIAs are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration. BIAs are identified by DAWE, however, they have no legal status, but are designed to assist decision making under the EPBC Act. They are not designed to identify protected areas, but may inform such processes. **Table 5-3** below provides an overview of BIAs in the EMBA for fish.

The DAWE may make recovery plans for threatened fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, and summary of relevant recovery plans is listed in **Section 13.2**. BIAs may overlap these sites, but may be identified for other purposes. DAWE state that the criteria used to identify 'habitat critical to the survival of the species' are more complex than those used it identify BIA. Specifically, the Sawfish and River Sharks Multispecies Recovery Plan (DoEE 2015) cites that *"all areas where aggregations of individuals have been recorded displaying biologically important behaviour such as breeding, foraging, resting or migrating, are considered critical to the survival of the species unless population survey data suggests otherwise"*.

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Table 5-3: Biologically important areas - fish

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Great white shark	*Carcharodon carcharias*	Foraging – associated with pinniped colonies in the mid-west and south west and waters off Bremer Bay	Waters off pinniped colonies throughout the South-west Marine Region Waters off Bremer Bay
Whale shark	*Rhincodon typus*	Foraging (high density prey) – Ningaloo Reef Foraging – Wider Ningaloo Region	Ningaloo Marine Park and adjacent Commonwealth waters Northward from Ningaloo along 200 m isobath
Dwarf sawfish	*Pristis clavata*	Foraging – Eighty Mile Beach, King Sound, Camden Sound Nursing - Eighty Mile Beach, King Sound, Fitzroy River and May Robinson River Pupping – Eighty Mile Beach, King Sound, Fitzroy River and May Robinson River Juvenile – King Sound, Fitzroy River and May Robinson River	Eighty Mile Beach Camden Sound - eastern shore Fitzroy River Mouth, May and Robinson River - tidal tributaries King Sound (inshore waters)
Freshwater sawfish	*Pristis pristis*	Nursing – King Sound Foraging – King Sound, Roebuck Bay, Eighty Mile Beach Pupping – Roebuck Bay, Eighty Mile Beach Juvenile – Roebuck Bay	Eighty Mile Beach King Sound - tidal tributaries Roebuck Bay
Green sawfish	*Pristis zijsron*	Pupping – Cape Keraudren, Eighty Mile Beach, Roebuck Bay, Willie Creek, Cape Leveque	Eighty Mile Beach Camden Sound Cape Keraudren

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
		Foraging - Cape Keraudren, Roebuck Bay, Cape Leveque, Camden Sound Nursing - Cape Keraudren, Eighty Mile Beach, Ashburton River and Hooley Creek near Onslow	Cape Leveque Roebuck Bay Willie Creek Ashburton River Hooley Creek

6. Marine Reptiles

Thirty-three species of listed marine reptiles under the Commonwealth *EPBC Act 1999* are known to occur in Australian waters in the EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DoEE 2019) showed that some listed reptile species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining reptile species identified in the Protected Matters search (**Appendix A**), eight are listed as threatened and seven are listed as migratory. These species are show in **Table 6-1** along with their WA conservation listing (as applicable)[3]. BIAs within the EMBA area discussed in **Table 6-3**.

Table 6-1: EPBC listed marine reptile species in the EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Green turtle (*Chelonia mydas*)	Vulnerable Migratory	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Flatback turtle (*Natator depressus*)	Vulnerable Migratory	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable Migratory	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Loggerhead turtle (*Caretta caretta*)	Endangered Migratory	Endangered	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered Migratory	Endangered	-	Foraging feeding or related behaviour known to occur within area	Yes – refer to **Table 6-3**
Leatherback turtle (*Dermochelys coriacea*)	Endangered Migratory	Vulnerable	-	Foraging feeding or related behaviour known to occur within area	Yes – refer to **Table 6-3**
Short-nosed seasnake (*Aipysurus apraefrontalis*)	Critically Endangered	Critically Endangered	-	Species or species habitat known to	None - No BIA defined

[3] An overview of WA fauna conservation codes is provided in **Section 5** (fish and sharks).

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
				occur within area	
Leaf-scaled seasnake (*Aipysurus foliosquama*)	Critically Endangered	Critically Endangered	-	Species or species habitat known to occur within area	None - No BIA defined

6.1 Marine Turtles

Six species of marine turtle occur in, use the waters, and nest on sandy beaches in WA. These are the green turtle (*Chelonia mydas*), flatback turtle (*Natator depressus*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), Olive Ridley turtle (*Lepidochelys olivacea)* and leatherback turtle (*Dermochelys coriacea*) (**Table 6-1**).

These six species are listed on the EPBC Act List of Threatened Species as either 'endangered' or 'vulnerable' and all six species are also listed as 'migratory'. They are also listed as threatened species under the BC Act.

A summary of the different habitat types used during the various life stages of marine turtle species identified in the EMBA is given in **Table 6-2.**

Table 6-2: Summary of habitat types for the life stages of the six marine turtle species in the EMBA (DSEWPaC, 2012b)

Life Stage		Green turtle	Flatback turtle	Hawksbill turtle	Loggerhead turtle	Olive ridley turtle	Leatherback turtle
Post-hatchling		Open ocean pelagic habitats (poorly studied for Australian populations)	Coastal waters (poorly studied for Australian populations)	Open ocean pelagic habitats (poorly studied for Australian populations)	Pelagic (poorly studied for Australian populations)	Pelagic (poorly studied for Australian populations)	Pelagic (no data for Australian populations)
Adult	Mating	Offshore from nesting beaches.	Currently unknown for North West Shelf region.	Offshore from nesting beaches.	Little is known for North West Shelf region but expected to occur either en-route or adjacent to nesting beaches.	Not recorded within North West Shelf region.	Not recorded within North West Shelf region.
	Nesting	Typically, high energy, steeply sloped beaches with deep sand and deep water approach.	Typically, low-energy beaches that are narrow with a low to moderate slope. Beach approach obstructed by broad intertidal mud or limestone platforms.	Typically beaches close to nearshore coral reefs and sediment comprised of coarse sand and coral rubble.	Poorly studied for North West Shelf region by generally prefer high energy, relatively narrow, steeply sloped, coarse-grained beaches.	Not recorded within North West Shelf region.	Not recorded within North West Shelf region.
	Internesting	Shallow coastal waters within several kms of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Shallow nearshore waters within 5-60 km of nesting beach. Inter-nesting buffers of 40-60 km identified around all nesting habitats.	Shallow coastal waters within several kilometres of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Shallow coastal waters within several kilometres of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Not recorded within North West Shelf region. Inter-nesting buffers of 20 km identified around all nesting habitats.	Not recorded within North West Shelf region.
	Foraging	Neritic habitats associated with seagrass and algae, and mangrove habitats.	Turbid, shallow inshore waters, subtidal, soft-bottomed habitats of the continental shelf.	Subtidal and intertidal coral and rocky reef habitats of the continental shelf.	Subtidal and intertidal coral and rocky reefs, seagrass and deeper soft-bottomed habitats of the continental shelf.	Many feed within continental shelf waters, however it is not known if others are pelagic, as with the east Pacific population.	Mostly pelagic but will forage close to shore and over continental shelf in temperate waters.

6.1.1 Loggerhead Turtle

The loggerhead turtle (*Caretta caretta*) has a worldwide distribution, living and breeding in subtropical to tropical locations (Limpus 2008b). Breeding aggregations in Australia occur on both the east coast (Queensland and NSW) and the west. The annual nesting population in Western Australia is thought to be 3,000 females annually (Baldwin *et al*. 2003), and this is considered to support the third largest population in the world (Limpus 2008b). Loggerhead turtles have one genetic breeding stock within Western Australia (Commonwealth of Australia 2017a).

The WA distribution of sandy beach nesting areas extends from Shark Bay to the southern area of the North West Shelf, with occasional late summer nesting crawls recorded as far north as Barrow and Varanus Island and the Lowendal and Rosemary Islands (DSEWPaC 2012d). Major nesting locations include the Muiron Islands, the Ningaloo Coast south to Carnarvon and the islands around Shark Bay, which includes Dirk Hartog Island, one of the principal nesting and inter-nesting sites in WA (Limpus 2008). The Recovery Plan for Marine Turtles in Australia (2017) identifies the Muiron Islands (as a principal rookery), and all waters within a 20 km radius as habitat critical to the survival of loggerhead turtles (Commonwealth of Australia 2017a).

Estimates of up to 5,000 female loggerhead turtles have been predicted within the Ningaloo Marine Park and Muiron Islands Marine Management Area (Waayers 2010). Earlier surveys found higher proportions of nesting loggerheads in the southern areas of the reserves (CALM 2005a). Aerial surveys conducted in 2000 and 2001 in the Exmouth region recorded only 12 sightings in Commonwealth waters and these turtles were most likely loggerheads (BHP 2005). In a survey commissioned by Santos WA around the islands in the Exmouth Region, loggerhead turtles were recorded nesting on Flat Island north of the Exmouth Gulf which was the first time they had been recorded in that location (Astron 2014).

Loggerhead nesting and breeding occurs from November to March, with a peak in late December/early January (Limpus 2008b). However, there is variability each year as illustrated in a study by Santos WA (Astron 2014) around the islands in the Exmouth Region where higher numbers of nesting turtles were recorded in October 2013 than in the subsequent January 2014 surveys.

Foraging areas are widespread for loggerhead turtle populations and migrations from nesting to feeding grounds can stretch thousands of kilometres, including feeding grounds as far north as the Java Sea of Indonesia for the WA population (Limpus 2008b). Shark Bay has been identified as an important foraging habitat for loggerhead turtles (Commonwealth of Australia 2017a). Loggerhead turtles are carnivorous and feed primarily on benthic invertebrates from depths of up to approximately 50 m to near shore tidal areas including areas of rocky and coral reef, muddy bays, sand flats, estuaries and seagrass meadows (Limpus 2008b).

Figure 6-1 illustrates the BIAs and habitat critical (draft) for loggerhead turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

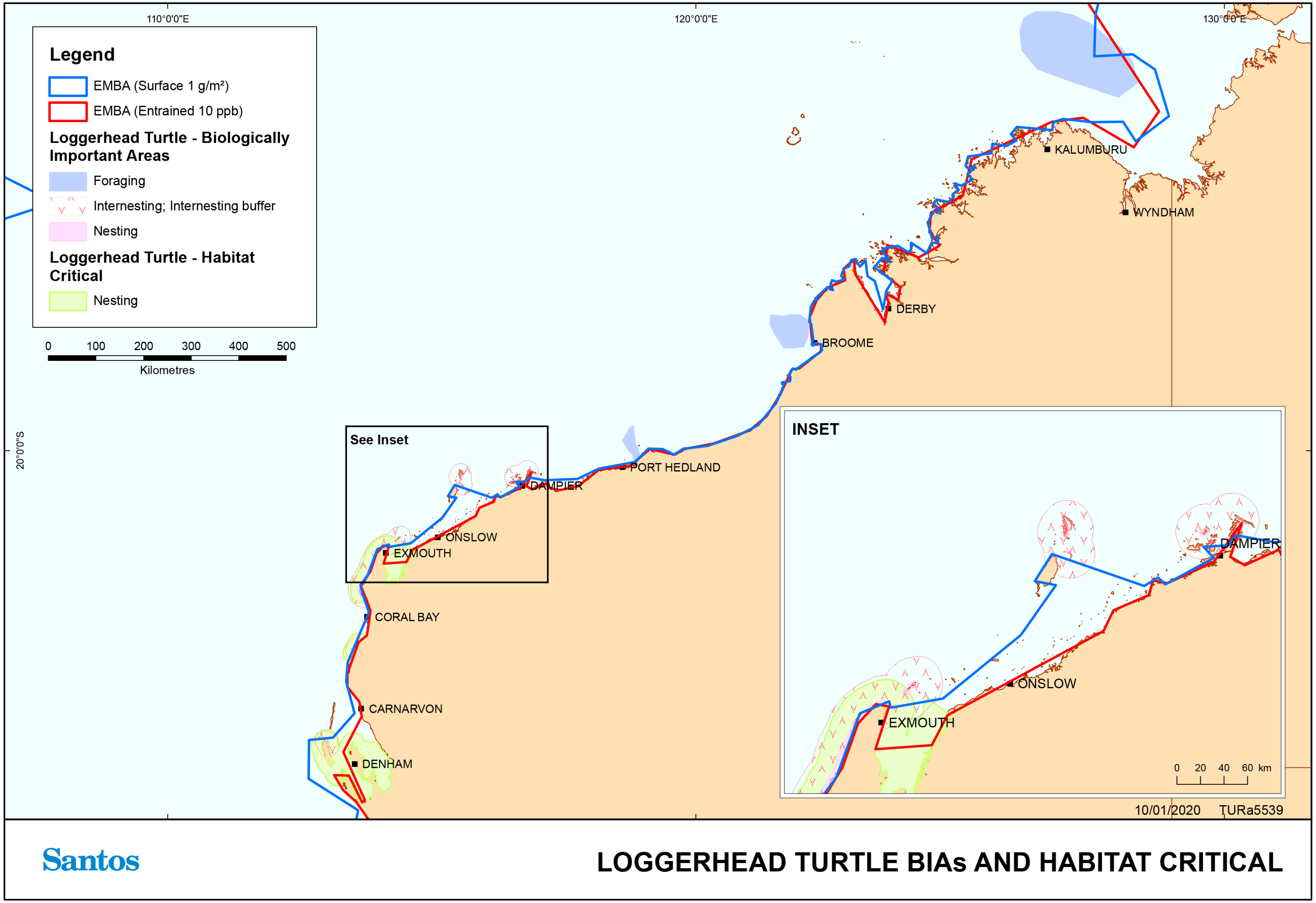


Figure 6-1: Biologically Important Areas and Habitat Critical – Loggerhead Turtle

6.1.2 Green Turtle

Australian population of green turtles is estimated to be approximately 70,000 and is divided into seven genetically distinct breeding aggregations. The species is widespread and abundant in WA waters with an estimated 20,000 individuals occurring, arguably the largest population in the Indian Ocean (Limpus 2008a). There are three distinct breeding stocks in WA waters which include: the North west Shelf stock, the Scott-Browse stock and the Ashmore Stock (Commonwealth of Australia 2017a).

The North west Shelf population is one of the largest in the world and the most significant rookery is the western side of Barrow Island (Prince 1994, Limpus 2008a). Other principal rookeries include the Lacepede Islands, Montebello Islands, Dampier Archipelago, Browse Island and North West Cape (Prince 1994, Limpus 2008a, DSEWPaC 2012b). See **Table 6-3** for a complete list.

Surveys by Waayers (2010) within the Ningaloo Marine Park and Muiron Islands Marine Management Area estimated up to 7,500 female green turtles used these areas. In 2014, Santos WA commissioned a survey of the islands in the Exmouth Region which found that North and South Muiron Islands were significant nesting sites for green turtles with over 100 green turtles nesting overnight on one beach at North Muiron Island (Astron 2014). The green turtle is also known to breed in large numbers in the dunes above the extensive beaches found on Serrurier Island, with counts indicating the island supports the second largest rookery in the Pilbara (Oliver 1990).

Lower density green turtle nesting has also been recorded on Jurabi coast, Thevenard Island, Lowendal Islands and in Exmouth Gulf (Limpus 2008a). Only low numbers of green turtles have been observed nesting on Varanus Island, as well as Airlie Island (Pendoley Environmental 2011). From monitoring undertaken in 2016/17 by Santos WA on Varanus Island; three green turtles were observed to nest over a four week tagging effort (Astron 2017).

Green turtle nesting abundance and timing fluctuates significantly from year to year depending on environmental variables, locality and food availability (Pendoley Environmental 2011). Nesting of green turtles has been recorded from August to March on Serrurier Island (Woodside 2002), from December to March along coast adjacent to Ningaloo (CALM 2005a) and from October to February on Varanus Island (Pendoley Environmental 2011). On Barrow Island, mating aggregations may commence from October with peak nesting from December to January, with hatchlings emerging through summer and early autumn. However, nesting on Barrow Island has been recorded all year round (Chevron 2005 and 2008, Pendoley 2005). Nesting on the Scott Reef-Sandy Islet and Browse Island has been observed all year round with peaks between December and January (Commonwealth of Australia 2017a). The re-nesting period for female green turtles is approximately five years (Hamann *et al*. 2002).

Green turtles spend the first five to ten years of their life drifting on ocean currents, before moving to reside in shallower benthic habitats, including tropical coral and rocky reefs and seagrass beds. Green turtles have been known to migrate more than 2,600 km between feeding and breeding grounds (Limpus 2008a).

Green turtles are omnivores, mainly feeding in shallow benthic habitats on seagrass and/ or algae, but are also known to feed on sponges, jellyfish and mangroves (Limpus 2008a). Green turtles are unlikely to forage or dwell within deeper offshore waters due to the water depths; however, they may occasionally migrate through it.

Figure 6-2 illustrates the BIAs and habitat critical (draft) for green turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

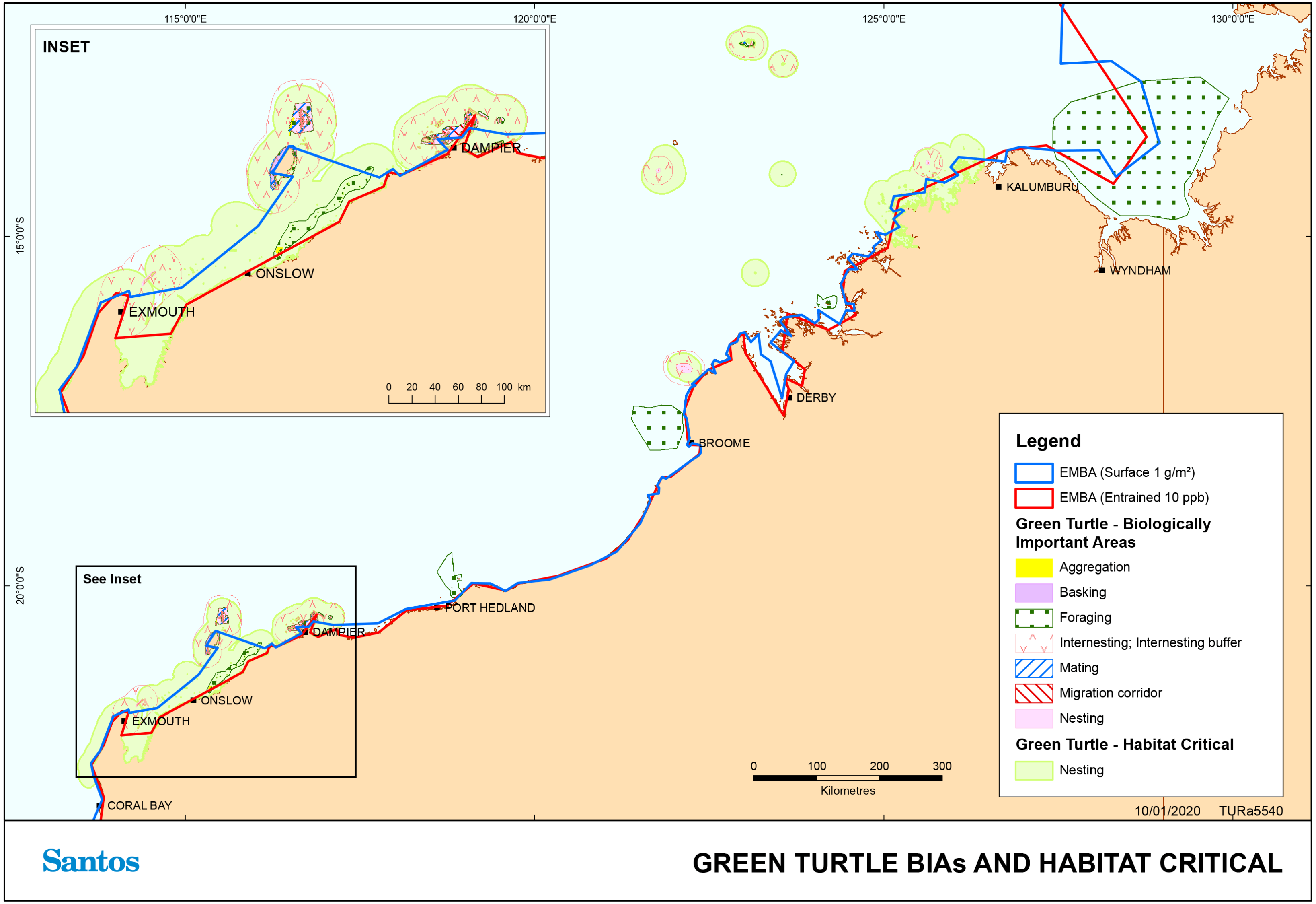


Figure 6-2: Biologically Important Areas and Habitat Critical – Green Turtle

6.1.3 Hawksbill Turtle

Hawksbill turtles (*Eretmochelys imbricata*) have a global distribution throughout tropical and sub-tropical marine waters. The Western Australian stock is concentrated on the North West Shelf (Dampier Archipelago) (Limpus 2009a), and is considered to be one of the largest hawksbill populations remaining in the world. The estimated number of nesting hawksbill turtles in WA waters is between 2,000 and 4,500 individuals (Morris 2004).

In WA, their nesting range is relatively small and extends from the Muiron Islands to the Dampier Archipelago, a distance of approximately 400 km. The most significant breeding areas, that support hundreds of nesting females annually, are around sandy beaches within the Dampier Archipelago, Montebello Islands, Lowendal Islands and Barrow Island (Pendoley 2005, Limpus, 2009a).

The largest known nesting area for the North West Shelf population is the sandy shoreline of Rosemary Island, within the Dampier Archipelago, particularly on the north-western side of the Island. It is believed that the Rosemary Island rookery may support up to 1,000 nesting females annually (Limpus 2009). Low density nesting is also known from Barrow Island, Airlie Island, Muiron Islands and North West Cape/ Ningaloo coast (Cape Range) (Limpus 2009a). Nesting hawksbills have also been found on NE Regnard Island and SW Regnard Island, confirming the Regnard Islands as hawksbill rookeries (Pendoley Environmental 2009).

The hawksbill turtle nesting population within the Exmouth region is also considered important as the populations in Western Australia represent the largest remaining population in the Indian Ocean (CALM 2005). The best estimate of numbers within the Ningaloo Marine Park and Muiron Islands Marine Management Area is between 20–700 individuals (Waayers 2010).

A snapshot survey of Varanus Island and the Lowendal Islands conducted for Santos WA during October 2012 found the five most frequented beaches by hawksbills, based on the track counts, were Beacon Island *(n*=43), Parakeelya (*n*=41), Kaia (*n*=40), Rose (*n*=30) and Pipeline (*n*=28). Results of the October 2012 three-day track census program showed that Beacon Island also hosted the highest daily number of overnight emergences by hawksbills and is therefore an important nesting beach for hawksbill turtles (Pendoley Environmental 2013).

On Varanus Island, hawksbill turtle nesting activity is predominantly distributed on the island’s east coast, including Pipeline, Harriet, and Andersons beaches (Pendoley Environmental 2019). Individual hawksbill turtles appear to show a strong fidelity to these beaches, often returning to the same beach to nest within the season (Pendoley Environmental 2019). Between 1986 and 2019, a total of 571 individual hawksbill turtles were tagged on Varanus Island.

Nesting is reported to occur between October and February in WA (Commonwealth of Australia 2017a). Hawksbill turtles have been observed breeding on the North West Shelf between July and March with peak nesting activity around the Lowendal Islands between October and December (Limpus 2009a).

Female hawksbills skip annual breeding opportunities (Kendall & Bjorkland 2001), presumably due to high energy demands of breeding (Chaloupka & Prince 2012).

Individuals may migrate up to 2,400 km between their nesting and foraging grounds (DSWEPaC 2012a). Satellite tracking of nesting turtles on Varanus Island (32 km) and Rosemary Island has shown adult turtles to feed between 50 and 450 km from their nesting beaches (DSWEPaC 2012a).

Adults tend to forage in tropical tidal and sub-tidal coral and rocky reef habitat where they feed on an omnivorous diet of sponges, algae, jelly fish and cephalopods (DSWEPaC 2012a). Hawksbill turtles are unlikely to spend significant time within offshore waters as it is too deep to act as a feeding ground. However, it is likely they may migrate through those areas.

Figure 6-3 illustrates the BIAs and habitat critical (draft) for hawksbill and olive ridley turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

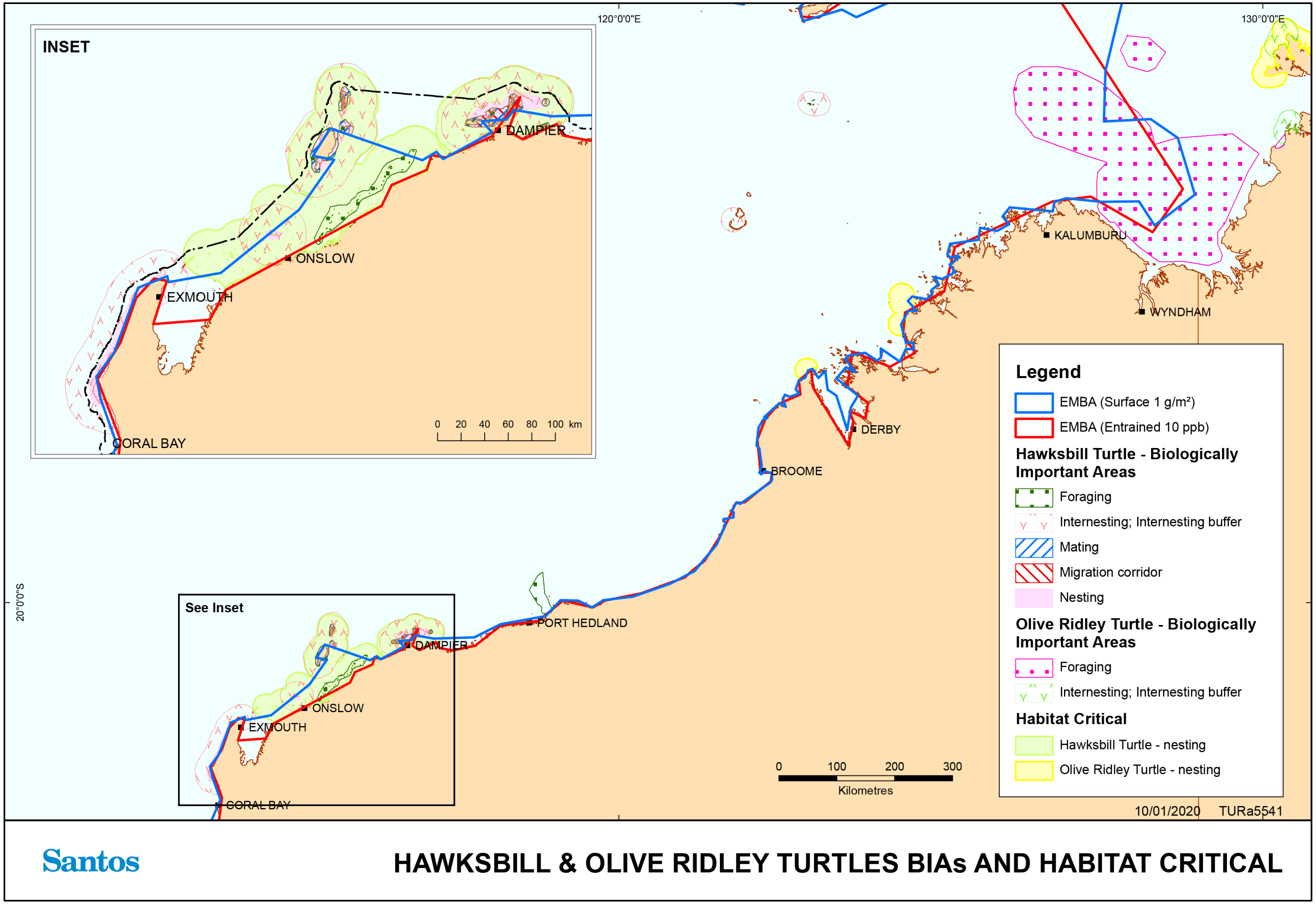


Figure 6-3: Biologically Important Areas and Habitat Critical – Hawksbill and Olive Ridley Turtle

6.1.4 Flatback Turtle

The flatback turtle (*Natator depressus*) has an Australasian distribution, with all recorded nesting beaches occurring within tropical to sub-tropical Australian waters. One third of the total breeding for the species occurs in Western Australia (WA) (Limpus, 2007). The management of the flatback turtle in Australia is broken up into five stocks currently described around Australia; eastern Queensland, Arafura Sea, Cape Domett, South-west Kimberley and Pilbara stocks (Commonwealth of Australia 2017).. The Pilbara stock nests throughout the North West Shelf and is characterised by summer nesting (October to March), and the northern stock at Cape Domett which breeds mainly in winter (July to September) (Commonwealth of Australia 2017a). The South-west Kimberley stock is also characterised by summer nesting.

The southern WA nesting population of flatback turtles occurs from Exmouth to the Lacepede Islands off the Kimberley coast (DSEWPaC 2012c). On the North West Shelf, significant rookeries are centred on Barrow Island especially the east coast beaches (DSEWPaC 2012b).

Montebello Islands, Thevenard Island, Varanus Island, the Lowendal Islands, King Sound and Dampier Archipelago are also significant rookeries (Pendoley 2005, Limpus 2007, Pendoley Environmental 2011). Nesting is also widespread along the mainland beaches from Mundabullangana on the Pilbara coast north, including Cemetery Beach near Port Hedland, Eighty Mile Beach and to Broome (Limpus 2007, DSEWPaC 2012b).

Long term monitoring of flatback turtles nesting in the Port Hedland area, specifically at Cemetery Beach and Pretty Pool Beach, was undertaken between 2004 and 2014. Monitoring results indicated the main nesting season of flatback turtles in the area was between mid-October and January, which is consistent with other rookeries in the Pilbara region including Barrow Island, Mundabullangana, Karratha and Onslow (Waayers and Stubbs 2016). The onset of the nesting season appears to be relatively consistent each year and is thought to be associated with the southern movement of warmer sea surface temperatures along the northern WA coast.

There have been occasional records of nesting by flatback turtles on the Jurabi Coast and Muiron Islands (CALM 2005). During turtle surveys for Santos, WA flatback turtle nesting was recorded on Bessieres Islands (Astron 2014), Serrurier, Flat, Table and Round Island in previous surveys (Pendoley Environmental 2009). Flatback turtle tracks have been seen on Forty Mile beach and evidence of flatback nesting was recorded on the same beach the next day (Pendoley Environmental 2009).Previously the status of the flatback population(s) was undetermined and although not well quantified, it was estimated to be many thousands of females (Limpus 2007). However, Pendoley *et al.* (2014) reported both Barrow Island and Mundabullangana flatback turtles as substantial reproductive populations with 4,000 and 3,500 turtles tagged at each location between 2006/2006 and 2010/2011. Cemetery beach at Port Hedland had approximately 350 turtles were tagged over two seasons of monitoring (2009/2010 and 2011/12).

Satellite tracking of adult (female) flatback turtles shows they use a variety of inshore and offshore marine areas off the east and west coasts of Barrow Island. Females inter-nest close to their nesting beaches, typically in 0–10 m of water (Chevron 2008). However, flatback turtles also travel approximately 70 km and inter-nest in shallow nearshore water off the adjacent mainland coast, before returning to Barrow Island to lay another clutch of eggs. The average inter-nesting period is 13–16 days.

From long-term tagging studies on Varanus Island and Pendoley's observations, it appears that the nesting season for flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March. Flatbacks have been observed to nest on Varanus Island between November and February (Chevron 2008, Pendoley Environmental 2011 & 2013). Population monitoring of flatback turtles on Varanus Island, calculated from 16 seasons, indicates a mean population estimate of 226 (+/- 97). Modelled Flatback turtle populations have shown a slight decline from 2008/09 to 2016/17, which is considered to be part of fluctuations in the natural cycle (Astron 2017). Flatback turtles tend to nest on all beaches on Varanus Island (Astron 2017). Flatback hatching and emergence success is noted as higher compared to that reported for other Western Australian rookeries (Pendoley et al. 2014; cited Astron 2017).

Santos

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).

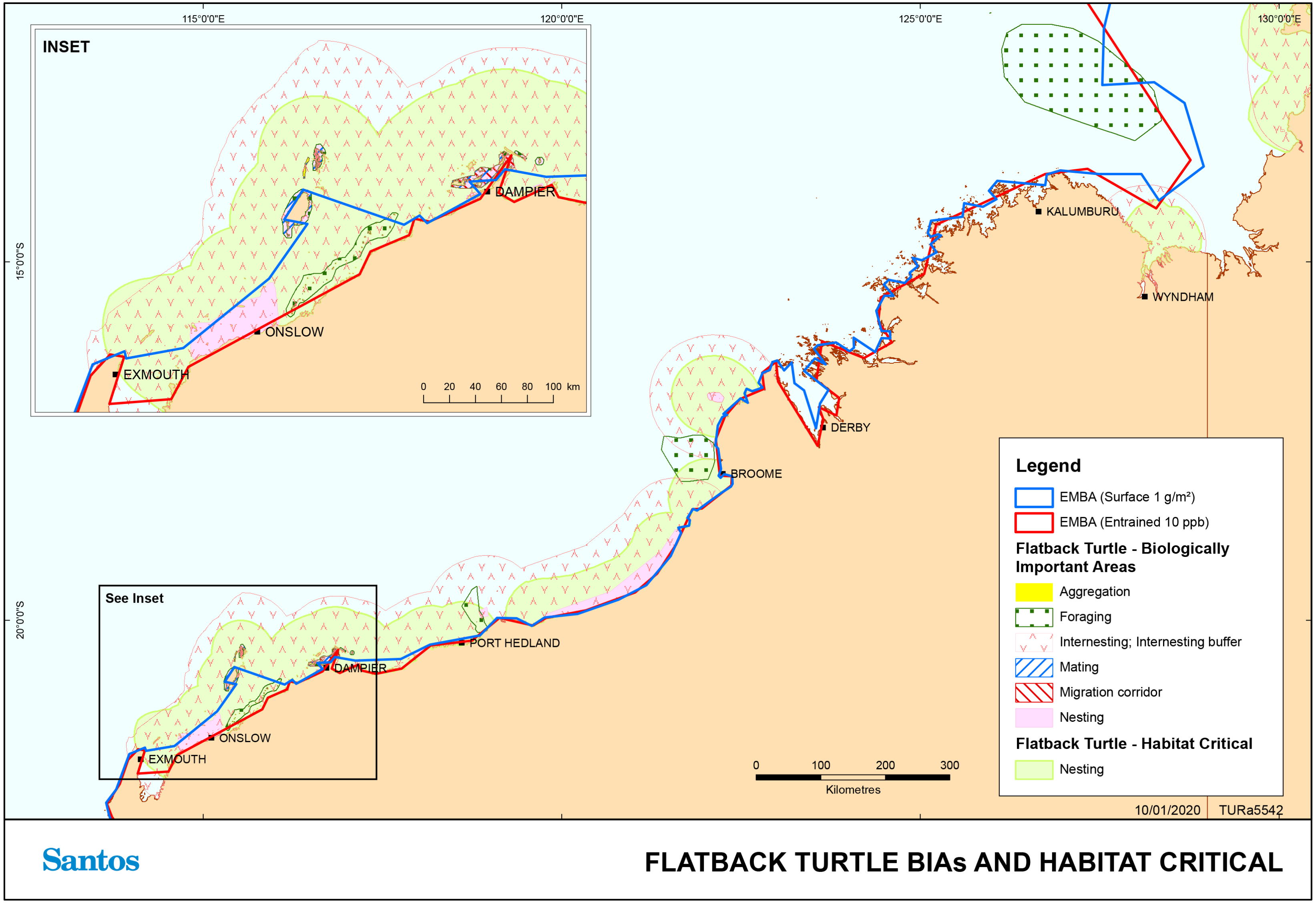


Figure 6-4: Biologically Important Areas and Habitat Critical – Flatback Turtle

6.1.5 Leatherback Turtle

The leatherback turtle *(Dermochelys coriacea)* has the widest distribution of any marine turtle, and can be found from tropical to temperate waters throughout the world (Márquez 1990). There are no major leatherback turtle centres of nesting activity that have been recorded in Australia, although scattered isolated nesting (one to three nests per annum) occurs in southern Queensland and the Northern Territory (Limpus and McLachlin 1994).

There have been several records of leatherback turtles off the coast of WA, but no confirmed nesting sites (Limpus 2009c). Turtle observations have mainly occurred south of the North West Shelf area and in open waters (>200 m deep) (Limpus 2009c). Due to the lack of nesting sites around Australian coastal waters, it is presumed that Leatherback turtles observed in Australian waters are migrating from neighbouring countries to utilise feeding grounds in Australia (Limpus 2009c).

The leatherback turtle will feed at all levels of the water column and is carnivorous feeding mainly on pelagic, soft-bodied marine organisms such as jellyfish, which occur in greatest concentrations in areas of upwelling or convergence (DSEWPaC 2012d). The leatherback turtle is a highly pelagic species with adults only going ashore to breed.

No leatherback turtle BIAs or habitat critical (draft) are found within the EMBA.

6.1.6 Olive Ridley Turtles

Olive ridley turtles (*Lepidochelys olivacea*) are the least common turtle species encountered with habitat critical nesting occurring near Vulcan Island, Darcy Island, Prior Point and Llanggi and Cape Leveque (Commonwealth of Australia 2017). This species forages within the shallow benthic habitats of northern Western Australia and is thought to feed primarily on gastropods and small crabs within the benthic, soft-bottomed communities of the continental shelf (Limpus 2009). Olive Ridley turtles forage as far south as the Dampier Archipelago-Montebello Islands.

BIAs for this endangered species are known to occur in the vicinity of Joseph Bonaparte Depression (DSEWPaC 2012b, Commonwealth of Australia 2017a). See **Figure 6-3** for identified olive ridley turtle BIAs and critical habitats (draft) within the EMBA (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

6.2 Seasnakes

Storr *et al*. (1986) estimate nine genera and 22 species of sea snakes occur in WA waters, with 25 listed marine seasnake species being recorded in the search area **Appendix A**. Little is known of the distribution of individual species, population sizes or aspects of their ecology. Sea snakes are essentially tropical in distribution, and habitats reflect influences of factors such as water depth, nature of seabed, turbidity and season (Heatwole and Cogger 1993). Seasnakes are widespread throughout waters of the North West Shelf in offshore and nearshore habitats. They can be highly mobile and cover large distances or they may be restricted to relatively shallow waters and some species must return to land to eat and rest. In the north-west region of Western Australia, no BIAs have been designated for seasnakes. However, both Ashmore Reef and Cartier Island are characterised for both a high density and high diversity of seasnakes (DSEWPaC 2012b).

Two species of seasnakes listed as threatened under the EPBC Act were identified in the Protected Matters search within the EMBA (**Appendix A**):

+ Short-nosed seasnake (*Aipysurus apraefrontalis*); and
+ Leaf-scaled seasnake (*Aipysurus foliosquama*).

6.2.1 Short-nosed Seasnake

The short-nosed seasnake (*Aipysurus apraefrontalis*) is listed as critically endangered under the EPBC Act and the BC Act. It is a fully aquatic, small snake and is endemic to WA. It has been recorded from Exmouth Gulf, WA to the reefs of the Sahul Shelf, in the eastern Indian Ocean. This species is believed to show strong site fidelity to shallow coral reef habitats in less than 10 m of water, with most specimens having been collected from Ashmore and Hibernia reefs (Minton & Heatwole 1975, Guinea and Whiting 2005).

The species prefers the reef flats or shallow waters along the outer reef edge in water depths to 10 m (McCosker 1975, Cogger 2000). The species has been observed during daylight hours, resting beneath small coral overhangs or coral heads in 1–2 m of water (McCosker 1975). Guinea and Whiting (2005) reported that very few short-nosed seasnakes moved even as far as 50 m away from the reef flat and are therefore unlikely to be expected in high numbers in offshore, deeper waters.

6.2.2 Leaf-scaled Seasnake

The leaf-scaled seasnake *(Aipysurus foliosquama)* is listed as critically endangered under the EPBC Act and the BC Act. It occurs in shallow water (less than 10 m in depth), in the protected parts of the reef flat, adjacent to living coral and on coral substrates (DoE 2014). The species is found only on the reefs of the Sahul Shelf in WA, especially on Ashmore and Hibernia Reefs (Minton and Heatwole 1975). The leaf-scaled seasnake forages by searching in fish burrows on the reef flat (DoE 2014).

6.3 Crocodiles

The salt-water crocodile (*Crocodylus porosus*) is a migratory species under the EPBC Act and is also listed as a specially protected species (Other specially protected fauna) under the BC Act. In WA, the species is found in most major river systems of the Kimberley, including the Ord, Patrick, Forrest, Durack, King, Pentecost, Prince Regent, Lawley, Mitchell, Hunter, Roe and Glenelg Rivers. The largest populations occur in the rivers draining into the Cambridge Gulf and the Prince Regent River and Roe River systems. There have also been isolated records in rivers of the Pilbara region, around Derby near Broome and as far south as Carnarvon on the mid-west coast (DEC 2009a).

6.4 Biologically Important Areas/Habitat Critical – Marine Reptiles

Table 6-3 provides an overview of BIAs in the EMBA for marine reptiles, as identified by the DAWE (Commonwealth) and critical habitats identified in associated recovery plans. The DAWE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[4].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of habitat critical - habitat 'critical to the survival of the threatened species. To date no habitat critical in WA has been listed under either Act.

[4] Further background information on BIA and identification of critical habitat in recovery plans is provided in **Section 5.4**.

Table 6-3: Biologically important areas/critical habitats and geographic locations - reptiles

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
Loggerhead turtle	*Caretta caretta*	Nesting, migration, foraging and internesting – Islands and coastline of the Kimberley region and islands of the North West Shelf, Ningaloo coast and Jurabi coast	Cohen Island De Grey River to Bedout Island Dirk Hartog Island Gnarloo Bay James Price Point Lowendal Island Montebello Island Muiron Island Ningaloo Coast and Jurabi coast Rosemary Island Western Joseph Bonaparte Depression	Exmouth and Ningaloo coast Gnaraloo Bay and beaches Shark bay, all coastal and island beaches out the to the northern tip of Dirk Hartog Island
Green turtle	*Chelonia mydas*	Nesting, migration foraging, aggregation, mating, basking and internesting – Offshore islands in the Browse Basin, North West Shelf and Kimberley/Pilbara coastlines Mating/nesting – Dampier Archipelago Basking – Middle Island	Ashmore Reef Barrow Island Browse Island Cartier Island Cassini Island Coral reef habitat west of the Montebello group. Extends the entire length of Montebellos Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Island Delambre Island Dixon Island Greens - inshore tidal and shallow subtidal areas around Barrow Island Hawksbills - shallow water coral reef and artificial reef (pipeline) habitat James Price Point Joseph Bonaparte Gulf Lacepede Island Legendre Island, Huay Island Middle Is. West Coast Barrow Island West Coast and North Coast Montebello Island - Hermite Island, NW Island, Trimouille Island Montebello Islands Montgomery Reef	Mainland east of Mary island to mainland adjacent to Murrara Island including all offshore islands Ashmore Reef and Cartier Reef Browse Island Scott Reef Adele Island Lacepede Island Dampier Archipelago Barrrow Island Montebello Islands Serrier Island and Thevenard Island Exmouth Gulf and Ningaloo Coast

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
			North and South Muiron Island North Turtle Island North West Cape Scott Reef Scott Reef - Sandy Islet Seringapatam Reef String of islands between Cape Preston and Onslow, inshore of Barrow Is	
Hawksbill turtle	*Eretmochelys imbricata*	Nesting, migration, mating, foraging and internesting – Offshore islands in the Browse Basin, North West Shelf and Kimberley/Pilbara coastlines Mating/nesting/internesting – Lowendal group, Montebello Islands	Ah chong and South East Island Ashmore Reef Barrow Island Cartier Island Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Is Delambre Island Delambre Island (and other Dampier Archipelago Islands) Dixon Island Greens - inshore tidal and shallow subtidal areas around Barrow Island Hawksbills - shallow water coral reef and artificial reef (pipeline) habitat Lowendal Island Group Montebello Island - Hermite Island, NW Island, Trimouille Island Montebello Island, Trimoulle and NW islands Ningaloo coast and Jurabi coast Rosemary Island Scott Reef String of islands between Cape Preston and Onslow, inshore of Barrow Island Thevenard Island Varanus Island	Cape Preston to mouth of Exmouth Gulf (including Montebello Islands and Lowendal Islands) Dampier Archipelago (including Delambre Island and Rosemary Island)
Flatback turtle	*Natator depressus*	Nesting, migration, mating, aggregation, foraging, internesting – Islands of the North West Shelf and the Pilbara/Kimberley coastlines	Eighty Mile beach Barrow Island Cape Domett Cape Thouin/ Mundabullangana/Cowrie Beach	Cape Domett and Lacrosse Island Lacepede Islands Eighty Mile beach Cemetary beach Eco Beach

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
		Mating, nesting – Barrow Island	Coral reef habitat west of the montebello group. Extends the entire length of Montebellos Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Is Delambre Island Dixon Island Holothuria Zone (Northern Kimberley, Holothuria Banks) Intercourse Island James Price Point Lacepede Island Legendre Island, Huay Is Montebello Island - Hermite Island, NW Island, Trimouille Island North Turtle Island Port Hedland, Cemetery Beach Port Hedland, Paradise Beach Port Hedland, Pretty Pool String of islands between Cape Preston and Onslow, inshore of Barrow Is The main nesting beach at Cape Domett is a 1.9-km-long north-west-facing sandy beach on the east of the Cambridge Gulf, East Kimberley, Western Australia (14 48.10S, 128 24.50E), located approximately 80 km north-north-east of the nearest town, Wyndham. Thevenard Island - South coast West of Cape Lambert Western Joseph Bonaparte Depression	Mundabullangana Beach Dampier Archipelago Barrow Island, Montebello Island, coastal islands from Cape Preston to Locker Island
Leatherback turtle	*Dermochelys coriacea*	None within EMBA	None within EMBA	None within EMBA
Olive ridley turtle	*Lepidochelys olivacea*	Foraging, migration – Joseph Bonaparte Gulf – Kimberley region	Western Joseph Bonaparte Depression	Cape Leveque Prior Point and Llanggi Darcy Island Vulcan Island

7. Marine Mammals

Forty-four species of listed marine mammals are known to occur in Australian waters in the EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DoEE 2019a) showed that some listed mammal species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining listed species, five are listed as threatened and migratory, one is listed as threatened and ten are listed as migratory under the Commonwealth EPBC Act (BIAs for marine mammals are discussed in **Table 7-3**). These species are shown in **Table 7-1** along with their conservation listing under the WA BC Act (as applicable).

The section below gives further details on marine mammal species listed as threatened and migratory and a summary is presented in **Table 7-2**. Identified BIAs are presented in **Table 7-3**.

Table 7-1: Marine mammals listed as threatened or migratory under the EPBC Act

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Other WA Conservation Code		
Sei whale *(Balaenoptera borealis)*	Vulnerable Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Blue whale (*Balaenoptera musculus*)	Endangered Migratory	Endangered	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 7-3**
Fin whale (*Balaenoptera physalus*)	Vulnerable Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Southern right whale (*Eubalaena australis*)	Endangered Migratory	Vulnerable	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Humpback whale (*Megaptera novaeangliae*)	Vulnerable Migratory	Specially Protected (special conservation interest)	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Sperm whale (*Physeter macrocephalus*)	Migratory	Vulnerable	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 7-3**
Antarctic minke whale *(Balaenoptera bonaerensis)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Bryde's whale (*Balaenoptera edeni*)	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Pygmy right whale (*Caperea marginate*)	Migratory	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Other WA Conservation Code		
Killer whale (*Orcinus orca)*	Migratory	-	-	Species or species habitat may occur within area	None - No BIA defined
Indo-Pacific humpback dolphin (*Sousa chinensis)*	Migratory	-	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Spotted bottlenose dolphin (Arafura/ Timor Sea Populations) *(Tursiops aduncus)*	Migratory	-	-	Species or species habitat likely to occur within area	Yes – Refer to **Table 7-3**
Irrawaddy dolphin (Australian snubfin dolphin) *(Orcaella heinsohni)*	Migratory	-	P4	Species or species habitat known to occur within area	Yes – Refer to **Table 7-3**
Dusky dolphin (*Lagenorhynchus obscurus)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Australian sea lion (*Neophoca cinérea)*	Vulnerable	Vulnerable	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Dugong (*Dugong dugon)*	Migratory	Specially protected (species otherwise in need of special protection)	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**

In addition, the New Zealand fur-seal *(Arctocephalus forsteri)*, has been identified as a species of relevance to the EMBA. The New-Zealand fur seal is listed as a protected species under WA BC Act, but not listed as threatened under the EPBC Act.

7.1 Threatened and Migratory Species

7.1.1 Sei Whale

Sei whales have a worldwide, oceanic distribution, ranging from polar to tropical waters. Sei whales tend to be found further offshore than other species of large whales (Bannister *et al*. 1996).

Sei whales move between Australian waters and Antarctic feeding areas however they are only infrequently recorded in Australian waters (Bannister *et al*. 1996) and their movements and distribution in Australian waters is not well known (DoEE 2019a). There are no known mating or calving areas in Australian waters (Parker 1978 in DoEE 2019a). The National Conservation Values Atlas currently record no BIAs for this species (DoEE 2019b). Surveys of the Bonney Upwelling (outside of the EMBA) between 2000 and 2003 recorded sightings of sei whales feeding during summer and autumn, indicating that this is potentially an important feeding ground (DoEE 2019b).

7.1.2 Blue Whale

Two sub-species of blue whale are recorded in Australian waters; the southern (or true) blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*Balaenoptera musculus brevicauda*). Southern blue whales are believed to occur in waters south of 60°S and pygmy blue whales occur in waters north of 55°S (i.e. not in the Antarctic) (DEWHA 2008a). By this definition all blue whales in waters from Busselton to the NT border are assumed to be pygmy blue whales, and are discussed below.

Pygmy blue whales have a southern hemisphere distribution, migrating from tropical water breeding grounds in winter to temperate and polar water feeding grounds in summer (Bannister *et al*. 1996, Double *et al*. 2014). The WA migration path takes pygmy blue whales down the WA coast to coastal upwelling areas along southern Australia (Gill 2002) and south at least as far as the Antarctic convergence zone (Gedamke *et al*. 2007).

Tagging surveys have shown pygmy blue whales migrating northward relatively near to the Australian coastline (100 km) until reaching North West Cape after which they travelled offshore (240 km) to Indonesia. Passive acoustic data documented pygmy blue whales migrating along the Western Australian shelf break (Woodside 2012). Tagging data collected by Gales *et al.* (2010) has provided the first definitive link between the blue whales that feed off the Perth Canyon and those that occur around Indonesia. This is movement is concordant with the proposed ‘Tasmania to Indonesia’ population described by Branch *et al.* (2007).

The northern migration passes the Perth Canyon from January to May and north bound animals have been detected off Exmouth and the Montebello Islands between April and August (Double *et al*. 2012a, McCauley & Jenner 2010). During the southern migration, pygmy blue whales pass south of the Montebello Islands and Exmouth from October to the end of January, peaking in late November to early December (Double *et al*. 2012b). Generally, they appear to travel as individuals or in small groups based on acoustic data. For example, analysis of pygmy blue whale calls from noise loggers deployed around Scott Reef (2006 to 2009) for the Woodside Browse project showed that 78% of the calls were from lone whales, 18% were from two whales and 4% were from three or more whales (McCauley 2011; Woodside 2014).

Pygmy blue whales appear to feed regularly along their migration route (i.e. at least once per week or more frequently) and are likely to have multiple food caches along their migratory route (e.g. Rowley Shoals and Ningaloo Reef) (ConocoPhillips 2018).

Recognised feeding areas of significance to this species, located within the EMBA include Ningaloo Reef and Perth Canyon (DEWHA 2010a). The Ningaloo Reef area has the capacity to offer feeding opportunities to pygmy blue whales through unique biophysical conditions able to support large biomasses of marine species (Double *et al*. 2014). Surface lunge feeding of pygmy blue whales has been observed at North West Cape and Ningaloo Reef in June (C. Jenner & M-N Jenner, unpublished data, 2001 in Double *et al*. 2014). A biologically important foraging area encompasses Seringapatam Reef, Scott Reef and the open waters to the west of these features (DoE 2015a; DoEE 2019c. These steep gradient features tend to stimulate upwelling and, therefore increased productivity (seasonally variable) (ConocoPhillips 2018). Hence, they provide a favourable foraging area.

Breeding areas have not yet been identified, however, it is likely that pygmy blue whales calve in tropical areas of high localised production such as deep offshore waters of the Banda and Molucca Seas in Indonesia (Double *et al*. 2014, DoEE 2019b). There are no known breeding areas of significance to blue whales in waters from Busselton to the Northern Territory border.

The BIAs for blue whale and pygmy blue whale are detailed in **Table 7-3** and depicted in **Figure 7-1** and **Figure 7-2.**

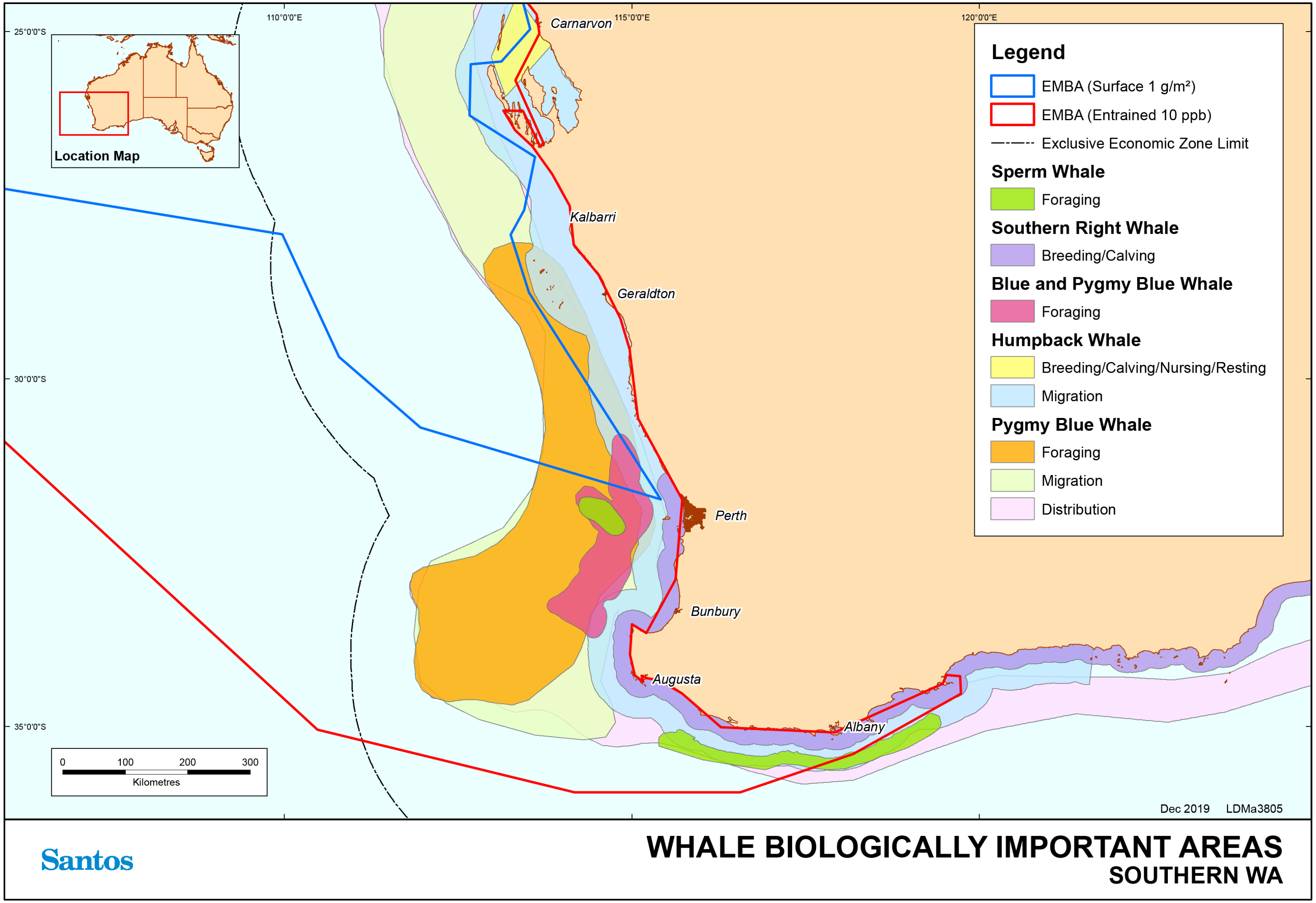


Figure 7-1: Biologically important areas – whales – Southern WA

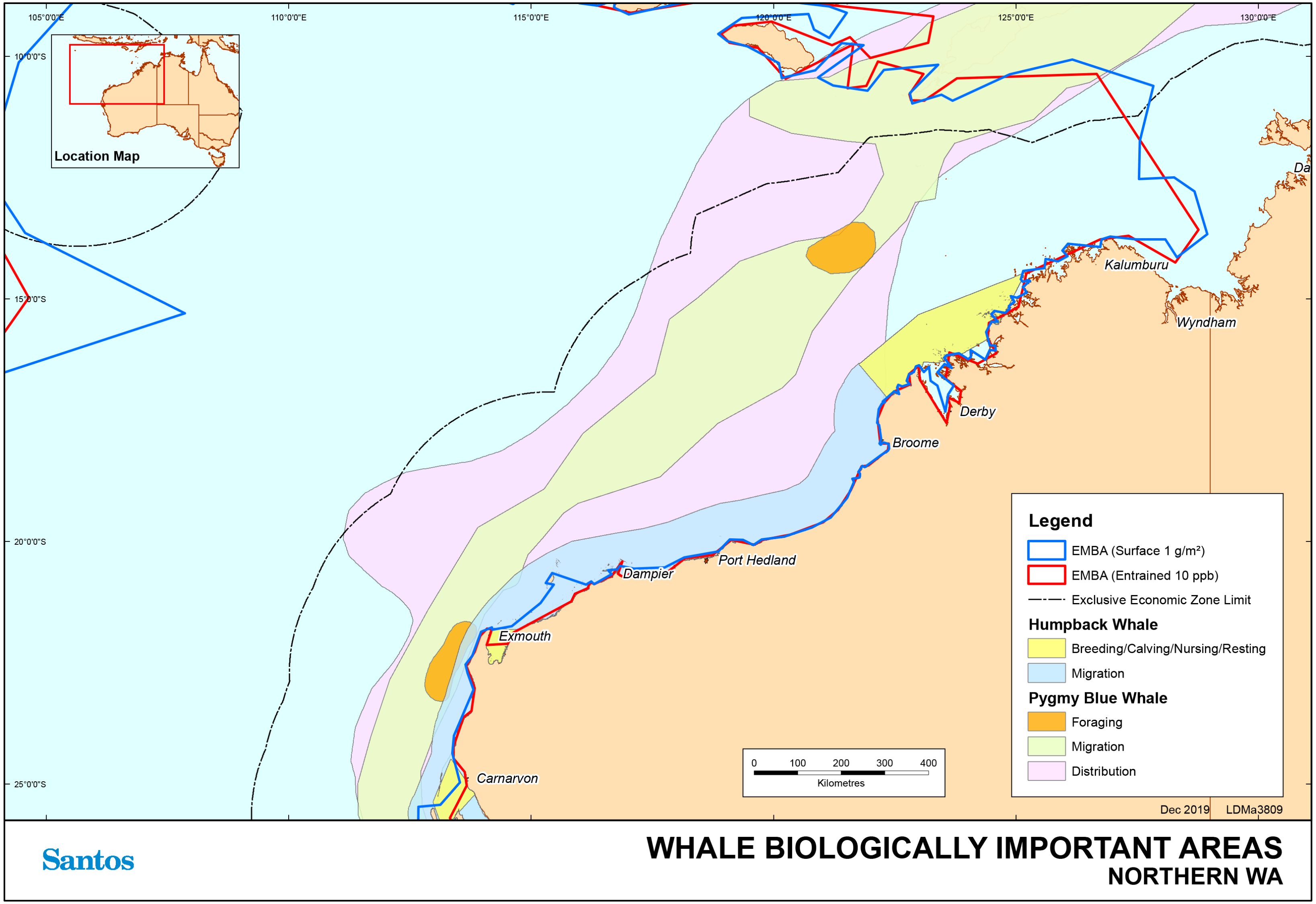


Figure 7-2: Biologically important areas – whales – Northern WA

7.1.3 Fin Whale

Fin whales have a worldwide distribution generally in deeper waters, with oceanic migrations between warm water breeding grounds and cold water feeding grounds.

The fin whale distribution in Australia is not clear due to the sparsity of sightings. Information is known primarily from stranding events and whaling records. According to the Species Profile and Threats database (DoEE 2019a); fin whales are thought to be present from Exmouth, along the southern coastline, to southern Queensland.

Migration paths are uncertain but are not thought to follow Australian coastlines (Bannister *et al*. 1996). There is insufficient data to prescribe migration times for fin whales. During summer and autumn this species has been recorded acoustically at the Rottnest Trench.

There are no known mating or calving areas in Australian waters (DoEE 2019a) and no BIAs for the fin whale are currently identified by the National Conservation Values Atlas (DoEE 2019b).

7.1.4 Southern Right Whale

The southern right whale is present in the southern hemisphere between approximately 30° and 60°S. The species feeds in the Southern Ocean in summer, moving close to shore in winter.

In Australian waters, southern right whales range from Perth, along the southern coastline, to Sydney. Sightings have been recorded as far north as Exmouth although these are rare (Bannister *et al*. 1996).

BIAs including calving and aggregation areas are recorded for this species along the southern coastline of Australia (DoEE 2019b). Details on the BIA for southern right whale are provided in **Table 7-3** and depicted in **Figure 7-1**.

7.1.5 Humpback Whale

Humpback whales have a worldwide distribution, migrating along coastal waters from polar feeding grounds to subtropical breeding grounds. Geographic populations are distinct and at least six southern hemisphere populations are thought to exist based on Antarctic feeding distribution and the location of breeding grounds on either side of each continent (Bannister *et al*. 1996). The population of humpback whales migrating along the WA coastline was recently estimated to be greater than 33,000 whales and likely increasing at exceptionally high growth rates between 10–12% (Hedley *et al*. 2011, Salgado Kent *et al*. 2012).

The west coast Australian humpback whale population migrates from Southern Polar Ocean ‘summer’ feeding grounds to their northern tropical ‘winter’ calving/ breeding grounds in coastal waters of the Kimberley. The northern migration tends to follow deeper waters of the continental shelf, whilst the southward migration concentrates whales closer to the mainland (Jenner *et al*. 2001). Recent satellite tagging of southbound humpback whales indicate that whales generally migrated close to the coastline, within a few tens of kilometres of shore and in a corridor frequently less than 100 km (Double *et al*. 2010). Aerial surveys and noise logger recordings undertaken for Chevron’s Wheatstone Project indicated that the main distribution of humpback whales were sighted at an average distance of 50 km from the mainland during the northern migration and 35 km during the southbound migration (RPS 2010a).

The precise timing of the migration varies between years by up to six weeks, influenced by water temperature, sea ice distribution, predation risk, prey abundance and the location of feeding grounds (DEWR 2007).

Peak northward migration across the North West Shelf is identified as from late July to early August, and peak southward migration from late August to early September (DoEE 2015c). Data collected between 1995 and 1997 by the Centre for Whale Research indicates that the period for peak northern migration into the calving grounds in the Kimberley is mid to late July. The peak for southern migration is in the first half of September (Jenner *et al.* 2001). Actual timing of annual migration may vary by as much as three weeks from year to year due to food availability in the Antarctic (DMP 2003).

Satellite tagging data collected for migrating northbound humpback whales identified a consistent narrow inshore distribution, unlike the southward migration. There was little evidence that the whales tended to venture further from shore and into deeper water at any point on their northward migration. Whales were seen with calves off the North West Cape outside the 'calving grounds; of Lacepede Islands to Camden Sound. This indicates some potential for this area being used as a 'calving site' as well as a migratory corridor. Consequently, the region from the Lacepede Islands to Camden Sound should not be seen as the exclusive 'calving ground' for this population (Double *et al.* 2012b).

Details on the BIA for humpback whales are provided in **Table 7-3** and depicted in **Figure 7-1** and **Figure 7-2**.

7.1.6 Sperm Whale

Sperm whales typically occur in WA along the southern coastline between Cape Leeuwin and Esperance (Bannister *et al.* 1996). Sperm whales are distributed worldwide in deep waters (greater than 200 m) off continental shelves and sometimes near shelf edges, averaging 20 to 30 nautical miles offshore (Bannister *et al.* 1996). The sperm whale is known to migrate northwards in winter and southwards in summer, however, detailed information on the distribution of sperm whales is not available for the timing of migrations. Sperm whales have been recorded in deep water off the North West Cape on the west coast of Western Australia (RPS 2010b), and appear to occasionally venture into shallower waters in other areas (RPS 2010b). Details on the BIA for sperm whales are provided in **Table 7-3** and are shown in **Figure 7-1.**

7.1.7 Antarctic Minke Whale

The Antarctic minke whale is distributed throughout the Southern Hemisphere from 55°S to the Antarctic ice edge during the austral summer and has been recorded in all Australian States (Bannister et al. 1996; Perrin & Brownell 2002). Detailed information on timing and location of migrations and breeding grounds on the west coast of Australia is largely unknown. However, it is believed that the Antarctic minke whale migrates up the WA coast to approximately 20°S during Australian winter to feed and possibly breed (Bannister *et al.* 1996).

7.1.8 Bryde's Whale

The Bryde's whale is found all year round in tropic and temperate waters (Kato 2002). Two forms are recognised: inshore and offshore Bryde's whales. It appears that the inshore form is restricted to the 200 m depth isobar whilst the offshore form is found in deeper waters of 500-1,000 m (DoEE 2019c). Both forms are expected to be found in zones of upwelling where they feed on shrimp like crustaceans (Bannister *et al.* 1996). Little is known about the population abundance of Bryde's whale, the location of exact breeding and calving grounds and large-scale migration patterns (DoEE 2019c). It is however, suggested that the offshore form migrates seasonally, heading towards warmer tropical waters during the winter.

7.1.9 Pygmy Right Whale

The pygmy right whale is considered the most elusive baleen whale and as a result very little is known about the whale's distribution in Australian waters. Records of the pygmy right whale in Australian waters are distributed between 32°S and 47°S and are restricted in the west by the Leeuwin current (Kemper 2002). It is possible that the pygmy right whale will be encountered in the southern extent of the EMBA, particularly in coastal areas of upwelling (Kemper 2002).

7.1.10 Killer Whale

The killer whale has a widespread global distribution and has been recorded in waters of all Australian states/territories (Bannister *et al.* 1996). Whilst more commonly found in cold, deeper waters, killer whales have been observed along the continental slope, shelf and shallow coastal areas of WA. Killer whales are known to make seasonal movements and are most likely to follow the migratory routes of their prey.

7.1.11 Indo-Pacific Humpback Dolphin

The Indo-pacific humpback dolphin is typically found in water less than 20 m deep, but has been recorded in waters up to 40 m deep. This species is generally found in association with river mouths, mangroves, tidal channels and inshore reefs (DoEE 2016a). This species of dolphin is known to have resident groups that forage, feed, breed and calve in the state waters of Roebuck Bay, Dampier Peninsula, King Sound north, Talbot Bay, Anjo Peninsula, Vansittart Bay, Napier Broome Bay and Deception Bay (DoEE 2016a).

The Indo-Pacific humpback dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3**.

7.1.12 Spotted Bottlenose Dolphin (Indo-Pacific bottlenose dolphin)

The spotted bottlenose dolphin (*Tursiops aduncus*) (Arafura / Timor Sea populations) is generally considered to be a warm water subspecies of the spotted bottlenose dolphin, occurring in shallow (often <10 m deep) inshore waters (Bannister et al., 1996; Hale et al., 2000). The known distribution of the spotted bottlenose dolphin extends from Shark Bay north to the western edge of the Gulf of Carpentaria in Australia (DoEE 2016b). The spotted bottlenose dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3**.

7.1.13 Irrawaddy Dolphin (Australian Snubfin Dolphin)

The Irrawaddy dolphin, also known as the snubfin dolphin (*Orcaella heinsohni*) is known to occur within the waters off northern Australia, extending north from Broome in Western Australia to the Brisbane River in Queensland (DoEE 2016c). Surveys have indicated that the species is typically found in protected shallow nearshore waters, generally less than 20 m deep, adjacent to river and creek mouths close to seagrass beds (DoEE 2016c). The snubfin dolphin was not recorded during any of the aerial surveys undertaken along the Dampier Peninsula coastline in the vicinity of James Price Point but were observed in Roebuck Bay from vessels on several occasions (RPS, 2010b). Based on the extensive survey effort and amenable conditions within the James Price Point coastal area during the survey, it is concluded that this species is seldom found outside of shallow and sheltered bays and inlets (DSD 2010). The Irrawaddy dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3.**

7.1.14 Dusky Dolphin

The dusky dolphin’s distribution is strongly linked to colder waters. In Australia, the dusky dolphin has been sighted in southern Australia from WA to Tasmania. It is presumed to be primarily an inshore species but has been known to move further offshore, possibly due to its desire for colder waters (Gill *et al.* 2000). Dusky dolphins are expected to be limited in their distribution along the WA coastline due to the presence of the southward-flowing warm water of the Leeuwin Current.

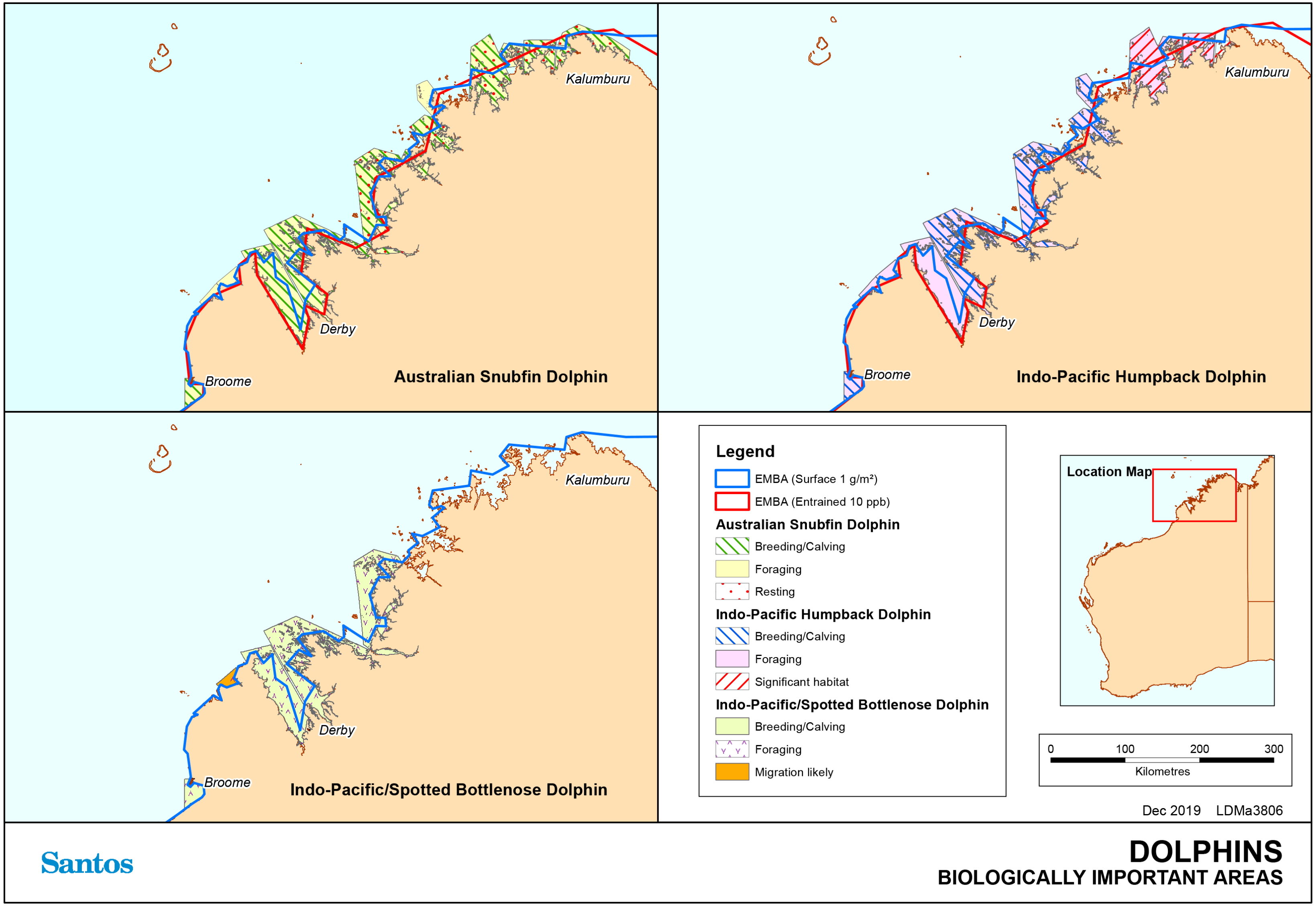


Figure 7-3: Biologically important areas – dolphins

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 border (DoEE 2019b). Male Australian sea lions have been recorded foraging in areas up to 60 km away from their birth colonies, with potentially larger dispersal ranges up to 180 km (Hamer *et al*. 2011). However, female Australian sea lions have restricted home ranges, with high rates of natal site fidelity and limited gene flow with other regions (Campbell 2005). The Australian sea lion BIA in the EMBA is outlined in **Table 7-3** and is depicted in **Figure 7-4.**

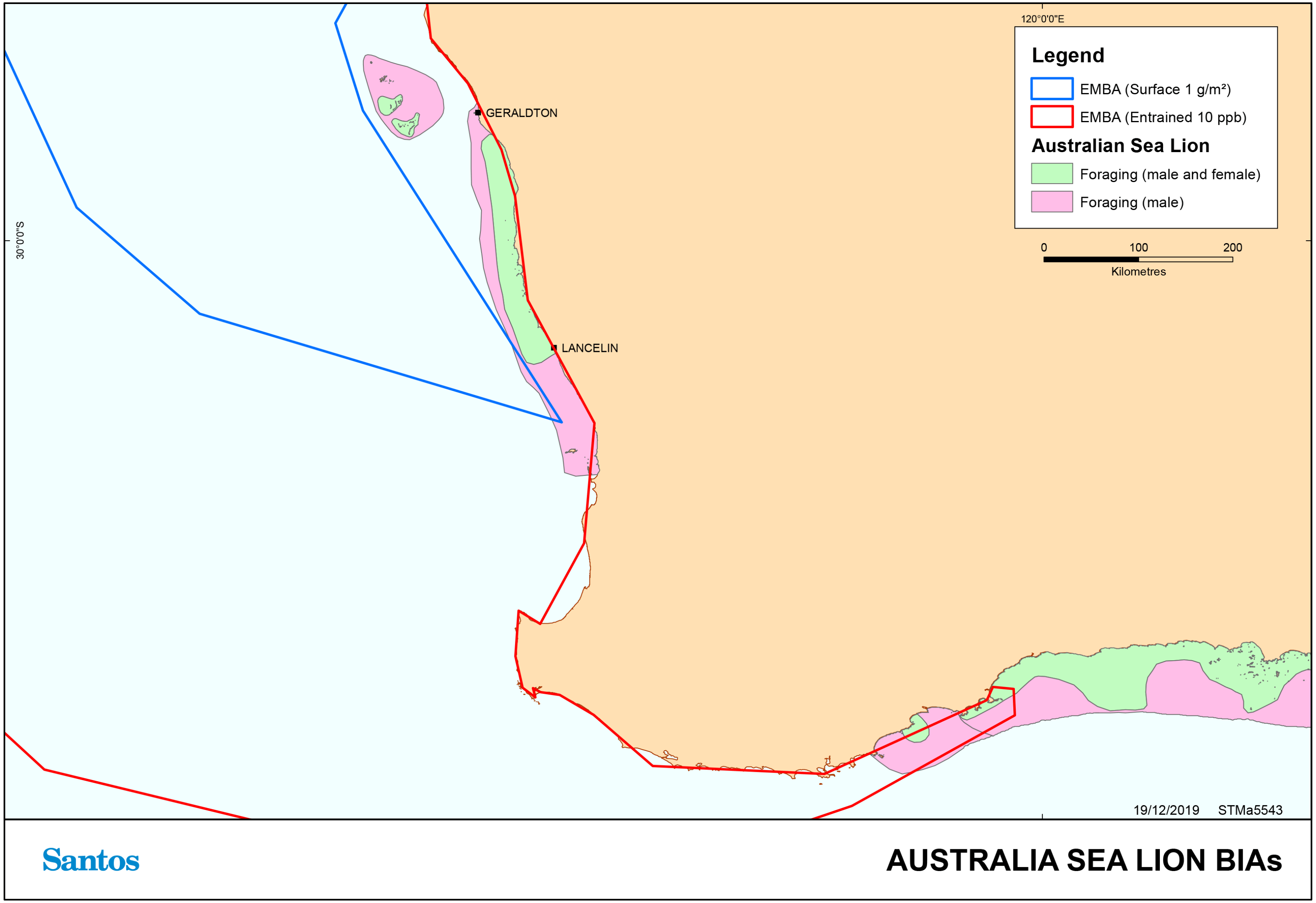


Figure 7-4: Biologically important areas – Australian sea lion

7.1.16 Dugongs

Dugongs (*Dugong dugon*) are large herbivorous marine mammals (up to 3 metres) that feed off seagrass and generally inhabit coastal areas. Key populations along the WA coast are principally located at: Shark Bay (the largest resident population in Australia), Ningaloo Marine Park and Exmouth Gulf, the Pilbara coast and offshore areas including Montebello/Barrow/Lowendal Islands, and further north at Eighty Mile Beach and off the Kimberley Coast, particularly Roebuck Bay and Dampier Peninsula (Marsh *et al*. 2002; DSEWPaC 2012). Populations are also present at Ashmore Reef. Dugong distribution and movement is based on the abundance, size and species of seagrass meadow. Dugongs can migrate hundreds of kilometres between seagrass habitat. The dugong BIAs in the EMBA are detailed in **Table 7-3** and shown in **Figure 7-5**.

7.1.17 New Zealand fur-seal

The New Zealand fur-seal (also known as the long-nosed fur seal) (*Arctocephalus forsteri*) is a specially protected species (Other Specially Protected) under the BC Act. The New Zealand fur seal is found in Ngari Capes Marine Park (two colonies) (and along other parts of Australia's southern coast).[5]

[5] Identified as a relevant species through review of *Biodiversity Conservation Act 2016* listed species for marine species without an EBPC Act listing.

Figure 7-5: Biologically important areas – dugongs

Table 7-2: Summary of information for marine mammals listed as threatened under the EPBC Act

Aspect	Sei whale	Blue and pygmy blue whales	Fin whale	Southern right whale	Humpback whale	Australian sea lion
Species expected in area	Unknown	Yes	Unknown	Unlikely, southern distribution	Yes	Unlikely, southern distribution
Migration depth (m)	Unknown, prefers offshore waters	500-1,000	Unknown	n/a	Up to 100	n/a
Migration seasonality	Unknown	Apr to Aug (north), Oct to Jan (south)	Unknown	n/a	Jun to Nov	n/a

7.2 Biologically Important Areas / Critical Habitat – Marine Mammals

Table 7-3 below provides an overview of BIAs in the EMBA for marine mammals

The DAWE may also make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[6].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Table 7-3: Biologically important areas – marine mammals

Species	Scientific name	Aggregation area and use	BIAs within EMBA
Blue and pygmy blue whales	*Balaenoptera musculus*	Migration – along the continental shelf edge off the WA coastline, extending offshore near Scott Reef and into Indonesian waters Foraging – along Ningaloo reef, around Scott Reef, around the Perth canyon	Blue and pygmy blue whale - Head of the Perth Canyon Outer continental shelf from Cape Naturaliste to south of Jurien Bay Outer Perth Canyon Head of the Perth Canyon Pygmy blue whale - Augusta to Derby. Tend to pass along the shelf edge at depths of 500 m to 1000 m; appear close to coast in the Exmouth-Montebello Islands area on southern migration. From Mandurah to south of Cape Naturaliste, seaward to the 50 m depth contour Indonesia- Banda Sea Ningaloo Perth Canyon Scott Reef

[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
Southern right whale	*Eubalena australis*	Breeding/calving – along the south west and southern coastline of WA/SA	Bunbury area, WA Camac Island/Fremantle, WA Coast Cape Naturaliste to Cape Leeuwin Coast Perth region to Cape Naturaliste Geographe Bay, WA Perth to Kangaroo Island
Humpback whale	*Megaptera novaeangliae*	Breeding/calving/nursing/resting – Kimberley/Coastal North Lacepede Island, Campden Sound, Exmouth Gulf, Shark Bay Migration - northern migration deeper waters of the continental shelf, southward migration – along the WA mainland	Cape Leeuwin to Houtman Abrolhos Cape Naturaliste Cape Naturaliste to Cape Leeuwin Exmouth Gulf Flinders Bay Geographe Bay Houtman Abrolhos Islands Kimberley/Coastal North Lacepede Island, Camden Sound North of Houtman Abrolhos Shark Bay The migration corridor extends from the coast to out to approximately 100 km offshore in the Kimberley region extending south to North West Cape. From North West Cape to south of shark Bay the migration corridor is reduced to approximately 50 km. West coast - Lancelin to Kalbarri West coast- Bunbury to Lancelin including Rottnest Island
Sperm whale	*Physeter macrocephalus*	Foraging - west end of Perth Canyon and Albany Canyons	Western end of Perth canyon Albany Canyons - Immediately south of the continental shelf edge extending over the continental slope
Indo-Pacific humpback dolphin	*Sousa chinensis*	Breeding, calving, foraging – Kimberley coastal waters and islands Significant habitat – unknown behavior – Admiralty Gulf & Parry Harbour and Bougainville Peninsula Significant habitat - Vansittart Bay, Anjo Peninsula	Admiralty Gulf & Parry Harbour Bougainville Peninsula Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) Carnot & Beagle bay King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Maret and Biggee Island Pender bay Port Nelson, York Sound, Prince Frederick Harbour Prince Regent River Roebuck Bay Vansittart Bay, Anjo Peninsula Willie Creek

Species	Scientific name	Aggregation area and use	BIAs within EMBA
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 Breeding/calving/nursing – Exmouth and the Ningaloo coastline	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 Exmouth Gulf

Species	Scientific name	Aggregation area and use	BIAs within EMBA
			Kimberley coast, Dampier Peninsula Middle Island, Kimberley coast North East Peron Peninsula, Shark Bay North of Faure Island, Shark Bay Pilbara and Kimberley coast near Dampier Peninsula Pilbara and Kimberley coast near James Price Point Roebuck Bay, Broome South Passage, Shark Bay Useless Loop, Shark Bay

8. Birds

Marine waters and coastal habitats in the EMBA contain key habitats that are important to birds, including offshore islands, sandy beaches, tidal flats, mangroves and coastal and pelagic waters. These habitats support a variety of birds which utilise the area in different ways and at different times of the year (DSEWPaC 2012a). Birds can be broadly grouped according to their preferred foraging habitat as coastal/ terrestrial birds, seabirds and shorebirds.

Coastal or terrestrial species inhabit the offshore islands and coastal areas of the mainland throughout the year. These species are either primarily terrestrial, or they may forage in coastal waters. Resident coastal and terrestrial species include osprey (*Pandion cristatus*), white-bellied sea eagle (*Haliaeetus leucogaster*), silver gull (*Larus novaehollandiae*) and eastern reef egret (*Egreta sacra*) (DEWHA 2008a).

Seabirds include those species whose primary habitat and food source is derived from pelagic waters. These species spend the majority of their lives at sea, ranging over large distances to forage over the open ocean. Seabirds present in the area include terns, noddies, petrels, shearwaters, tropicbirds, frigatebirds boobies and albatrosses (DEWHA 2008a).

Shorebirds, including waders, inhabit the intertidal zone and adjacent areas. Some shorebird species, including oystercatchers are resident (Surman & Nicholson 2013). Other shorebirds are migratory and include species that utilise the East Asian–Australasian Flyway, a migratory pathway for millions of migratory shorebirds that travel from Northern Hemisphere breeding grounds to Southern Hemisphere resting and foraging areas. Shorebirds that regularly migrate through the area include the *Scolopacidae* (curlews, sandpipers etc.) and *Charadriidae* (plovers and lapwings) families.

Surveys in the area by Santos WA and other agencies have built a picture of diverse avifauna. A summary of research is discussed below, followed by information on threatened and migratory birds. Wetlands of international importance are discussed in **Section 9.2**.

8.1 Regional Surveys

8.1.1 Abrolhos Islands

The Abrolhos Islands are one of the most significant seabird nesting areas in the eastern Indian Ocean with over two million birds breed on the islands and small rocky atolls in the Abrolhos (DoF 2012). The mixture of species is unique, as subtropical and tropical species, and littoral and oceanic foragers, share the breeding islands. A total of 95 bird species have been recorded as residents or visitors to the Abrolhos Islands. Of these 35 species are known to breed at the Abrolhos (DoF, 2012):

+ Common noddy (rookery – Pelseart Island): The Abrolhos supports 80 per cent of the Australian breeding population of the common noddy (*Anous stolidus*) with up to 250,000 common noddies breed at Pelsaert Island. These birds lay their eggs in spring, but the actual month can vary, depending on their food supply and the weather conditions existing in offshore waters (DoF 2012);
+ Caspian tern (rookeries – Leo Island, West Wallabi Island and Pelsaert Island): Unlike other more social terns, Caspian terns (*Hydroprogne caspia*) are usually solitary nesters. There are less than 150 of these breeding at the Abrolhos, across 22 islands (DoF 2012);
+ Wedge-tailed shearwaters (rookeries): The Abrolhos are the most important breeding sites in Australia for the wedge tailed shearwater (Ardenna pacifica), with between 500,000 and a million of these birds breeding there every year, predominantly on West Wallabi Island. The wedge-tailed shearwater breeding colonies at the Abrolhos are the largest in Australia (DoF 2012);
+ Bridled tern (rookeries – Gun Island, Leo Island, Pelsaert Island, Little North Island, Fisherman Islands, Beagle Islands and Penguin Island): Bridled terns (*Onychoprion anaethetus*) breed on 90 islands throughout the Abrolhos. These birds fly north for the winter, through Indonesia to waters around the Phillippines. There are approximately 4,000 bridled terns who return to the Abrolhos around October every

year to lay their eggs. Bridled terns nest on more islands in the Abrolhos than any other bird species (DoF, 2012);

+ Osprey (nesting area – Pelseart Island): Up to 100 eastern ospreys (Pandion cristatus) nest at a number of sites throughout all three island groups at the Abrolhos, including nesting platforms made from converted rock lobster pots and stacked fishing equipment on jetties (DoF 2012);
+ White-bellied sea eagle (nesting area – West Wallabi Island): At the Abrolhos, there are up to 50 breeding white-breasted sea eagles (Haliaeetus leucogaster), spread across all three island groups (DoF 2012);
+ Australian lesser noddy (feeding area and rookeries Morley Island, Wooded Island and Pelseart Island): In Australia the Australian lesser noddy is only known to breed in this area and is known to forage between the islands and the continental shelf edge; and
+ Other areas rookeries identified for both the wedge-tailed shearwater and bridled tern within the south west area include Lancelin Island, Rottnest Island and Safety Bay.

8.1.2 North West Cape

Avifauna surveys of the North West Cape have recorded 144 bird species, one third of which are seabirds and shorebirds (resident and migratory) (May *et al*. 1983). Approximately 33 species of seabirds and shorebirds are found in the Ningaloo Marine Park with the main breeding areas at Mangrove Bay, Mangrove Point, Point Maud, the Mildura wreck site and Fraser Island (CALM & MPRA 2005a).

8.1.3 Muiron Islands and Exmouth Gulf Islands

Muiron Islands and Exmouth Gulf Islands are generally lacking in published bird observations data. Early indications from surveys commissioned by Santos WA in 2013/14 indicate that South and North Muiron Islands are regionally significant in terms of wedge-tailed shearwater (*Puffinus pacificus*) nesting, whilst Bessiers and Fly islands are also significant (Surman pers comm. 2013). Nine coastal/terrestrial species and 21 shorebirds were identified on the Muiron and Exmouth Gulf Islands during the first of these surveys and seven bird species were recorded nesting (Surman 2013).

8.1.4 Dampier Archipelago/Cape Preston Region

The Dampier Archipelago/Cape Preston region is a nesting area for at least 16 species of seabirds. Many of the islands and rocks in the area are known breeding grounds for birds, including wedge-tailed shearwaters (*Puffinus pacificus*), Caspian terns (*Sterna caspia*), bridled terns (*Sterna anaethetus*) and roseate terns (*Sterna dougallii*). Small islands and islets such as Goodwyn Island, Keast Island and Nelson Rocks provide important undisturbed nesting and refuge sites and Keast Island provides one of the few nesting sites for pelicans in WA (CALM & MPRA 2005).

8.1.5 Barrow Island and Lowendal Island Group

Barrow Island and surrounding islands have a diverse avifauna comprising at least 110 species, including 11 resident land birds, eight resident seabirds, 17 seabirds, 22 species of migratory waders, six resident shorebirds and 43 irregular visitors (Surman 2003). The avifauna of Barrow Island is thus poor in terms of land birds and waterfowl compared to mainland areas of the Pilbara, but rich in migratory waders and seabirds. Compared to other nearby offshore islands, Barrow Island has substantially more migratory waders but fewer breeding seabirds (Surman 2003).

The Lowendal Island Group has a diverse avifauna comprising 89 recorded species (Dinara Pty Ltd. 1991, Burbidge *et al*. 2000). Six species of resident land birds and six species of raptors have been recorded at the Lowendal Islands (Surman & Nicholson 2012). Up to fourteen seabird species have been observed at any one time during annual surveys of the Lowendal Islands between 2004 and 2012. Surveys at the Montebello Islands have recorded 70 bird species. This includes 12 species of seabirds and 14 species of migratory shorebirds (Burbidge *et al*. 2000).

8.1.6 Varanus, Airlie, Serrurier, Bridled, Abutilon, Beacon and Parakeelya Islands

Wedge-tailed shearwaters have been identified to nest on Varanus, Airlie, Serrurier and Bridled Islands (Astron 2017a). Breeding participation on the islands appears to be largely influenced by pre-breeding oceanographic conditions (Astron 2017a). Monitoring in 2016/17 was undertaken by Santos WA and demonstrated the colony sizes for wedgetailed shearwaters to be within or above previously reported ranges (Astron 2017a). This is informed though monitoring that has been undertaken under the Integrated Shearwater Monitoring Program (ISMP), established in 1994.

In 2016/17, areas of potential wedge-tailed shearwater nesting habitat were recorded on Varanus Island (5.53 ha) and Airlie Island (12.47 ha) and surrounding islands of Bridled (2.94 ha), Serrurier (130.89 ha), Abutilon (2.02 ha) and Parakeelya (1.66 ha) (Astron 2017a). The number of wedge-tailed shearwater breeding pairs was also estimated for each of Varanus (1,492 +/- 702), Airlie (600 +/- 124), Bridled (1,039 +/- 342), Serrurier (23,240 +/- 4,341), Abutilon (317 +/- 210) and Parakeelya (172 +/- 138) islands (Astron 2017a).

Other seabird species utilising Abutilon, Beacon, Bridled and Parakeelya islands for nesting include bridled terns, silver gulls, crested terns and lesser crested terns. Monitoring for these seabirds in 2016/17 was also completed by Santos WA, with monitoring results concluded to support previous trends for all species. Bridled terns mainly utilise Abutilon, Bridled and Parakeelya islands for breeding, with smaller numbers noted on Beacon and Varanus Islands. The bridled terns have not been recorded on Airlie Island and only in very small numbers on Varanus Island (Astron 2017b).

Silver gull numbers appear to be growing across the region (2010/2011). However, reasons for this are unknown but considered possibly to be due to greater prey availability or immigration from the mainland (Astron 2017b). Silver gulls have been found to utilise Bridled, Parakeelya, Abutilon and Beacon islands longer term for breeding. Silver gulls have not been identified to nest on Varanus island and were only recorded nesting on Airlie island for the first time in 2016/17 since monitoring commencement in 2004/05 (Astron 2017b).

The crested tern and lesser crested tern are noted as nomadic breeders that appear to use a consistent subset of islands for breeding. In 2016/17, Beacon Island was the favourable nesting site for the crested tern and lesser crested tern (Astron 2017b). Surveys in the vicinity of Port Hedland (Bennelongia 2011) recorded 23 species of migratory shorebird between 2002 and 2011. Terrestrial/coastal and seabird species were not targeted. A total of 4,248 migratory shorebirds of 18 species were observed during the field survey in April 2011.

8.2 Threatened Species

A Protected Matters search of the EMBA identified 55 bird species (**Appendix A**) listed under the EPBC Act as threatened.

An examination of the species profile and threats database (DoEE 2019a) and The Action Plan for Australian Birds (Garnet 2011) showed that some listed bird species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial or southern distributions. Hence, these species are not discussed further.

EPBC Act threatened species expected to occur in the area are listed in **Table 8-1** along with their WA conservation status (as applicable), and discussed below. BIAs for birds are detailed in **Table 8-5** and depicted in **Figure 8-1** and **Figure 8-2**.

Table 8-1: Birds listed as threatened under the EPBC Act

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Shorebirds					
Red knot (*Calidris canutus)*	Endangered	Endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Curlew sandpiper (*Calidris ferruginea)*	Critically endangered	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Great knot (*Calidris tenuirostris)*	Critically endangered	Critically endangered	-	Roosting known to occur within area	None - No BIA defined
Greater sand plover (*Charadrius leschenaultia)*	Vulnerable	Specially protected (migratory)	-	Roosting known to occur within area	None - No BIA defined
Lesser sand plover (*Charadrius mongolus)*	Endangered	Endangered	-	Roosting known to occur within area	None - No BIA defined
Western Alaskan bar-tailed godwit (*Limosa lapponica baueri)*	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area	None - No BIA defined
Northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri)*	Critically endangered	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Eastern curlew (*Numenius madagascariensis)*	Critically endangered	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Australasian bittern (*Botaurus poiciloptilus)*	Endangered	Endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Australian painted snipe (*Rostratula australis)*	Endangered	Endangered	-	Species or species habitat may occur within area	None - No BIA defined
Seabirds					
Australian lesser noddy (*Anous tenuirostris melanops)*	Vulnerable	Endangered	-	Breeding known to occur within area	Yes – refer to **Table 8-5**
Fairy piron (southern)	Vulnerable	-	-	Species or species habitat	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		
(*Pachyptila tutur subantarctica)*				known to occur within area	
Southern royal albatross (*Diomedea epomophora)*	Vulnerable	Specially protected (migratory)	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Northern royal albatross (*Diomedea sanfordi)*	Endangered	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Amsterdam albatross (*Diomedea amsterdamensis*)	Endangered	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	Endangered	-	Species or species habitat may occur within area	None - No BIA defined
Tristan albatross (*Diomedea dabbenea)*	Endangered	Critically endangered	-	Species or species habitat may occur within area	None - No BIA defined
Wandering albatross (*Diomedea exulans)*	Vulnerable	Specially protected (migratory)	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
Christmas island frigatebird (*Fregata andrewsi)*	Endangered	Specially protected (migratory)	-	Foraging, feeding or related behaviour known to occur within area	None - No BIA defined
Southern giant petrel (*Macronectes giganteus)*	Endangered	Specially protected (migratory)	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Northern giant petrel (*Macronectes halli)*	Vulnerable	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	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		
				likely to occur within area	
Soft-plumaged petrel (*Pterodroma mollis)*	Vulnerable	-	-	Foraging, feeding or related behaviour known to occur within area	Yes – refer to **Table 8-5**
Blue Petrel (*Halobaena caerulea)*	Vulnerable	-	-	Species or species habitat may occur within area	None - No BIA defined
Australian fairy tern (*Sternula nereis)*	Vulnerable	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 8-5**
Indian yellow-nosed albatross (*Thalassarche carteri)*	Vulnerable	Specially protected (migratory)	-	Foraging, feeding or related behaviour may occur within area	Yes – refer to **Table 8-5**
Shy albatross (*Thalassarche cauta)*	Vulnerable	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
White-capped albatross (*Thalassarche cauta steadi)*	Vulnerable	Specially protected (migratory)	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
Black-browed albatross (*Thalassarche melanophris)*	Vulnerable	Endangered	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Campbell albatross (*Thalassarche impavida)*	Vulnerable	Specially protected (migratory)	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Christmas Island white-tailed tropicbird (*Phaethon lepturus fulvus)*	Endangered	-	-	Species or species habitat may occur within area	None - No BIA defined

8.2.1 Shorebirds

Red Knot (New Siberian Islands and north-eastern Siberia)

The red knot is a migratory shorebird and the species includes five subspecies, including two found in Australia, *Calidris canutus piersmai* and *Calidris canutus rogersi*. The red knot breeds in Siberia and spends the non-breeding season in Australia and New Zealand. During the non-breeding season the species spends the majority of its time on tidal mudflats or sandflats where they feed on intertidal invertebrates, especially shellfish (Garnet *et al.* 2011).

Curlew Sandpiper

This species is a migratory shorebird that breeds in north Siberia and spends the non-breeding season from western Africa to Australia (Bamford *et al.* 2008). The curlew sandpiper occurs around coastal Australia and preferred habitats include coastal brackish lagoons, tidal mud and sand flats, estuaries, saltmarshes and less often inland. Their diet is mainly comprised of polychaete worms, molluscs and crustaceans (Higgins & Davies 1996 in Garnet *et al.* 2011).

Great Knot

The great knot is a migratory shorebird with a global distribution, breeding in north-east Siberia and spending the non-breeding season along coasts from Arabia to Australia. Non-breeding birds migrate to inlets, bays, harbours, estuaries and lagoons with large intertidal mud and sand flats where they feed on bivalves, gastropods, crustaceans and other invertebrates (Higgins & Davies 1996 in Garnet *et al.* 2011).

Greater Sand Plover and Lesser Sand Plover

The greater sand plover and lesser sand plover are congeners that breed in China, Mongolia and Russia. The greater sand plover spends the non-breeding season along coasts from Japan through southeast Asia to Australasia, while the lesser sand plover spends the non-breeding season along coasts from Taiwan to Australasia (Banford *et al*. 2008). Non-breeding birds occur along all Australian coasts, especially in the north for the greater sand plover (DoEE 2019a) and in the east for the lesser sand plover (DoEE 2019a).

Non-breeding birds forage on beaches, salt-marshes, coastal bays and estuaries, and feed on marine invertebrates including molluscs, worms, crustaceans and insects (Marchant & Higgins 1993 in Garnet *et al*. 2011).

Bar-tailed Godwit (Western Alaskan and Northern Siberian Subspecies)

Two subspecies of the bar-tailed godwit exist, as determined by their breeding locations in Siberia and Alaska (Bamford *et al*. 2008). Non-breeding birds migrate to the coasts of Australia. The western Alaskan subspecies occurs especially on the north and east coasts of Australia whilst the northern Siberian subspecies occurs especially along the coasts of north Western Australia (DoEE 2019b).

Non breeding birds are found on muddy coastlines, estuaries, inlets, mangrove-fringed lagoons and sheltered bays, feeding on annelids, bivalves and crustaceans (Higgins and Davies 1996 in Garnet *et al*. 2011).

Eastern Curlew

The eastern curlew is a migratory shorebird that breeds in Siberia, Kamchatka and Mongolia and migrates to coastal East Asia and Australia. The South Korean Yellow Sea is an important staging post for this species. Non breeding birds occur around coastal Australia, are more common in the north and have disappeared or become much rarer at many sites along the south coast (Garnet 2011).

Non breeding birds are present at estuaries, mangroves, saltmarshes and intertidal flats, particularly those with extensive seagrass (Zosteraceae), where they feed on marine invertebrates, especially crabs and small molluscs (Higgins & Davies 1996 in Garnet 2011).

Australian Painted Snipe

The Australian painted snipe has been recorded at wetlands in all states of Australia (DoE 2014g). The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or canegrass or sometimes tea-tree (*Melaleuca*). The Australian painted snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (DoE 2014g).

Australasian Bittern

The Australasian bittern is found in coastal and sub-coastal areas of south-eastern and south-western mainland Australia and the eastern marshes of Tasmania (Birdlife Australia 2017). The specie lives predominantly in reedbeds and other water vegetation. Feeding on other small animals, insects, snails and spiders the bittern forages at night. Breeding occurs during summer from October to January.

8.2.2 Seabirds

Australian Lesser Noddy

This species is usually found only around its breeding islands in the Houtman Abrolhos Islands in Western Australia (Storr *et al*. 1986). The Australian lesser noddy occupies coral-limestone islands that are densely fringed with white mangrove *Avicennia marina*, and it occasionally occurs on shingle or sandy beaches (Higgins & Davies 1996 in DoEE 2019a). This species is thought to be sedentary or resident, staying near to its breeding islands in the non-breeding season. It may leave nesting islands for short periods during the non-breeding season, and probably forages widely (Higgins & Davies 1996 in DoEE 2019a).

Breeding apparently occurs only on Morley, Wooded and Pelsaert Islands at the Houtman Abrolhos Islands (Higgins and Davies 1996 in DoE 2014b). Mangrove stands support approximately 68,000 breeding pairs spread over the three islands (Surman & Nicholson 2006). Breeding may also occur on Ashmore Reef (Stokes & Hinchey 1990). The breeding season extends from mid-August to early April (Higgins & Davies 1996 in DoE 2014b).

The National Conservation Values Atlas identifies BIAs for this species in the area of the Houtman Abrolhos islands (**Table 8-5**). The Species Group Report Card – Seabirds (DSEWPaC 2012b) states that the entire Australian population of this species breeds in the South-west Marine Region, south of Busselton.

Albatrosses

A Protected Matters search of the waters in the EMBA (**Appendix A**) identified several albatross species that may occur in the area, comprising of the southern royal albatross, northern royal albatross, Amsterdam albatross, Antipodean albatross, Tristan albatross, sooty albatross, wandering albatross, Indian yellow-nosed albatross, shy albatross, white-capped albatross, black-browed albatross and Campbell albatross. All these species predominantly occur in subantarctic to subtropical waters and breed on islands in the southern oceans (DoEE 2019a).

The National Conservation Values Atlas (DoEE 2019b) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) do not identify any BIAs for these species in the area from Busselton to the Northern Territory border. However, a BIA for the Indian yellow-nosed albatross is identified for foraging north to Shark bay and extending east into Bass Strait.

Christmas Island Frigatebird

The Christmas Island frigatebird is a very large seabird. Breeding colonies of the Christmas Island frigatebird is currently confined to Christmas Island in the Indian Ocean (DoE 2014c). No breeding colonies have ever been found away from Christmas Island.

Southern Giant Petrel

The southern giant petrel is a highly migratory bird with a large natural range. This species occurs from Antarctic to subtropical waters and breeds on the Antarctic continent, peninsular and islands and on subantarctic islands and South America. Breeding occurs annually between August and March (DoEE 2019a).

The National Conservation Values Atlas (DoEE 2019b) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) do not identify any BIAs for this species in the area from Busselton to the NT border.

Northern Giant Petrel

The northern giant petrel occupies the Antarctic Polar Front. In summer, it occurs predominantly in sub-Antarctic to Antarctic waters, usually between 40 and 64° The northern giant-petrel breeds on sub-Antarctic islands. Its breeding range extends into the Antarctic zone at South Georgia. It nests in coastal areas where vegetation or broken terrain offers shelter, on sea-facing slopes, headlands, in the lee of banks, under or against vegetation clumps, below cliffs or overhanging rocks, or in hollows. On Campbell Island, it nests on the edge of the coastal plateau. Tussock-grass is widespread at many breeding sites. Its nests are built in secluded, coastal sites, sheltered by heavy vegetation. On Antipodes Island, it nests under *Senecio antipoda* (DoE 2014d).

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species in the area spanning SW WA to the Northern Territory border.

Soft-Plumaged Petrel

The soft-plumaged petrel is generally found over temperate and subantarctic waters in the South Atlantic, Southern Indian and western South Pacific Oceans. The species breeds colonially on islands in the southern oceans. Breeding occurs from August to May (Marchant & Higgins 1990 in DoEE 2019a).

A BIA for this species is identified for foraging in seas north to 21°30'S off WA.

Blue Petrel

The blue petrel is marine species of the Sub Antarctic and Antarctic seas. In summer, it occurs mainly over waters of -2 to 2° C in surface temperature, but it also ranges south to the edge of the pack-ice and north to approximately 30° south, or further north over cool currents (DoE 2014e). In the Antarctic, it generally avoids the pack-ice, and only occasionally approaches the edge of the ice. Given the location of the EMBA, this species is unlikely to occur.

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species in the area spanning SW WA to the NT border.

Abbott's Booby

Currently, Abbott's booby is only known to breed on Christmas Island and to forage in the waters surrounding the island (DoE 2014f). Within Christmas Island, most nests are found in the tall plateau forest on the central and western areas of the island, and in the upper terrace forest of the northern coast.

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species in the area spanning SW WA to the NT border.

Australian Fairy Tern

The Australian fairy tern is distributed in a large geographic range between Australia, New Zealand and New Caledonia. Three subspecies have been identified, one of which is found in Australia. The Australian fairy tern occurs along the coasts of Victoria, Tasmania, South Australia and WA; occurring as far north as the Dampier Archipelago (DoEE 2019a). The subspecies has been found in embayments of a variety of habitats including offshore, estuarine or lacustrine islands, wetlands and mainland coastline (Higgins & Davies 1996 in DoE 2014b, Lindsey 1986).

Australian fairy terns nest on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The Australian fairy tern breeds from August to February depending on the location of the breeding colony (Higgins & Davies 1996 in DoEE 2019a). They generally nest in small colonies of up to 100 birds, although larger colonies of more than 1400 pairs have been reported in Western Australia (Hill *et al*. 1988).

The National Conservation Values Atlas (DoEE 2019b) identifies the vicinity of the lower north-west coast (north to Dampier Archipelago) and west coast (south to Peel inlet) as BIAs for foraging. Biologically important breeding areas were also identified scattered along the coast between Shark Bay and the Pilbara (**Table 8-5**).

Christmas Island White-tailed Tropicbird

The Christmas Island white-tailed tropicbird is endemic to Christmas Island and leaves the island to forage in the warm waters of the Indian Ocean (Garnett 2011). The white-tailed tropicbird roots at sea; only incubating or brooding adults remain on nests on the island at night (Stokes 1988).

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species within the EMBA.

Fairy Piron (southern)

The fairy piron is distributed off the cold-water coasts of Antarctica and southern Australia and New Zealand. The southern subspecies is known to breed on Macquarie Island, Langdon Point, Davis Point and Bishop and Clerk islands (Garnett & Crowley 2000). It is estimated that the population of the fairy piron (southern) is a little over 50 pairs (Brothers 1984).

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species within the EMBA.

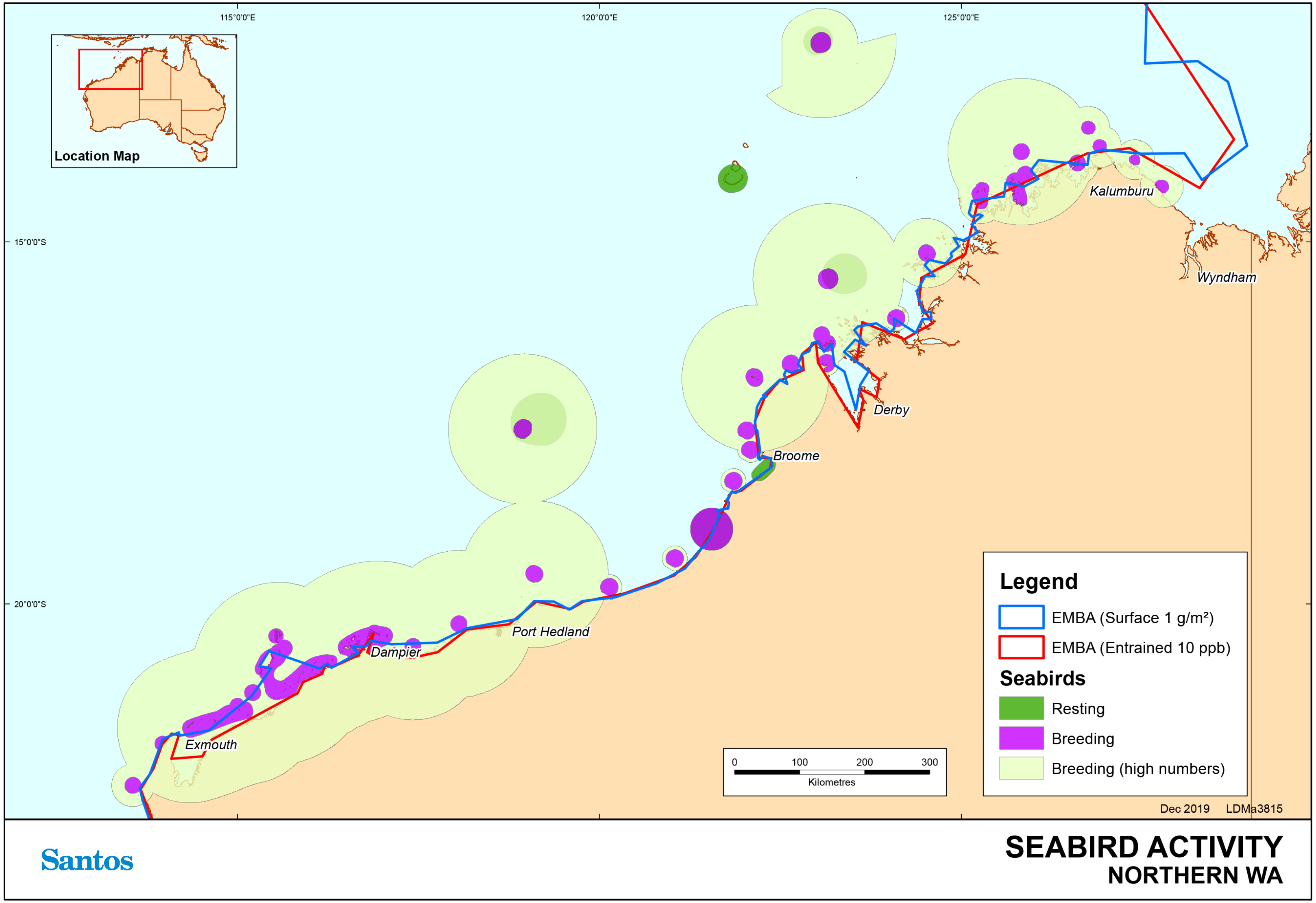


Figure 8-1: Biological important areas – birds – Northern WA

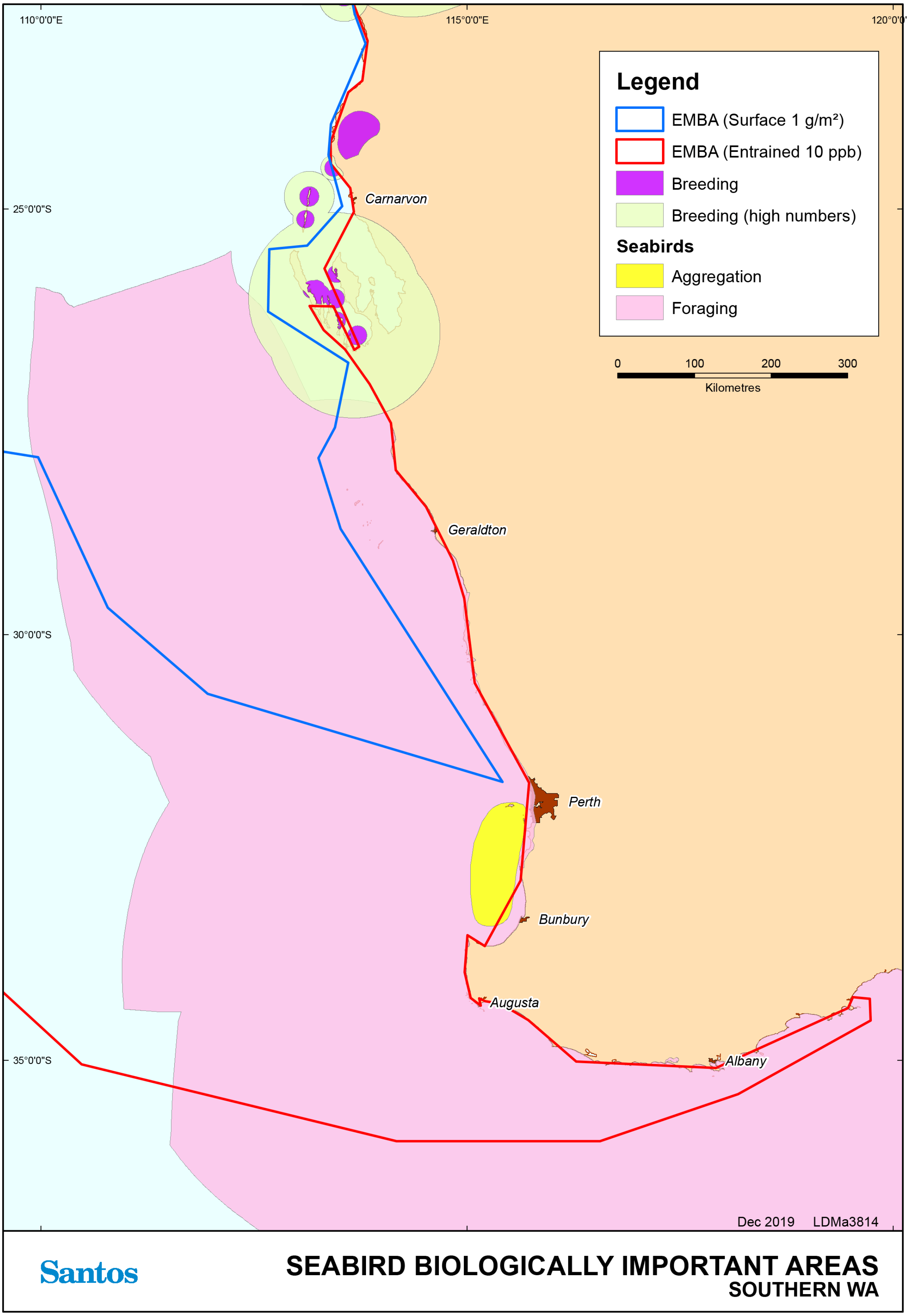


Figure 8-2: Biologically important areas – birds – Southern WA

Table 8-2: Summary of information for birds listed as threatened under the EPBC Act that may be in the EMBA

Species	Species Expected in EMBA	Breeding in the Area /Seasonality	Foraging
Shorebirds			
Red knot	Yes	No	Intertidal invertebrates
Curlew sandpiper	Yes	No	Polychaete worms, molluscs and crustaceans taken from shorelines
Great knot	Yes	No	Bivalves, gastropods, crustaceans and other invertebrates taken from shorelines
Greater sand plover/lesser sand plover	Yes	No	Marine invertebrates taken from shorelines
Bar-tailed godwit	Yes	No	Annelids, bivalves and crustaceans taken from shorelines
Eastern curlew	Yes	No	Marine invertebrates associated with seagrass
Australasian bittern	Yes	No	Other small animals, insects, snails and spiders
Australian painted snipe	Yes	No	Seeds and small invertebrates
Western Alaskan bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects
Northern Siberian bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects and some plant material
Seabirds			
Australian lesser noddy	May forage from Kalbarri to Shark Bay	No	Small fish taken from marine and coastal waters (DoE 2014b)
Amsterdam albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Antipodean albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Black-browed albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Campbell albatross	Low densities	No	Cephalopods, fish, salps, jellyfish and crustaceans taken from marine and coastal waters.
Indian yellow-nosed albatross	Low densities	No	Cephalopods, and fish taken from marine and coastal waters.
Northern royal albatross	Low densities	No	Cephalopods, fish, salps and crustaceans taken from marine and coastal waters.
Shy albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Sooty Albatross	Low densities	No	Cephalopods, fish, crustaceans, siphonophores and penguin carrion taken from marine waters.

Species	Species Expected in EMBA	Breeding in the Area /Seasonality	Foraging
Southern royal albatross	Low densities	No	Cephalopods, and fish taken from marine and coastal waters.
Tristan albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine waters.
Wandering albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
White-capped albatross	Low densities	No	Cephalopods and fish taken from marine and coastal waters.
Southern & Northern giant petrel	Low densities	No	Scavenges penguin, seal and whale carcasses. Hunts live birds, penguin chicks' cephalopods and krill. Marine and coastal waters (DoE 2014b)
Soft-plumaged petrel	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters (DoE 2014b)
Australian fairy tern	Yes	Yes Aug to Feb	Bait fish taken from coastal waters
Fairy piron (southern)	Very low densities	No	Small pelagic crustaceans, small fish and squid
Christmas Island frigatebird	Low densities	No	Planktonic crustaceans, fish and squid
Abbott's booby	Low densities	No	Fish and squid
Blue petrel	Low densities	No	Crustaceans, small fish and squid
Christmas Island white-tailed tropicbird	Very low densities	No	Squid and flying fish

8.3 Migratory Species

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 2016.

Three internationally recognised areas that support shorebird migrations are protected as wetlands of international importance; Ashmore Reef, Eighty-mile Beach and Roebuck Bay. These wetlands are discussed further in **Section 9.2**.

The EPBC Act Policy Statement 3.21 sets out criteria for determining the significance of sites to migratory shorebirds based on the number of migratory species and the proportion of a species population that is supported by the site (Commonwealth of Australia 2017b). Site significance can be difficult to assess, particularly for ephemeral inland wetlands. These areas may be used rarely, depending weather conditions, but still provide important habitat for migratory shorebird species.

Migratory shorebirds require a particular conservation approach due to their migration patterns that take them across international boundaries (Bamford *et al*. 2008). These species and their habitats are sensitive to threats due to their high site fidelity, tendency to aggregate, high energy demands and the need for habitat networks containing both roosting and foraging sites (Commonwealth of Australia 2017b). Migratory shorebirds are known to use networks of connected sites (also known as site complexes). They move within these networks depending on the time of day, availability of resources and environmental conditions at the site (Commonwealth of Australia 2017b).

The types of habitat used by migratory shorebirds in Australia vary across the species identified in the PMST search. Migratory shorebirds use both coastal and inland habitats that most commonly include:

+ Coastal habitats: coastal wetlands, estuaries, mudflats, rocky inlets, reefs and sandy beaches, sometimes supporting mangroves; and
+ Inland habitats: inland wetlands, floodplains and grassland areas, often with ephemeral water sources (Commonwealth of Australia 2017b).

Feeding guilds provide an explanation for much of the shorebird distribution pattern in the north Western Australia. For example, Rogers (1999) classified shorebirds (and others) in Roebuck Bay as belonging to seven guilds on the basis of prey choice and foraging method. In order of abundance; these are summarised in **Table 8-3**.

Table 8-3: Feeding guilds based on prey choice and foraging method (Rogers 1999) adapted from DEC (2003) and Bennelongia (2008)

Feeding habitat	Feeding guild	Species
Sea edge	Tactile hunters of macrobenthos	Great knot, red knot, bar-tailed godwit, black-tailed godwit, Asian dowitcher
Along sandy sea edges or near tidal creeks	Tactile hunters of microbenthos	Curlew sandpiper, red-necked stint, broad-billed sandpiper, marsh sandpiper, sharp-tailed sandpiper
Reefs or mangrove fringes	Visual hunters of slow surface-dwelling prey	Common sandpiper, sooty oystercatcher, pied oystercatcher, silver gull, ruddy turnstone
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 2015.

Table 8-4: Birds subject to the Wildlife Conservation Plan 2015

Migratory species	DoEE SPRAT information on distribution within the area of interest
Common sandpiper	WA distribution: • Roebuck Bay; and • Nuytsland Nature Reserve.
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).
Oriental pratincole	Internationally important site: • Eighty Mile Beach (2.88 million birds).

Migratory species	DoEE SPRAT information on distribution within the area of interest
	The species occurs at numerous and widespread sites in northern Australia, especially near the Pilbara and Kimberley coasts of northern WA.
Oriental plover	Internationally important marine sites: • Eighty Mile Beach (approximately 60,000 birds); and • Roebuck Bay (Approximately 8500 birds).
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).
Streaked shearwater	Exmouth Gulf to the north.

Shorebird migration patterns are seasonal and vary according to species (DSEWPaC 2012). Generally, shorebirds migrate to northern Australia in August to November. Many birds remain in northern Australia but others disperse southwards (Bennelongia 2011). Migratory shorebird numbers on northern beaches peak in November then again in March as the majority of birds begin their return to the northern hemisphere between March and May. Most migratory shorebirds do not breed in Australia and juvenile birds may spend several years in Australia before reaching maturity and returning north to breed (DEWHA 2009).

8.4 Biologically Important Areas / Habitat Critical – Birds

Table 8-5 below provides an overview of BIAs in the EMBA for birds. The DAWE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that ‘habitat critical to the survival of the listed threatened species’ is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[7].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat ‘critical to the survival of the threatened species’. To date no critical habitat in WA has been listed under either Act.

Table 8-5: Biologically important areas - birds

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Common noddy	*Anous stolidus*	Foraging	Around Houtman Abrolhos Around Lancelin Island
Australian lesser noddy	*Anous tenuirorstris melanops*	Foraging - Houtman Abrolhos Islands	Houtman Abrolhos Islands
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.
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.

[7] 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
			Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef
Little penguin	*Eudyptula minor*	Foraging - Perth to Bunbury	Perth to Bunbury
Lesser frigatebird	*Fregata ariel*	Breeding, foraging – Kimberley and Pilbara coasts and islands also Ashmore Reef.	Kimberley and Pilbara coasts and islands also Ashmore Reef.
Greater frigatebird	*Fregata minor*	Breeding, foraging - Kimberley and Ashmore Reef	Kimberley and 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.
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).
Bridled tern	*Sterna anaethetus*	Foraging - West coast of Western Australia and around to Recherche Archipelago	West coast of WA and around to Recherche Archipelago including offshore waters
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
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
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
Soft plumage petrel	*Pterodroma mollis*	Foraging - seas north to 21º30'S	In WA found in seas north to 21º30'S.
Little shearwater	*Puffinus assimilis*	Foraging - From Kalbarri to Eucla	From Kalbarri to Eucla including offshore waters
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

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
			Ashmore Reef, Bedout Island and the Houtman Abrolhos.
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
Australian fairy tern	*Sternula nereis*	Foraging – Kimberley, Pilbara and Gascoyne coasts and islands	Found in the vicinity of lower north-west coast (north to Dampier Archipelago), west coast (south to Peel Inlet) and south coast (from Flinders Bay east to Israelite Bay), including islands (as far offshore as Trimouille Island and Houtman Abrolhos. Pilbara and Gascoyne coasts and islands
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.
Red-footed Booby	*Sula sula*	Breeding, foraging - north west Kimberley and Ashmore reef	North west Kimberley and Ashmore reef
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
White-faced storm petrel	*Pelagodroma marina*	Foraging (in high numbers) - Offshore areas of the south-west marine region and into the adjacent south-east marine region and the north-west marine region to north of Shark Bay	Offshore areas of the south-west marine region and into the adjacent south-east marine region and the north-west marine region to north of Shark Bay

9. Protected Areas

A number of areas in the EMBA are protected under state and federal legislation. Protected areas include World Heritage Areas, Wetlands of International Importance (Ramsar), Wetlands of National Importance, National and Commonwealth Heritage Places, and terrestrial conservation reserves (National Parks, Nature Reserves and Conservation Parks) that bound marine waters. These areas are listed in **Table 9-1**, and shown in **Figure 9-1**, **Figure 9-2** and **Figure 9-3**, and discussed below. Other protected areas include Key Ecological Features (discussed in **Section 10**) and State and Commonwealth Marine Parks/Reserves (discussed in **Section 11** and **Section 12**). A Protected Matters search of the EMBA (**Appendix A**) identified several protected areas which were deemed to be irrelevant to Santos WA's petroleum activities due to their terrestrial location (e.g. Forrestdale and Thomsons Lakes – Ramsar wetland).

The Register of the National Estate (RNE) provides a listing of more than 13,000 natural, historic and indigenous sites of significance. However, in 2012 all references to the RNE were removed from the EPBC Act and the *Australian Heritage Council Act 2003*.The RNE is now maintained on a non-statutory basis as a publicly available archive and educational resource. A protected matters search of the area from the South Australian border to the NT border listed 197 places on the RNE, although it is recognised that not all indigenous sites may be listed (**Appendix A**). The RNE places are not discussed further here but are listed in **Appendix A**.

Table 9-1: Summary of protected areas in waters within the EMBA

Area type	Title
World Heritage Area	Shark Bay
	The Ningaloo Coast
Wetland of International Importance (Ramsar)	Eighty Mile Beach
	Roebuck Bay
	Ashmore Reef National Nature Reserve
	Becher Point
	Peel-Yalgorup System
	Vasse-Wonnerup System
	Hosnies Spring
	The Dales
Wetlands of National Importance	Ashmore Reef
	Mermaid Reef
	Vasse-Wonnerup Wetland System
National Heritage Place	HMAS Sydney II and HSK Kormoran Shipwreck Sites
	Batavia Shipwreck Site and Survivor Camps Area 1629- Houtman Abrolhos
	The West Kimberley
	The Ningaloo Coast
	Shark Bay
	Dirk Hartog Landing Site 1616 - Cape Inscription Area
	Dampier Archipelago (including Burrup Peninsula)
	Fitzgerald River National Park
	Lesueur National Park
Commonwealth Heritage Place	HMAS Sydney II and HSK Kormoral Shipwreck Sites

Area type	Title
	Ningaloo Marine Area - Commonwealth Waters
	Mermaid Reef - Rowley Shoals
	Ashmore Reef National Nature Reserve
	Scott Reef and Surrounds – Commonwealth Area
	Garden Island
	Christmas Island Natural Areas
	Yampi Defence Area
	Learnmonth Air Weapons Range Facility
	Lancelin Defence Training Area
Threatened Ecological Communities	Monsoon Vine Thickets on the ridge on the coastal sand dunes of Dampier Peninsula
	Roebuck Bay mudflats
	Subtropical and Temperate Coastal Saltmarsh
Terrestrial Conservation Reserves e.g. national parks, nature reserves, and conservation parks.	Numerous bounding marine waters – refer to **Section 9.6.**

9.1 World Heritage Areas

There are two World Heritage Areas located in marine waters of WA, both of which occur in the waters from the South Australian border to the NT border: the Ningaloo Coast and Shark Bay (DEC 2012).

9.1.1 Shark Bay

Shark Bay was included on the World Heritage List in 1991 and is one of the few properties inscribed for all four outstanding natural universal values:

+ An outstanding example representing the major stages in the earth's evolutionary history;
+ An outstanding example representing significant ongoing ecological and biological processes;
+ An example of superlative natural phenomena; and
+ Containing important and significant habitats for in situ conservation of biological diversity.

Since 1997, an agreement established the joint management of the Shark Bay WHA by the Australian Commonwealth government and the Western Australian state government, with the operational responsibility by the Western Australian agencies (DEWHA 2008a). This agreement also created a Community Consultative Committee and a Scientific Advisory Committee, both of which provide advice as required. The entire WHA encompasses islands and peninsulas, with an area of approximately 2.2 million hectares (70% of which is marine waters), and includes the following areas (UNESCO 2020):

+ Hamelin Pool Marine Nature Reserve;
+ Francois Peron National Park;
+ Shell Beach Conservation Park;
+ Monkey Mia Reserve;
+ Monkey Mia Conservation Park;
+ Zuytdorp Nature Reserve;

- Bernier, Dorre and Koks Islands Nature Reserves;
- Dirk Hartog Island National Park; and
- Various pastoral leases.

The marine environment of the Shark Bay World Heritage Area is protected as a State Marine Reserve and is discussed further in **Section 11.1.3**.

9.1.2 The Ningaloo Coast

The Ningaloo Coast was included on the World Heritage List in 2011 and was inscribed for outstanding natural universal values as follows:

- An example of superlative natural phenomena and areas of exceptional natural beauty and aesthetic importance;
- outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features; and
- the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The Ningaloo Coast WHA includes (DEWHA 2010b):

- Ningaloo Marine Park (Commonwealth waters);
- Ningaloo Marine Park (Western Australia state waters);
- Muiron Island Marine Management Area (including the Muiron Islands);
- Jurabi Coastal Park;
- Bundegi Coastal Park;
- Cape Range National Park; and
- Learmonth Air Weapons Range.

The Ningaloo Coast World Heritage Area (including the Muiron Islands) is managed under a plan that is consistent with the World Heritage Convention and Australia's World Heritage management principles. World Heritage Management principles are set out in regulations and cover matters relevant to the preparation of management plans, the environmental assessment of actions that may affect the property and community consultation processes.

The Australian World Heritage management principles are outlined under Schedule 5 of the EPBC regulations (2000). The objective is to ensure that any likely impact of an action on the World Heritage values of the property should be considered. Any action should be consistent with the protection, conservation, presentation or transmission to future generations of the World Heritage values of the property.

The marine environment of the Ningaloo Coast World Heritage Area is protected as a State Marine Park, a Commonwealth Marine Park, and is discussed further in **Section 11.1.4** and **Section 12.3.4**, respectively.

9.2 Wetlands of International Importance (Ramsar)

There are nine wetlands of international importance (Ramsar wetlands) in waters from the South Australian border to the NT border; all were listed in 1990 with the exception of Becher Point which was listed in 2001 and The Dales which was listed in 2002. The Ashmore Reef National Nature Reserve (listed in 2002) is also a Commonwealth Marine Park and is discussed further in **Section 12.3.12.**

9.2.1 Eighty Mile Beach

The Eighty Mile Beach Ramsar site comprises a 220 km beach between Port Hedland and Broome with extensive intertidal mudflats and Mandora Salt Marsh, located 40 km east (Hale & Butcher 2009) totalling 175,487 ha. Eighty Mile Beach is characterised by extensive mudflats supporting an abundance of macroinvertebrates which provide food for large numbers of shorebirds.

Eighty Mile Beach is one of the most important sites for migratory shorebirds in the East Asian Australasian Flyway, with 42 migratory shorebird species recorded at this location. It is estimated that 500,000 shorebirds use Eighty Mile Beach as a migration terminus annually (Hale and Butcher 2009), and more than 472,000 migratory waders have been counted on the mudflats during the September to November period. The location of Eighty Mile Beach makes it a primary staging area for many migratory shorebirds on their way to and from Alaska and eastern Siberia (Hale & Butcher 2009). Although many birds move further on their journey, others remain at the site for the non-breeding period.

Eighty-mile Beach supports more than one per cent of the flyway population (or one per cent of the Australian population for resident species) of 21 waterbirds, including 17 migratory species and four Australian residents. It is one of the most important sites in the world for the migration of Great Knot.

Eighty Mile Beach also supports a high diversity and abundance of wetland birds. A total of 97 wetland bird species have been recorded within the beach portion of the Ramsar site (Hale & Butcher 2009). This includes 42 species that are listed under international migratory agreements CAMBA (38), JAMBA (38) and ROKAMBA (32) as well as an additional 22 Australian species that are listed under the EPBC Act. In addition, there is a single record for Nordmann's Greenshank (*Tringa guttifer*) from the beach, which is listed as endangered under the IUCN Red List (IUCN 2019).

The Mandora Salt Marsh area contains an important and rare group of wetlands (Lake Walyarta and East Lake), including raised peat bogs, a series of small permanent mound springs and the most inland occurrence of mangroves in WA (Hale & Butcher 2009). A small number of tidal creeks dissect the beach, including Salt Creek which is fed partly from groundwater and has permanent surface water. The Mandora Salt Marsh lakes fill predominantly from rainfall and runoff in the wet season then dry back to clay beds. The mound springs likely come from water deep within the Broome sandstone aquifer rising through fractures in the rock, and resulting in permanent mostly freshwater surface water. Flatback turtles (*Natator depressus*), listed as vulnerable under the EPBC Act, regularly nest at scattered locations along Eighty Mile Beach.

Eighty Mile Beach is used for beach based recreation, including four-wheel driving, motorcycling, fishing and shell collecting. Mandora Salt Marsh is mainly used for cattle grazing. The site is traditionally part of Karajarri Country in the north, Nyangumarta Country in the south and Ngarla Country in the southern end of Eighty Mile Beach. The site has artefacts such as middens, pinka (large baler shells used to scoop and carry water for drinking), wilura (used for sharpening spear heads), axes, and flakes, and kurtanyanu and jungari (grinding stones).

9.2.2 Roebuck Bay

The Roebuck Bay Ramsar site is located at Roebuck Bay near Broome in northern WA totalling 34,119 ha. Roebuck Bay has a large tidal range which exposes around 160 km^2 of mudflat, covering most of the Ramsar site (DoE 2014c). Waters more than 6 m deep at low tide are excluded from the site (Bennelongia 2009). The eastern edge of the site is made up of microscale linear tidal creeks (DoE 2014c).

The intertidal mud and sand flats support a high abundance of bottom dwelling invertebrates (between 300—500 benthic invertebrate species), which are a key food source for waterbirds (Bennelongia 2009). The site is one of the most important migration stopover areas for shorebirds in Australia and globally. For many shorebirds, Roebuck Bay is the first Australian landfall they reach on the East Asian Australasian Flyway. The total numbers of waders using the site each year is estimated at over 300,000 (DoE 2014c). The northern beaches and Bush Point provide important high tide roost sites.

The site receives tidal seawater as well as fresh surface and groundwater, and the balance between the two influences the residual groundwater salinity and the distribution of plants and animals (DoE 2014c). Mangrove swamps line the eastern and southern edges of the site, and extend up into the linear tidal creeks (DoE 2014c). They are important nursery areas for marine fishes and crustaceans, particularly prawns.

Extensive seagrass beds occur in the bay, providing an important feeding ground for dugongs and loggerhead and green turtles (Bennelongia 2009). Flatback turtles nest in small numbers, while marine fish (including sawfish) regularly breed in the tidal creeks and mangroves. Dolphins also regularly use the site (DoE 2014c).

The site is used for recreational or tourism activities such as fishing, crabbing, sightseeing and bird watching. Broome Bird Observatory, a small reserve at the northern end of the site, engages in shorebird research and public education.

Roebuck Bay lies in the traditional estate of Indigenous people belonging to both Jukun and Yawuru groups. The site was an important area for seasonal meetings, exchanging gifts, arranging marriages and settling disputes. Numerous shellfish middens, marking former camping places, can still be seen along coastal cliffs and dunes. Indigenous people continue to make extensive use of Roebuck Bay's natural resources for activities such as gathering shellfish, fishing and hunting.

9.2.3 Ashmore Reef National Nature Reserve

In addition to being listed as a National Nature Reserve, Ashmore Reef has been designated a Ramsar Wetland of International Importance due to the importance of the islands in providing a resting place for migratory shorebirds and supporting large breeding colonies of seabirds (Hale and Butcher, 2013). The reserve provides a staging point for many migratory wading birds from October to November and March to April as part of the migration between Australia and the northern hemisphere (Commonwealth of Australia, 2002). Migratory shorebirds use the reserve’s islands and sand cays as feeding and resting areas during their migration.

Ashmore is the largest of the atolls in the Timor Province bioregion. The three islands within the site are also the only vegetated islands in the bioregion. Each of the wetland types present are in near natural condition and the site has the largest seagrass coverage in the bioregion. The reserve supports 64 species of internationally and nationally threatened species. This includes 41 species of hard reef forming coral, eight fish, six reptiles (including endangered and critically endangered sea turtles and seasnakes), five sea cucumbers, two giant clams, one soft coral and the dugong.

Ashmore Reef plays a primary role in the maintenance of biodiversity in reef systems in the region. The Reserve supports 275 species of reef building coral, 13 species of sea cucumbers, and high numbers of mollusc species. There are over 760 fish species, 13 species of sea snake, 99 species of decapod crustacean and 47 species of waterbird listed as migratory under international treaties. It supports breeding of 20 species of waterbirds including the brown booby, lesser frigatebird, crested tern, bridled tern, sooty tern and common noddy. The Ramsar site is also important for feeding for green turtles, hawksbill turtle and loggerhead turtle and critical nesting and inter-nesting habitats for green and hawksbill turtles.

Ashmore Reef regularly supports more than 20,000 waterbirds and has been known to support more than 65,000 waterbirds. The Ramsar site regularly supports more than one per cent of at least six species of waterbird including the sooty tern, bar-tailed godwit, grey-tailed tattler, ruddy turnstone, sanderling and greater sand plover.

9.2.4 Becher Point

The Becher Point Wetlands Ramsar site is a system of about sixty small wetlands located near Rockingham in south-west Western Australia and covers 677 ha. The wetlands are made up of chains of small, linear ovoid or irregular shaped basins arranged in five groups, each roughly parallel to the coast and separated by sand ridges (DoE 2014l). The wetlands are an example of shrub swamps and seasonal marshes that have formed in an extensive sequence of inter-dunal depressions that have arisen from seaward advancement of the coastline over recent millennia.

The wetlands in the site are shallow and fill seasonally. Rainfall in winter and spring recharges the groundwater, which rise up to waterlog the wetland basins. The wetlands then dry out again for summer to autumn. When flooded the wetlands are mainly freshwater (DoE 2014l).

The wetlands support sedgelands, herblands, grasslands, open-shrublands and low open-forests. The sedgelands that occur within the linear wetland depressions of the Ramsar site are a nationally listed threatened ecological community. At least four species of amphibians and 21 species of reptiles have been recorded within the wetlands, as well as the Southern Brown Bandicoot (DoE 2014l).

9.2.5 Peel-Yalgorup System

The Peel-Yalgorup System located adjacent to the city of Mandurah in Western Australia, is a large and diverse system of shallow estuaries, coastal saline lakes and freshwater marshes. The site includes the Peel Inlet, Harvey Estuary, Lake McLarty, Lake Mealup and ten Yalgorup National Park wetlands and covers an area of 26, 530 ha (DoE 2014m). Lake Clifton, which is part of the wetlands is one of the few locations in the word where thrombolites occur in inland, hyposaline waters. Thrombalites are underwater rock-like structures that are formed by the activities of microbial communities.

The Peel-Yalgorup System Ramsar site is the most important area for waterbirds in south-western Australia, supporting in excess of 20,000 waterbirds annually (DoE 2014m). It also supports a wide variety of invertebrates and estuarine and marine fish.

9.2.6 Vasse-Wonnerup System

The Vasse-Wonnerup System Ramsar wetland is situated in the Perth Basin, south-western Western Australia and covers an area of 1,115 ha. It is an extensive, shallow, nutrient-enriched wetland system of highly varied salinities. The site is located on a narrow, flat plain separated from the ocean by a narrow system of low dunes. The system is comprised of two former estuaries – the Vasse and Wonnerup lagoons (DoE 2014n).

The system supports tens of thousands of resident and migrant waterbirds of a wide variety of species. More than 33,000 waterbirds have been counted at the Vasse-Wonnerup System and more than 80 species have been recorded in the System including Red-necked Avocets and Black-winged Stilts, Wood Sandpiper, Sharp tailed Sandpiper, Long-toed Stint, Curlew Sandpiper and Common Greenshank (DoE 2014n).

9.2.7 Hosnies Spring

The Hosnies Spring Ramsar site is located on Christmas Island and is a small area of shallow freshwater streams and seepages, 20–45 metres above sea-level on the shore terrace of the east coast of the island covering an area of approximately 199 ha. The site includes surrounding terrestrial areas with rainforest grading to coastal scrub, and includes an area of shoreline and coral reef (DoEE 2019).

The Hosnies Spring Ramsar site supports a unique wetland of Christmas Island with the mangrove forest present at the site unique within the bioregion and possibly worldwide. The two species of mangroves that make up the stand, which normally grow intertidally, grow to a height of 24–37 m above sea level that have been estimated to have persisted for 120,000 years. Additionally, the site is important to blue crabs which rely on the freshwater provided by the spring and as a likely migratory route for the endemic red crab during breeding migrations (DoEE 2019).

9.2.8 The Dales

The Dales Ramsar site is located on Christmas Island and is comprised of a near-pristine system of seven watercourses collectively known as The Dales and covers an area of 585 ha. The Dales includes permanent and perennial streams, permanent springs, and include the majority of surface water on the Island. Most rainfall on Christmas Island filters down through the soil and limestone, and surface runoff only occurs after heavy rain. The Dales contain numerous wetland types including surface and karst features, and inland and coastal wetlands (DoEE 2019a).

The Dales support a number of unique ecological and geomorphic features including anchialine cave communities, surface karst including the unique stepped tufa deposits at Hugh's waterfall, a stand of Tahitian chestnuts, a large number of endemic terrestrial species and a significant number of seabirds including Abbott's booby, red-footed booby and the brown booby, all of which breed at the site, and provide essential habitat for the Christmas Island frigatebird (DoEE 2019a).

9.3 Wetlands of National Importance

9.3.1 Ashmore Reef

See the Ashmore Reef National Nature Reserve (**Section 9.2.3**) and Ashmore Reef Marine Park (**Section 12.3.12**).

9.3.2 Mermaid Reef

See the Mermaid Reef Marine Park (**Section 12.3.9**).

9.3.3 Vasse-Wonnerup Wetland System

See the Vasse-Wonnerup Wetland System (**Section 9.2.6**).

9.4 National Heritage Places

Natural, historic and indigenous places that are of outstanding heritage value to the Australian nation are recorded as National Heritage Places. Eleven National Heritage Places are found in waters from the South Australian border to the NT border, with nine od these occurring within the EMBA. Shark Bay and The Ningaloo Coast are listed as both World Heritage Areas and National Heritage Places, and are discussed in **Section 9.1**.

9.4.1 HMAS Sydney II and HSK Kormoran Shipwreck Sites

The naval battle fought in 1941 between the Australian warship HMAS Sydney II and the German commerce raider HSK Kormoran off the Western Australian coast during World War II was a defining event in Australia's cultural history. The loss of HMAS Sydney II, along with its entire crew of 645 following the battle with HSK Kormoran, remains Australia's worst naval disaster (DoE 2014d).

The shipwreck sites are comprised of two areas located approximately 290 km west-southwest of Carnarvon. The shipwrecks of the HMAS Sydney II and HSK Kormoran are located on the seabed approximately 22 km apart (DoE 2014d).

9.4.2 Batavia Shipwreck site and Survivor Camps Area 1629 - Houtman Abrolhos

The Batavia was included on the National Heritage List in 2006. This shipwreck is the oldest of the known Verenigde Oost-Indische Compagnie (VOC) wrecks on the WA coast and has a unique place in Australian shipwrecks. Because of its relatively undisturbed nature the archaeological investigation of the wreck itself has revealed a range of objects of considerable value to the artefact specialist and historian. The recovered sections of the hull of the Batavia that have been reconstructed in the Western Australian Maritime Museum and provides information on 17th century Dutch ship building techniques, while the remains of the cargo carried by the vessel have provided economic, and social evidence of the operation of the Dutch port at Batavia (now Jakarta) in the early 17th century (DoE 2014d).

9.4.3 The West Kimberley

The West Kimberley was included on the National Heritage List in 2011 and has numerous values which contribute to the significance of the property, including indigenous, historic, aesthetic, cultural and natural heritage values (DoE 2014d). Of these values, the most relevant to the marine environment is Roebuck Bay as a migratory hub for shorebirds. These values are discussed in **Section 9.2.2**. The area is characterised by a diversity of landscapes and biological richness found in its cliffs, headlands, sandy beaches, rivers, waterfalls and islands.

9.4.4 The Ningaloo Coast

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.4.5 Shark Bay

See Shark Bay World Heritage Area (**Section 9.1.1**).

9.4.6 Dirk Hartog Landing Site 1616 - Cape Inscription Area

Cape Inscription is the site of the oldest known landings of Europeans on the Western Australian coastline (from Dirk Hartog of the Dutch East India Company's ship the Eendracht in October 1616), and is associated with a series of landings and surveys by notable explorers over a 250-year period (DoEE 2019b). The landing site forms part of the Dirk Hartog Island, and is about 1,110 ha located 100 km south west of Carnarvon (DoEE 2019b).

9.4.7 Dampier Archipelago (including Burrup Peninsula)

The Dampier Archipelago (including the Burrup Peninsula) contains one of the densest concentrations of rock engravings in Australia, with some sites containing thousands or tens of thousands of images. At a national level it has an exceptionally diverse and dynamic range of schematised human figures, and provides an unusual and outstanding visual record of the Aboriginal responses to the rise of sea levels at the end of the last Ice Age (DoEE 2019c).

The site is about 36,860 ha at Dampier and comprises of nine distinct areas of the Burrup Peninsula Areas and part of the following surrounding islands: West Intercourse Island, West Mid Intercourse Island, Enderby Island, Goodwin Island, West Lewis Island and East Lewis Island, Rosemary Island, Brigadier Island, Miller Rocks, Lady Nora Island and Elphick Nob, Malus Islands, Angel Island, Gidley Island, Cohen Island, Keast Island and Collier Rocks, Tozer Island, Dolphin Island, and Unnamed Island (DoEE 2019c).

9.4.8 Fitzgerald River National Park

The Fitzgerald River National Park contains an exceptional concentration of plant species richness and endemism. At an international level it is recognised as a biodiversity hotspot of south western Australia and at a national level it has an exceptional endemism and diversity for plant species. The diversity is considered high due to a wide range of landforms, geology and soil types that supports a diverse community of shrublands and heath, often dominated by eucalypt mallee species (DoEE 2019d).

The national park is approximately 297,244 ha located between Bremer Bay and Hopetoun in the south west of Western Australia. The park contains extensive marine plain sediments deeply incised by several rivers, creating valleys and tablelands. The park's coastline is diverse, consisting of long beaches, quartzite cliffs, extensive sand drifts and inlets. Along the Hamersley and Fitzgerald River valleys are spongolite cliffs that were formed more than 36 million years ago (Eocene period) and consist of sea sponge fossils (DoEE 2019d)

9.4.9 Lesueur National Park

The Lesueur National Park contains an exceptional concentration of plant species richness and endemism. At an international level it is recognised as a biodiversity hotspot of south western Australia and at a national level it has an exceptional endemism and diversity for plant species. The diversity is considered high due to a wide range of landforms, geology and soil types that supports a diverse community of shrublands and heath (DoEE 2019e).

The national park is approximately 27,235 ha located near the towns of Green Head and Jurien Bay. Coastal areas consist of recent (Holocene) sand deposits and mobile dunes extending inland for approximately two kilometres. The dunes are bordered by a series of mainly saline lakes with some freshwater springs and swamps on the eastern margins. Further inland are older (Quaternary) dune systems that have been compacted in places to form limestone. The park supports approximately 122 birds, including a diverse range of honeyeaters, fairy wrens and thornbills (DoEE 2019e).

9.5 Commonwealth Heritage Places

The Commonwealth Heritage Places List comprises natural, indigenous and historic heritage places which are either entirely within a Commonwealth area, or outside the Australian jurisdiction and owned or leased by the Commonwealth or a Commonwealth Authority. Nine natural Commonwealth Heritage Places are found in or adjacent to the EMBA. Three of these places (Ashmore Reef, Mermaid Reef and the Ningaloo Marine Area – Commonwealth Waters) are found in Marine Parks and are discussed further in **Section 12**. The HMAS

Sydney II and HSK Kormoran Shipwreck Sites is listed under both National and Commonwealth Heritage Lists and discussed in **Section 9.4.1**.

9.5.1 Scott Reef and Surrounds – Commonwealth Area

Scott Reef is a large, emergent shelf atoll located on the edge of the broad continental shelf, about 300 km from mainland north-western Australia. The listing comprises the areas of Scott Reef that are within Commonwealth waters to the 50 m BSL bathymetric contour. This includes North Reef, an annular reef, 16.3 km long and 14.4 km wide; and parts of the lagoon of South Reef, a crescent shaped reef 17 km across (DoE 2014d).

The place is regionally significant both because of its high representation of species not found in coastal waters off Western Australia and for the unusual nature of its fauna which has affinities with the oceanic reef habitats of the Indo-West Pacific as well as the reefs of the Indonesian region (DoE 2014d).

9.5.2 Mermaid Reef – Rowley Shoals

See the Mermaid Reef Marine Park (**Section 12.3.9**).

9.5.3 Ningaloo Marine Area – Commonwealth Waters

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.5.4 Ashmore Reef National Nature Reserve

See the Ashmore Reef Marine Park (**Section 12.3.12**).

9.5.5 Garden Island

Garden Island is located to the south of Perth, 5 km northwest of Rockingham. It was registered in 2004 based on various fauna, geological, European and Aboriginal heritage and vegetation values. It was the original first site occupied by Governors Stirling's Party in 1829, with prior use by Aborigines and the French (being called Ile de Buache by the French in 1801). The island is virtually free from widespread feral animal colonisation, providing important habitat for various species that have reduced on the mainland. The island provides breeding habitat for bridled tern (*Sterna anaethetus*), rainbow bee-eaters (*Merops ornatus*) and osprey (*Pandion haliaetus*), which nest on the rocks surrounding the island. Important feeding habitat for the Sanderling (*Calidris alba*) is provided by sandy beaches on the west coast of the island.

The island provides nesting habitat on beaches for the breeding migrant fairy tern (*Sterna nereis*), which requires undisturbed nesting periods. The mature relatively undisturbed heath, scrub and low forest communities unburnt since the 1920's in the northern section of the island are especially important as a reference site for natural history. The least disturbed examples of calcaronite reef structures dune and tamate landscapes in the metropolitan region are present on the western side of the island (DoEE 2016b).

9.5.6 Christmas Island Natural Areas

Christmas Island is located is approximately 1,500 km from Exmouth and is approximately 2,200 ha above Low Water and 3,600 ha below Low Water in the Indian Ocean. The island is an uplifted coral atoll with its characteristic steep series of rainforest-covered terraces and sheer limestone cliffs. It was registered in 2004 based on various fauna, vegetation, geological and cultural heritage values. The evolutionary significance of Christmas Island is demonstrated both by its high level of endemism and by its unique assemblage of plant and animal species. The island hosts seventeen endemic plant species and rich endemic fauna includes three mammal species, ten bird species, five reptile species, one crab species, two insects, three marine fish species and several marine sponge species (DoEE 2019f).

The rainforests of Christmas Island are biogeographically significant; species have evolved from being either shoreline forest or early rainforest succession species to those that fill a tall climax rainforest role. The Island contains unique plant communities of high conservation and scientific interest including a variety of elevated and relict cycad and back-mangrove communities of international significance (DoEE 2019f).

The island is also one of the world's most significant seabird islands, both for the variety and numbers of sea-birds, with over 100 species of bird having been recorded, including eight species that breed on the island. The island rainforest provides significant habitat for two endemics the nationally endangered Abbott's booby and the nationally vulnerable Christmas Island frigate bird (DoEE 2019f).

The fringing simple reefs and adjacent waters of Christmas Island support provides habitat for two nationally vulnerable species of turtle, the green and hawksbill which nest on two of the Island's beaches and two nationally vulnerable shark species (DoEE 2019f).

9.5.7 Yampi Defence Area

The Yampi Defence Area is located at the confluence of the Dampierland, Central and Northern Kimberley biogeographic regions and has a diverse range of ecosystems of landforms, soils and vegetation representative of the transition from the sandstone plateaux of the wetter north-west Kimberley, to the broad plains and pindan scrub of the drier south-west Kimberley (DoEE 2019g).

The diversity of landforms in the place and the resultant high concentration of small refugial habitats support a regionally rich vertebrate fauna. The bird fauna is significant as it represents a suite of species which are at or near the southern edge of their range in the semi-humid zone of the Kimberley. The place is also an important zone of overlap between many northern and southern species and sub-species. The vertebrate fauna shows its closest similarity to those recorded from the wetter areas of the west Kimberley that lie further to the north. The place supports several fauna and flora species that are listed as specially protected, threatened or having priority status in Western Australia in addition to four fauna species that are nationally vulnerable and one nationally endangered (DoEE 2019g).

9.5.8 Learmonth Air Weapons Range Facility

The Learmonth Air Weapons Range Facility is located 30 km south west of Learmonth within Cape Range and Adjacent Coastal Plain, which is listed on the Register of the National Estate. As the Learmonth Air Weapons Range Facility is located within Cape Range it is of considerable importance of showing he sea level and landform changes for the past 1.8 million years (DoEE 2019h).

The area is important to a number of cave fauna of Cape Range and is considered of exceptional biogeographical importance. It hosts a high number of endemic aquatic stygofauna with ecosystems found within this area are considered rare within Western Australia and are considered to be of considerable scientific interest. The area also supports several species of terrestrial fauna that are isolated populations, populations at the extent of their range and a number of fauna and flora species that are endemic to southern WA and restricted to sandy coastal habitats along the western coast (DoEE 2019h).

9.5.9 Lancelin Defence Training Area

The Lancelin Defence Training Area is located approximately 11 k north of Lancelin township situated on the Swan Coastal Plain and consists of three main land systems that include Quindalup and Spearwood Dune Systems (together making up the Coastal Belt), and the Bassendean Dunes (DoEE 2019i).

The area supports a high diversity of vegetation types, flora species, fauna habitat types and a high diversity of terrestrial fauna.

9.6 Coastal Terrestrial Conservations Reserves – bound by marine waters

Conservation reserves are created under the Land Administration Act 1997, and once reserved and set aside for conservation purposes are regulated under the *Conservation and Land Management Act (CALM) 1984*. Most conservation reserves in WA are vested in (owned) by the WA Conservation and Parks Commission, an independent statutory body established by the CALM Act 1984, and most are managed by the Department of Biodiversity, Conservation and Attractions – Parks and Wildlife Service.

In WA there are three main types of terrestrial conservation reserves with legislative protection:

- Nature reserves – established for wildlife and landscape conservation; scientific study; and preservation of features of archaeological, historic or scientific interest;

- National parks – as above but also to be used for enjoyment by the public. Have national or international significance; and
- Conservation parks – as above but have local or regional significance.

Nature reserves can have an extra classification applied to them and become ‘A class’ reserves, which generally require an Act of Parliament to alter.

There are numerous terrestrial conservation reserves located adjacent to the coast in the EMBA. The oceanward boundary of the reserves varies. In some cases, the reserves extend to the low water mark, i.e. including the inter-tidal zone (particularly applicable to older gazetted reserves and terrestrial reserves not surrounded by a marine reserve). While in other cases, the terrestrial reserves extend to the high-water mark e.g. Lowendal Islands Nature Reserve (particularly applicable to terrestrial reserves adjacent to more recently gazetted marine parks). In other cases, the seaward boundary of the reserves is not defined. Management plans also contain the caveat for further consideration of the most appropriate tenure for intertidal areas and management arrangements.

Further information on coastal terrestrial reserves is provided below in **Section 9.6.1** (national parks) and **Section 9.6.2** (nature reserves and conservations parks).

9.6.1 Coastal National Parks

Protected coastal national parks managed under the CALM Act 1984 in the EMBA are listed in **Table 9-2**. The table also includes: any applicable management plan; whether the park includes the inter-tidal area; and the name of any adjacent state marine reserve. All National Parks are WA Class A reserves and IUCN Class 2.

Table 9-2: Coastal National Parks – coastal boundary in relation to inter-tidal zone

National Park	IBRA bioregion[8]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Reserves of Northern WA (see Figure 9-4)				
Lawley River	Northern Kimberley	-	No [9]	Kimberley Marine Park
Mitchell River		-		
Prince Regent		-		
Reserves of North-West WA (see Figure 9-5)				
Murujuga	Pilbara	Murujuga National Park management plan 78 (DEC 2013)	Yes [10]	-
Cape Range	Carnarvon	Cape Range National Park Management Plan (DEC 2010a)	No	Ningaloo Marine Park
Reserves of Southern WA – (see Figure 9-6)				
Francois Peron	Carnarvon	Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan (2012)	No	Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve
Dirk Hartog	Yalgoo		Yes – intertidal zone on western side of Dirk Hartog is included (as no marine park on western side of island)	

[8] IBRA classifies Australia’s landscapes into large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (DoEE 2012).

National Park	IBRA bioregion[8]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Kalbarri	Geraldton Sandplains	Kalbarri National Park Management Plan (DPAW 2015)	Yes [10]	-
Namburg	Geraldton Sandplains	Namburg National Park Management Plan (1998)	Yes	-
Yalgorup	Swan Coastal Plain	Yalgorup National Park Management Plan (CALM 1995)	Yes [10]	-
Leeuwin - Naturaliste	Warren	Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan (DPAW 2015)	No	Ngari Capes Marine Park
Torndirrup	Warren	Albany coast draft management plan 2016 (DPaW 2016b)	Yes[10]	
Walpole-Nornalup	Warren	Walpole Wilderness and Adjacent Parks and Reserves Management Plan (DEC 2008) Walpole and Nornalup Inlets Marine Park Management Plan No 62 (DEC 2009b)	Yes[10]	Walpole and Nornalup Inlets Marine Park
Waychinicup	Southern Jarrah Forest and Fitzgerald	Albany coast draft management plan 2016 (DPAW 2016)	Yes[10]	
West Cape Howe	Warren	Albany coast draft management plan 2016 (DPaW 2016)	Yes[10]	
D'Entrecasteaux	Warren	Shannon and D'Entrecasteaux National Parks Management Plan No. 71 (DEC 2012b)	Yes[10]	
Fitzgerald River	Fitzgerald	Fitzgerald River National Park Management Plan 1991 – 2001 No. 15 (CALM 1991)	Yes[10]	

9.6.2 Coastal Nature Reserves and Conservation Parks

Protected coastal nature reserves and conservation parks managed under the CALM Act 1984 in the EMBA are listed in **Table 9-3** and shown in **Figure 9-4**, **Figure 9-5** and **Figure 9-6** for the north, north-west and south of WA respectively. The table also includes: reserve class; IUCN classification; any applicable management plan; whether the reserve includes the inter-tidal area; and the name of any adjacent state marine reserve (may also describe inter-tidal areas values).

The CALM Act does not require management plans to be in place for conservation reserves at all time, instead they are required to be made as is reasonably practicable regarding resources. This means some conservation reserves do not have a management plan, or do not have a recent management plan.

Table 9-3: Nature Reserves (NR) and Conservation Parks (CP) in EMBA

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Reserves of Northern WA (see Figure 9-4)					
Ord River NR	-	1a	-	No [9]	North Kimberley Marine Park
Pelican Island NR	-	1a			
Lesueur Island NR	A	1a			
Low Rocks NR	A	1a			
Browse Island NR	A	1a	-	Yes [10]	-
Scott Reef NR	-	1a	-	Yes [10]	-
Adele Island NR	A	1a	-	Yes [10]	-
Tanner Island NR	A	1a	-	Yes [10]	-
Lacepede Islands NR		1a	-	Yes [10]	-
Coulomb Point NR	A	1a	-	Yes [10]	-
Yawaru Birragun CP; Yawuru Northern Intertidal Area	- & A	2 & 6	Yawaru Birragun Conservation Park Management Plan (DPaW 2016). *Yawuru Intertidal Area management plan is not yet available.*	Yes	-
Jinmarnkur CP	C	-	Parks and reserves of the south-west Kimberley and north-west Pilbara Draft Management Plan (DPAW 2016). *Covers 80 Mile Beach coastal reserves.*	No	Eighty Mile Beach Marine Park
Jinmarnkur Kulja NR	A	-			
Kujungurru Warrarn NR	A	1a			
Kujungurru Warrarn CP	C	-			
Unnamed	A	-			
Jarrkunpungu NR	A				
Bedout Island NR	A	1a	-	Yes [10]	-
North Turtle Island NR	A	1a	-	Yes [10]	-
Reserves of North-West WA (see Figure 9-5)					
Unnamed (Dampier Archipelago) NR	A	1a	Dampier Achipelago Management Plan (CALM 1990).	Yes	-

[9] Inferred as adjacent marine park boundary is the high water mark and dual tenure cannot exist.

[10] Conservatively inferred as no adjacent Marine Park.

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
			Covers 25 of the islands		
Swan Island NR	A	1a	-	Yes[10]	Kimberly Marine Park
Unnamed NR		1a	-	Yes [10]	-
North Sandy Island NR	A	1a	-	Yes [10]	-
Montebello Islands CP	A	2	-	Partially [11]	Montebello Islands Marine Park
Lowendal Island NR		1a	-	No	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 [10]	-
Little Rocky Island NR	A	1a	-	Yes [10]	-
Airlie Island NR	-	1a	-	Yes [10]	-
Thevenard Island Nature	-	1a	-	Yes [10]	-
Bessieres Island NR	A	1a	-	Yes [10]	-
Serrurier Island NR	-	1a	-	Yes [10]	-
Round Island NR	-	1a	-	Yes [10]	-
Locker Island NR	A	1a	-	Yes [10]	-
Rocky Island NR	-	1a	-	Yes [10]	-
Gnandaroo Island NR	A	1a	-	Yes [10]	-
Victor Island NR	-	1a	-	Yes [10]	-
Y Island NR	-	1a	-	Yes [10]	-
Tent Island NR	-	1a	-	Yes [10]	-
Burnside and Simpson Island NR	-	1a	-	Yes [10]	-
Whalebone Island NR		1a	-	Yes [10]	-
Whitmore, Roberts, Doole Islands & Sandalwood Landing NR	-	1a	-	Yes [10]	-
Muiron Islands NR	-	1a	Jarabi and Bundegi Coastal Parks and Muiron Islands (CALM 1999)	No [9]	Muiron Islands Marine Management Area

[11] Reserve R42197 includes the inter-tidal zone and reserve R42196 does not.

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
OneTree Point NR	A	1a	-	Yes [10]	
Reserves of Southern WA – (see Figure 9-6)					
Koks Island NR	A	1a	Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan (DPAW 2012) -	Yes [10]	-
Bernier and Dorre Islands NR	A	4			
Shell Beach CP	-	3		No	Shark Bay Marine Park
Freycinet, Double Islands etc NR	A	1a			Shark Bay Marine Park
Zuytdorp NR	-	1a		Yes [10]	-
Beekeepers NR	-	1a	-	Yes [10]	-
Beagle Islands NR	A	1a	Turquoise Coast Nature Reserve Management Plan (CALM 2004). *Covers chain of approximately 40 protected islands lying between Lancelin and Dongara.*	Yes	-
Lipfert, Milligan, etc Islands NR	A	1a			-
Fisherman Islands NR	A	1a			Jurien Bay Marine Park: extends from Greenhead south to Wedge Island
Sandland Islands NR	A	1a			
Boullanger, Whitlock, Favourite, Tern and Osprey Islands NR	A	1a			
Escape Island NR	A	1a			
Essex Rocks NR	A	1a			
Outer Rocks NR	A	1a			
Ronsard Rocks NR	A	1a			
Cervantes Islands NR	A	1a			
Buller, Whittell and Green Islands NR	A	1a			
Wedge Island NR	A	1a			
Lancelin and Edwards Islands NR	A	1a			-
Southern Beekeepers NR	-	1a	Namburg National Park Management Plan (CALM 1998)	No	-
Wanagarren NR	-	1a		Yes	
Nilgen NR	-	1a		Yes	
Unnamed CP (R 49994) west of Wilbinga	-	2		Yes [10]	-
Unnamed CR (R 42469) at Woodman Point	-	-	Woodman Park Regional Park Management Plan (DEC 2010b)	No	-
Unnamed CP at Woodman Point (R 49220)	-	2		No	-

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
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[10]	-
Doubtful Islands NR	A	1a		Yes	Bremer Marine Park
Quarram NR	A	1a		Yes	South-west corner Marine Park
Chatham Island NR	A	1a		Yes	
Two Peoples Bay NR	A	4	Albany coast draft management plan 2016 (DPAW 2016b)	Yes[10]	-
Breaksea Island NR	A	1a		Yes[10]	-
Bald Island NR	A	1a		Yes[10]	-
Eclipse Island NR	A	1a		Yes[10]	-
Michaelmas Island NR	A	1a		Yes[10]	-
Glasse Island NR	A	1a		Yes[10]	-
Arpenteur NR	-	1a		No	-

Further information is provided below in relation to Varanus Island and Airlie Island Nature Reserves. Santos WA's Varanus Island Processing Hub and Airlie Island (operations ceased) co-exist with the reserves.

Lowendal Islands Nature Reserve - Varanus Island

Varanus Island is part of the Lowendal Islands group, a Nature Reserve (Class C). The Lowendal Islands comprise more than 40 limestone islands, islets and rocky stacks. There is not currently a DBCA Management Plan covering the Lowendal Islands Nature Reserve. Varanus Island is the largest island in the Lowendal Islands and is approximately 2.5 km long and 600m wide at its widest point. Its highest point is approximately 30m above sea level.

Described ecological conservation values of marine relevance include: Wedge-tailed Shearwater nesting (see Section **8.1.6**); Loggerhead and Hawksbill Turtle nesting (see Section 6.1.1 and Section **6.1.3**), Flatback Turtle nesting (Section 6.1.4). The Lowendal Islands are described as particularly important for tern breeding (DEC 2002), further information on terns is provided in **Section 8.2.1**.

Airlie Island Nature Reserve

Airlie Island Nature Reserve is an ungazetted 'C' class nature (Reserve identifier: 40323, Crown Lease 1901/100) located on Airlie Island. Airlie Island is a small sand cay (26 Ha) located 35 km NNE of Onslow. It is part of the Pilbara Inshore Islands chain. A management plan for the nature reserves of the Pilbara Inshore Islands is currently under development (DBCA 2019) i.e. there is not currently a DBCA Management Plan covering Airlie Island Nature Reserve.

Described ecological conservation values of marine relevance include: a wedge-tailed shearwater nesting (see **Section 8.1.6**); silver gull nesting (see **Section 8.1.6**) and low levels of green turtle and hawksbill turtle nesting (see **Section 6.1.2** and **6.1.3**).

9.7 Threatened Ecological Communities

An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat. Ecological communities are listed under the EPBC Act as threatened if the community is at risk of extinction.

Similarly, ecological communities can be listed under the WA BC Act as threatened if facing a risk of becoming a collapsed ecological community. To date no ecological communities are listed as threatened under the WA Act, however several ecological communities are currently endorsed by the WA Minister of Environment as Threatened Ecological Communities (TECs) through the previous non-statutory process.

TECs of relevance (likely to exist in marine water inter-tidal areas) in the EMBA are listed in **Table 9-1** and further described below.

Table 9-4: Relevant TEC in the marine EMBA

Species	Conservation Status		
	EPBC Act 1999 (Cwth)	**BC Act 2016 (WA)**	**Otherwise endorsed by the WA Minister for Environment**
Monsoon Vine Thicket on the Ridge on the Coastal Sand Dunes of Dampier	Endangered	-	Vulnerable
Roebuck Bay mudflats	-	-	Vulnerable
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	-	-

9.7.1 Monsoon Vine Thicket on the Ridge on the Coastal Sand Dunes of Dampier

Monsoon vine thicket occurs as semi - deciduous and evergreen vine thicket communities on and behind landward slopes of coastal sand dunes on the Dampier Peninsula in the Kimberley Region. This community is closely associated with coastal dunes elsewhere on the Dampier Peninsula and is listed as Endangered under the EPBC Act (Government of Western Australia 2010; DoEE 2016b). The community is also endorsed by the WA Minister for Environment as a threatened ecological community (non-statutory process).

9.7.2 Roebuck Bay Mudflats

Roebuck Bay mudflats (Kimberley region) have been endorsed by the WA Minister for Environment as a threatened ecological community (non-statutory process). The TEC is not listed under the EPBC Act.

Roebuck Bay mudflats (Kimberley region) are described as a 'species rich faunal community of the intertidal mudflats of Roebuck Bay' in the Kimberley region. Classed as Vulnerable (B). Roebuck Bay is a tropical marine embayment with extensive, biologically diverse, intertidal mudflats.

Roebuck Bay is protected as a designated Ramsar Wetland of International Importance (**Section 9.2.2**) and Marine Park (see **Sections 11.1.17** and **12.3.10**).

9.7.3 Subtropical and Temperate Coastal Saltmarsh

Subtropical and Temperate Coastal Saltmarsh occurs within the subtropical and temperate climatic zones and is present in coastal areas under regular or intermittent tidal influences and occurs over six State jurisdictions (Queensland, New South Wales, Victoria, Tasmania and WA). In WA it occurs from the south coast up to the southern part of Shark Bay. The community is made up of mainly salt tolerant vegetation which include halophytes as well as a number of non-vascular plant species. The community is listed as vulnerable under the EPBC Act (DoE 2014k).

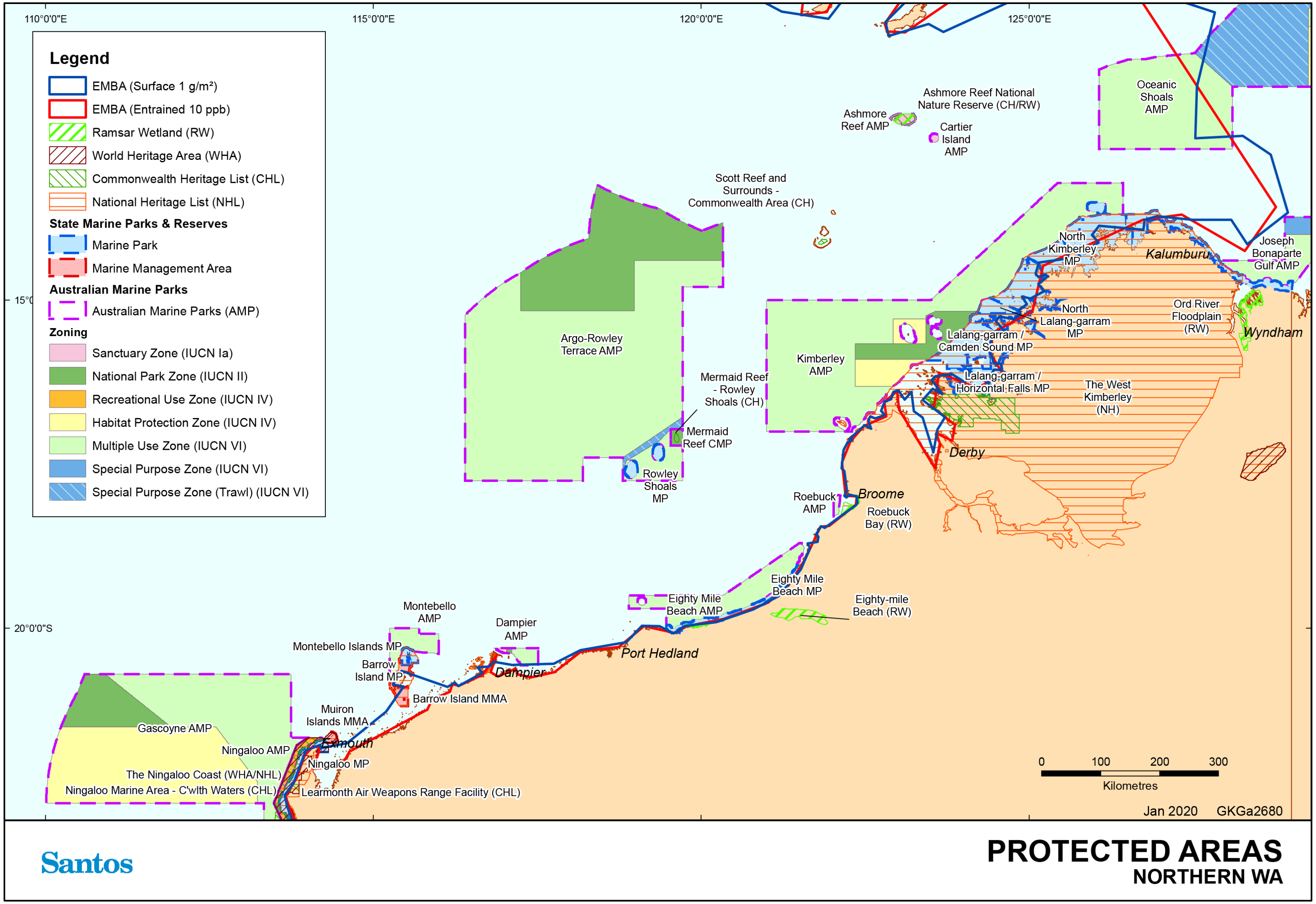


Figure 9-1: Protected areas in Northern WA

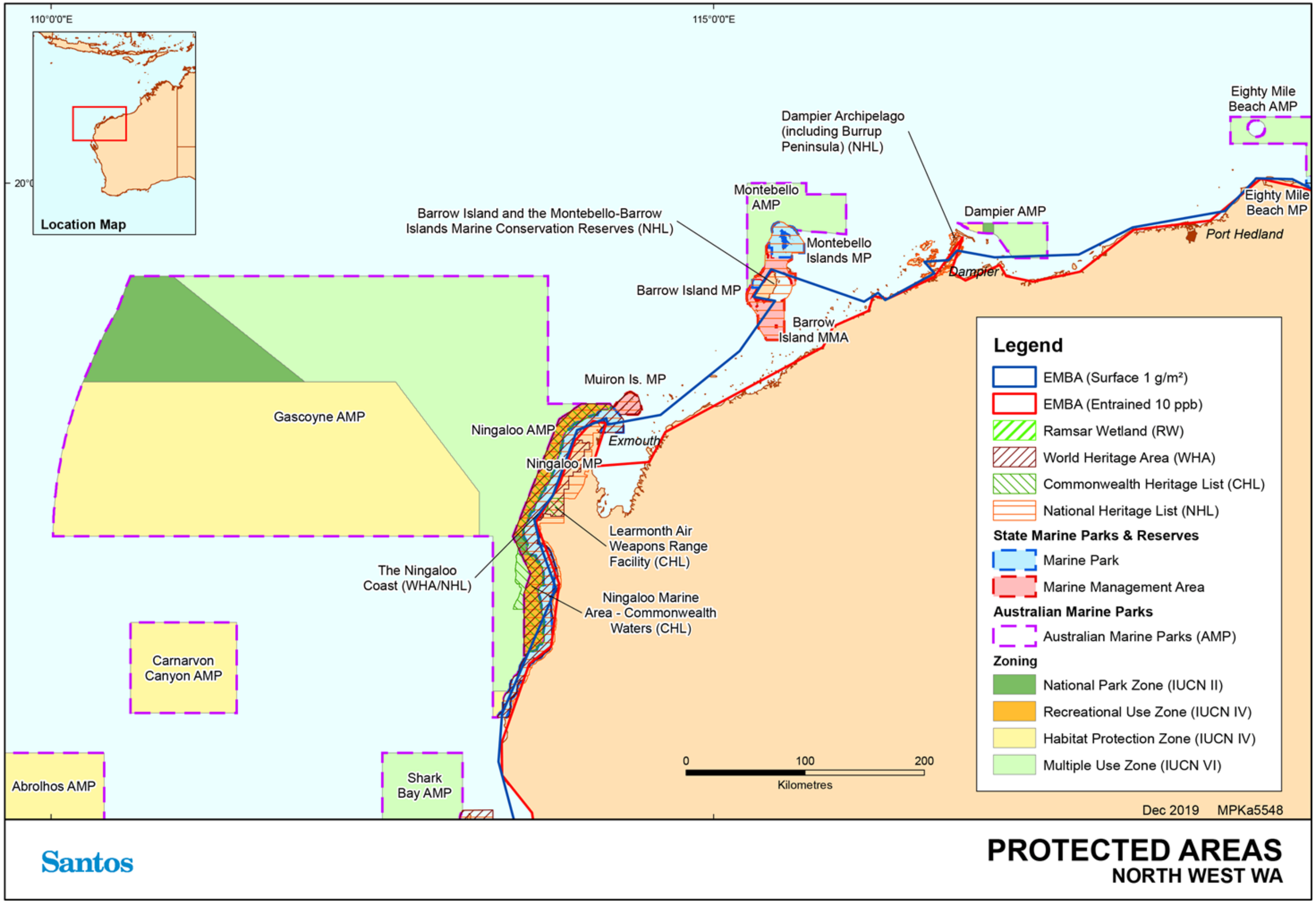


Figure 9-2: Protected areas in North-West WA

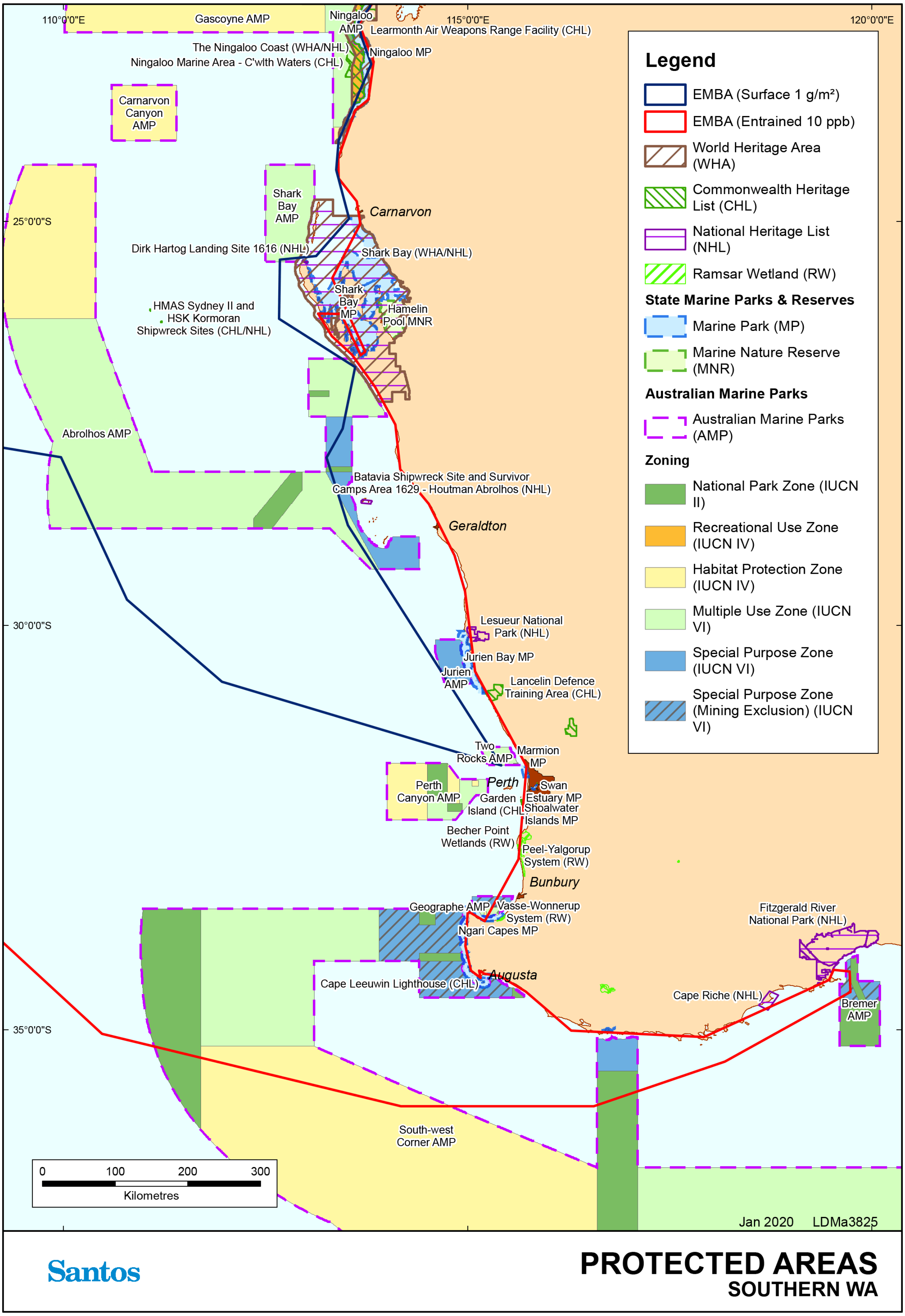


Figure 9-3: Protected areas in Southern WA

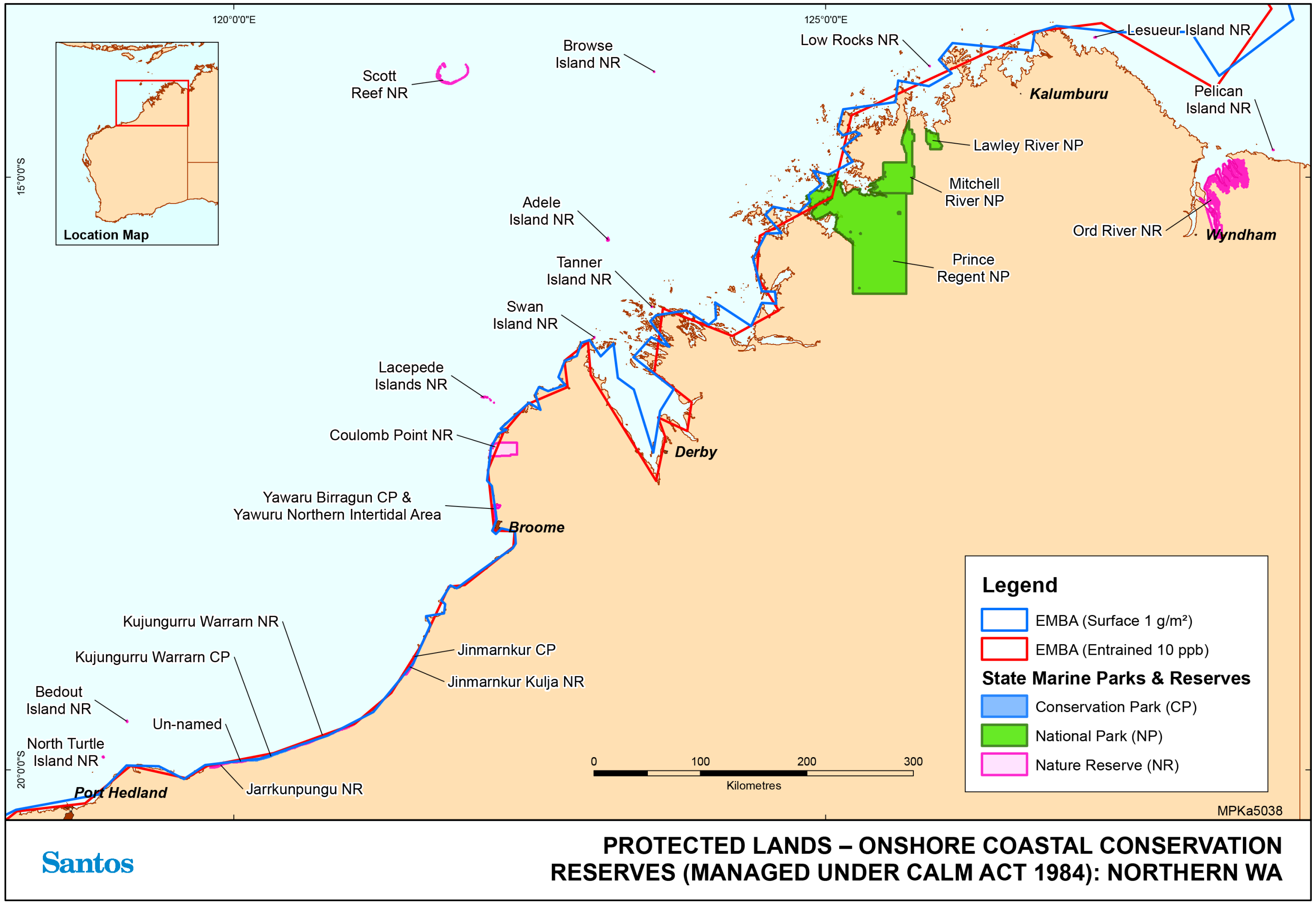


Figure 9-4: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in northern WA[12]

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[12] Yawaru Minyirr Buru Conservation Reserve (adjacent to Roebuck Bay) not shown as exact spatial extent unavailable, however the adjacent inter-tidal waters are managed under adjacent Roebuck Bay Marine Park (described in **Section 11.1.17**).

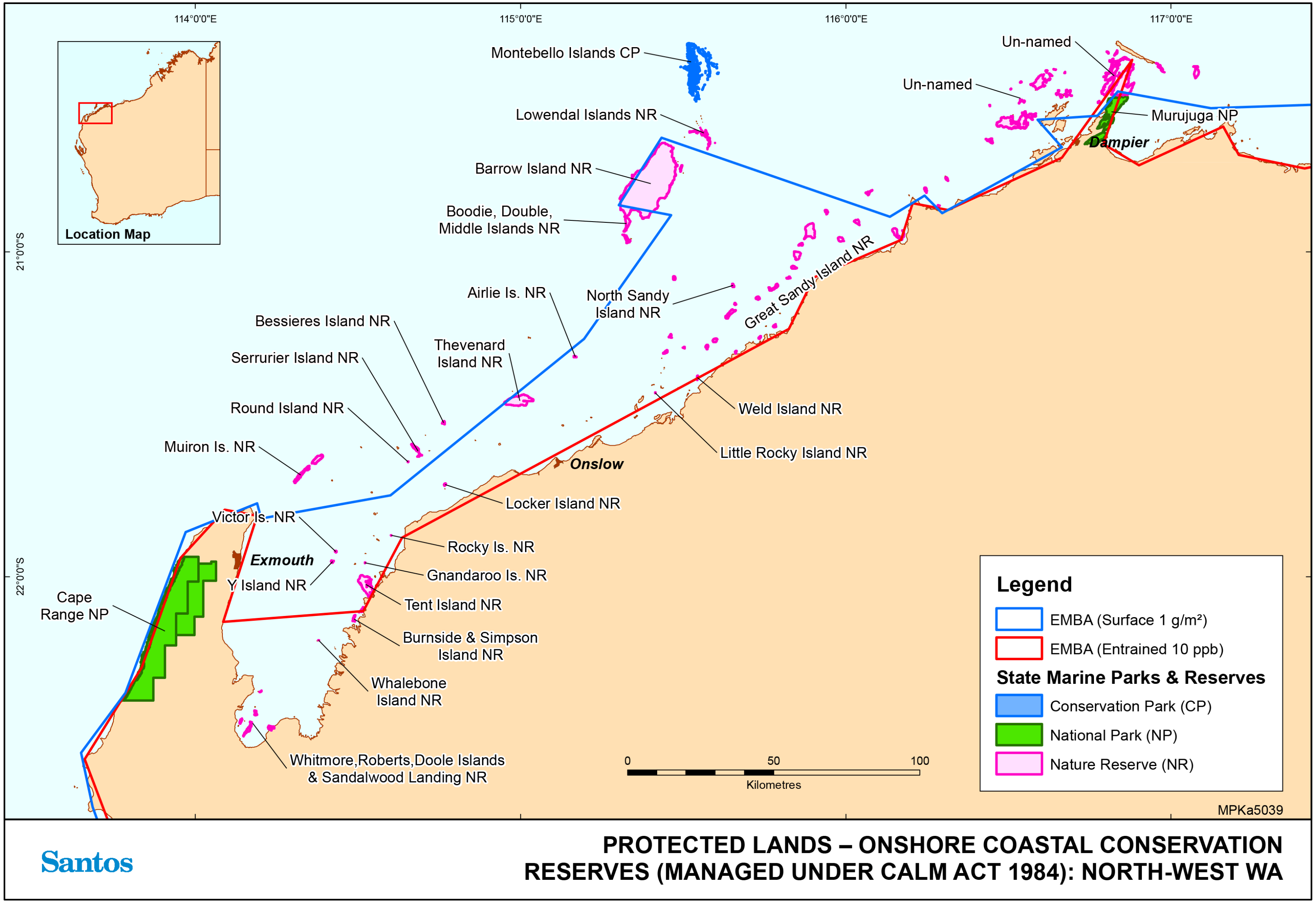

Figure 9-5: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in North-West WA

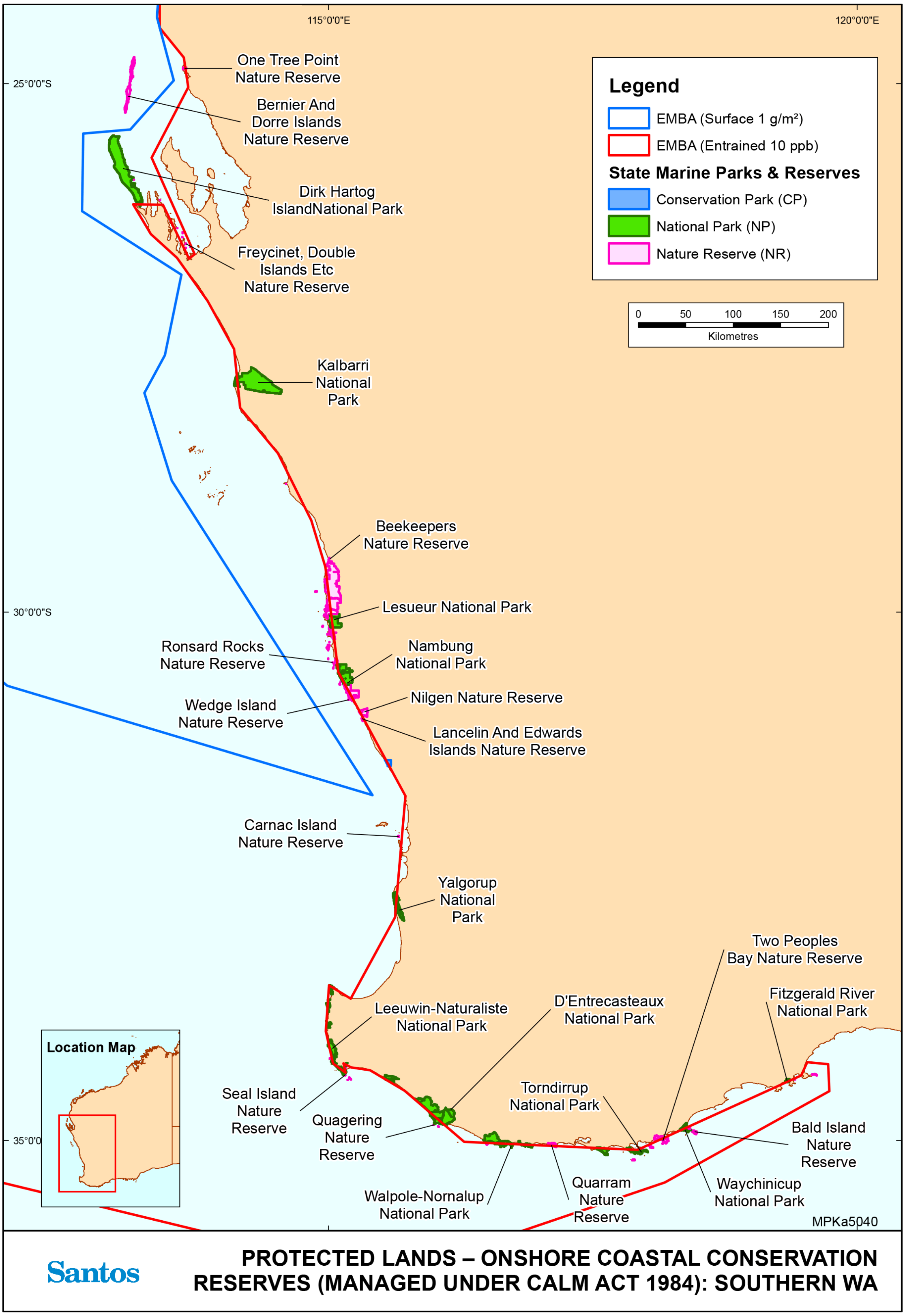

Figure 9-6: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in Southern WA[13]

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[13] Rottnest Islands Conservation Park Conservation Park is not shown (managed under Rottnest Island Authority Act 1987).

9.8 International Protected Areas

There are 53 National Parks in Indonesia, six are World Heritage Sites, nine are part of the World Network of Biosphere Reserves and five are wetlands of international importance under the Ramsar convention. A total of nine parks are largely marine (ADB 2014). Of these protected areas only the Laut Sawu Marine National Park (including the Tirosa Batek Marine Area and the Sumba Strait Marine Area) intersects with the EMBA.

The Laut Sawu Marine National Park located within the Lesser Sunda Ecoregion in the Savu Sea and covers a reported 35,211 km^2 (Protected Planet 2017). It was established in 2009 and has an IUCN Category II status (Protected Planet 2017). The marine park area is a known migration route for several cetacean species, including the blue whale and sperm whale. Other cetacean species such as pygmy killer whales, melon-head whale, short-finned pilot whales and numerous dolphin species (including Risso's dolphin, Fraser's dolphin, common dolphin, bottlenose dolphin and spinner dolphin) are known to frequent the marine park area. Several species of marine turtle, including the green turtle, hawksbill turtle and leatherback turtle have also been recorded in the marine park area.

The marine park area covers a range of habitats and species diversity, including:

+ 532 corals species which include 11 endemic and sub endemic species;
+ 350 reef fish species;
+ fifteen mangrove species are recorded that represented 9 families of mangrove;
+ ten seagrass species;
+ deep-water habitats such as seamounts, deep-water canyons, straits (migratory corridors);
+ large persistent pelagic habitats;
+ main migratory corridors and habitats for 14 whale species, seven dolphin's species, and dugong; and
+ habitats for five sea turtle species (green, leatherback, olive ridley, loggerhead, and flatback) as well as for large marine fauna such as sharks, napoleon, parrotfish and groupers (Savu Sea National Marine Conservation Area undated).

10. Key Ecological Features

10.1 Introduction

Key ecological features (KEFs) are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity. KEFs meet one or more of the following criteria (DSEWPaC 2012a):

- A species, group of species or a community with a regionally important ecological role;
- A species, group of species or a community that is nationally or regionally important for biodiversity;
- An area or habitat that is nationally or regionally important for:
  - Enhanced or high biological productivity;
  - Aggregations of marine life; or
  - Biodiversity and/or endemism
- A unique seafloor feature with ecological properties of regional significance.

Twenty five key ecological features of the Commonwealth waters in the EMBA (covering the NMR, the NWMR and the SWMR) have been identified in the protected matters search (**Figure 10-1** and **Figure 10-2**) and are discussed in this section.

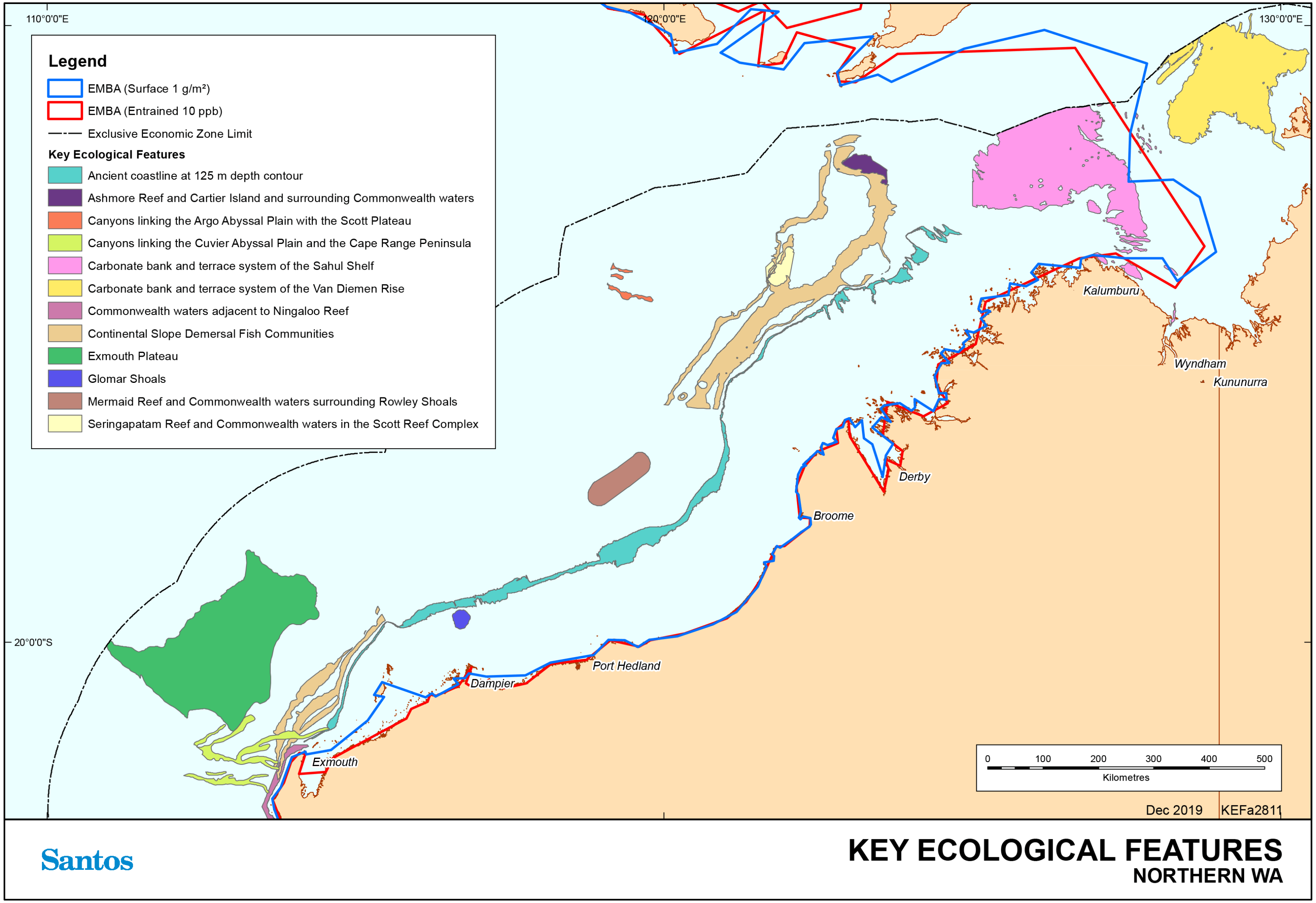

Figure 10-1: Key ecological features of Northern WA

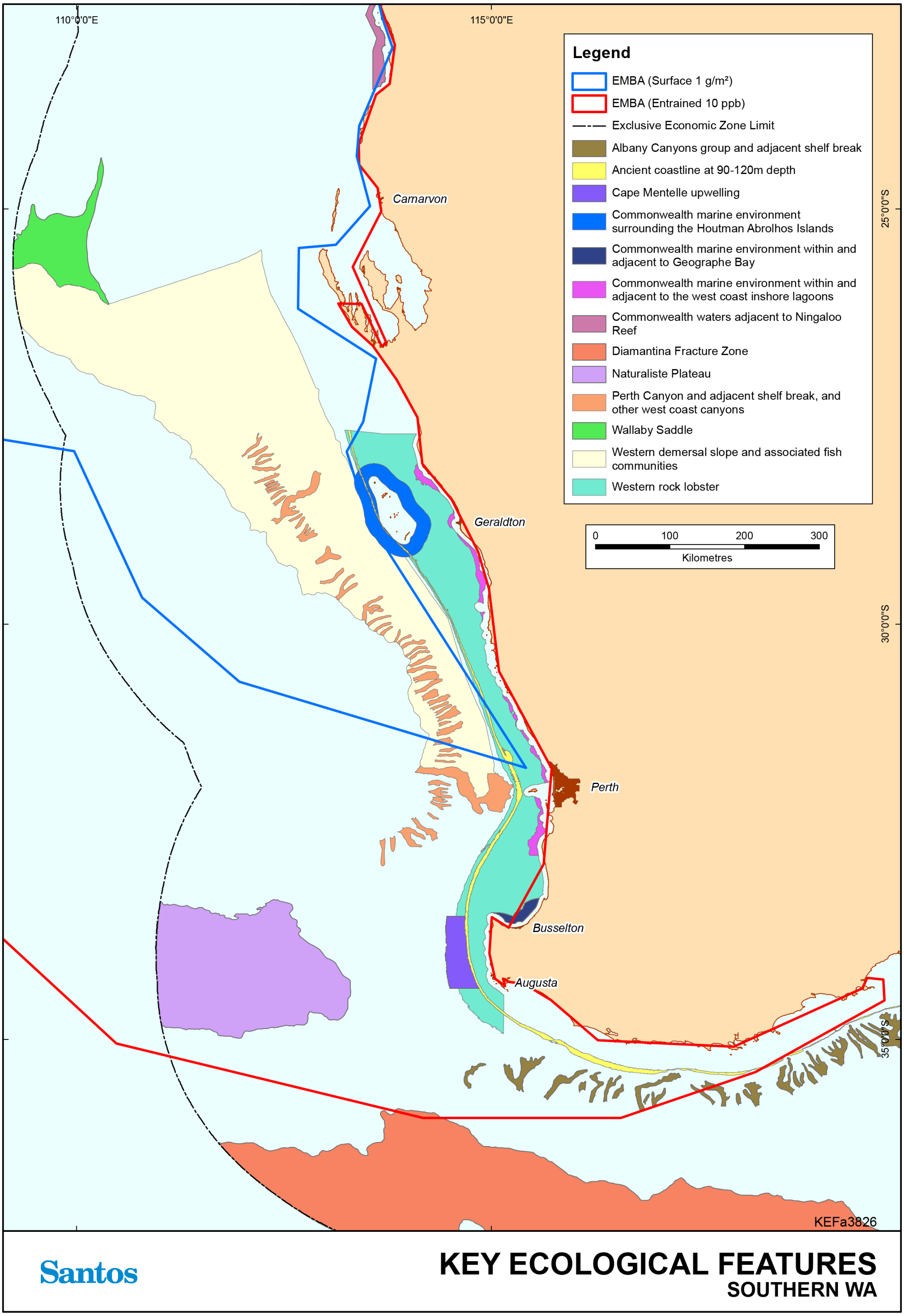

Figure 10-2: Key ecological features of Southern WA

10.1.1 Commonwealth Marine Environment Surrounding the Houtman Abrolhos Islands (and Adjacent Shelf Break)

The Commonwealth marine environment surrounding the Houtman Abrolhos Islands (and adjacent shelf break) is defined as a KEF for its high levels of biodiversity and endemism in benthic and pelagic habitats. The Houtman Abrolhos Islands and surrounding reefs support a unique mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The reefs are composed of 184 known species of corals that support about 400 known species of demersal fish, 492 known species of molluscs, 110 known species of sponges, 172 known species of echinoderms and 234 known species of benthic algae (DEWHA 2008b). The Houtman Abrolhos Islands are the largest seabird breeding station in the eastern Indian Ocean (DSEWPaC 2012a). They support more than one million pairs of breeding seabirds. The Houtman Abrolhos Islands and surround waters are also BIAs for Australian sea lions for foraging and breeding (DEWHA 2010b).

10.1.2 Perth Canyon and Adjacent Shelf Break, and other West-Coast Canyons

The Perth Canyon is defined as a KEF for its high biological productivity and aggregations of marine life and unique seafloor features with ecological properties of regional significance. The Perth Canyon is the largest known undersea canyon in Australian waters. In the Perth Canyon, interactions between the Leeuwin Current and the Canyon topography induce clockwise-rotating eddies that transport nutrients upwards in the water column from greater depths (DoEE 2019a). Due to the Canyon's depth and Leeuwin Current's barrier effect, this remains a subsurface upwelling which supports ecological complexity that is typically absent from canyon systems in other areas (Pattiaratchi 2007). This nutrient-rich cold-water habitat attracts feeding aggregations of deep-diving mammals, such as pygmy blue whales and large predatory fish that feed on aggregations of small fish, krill and squid (DSEWPaC 2012a). The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs (DoEE 2017a).

10.1.3 Commonwealth Marine Environment within and adjacent to the West-Coast Inshore Lagoons

This key ecological feature is composed by a chain of inshore lagoons of limestone reef (as deep as 30 m) extending along the Western Australian coast from south of Mandurah to Kalbarri. The mix of sheltered and exposed seabeds form a complex mosaic of habitats. The lagoons are dominated by seagrass and epiphytic algae (Dambacher et al. 2009). Although macroalgae (principally Ecklonia spp.) and seagrass appear to be the primary source of production, scientists suggest that groundwater enrichment may supplement the supply of nutrients to the lagoons. The lagoons are associated with high biodiversity and endemism, containing a mix of tropical, subtropical and temperate flora and fauna.

The inshore lagoons are important areas for the recruitment of the commercially and recreationally important western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, abalone and many other reef species. The area includes breeding and nursery aggregations for many temperate and tropical marine species (Goldberg & Collings 2006 in McClatchie et al. 2006). Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon.

10.1.4 Commonwealth Marine Environment within and Adjacent to Geographe Bay

The Commonwealth marine environment within and adjacent to Geographe Bay is defined as a KEF for its high productivity and aggregations of marine life and high levels of biodiversity and endemism. Geographe Bay is known for its extensive beds of tropical and temperate seagrass that account for about 80 % of benthic primary production in the area (DEH 2006). This habitat supports a diversity of species, many of them not found anywhere else (DSEWPaC 2012a). The bay provides important nursery habitat for many species, including juvenile dusky whaler sharks. It is also an important resting area for migrating for humpback whales (McCauley *et al.* 2000).

10.1.5 Cape Mentelle Upwelling

The Cape Mentelle upwelling is defined as a KEF for its high productivity and aggregation soft marine life. The Cape Mentelle upwelling draws relatively nutrient-rich water from the base of the Leeuwin Current, up the continental slope and onto the inner continental shelf, where it results in phytoplankton blooms at the surface. The phytoplankton blooms provide the basis for an extended food chain characterised by feeding aggregations of small pelagic fish, larger predatory fish, seabirds, dolphins and sharks (DSEWPaC 2012a). The Cape Mentelle upwelling has a disproportionate influence on the overall-nutrient poor nature of the region's water.

10.1.6 Naturaliste Plateau

The Naturaliste Plateau is defined as a KEF for its unique seafloor feature with ecological properties of regional significance. The Naturaliste Plateau is Australia's deepest temperate marginal plateau and occurs an area where numerous water bodies and currents converge. It is also the only seafloor feature in the region that interacts with the subtropical convergence front (DoEE 2019b). Although there is very little known about the marine life of the plateau, it is speculated that the combination of its structural complexity, mixed water dynamics and relative isolation indicate that it supports deep-water communities with high species diversity and endemism (DEWHA 2008b; DSEWPaC 2012a). The Plateau acts as an underwater 'biogeographical island' on the edge of the abyssal plain, providing habitat for fauna unique to these depths (Richardson et al. 2005). The Plateau is also within a deep eddy field that is thought to be associated with high productivity and aggregations of marine life (Pattiaratchi 2007). Proximity to the nearby subtropical convergence front is thought to have a significant influence on the biodiversity of the Plateau (DEWHA 2008b).

10.1.7 Western Demersal Slope and associated Fish Communities

The Western Demersal Slope and associated Fish Communities, also known as the Demersal Slope and associated Fish Communities of the Central Western Province, is defined as a key ecological community for its high levels of biodiversity and endemism. The western demersal slope provides important habitat for demersal fish communities, with a high level of diversity and endemism. A diverse assemblage of demersal fish species below a depth of 400 m is dominated by relatively small benthic species such as grenadiers, dogfish and cucumber fish. Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the sea floor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits (DSEWPaC 2012a). Scientists have described 480 species of demersal fish that inhabit the slope, and 31 of these are considered endemic (DoEE 2019a).

10.1.8 Western Rock Lobster

The Western Rock Lobster KEF is defined due to its presumed ecological role on the West Coast Continental Shelf. This species is the dominant large benthic invertebrate in the region. The lobster plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western rock lobsters are an important part of the food web on the inner shelf, particularly as juveniles as they are preyed upon by octopus, cuttlefish, baldchin groper, dhufish, pink snapper, wirrah cod and breaksea cod (DEWHA 2008b, DSEWPaC 2012a). The high biomass of western rock lobsters and their vulnerability to predation suggest that they are an important trophic pathway for a range of inshore species that prey upon juvenile lobsters (DEWHA 2008b).

10.1.9 Wallaby Saddle

The Wallaby Saddle is defined as a KEF for its high productivity and aggregations of marine life. The Wallaby Saddle is an abyssal geomorphic feature located on the upper continental slope at a depth of 4,000–4,700 m (DSEWPaC 2012a). The feature connects the north-west margin of the Wallaby Plateau with the margin of the Carnarvon Terrace (Falkner *et al*. 2009 in DSEWPaC 2012a). The Wallaby Saddle is situated within the Indian Ocean water mass and is thus differentiated from systems to the north that are dominated by transitional fronts or the Indonesian Throughflow (DSEWPaC 2012a). Little is known about the Wallaby Saddle; however, the area is considered one of enhanced productivity and low habitat diversity (Brewer *et al*. 2007). The Wallaby Saddle is associated with historical aggregations of sperm whales (DEWHA 2008c).

10.1.10 Commonwealth Waters Adjacent to Ningaloo Reef

The Commonwealth Waters adjacent to Ningaloo Reef KEF is defined for high productivity and aggregations of marine life. The Ningaloo Reef extends almost 300 km along the Cape Range Peninsula to the Red Bluff and is globally significant as the only extensive coral reef in the world that fringes the west coast of a continent. Commonwealth waters adjacent to the reef are thought to support the rich aggregations of marine species at Ningaloo Reef through upwellings associated with canyons on the adjacent continental slope and interactions between the Ningaloo and Leeuwin currents (Brewer *et al*. 2007, DEWHA 2008d, DSEWPaC 2012a). The narrow continental shelf (10 km at its narrowest) means that the nutrients channelled to the surface via canyons are immediately available to reef species. Terrestrial nutrient input is low, hence this deep-water source is a major source of nutrients for Ningaloo Reef and therefore very important in maintaining this system (DEWHA 2008c).

The reef is known to support an extremely abundant array of marine species including over 200 species of coral and more than 460 species of reef fish, as well as molluscs, crustaceans and other reef plants and animals (DEWHA 2008c). Marine turtles, dugongs and dolphins frequently visit the reef lagoon. The Commonwealth waters around Ningaloo include areas of potentially high and unique sponge biodiversity (DEWHA 2008c). Upwellings on the seaward side support aggregations such as whale sharks and manta rays (these waters are the main known aggregation area for whale sharks in Australian waters). Humpback whales are seasonal visitors to the outer reef edge and seasnakes, sharks, large predatory fish and seabirds also utilise the reef and surrounding waters.

The Ningaloo Marine Park includes this Key Ecological Feature and is discussed in **Section 12.3.4**.

10.1.11 Canyons Linking the Cuvier Abyssal Plain with the Cape Range Peninsula

The Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula are defined as a KEF as they are unique seafloor features with ecological properties of regional significance.

Cape Range Peninsula and the Cuvier Abyssal Plain are linked by canyons, the largest of which are the Cape Range Canyon and Cloates Canyon. These two canyons are located along the southerly edge of Exmouth Plateau adjacent to Ningaloo Reef and are unique due to their close proximity to the North West Cape (DSEWPaC 2012a). The Leeuwin Current interacts with the heads of the canyons to produce eddies resulting in delivery of higher nutrient, cool waters from the Antarctic intermediate water mass to the shelf (Brewer *et al*. 2007). Strong internal tides also create upwelling at the canyon heads (Brewer *et al*. 2007). Thus the canyons, the Exmouth Plateau and the Commonwealth waters adjacent to Ningaloo Reef interact to create the conditions for enhanced productivity seen in this region (Sleeman *et al*. 2007 in DSEWPaC 2012a). The canyons are also repositories for particulate matter deposited from the shelf and sides of the canyons and serve as conduits for organic matter between the surface, shelf and abyssal plains (DSEWPaC 2012a).

The soft bottom habitats within the canyons themselves are likely to support important assemblages of epibenthic species. Biological productivity at the head of Cape Range Canyon in particular, is known to support species aggregations, including whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds. The canyons are thought to be significant contributors to the biodiversity of the adjacent Ningaloo Reef, as they channel deep water nutrients up to the reef, stimulating primary productivity (DEWHA 2008c).

10.1.12 Exmouth Plateau

The Exmouth Plateau is defined as a KEF as it is a unique seafloor feature with ecological properties of regional significance. The Exmouth Plateau covers an area of 49,310 km^2 and is located approximately 150 km northwest of Exmouth. The plateau ranges in water depths from 800 to 4,000 m (Heap & Harris 2008 in DSEWPaC 2012a). The plateau's surface is rough and undulating at 800–1,000 m depth. The northern margin is steep and intersected by large canyons (e.g. Montebello and Swan canyons) with relief greater than 50 m. The western margin is moderately steep and smooth and the southern margin is gently sloping and virtually free of canyons (Falkner *et al*. 2009 in DSEWPaC 2012a).

The Exmouth Plateau is a regionally and nationally unique tropical deep sea plateau. It that may serve an important ecological role by acting as a topographic obstacle that modifies the flow of deep waters that generate internal tides, causing upwelling of deeper water nutrients closer to the surface (Brewer *et al.* 2007). Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna. Whaling records from the 19th century suggest that the Exmouth Plateau may have supported large populations of sperm whales (Bannister *et al*. 2007). Fauna in the pelagic waters above the plateau are likely to include small pelagic species and nekton (Brewer *et al.* 2007).

10.1.13 Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals

Mermaid Reef and Commonwealth waters surrounding Rowley Shoals is defined as a KEF for its enhanced productivity and high species richness. The Rowley Shoals are a group of three atoll reefs—Clerke, Imperieuse and Mermaid reefs—located about 300 km north-west of Broome. Mermaid Reef lies 29 km north of Clerke and Imperieuse reefs and is totally submerged at high tide. Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals are regionally important in supporting high species richness, higher productivity and aggregations of marine life associated with the adjoining reefs themselves (Done et al. 1994). Rowley shoals contain 214 coral species and approximately 530 species of fishes (Gilmour et al. 2007), 264 species of molluscs and 82 species of echinoderms (Done et al. 1994; Gilmour et al. 2007). Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Done et al. 1994).

Mermaid Reef falls under Commonwealth jurisdiction and forms the Mermaid Reef Commonwealth Marine Park. Clerke and Imperieuse reefs constitute the Rowley Shoals Marine Park, which falls under Western Australian Government jurisdiction (EA 2000). The Rowley Shoals are discussed with the Commonwealth and State Marine Park (**Sections 11.1.9** and **12.3.9**).

10.1.14 Glomar Shoals

The Glomar Shoals are a submerged feature situated at a depth of 33–77 m, approximately 150 km north of Dampier on the Rowley Shelf (Falkner *et al*. 2009 in DSEWPaC 2012a). They consist of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells (McLoughlin & Young 1985 in DSEWPaC 2012a). The area's higher concentrations of coarse material compared to surrounding areas are indicative of a high energy environment subject to strong seafloor currents (Falkner *et al*. 2009 in DSEWPaC 2012a).

Biological communities found at the Glomar Shoals have not been comprehensively studied, however the shoals are known to be an important area for a number of commercial and recreational fish species such as rankin cod, brown striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish. Catch rates at the Glomar Shoals are high, indicating that the area is a region of high productivity (Falkner *et al*. 2009, Fletcher & Santoro 2009 in DSEWPaC 2012a). It is unclear if the removal of non-target species due to the commercial fishing over the shoals is having an impact on its value (DSEWPaC 2012a).

The Glomar Shoals are regionally important for their potentially high biological diversity and localised productivity. Biological data specific to the Glomar Shoals is limited, however the fish of the shoals are probably a subset of reef-dependent species and anecdotal evidence suggests they are particularly abundant (DSEWPaC 2012a).

10.1.15 Ancient Coastline at 125 m Depth Contour

The shelf of the North-west Marine Region contains several terraces and steps which reflect changes in sea level that occurred over the last 100,000 years. The most prominent of these features occurs at a depth of 125m as an escarpment along the North West Shelf and Sahul Shelf (DSEWPaC 2012a). Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher biological diversity. Little detailed knowledge is available, but the hard substrate of the escarpment is likely to support sponges, crinoids, molluscs, echinoderms (DSEWPaC 2012a). It is understood that changes in topography at these depths are critical points for the generation of internal waves (Holloway *et al.* 2001 cited in DEWHA 2008c), playing a minor role in aiding localised upwelling or at least regional mixing associated with the seasonal changes in currents and winds. It is also believed that this prominent floor feature could be important as a migratory pathway for cetaceans and pelagic species such as the whale shark and humpback whale, as they move north and south between feeding and breeding grounds (DEWHA 2008c).

Parts of the ancient coastline are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column providing a relatively nutrient-rich environment for species present on the escarpment (DSEWPaC 2012a). This enhanced productivity could potentially be attracting baitfish, which in turn provide food for the migratory species. The pressures of potential concern on the biodiversity value of this feature generally include ocean acidification as a result of climate change (DoEE 2019a).

10.1.16 Ancient Coastline at 90-120 m Depth

This coastline is found in the South-west Marine Region and contains several terraces and steps reflecting a gradual increase in sea level across the shelf that occurred during the Holocene. Some of these features create escarpments of distinct elevation, creating topographic complexity through the exposure of rocky substrates. The most prominent of these occurs close to the middle of the continental shelf off the Great Australian Bight at a depth of 90-120 m, which provides a complex habitat for a number of species (DSEWPaC 2012c). The area has important conservation value due to its potential for high productivity, biodiversity and aggregations of marine life. Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment of exposed hard substrates, where it is dominated by sponge communities of significant biodiversity and structural complexity (DSEWPaC 2012c). These sponge communities have been recorded to contain sponges up to one metre across, which implies that some of the sponges in this region are likely to be many decades old (DSEWPC 2012c). It has been suggested that in certain places, the area may support some demersal fish species, travelling to the upper continental slope from across the continental shelf. The transportation of fine grained sediments off shelf occurs as a physical process down to depths of approximately 120 m, and influence the benthic invertebrate communities of the Great Australian Bight (DSEWPaC 2012c). Both species richness and biomass in the area, has been associated as declining with increasing depth and percentage of fines in sediment (Ward *et al.* 2006 cited in DSEWPaC 2012c).

10.1.17 Canyons Linking the Argo Abyssal Plain with Scott Plateau

The Scott Plateau connects with the Argo Abyssal Plain via a series of canyons, the largest of which are the Bowers and Oates canyons (DSEWPaC 2012a). The canyons are believed to be up to 50 million years old and excavated during the evolution of the region through sediment and water movements (DEWHA 2008d). The canyons cut deeply into the south-west margin of the Scott Plateau and act as conduits for transport of sediments from an approximate depth of 2,000–3,000 m to depths of more than 5,500 m (DSEWPaC 2012a). The water masses at these depths are deep Indian Ocean water on the Scott Plateau and Antarctic bottom water on the Argo Abyssal Plain. Both water masses are cold, dense and nutrient-rich (Lyne *et al*. 2006 in DSEWPaC 2012a). The high productivity of the region is believed to be led by topographically induced water movements through the canyons and the action of internal waves in these canyons as well as around islands and reefs. The canyons are therefore thought to be linked to small and periodic upwellings that enhance this biological productivity (DEWHA 2008d).

The Canyons linking the Argo Abyssal Plain and Scott Plateau are likely to be important features due to their historical association with sperm whale aggregations (DSEWPaC 2012a). Historical records of whaling in the Timor region indicate that the number of sperm whales was high in the region in the past. Though current numbers are unknown, it is possible that they congregate around the canyon heads adjacent to the Scott Plateau, encouraged by the high biological productivity, supporting stocks of their prey (DEWHA 2008d). There is anecdotal evidence that supports the idea that the Scott Plateau itself may be a breeding ground for sperm and beaked whales. It is also likely that important demersal communities occur in the canyons, as they do in the Scott Plateau supported by the localised upwelling, which in turn attract larger predatory fish, sharks and cetaceans (DEWHA 2008d).

10.1.18 Continental Slope Demersal Fish Communities

The Australian Continental Slope provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Specifically, the continental slope between North West Cape and the Montebello Trough is the most diverse slope bioregion in Australia with more than 500 fish species, 76 of which are endemic (Last *et al*. 2005 in DSEWPaC 2012).

The Continental Slope consists of two distinct community types, associated with the upper and mid slope, 225 – 500 m and 750 – 1000 m respectively. The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope (DSEWPaC 2012). The bacteria and fauna that is present in the system on the Continental Slope are the basis for the food web for demersal fish and higher order consumers in the system. Further information of this system has been poorly researched, though it has been suggested that it is a detritus-based system, where infauna and epifauna become prey for a range of teleost fish, molluscs and crustaceans (Brewer *et al.* 2007). The higher order consumers supported by this system are likely to be carnivorous fish, deep water sharks, large squid and toothed whales (Brewer *et al.* 2007). The pelagic production is known to be phytoplankton based, with hotspots located around oceanic reefs and islands (Brewer *et al.* 2007).

It is believed that the loss of the benthic habitat along this continental shelf region would likely lead to a decline in the species diversity and endemism that this feature is associated with (DoEE 2019a). The endemism of the region is not supported by large data sets and is scarce. It is consequently not well understood what interactions exist between the physical processes and trophic structures that lead to this high diversity of fish and the suggested presence of endemic species in the region (DoEE 2019a).

10.1.19 Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex

Scott and Seringapatam reefs are part of a series of submerged reef platforms that rise steeply from the sea floor between the 300–700 m contours on the north-west continental slope and lie in the Timor Province (Falkner et al. 2009). Scott Reef consists of two separate reef formations, North Reef and South Reef. The total area of the key ecological feature is approximately 2,418 km². As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region.

Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life including humpback whales on their northerly migration, Bryde's whales, pygmy blue whales, Antarctic minke whales, dwarf minke whales, minke whales, dwarf sperm whales and spinner dolphins (Jenner et al. 2008; Woodside 2009). Whale sharks and several species of sea snakes have also been recorded in this area (Donovan et al. 2008). Green and hawksbill turtles nest during the summer months on Sandy Islet on South Scott Reef. These species also internest and forage in the surrounding waters (Guinea 2006). Scott Reef is a particularly biologically diverse system and includes more than 300 species of reef-building corals, approximately 400 mollusc species, 118 crustacean species, 117 echinoderm species and around 720 fish species (Woodside 2009). Corals and fish at Scott Reef have higher species diversity than the Rowley Shoals (Done et al. 1994).

Scott Reef is listed as Commonwealth Heritage Places and is discussed in **Section 9.5.1**.

10.1.20 Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters

Ashmore Reef and Cartier Island are situated on the shallow upper slope of the Sahul Shelf, north of Scott and Seringapatam reefs. Rising from a depth of more than 100 m, the reef platform is at the edge of the North West Shelf and covers an area of 239 km². Ashmore Reef Commonwealth Marine Reserve encloses an area of about 583 km² of seabed (EA 2002). Cartier Island lays about 350 km off Australia's Kimberley coast, 115 km south of the Indonesian island of Roti and 45 km south-east of Ashmore Reef Commonwealth Marine Reserve. Cartier Island Commonwealth Marine Reserve covers 167 km² (EA 2002). Species at Ashmore Reef and Cartier Island include more than 225 reef-building corals, 433 molluscs, 286 crustaceans, 192 echinoderms, and the most diverse variety of fish of any region in Western Australia with 709 species (EA 2002).

Sandy beaches provide important habitat for nesting green and hawksbill turtles throughout the year. Seagrass present at Ashmore Reef provides critical breeding (April–May) and foraging (throughout the year) habitat for a genetically distinct population of dugong with their range probably extending to other submerged shoals within the area (Brown & Skewes 2005; Whiting 1999). The emergent habitat at Ashmore also provides important nesting sites for seabirds, many of which are migratory. Ashmore's islands are regarded as supporting some of the most important seabird rookeries on the North West Shelf seasonally supporting up to 50,000 seabirds (26 species) and up to 2,000 waders (30 species, representing almost 70% of wader species that regularly migrate to Australia) (Milton 2005). Large colonies of sooty terns, crested terns, bridled terns and common noddies breed on the east and middle islands. Smaller breeding colonies of little egrets, eastern reef egrets, black noddies and possibly lesser noddies also occur. Migratory wading birds include eastern curlews, ruddy turnstones, whimbrels, bar-tailed godwits, common sandpipers, Mongolian plovers, red-necked stints and tattlers, during October–November and March–April as part of the migration between Australia and the Northern Hemisphere (Milton 2005).

10.1.21 Carbonate Bank and Terrace System of the Sahul Shelf

The Carbonate Banks and Terrace System of the Sahul Shelf are located in the western Joseph Bonaparte Gulf and to the north of Cape Bougainville and Cape Londonderry. The banks consist of a hard substrate and flat tops at depths of 150–300 m. Each bank occupies an area generally less than 10 km^2 and is separated from the next bank by narrow sinuous channels with depths up to 150 m. The origin of the banks is uncertain, though the area contains predictably high levels of productivity, in comparison to the generally low productivity of the region (DSEWPaC 2012).

The banks are foraging areas for loggerhead, olive ridley and flatback turtles and provide habitat for humpback whales, and green and freshwater sawfish (Donovan *et al*. 2008 in DSEWPaC 2012). The hard substrate of the banks is thought to support diverse organisms including sessile benthic invertebrates such as sponges, soft and hard corals, gorgonians, bryozoans, ascidians and associated reef fish and elasmobranchs (Brewer *et al*. 2007). Cetaceans, green and fresh sawfish are also likely to occur in the area, as well as possibly the Australian snubfin dolphin, a migratory species occurring mostly on the northern extent of the Sahul Shelf (DSEWPaC 2012).

According to DSEWPaC (2012) the carbonate banks and terrace system of the Sahul Shelf are regionally important because of their role in enhancing productivity relative to their surrounds. Little is known about the banks, terraces and associated channels but they are believed to be areas of enhanced productivity and biodiversity due to the upwellings of cold nutrient-rich water at the heads of the channels and the availability of hard substrate (Brewer *et al*. 2007).

10.1.22 Pinnacles of the Bonaparte Basin

The limestone Pinnacles of the Bonaparte Basin are located in the mid-outer shelf of the western Joseph Bonaparte Gulf and comprise of 61% of the limestone pinnacles in the Northwest Marine Region and 8% of the total limestone pinnacles found within the Australian Exclusive Economic Zone (Baker *et al.* 2008). The pinnacles range from water depths of 30 to 80 m providing hard substrate in a relatively sparse soft sediment habitat for sessile species. The pinnacles are thought to be remnants of the calcareous shelf and coastal features from previous low sea level stands, and have been recorded to be up to 50 m in height and range from 50 to 100 km long (Baker *et al.* 2008, Heyward *et al.* 1997).

Diverse communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species such as snappers, emperors and groupers have been recorded (Brewer *et al.* 2007, Nichol *et al.* 2013). Foraging and general use has been recorded within the pinnacles by marine turtles and the area has also been suggested to be used by freshwater and green sawfish as well as humpback whales (Donovan *et al.* 2008). The pinnacles have been recognised as a sponge biodiversity hotspot which has recorded greater diversity and communities than that of the surrounding seafloor (NERP MBH 2014).

According to DSEWPaC (2012) the Pinnacles of the Bonaparte Basin are regionally important because of its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats. The hard substrate of the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required.

10.1.23 Diamantina Fracture Zone

The Diamantina Fracture Zone is located south of the Naturaliste Plateau covering a range of more than 100,00 km^2 in water depths greater than 3,000 m. The ridge, troughs and seamounts that form the fracture zone have been recorded to have a relief up to 4,000 m which has resulted in highly variable environmental conditions (Stow 2006, Richardson *et al.* 2005). The Diamantina Fracture Zone encompasses the deepest known points in Australia's exclusive economic zone, reaching depths of more than 6,000 metres.

Limited information is available for the Diamantina Fracture Zone, however it is likely that due to the highly variable environmental conditions within the distinctive community structures and unique habitats have the potential to form. The presence of seamounts and ridges has the potential to increase local primary and secondary productivity, which may in turn promote phytoplankton growth. Increased phytoplankton has been recorded to increase the diversity and abundance of marine life (e.g. whales, dolphins, fish and benthic species) (Rowden *et al.* 2010). The area is expected to sustain similar habitats to that of and around the Tasmanian Seamounts due to similar depths in the South-east Marine Region (Richardson et al. 2005).

According to DSEWPaC (2012) the Diamantina Fracture Zone is regionally important because of to enhance productivity and assist with dispersal and migration of species across the region and wider abyssal plain (Wilson & Kaufman 1987, in Richardson *et al.* 2005). While research on the Diamantina Fracture Zone is limited, its size, physical complexity and isolation indicate that it is likely to support deepwater communities characterised by high species diversity and endemism.

10.1.24 Demersal Slope and Associated Fish Communities of the Central Western Province)

The demersal slope and associated fish communities of the Central Western Province is located on the edge of the shelf to the limit of the exclusive economic zone from Perth to the northern boundary of the SWMR. The area supports a diverse demersal fish species assemblage of relatively small benthic species (e.g. grenadier, dogfish and cucumber fish) at depths greater than 400 m. Fish species within this area have adapted physically to feed on the seafloor and do not appear to migrate vertically to feed (Williams *et al.* 2001).

According to DSEWPaC (2012), the demersal slope and associated fish communities of the Central Western Province are recognised as a KEF for their high levels of biodiversity and endemism. A total of 480 fish species have been described that inhabit the slope of this bioregion with 31 considered to be endemic to the bioregion. Demersal fish communities within the area have recorded higher diversity when compared to other oceanic regions which have been more intensively sampled. The increased diversity within the area has been attributed to the overlap of ancient and extensive Indo-west Pacific and temperate Australasian fauna (Williams et al. 2001).

10.1.25 Albany Canyons Group and Adjacent Shelf Break

The Albany Canyons group and adjacent shelf break is located along a 700 km extent ranging from Cape Leeuwin to the east of Esperance and consists of 32 deep canyons which cut into the continental slope. Sonar surveys have indicated that individual canyons can extent up to 90 km long at water depths of 2,000 m. The canyons can start at the uppermost continental slope and reach the lowermost slope and extend onto the abyssal plain (Exon *et al.* 2005).

Due to close spacing of the numerous canyons, a wide range of depth dependent benthic habitats are connected increasing the habitat heterogeneity along the south western Australian continental margin. Offshore transport increases the sediment load and organic material is received from productive shelf waters. The closely spaced canyons have the potential to allow increased amounts of organic matter to reach the abyssal plain which may increase biodiversity in comparison to other areas within the south west Marine Region. (Richardson e*t al.* 2005).

According to DSEWPaC (2012), the Albany Canyons group and adjacent shelf break is regionally important and recognised as a key ecological feature for its high productivity, aggregations of marine life, and as a unique seafloor feature with ecological properties of regional significance (Pattiaratchi 2007). Both benthic and demersal habitats within the feature are of conservation value. The canyons are known to be a feeding area for the sperm whale (Bannister *et al.* 1996) and sites of orange roughy aggregations (Caton & McLoughlin 2004).

11. State Marine Conservation Reserves

11.1 Introduction

Marine parks and reserves have been progressively established in Western Australia since 1987. The Conservation and Parks Commission (CPC) is the vesting authority for marine parks and reserves under the provisions of the *Conservation and Land Management Act 1984*. Parks and Wildlife, within the Department of Biodiversity, Conservation and Attractions (DBCA), is responsible for day to day management of the parks.

There are three categories of state marine conservation reserves: marine parks; marine management areas; and marine nature reserves.

Marine parks are created to protect natural features and aesthetic values while allowing recreational and commercial uses that do not compromise conservation values. There are currently 18 marine parks within the EMBA (refer **Figure 9-1**, **Figure 9-2** and **Figure 9-3**).

Marine parks are multiple-use reserves that cater for a wide range of activities. Within marine parks there may be four types of management zones: recreation zones: general use zones; no-take areas known as sanctuary zones; and special purpose zones.

Each marine park has a 'management plan' that contains strategies to protect the high value assets in the park, as well as permitted activities tables. These tables provide explicit regulatory management.

Sanctuary zones are 'no-take' areas created primarily for conservation and scientific research and are designed to protect a particular significant ecosystem or habitat. Low-impact tourism may be permitted, but no recreational or commercial fishing, aquaculture, pearling, petroleum drilling or production is allowed.

Marine management areas provide an integrated management structure over areas that have high conservation value and intensive multiple-use. There are two marine management areas within the EMBA (described below).

There is currently only one state marine nature reserve: Hamelin Pool Nature Reserve part of the Shark Bay World Heritage Area (**Section 9.1.1**)

11.1.1 Ngari Capes Marine Park

The Ngari Capes Marine Park is gazetted as a Class A Marine Park. The park is located off the southwest coast of Western Australia, approximately 250 km south of Perth, covering approximately 123,790 ha. The seaward boundary of the marine park is congruent with the seaward limit of Western Australian waters (three nautical miles from the territorial baseline). The north-eastern boundary in Geographe Bay is located near the intersection of the Shire of Busselton boundary with the coastline. The Shire of Busselton–Shire of Capel boundary is approximately 30 m north-east of the marine park boundary, while the south-eastern boundary in Flinders Bay is located at 115˚17'00" E. The marine park consists of four areas that are representative of the Leeuwin–Naturaliste marine bioregion: Geographe Bay; Cape Naturaliste to Cape Mentelle coast; the Cape Mentelle to Cape Leeuwin coast; and Flinders Bay. These areas show distinct differences in geomorphology, oceanography, habitats and flora and fauna.

The Ngari Capes Marine Park was identified as one of the most diverse temperate marine environments in Australia. Warm, tropical waters of the Leeuwin Current mix with the cool waters of the Capes Current, resulting in high finfish diversity, including tropical and temperate species (see fish in **Section 5.1.1**) and internationally significant seagrass diversity with seagrasses occurring at depths greater than 40 m (see seagrasses in **Section 3.2**). The marine park also surrounds a number of islands that are important seabird nesting habitat and pinniped haul-outs (places where seals and sea lions leave the water and come onto land), including Hamelin Island, Sugarloaf Rock and the Saint Alouarn Islands which include Flinders Island, Seal Island and Square Rock (DEC 2013). These islands are vested with the Conservation Commission as nature reserve and are managed by DBCA for the purpose of conservation. The marine park is also adjacent to the Leeuwin Naturaliste National Park which extends to the high water mark (DEC 2013).

The Ngari Capes marine park was also created for its high social values. The unique geographical location of this region exposes it to large, uninterrupted ocean swells and results in the South West capes area being recognised as one of the world's premier surfing regions. Many activities occurring in the region are marine based, including commercial and recreational fishing, swimming, surfing, diving, snorkelling, boating, and marine nature-based tourism.

11.1.2 Jurien Bay Marine Park

The Jurien Bay Marine Park is a Class A marine park located on the central west coast of Western Australia about 200 km north of Perth and covers an area of 82,375 ha (CALM 2005b). Its western boundary is the seaward limit of Western Australian coastal waters. Its northern boundary is the northern point of Dynamite Bay at Green Head (30° 4' 7.9" South), and its southern boundary is located just south of Wedge (30° 50' 20" South) and is contiguous with the southern boundary of the Wanagarren Nature Reserve.

Jurien Bay Marine Park is considered to be broadly representative of the Central West Coast limestone reef system, which is a major marine ecosystem within this bioregion. The marine biota of the area consists of an unusual mix of tropical and temperate species as well as many endemic species (Larkum & Hartog, 1989). The Marine Park is dominated by five major marine habitat types: seagrass meadows; bare or sparsely vegetated mobile sand; shoreline and offshore intertidal reef platforms; subtidal limestone reefs; and reef pavement (CALM 2005b). Marine wildlife includes 14 species of cetaceans, a variety of sea and shorebirds which nest on the islands and the Australian sea lion (North Fisherman Island to the north of Jurien Bay is one of the main breeding sites for sea lions in the Central West Coast region and it is believed this breeding population is genetically distinct from the southern coast population – Gales et al. 1992). Commercial fishing for western rock lobster as well commercial wetlining, abalone, shark netting, beach seining for mullet and collecting of specimen shells and aquarium fish are carried out within the marine park.

11.1.3 Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve

The Shark Bay Marine Reserves comprise the Shark Bay Marine Park and the Hamelin Pool Marine Nature Reserve. The Shark Bay Marine Park was gazetted on 30 November 1990 as A Class Marine Park Reserve No. 7 and vested in the National Park and Nature Conservation Authority (NPNCA) under the CALM Act. The marine park encompasses an area of 748,725 ha (CALM 1996).

The Bay is located near the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay, 83% are tropical species with 11% warm temperate and 6% cool temperate species. Similarly, of the 218 species of bivalves recorded in Shark Bay, 75% have a tropical range and 10% a southern Australian range, with 15% being endemic to the west coast (CALM 1996).

Key features of Shark Bay Marine Park include (CALM 1996, DSEWPaC 2013b):

+ 12 species of seagrass making it one of the most diverse seagrass assemblages in the world;
+ Seagrass that covers over 4,000 km2 of the bay. The 1,030 km2 Wooramel Seagrass Bank is the largest structure of its type in the world;
+ An estimated population of about 11,000 dugongs, one of the largest populations in the world;
+ Humpback and southern right whales use the bay as a migratory staging post;
+ Bottlenose dolphins occur in the bay, and green turtle and loggerhead turtle nest on the beaches;
+ Large numbers of sharks including whaler, tiger shark and hammerhead are present as well as an abundant population of rays, including the manta ray;
+ Hamelin Pool in Shark Bay contains the most diverse and abundant examples of stromatolite forms in the world, representative of life-forms which lived some 3,500 million years ago; and
+ Shark Bay Marine Park does not cover Bernier and Dorre Islands and only coastal waters inshore of Dirk Hartog Island (east of eastern shoreline).

Shark Bay was included on the World Heritage List in 1991 primarily on the basis of three natural features: vast seagrass beds; dugong population; and stromatolites (microbial colonies that form hard, dome-shaped deposits and are among the oldest forms of life on Earth) (DSEWPaC 2013b; see **Section 9.1**).

There is no zoning within the Hamelin Pool Marine Nature Reserve. This area is a 'look but don't take' area managed solely for the conservation of globally outstanding marine life. Hamelin Pool is one of only two known places in the world with living examples of marine stromatolites (DEC 2010). The shores of Hamelin Pool are also important for the formation of extensive marine algal mats formed by microbial algae. If damaged, the mats and stromatolites can take many hundreds of years to recover (DEC 2010).

11.1.4 Ningaloo Marine Park

The Ningaloo Marine Park was declared in May 1987 under the National Parks and Wildlife Conservation Act 1975 (Commonwealth). The Ningaloo Coast, incorporating both key marine and terrestrial values was later granted World Heritage Status in June 2011. In November 2012, the Ningaloo Marine Park (Commonwealth Waters) was renamed to be incorporated in the North-west Commonwealth Marine Reserves Network. The park covers an area of 263,343 km^2, including both State and Commonwealth waters, extending 25 km offshore.

The park protects a large portion of Ningaloo Reef, which stretches over 300 km from North West Cape south to Red Bluff. It is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that varies in width from 200 m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). The Ningaloo Marine Park forms the backbone of the nature-based tourism industry, and recreational activities in the Exmouth region. Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

The reef is composed of partially dissected basement platform of Pleistocene marine or Aeolian sediments or tertiary limestone, covered by a thin layer of living or dead coral or macroalgae. Key features that characterise the Ningaloo Reef include (CALM 2005):

+ Over 217 species of coral (representing 54 genera);
+ Over 600 species of mollusc (clams, oysters, octopus, cuttlefish, snails);
+ Over 460 species of fish;
+ Ninety-seven species of echinoderms (sea stars, sea urchins, sea cucumbers);
+ Habitat for numerous threatened species, including whales, dugong, whale sharks and turtles; and
+ Habitat for over 25 species of migratory wading birds listed in CAMBA and JAMBA.

11.1.5 Muiron Islands Marine Management Area

The Ningaloo Marine Park Management Plan (CALM 2005) created a MMA for the Muiron Islands, immediately adjacent to the northern end of the Park. This is managed as an integrated area together with the Ningaloo Marine Park, but its status as a MMA means that some activities, including oil and gas exploration, are still permitted under a strict environmental assessment process involving DMIRS.

The Muiron Islands, located 15 km northeast of the North West Cape comprise the North and South Muiron Islands and cover an area of 1,400 ha (AHC 2006). They are low limestone islands (maximum height of 18 m above sea level (ASL)) with some areas of sandy beaches, macroalgae and seagrass beds in the shallow waters (particularly on the eastern sides) and coral reef up to depths of 5m, which surrounds both sides of South Muiron Island and the eastern side of North Muiron Island. The Muiron Islands MMA was WA's first MMA, gazetted in November 2004. It covers an area of 28,616 ha and occurs entirely within state waters (CALM 2005).

11.1.6 Barrow Island Marine Park

The Barrow Island Marine Park covers 4,169 ha, all of which is zoned as sanctuary zone (the Western Barrow Island Sanctuary Zone) (DEC 2007). It includes Biggada Reef, an ecologically significant fringing reef, and Turtle Bay, an important turtle aggregation and breeding area (DEC 2007). Representative areas of seagrass, macroalgal and deep water habitat are also represented within the marine park (DEC 2007). Passive recreational activities (such as snorkelling, diving and boating) are permitted but extractive activities such as fishing and hunting are not.

11.1.7 Barrow Island Marine Management Area

The Barrow Island Marine Management Area (MMA) is the largest reserve within the Montebello/Barrow Islands marine conservation reserves, covering 114,693 ha (DEC 2007). The MMA includes most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park, with the exclusion of the port areas of Barrow Island and Varanus Island.

The MMA is not zoned apart from one specific management zone: the Bandicoot Bay Conservation Area. This conservation area is on the southern coast of Barrow Island and has been created to protect benthic fauna and seabirds. It includes the largest intertidal sand/mudflat community in the reserves, is known to be high in invertebrate diversity and is an important feeding area for migratory birds.

As for the other reserves in the Montebello/Barrow Islands marine conservation reserves, the Barrow Island MMA includes significant breeding and nesting areas for marine turtles and the waters support a diversity of tropical marine fauna, important coral reefs and unique mangrove communities (DEC 2007). Green, hawksbill and flatback turtles regularly use the island's beaches for breeding, and loggerhead turtles are also occasionally sighted.

11.1.8 Montebello Islands Marine Park

Montebello/Barrow/Lowendal Islands are part of a shallow submarine ridge, which extends north from the mainland near Onslow. The ridge contains extensive areas of intertidal and shallow subtidal limestone pavement surrounding the numerous, mostly small islands which are found in the region. The seabed is generally less than 5 m deep and consists of sand veneered limestone pavement with patches of fringing coral reef (DEC 2007).

The island chain lies entirely within WA State waters, with the State-Commonwealth boundary extending out to encompass the islands and waters 3 nm west of Barrow Island and north of the Montebello Islands. These islands are protected within as marine conservation reserves: Montebello Islands Marine Park, Barrow Islands Marine Park and Barrow Island Marine Management Area.

The Montebello Islands Marine Park (58,331 ha), consists of two sanctuary zones, two recreation zones, one special purpose zone for benthic protection, eleven special purpose zones for pearling and general use zones.

The Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops; rocky shore accounts for 81% of shoreline habitat (DEC 2007a).

The ecological and conservation values of the Montebello and Barrow Islands Marine Conservation Reserve (MCR) include important habitats including corals reefs and bommies, mangroves, seagrass and macroalgae meadows, rocky shorelines and hard substrate, intertidal sand and mudflat communities. These habitats provide protection, food and habitat for a large diversity of species, including dugongs, turtles, whales, other protected cetaceans and birds as well as sea snakes and fish. The area is considered to have a high biodiversity. The islands also provide feeding and resting areas for migrating shorebirds and seabird nesting areas.

Socio-economic values of the Montebello and Barrow Islands MCR include hydrocarbon exploration and production, pearling, nature-based tourism, commercial and recreational fishing, water sports, European history and maritime heritage and scientific research (DEC 2007)

Special purpose zones for pearling are established for the existing leaseholder to allow pearling to be the priority use of these areas (DEC 2007a). Commercial fishing includes a trap fishery for reef fishes, mainly in water depths of 30–100 m, and wet lining for reef fish and mackerel. Fish trawling also occurs in the waters near to the Montebello Islands. A tourist houseboat operates out of Claret Bay, at the southern end of Hermite Island, during the winter months. The Montebello Islands are becoming more frequently used by recreational boaters for camping, fishing and diving activities.

11.1.9 Rowley Shoals Marine Park

The Rowley Shoals (including the Commonwealth-managed Mermaid Reef Marine National Nature Reserve) are located approximately 300 km west-northwest of Broome, lying between 17°07'S, 119°36'E and 17°35'S, 118°56'E and encompassing approximately 87,674 ha (DEC 2007b).

The Rowley Shoals is ecologically significant in that the reefs form part of a series of important ecological "stepping stones" for a range of reef biota originating in Indonesian/west Pacific waters. Their position off the north-west Australian coast, an area of few offshore reef systems, provides an important upstream source for recruitment to reefs further south (DEC 2007b). Marine wildlife includes 184 species of corals, primarily Indo-West Pacific species, indicating the strong affinity of the Rowley Shoals communities with Indonesia. In terms of other species, at least 264 species of molluscs, 82 species of echinoderms and 389 species of finfish were also identified (DEC 2007b). The faunal assemblages of the Rowley Shoals Marine Park are regionally significant as they contain large numbers of species not found in the more turbid coastal environments of tropical Western Australia (DEC 2007b). There is a relatively low level of recreational and commercial activity, mostly atribuated to the remoteness of the Shoals with access difficult from both Indonesia and mainland Australia (DEC 2007b).

11.1.10 Lalang-garram/Camden Sound Marine Parks

The Lalang-garram/Camden Sound Marine Park was created on 19 June 2012 under Section 13 of the Conservation and Land Management Act 1984 (CALM Act). It is a multiple zone marine park that includes; Sanctuary, Special Purpose, and General Use zones (DPaW 2013). The marine park falls within the west Kimberley, which was recently added to the Australian National Heritage List because of its natural, indigenous and historic values to the nation.

The marine park is located about 150 km north of Derby (or 300 km north of Broome) and lies within the traditional country of three Aboriginal native title groups. The Dambimangari people's determination overlies the majority of the marine park. A section of the Wunambal Gaambera people's Uunguu determination includes a small portion of St George Basin, while a small section of the Mayala people's claim (native title not determined at the time of writing of Management Plan) overlies the southwest corner of the marine park (DPaW 2013).

The marine park covers an area of approximately 705,000 ha. It recognises and provides special management arrangements for this area of the Kimberley, which is a principal calving habitat of the humpback whale (*Megaptera novaeangliae*) population that migrates annually along Western Australia's coast. The marine park also conserves a range of species listed as having special conservation status including marine turtles, snubfin and Indo-Pacific humpback dolphins, dugong, saltwater crocodiles, and several species of sawfish. The park also includes a wide range of marine habitats and associated marine life, such as coral reef communities, rocky shoals, and the extensive mangrove forests and marine life of the St George Basin and Prince Regent River (DPaW 2013).

11.1.11 Marmion Marine Park

Marmion Marine Park was Western Australia's first marine park, declared in 1987 and is a multi-use reserve (CALM 2002). Marmion Marine Park is located offshore from Perth's northern suburbs, between Trigg Island and Burns Beach.

Habitats in the area include intertidal reef platforms, coastal sand beaches, a high limestone reef about 1 km from shore, Little Island and the Three Mile Reef system. Of note are complex assemblages of sea floor communities, including seagrass meadows, algal limestone pavement communities and crevice animal associations (CALM 2002).

The marine park provides an important habitat for marine mammals, such as sea lions, dolphins and whales. The island nature reserves within Marmion Marine Park provide an important habitat for several species of seabirds and haul-out areas for Australian sea lions, especially at Little Island and Burns Rocks (CALM 2002).

11.1.12 Swan Estuary Marine Park

The Swan Estuary Marine Park (A Class marine reserve number 4) was gazetted on 25 May 1990. The Swan Estuary Marine Park and Adjacent Nature Reserves Management Plan 1999-2009 was gazetted 7 April 2000 (CALM 1999).

The Swan Estuary Marine Park encompasses Alfred Cove, 200 ha adjacent to the suburbs of Attadale and Applecross; Pelican Point, a 45 ha area in Crawley; and Milyu, 95 ha adjacent to the Como foreshore (CALM 1999). All three localities are within 20 minutes of the Perth CBD.

These areas encompass mudflats, seagrass beds and intertidal vegetation such as sedges and saltmarsh, which provide many different habitats for a host of animals. The most important of these, due to their international significance, are the migratory wading birds. They come from as far afield as Asia, Mongolia and Siberia. About 33 of these species are protected, including the red-necked stint (CALM 1999).

11.1.13 Shoalwater Islands Marine Park

The Shoalwater Islands Marine Park is located within the Perth metropolitan area, adjacent to the city of Rockingham and was gazetted in 1990 (DEC 2007). There are three sanctuary zones, two special purpose zones and a large general use zone in the park.

The Shoalwater Island region is dominated by beach and rocky shore shoreline habitats. The many jagged edged islands and rocky islets of the marine park provide important roosting and nesting areas for numerous bird species. The marine park has some of the healthiest seagrass meadows in the Perth metropolitan area, consisting of long lived species such as *Posidonia* spp. and *Amphibolis* spp. Seagrass meadows provide an important habitat and nursery area for a large number of marine species such as fish, rock lobsters, worms, shellfish, crustaceans, fish sharks and rays (DEC 2007).

The habitats of the marine park are important for the feeding, resting and breeding of little penguins and other sea and shore birds. Penguin Island which is found within the marine park has the largest breeding colony of little penguin on the west coast of Australia (DEC 2007). The bottlenose dolphin is the most common marine mammal, and Australian sea lions are commonly seen throughout the park.

11.1.14 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park, located between Port Hedland and Broome, was gazetted on 29 January 2013. It covers an area of approximately 200,000 ha stretching for some 220 km from Cape Missiessy to Cape Keraudren, and includes sanctuary, recreation, general use and special purpose zones. The park is managed under the Eighty Mile Beach Marine Park Management Plan 2014-20124 (DPaW, 2014).

The listed ecological values of the Eighty Mile Beach Marine Park include the high sediment and water quality, the juxtaposition of the beach, coastal topography and seabed and the diverse and ecologically important habitats and marine/coastal flora and fauna. The listed habitat values of the marine park are as follows:

+ The intertidal sand and mudflat communities supporting a high abundance and diversity of invertebrate life and providing a valuable food source for shorebirds (including migratory species) and other fauna;
+ The diverse subtidal filter-feeding communities;
+ Macroalgal and seagrass communities providing habitat and feeding opportunities for fish, invertebrates and dugongs;
+ High diversity intertidal and subtidal coral reef communities; and
+ Mangrove communities and adjacent saltmarshes provide nutrients to the surrounding waters and habitat for fish and invertebrates.

The listed marine and coastal fauna values are as follows:

+ A high diversity and abundance of nationally and internationally important shorebirds and waders (including migratory species) are found in the marine park;
+ Flatback turtles are endemic to northern Australia and nest at Eighty Mile Beach;
+ Dugongs and several whale and dolphin species inhabit or migrate through the marine park;
+ A highly diverse marine invertebrate fauna provides an important food source for a variety of animals, including birds, fish and turtles, along with recreational and commercial fishing opportunities;
+ A diversity of fish species provides recreational and commercial fishing opportunities; and
+ A diversity of sharks and rays, including several protected species, are found in the park.

In addition to these natural values, the marine park contains land and sea important to traditional Indigenous owners through identity and place, family networks, spiritual practice and resource gathering. The marine park also has a history of European activity including exploration, pastoralism and commercial fishing (e.g. the pearl oyster fishery). The park contains a historical WWII plane wreck (*Dornier Do-24 X-36*) and shipwrecks (two pearl luggers). The marine park provides tourism opportunity and recreational value through its remoteness, diversity and abundance of habitats and marine fauna and the pristine nature of the marine and coastal environment.

The marine park contains vast intertidal sand and mudflats that extend up to 4 km wide at low tide and provide a rich source of food for many species. Eighty Mile Beach Marine Park is one of the world's most important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DPaW 2014) (see **Section 9.2.1**).

11.1.15 Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Parks

The Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Parks were established in 2016 under the State Government's *Kimberley Science and Conservation Strategy* and are jointly managed by Dambimangari Traditional Owners and the Department of Parks and Wildlife (DPaW 2016). The marine parks fall within the west Kimberly region, included in the Australian National Heritage List for its nationally significant natural, indigenous and historic values (DoEE 2019c).

The Lalang-garram/ Horizontal Falls Marine Park extends from Talbot Bay (*Ganbadba*) in the west to Walcott Inlet (*Iledda*) and Glenelg River (*Molor Moloiyn*) in the east and covers approximately 353,000 ha (DPaW 2016). The marine park protects the internationally recognised Horizontal Falls and is important for the region's tourism. The North Lalang-garram Marine Park lies between the Lalang-garram / Camden Sound and North Kimberley Marine Parks and covers approximately 110,000 ha (DPaW 2016).

The area's large tidal range results in extensive intertidal areas with diverse ecosystems such as fringing coral reefs, mangroves and mudflat communities. Subtidal habitats and communities common to the marine parks include filter feeding communities of sponges and hard and soft corals. These intertidal and subtidal habitats provide critical foraging and nursery areas for dugong, marine turtles, estuarine crocodiles, snubfin and Indo-Pacific humpback dolphins, several species of sawfish and migratory seabirds. The marine parks are also a principal calving habitat for humpback whales (DPaW 2016).

11.1.16 North Kimberley Marine Park

The North Kimberley Marine Park was established in December 2016 as a Class A marine park under the CPC (DPaW 2016a). The marine park comprises four separate management areas including, Uunguu, Balanggarra, Miriuwung Gajerrong, and Wilinggin. It is a multiple zone marine park that includes: eight sanctuary zones, nine special purpose zones (recreation and conservation), two special use zone (cultural heritage), and general use areas (DPaW 2016a). The marine park is managed in accordance with the provisions of the CALM Act with joint management between the Department of Parks and Wildlife and Traditional Owners of the area.

The area within the marine park is recognised for its Aboriginal cultural and heritage values, natural values including coral reefs, marine turtle species, dugongs, seagrass and macroalgal communities, mangroves and saltmarshes, finfish, and water and sediment quality, as well as for its social values (i.e. recreation, tourism and community values) and commercial values and resource use (e.g. commercial fishing). The marine park lies within the Indian Ocean and Timor Sea of Western Australia's Kimberley region, covering an area of approximately 1,845,000 hectares (DPaW 2016a). The south-western boundary is approximately 270 km northeast of Derby.

11.1.17 Yawuru Nagulagun/ Roebuck Bay Marine Park

The Yawuru Nagulagun/Roebuck Bay Marine Park was approved by the State Minister for Environment in October 2016 and declared as a Class A reserve over the subtidal and intertidal areas of Roebuck Bay (excluding the Kimberley Ports Authority waters), (DBCA, 2017a). The Marine Park is managed with a joint management framework between Parks and Wildlife and Yawuru Registered Native Title Body Corporation (RNTBC). The intent is to manage the areas from the offshore waters around Roebuck and Broome, collectively referred to as the Yawuru conservation estate, as one ecological system (DPaW 2016b). The development of the joint management plan is in accordance with the Conservation and Land Management Act 1984 (Yawuru Organisation 2017) as well as contributes to the State Governments commitment under the Kimberly Science and Conservation Strategy, released in June 2011.

The Yawuru people have lived along the foreshores of Roebuck Bay for thousands of years, the Bay is part of the Yawuru traditional estate (DPaW 2016b). Roebuck Bay is an internationally significant Ramsar wetland, declared in 1990, and an important feeding ground for many species of migratory shorebirds. It hosts possibly the greatest diversity of shorebird species at any site across the globe (DBCA 2017b). The Bay has some of the most productive tropical intertidal flats in the world, and is consequently an important ground for Yawuru fishing, hunting and gathering of sea food. The Bay hosts communities of seagrass and macroalgae, providing food for protected species such as the dugong and flatback turtle. Marine mammals also pass through the waters of the Bay such as the Australian snubfin dolphin and the humpback dolphin, the humpback whale can also be found during annual migration (DPaW 2016b).

12. Australian Marine Parks

12.1 Introduction

In agreement with the States and NT governments, the Australian Commonwealth government was committed to establish Commonwealth marine parks as a component of the National Representative System of Marine Protected Areas (DoE 2014) (See **Figure 9-1, Figure** 9-2 and **Figure 9-3**). In November 2012, the Commonwealth Marine Reserves Network was proclaimed with the purpose of protecting the biological diversity and sustainable use of the marine environment (Director of National Parks 2012a). Commonwealth Marine Reserves were renamed as Australian Marine Parks in October 2017. Six marine regions are included in the Australian Marine Parks Network, including the Coral Sea, the South-west, the Temperate East, the South-east the North and the North-west. The South-east network 10-year Management Plan came into effect on 1 July 2013. The remaining networks 10-year Management Plans were approved and came into effect on 1 July 2018.

The new management plans establish the management and zoning of the designated marine parks. The marine park networks pertinent to the EMBA include:

- The South-West Marine Parks Network;
- The North-West Marine Parks Network; and
- The North Marine Parks Network.

The South-West Marine Parks Network comprises 14 marine parks. Six of these occur in West Australian waters in the EMBA, including:

- Abrolhos Commonwealth Marine Park;
- Jurien Marine Park;
- Two Rocks Marine Park;
- Perth Canyon Marine Park;
- Geographe Marine Park;
- South-west Corner Marine Park; and
- Bremer Marine Park

The North-West Marine Parks Network comprises 13 marine parks which all occur in West Australian waters pertinent to the EMBA:

- Carnarvon Canyon Marine Park;
- Shark Bay Marine Park;
- Gascoyne Marine Park;
- Ningaloo Marine Park;
- Montebello Marine Park;
- Dampier Marine Park;
- Eighty Mile Beach Marine Park;
- Argo-Rowley Terrace Marine Park;
- Mermaid Reef Marine Park;
- Roebuck Marine Park;

+ Kimberley Marine Park;
+ Ashmore Reef Marine Park; and
+ Cartier Island Marine Park.

The Northern Marine Parks Network comprises eight marine parks. However, only the Oceanic Shoals Marine Park extends across the boundary with the North-West Marine Parks Network, into the EMBA.

The sizes of these marine parks range from 300—152,000 km^2, and the water depths within the marine parks vary from approximately 15—1,500 m deep. The EPBC Act requires that each management plan assign an International Union for the Conservation of Nature (IUCN) category to each marine park. Additionally, the Act also allows for the management plan to divide a marine park into zones and to assign a category to each zone, which may differ from the overall category of the marine park. Zoning takes into account the purposes for which the marine parks were declared, the objectives of the relevant management plans, the values of the marine park and requirements of the EPBC Act and EPBC Regulations.

Five types of zone are represented within the North Marine Parks Network. However, it is only the Multiple Use Zone (IUCN Category VI) of the Oceanic Shoals Marine Park which extends into the EMBA.

The North-West Marine Parks Network includes six different types of zoning:

+ Sanctuary Zone (IUCN Category Ia);
+ National Park Zone (IUCN Category II);
+ Recreational Use Zone (IUCN Category IV);
+ Habitat Protection Zone (IUCN Category IV);
+ Multiple Use Zone (IUCN Category VI); and
+ Special Purpose Zone (Trawl) (VI).

The South-west Marin Parks Network includes six different types of zoning:

+ National Park Zone (IUCN Category II);
+ Habitat Protection Zone (IUCN Category IV);
+ Multiple Use Zone (IUCN Category VI);
+ Special Purpose Zone (Mining Exclusion) (IUCN Category VI);
+ Special Purpose Zone (IUCN Category VI); and
+ Special Purpose Zone (Trawl) (IUCN Category VI).

A summary of the South-West and North-West Marine Parks Networks is provided in **Table 12-1**.

12.2 South-West Marine Parks Network

The South-West Commonwealth Marine Parks Network is aligned to the South-West Marine Region. The network covers 508,371 km^2 and includes 14 marine parks (Director of National Parks, 2018a). Broad values of the South-west Australian Marine Parks include:

+ Natural values;
+ Cultural values;
+ Heritage values; and
+ Socio-economic values.

Further detail on each of the relevant marine parks those that fall within the EMBA is provided below.

12.2.1 Abrolhos Marine Park

The Abrolhos Marine Park (including zones within the EMBA: Marine National Park Zone – IUCN Category II-2,548 km^2; Habitat Protection Zone – IUCN Category VI-23,239 km^2; Multiple Use Zone – IUCN Category VI-56,545 km^2; Special Purpose Zone – IUCN Category VI-5,729 km^2) covers and area of approximately 88,060 km^2 and protects the following conservation values (Director of National Parks, 2018a):

- Important foraging areas for the:
  - Threatened Australian lesser noddy;
  - Northernmost breeding colony of the threatened Australian sea lion;
  - Great white sharks; and
  - Migratory common noddy, wedge-tailed shearwater, bridled tern, Caspian tern and roseate tern.
- Important migration habitat for the protected humpback whale and pygmy blue whales;
- The second largest canyon on the west coast, the Houtman Canyon;
- Examples of the northernmost ecosystems of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion);
- Examples of the deeper ecosystems of the Abrolhos Islands meso-scale bioregion;
- Examples of the shallower, southernmost ecosystems of the Central Western Shelf Province provincial bioregion including the Zuytdorp meso-scale bioregion;
- Examples of the deeper ecosystems of the Central Western Transition provincial bioregion;
- Examples of diversity of seafloor features including: southern most banks and shoals of the North-west region; deep holes and valleys; slope habitats; terrace and shelf environments; and
- Seven KEFs.

The Abrolhos Marine Park is adjacent to the Shark Bay World Heritage Property. The marine park does not contain any Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains 11 known shipwrecks listed under the *Underwater Culture Heritage Act 2018* . Commercial tourism, fishing, recreation and mining are important supported socio-economic activities in the park.

12.2.2 Jurien Marine Park

The Jurien Marine Park (including zones within the EMBA): Marine National Park Zone -IUCN Category II – 31 km^2 Special Purpose Zone -IUCN Category VI – 1,820 km^2) covers and area of approximately 1,851 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Threatened Australian sea lion;
  - Threatened white shark; and
  - Migratory roseate tern, bridled tern, wedge-tailed shearwater, and common noddy.
- Important migration habitat for the protected humpback whale;
- Examples of the ecosystems of two provincial bioregions: the central part of the South-west Shelf Transition (which includes the Central West Coast meso-scale bioregion) and small parts of the Central Western Province;
- Three KEFs; and
- Heritage values represented by the SS Cambewarra and Oleander historic shipwreck.

The Jurien Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, recreation and mining are important supported socio-economic activities in the park.

12.2.3 Two Rocks Marine Park

The Two Rocks Marine Park (including zones within the EMBA): Multiple Use Zone - IUCN Category VI – 867 km^2; Marine National Park Zone - IUCN Category II – 15 km^2) covers an area of approximately 882 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Threatened Australian sea lion; and
  - Migratory roseate tern, bridled tern, Caspian tern, wedge-tailed shearwater, and common noddy.
- Important migratory areas for protected humpback whales and pygmy blue whales;
- Seasonal calving habitat for the threatened southern right whale;
- Examples of the ecosystem of the southernmost parts of the South-west Shelf Transition (including the Central West Coast meso-scale bioregion); and
- Three KEFs.

The Two Rocks Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, recreation and scientific research are important supported socio-economic activities in the park.

12.2.4 Perth Canyon Marine Park

Perth Canyon Marine Park (including zones within the EMBA): Marine National Park Zone – IUCN Category II – 1,241 km^2; Habitat Protection Zone – IUCN Category IV –4,352 km^2; Multiple Use Zone – IUCN Category VI – 1,816 km^2) covers an area of approximately 7,409 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Globally important seasonal feeding aggregation for the threatened blue whale;
- Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Migratory sperm whale; and
  - Migratory wedge-tailed shearwater.
- Important migratory areas for protected humpback whales and blue whales;
- Seasonal calving habitat for the threatened southern right whale;
- Examples of the ecosystems of the southernmost parts of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion), and the northernmost parts of the South-west Transition and Southwest Shelf Province (including the Leeuwin-Naturaliste meso-scale bioregion); and
- Four KEFs.

The Perth Canyon Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, shipping, recreation and defence training are important supported socio-economic activities in the park.

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12.2.5 Geographe Marine Park

Geographe Marine Park (including zones within the EMBA): Marine National Park Zone - IUCN Category II – 15 km^2; Special Purpose Zone - IUCN VI – 650 km^2; Multiple Use Zone - IUCN Category VI – 291 km^2; Habitat Protection Zone (IV) 21 km^2) covers an area of approximately 977 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important foraging areas for the:
  - Threatened soft-plumaged petrel; and
  - Migratory wedge-tailed shearwater.
+ Important pre-migration aggregation area for the migratory flesh-footed shearwater;
+ Important migratory habitat for the protected humpback whale and blue whale;
+ Seasonal calving habitat for the threatened southern right whale.
+ Seasonal calving habitat for the threatened southern right whale.
+ Representation of the South-west Shelf Province on the continental shelf as well as the Leeuwin-Naturaliste meso-scale bioregion;
+ Two KEFs; and
+ Representation of the seagrass habitats of the Geographe Bay key ecological feature, which in this location extend the furthest into Commonwealth waters.

The Geographe Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains eight known shipwrecks listed under the *Underwater Culture Heritage Act 2018.* Commercial tourism, fishing and recreation are important supported socio-economic activities in the park.

12.2.6 South-west Corner Marine Park

The South-west Corner Marine Park (including zones within the EMBA: Marine National Park Zone - IUCN II – 54,841 km^2; Multiple Use Zone - IUCN VI –106,602 km^2; Special Purpose Zone (Mining exclusion) - IUCN VI – 9,550 km^2, Special Purpose Zone – IUCN VI – 5753 km^2; Habitat Protection Zone - IUCN IV – 95,088 km2) covers an area of approximately 271,833 km2 within the EMBA and protects the following conservation values (Director of National Parks 2018a):

+ Important migratory area for protected humpback whales and blue whales;
+ Important foraging areas for the:
  - Threatened white shark;
  - Threatened Australian sea lion;
  - Threatened Indian Yellow-nosed albatross and soft-plumaged petrel;
  - Sperm whale;
  - Migratory flesh-footed shearwater, short-tailed shearwater and Caspian tern; and
  - Seasonal calving habitat for the threatened southern right whale.
+ Representation of three provincial bioregions (the South-west Transition and Southern Province in the off-shelf area, and the South-west Shelf Province on the continental shelf) and two meso-scale bioregions (southern end of the Leeuwin-Naturaliste meso-scale bioregion and western and central parts of the Western Australia South Coast meso-scale bioregion);
+ Representation of the Donnelly Banks, east of Augusta, characterised by higher productivity and including nursery habitats; and

- Six KEFs.

The South-west Corner Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains ten known shipwrecks listed under the *Underwater Culture Heritage Act 2018* . Commercial tourism, fishing, shipping and recreation are important supported socio-economic activities in the park.

12.2.7 Bremer Marine Park

The Bremer Marine Park: National Park Zone – IUCN II – 3,172 km^2; Special Purpose Zone (Mining exclusion) - IUCN VI – 1,300 km^2, which covers an area of approximately 4,472 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Contains habitats, species and ecological communities associated with two bioregions: Southern Province and South-west Shelf Province;
- Two key ecological features (Albany Canyon group and adjacent shelf break and ancient coastline between 90 m and 120 m depth);
- Important foraging areas for:
- Threatened white shark;
- Threatened Australian sea lion;
- Threatened Indian Yellow-nosed albatross, Fairy tern and soft-plumaged petrel; and
- Migratory flesh-footed shearwater, short-tailed shearwater, Bridled tern and Caspian tern.
- Important migratory pathway for humpback whales;
- Significant calving habitat for the threatened southern right whale; and
- Important aggregation area for killer whales

The marine park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, shipping and recreation are important supported socio-economic activities in the park.

12.3 North-West Marine Park Network

The North-West Marine Parks Network is aligned to the North-west Marine Region. The network covers 335, 341 km^2 and includes 13 marine parks (Director of National Parks, 2018b). Broad values of the North-west Commonwealth Marine Reserves Network include:

- Natural values;
- Cultural values;
- Heritage values; and
- Socio-economic values.

Further detail on each of the relevant marine parks within the EMBA is provided below.

12.3.1 Carnarvon Canyon Marine Park

The Carnarvon Canyon Marine Park (Habitat Protection Zone – IUCN Category IV) covers an area of approximately 6,177 km^2 and protects the following conservation values (Director of National Parks 2018b):

- The Carnarvon Canyon a single channel canyon with seabed features that include slope, continental rise and deep holes and valleys;

- The Carnarvon Canyon ranges in depth from 1500 m to over 5,000 m, thereby providing habitat diversity for benthic and demersal species; and
- Central Western Transition provincial bioregion ecosystem examples are found here, which are characteristic of the biogeographic faunal transition between tropical and temperate species.

There is limited information about species' use of this Marine Park (Director of National Parks 2018b). The marine park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018b). Commercial fishing, tourism, shipping and mining are important supported socio-economic activities in the marine park.

12.3.2 Shark Bay Marine Park

The Shark Bay Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 7,443 km^2 and protects the following conservation values (Director of National Parks 2018b):

- Foraging areas adjacent to important breeding areas for several species of migratory seabirds;
- Part of the migratory pathway of protected humpback whales;
- Internesting habitat for marine turtles;
- Waters that are adjacent to the largest nesting area for loggerhead turtles in Australia;
- Marine park and adjacent coastal areas important for shallow-water snapper;
- Protection to shelf and slope habitats as well as a terrace feature;
- Examples of the shallower ecosystems of the Central Western Shelf Province and Central Western Transition provincial bioregions including the Zuytdorp meso-scale bioregion; and
- Connectivity between the inshore waters of the Shark Bay World Heritage Area and the deeper waters of the area.

Whilst no listed international, Commonwealth or National Heritage places are within the marine park, the park is adjacent to Shark Bay World Heritage Area (Director of National Parks 2018b). Commercial tourism, fishing, mining and recreation are important socio-economic values of the park.

12.3.3 Gascoyne Marine Park

The Gascoyne Marine Park (Multiple Use Zone – IUCN Category VI-33,652 km^2; Habitat Protection Zone – IUCN Category IV-38,982 km^2; Marine National Park Zone – IUCN Category II-9,132 km^2) covers an area of approximately 81,766 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Important foraging areas for: migratory seabirds threatened and migratory hawksbills and flatback turtles; and vulnerable and migratory whale shark;
- A continuous connectivity corridor from shallow depths around 15 m out to deep offshore waters on the abyssal plain at over 5,000 m in depth;
- Seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise. It also provides protection for sponge gardens in the south of the reserve adjacent to Western Australian coastal waters;
- Ecosystems examples from the Central Western Shelf Transition, the Central Western Transition and the Northwest province provincial bioregions as well as the Ningaloo meso-scale bioregion;
- Four KEFs for the region:
    - Canyons on the slope between the Cuvier Abyssal Plain and the Cape Range Peninsula (enhanced productivity, aggregations of marine life and unique sea-floor feature);
    - Exmouth Plateau (unique sea-floor feature associated with internal wave generation);

- Continental slope demersal fish communities (high species diversity and endemism – the most diverse slope bioregion in Australia with over 500 species found with over 64 of those species occurring nowhere else); and
- Commonwealth waters adjacent to Ningaloo Reef.

+ The canyons in this reserve are believed to be associated with the movement of nutrients from deep water over the Cuvier Abyssal Plain onto the slope where mixing with overlying water layers occurs at the canyon heads. These canyon heads, including that of Cloates Canyon, are sites of species aggregation and are thought to play a significant role in maintaining the ecosystems and biodiversity associated with the adjacent Ningaloo Reef; and
+ The reserve therefore provides connectivity between the inshore waters of the existing Ningaloo Commonwealth marine park and the deeper waters of the area.

The park is also adjacent to World Heritage listings associated with the Ningaloo Coast. Commercial tourism, commercial fishing, mining and recreation are important socio-economic values of the park (Director of National Parks 2018b).

12.3.4 Ningaloo Marine Park

Ningaloo Marine Park stretches approximately 300 km along the west coast of the Cape Range Peninsula and is adjacent to the Western Australian Ningaloo Marine Park and Gascoyne Marine Park (Director of National Parks, 2018b). Ningaloo Reef is the longest fringing barrier reef in Australia forming a discontinuous barrier that encloses a lagoon that varies in width from 200 m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). It is the only example in the world of extensive fringing coral reef on the west coast of a continent.

The Ningaloo Marine Park (Recreational Use Zone – IUCN Category II) covers an area of approximately 2,435 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important habitat (foraging areas) for vulnerable and migratory whale sharks;
+ Areas used for foraging by marine turtles adjacent to important internesting sites;
+ Part of the migratory pathway of the protected humpback whale;
+ Foraging and migratory pathway for pygmy blue whales;
+ Breeding, calving, foraging and nursing habitat for dugong;
+ Shallow shelf environments which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
+ Seafloor habitats and communities of the Central Western Shelf Transition;
+ Three KEFs; and
+ The Ningaloo Coast World Heritage Property, the Ningaloo Coast National Heritage listing and Ningaloo Marine Area Commonwealth Heritage Listing.

Commercial tourism and recreation are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.5 Montebello Marine Park

The Montebello Marine Park is located offshore of Barrow Island and 80 km west of Dampier extending from the Western Australian state water boundary, and is adjacent to the Western Australian Barrow Island and Montebello Islands Marine Parks. The Montebello Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 3,413 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging areas for migratory seabirds that are adjacent to important breeding areas;

- 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 km² and protects the following conservation values (Director of National Parks 2018b):

+ Mermaid Reef and Commonwealth waters surrounding Rowley Shoals are valued for its high productivity, aggregations of marine life and high species richness;
+ Mermaid Reef, Clerke Reef and Imperieuse Reef are biodiversity hotspot and key topographic feature of the Argo Abyssal Plain;
+ Rowley Shoals present some of the best geological examples of shelf atolls in Australian waters, and are ecologically significant in that they are considered ecological steppingstones for reef species originating in Indonesian/Western Pacific waters, are one of a few offshore reef systems on the north-west shelf, and may also provide an upstream source for recruitment to reefs further south;
+ Breeding habitat for seabirds;
+ Migratory pathway for the pygmy blue whale; and
+ One known shipwreck listed under the *Underwater Cultural Heritage Act 2018*: Lively (wrecked in 1810).

Tourism, recreation, and scientific research are important activities in the Marine Park (Director of National Parks 2018b).

12.3.10 Roebuck Marine Park

The Roebuck Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 304 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging habitat area for migratory seabirds adjacent to important breeding areas;
+ Foraging area adjacent to important nesting sites for flatback turtles;
+ Parts of the migratory pathway of the protected humpback whale;
+ Habitat adjacent to important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish;
+ Foraging and calving areas for Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins;
+ Foraging habitat for dugong;
+ Protection for shallow shelf habitats ranging in depth from 15–70 m;
+ Ecosystems example of the Northwest Shelf Province provincial bioregion and the Canning meso-scale bioregion; and
+ Sea country valued for indigenous cultural identity, health and well-being for the Yawuru people (Director of National Parks 2018b).

No heritage listings apply to the marine park. Commercial tourism, fishing, pearling and recreation are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.11 Kimberley Marine Park

The Kimberley Marine Park (Multiple Use Zone – IUCN Category VI) is located approximately 100 km north of Broome, Western Australia, and extends from the Western Australian state water boundary north from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville. It is adjacent to the Western Australian Lalanggarram / Camden Sound Marine Park and the North Kimberley Marine Park. It covers an area of 74,469 km^2, and protects the following conservation values (Director of National Parks 2018b):

+ Northwest Shelf Province;
  - Diverse benthic and pelagic fish communities
  - Ancient coastline thought to be an important seafloor feature
  - Migratory pathway for humpback whales
+ Northwest Shelf Transition;
  - High levels of species diversity
  - Endemism occur among demersal fish communities on the continental slope
+ Timor Province;
  - Reefs and islands of the bioregion are regarded as biodiversity hotspots
  - Endemism in demersal fish communities of the continental slope is high (two distinct communities have been identified on the upper and mid slopes)
  - Ancient coastline at the 125 m depth contour where rocky escarpments are thought to provide biologically important habitats in areas otherwise dominated by soft sediments;
  - Continental slope demersal fish communities characterised by high diversity of demersal fish assemblages;
  - breeding and foraging habitat for seabirds;

- Internesting and nesting habitat for marine turtles;
- Breeding, calving and foraging habitat for inshore dolphins;
- Calving, migratory pathway and nursing habitat for humpback whales;
- Migratory pathway for pygmy blue whales;
- Foraging habitat for dugong and whale sharks;
- The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people's sea country extends into the Kimberley Marine Park. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities; and
- More than 40 known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*.

Tourism, commercial fishing, mining, recreation, including fishing, and traditional use are important activities in the Marine Park (Director of National Parks 2018b).

12.3.12 Ashmore Reef Marine Park

The Ashmore Reef Marine Park (Sanctuary Zone – IUCN Category Ia; Recreational Use Zone – IUCN Category II) covers an area of approximately 583 km^2 (Director of National Parks 2018b). It forms part of the North-west Park Network. As the only oceanic reef in the north-east Indian Ocean with vegetated islands (East, Middle and West Islands), Ashmore is also the largest of three emergent, oceanic reefs in the region (DSEWPaC 2012). Both the Ashmore and Cartier Islands fall under the legal memorandum of understanding between Indonesia and Australia, as both areas are located within Australia's external territory (DSEWPaC 2012).

Ashmore Reef Marine Park is located on Australia's North West Shelf in the Indian Ocean, about 450 nautical miles (840 km) west of Darwin and 330 nautical miles (610 km) north of Broome. The reserve covers 583 km^2 and includes two extensive lagoons, shifting sand flats and cays, seagrass meadows, a large reef flat covering an area of 239 km^2. Within the reserve are three small islands known as East, Middle and West Islands (DoE, 2002).

Ashmore was designated a Ramsar Wetland of International Importance in 2003 due to the importance of its islands providing a resting place for migratory shorebirds and supporting large seabird breeding colonies.

The proclaimed marine park will protect the following conservation values (DoE 2014):

+ Ecosystems, habitats and communities associated with; the North West Shelf; Timor Province; and emergent oceanic reefs;
+ The island and reef habitats:
  - Contains critical nesting and internesting habitat for green turtles (including one of three genetically distinct breeding populations in the North-west Marine Region). Low level nesting activity by loggerhead turtles has also been recorded;
  - Large and significant feeding populations of green, hawksbill and loggerhead turtles occur around the reefs (it is estimated that approximately 11,000 marine turtles feed in the area throughout the year);
  - Supports a small dugong population of less than 50 individuals that breed and feed around the reef. This population is thought to be genetically distinct from other Australian populations;
  - Migratory pathway for pygmy blue whales (Director of National Parks 2018b);
  - Support some of the most important seabird rookeries on the North West Shelf including colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns;
  - Is an important staging points/feeding areas for many migratory seabirds; and
  - Is internationally significant for its abundance and diversity of sea snakes.

+ Two KEFs:
+ Ashmore Reef and Cartier Island and surrounding Commonwealth waters; and
+ Continental slope demersal fish communities (Director of National Parks 2018b);
+ Cultural and heritage sites, including;
+ Ashmore lagoon as a rest/staging area for traditional Indonesian fishers
+ Indonesian artefacts; and
+ Grave sites.
+ Commonwealth heritage listing – Ashmore Reef

Ashmore Reef and nearby islands and reefs are associated with benthic communities consisting predominantly of sand and coral rubble, with noteworthy hard coral, soft coral, algae and seagrasses (Heyward *et al.* 2012; Skewes et al., 1999a, 1999b). The reefs host similar benthic communities, with areas of relatively high live coral cover, although episodes of coral bleaching have been recorded (Heyward *et al.* 2012). Benthic organisms that depend on photosynthesis such as seagrasses, macroalgae and zooxanthellate corals are typically restricted to shallower waters around the reefs, although in the clear tropical waters may be found at considerable depths. Given the shallowest sampling location is greater than 60 m, and that most sampling locations are greater than 100 m deep, diverse benthic communities driven by primary producers such as seagrasses, algae and zooxanthellate corals are not expected to occur at the sampling locations. Data collected in the vicinity of Ashmore Reef indicates that corals are likely to spawn during March and April (Heyward *et al.* 2010).

Soft sediments are widespread in the region, with sediment infauna communities in the region dominated by polychaetes and crustaceans. These taxa accounted for over 80% of benthic infauna sampled, both in terms of numbers of species and individual organisms (Smith *et al.* 1997).

Commercial tourism, recreation and scientific research are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.13 Cartier Island Marine Park

The Cartier Island Marine Park (Sanctuary Zone – IUCN Category Ia) is located approximately 45 km south-east of Ashmore Reef Marine Park and 610 km north of Broome, Western Australia. Both Marine Parks are in Australia's External Territory of Ashmore and Cartier Islands and are also within an area subject to a Memorandum of Understanding (MoU) between Indonesia and Australia, known as the MoU Box. The Marine Park covers an area of 172 km² and protects the following conservation values (Director of National Parks 2018b):

+ Ashmore Reef and Cartier Island and surrounding Commonwealth waters;
+ Areas of enhanced productivity in an otherwise low-nutrient environment;
+ Regional importance for feeding and breeding aggregations of birds and marine life;
+ Continental slope demersal fish communities;
+ Area of high diversity in demersal fish assemblages;
+ Area of high diversity and abundance of hard and soft corals, gorgonians (sea fans), sponges and a range of encrusting organisms;
+ Breeding and foraging habitat for seabirds;
+ Internesting, nesting and foraging habitat for marine turtles;
+ Foraging habitat for whale sharks;
+ Internationally significant for its abundance and diversity of sea snakes;

+ One known shipwreck listed under the *Underwater Cultural Heritage Act 2018*: the Ann Millicent (wrecked in 1888).

Scientific research is an important activity in the Marine Park (Director of National Parks 2018b).

12.4 North Marine Park Network

The North Park Network is aligned to the North Marine Region. The network covers 157,480 km^2 (Director of National Parks 2018c). Broad values of the North Network include:

+ Natural values;
+ Cultural values;
+ Heritage values; and
+ Socio-economic values.

Further detail on the applicable Oceanic Shoals Marine Park is provided below.

12.4.1 Oceanic Shoals Marine Park

The Oceanic Shoals Marine Park (zones within EMBA: Multiple Use Zone - IUCN Category VI- 32,488 km^2; Special Purpose Zone – IUCN VI-24,443 km^2) covers an area of approximately 56,931 km^2 within the EMBA.

The marine park protects the following conservation values (DoE 2014):

+ Important resting area for turtles between egg laying (internesting area) for the threatened flatback turtle and olive ridley turtle;
+ Important foraging area for the threatened loggerhead turtle and olive ridley turtle;
+ Examples of the ecosystems of two provincial bioregions: the Northwest Shelf Transition Province (which includes the Bonaparte, Oceanic Shoals, and Tiwi meso-scale bioregions) and the Timor Transition Province;
+ KEFs represented in the park are (Director of National Parks 2018c):
  - Carbonate bank and terrace system of the Van Diemen Rise (unique sea-floor feature);
  - Carbonate banks and terrace system of the Sahul Shelf (unique sea-floor feature);
  - Pinnacles of the Bonaparte Basin (enhanced productivity, unique sea-floor feature); and
  - Shelf break and slope of the Arafura Shelf (unique sea-floor feature).

No heritage listings apply to the marine park. Commercial fishing and mining are important socio-economic values for the park (Director of National Parks 2018c).

A spatial predictive benthic habitat model of the Oceanic Shoals Marine Park has been developed by AIMS, as part of the Australian National Environmental Science Programme, to determine the spatial heterogeneity of the benthic environment and key classes of organisms within the reserve. The benthic habitat model maps the 10 broad classes of benthic organisms; alcyons, gorgonians, soft corals, hard corals, halimeda, macroalgae, seagrass, filterers (e.g. sponges), burrowers (e.g. sea urchins) and no biota detected (Radford and Puotinen 2016).

Table 12-1 Summary of marine network values, pressures, management programs and actions applicable to the EMBA

Marine network	Values	Pressures	Management programs and actions
SOUTH WEST	• Nine bioregions • Key ecological features • EPBC listed species • Biologically important areas • Sea country indigenous values • Historic shipwrecks • Adjacent to Shark Bay World Heritage Area • Shipping and port activities • Commercial fishing • Marine tourism	• Climate change • Hydrological changes from coastal development and agriculture (increase sediment loads and pollutants) • Illegal/unregulated/unreported fishing • Bycatch of non-target species • Habitat modification from mining • Human presence • Invasive species • Marine pollution	• Communication, education and awareness programs • Promote suitable tourism experience • Facilitate partnerships between tourism operators and Indigenous operators • Indigenous engagement program • Marine monitoring programs • Park management via assessments / authorisation program for marine park activities • Marine park management and development of suitable infrastructure • Compliance planning and surveillance
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

Marine network	Values	Pressures	Management programs and actions
NORTH	• One bioregion • Key ecological features • EPBC listed species • Biologically important areas • Historic shipwrecks	• Climate change • Hydrological changes reliance upon the large number of estuaries and waterways that feed into the Gulf of Carpentaria and the waters adjacent to the Northern Territory coastline • Illegal/unregulated/unreported fishing • Bycatch of non-target species • Physical Habitat modification • Marine pollution	• Communication, education and awareness programs • Promote suitable tourism experience • Facilitate partnerships between tourism operators and Indigenous operators • Indigenous engagement program • Marine monitoring programs • Park management via assessments / authorisation program for marine park activities • Marine park management and development of suitable infrastructure • Compliance planning and surveillance

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 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
	Christmas Island frigatebird	Approved Conservation Advice for *Fregata andrewsi* (Christmas Island frigatebird) (2016)	Habitat loss, disturbance and modifications (terrestrial related)
			Fishing
			Invasive species
			Fire
			Climate change
	Australasian bittern	Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (2011)	Reduction in extent and quality of habitat due to the diversion of water away from wetlands
			Drainage of swamps
			Loss or alteration of wetland habitats due to clearing for urban and agricultural development
			Peat mining
			Predation by introduced vertebrate pests such as foxes and cats
			Reduced water quality as a result of increasing salinity, siltation and pollution
			Overgrazing by livestock
			Detrimental fire regimes
	Red knot	Approved Conservation Advice for *Calidris canutus* (Red knot) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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)	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)	Habitat loss and habitat degradation
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Climate change impacts
	Lesser sand plover	Approved Conservation Advice for *Charadrius mongolus* (Lesser sand plover) (2016)	Habitat loss and habitat degradation
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Climate change impacts
	Antipodean albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Amsterdam albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			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
	Tristan albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Southern royal albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Wandering albatross		Incidental catch resulting from fishing operations

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Northern royal albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Western Alaskan bar-tailed godwit	Wildlife Conservation Plan for Migratory Shorebirds (2015) Approved Conservation Advice for *Limosa lapponica baueri* (Bar-tailed godwit (western Alaskan)) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Northern Siberian bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian)) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Southern giant petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Northern giant petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Eastern curlew	Approved Conservation Advice *for Numenius madagascariensis* (eastern curlew) (2015)	Ongoing human disturbance
			Habitat loss and degradation from pollution
			Changes to the water regime
			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		Clearance of about a third of the former nesting rainforest habitat

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice for *Papasula abbotti* (Abbott's booby) (2015)	Crazy ants
	Christmas Island white-tailed tropicbird	Conservation Advice for *Phaethon lepturus fulvus* white-tailed tropicbird (Christmas Island) (2014)	Introduced predators on Christmas Island
			Crazy ants
	Sooty albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Soft-plumaged petrel	Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (2015)	Accidental introduction of predators (relevant only to Maatsuyker Island, located offshore of Tasmania)
	Australian painted snipe	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Australian fairy tern	Commonwealth Conservation Advice on *Sternula nereis nereis* (fairy tern) (2011)	Predation by introduced mammals and native birds
			Disturbance by humans, dogs and vehicles
			Increasing salinity in waters adjacent to Fairy Tern colonies
			Irregular water management
			Weed encroachment
			Oil spills, particularly in Victoria (potential threat)
	Indian yellow-nosed albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Shy albatross	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
	White-capped albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Campbell albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Black-browed albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
Mammals	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance
			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		Whaling

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Blue Whale Conservation Management Plan 2015 - 2025 (2015)	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
			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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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
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)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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)
			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)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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
			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)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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)
			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)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
	Flatback turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Fisheries bycatch – international (low), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation (moderate)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Flatback turtle – Pilbara coast genetic stock (Pil), South-west Kimberley coast genetic stock (swKim) and Cape Domett (CD)	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
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			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
			Indigenous fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation and modification
			Marine debris
			Collection of animals for display in public aquaria

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	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
	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

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Black-stripe minnow	Approved Conservation Advice for *Galaxiella nigrostriatal* (Black-striped minnow) (2018)	Climate change – increased air and water temperatures, decreased rainfall, increased evaporation, lowering groundwater table.
			Invasive species (*Gambusia holbrooki*), aggressive interactions and competition

14. Social, Economic and Cultural Features

14.1 Industry

In 2018/19, Western Australia's petroleum industry was worth $38.4 billion per annum. The petroleum sector accounted for 26% of the total value of WA's mineral and petroleum sales in 2018/19, with 20 per cent of all mineral and petroleum sales coming from Liquefied Natural Gas (LNG). Currently Western Australia has four operating LNG projects; the North West Shelf, Gorgon, Pluto and Wheatstone. There are also a number of Floating Production and Storage Offtake (FPSO) facilities in the Timor Sea and North West Shelf, as denoted on **Figure 14-1** to **Figure 14-3**. Offshore development is focussed in the Carnarvon Basin, Browse Basin and on the North West Shelf (DMP 2014). There are also domestic gas plants on Varanus Island in the North West Shelf, Devil Creek Onshore Gas Plant and Macedon Gas Plant in the Pilbara region and an oil facility near Dongara called Cliff Head. There are several exploration and production permits and leases throughout WA and Commonwealth waters in the EMBA. Existing petroleum infrastructure, permits and licences are shown in **Figure 14-1** to **Figure 14-3**.

14.2 Other Infrastructure

The Jasuraus submarine communication cable links Australia with Indonesia. The cable was installed as a link from Australia to provide telephone services connection to the world in 1995-1996. Travelling north out of Port Hedland for approximately 210 km the cable then heads north-west toward Jakarta, Indonesia. The cable runs up through Permit Areas WA-435-P and WA437-P. Its capacity and major role was overtaken in 2000 by other subsea cables out of Australia. However, Telstra continues to manage the cable as it remains an emergency backup link out of Australia. The cable includes two submerged repeaters in the wider region.

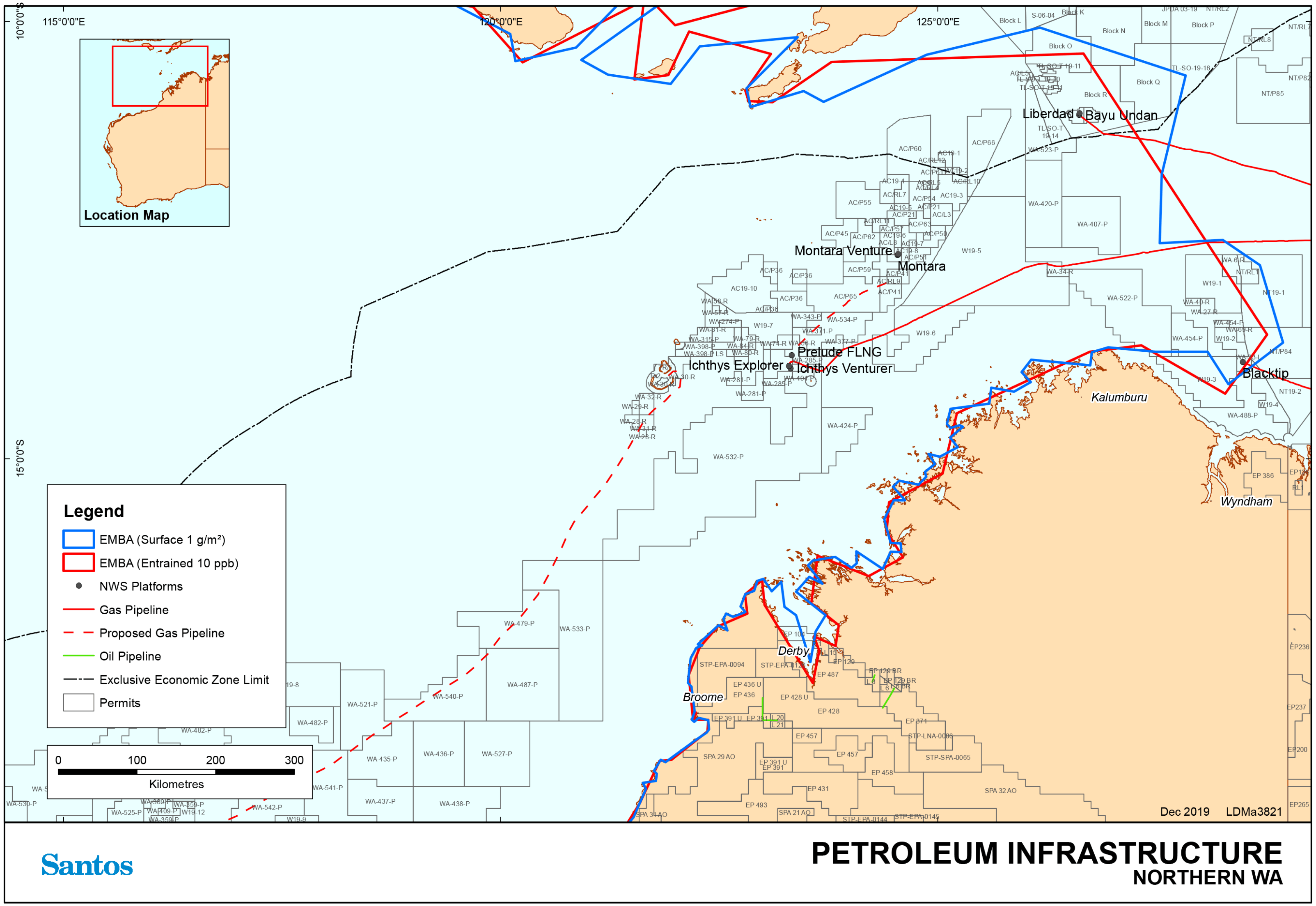

Figure 14-1: Existing petroleum infrastructure, permits and licences – Northern WA

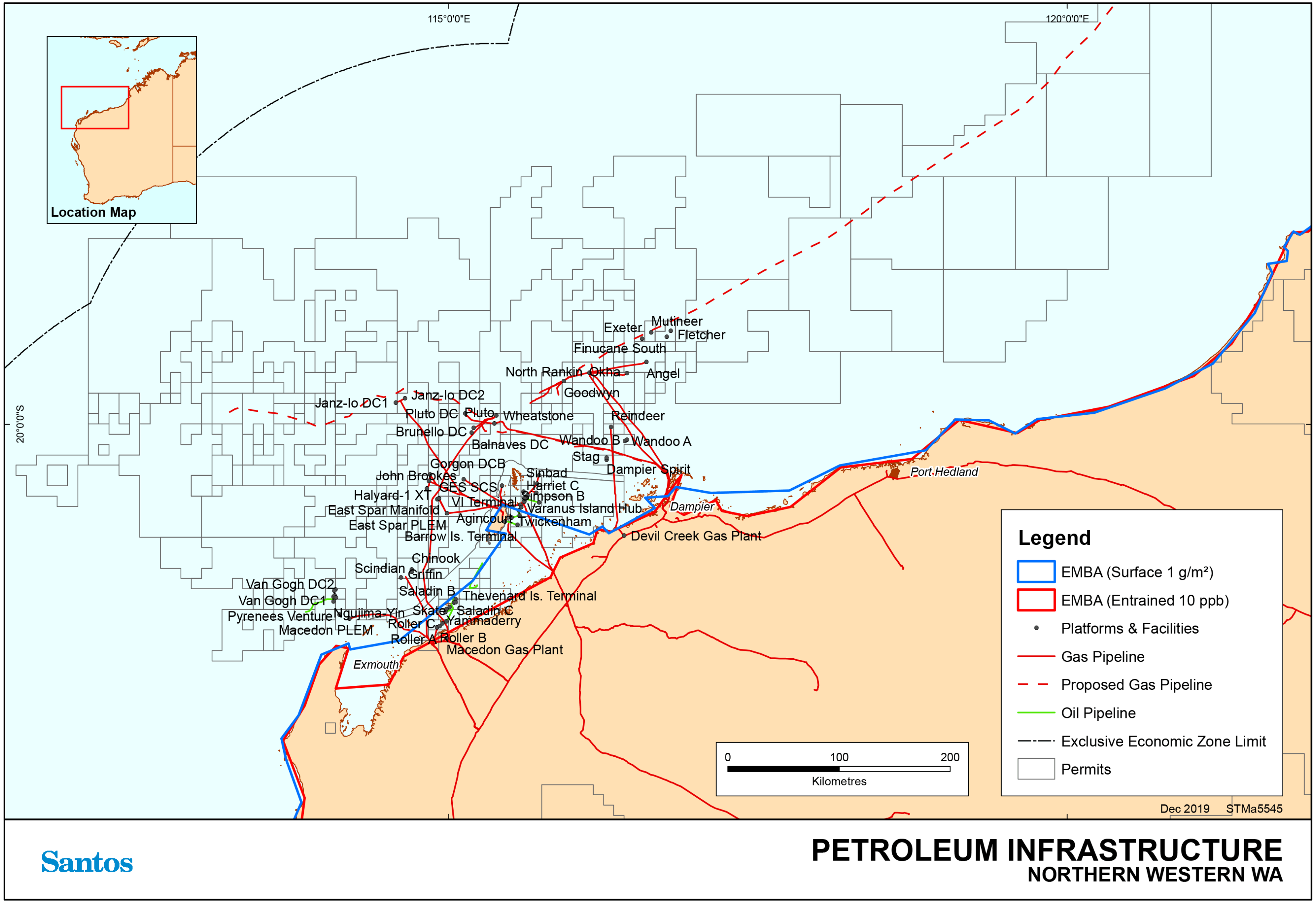

Figure 14-2: Existing petroleum infrastructure, permits and licences – Northern Western Australia

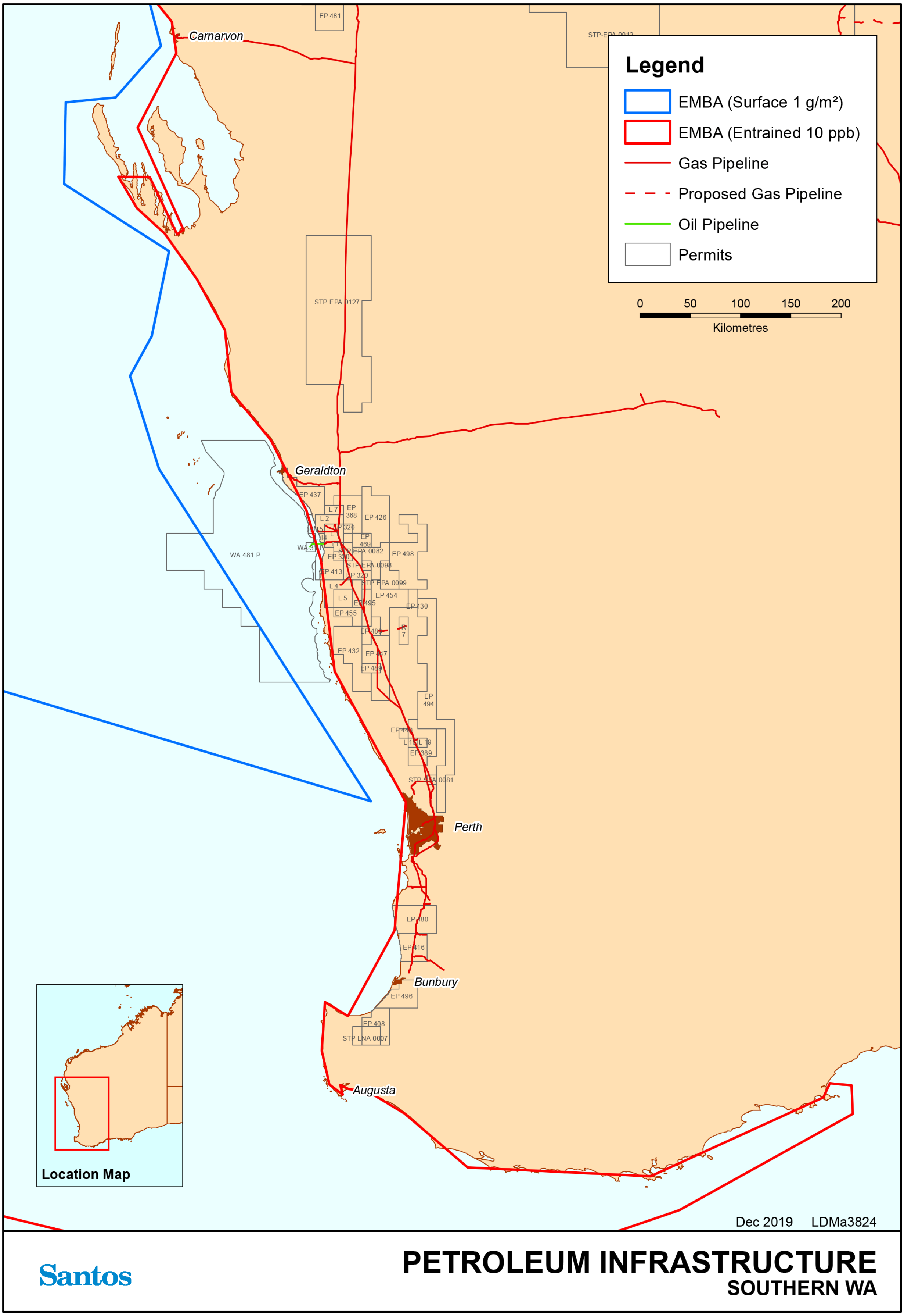

Figure 14-3: Existing petroleum infrastructure, permits and licences –Southern WA

14.3 Shipping

The Western Australian coastline supports twelve ports including the major ports of Dampier, Port Hedland and Broome which are operated by their respective port authorities. Large cargo vessels move through the region to and from Fremantle, transiting along coastline. Commercial shipping also moves to and from marine terminals associated with the oil and gas industry (see **Section 14.1**). Other large ports include Geraldton, Busselton, Albany and Esperance. Closer proximity shipping also includes construction vessels/barges/dredges, domestic support vessels, and offshore survey vessels.

The Australian Maritime Safety Authority (AMSA) has established a network of shipping fairways off the north-west coast of Australia to manage traffic patterns (AMSA 2013). The Shipping Fairways are designed to keep shipping traffic away from offshore infrastructure and aims to reduce the risk of collision (AMSA 2013).

Use of the fairways is strongly recommended but not mandatory. The International Regulations for *Preventing Collisions at Sea 1972* apply to all vessels navigating within or outside the shipping fairways. The use of these fairways does not give vessels any special right of way (AMSA 2012).

Under the *Commonwealth Navigation Act 2012*, certain vessels operating in Australian waters are required to report their location on a daily basis to the Rescue Coordination Centre (RCC) in Canberra. This Australian Ship Reporting System (AUSREP) is an integral part of the Australian Maritime Search and Rescue system and is operated by AMSA through the RCC. Vessels recorded in waters in the EMBA through the AUSREP system in 2019 are shown in **Figure 14-4**.

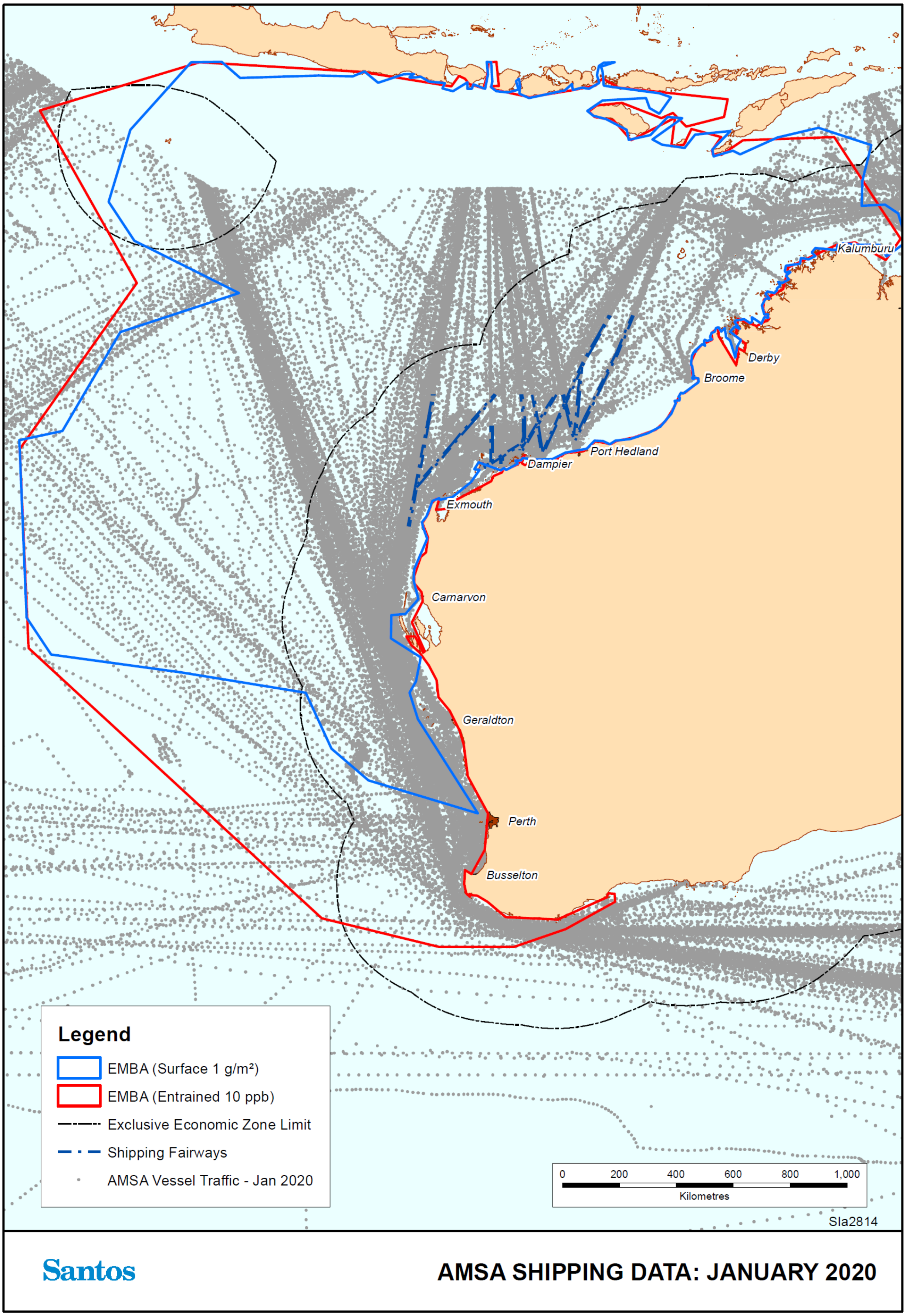

Figure 14-4: AMSA ship locations and shipping routes

14.4 Defence Activities

Key defence bases and facilities are illustrated in **Figure** 14-5.

The Naval Communication Station Harold E. Holt is located on the northwest coast of Australia, 6 km north of Exmouth. The town of Exmouth was built at the same time as the communications station to provide support to the base and to house dependent families of US Navy personnel (Shire of Exmouth 2018, DoE 2014).

The station provides very low frequency radio transmission to US Navy and Royal Australian Navy ships and submarines in the western Pacific Ocean and eastern Indian Ocean. With a transmission power of 1 megawatt, it is the most powerful transmission station in the southern hemisphere (Shire of Exmouth 2018, DoE 2014).

Two Royal Australian Airforce (RAAF) bases are located in the northwest of WA; Learmonth RAAF Base, near Exmouth and Curtin RAAF Base near Derby (RAAF 2014).

Designated military exercise areas occur over waters and airspace of the north west of WA and may be activated following the required notifications.

Additional defence activities that occur within the EMBA include:

+ Broome training depot;
+ Exmouth admin and high frequency transmitting;
+ Exmouth Very Low Frequency transmitting station;
+ Geraldton training depot "A" Company 16th Battalion;
+ HMAS Stirling-Rockingham;
+ HMAS Stirling-Garden Island;
+ Karratha training depot;
+ Learmonth – air weapons range;
+ Learmonth radar site – Vlaming Head Exmouth; and
+ Yampi Sound training area.

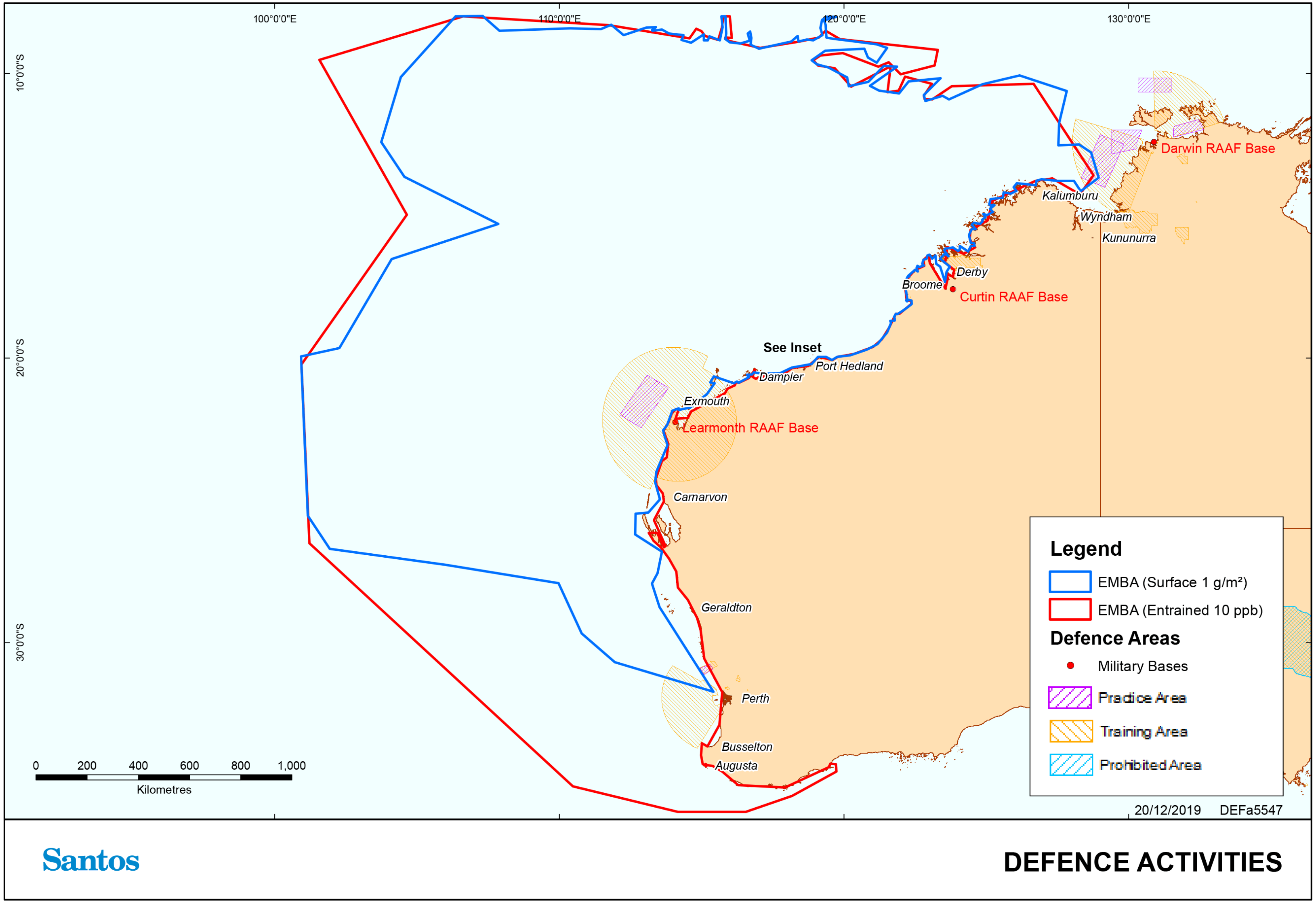

Figure 14-5: Defence activities in WA

14.5 Tourism

The Kimberley, Pilbara and Gascoyne regions are popular visitor destination for Australian and international tourists. Tourism is concentrated in the vicinity of population centres including Broome, Dampier, Exmouth, Coral Bay and Shark Bay.

Marine and coastal use is also clustered around major population centres along the WA coastline including Perth, Bunbury, Geraldton, Margaret River, Jurien Bay, August and Albany.

Tourism contributes to local economies in terms of both income and employment and tourists include local, interstate and international visitors. Popular water-based activities include fishing, swimming, snorkelling/ diving, surfing/windsurfing/kiting and boating, while popular land based activities include bushwalking, camping, bird watching and four-wheel driving.

Seasonal nature-based tourism such as humpback whale watching, whale shark encounters and tours of turtle hatching mainly occurring around Ningaloo Reef, Cape Range National Park, Broome and Perth (Tourism Western Australia 2014). Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

14.6 Cultural Heritage

Four places of cultural significance are protected as National Heritage Places in the waters from Busselton to the NT border. The Dampier Archipelago (including Burrup Peninsula), Batavia Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos, Dirk Hartog Landing Site 1616 – Cape Inscription area and the HMAS Sydney II and HSK Kormoran Shipwreck Site are discussed in **Section 9**. Additional Commonwealth Heritage Places denoted for their historic value in the EMBA are listed in **Appendix A**.

14.6.1 Indigenous Heritage

Indigenous people have a strong ongoing association with the area that extends from the beginning of human settlement in Australia some 50,000 years ago. The close, long standing relationship between Aboriginal peoples and the coastal and marine environments of the area is evident in indigenous culture today, in addition to archaeological sites such as the Burrup Peninsula. The Indigenous peoples of the northwest continue to rely on coastal and marine environments and resources for their cultural identity, health and wellbeing, as well as their domestic and commercial economies (DEWHA 2008a). With the EMBA, Barrow Island, Montebello Islands, Exmouth, Ningaloo Reef, Kimberly Coast, Eighty Mile Beach, Roebuck Bay, Dampier Peninsula and the South West and the adjacent foreshores have a long history of occupancy by Indigenous communities. Areas that are covered by registered native title claims are likely to practice indigenous fishing techniques at various sections of the WA coastline; most notably in the Kimberley coastal region and islands.

Marine resource use by Indigenous people is generally restricted to coastal waters. Fishing, hunting and the maintenance of maritime cultures and heritage through ritual, stories and traditional knowledge continue as important uses of the nearshore region and adjacent areas. However, while direct use by Aboriginal people deeper offshore waters is limited, many groups continue to have a direct cultural interest in decisions affecting the management of these waters. The cultural connections Aboriginal people maintain with the sea may be affected, for example, by offshore fisheries and industries. In addition, some Indigenous people are involved in commercial activities such as fishing and marine tourism, so have an interest in how these industries are managed in offshore waters with respect to their cultural heritage and commercial interests (DEWHA 2008a).

14.6.2 Maritime Heritage

Details of recorded shipwreck sites are available on the Australian National Shipwreck Database are managed by the DAWE although precise locations of the wrecks are sometimes unknown. A search of the Australian National Shipwreck Database in the EMBA identified 942 shipwrecks. Key shipwrecks in the North West Marine Region are listed in **Table 14-1** and shown in **Figure 14-6** to **Figure 14-9**, in addition to the Ann Millicent (DEWHA 2008a). Under the Commonwealth *Underwater Culture Heritage Act 2018* all shipwrecks older than 75 years are protected, while those dated pre-1900 are protected by WA law under the *Maritime Archaeology Act 1973*. Within the EMBA, there are 697 shipwrecks in excess of 75 years old.

Table 14-1: Shipwrecks

Name	Description	Location
Ann Millicent	Iron hulled barque, wrecked c. 1888	Cartier Island
Crown of England	1,847 t sailing ship, wrecked c. 1912	Wreck Point, Depuch Island
Eddystone	2,040 t brigantine rigged iron steamship	Cossack Roads, Depuch Island Passage
Perentie	Barge	Barrow Island
Fin	Early iron whaler	Frazer Island, Point Cloates
Karrakatta	1,271 t, schooner rigged, coastal steamship	King Sound, 140 km north-northwest of Derby
Manfred	587 t barque	3 km north west of West Island in the Lacepede Islands
Perth	499 t, iron coastal steamship	Ningaloo Reef
Rowley Shoals unconfirmed wreck	Armed whaler of 200–250 t, possibly the Lively, wrecked c 1800	Mermaid Reef
Zvir	Iron steamer	Frazer Island, Point Cloates
Browse Island (East) unconfirmed wreck	Late nineteenth century iron sailing vessel of approximately 1,000 t	Browse Island
Fairy Queen	115 t Singapore built brigantine	Point Murat, North West Cape
Gudrun	Iron frames and fastenings	Cape Peron Flats in Shark Bay
SS Sunbeam	Iron hulled, single screw steamer	Middle Osborne Island, Admiralty Gulf
Trial	English East Indiaman of about 500 t, wrecked c 1622	Trial (or Tryal) Rocks, 20 km northwest of the Montebello Islands
Zuytdorp	Seventeenth century Dutch East Indiaman	Zuytdorp Cliffs, 75 km north of Kalbarri

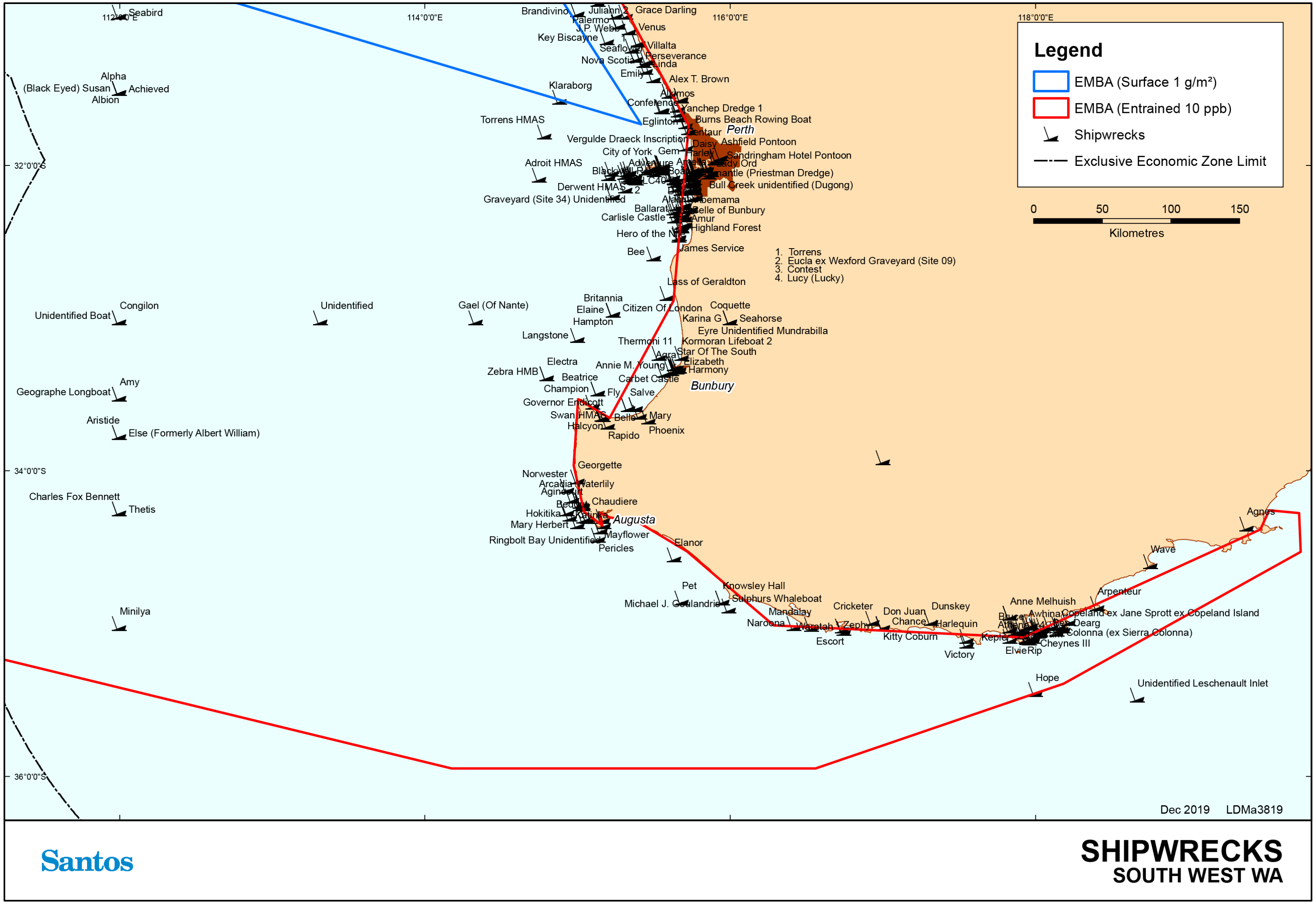

Figure 14-6: Shipwrecks – South West WA

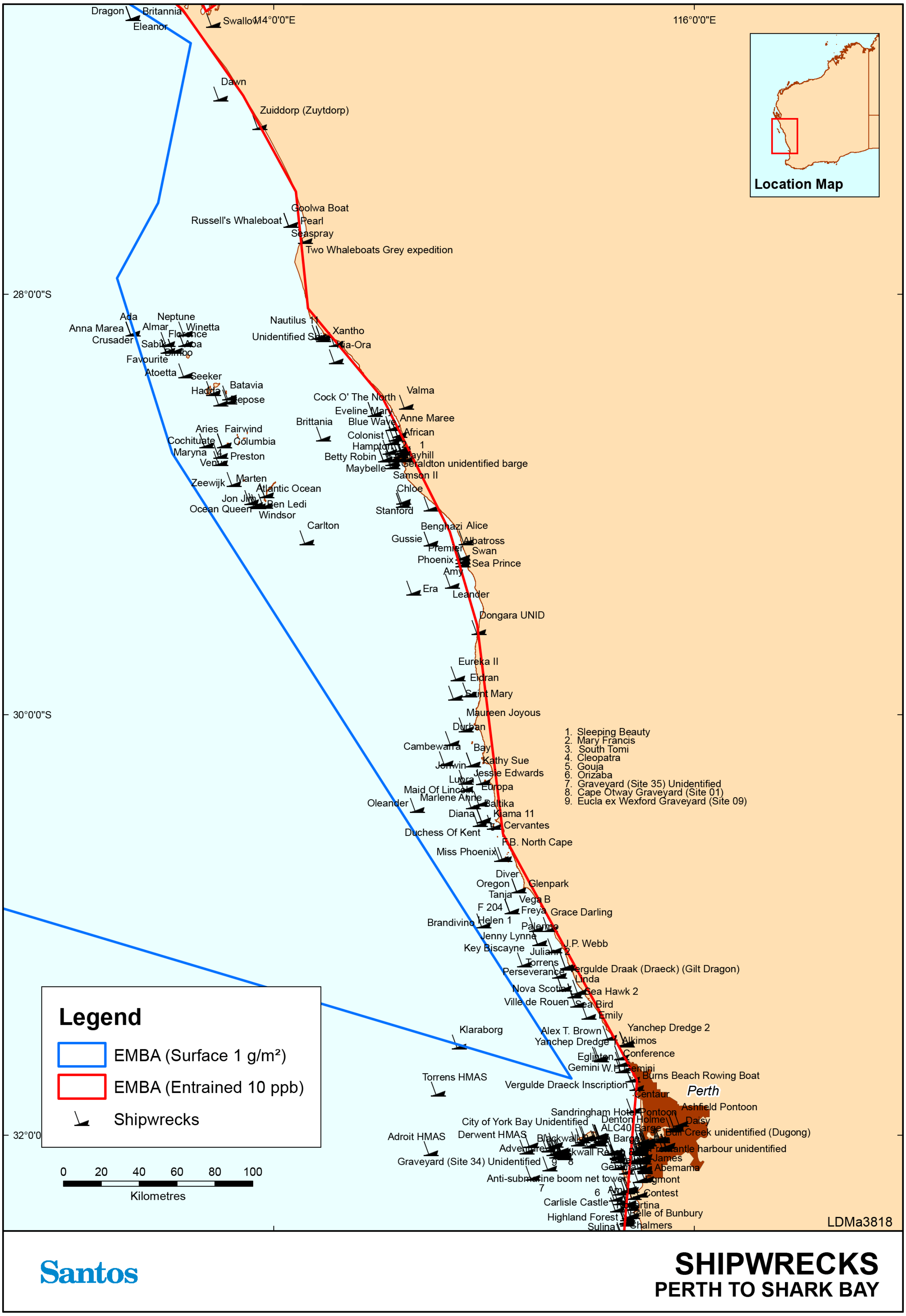

Figure 14-7: Shipwrecks – Perth – Shark Bay

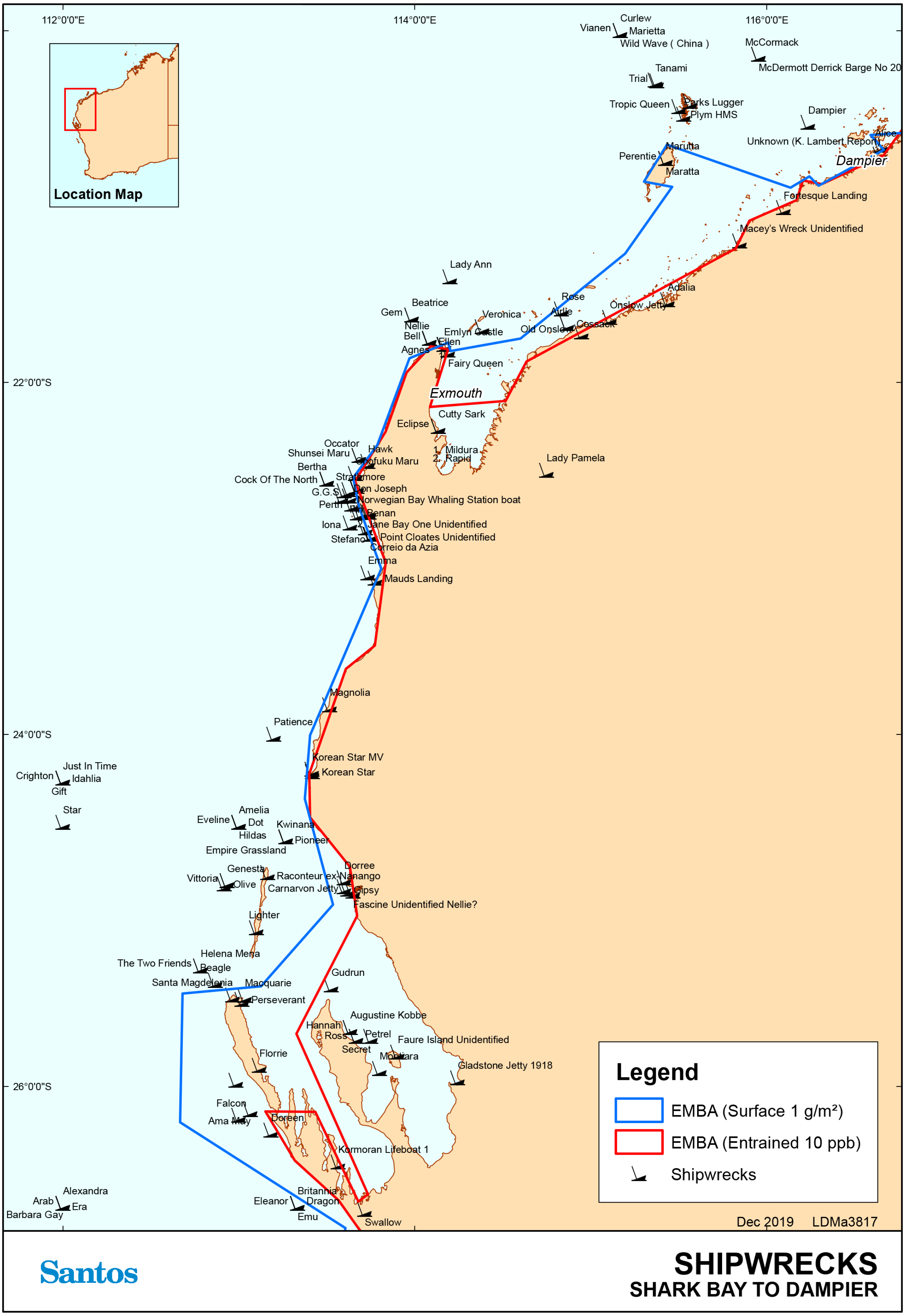

Figure 14-8: Shipwrecks – Shark Bay – Dampier

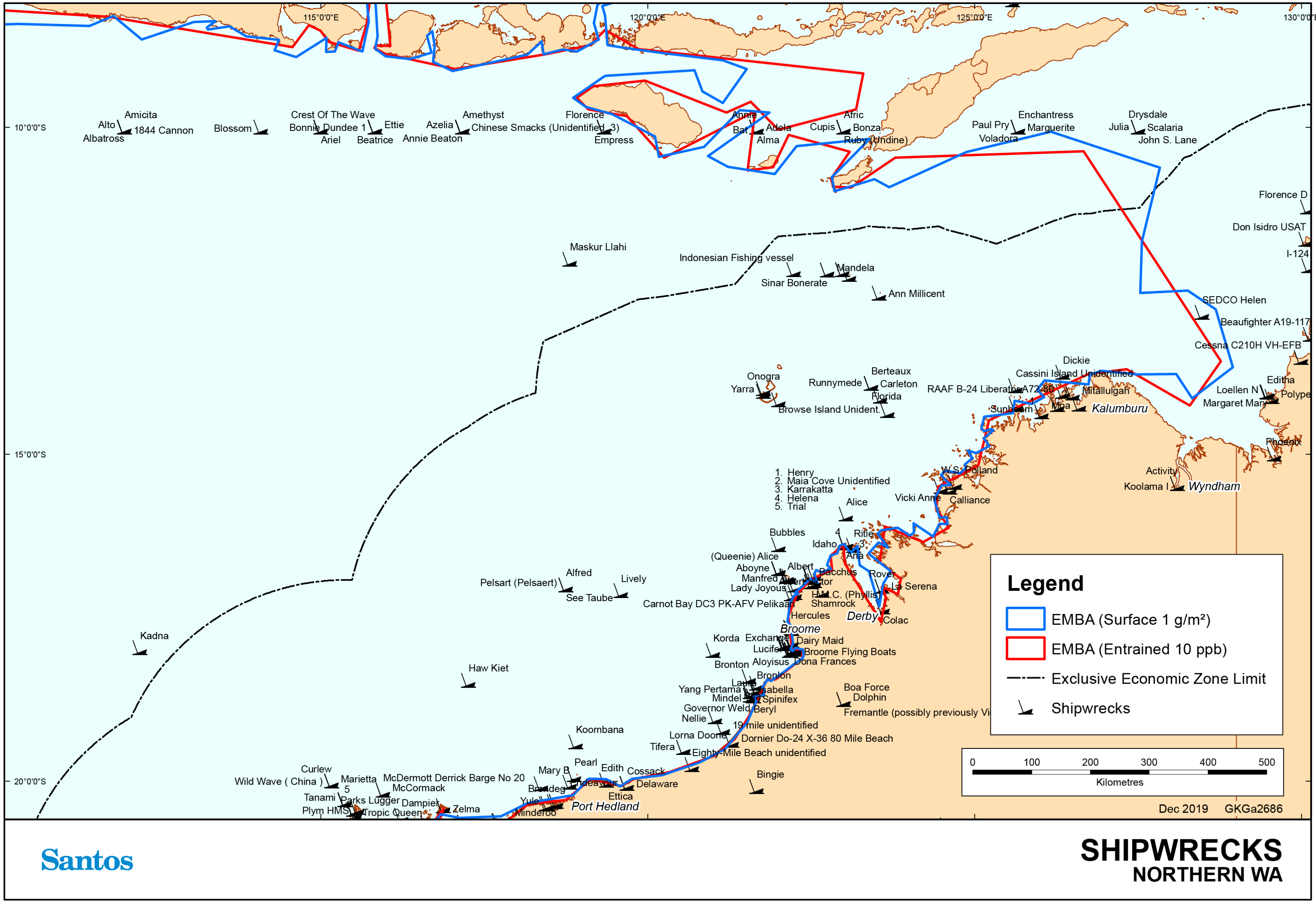

Figure 14-9: Shipwrecks – Northern WA

14.7 Commercial Fisheries

A valuable and diverse commercial fishing industry is supported by both the offshore and coastal waters in the North Coast, Gascoyne, West Coast and South Coast Bioregions between the WA and NT and South Australian borders. The major fisheries in this area target tropical finfish, large pelagic fish species, crustaceans (prawns and scampi), Western Rock Lobster and pearl oysters (Fletcher and Santoro 2013). A number of smaller fisheries also exist in this area including the octopus and beche-de-mer fisheries.

14.7.1 State Fisheries

State fisheries are managed by the WA Department of Primary Industries and Regional Development (DPIRD) (formerly Department of Fisheries (DoF)) with specific management plans, regulations and a variety of subsidiary regulatory instruments under the *Fish Resources Management Act 1994* (WA). The information on State managed fisheries has been derived from '*The State of the Fisheries'* Report 2017/2018 (Gaughan *et al.* 2019) and direct consultation with DPIRD. Santos WA consults regularly with State fisheries relevant to activity operational areas, mainly by distribution of an Annual Consultation Update by post.

State commercial fisheries that exist between Kalbarri (WA) and the NT border are shown in **Figure** 14-10. A summary of all commercial fisheries in the area is also summarised **Table 14-2**. These are:

North Coast Bioregion

+ Onslow Prawn Managed Fishery (OPMF);
+ Nickol Bay Prawn Managed Fishery (NBPMF) – referred to as Nickol Bay Prawn Limited Entry Fishery in **Figure** 14-10;
+ Broome Prawn Managed Fishery (BPMF);
+ Kimberley Prawn Managed Fishery (KPMF);
+ Kimberley Gillnet & Barramundi Managed Fishery (KGBF);
+ Northern Demersal Scalefish Managed Fishery (NDSF);
+ Kimberley Developing Mud Crab Fishery – not shown in **Figure** 14-10;
+ Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF);
+ Pilbara Trap Managed Fishery (PTMF);
+ Pilbara Line Fishery;
+ Western Australian Sea Cucumber Fishery (referred to as Beche-de-mer Fishery in **Figure** 14-10);
+ Mackerel Managed Fishery (Area 1 – Kimberley and Area 2 – Pilbara);
+ Western Australian Pearl Oyster Fishery – referred to as Pearl Oyster Managed Fishery in **Figure** 14-10;
+ Northern Shark Fisheries (closed, not shown in **Figure** 14-10) including:
    - Western Australian North Coast Shark Fishery - not shown in **Figure** 14-10; and
    - Joint Authority Northern Shark Fishery - not shown in **Figure** 14-10;
    - North Coast Trochus Fishery – not shown in **Figure** 14-10; and
    - Pilbara Developing Crab Fishery – not shown in **Figure** 14-10.

Gascoyne Bioregion

+ Exmouth Gulf Prawn Managed Fishery;
+ Gascoyne Demersal Scalefish Managed Fishery;

- Shark Bay Scallop Managed Fishery – referred to as Shark Bay Scallop Limited Entry Fishery on **Figure** 14-10;
- Shark Bay Prawn Managed Fishery – referred to as Shark Bay Prawn Limited Entry Fishery on **Figure** 14-10;
- Shark Bay Crab Interim Managed Fishery; and
- Mackerel Fishery (Area 3 – Gascoyne/West Coast).

West Coast Bioregion

- Roe's Abalone – not shown in **Figure** 14-10;
- Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWRMF) (Closed) – referred to as Abrolhos Islands and Mid-West Trawl Limited Entry Fishery in **Figure** 14-10;
- West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF);
- South West Trawl Managed Fishery – referred to as South West Trawl Limited Entry Fishery in **Figure** 14-10;
- Mandurah to Bunbury Developing Crab Fishery – not shown in **Figure** 14-10;
- Cockburn Sound Crab Managed Fishery – not shown in **Figure** 14-10**;**
- Cockburn Sound Line and Pot Managed Fishery – not shown in **Figure** 14-10;
- Cockburn Sound Mussel Managed Fishery – not shown in **Figure** 14-10;
- Warnbro Sound Crab Managed Fishery (closed) – not shown in **Figure** 14-10;
- West Coast Nearshore and Estuarine Finfish Fisheries, including:
- Cockburn Sound Fish Net Managed Fishery – not shown in **Figure** 14-10;
- West Coast Beach Baited Managed Fishery – not shown in **Figure** 14-10;
- South West Beach Seine Fishery – not shown in **Figure** 14-10; and
- West Coast Estuarine Managed Fishery – not shown in **Figure** 14-10;
- Temperate Demersal Gillnet and Demersal Longline Fisheries, including:
    - West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (West Coast Bioregion) – not shown in **Figure** 14-10;
- West Coast Deep Sea Crab (Interim) Managed Fishery – referred to as West Coast Deep Sea Crustacean Managed Fishery in **Figure** 14-10;
- West Coast Nearshore Net Managed Fishery – not shown in **Figure** 14-10;
- Octopus Interim Managed Fishery – not shown in **Figure** 14-10;
- West Coast Rock Lobster Managed Fishery; and
- West Coast Purse Seine Fishery – not shown in **Figure** 14-10.

South Coast Bioregion

- Greenlip/Brownlip Abalone Fishery – not shown in **Figure** 14-10;
- South Coast Deep-Sea Crab Fishery – not shown in **Figure** 14-10;
- South Coast Open Access Netting Fishery – not shown in **Figure** 14-10; and

+ South West Coast Beach Net – not shown in **Figure** 14-10.
+ South Coast Salmon Managed Fishery (forms part of the South Coast Nearshore and Estuarine Finfish Fishery);
+ South West Coast Salmon Managed Fishery;
+ Temperate Demersal Gillnet and Demersal Longline Fisheries including:
    - Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (South Coast Bioregion)
    - South West Trawl Managed Fishery (SWTMF) – referred to as South West Trawl Limited Entry Fishery in **Figure** 14-10; and
    - Windy Harbour/Augusta Rock Lobster Managed Fishery – not shown in **Figure** 14-10.

Whole of State Fisheries

+ Marine Aquarium Fish Managed Fishery (MAFMF);
+ Specimen Shell Managed Fishery; and
+ Hermit Crab Fishery (HCF) – not shown in **Figure** 14-10.

Some of the fisheries listed above will be more susceptible to impacts than others, particularly fisheries without the ability to escape impacts. For example, above average water temperatures over the last three years will have had an impact on prawn fisheries in Exmouth and scallops and blue swimmer crabs in Shark Bay which have been significantly affected by the initial heat wave event of 2010/11 (Caputi *et al*. 2014).

14.7.2 Commonwealth Fisheries

Commonwealth fisheries are those within the 200 nautical mile Australian Fishing Zone (AFZ) managed by Australian Fisheries Management Authority (AFMA) and are, on the high seas, and, in some cases, by agreement with the States and Territory, to the low water mark. Information on Commonwealth managed fisheries has been derived from '*Fishery Status'* Report 2019 (Department of Agriculture 2019)

Commonwealth fisheries who have permits to operate in the EMBA include:

+ North West Slope Trawl (NWST);
+ Northern Prawn Fishery (NPF);
+ Southern Bluefin Tuna Fishery (SBFTF);
+ Western Tuna and Billfish Fishery (WTBF) (including Southern Tuna and Billfish Fishery shown in **Figure** 14-11**)**;
+ Small Pelagic Fishery (SPF);
+ Southern and Eastern Scalefish and Shark Fishery (SESSF) – not shown in **Figure** 14-11;
+ Skipjack Tuna Fishery (STF) (referred to as Western Skipjack Tuna Fishery in **Figure** 14-11); and
+ Western Deepwater Trawl (WDTF) (referred to as Western Deepwater Trawl Fishery in **Figure** 14-11).

Commonwealth commercial fisheries between Kalbarri (WA) and the NT Border are shown in **Figure** 14-11 and summarised in **Table 14-2**.

14.7.3 Indonesian Commercial and Subsistence Fishing

Within the northern and north-western extent of the EMBA is a defined area where a Memorandum of Understanding (MoU) exists between the Australian and Indonesian Governments. The Agreement between the Government of Australia and the Government of the Republic of Indonesia Relating to Cooperation in

Fisheries (1992 Fisheries Cooperation Agreement) provides the framework for fisheries and marine cooperation between Australia and Indonesia, and facilitates information exchange on research, management and technological developments, complementary management of shared stocks, training and technical exchanges, aquaculture development, trade promotion and cooperation to deter illegal fishing.

Cooperation under the Agreement today takes place under the auspices of the Working Group on Marine Affairs and Fisheries. Established in 2001, the Working Group on Marine Affairs and Fisheries is the primary bilateral forum to enhance collaboration across the spectrum of marine and fisheries issues relevant to the areas of the Arafura and Timor seas. The Working Group brings together the fisheries, environment and scientific research portfolios and agencies from both countries.

The MoU Box (shown on **Figure** 14-10 and **Figure** 14-11) is an area of Australian water in the Timor Sea where Indonesian traditional fishers, using traditional fishing methods only, are permitted to operate. Officially it is known as the Australia-Indonesia Memorandum of Understanding regarding the Operations of Indonesian Traditional Fishermen in Areas of the Australian Fishing Zone and Continental Shelf – 1974.

As part of negotiations to delineate seabed boundaries, Australia and Indonesia entered into the MoU which recognises the rights of access for traditional Indonesian fishers in shared waters to the north of Australia. This access was granted in recognition of the long history of traditional Indonesian fishing in the area. The MoU provides Australia with a tool to manage access to its waters while for Indonesia, it enables Indonesian traditional fishers to continue their customary practices and target species such as trepang, trochus, abalone and sponges. Guidelines under the MoU were agreed in 1989 in order to clarify access boundaries for traditional fishers and take into account the declaration of the 200 nautical mile fishing zones. Because of its approximate shape the MoU area became known as the MoU Box.

Between 2006 and 2008, a series of surveys were undertaken to understand the traditional practice of Indonesian fishers that journey to Scott Reef within the MoU boundary (ERM 2008, 2009). The majority of perahu (vessels) that travel to Scott Reef originate from the islands of Rote (near West Timor) and Tonduk and Raas (in East Java). Some crew from the Rote perahus are recruited from the region of Alor (one of the Lesser Sundas chain, located north of East Timor and east of Bali). In 2007, an estimated 800 fishers (approximately 80 vessels) travelled from these home islands to Scott Reef, mainly to collect trepang. Similar vessel numbers sailed to Scott Reef in 2008.

Journeys to Scott Reef are generally restricted to drier months when wind speeds and directions are more desirable. Most Indonesian fishers travel to Scott Reef during July to October, although a few Rotenese make the journey to Scott Reef in the early season between April and June. Other fishers plan to go after Aidil Fitri, a religious holiday widely celebrated on Tonduk Island that celebrates the end of Ramadan.

The fishers focus their activities in and around the shallow water lagoons of Scott Reef primarily targeting trepang; and opportunistically gather trochus shells. They also catch fish largely for subsistence purposes although the average fish catch per lete-lete (traditional Indonesian fishing vessel) in 2008 increased to commercial volumes. Although deeper waters are more plentiful in trepang, deep diving is generally not undertaken by the fishers due to the MoU stipulation on the exclusive use of traditional equipment only (Woodside Energy Limited 2011).

14.8 Aquaculture

14.8.1 North Coast Bioregion

Aquaculture development in this region is dominated by the production of pearls from the species *Pinctada maxima.* A large number of pearl oysters for seeding is obtained from wild stocks and supplemented by hatchery-produced oysters with major hatcheries operating at Broome and the Dampier Peninsular. Pearl farm sites are located mainly along the Kimberley coast, particularly in the Buccaneer Archipelago, in Roebuck Bay and at the Montebello Islands. Developing marine aquaculture initiatives in this region include growing trochus and barramundi. Marine production of barramundi is focussed in Cone Bay fishing (Fletcher and Santoro 2015).

The Pearl Oyster Fishery of Western Australia operates in shallow coastal waters (DoF 2006). All the leases are within the 35m diving depth. Through consultation the Pearl Producer's Association (PPA) have raised concern that spawning stock is found to the 100 m depth contour. However, this is not supported in the study by Condie *et al* (2006) who modelled oyster larva transport in the Eighty Mile Beach region and found that while some larvae travelled more than 60 km, most were transported less than 30 km. The model results suggest that spawning in the Eighty Mile Beach region is concentrated around the 8 to 15m depth range, with potential smaller contributions from the northeast. These spawning events are likely to lead to successful recruitment locally and alongshore to the southwest.

They also feed larvae into neighbouring shallow coastal environments (through tidal oscillations) and deeper waters to the west (>20 m). However, spat abundances seem to be low in these areas, suggesting that recruitment is strongly limited by habitat availability and possibly high mortality rates in shallow water. High local abundances of broodstock and spat observed occasionally in deeper water (<30 m) seem to be supported by intermittent larval transport from inshore populations. Spawning in this area seems to contribute little to recruitment in the inshore populations.

Further aquaculture operations are expected in the region with recent funding supporting the establishment of an aquaculture zone (Gaughan *et al.* 2019).

14.8.2 Gascoyne Coast Bioregion

Hatchery production of oysters is the core of the pearling industry in the Gascoyne region. Hatcheries in Carnarvon and Exmouth supply spat to pearl farms in the north-west and several hatcheries supply juveniles to the black-lip pearl oyster to developing black pearl farms in the region. Pearl production is carried out on a small scale in Shark Bay and Exmouth Gulf. The local aquiculture sector is also focussing on the production of aquarium species.

14.8.3 West Coast Bioregion

The principal aquaculture development activities in this region are the production of blue mussels (*Mytilus galloprovincialis*) and marine algae (*Dunaliella salina*) and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands. The main mussel farming area is in southern Cockburn Sound, where conditions are sheltered and the nutrient and planktonic food levels are sufficient to promote good growth rates fishing (Fletcher and Santoro 2015).

Currently, the Department of Fisheries is seeking to secure strategic environmental approvals for a Mid-West Aquaculture Development Zone (Gaughan *et al*. 2019).

14.8.4 South West Bioregion

The predominant aquaculture activity undertaken in this region is the production of mussels and oysters from Oyster Harbour at Albany. This activity is restricted to this area where there are sufficient nutrient levels related to terrestrial run-off to provide the planktonic food necessary to promote growth of filter-feeding bivalves fishing (Fletcher and Santoro 2015). The high-energy environment and limited protected deep waters limits other forms of aquaculture.

14.8.5 Indonesian Aquaculture

An analysis by WorldFish has indicated that aquaculture will overtake capture fisheries as the major source of fish in Indonesia before 2030 (Phillips *et al.* 2015). By volume, Indonesian aquatic production is dominated by seaweeds, but by value, domestically consumed species such tilapia and milkfish, together with export-orientated commodities such as shrimp and tuna, are of greater importance (Phillips *et al*. 2015).

Carrageenan seaweed farming based primarily on the cultivation of *Kappaphycus* and *Eucheuma* species has grown significantly in Indonesia. Due to the simple farming techniques required, low requirements of capital and material inputs, and short production cycles it has become a favourable livelihood for smallholder farmers and fishers (Valderrama *et al*. 2013). Indonesia's coastline provides ideal conditions for fish farming in "brackish waters". Aquaculture in Indonesia is predominantly used for seaweed production, whilst offshore fish cultivation remains relatively undeveloped (Global Business Guide 2014).

14.9 Recreational Fisheries

14.9.1 North Coast Bioregion

The North Coast Bioregion (Pilbara/Kimberley) runs from the Ashburton River to the Western Australia/Northern Territory border (WAFIC 2016). The oceanography of this region includes waters of Pacific Ocean origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian throughflow and Holloway currents which flow seasonally and interact with Indian ocean waters. Recreational fishing is experiencing a significant growth in this region, with a distinct seasonal peak in winter when the local population increases by significant numbers of metropolitan and inter-state tourists. This has been added to by the increased recreational fishing by those involved in the construction or operation of major developments in this region. Owing to the high tidal range, much of the angling activity is boat-based with beach fishing limited to periods of flood tides and high water. Numerous creek systems, mangroves, rivers and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including saddletail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, mackerels and billfish (WAFIC 2016).

14.9.2 Gascoyne Coast Bioregion

The Gascoyne Coast Bioregion extends from just north of Kalbarri to the Ashburton River, south of Onslow. The marine environment of this region represents a transition between the fully tropical waters of the north-west shelf of the north coast region and the temperate waters of the west coast region. This region has been identified as one of the 18 world ‘hotspots’ in terms of tropical reef endemism and the second most divers marine environment in the world in terms of tropical reef species. This region is a focal point for winter recreational fishing and is a key component of many tourist visits. Angling activities include beach and cliff fishing (e.g. Steep Point and Quobba), embayment and shallow-water boat angling (e.g. Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g. off Ningaloo). The predominant target species include the tropical species such as emperors, tropical snappers, groupers, mackerels, trevallies and other game fish. Temperate species at the northern end of their ranges such as pink snapper, tailor and whiting also provide significant catches, particularly in Shark Bay (WAFIC 2016).

14.9.3 West Coast Bioregion

The marine environment of the West Coast Bioregion which lies between Kalbarri and Augusta is predominantly a temperate oceanic zone, but it is heavily influenced by the Leeuwin current, which transports warm tropical water southward along the edge of the continental shelf. This region contains the state’s major population centres and is the most heavily used bioregion for recreational fishing (Fletcher and Santoro 2015). The range of recreational fishing opportunities includes estuarine fishing, beach fishing and boat fishing either in embayments or offshore for demersal and pelagic game species often around the islands and out to the continental shelf (WAFIC 2016).

14.9.4 South West Bioregion

The South West Bioregion includes the water from Augusta to Eucla on the Western Australia/South Australia border. The continental shelf waters of this region are generally temperate but low in nutrients due to the seasonal presence of the tail of the tropical Leeuwin current and limited terrestrial run-off. As much of the south coast is remote or difficult to access, recreational beach and boat fishing tends to be concentrated around the main population and holiday centres. The major target species for beach and rock anglers are salmon, herring, whiting and trevally, while boat anglers target pink snapper, queen snapper, Bight redfish, a number of shark species, salmon fish and King George whiting. Another component of the recreational fishery is dinghy and shoreline fishing off estuaries and rivers where the main angling targets are black bream and whiting. Recreational netting primarily targeting mullet also occurs in these estuaries (WAFIC 2016).

Santos

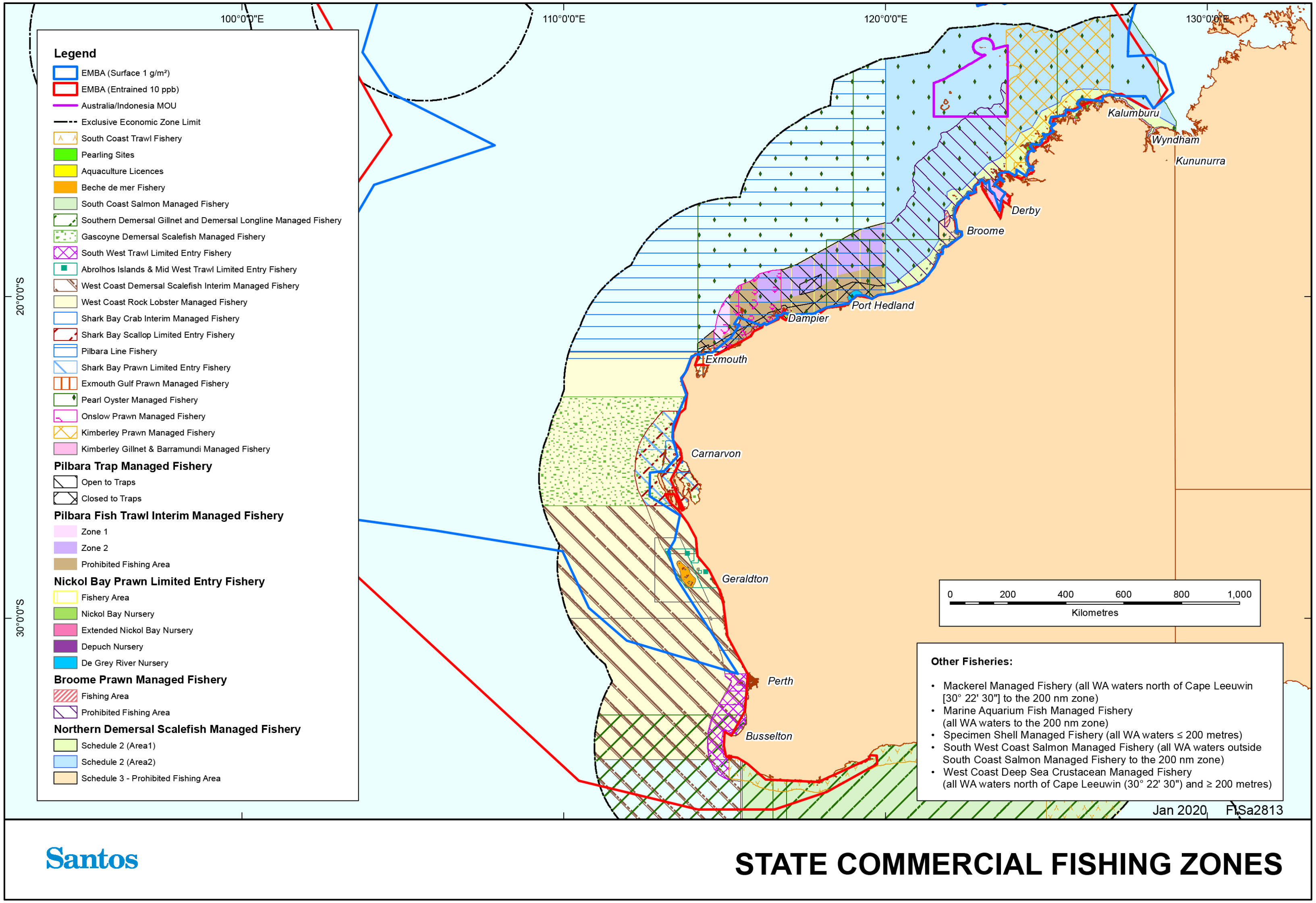

Figure 14-10: State commercial fishing zones

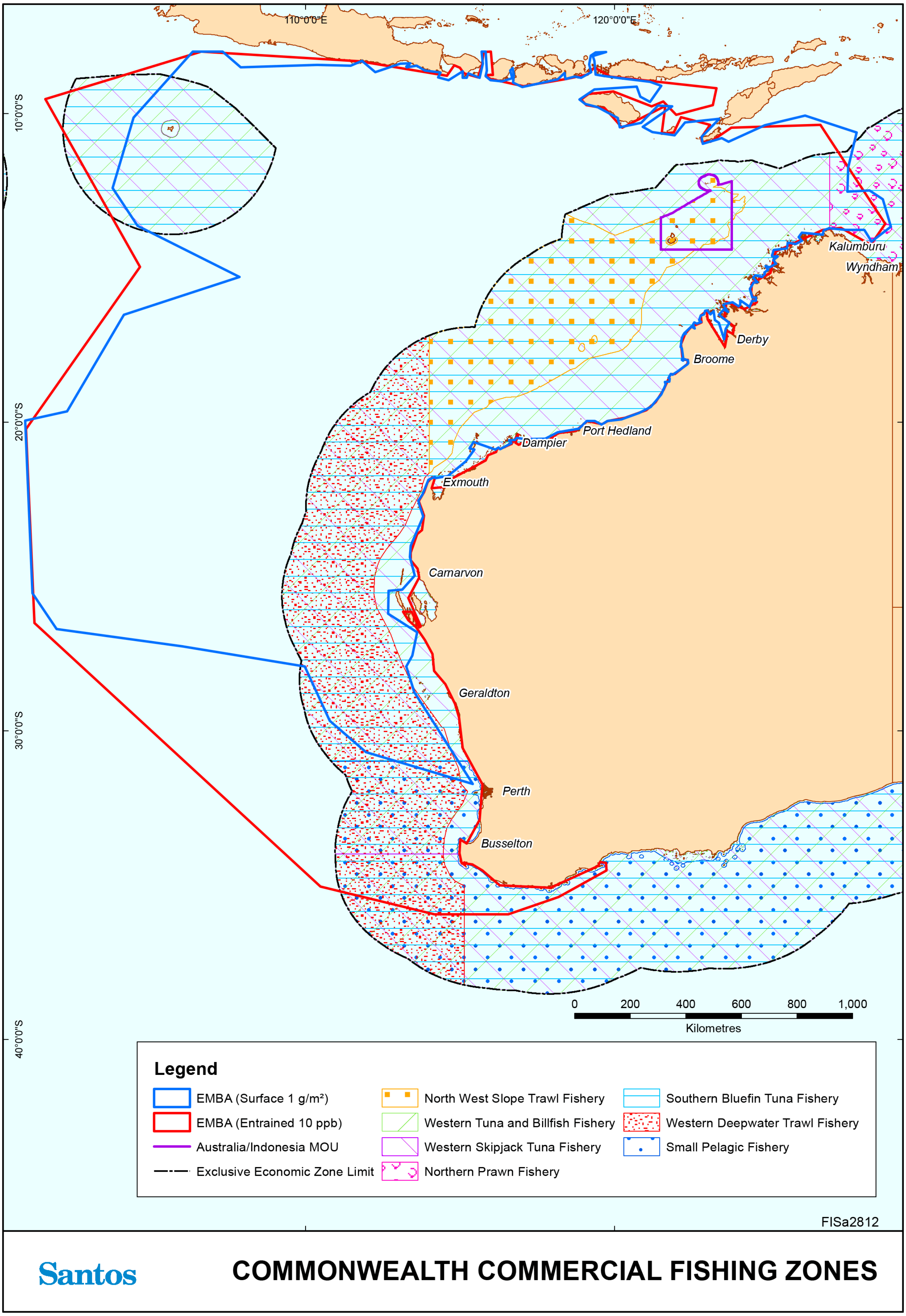

Figure 14-11: Commonwealth commercial fishing zones

Table 14-2: Commercial fisheries with permits to operate within the EMBA

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
State Managed Fisheries				
Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWTMF)	Saucer scallops (*Ylistrum balloti*), with a small component targeting the western king prawn (*Penaeus latisulcatus*)	2017/2018: 651 tonnes	Operates using low opening otter trawl systems.	All the waters of the Indian Ocean adjacent to Western Australia between 27°51´ south latitude and 29°03´ south latitude on the landward side of the 200 m isobath'.
Broome Prawn Managed Fishery (BPMF)	Western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species).	Extremely low fishing effort occurred as only a single boat undertook trial fishing to investigate whether catch rates were sufficient for commercial fishing. This resulted in negligible landings of western king prawns with no byproduct recorded.	Otter trawl	The BPMF operates in a designated trawl zone off Broome. The boundaries of the BPMF are 'all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200 m isobath'. The actual trawl area is contained within a delineated small area north west of Broome.
Cockburn Sound Mussel Managed Fishery	Blue mussels (*Mytilus edulis*)	2015: Unspecified	Agriculture	Main mussel farming occurs in southern Cockburn Sound.
Cockburn Sound Crab Managed Fishery	Blue Swimmer (*Portunus armatus)* Blue swimmer crab (*Portunus armartus)*	2017/2018: 5: closed to commercial and recreational fishing since April 2014	Drop nets, scoop nets, diving	Encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island and back to John Point on the mainland.
Cockburn Sound Line and Pot Managed Fishery	Southern garfish (*Hyporhamphus melanochir*), Australian herring (*Arripis geogianus*)	2017/2018: 257 tonnes	Line (fish) Shelter and trigger pots (octopus)	Encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island and back to John Point on the mainland.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Exmouth Gulf Prawn Managed Fishery	Western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*).	2017/2018: 713 tonnes	Low opening otter trawls.	Sheltered waters of Exmouth Gulf Essentially the western half of the Exmouth Gulf (eastern part is a nursery ground). The Muiron Islands and Point Murat provide the western boundary; Serrurier Island provides the northern limit
Gascoyne Demersal Scalefish Managed Fishery (GDSMF)	Targets pink snapper (*Pagrus auratus*) and goldband snapper (*Pristipomoides multidens*). Other demersal species caught include the rosy snapper (*P. filamentosus*), ruby snapper (*Etelis carbunculus*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, including spangled emperor*, Lethrinus nebulosus*, and redthroat emperor, *L. miniatus*), cods (Epinephelidae, including Rankin cod, *Epinephelus multinotatus* and goldspotted rockcod, *E. coioides*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicas*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).	2017/2018: Snapper: 133 tonnes Other demersals: 144 tonnes	Mechanised handlines	The GDSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°07'30"S and 26°30'S. Vessels are not permitted to fish in inner Shark Bay.
Abalone Managed Fishery	Greenlip abalone (*Haliotis laevigata*) Brownlip abalone (*H. conicopora)*	2017/2018: 98 tonnes	Dive fishery The principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) or SCUBA using an abalone 'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.	Shallow coastal waters off the south-west and south coasts of Western Australia Covers all Western Australian coastal waters, which are divided into eight management areas. Commercial fishing for greenlip/brownlip abalone is managed in three separate areas.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Hermit Crab Fishery (HCF)	Australian land hermit crab (*Coenobita variabilis*)	2017/2018: 58,643 (lowest reported in the last 10 years (2008-2017; catch range 58,643-118,203).	Land based hand collection typically using four-wheel drives to access remote beaches	Operates in Western Australian waters north of the Exmouth Gulf (22°30'S)
Kimberley Developing Mud Crab Managed Fishery	Mud crab (*Scylla serrata*)	2017/2018: 60 tonnes (also includes catch data from Pilbara Developmental crab fishery)	Mud Crab traps	This fishery operates between Broome and Cambridge Gulf. Three commercial operators are permitted to fish from King Sound to the Northern Territory border, with closed areas around communities and fishing camps. One Aboriginal Corporation is permitted to fish in King Sound, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier peninsula, north of Broome. Notices issued under the *Fish Resources Management Act 1994* prohibit all commercial fishing for mud crabs in Roebuck Bay and an area of King Sound near Derby.
Kimberley Gillnet and Barramundi Managed Fishery (KGBF)	Barramundi *(Lates calcarifer),* King threadfin *(Polydactylus macrochir),* Blue threadfin *(Eleutheronema tetradactylum)*	2017/2018: 79.9 tonnes	Gill net in inshore waters	Nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129ºE) to the top end of Eighty Mile Beach, south of Broome (19ºS). The waters of the KGBF are defined as 'all Western Australian waters north of 19° south latitude and west of 129° east longitude and within three nautical miles of the high water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47´ south latitude.
Kimberley Prawn Managed Fishery (KPMF)	Banana prawns (*Penaeus merguiensis*) Tiger prawns (*Penaeus esculentus*)	2017/2018: 269 tonnes	Otter trawl	The KPMF operates off the north of the state between Koolan Island and Cape Londonderry.

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Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	Endeavour prawns (*Metapenaeus endeavouri*) Western king prawns (*Penaeus latisulcatus*)			The boundaries of the KPMF are 'all Western Australian waters of the Indian Ocean lying east of 123°45´ east longitude and west of 126°58´ east longitude'. It abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF).
Mandurah to Bunbury Developing Crab Fishery	Blue swimmer crab (*Portunus armartus)*	2017/2018: 5.2 tonnes	Drop nets, scoop nets, diving	Fishery extends from south of the Shoalwater Islands Marine Park (32°22'40''S) to Point McKenna near Bunbury (33°16'S) and offshore to 115°30'E. The fishery is divided into two zones with crab fishing historically being permitted within Area 1, Comet Bay between 32°22''40''S and 32°30'S, and Area 2, Cape Bouvard to the southern boundary of the fishery. In 2015 crab fishing within Area 2 ceased.
Marine Aquarium Fish Managed Fishery (MAFMF)	Over 250 target species of finfish. (228 species caught in 2012). Fishermen can also take coral, live rock, algae, seagrass and invertebrates. The main fish species landed in 2012 were scribbled angelfish (*Chaetodontoplus duboulayi*) and green chromis (*Chromis cinerascens*) The main coral species landed in 2012 were the coral like anemones of the Corallimorpharia.	2017/2018: Total catch of 150,544 fishes, 21.9 t of coral, live rock & living sand and 322 L of marine plants.	Hand harvest while diving or wading. Hand held nets	Dive based fishery operating all year throughout WA waters, but restricted by diving depths. The MAFMF is able to operate in all State waters (between the Northern Territory border and South Australian border). The fishery is typically more active in waters south of Broome with higher levels of effort around the Capes region, Perth, Geraldton, Exmouth and Dampier. Operators in the MAFMF are also permitted to take coral, live rock, algae, seagrass and invertebrates under the Prohibition on Fishing (Coral, 'Live Rock' and Algae) Order 2007 and by way of Ministerial Exemption (Gaughan & Santoro, 2018).
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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				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* in the northern parts of the fishery,	2017/2018: Commercial: 257 tonnes Recreational: 1 tonne	Line and pots Trawl and trap (land Octopus as byproduct)	Fishery in development phase. Four main categories in WA waters. Octopus are primarily caught in the Developing Octopus Interim Managed Fishery (largest fishery) are

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	and *O.maorum* in the southern and deeper sectors.			limited to the boundaries of the developmental fishery, which is an area bounded by the Kalbarri Cliffs (26°30'S) in the north and Esperance in the south. Passive and by-product harvests of octopus occur in both the Cockburn Sound (Line and Pot) Managed Fishery and the West Coast Rock Lobster Managed Fishery.
Onslow Prawn Managed Fishery (OPMF)	Western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.)	2017/2018: Negligible (Minimal fishing occurred in 2017)	Otter trawl	Operates along the western part of the North-West Shelf with most prawning activities concentrated in the shallower water off the mainland. The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200 m depth isobath'.
Pilbara Developmental Crab Fishery	Blue Swimmer (*Portunus armatus)* Mud Crab (*Scylla* spp)	2017/2018: 60 tonnes (total number includes Kimberley Developing Mud Crab Fishery)	Variety of gear but mostly commercial crab pots (Hourglass traps used in inshore waters from Onslow through to Port Hedland with most commercial and activity occurring in and around Nickol Bay) Recreational fishers use drop nets or scoop nets, with diving for crabs becoming increasingly popular	The majority of the commercially and recreationally-fished stocks are concentrated in the coastal embayments and estuaries between Geographe Bay in the south west and Nickol Bay in the north. Crabbing activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around Nickol Bay.
Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor	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

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 Moses' snapper (*Argyrops Lutjanusspinifer russelli*).			longitudes 114°9'36"E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath. The Fishery consists of two zones; Zone 1 in the south west of the Fishery (which is closed to trawling) and Zone 2 in the North, which consists of six management areas.
Pilbara Trap Managed Fishery (PTMF)	Blue-spot emperor (*Lethrinus hutchinsi*), Red snapper (*Lutjanus erythropterus*), Goldband snapper (*Pristipomoides multidens*), Scarlet perch (*Lutjanus malabaricus*), Red emperor (*Lutjanus sebae*), Spangled emperor (*Lethrinus nebulosus*), Rankin cod (*Epinephelus multinotatus*)	2017/2018: 400–600 tonnes	Use of rectangular traps with single opening and 50 mm x 70 mm rectangular mesh panels. Trap fishing normally targets areas around rocky outcrops and reefs	Permitted to operate within waters bounded by a line commencing at the intersection of 21°56´ S latitude and the high water mark on the western side of the North West Cape.
Pilbara Line Managed Fishery	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and frypan snapper (*Argyrops spinifer*), Ruby	2017/2018: 50–115 tonnes	Line	The Pilbara Trap Managed Fishery lies north of latitude 21°44´ S and between longitudes 114°9´36´´ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus)*			
Roe's Abalone	Western Australian Roe's abalone (*Haliotis roei*)	2017/2018: Commercial: 49 tonnes Recreational: 23 tonnes	Dive and wade fishery. The commercial fishery harvest method is a single diver working off a 'hookah' (surface-supplied breathing apparatus) using an abalone 'iron' to prise the shellfish off rocks. Abalone divers operate from small fishery vessels (generally less than 9 metres in length).	Operating in shallow coastal waters along WA's western and southern coasts from Shark Bay to the SA border. Divided into 8 management areas. Commercial fishing for Roe's abalone is managed in 6 separate regions from the South Australian border to Busselton Jetty – Areas 1, 2, 5, 6, 7 and 8. Area 8 of the fishery was not fished in 2013.
Shark Bay Crab Interim Managed Fishery	Blue swimmer crab (*Portunus armatus*)	2017/2018: 443 tonnes total Crab: 153 tonnes	Trawl and trap	Waters of Shark Bay north of Cape Inscription, to Bernier and Dorre Islands and Quobba Point. In addition, two fishers with long-standing histories of trapping crabs in Shark Bay are permitted to fish in the waters of Shark Bay south of Cape Inscription.
Shark Bay Prawn Managed Fishery	Western king prawn (*Penaeus latisulcatus*), brown tiger prawn (*Penaeus esculentus*), Variety of smaller prawn species including endeavour prawns (*Metapenaeus* spp.) and coral prawns (various species).	2017/2018: 1,608 tonnes	Low opening otter trawls	The boundaries of the Shark Bay Prawn Managed Fishery are located in and near the waters of Shark Bay
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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
South Coast Open Access Netting Fishery	Insufficient information	Insufficient information	Insufficient information	Bunbury to the South Australian Border
Specimen Shell Managed Fishery (SSF)	Shells (cowries, cones) The Specimen Shell Managed Fishery (SSF) is based on the collection of individual shells for the purposes of display, collection, cataloguing, classification and sale. Just under 200 (196) different Specimen Shell species were collected in 2012, using a variety of methods.	2017/2018: 7,806 shells	Hand harvest while diving or wading along coastal beaches below the high water mark An exemption method being employed by the fishery is using a remote controlled underwater vehicle at depths between 60 and 300 m.	Dive based fishery operating all year throughout WA waters, but restricted by diving depths. The fishing area includes all Western Australian waters between the high water mark and the 200 m isobath. While the fishery covers the entire WA coastline, there is some concentration of effort in areas adjacent to population centres such as Broome, Karratha, Exmouth, Shark Bay, metropolitan Perth, Mandurah, the Capes area and Albany.
South Coast Salmon Managed Fishery	WA salmon (*Arripis truttaceus*)	2017: 50 tonnes	Beach seine net, rod and line	Licensees operate from 18 designated beaches within the South Coast Bioregion, many of which have huts that are referred to as salmon camps.
South West Coast Salmon Managed Fishery	WA salmon (*Arripis truttaceus*)	Insufficient information	Insufficient information	Insufficient information
South West Coast Beach Net	Insufficient information	Insufficient information	Insufficient information	Insufficient information
South West Trawl Managed Fishery (SWTMF)	Saucer scallops (*Ylistrum balloti*)	2017/2018: 460 t meat weight (2,301 t whole weight)	Otter trawls	Waters between 31°34’27’’S and 115°8’8’’E where it intersects with the high water mark at Cape Leeuwin and on the landward side of the 200 m isobath.
Temperate Demersal Gillnet and Demersal	Gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Longline Fisheries (TDGDLF)	sandbar shark (*Carcharhinus plumbeus*).			and Demersal Longline (Interim) Managed Fishery. The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF) spans the waters from 33° S latitude to the WA/SA border and comprises three management zones Zone 1 extends southwards from 33° S to 116° 30' E longitude off the south coast. Zone 2 extends from 116°30' E to the WA/SA border (129° E). A small number of Zone 3 units permit fishing throughout Zone 1 and eastwards to 116° 55'40" E. The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) technically extends northwards from 33° S latitude to 26° S longitude. However, the use of shark fishing gear has been prohibited north of 26° 30' S (Steep Point) since 1993. Demersal gillnet and longline fishing inside the 250 metre depth contour has been prohibited off the Metropolitan coast (between latitudes 31° S and 33° S) since November 2007.
Warnbro Sound Crab Managed Fishery	Blue Swimmer (*Portunus armatus)* Blue swimmer crab (*Portunus armartus)*	2017/2018: closed to commercial and recreational fishing	Drop nets, scoop nets, diving	Includes Warnbro sound and adjacent water, extending from Becher Point to John Point.
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	West Coast Inshore Demersals:	2017/2018: 248 tonnes	Handline and drop line	The WCDSIMF encompasses the waters of the Indian Ocean just south of Shark Bay (at

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
(Interim) Managed Fishery	West Australian Dhufish (*Glaucosoma hebraicum*), Pink snapper (*Pagrus auratus*) with other species captured including Redthroat Emperor (*Lethrinus miniatus*), Bight Redfish (*Centroberyx gerrardi*) and Baldchin Groper (*Choerodon rubescens*). West Coast Offshore Demersals: Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneios*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.			26°30'S) to just east of Augusta (at 115°30'E) and extends seaward to the 200 nm boundary of the Australian Fishing Zone (AFZ). The commercial fishery is divided into five management areas comprising four inshore areas and one offshore area. The inshore areas, i.e. Kalbarri, Mid-West, Metropolitan and South-West, extend outwards to the 250 m depth contour, while the Offshore Area extends the entire length of the fishery from the 250 m depth contour to the boundary of the AFZ.
West Coast Estuarine Managed Fishery	Blue swimmer crab (*Portunus armartus)*	2017/2018: 353 tonnes (blue swimmer crab) commercial and 58-77 tonnes recreational	Drop nets, scoop nets, diving (crabs)	Includes the waters of the Swan and Canning Rivers (Area 1), the waters of the Peel Inlet and Harvey Estuary, together with the Murray Serpentine, Harvey and Dandalup Rivers (Area 2) and waters of the Hardy Inlet (Area 3). Of these areas only Areas 1-2 are permitted for crab fishing.
West Coast Nearshore and Estuarine Finfish Fisheries	<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	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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	(*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).			various beaches from Tim's Thicket southwards to Port Geographe Bay Marina. Estuarine: West Coast Estuarine Managed Fishery operating in the Swan/Canning and Peel Harvey estuaries, and in the Hardy Inlet
West Coast Nearshore Net Managed Fishery	Southern garfish (Hyporhamphus melanochir), Australian herring (Arripis georgianus),	Insufficient information	Insufficient information	Insufficient information
West Coast Purse Seine Fishery	Scaly mackerel (*Sardinella lemuru*), pilchard (*S. sagax*), Australian anchovy (*Engraulis australis*), yellowtail scad (*Trachurus novaezelandiae*) and maray (*Etrumeus teres*).	2017/2018: 1,095 tonnes	Purse seine gear	Waters between Ningaloo and Cape Leeuwin including three separate zones: Northern Development (22°00'S to 31°00'S), Perth Metropolitan (31°00'S to 33°00'S) and Southern Development Zone (33°00'S to Cape Leeuwin).
West Coast Rock Lobster Managed Fishery (WCRLMF)	Western rock lobster (*Panulirus cygnus*)	2016: 272 – 400 tonnes (346-481 tonnes based on updated average weight)	Baited traps (pots). Pots and diving (recreational catch)	The fishery is situated along the west coast of Australia between Latitudes 21°44´ to 34°24´ S. The fishery is managed in three zones: Zone A – Abrolhos Islands, north of latitude 30° S excluding the Abrolhos Islands (Zone B) and south of latitude 30° S (Zone C).
West Coast Demersal Gillnet and Demersal Longline (WCDGDLF)*	Gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and sandbar shark (*C. plumbeus*)	2016/2018: 936 tonnes of sharks and rays	Demersal gillnets and demersal longline (not widely used)	Operates between 26° and 33° S.
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.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				Catches are reported separately for three Areas: Area 1 - Kimberley (121º E to WA/NT border); Area 2 -Pilbara (114º E to 121º E); Area 3 - Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S).
Western Australian Pearl Oyster Managed Fishery	Indo- Pacific silver-lipped pearl oyster (*Pinctada maxima*).	2018: 468,573 shells	Drift diving restricted to shallow diveable depths. The collection of pearl oysters for the Pearl Oyster Managed Fishery is restricted to shallow diving depths below 35 m. Divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legalised oysters by hand as they are seen.	The fishery is separated into four zones: Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30'E. There are five licensees in this zone. No fishing in this zone since 2008 Pearl Oyster Zone 2: East of Cape Thouin (118°20´ E) and south of latitude 18°14´ S. The 9 licensees in this zone also have full access to Zone 3. This zone is the mainstay of the fishery. Pearl Oyster Zone 3: West of longitude 125°20´ E and north of latitude 18°14´ S. The 2 licensees in this zone also have partial access to Zone 2. Pearl Oyster Zone 4: East of longitude 125°20´ E to the Western Australia/Northern Territory border. Although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not 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

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				and Cape Lambert, the Rowley Shoals and the Abrolhos Islands. The fishery is primarily based in the northern half of the State, from Exmouth Gulf to the Northern Territory border.
Commonwealth Managed Fisheries				
North West Slope Trawl	Scampi (crayfish): velvet scampi (*Metanephrops velutinus*) and boschmai scampi (*Metanephrops boschmai*). Deepwater prawns (penaeid and carid): pink prawn (*Parapenaeus longirostris*), red prawn (*Aristaeomorpha foliacea*), striped prawn (*Aristeus virilis*), giant scarlet prawn (*Aristaeopsis edwardsiana*), red carid prawn (*Heterocarpus woodmasoni*) and white carid prawn (*Heterocarpus sibogae*). Snapper.	2017-18: 79.7 total tonnes.	Demersal crustacean trawl seaward of the 200 m isobath.	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ).
Western Skipjack Tuna Fishery	Skipjack tuna (*Katsuwonus pelamis*)	2017-18: None in either zones	Purse seine	The Skipjack Tuna Fishery is split into two sectors; east and west. The Western Skipjack Tuna Fishery is located in all Australia waters west of 142° 30’ 00°E, out to 200 nm from the coast. 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	2018-19: 9,424 tonnes	Purse-seine and midwater trawling	Extends from Queensland to southern Western Australia.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	(*Trachurus declivis*) and redbait (*Emmelichthys nitidus*).			
Southern Bluefin Tuna Fishery	Southern bluefin tuna (*Thunnus maccoyii*).	2017-18: 6,159 tonnes	Purse seine vessels primarily in Great Australian Bight all year round and longline off southern NSW in winter. Around 98% of Australia's SBT quota is taken by 5–10 purse seine vessels fishing for 13–25 kg southern bluefin tuna.	Fishery includes all waters of Australia, out to 200 nm from the coast. No current effort on the North West Shelf, fishing activity is concentrated in the Great Australian Bight and off South-east Australia (Department of Agriculture 2019).
Western Deepwater Trawl Fishery	A diverse range of species are caught, ranging from tropical and ruby snappers on the shelf edge to orange roughy (*Hoplostethus atlanticus*), oreo dories and bugs (*Ibacus* spp.) in the deeper temperate waters.	2017-18: 101.9 tonnes	Demersal fish trawl seaward of the 200 m isobath.	Its northernmost point is from the boundary of the AFZ to longitude 114° E, and its southernmost point is from the boundary of the AFZ to longitude 115°08' E. Deep water off WA, from the 200 m isobath to the edge of the AFZ.
Western Tuna and Billfish Fishery	Broadbill swordfish (*Xiphias gladius*), albacore tuna (*Thunnus alalunga*), striped marlin (*Kajikia audax*), bigeye tuna (*T. obesus*) and yellowfin tuna (*T. albacares*).	2018: 278 tonnes	Pelagic, longline, minor line and purse seine.	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. In recent years, fishing effort has concentrated off south-west Western Australia and South Australia with no current effort on the North West Shelf (Department of Agriculture 2019).

Source: Apache (2008); Australian Fisheries Management Authority (2011); Department of Fisheries (2013), Stakeholder consultation.

[1]Sources for catch data: Department of Agriculture 2019; Gaughan *et al*, 2019; DPIRD 2018.

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Appendix A: EPBC Act Protected Matters Report

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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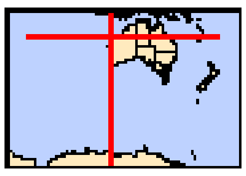

Summary

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:	9
Wetlands of International Importance:	7
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	199
Listed Migratory Species:	108

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	9
Commonwealth Heritage Places:	24
Listed Marine Species:	216
Whales and Other Cetaceans:	44
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Australian Marine Parks:	45

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	140
Regional Forest Agreements:	1
Invasive Species:	64
Nationally Important Wetlands:	19
Key Ecological Features (Marine)	24

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Fitzgerald River National Park	WA	Listed place
Lesueur National Park	WA	Listed place
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place
The West Kimberley	WA	Listed place
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place
Historic		
Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos	WA	Listed place
Dirk Hartog Landing Site 1616 - Cape Inscription Area	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Ashmore reef national nature reserve	Within Ramsar site
Becher point wetlands	Within 10km of Ramsar
Eighty-mile beach	Within Ramsar site
Hosnies spring	Within Ramsar site
Peel-yalgorup system	Within Ramsar site
Roebuck bay	Within Ramsar site
The dales	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North
North-west
South-west

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes	Endangered	Community likely to

Name	Status	Type of Presence
of Dampier Peninsula		occur within area
Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)	Critically Endangered	Community known to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Name	Status	Type of Presence
Birds		
Accipiter hiogaster natalis		
Christmas Island Goshawk [82408]	Endangered	Species or species habitat known to occur within area
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Atrichornis clamosus		
Noisy Scrub-bird, Tjimiluk [654]	Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris		
Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus banksii naso		
Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii		
Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Breeding known to occur within area
Calyptorhynchus latirostris		
Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Cereopsis novaehollandiae grisea		
Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
Chalcophaps indica natalis		
Christmas Island Emerald Dove, Emerald Dove (Christmas Island) [67030]	Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Dasyornis longirostris		
Western Bristlebird [515]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren [26004]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Ninox natalis Christmas Island Hawk-Owl, Christmas Boobook [66671]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Pezoporus flaviventris Western Ground Parrot, Kyloring [84650]	Critically Endangered	Species or species habitat likely to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat known to occur within area
Psophodes nigrogularis nigrogularis Western Heath Western Whipbird [64449]	Endangered	Species or species habitat known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta cauta Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Turdus poliocephalus erythropleurus Christmas Island Thrush [67122]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Turnix varius scintillans Painted Button-quail (Houtman Abrolhos) [82451]	Vulnerable	Species or species habitat likely to occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Galaxiella nigrostriata Blackstriped Dwarf Galaxias, Black-stripe Minnow [88677]	Endangered	Species or species habitat known to occur within area
Milyeringa veritas Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Nannatherina balstoni Balston's Pygmy Perch [66698]	Vulnerable	Species or species habitat known to occur within area
Ophisternon candidum Blind Cave Eel [66678]	Vulnerable	Species or species habitat known to occur within area
Insects		
Hesperocolletes douglasi Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
Trioza barrettae Banksia brownii plant louse [87805]	Endangered	Species or species habitat known to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Bettongia lesueur lesueur Burrowing Bettong (Shark Bay), Boodie [66659]	Vulnerable	Species or species habitat known to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat likely to occur within area
Crocidura trichura Christmas Island Shrew [86568]	Critically Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon auratus auratus Golden Bandicoot (mainland) [66665]	Vulnerable	Species or species habitat likely to occur within area
Isoodon auratus barrowensis Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Lagorchestes hirsutus bernieri Rufous Hare-wallaby (Bernier Island) [66662]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus dorreae Rufous Hare-wallaby (Dorre Island) [66663]	Vulnerable	Species or species habitat known to occur within area
Lagostrophus fasciatus fasciatus Banded Hare-wallaby, Merrnine, Marnine, Munning [66664]	Vulnerable	Species or species habitat known to occur within area
Leporillus conditor Wopilkara, Greater Stick-nest Rat [137]	Vulnerable	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesembriomys gouldii gouldii Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known to occur within area
Osphranter robustus isabellinus Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat known to occur within area
Perameles bougainville bougainville Western Barred Bandicoot (Shark Bay) [66631]	Endangered	Species or species habitat known to occur within area
Petrogale concinna monastria Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Phascogale calura Red-tailed Phascogale, Red-tailed Wambenger, Kenngoor [316]	Vulnerable	Species or species habitat may occur within area
Phascogale tapoatafa kimberleyensis Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat likely to occur within area
Pipistrellus murrayi Christmas Island Pipistrelle [64383]	Critically Endangered	Species or species habitat known to occur within area
Potorous gilbertii Gilbert's Potoroo, Ngilkat [66642]	Critically Endangered	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Breeding known to occur within area
Pseudomys fieldi Shark Bay Mouse, Djoongari, Alice Springs Mouse [113]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys shortridgei Heath Mouse, Dayang, Heath Rat [77]	Endangered	Species or species habitat may occur within area
Pteropus natalis Christmas Island Flying-fox, Christmas Island Fruit-bat [87611]	Critically Endangered	Roosting known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
Other		
Idiosoma nigrum Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat may occur within area
Kumonga exleyi Cape Range Remipede [86875]	Vulnerable	Species or species habitat likely to occur within area
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
Adenanthos dobagii Fitzgerald Woollybush [21253]	Endangered	Species or species habitat likely to occur within area
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Androcalva bivillosa Straggling Androcalva [87807]	Critically Endangered	Species or species habitat may occur within area
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Banksia brownii Brown's Banksia, Feather-leaved Banksia [8277]	Endangered	Species or species habitat known to occur within area
Banksia nivea subsp. uliginosa Swamp Honeypot [82766]	Endangered	Species or species habitat likely to occur within area
Banksia pseudoplumosa False Plumed-Banksia [82760]	Endangered	Species or species habitat may occur within area
Banksia squarrosa subsp. argillacea Whicher Range Dryandra [82769]	Vulnerable	Species or species habitat may occur within area
Banksia verticillata Granite Banksia, Albany Banksia, River Banksia [8333]	Vulnerable	Species or species habitat likely to occur within area
Beyeria lepidopetala Small-petalled Beyeria, Short-petalled Beyeria [18362]	Endangered	Species or species habitat likely to occur within area
Boronia clavata Bremer Boronia [5538]	Endangered	Species or species habitat likely to occur within area
Caladenia barbarella Small Dragon Orchid, Common Dragon Orchid [68686]	Endangered	Species or species habitat may occur within area
Caladenia bryceana subsp. cracens Northern Dwarf Spider-orchid [64556]	Vulnerable	Species or species habitat known to occur within area
Caladenia busselliana Bussell's Spider-orchid [24369]	Endangered	Species or species habitat likely to occur within area
Caladenia caesarea subsp. maritima Cape Spider-orchid [64856]	Endangered	Species or species habitat known to occur within area
Caladenia elegans Elegant Spider-orchid [56775]	Endangered	Species or species habitat likely to occur within area
Caladenia excelsa Giant Spider-orchid [56717]	Endangered	Species or species habitat likely to occur within area
Caladenia granitora [65292]	Endangered	Species or species habitat known to occur within area
Caladenia hoffmanii Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat known to occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Caladenia lodgeana Lodge's Spider-orchid [68664]	Critically Endangered	Species or species habitat known to occur within area
Caladenia procera Carbunup King Spider Orchid [68679]	Critically Endangered	Species or species habitat may occur within area
Caladenia viridescens Dunsborough Spider-orchid [56776]	Endangered	Species or species habitat known to occur within area
Calectasia cyanea Blue Tinsel Lily [7669]	Critically Endangered	Species or species habitat known to occur within area
Chamelaucium sp. S coastal plain (R.D.Royce 4872) Royce's Waxflower [87814]	Vulnerable	Species or species habitat may occur within area
Chordifex abortivus Manypeaks Rush [64868]	Endangered	Species or species habitat known to occur within area
Chorizema varium Limestone Pea [16981]	Endangered	Species or species habitat known to occur within area
Conostylis micrantha Small-flowered Conostylis [17635]	Endangered	Species or species habitat may occur within area
Conostylis misera Grass Conostylis [21320]	Endangered	Species or species habitat may occur within area
Darwinia oxylepis Gillam's Bell [13188]	Endangered	Species or species habitat may occur within area
Darwinia wittwerorum Wittwer's Mountain Bell [15626]	Endangered	Species or species habitat may occur within area
Daviesia obovata Paddle-leaf Daviesia [17311]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat known to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Drummondita ericoides Morseby Range Drummondita [9193]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus cuprea Mallee Box [56773]	Endangered	Species or species habitat may occur within area
Eucalyptus x phylacis Meelup Mallee [87817]	Endangered	Species or species habitat known to occur within area
Gastrolobium papilio Butterfly-leaved Gastrolobium [78415]	Endangered	Species or species habitat may occur within area
Grevillea batrachioides Mt Lesueur Grevillea [21735]	Endangered	Species or species habitat may occur within area
Grevillea brachystylis subsp. australis [55525]	Vulnerable	Species or species habitat may occur within area
Grevillea humifusa Spreading Grevillea [61182]	Endangered	Species or species habitat may occur within area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat likely to occur within area
Isopogon uncinatus Albany Cone Bush, Hook-leaf Isopogon [20871]	Endangered	Species or species habitat known to occur within area
Kennedia glabrata Northcliffe Kennedia [16452]	Vulnerable	Species or species habitat likely to occur within area
Kennedia lateritia Augusta Kennedia [45985]	Endangered	Species or species habitat likely to occur within area
Keraudrenia exastia Fringed Keraudrenia [66301]	Critically Endangered	Species or species habitat known to occur within area
Lambertia echinata subsp. occidentalis Western Prickly Honeysuckle [64528]	Endangered	Species or species habitat may occur within area
Lambertia orbifolia Roundleaf Honeysuckle [15725]	Endangered	Species or species habitat likely to occur within area
Lechenaultia chlorantha Kalbarri Leschenaultia [16763]	Vulnerable	Species or species habitat likely to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Leptomeria dielsiana Diels' Currant Bush [5146]	Vulnerable	Species or species habitat known to occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Marianthus paralius [83925]	Endangered	Species or species habitat known to occur within area
Pityrodia augustensis Mt Augustus Foxglove [4962]	Vulnerable	Species or species habitat likely to occur within area
Pneumatopteris truncata fern [68812]	Critically Endangered	Species or species habitat known to occur within area
Reedia spathacea Reedia [2995]	Critically Endangered	Species or species habitat likely to occur within area
Sphenotoma drummondii Mountain Paper-heath [21160]	Endangered	Species or species habitat likely to occur within area
Stachystemon nematophorus Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat known to occur within area
Tectaria devexa [14767]	Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may occur within area
Verticordia apecta Hay River Featherflower, Scruffy Verticordia [65545]	Critically Endangered	Species or species habitat may occur within area
Verticordia plumosa var. vassensis Vasse Featherflower [55804]	Endangered	Species or species habitat may occur within area
Wurmbea calcicola Naturaliste Nancy [64691]	Endangered	Species or species habitat known to occur within area
Wurmbea tubulosa Long-flowered Nancy [12739]	Endangered	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Cryptoblepharus egeriae Christmas Island Blue-tailed Skink, Blue-tailed Snake-eyed Skink [1526]	Critically Endangered	Species or species habitat likely to occur within area
Ctenotus lancelini Lancelin Island Skink [1482]	Vulnerable	Species or species habitat known to occur within area
Ctenotus zastictus Hamelin Ctenotus [25570]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Cyrtodactylus sadleiri Christmas Island Giant Gecko [86865]	Endangered	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat known to occur within area
Emoia nativitatis Christmas Island Forest Skink, Christmas Island Whiptail-skink [1400]	Critically Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lepidodactylus listeri Christmas Island Gecko, Lister's Gecko [1711]	Critically Endangered	Species or species habitat known to occur within area
Lerista nevinae Nevin's Slider [85296]	Endangered	Species or species habitat known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area
Liopholis pulchra longicauda Jurien Bay Skink, Jurien Bay Rock-skink [83162]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Ramphotyphlops exocoeti Christmas Island Blind Snake, Christmas Island Pink Blind Snake [1262]	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding likely to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known

Name	Status	Type of Presence
		to occur within area

Listed Migratory Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Breeding known to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Onychoprion anaethetus		
Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus		
White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon rubricauda		
Red-tailed Tropicbird [994]		Breeding known to occur within area
Phoebetria fusca		
Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sterna dougallii		
Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons		
Little Tern [82849]		Breeding known to occur within area
Sula dactylatra		
Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster		
Brown Booby [1022]		Breeding known to occur within area
Sula sula		
Red-footed Booby [1023]		Breeding known to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta		
Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata		
Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis		
Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
Balaenoptera bonaerensis		
Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat known to occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area

Name	Threatened	Type of Presence
Pluvialis fulva		
Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola		
Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii		
Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes		
Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola		
Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus		
Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Christmas Island National Park
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion
Defence - GREENOUGH RIFLE RANGE
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND
Defence - LANCELIN TRAINING AREA
Defence - LEARMONTH - AIR WEAPONS RANGE
Defence - YAMPI SOUND TRAINING AREA

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ashmore Reef National Nature Reserve	EXT	Listed place
Christmas Island Natural Areas	EXT	Listed place
Garden Island	WA	Listed place
Lancelin Defence Training Area	WA	Listed place
Learmonth Air Weapons Range Facility	WA	Listed place
Mermaid Reef - Rowley Shoals	WA	Listed place
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place
Yampi Defence Area	WA	Listed place
Historic		
Administrators House Precinct	EXT	Listed place
Bungalow 702	EXT	Listed place
Cape Leeuwin Lighthouse	WA	Listed place
Cliff Point Historic Site	WA	Listed place
Drumsite Industrial Area	EXT	Listed place
Geraldton Drill Hall Complex	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Industrial and Administrative Group	EXT	Listed place

Name	State	Status
J Gun Battery	WA	Listed place
Malay Kampong Group	EXT	Listed place
Malay Kampong Precinct	EXT	Listed place
Phosphate Hill Historic Area	EXT	Listed place
Poon Saan Group	EXT	Listed place
Settlement Christmas Island	EXT	Listed place
South Point Settlement Remains	EXT	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous minutus Black Noddy [824]		Breeding known to occur within area
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area

Name	Threatened	Type of Presence
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding likely to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Breeding known to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Puffinus huttoni Hutton's Shearwater [1025]		Foraging, feeding or related behaviour known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur

Name	Threatened	Type of Presence
		within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
Sterna albifrons Little Tern [813]		Breeding known to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Roosting known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys sculptus Sculptured Pipefish [66197]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Cosmocampus maxweberi Maxweber's Pipefish [66209]		Species or species habitat may occur within area
Doryrhamphus baldwini Redstripe Pipefish [66718]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus macrorhynchus Whiskered Pipefish, Ornate Pipefish [66222]		Species or species habitat may occur within area
Halicampus mataafae Samoan Pipefish [66223]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippichthys spicifer Belly-barred Pipefish, Banded Freshwater Pipefish [66232]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Breeding known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus fuscus Dusky Seasnake [1119]		Species or species habitat known to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur

Name	Threatened	Type of Presence
		within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake [1126]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis coggeri Slender-necked Seasnake [25925]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis inornatus Plain Seasnake [1107]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area

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)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)

Name	Label
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Geographe	Habitat Protection Zone (IUCN IV)
Geographe	Multiple Use Zone (IUCN VI)
Geographe	Special Purpose Zone (Mining
Jurien	National Park Zone (IUCN II)
Jurien	Special Purpose Zone (IUCN VI)
Kimberley	Habitat Protection Zone (IUCN IV)
Kimberley	Multiple Use Zone (IUCN VI)
Kimberley	National Park Zone (IUCN II)
Mermaid Reef	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Perth Canyon	Habitat Protection Zone (IUCN IV)
Perth Canyon	Multiple Use Zone (IUCN VI)
Perth Canyon	National Park Zone (IUCN II)
Roebuck	Multiple Use Zone (IUCN VI)
Shark Bay	Multiple Use Zone (IUCN VI)
South-west Corner	Habitat Protection Zone (IUCN IV)
South-west Corner	Multiple Use Zone (IUCN VI)
South-west Corner	National Park Zone (IUCN II)
South-west Corner	Special Purpose Zone (IUCN VI)
South-west Corner	Special Purpose Zone (Mining
Two Rocks	Multiple Use Zone (IUCN VI)
Two Rocks	National Park Zone (IUCN II)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Adele Island	WA
Airlie Island	WA
Arpenteur	WA
Bald Island	WA
Bardi Jawi	WA
Barrow Island	WA
Bedout Island	WA
Beekeepers	WA
Bernier And Dorre Islands	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	WA
Breaksea Island	WA
Browse Island	WA
Burnside And Simpson Island	WA
Cape Range	WA
Carnac Island	WA
Chatham Island	WA
Coulomb Point	WA
D'Entrecasteaux	WA
Dambimangari	WA
Dambimangari	WA
Dirk Hartog Island	WA
Doubtful Islands	WA
Eclipse Island	WA
Escape Island	WA
Fitzgerald River	WA
Flinders Bay	WA
Freycinet, Double Islands etc	WA
Glasse Island	WA
Gnandaroo Island	WA
Hamelin Island	WA
Jarrkunpungu	WA

Name	State
Jinmarnkur	WA
Jinmarnkur Kulja	WA
Jurabi Coastal Park	WA
Kalbarri	WA
Karajarri	WA
Koks Island	WA
Kujungurru Warrarn	WA
Lacepede Islands	WA
Lancelin And Edwards Islands	WA
Leeuwin-Naturaliste	WA
Lesueur	WA
Little Rocky Island	WA
Locker Island	WA
Low Rocks	WA
Lowendal Islands	WA
Michaelmas Island	WA
Montebello Islands	WA
Mount Manypeaks	WA
Muiron Islands	WA
Murujuga	WA
NTWA Bushland covenant (0005)	WA
NTWA Bushland covenant (0013)	WA
NTWA Bushland covenant (0090)	WA
Nambung	WA
Nilgen	WA
North Sandy Island	WA
North Turtle Island	WA
Nyangumarta Warrarn	WA
One Tree Point	WA
Prince Regent	WA
Quagering	WA
Quarram	WA
Rottnest Island	WA
Round Island	WA
Scott	WA
Seal Island (WA25645)	WA
Seal Island (WA32199)	WA
Serrurier Island	WA
Southern Beekeepers	WA
St Alouarn Island	WA
Sugar Loaf Rock	WA
Swan Island	WA
Tamala Pastoral Lease (Part)	WA
Tanner Island	WA
Tent Island	WA
Torndirrup	WA
Two Peoples Bay	WA
Unnamed WA11883	WA
Unnamed WA11962	WA
Unnamed WA15185	WA
Unnamed WA26400	WA
Unnamed WA28968	WA
Unnamed WA32478	WA
Unnamed WA33799	WA
Unnamed WA34039	WA
Unnamed WA36907	WA
Unnamed WA36909	WA
Unnamed WA36910	WA
Unnamed WA36913	WA
Unnamed WA36915	WA
Unnamed WA37168	WA
Unnamed WA37338	WA
Unnamed WA37383	WA
Unnamed WA37500	WA
Unnamed WA40322	WA
Unnamed WA40828	WA

Name	State
Unnamed WA40877	WA
Unnamed WA41080	WA
Unnamed WA41775	WA
Unnamed WA42030	WA
Unnamed WA44665	WA
Unnamed WA44667	WA
Unnamed WA44669	WA
Unnamed WA44672	WA
Unnamed WA44673	WA
Unnamed WA44676	WA
Unnamed WA44682	WA
Unnamed WA44685	WA
Unnamed WA44688	WA
Unnamed WA44690	WA
Unnamed WA44709	WA
Unnamed WA46982	WA
Unnamed WA46983	WA
Unnamed WA46984	WA
Unnamed WA48205	WA
Unnamed WA48858	WA
Unnamed WA48968	WA
Unnamed WA49994	WA
Unnamed WA51105	WA
Unnamed WA51162	WA
Unnamed WA51617	WA
Unnamed WA51932	WA
Unnamed WA53015	WA
Utcha Well	WA
Uunguu	WA
Victor Island	WA
Walpole-Nornalup	WA
Wanagarren	WA
Waychinicup	WA
Wedge Island	WA
Weld Island	WA
West Cape Howe	WA
Y Island	WA
Yalgorup	WA
Yampi	WA
Yawuru	WA
Zuytdorp	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis		
Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos		
Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis		
European Goldfinch [403]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Gallus gallus Red Junglefowl, Domestic Fowl [917]		Species or species habitat likely to occur within area
Lonchura oryzivora Java Sparrow [59586]		Species or species habitat likely to occur within area
Meleagris gallopavo Wild Turkey [64380]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pavo cristatus Indian Peafowl, Peacock [919]		Species or species habitat likely to occur within area
Phasianus colchicus Common Pheasant [920]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus exulans Pacific Rat, Polynesian Rat [79]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Andropogon gayanus Gamba Grass [66895]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus declinatus Bridal Veil, Bridal Veil Creeper, Pale Berry Asparagus Fern, Asparagus Fern, South African Creeper [66908]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Cylindropuntia spp. Prickly Pears [85131]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur

Name	Status	Type of Presence
		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 likely to occur within area

Nationally Important Wetlands

[Resource Information]

Name	State
"The Dales", Christmas Island	EXT
Ashmore Reef	EXT
Cape Leeuwin System	WA
Cape Range Subterranean Waterways	WA
Doggerup Creek System	WA
Eighty Mile Beach System	WA
Exmouth Gulf East	WA
Hosine's Spring, Christmas Island	EXT
Hutt Lagoon System	WA
Lake MacLeod	WA
Lake Thetis	WA
Learmonth Air Weapons Range - Saline Coastal Flats	WA
Leslie (Port Hedland) Saltfields System	WA
Mermaid Reef	EXT
Prince Regent River System	WA
Roebuck Bay	WA
Rottnest Island Lakes	WA
Shark Bay East	WA
Yalgorup Lakes System	WA

Key Ecological Features (Marine)

[Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Ashmore Reef and Cartier Island and surrounding	North-west
Canyons linking the Argo Abyssal Plain with the	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Carbonate bank and terrace system of the Sahul	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	North-west
Mermaid Reef and Commonwealth waters	North-west

Name	Region
Pinnacles of the Bonaparte Basin	North-west
Seringapatam Reef and Commonwealth waters in	North-west
Wallaby Saddle	North-west
Albany Canyons group and adjacent shelf break	South-west
Ancient coastline at 90-120m depth	South-west
Cape Mentelle upwelling	South-west
Commonwealth marine environment surrounding	South-west
Commonwealth marine environment within and	South-west
Commonwealth marine environment within and	South-west
Diamantina Fracture Zone	South-west
Naturaliste Plateau	South-west
Perth Canyon and adjacent shelf break, and other	South-west
Western demersal slope and associated fish	South-west
Western rock lobster	South-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

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9.177999538 123.2974515

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
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-Birdlife Australia
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-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
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-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
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-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
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-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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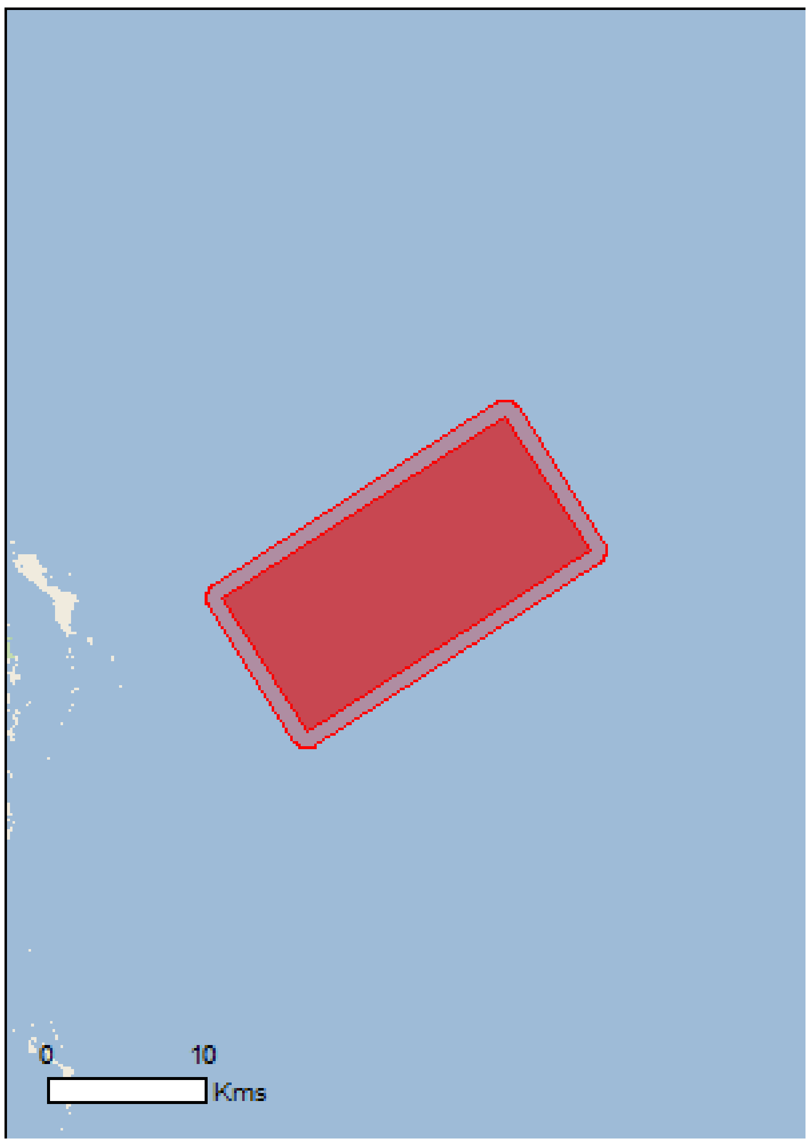

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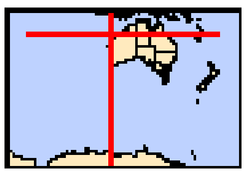

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	18
Listed Migratory Species:	31

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	65
Whales and Other Cetaceans:	12
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	1

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Sternula nereis nereis		
Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Mammals		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis		
Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species

Name	Status	Type of Presence
		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 known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	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 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

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	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
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat 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 likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known 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 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
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		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 likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris 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
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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		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 grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
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 may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat 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
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to 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 ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata		
Minke Whale [33]		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
Delphinus delphis		
Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Grampus griseus		
Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis		
Indo-Pacific Humpback Dolphin [50]		Species or species habitat may 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 likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Tursiops truncatus s. str.		
Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Montebello	Multiple Use Zone (IUCN VI)

Extra Information

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-20.303914 115.824229,-20.375289 115.87301,-20.472385 115.713164,-20.400942 115.664413,-20.303914 115.824229

Acknowledgements

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-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
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-CSIRO
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-Australian Government – Australian Antarctic Data Centre
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-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

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Australian Government
Department of the Environment and Energy

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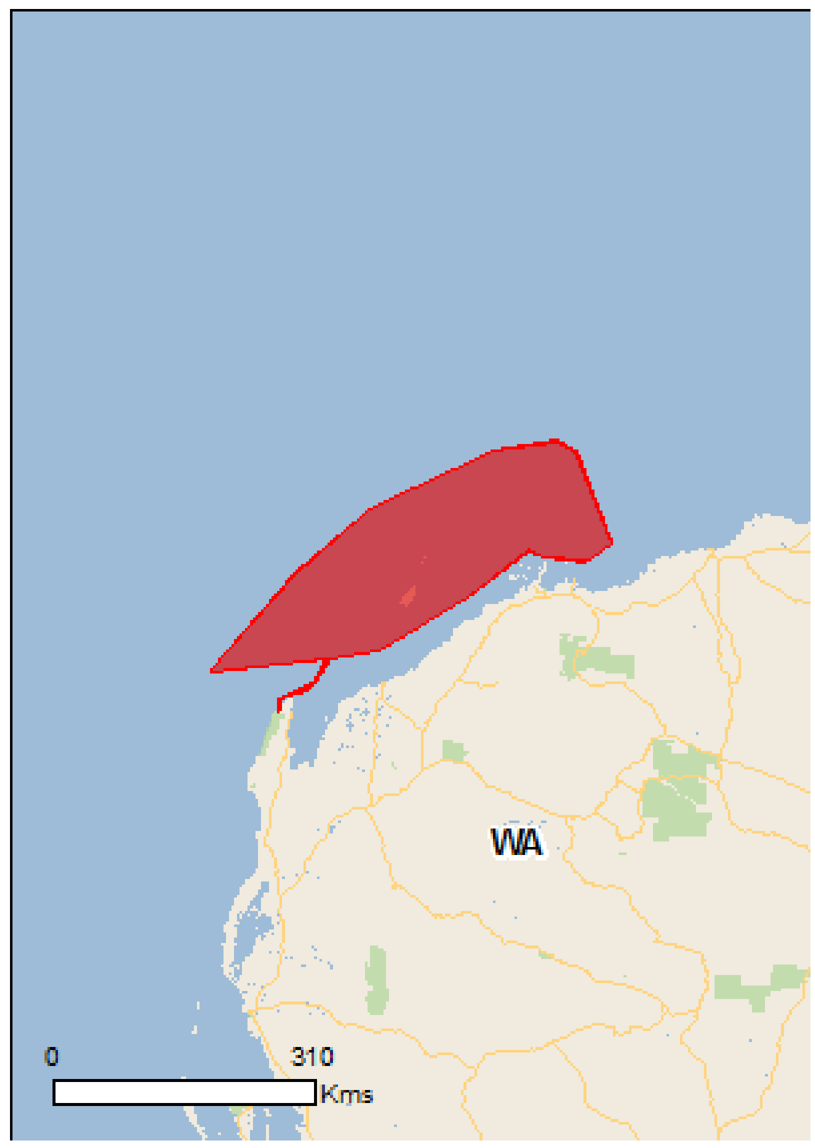
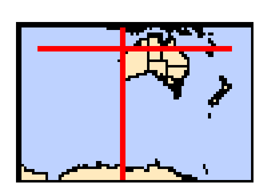


This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 1.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	2
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	40
Listed Migratory Species:	52

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	1
Listed Marine Species:	96
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	6

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	9
Regional Forest Agreements:	None
Invasive Species:	11
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	5

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
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
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may 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
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		
Balaenoptera borealis Sei Whale [34]	Vulnerable	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	Species or species habitat 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
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	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	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation 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

Name	Status	Type of Presence
Petrogale lateralis lateralis		
Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	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
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus zastictus		
Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Liasis olivaceus barroni		
Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat may occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat 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
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
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
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	Species or species habitat 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	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
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence
		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
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	Congregation or aggregation known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding 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	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		

Name	Threatened	Type of Presence
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Thalasseus bergii Crested Tern [83000]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
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

Name	Threatened	Type of Presence
		habitat may occur within area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area
[Numenius madagascariensis](#) Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
[Pandion haliaetus](#) Osprey [952]		Breeding known to occur within area
[Pterodroma mollis](#) Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
[Puffinus carneipes](#) Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat may occur within area
[Puffinus pacificus](#) Wedge-tailed Shearwater [1027]		Breeding known to occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat likely 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
[Thinornis rubricollis](#) Hooded Plover [59510]		Species or species habitat known to occur within area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
[Acentronura larsonae](#) Helen's Pygmy Pipehorse [66186]		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

Name	Threatened	Type of Presence
		area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
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 grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within 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

Name	Threatened	Type of Presence
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat 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
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 czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	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		

Name	Status	Type of Presence
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	Species or species habitat 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	Species or species habitat 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	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
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Congregation or aggregation known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Dampier	Habitat Protection Zone (IUCN IV)
Dampier	Multiple Use Zone (IUCN VI)
Dampier	National Park Zone (IUCN II)
Gascoyne	Multiple Use Zone (IUCN VI)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	Recreational Use Zone (IUCN IV)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Barrow Island	WA
Boodie, Double Middle Islands	WA
Jurabi Coastal Park	WA
Lowendal Islands	WA
Montebello Islands	WA
Muiron Islands	WA
Unnamed WA36915	WA
Unnamed WA40828	WA
Unnamed WA41080	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
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 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 rattus		
Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Glomar Shoals	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

-19.227573603 116.992151279,-19.3267474164 116.293310279,-19.8883002137 115.022678102,-19.969996129 114.902363419,-20.5688260614 114.156554296,-21.5112106809 113.284304967,-21.5339116114 113.283726903,-21.3932556595 114.522291776,-21.6225108813 114.382008226,-21.683389569 114.299684247,-21.8017017121 114.010708142,-21.8980533053 113.985142904,-21.9139849054 113.984826392,-21.9138761789 113.991797976,-21.9051908488 114.001353952,-21.8067406497 114.020330153,-21.71167 114.30604,-21.63292 114.39202,-21.3957058525 114.548371426,-21.3207867395 115.080985176,-20.78292676 116.018276377,-20.319222422 116.670467241,-20.3820024658 116.835769479,-20.4214892147 117.277525988,-20.4123151005 117.320357978,-20.2452193646 117.544906768,-19.3262974401 117.162758633,-19.227573603 116.992151279

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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GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix C - Stakeholder Consultation

Santos

STAKEHOLDER CONSULTATION

Consultation Correspondence

Sample cover email sent to stakeholders

Consultation, [redacted]

From: Consultation, [redacted]
Sent: Monday, 13 January 2020 1:48 PM
To: [redacted]
Subject: Santos Consultation | WA-499-P Exploration Drilling and Site Survey Program
Attachments: Santos Consultation - WA-499-P Exploration Drilling and Site Survey Program.pdf

Hello [redacted]

On behalf of Santos, please find attached consultation material relating to Santos' proposed WA-499-P Exploration Drilling and Site Survey Program.

Santos proposes to drill an exploration well in petroleum exploration permit WA-499-P, located in Commonwealth waters approximately 102 kilometres offshore from Dampier in Western Australia. As part of the preparatory work required to safely undertake the drilling, a site survey is also required.

The site survey activity is planned to commence in a window between Q2 2020 to Q2 2021 with an anticipated duration of up to 10 days after commencement. The drilling activity is planned to commence in a window between Q4 2020 to Q3 2021 with an anticipated duration of up to 60 days after commencement.

Santos is preparing separate Environment Plans (EPs) for the site survey and the exploration well in accordance with the following Commonwealth and Western Australian (WA) State environmental regulations:

+ Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R) for acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).
+ WA State Petroleum (Submerged Lands) (Environment) Regulations 2012 (P(SL)(E)R) for acceptance by the Department of Mines, Industry Regulation and Safety (DMIRS).

Should you require additional information or have a comment to make about the proposed activity, please be in touch via the contact details below.

Kind regards

Santos

[redacted]
Santos Limited, Level 7 100 St Georges Tce, Perth WA 6000
t: +61 8 6218 [redacted] m: +61 [redacted]

https://www.santos.com/

Sample cover email sent to commercial fishers

[redacted]

From: [redacted]
Sent: Monday, 13 January 2020 4:39 PM
To: [redacted]
Cc: [redacted]
Subject: ![EXT]: 2020 Jan 13 - Santos Exploration Drilling and Site Survey Environment Plan - Commercial fishing specific information - [redacted]
Attachments: Santos Consultation Commercial Fishers - WA-499-P Exploration Drilling & Site Survey Program January 2020.pdf; FISa5555_Yoorn-1 _PilbaraTrap_fishery.pdf

Good afternoon [redacted]

Santos is preparing two Environment Plans (EP) in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth) for a site survey and drilling of one exploration well offshore from Dampier.

WAFIC is sending this information to commercial fishers on a fee-for-service basis on behalf of Santos to ensure all licence holders receive this in a timely manner via an accurate list. All feedback / input etc is to go directly to [redacted] at Santos (see below).

On behalf of Santos, please find attached consultation material with more information outlining this proposed site survey and well exploration drilling in relation to Pilbara Trap (see also the overlay map attached), the last page is a great map so you can get a clear visual where this activity is proposed to take place.

Site Survey:

Location: Approximately 7km west of the Montebello Islands, approx. 93km from Dampier.
Latitudes and longitudes in the attached fact sheet.

Water Depth: Range of approximately 40 metres to 50 metres.

Schedule: Targeting a commencement window between Q2 2020 and Q2 2021.

Survey Duration: Up to 10 days (allowing for potential downtime such as weather), operating 24 hours per day.

Exclusion Zone: A 500 metre exclusion zone around the survey vessel (not seismic, no streamers) at all times.

Vessels: One survey vessel (no support vessels).

Exploration Well Drilling - "Yoorn":

Location: In permit WA-499-P, approximately 21km west of the Montebello Islands, approx. 102km from Dampier.
Latitude 20° 20' 32" S and Longitude 115° 47' 14" E.

Water Depth: Range of approximately 40 metres to 50 metres.

Schedule: Targeting a commencement window between Q4 2020 to Q3 2021

Drilling Duration: Mobile offshore drilling unit (MODU) to be on location for up to 60 days, dependant on operational down time and any weather etc delays.

Exclusion Zone: A 500 metre exclusion zone around the MODU at all times.
This is a temporary exclusion zone and will cease on MODU departure.

Support Vessels: One or two support vessels.

If you have any issues or concerned with these activities any other issues relevant to this location and this proposed activity then please respond directly to Santos:

[redacted]

Santos has noted that you please be aware that your feedback will be communicated via the EP to NOPSEMA, as is required under legislation.

Look forward to your feedback.

[redacted]

WAFIC FISHING PEARLING AQUACULTURE

[redacted]

L1, 56 Marine Tce. Fremantle WA 6160
PO Box 1605. Fremantle WA 6959

[redacted]

wafic.org.au
wamsc.com.au

WESTERN AUSTRALIAN FISHING INDUSTRY COUNCIL INC

STAKEHOLDER CONSULTATION

Consultation Pack

STAKEHOLDER CONSULTATION

Santos

WA-499-P

Exploration Drilling and Site Survey Program

Santos proposes to drill an exploration well in petroleum exploration permit WA-499-P, located in Commonwealth waters approximately 102 kilometres offshore from Dampier in Western Australia. As part of the preparatory work required to safely undertake the drilling, a site survey is also required to assess the shallow seabed soils suitability to provide a safe foundation for a Jack Up Mobile Offshore Drilling Unit (MODU).

The proposed exploration well is targeting the Yoorn hydrocarbon prospect. A notional Yoorn-1 exploration well location and the proposed site survey operational area is shown in **Figure 1**.

Before Santos can undertake the site survey and then drill the exploration well, the company must prepare, and have accepted, separate Environment Plans (EPs) for the site survey and the exploration well. Before Santos can submit the two EPs for assessment, it must have consulted with relevant stakeholders.

The EPs will be developed and implemented in accordance with the following Commonwealth and Western Australian (WA) State environmental regulations:

+ Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R) for acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).
+ WA State Petroleum (Submerged Lands) (Environment) Regulations 2012 (P(SL)(E)R) for acceptance by the Department of Mines, Industry Regulation and Safety (DMIRS).

Effective 25 April 2019, exploration drilling environment plans submitted to NOPSEMA must be published on their website for a 30-day public comment period. Santos anticipates that its exploration well EP will be available for public comment in February/March 2020. Additional information on the public comment period can be found at https://info.nopsema.gov.au/home/open_for_comment. The site survey EP will not be open for public comment.

While this process provides for increased transparency and an opportunity for the public to provide input to the environmental management of the proposed exploration drilling activity, all stakeholders are encouraged to review the consultation material contained in this document and to respond to Santos prior to the public comment period.

Activity Description

Site Survey

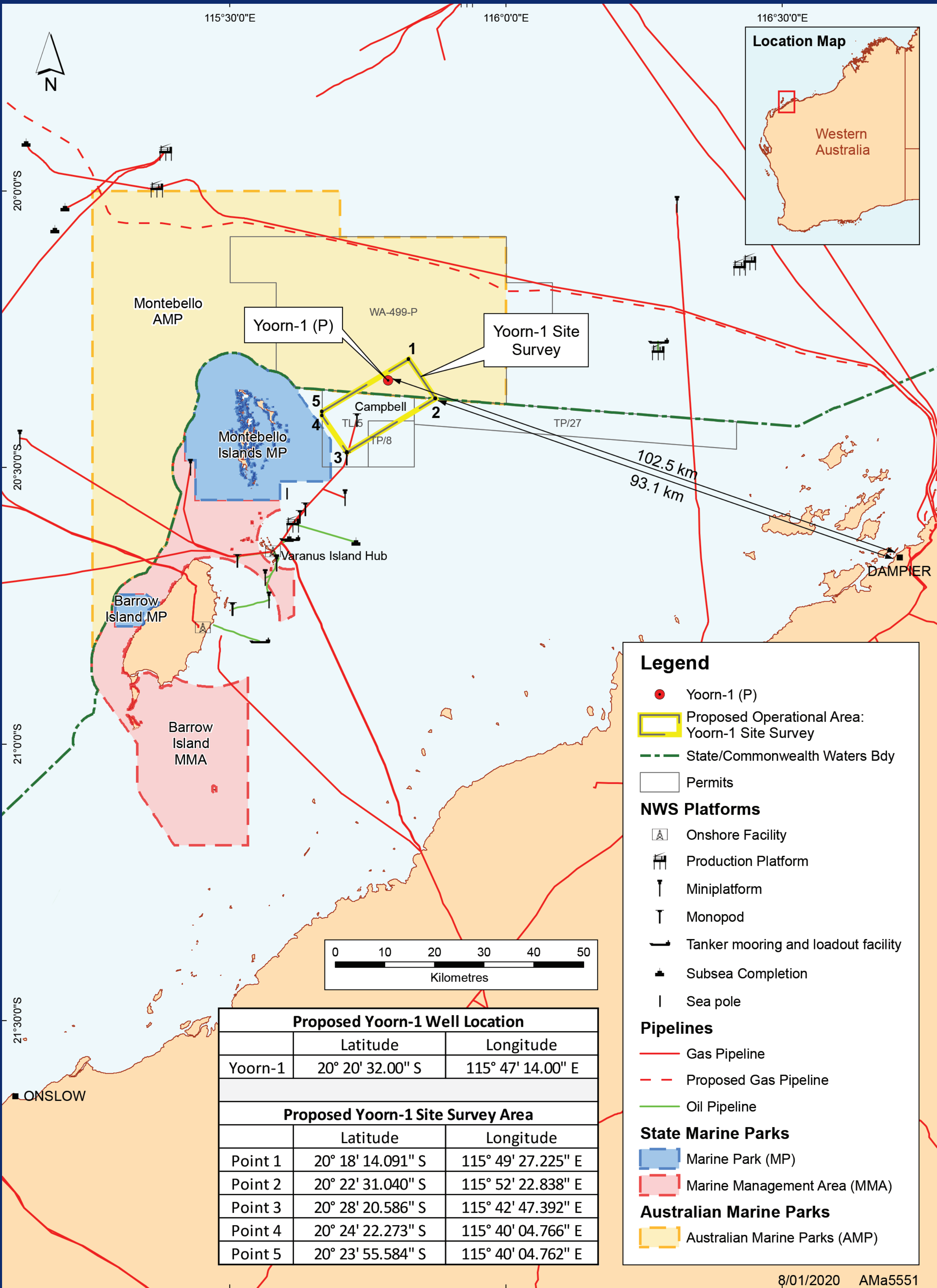
The vessel-based activity will be undertaken using geophysical survey techniques and will include surveying a 1-km x 1-km grid at the proposed exploration well location, plus potential survey tie-in lines extending from the proposed well location to other sites with known geological information.

The survey will involve the following:

+ Acquisition of multi-beam echo sounding (MBES) and side-scan sonar (SSS) data to define the bathymetry / seafloor morphology (e.g. depth, bedform character) and confirm the absence of debris or other anomalous seabed features.
+ Identification of any hazards that may impact the location of a MODU through sub-bottom profiling (SBP), including shallow gas, lateral variability in layer properties, adverse near-seabed stratigraphy, anomalous layers of hard/soft formations, localised/regional outcrops or sub-crops, mobile bedforms, and impediments to providing adequate foundations for supporting the rig when it is elevated above the water.
+ Grab sampling or drop cores for ground-truthing the surficial geophysics and to support MODU spud-can penetration assessments.

Data acquired from the site survey will subsequently be processed to generate site survey reports for use in drilling the well. This data is required up to six months prior to drilling to inform planning for drilling the well.

Figure 1: Proposed WA-499-P Exploration Drilling Program Location Map



Proposed Yoorn-1 Well Location

	Latitude	Longitude
Yoorn-1	20° 20' 32.00" S	115° 47' 14.00" E

Proposed Yoorn-1 Site Survey Area

	Latitude	Longitude
Point 1	20° 18' 14.091" S	115° 49' 27.225" E
Point 2	20° 22' 31.040" S	115° 52' 22.838" E
Point 3	20° 28' 20.586" S	115° 42' 47.392" E
Point 4	20° 24' 22.273" S	115° 40' 04.766" E
Point 5	20° 23' 55.584" S	115° 40' 04.762" E

SITE SURVEY ACTIVITY DETAILS			
Permit number	WA-499-P, TL/5, TP/27 and TP/8		
Water depth	Approx. 40 m to 50 m		
Exclusion zone	500 m around the survey vessel at all times		
Operational area		**Latitude (GDA 94)**	**Longitude (GDA 94)**
	Point 1	20° 18' 14.091" S	115° 49' 27.225" E
	Point 2	20° 22' 31.040" S	115° 52' 22.838" E
	Point 3	20° 28' 20.586" S	115° 42' 47.392" E
	Point 4	20° 24' 22.273" S	115° 40' 04.766" E
	Point 5	20° 23' 55.584" S	115° 40' 04.762" E
Equipment	A single survey vessel will be utilised to undertake the activity. Approx. 60 m long, multi-purpose support vessel.		
Description of natural environment	The activity overlaps the Northwest Shelf Provincial Bioregion (based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0).		
Timing and duration	The activity is planned to take place in a window between Q2 2020 and Q2 2021. Allowing for potential down time, for example due to weather, the activity may extend to up to 10 days. Activities will be undertaken 24 hours per day.		
Nearest proximity to key regional features	**Regional Feature**		**Yoorn-1**
	Barrow Island		34.3 km SW
	Varanus Island		24.1 km SW
	Closest Montebello Island		6.9 km W
	Dampier		93.1 km SE
	Onslow		143.3 km SW
	Closest mainland point		61.3 km SE (Cape Preston)
	Montebello Marine Park (Australian Marine Park)		0 km (intersects)
	Montebello Islands Marine Park (State)		1.3 km
	Barrow Island Marine Management Area (State)		15.8 km
	Barrow Island Marine Park (State)		46.5 km
Worst case hydrocarbon spill scenario	250m^3 marine diesel from a vessel collision.		
Response tier required	In the event of a diesel spill, a Tier 3 response would be implemented as defined in the activity-specific Oil Pollution Emergency Plan.		

Santos has conducted the following assessment of potential environmental risks and impacts from the drilling activity.

POTENTIAL RISKS AND/OR IMPACTS	MANAGEMENT MEASURE
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, which includes the following controls: - Vessel will not travel at greater than 6 knots within 300 m of a whale. - Vessel will not approach within 100 m of a whale.
Light emissions	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. Objects dropped overboard are recovered (where possible) to mitigate the environmental consequences from objects remaining in the marine environment.
Interaction with other marine users	Relevant stakeholders will be notified prior to the commencement and on cessation of the survey. Relevant maritime notices issued. A visual and radar watch will be maintained on the vessel bridge at all times. Santos will not restrict commercial fishing access to the operational area and is committed to concurrent operations. Survey vessel will avoid commercial vessels that are actively fishing and avoid schooling fish in the vicinity of active commercial fishing. Survey vessel will be prohibited from recreational fishing within the operational area.
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 Santos WA OPEP requirements are implemented to mitigate environmental impacts.

Exploration Drilling

Santos proposes to drill an exploration well at the Yoorn location, approximately 102 km offshore from Dampier in Western Australia. This activity is expected to commence in a window between Q4 2020 to Q3 2021 using a MODU.

EXPLORATION DRILLING ACTIVITY DETAILS		
Permit number	WA-499-P	
Water depth	Approx. 40 m to 50 m	
Exclusion zone	500 m around MODU at all times	
Indicative Yoorn-1 well location	Latitude 20° 20' 32" S	Longitude 115° 47' 14" E
Equipment	MODU with support vessels and helicopters	
Description of natural environment	The activity overlaps the Northwest Shelf Provincial Bioregion (based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0).	
Timing and duration	The activity is planned to commence in a window between Q4 2020 to Q3 2021. Following commencement, Santos expects the MODU to be on location for up to 60 days, dependant on operational down time and weather delays.	
Nearest proximity to key regional features	Regional Feature	Yoorn-1
	Barrow Island	50.2 km SW
	Varanus Island (Santos operated)	40.4 km SW
	Closest Montebello Island	21.4 km WSW
	Dampier	102.5 km SE
	Onslow	159.7 km SW
	Closest Mainland Point	69.4 km SE (Cape Preston)
	Montebello Marine Park (Australian Marine Park)	0 km (intersects)
	Montebello Islands Marine Park (State)	15.6 km
	Barrow Island Marine Management Area (State)	31.4 km
	Barrow Island Marine Park (State)	62.0 km
Hydrocarbon type	Gas condensate	
Worst case hydrocarbon spill scenario	311,456 m^3 condensate loss of well control	
Oil spill response level required	In the event of a hydrocarbon spill, a Level 1, 2 or 3 response would be implemented as defined in the activity-specific Oil Pollution Emergency Plan.	

Santos has conducted the following assessment of potential environmental risks and impacts from the drilling activity.

POTENTIAL RISKS AND/OR IMPACTS	MANAGEMENT MEASURE
Hydrocarbon release	NOPSEMA-accepted MODU safety case and Santos Well Operations Management Plan (WOMP) in place. Prior to exploration drilling there will be a relief well plan in place. Appropriate refuelling procedures and equipment will be used to prevent spills to the marine environment. Appropriate spill response plans (OPEP), equipment and materials will be in place and maintained.
Drilling discharge	Drilling and cement chemicals potentially discharged to sea are Gold/Silver/D or E rated through OCNS, or PLONOR substances listed by OSPAR, or have a completed Santos risk assessment so that only environmentally acceptable products are used. Only water-based drilling fluid systems will be used.
Marine fauna interactions	Implementation of EPBC Regulations (Part 8) for interacting with cetaceans to minimise the disturbance to fauna caused by marine vessels and helicopters.
Light emissions	MODU/vessels navigation lighting and equipment are compliant with SOLAS/AMSA Marine Orders.
Atmospheric emissions	MODU/vessels marine diesel (fuel oil) sulphur content is compliant with MARPOL/AMSA Marine Order.
Seabed disturbance	Site survey prior to MODU arrival to identify and avoid any environmentally sensitive seabed features. No vessel anchoring, unless in an emergency. Objects dropped overboard are recovered (where possible) to mitigate the environmental consequences from objects remaining in the marine environment.
Interaction with other marine users	Relevant stakeholders will be notified prior to commencement and on cessation of the activity. Relevant maritime notices issued. A 500 m radius exclusion zone will be in place around the MODU for the duration of the activity A visual and radar watch will be maintained on the support vessel bridge at all times. Recreational fishing will be prohibited during the activity.
Operational MODU and vessel discharges	Routine MODU and 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	MODU and vessels are managed to low risk in accordance with the Santos Invasive Marine Species Management Plan prior to movement/transit into or within the invasive marine species management zone, which requires: - assessment of applicable MODU/vessels using the DPIRD Vessel Check Tool; and - the management of immersible equipment to low risk.
Spill response operations	In the event of a hydrocarbon spill, the Santos WA OPEP requirements are implemented to mitigate environmental impacts.

Consultation

Relevant stakeholders have been provided information in this Stakeholder Consultation document to allow stakeholders to assess potential impacts and risks to their functions, interests or activities. If you wish to comment on these activities please respond or contact Santos by **Monday 10 February 2020**, to the following contact details:

[redacted]
Santos, PO Box 5624, Perth, 6831
Telephone: [redacted]
Email: [redacted]

COMMERCIAL FISHER CONSULTATION

Santos

WA-499-P

Exploration Drilling and Site Survey Program

Santos proposes to drill an exploration well in petroleum exploration permit WA-499-P, in Commonwealth waters approximately 102 kilometres offshore from Dampier and seven kilometres west of the Montebello Islands. As part of the preparatory work required to safely undertake the drilling, a site survey is also required.

The proposed exploration well named Yoorn-1 and the proposed site survey operational area are shown in **Figure 1**.

As a relevant and potentially affected party to these activities Santos seeks your feedback. Please advise if you have any issues or concerns or if you require any additional information about each project. Santos will address these issues prior to the final environment plan (EP) being published.

Like all exploration drilling EPs, the final version will be published on the NOPSEMA website for a 30-day public comment period. Santos anticipates that its exploration well EP will be available for public comment in February/March 2020. Additional information on the public comment period can be found at https://info.nopsema.gov.au/home/open_for_comment. Please inform Santos if you would like to be advised when the final draft EP has gone live on the NOPSEMA site. The site survey EP will not be open for public comment.

EP publication provides for increased transparency and an opportunity for the broader public to comment, however, Santos especially seeks direct feedback and input from the commercial fishing sector as relevant and potentially affected parties to these proposed activities prior to the public comment period. This will assist in Santos delivering better environment plans relevant to your activities and your resource.

Site Survey

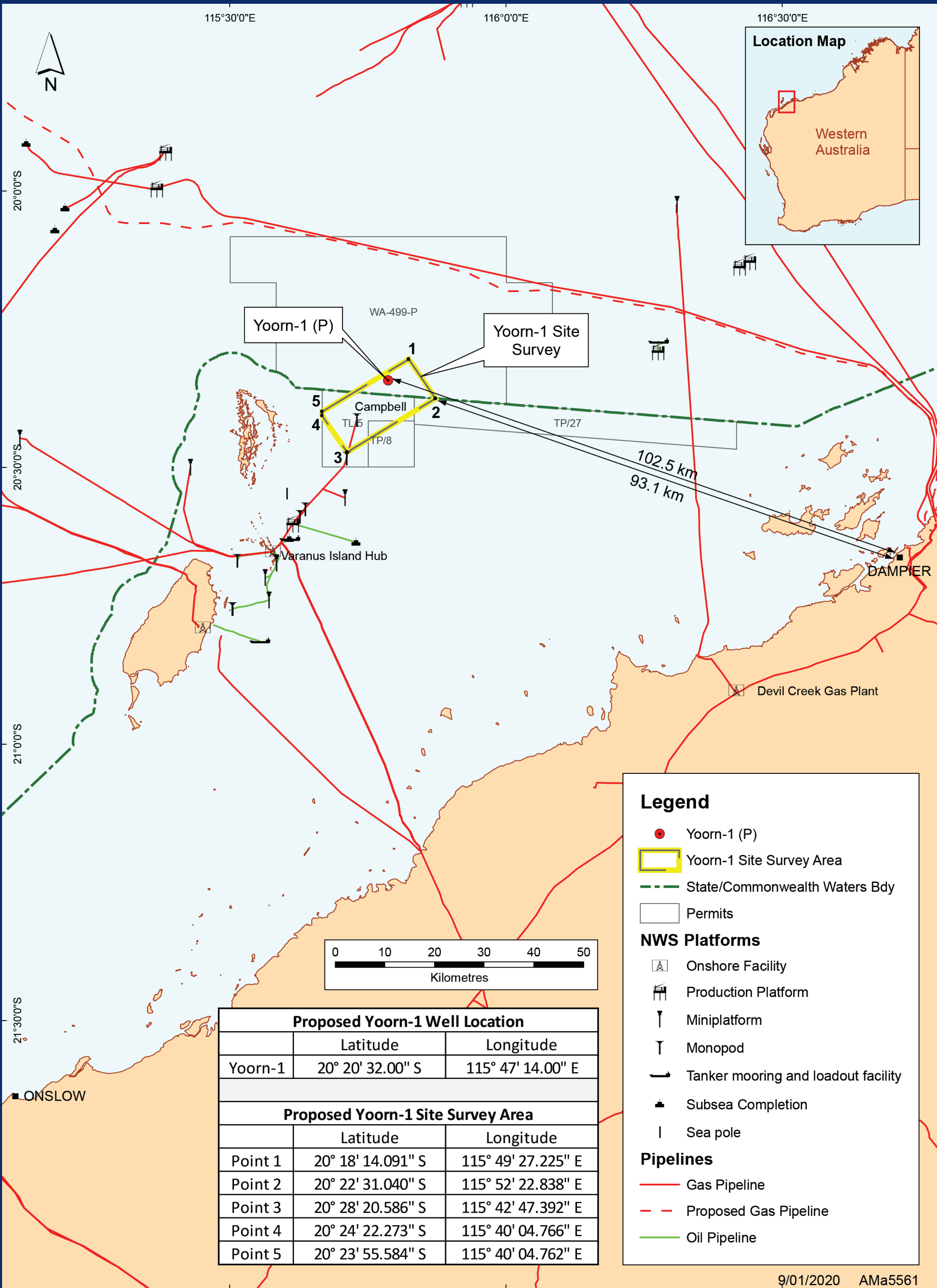
The vessel-based activity will be undertaken using geophysical survey techniques and will include surveying a 1 km x 1 km grid at the proposed exploration well location, plus potential survey tie-in lines extending from the proposed well location to other sites with known geological information.

The survey will involve the following:

+ Acquisition of multi-beam echo sounding (MBES) and side-scan sonar (SSS) data to define the bathymetry / seafloor morphology (e.g. depth, bedform character) and confirm the absence of debris or other anomalous seabed features.
+ Identification of any hazards that may impact the location of a mobile offshore drilling unit (MODU) through sub-bottom profiling (SBP), including shallow gas, lateral variability in layer properties, adverse near-seabed stratigraphy, anomalous layers of hard/soft formations, localised/regional outcrops or sub-crops, and mobile bedforms.
+ Grab sampling or drop cores for ground-truthing the surficial geophysics and to support MODU spud-can penetration assessments.

Data acquired from the site survey will subsequently be processed to generate site survey reports for use in drilling the well. This data is required up to six months prior to drilling to inform planning for drilling the well.

Figure 1: Proposed WA-499-P Exploration Drilling Program Location Map



Proposed Yoorn-1 Well Location

	Latitude	Longitude
Yoorn-1	20° 20' 32.00" S	115° 47' 14.00" E

Proposed Yoorn-1 Site Survey Area

	Latitude	Longitude
Point 1	20° 18' 14.091" S	115° 49' 27.225" E
Point 2	20° 22' 31.040" S	115° 52' 22.838" E
Point 3	20° 28' 20.586" S	115° 42' 47.392" E
Point 4	20° 24' 22.273" S	115° 40' 04.766" E
Point 5	20° 23' 55.584" S	115° 40' 04.762" E

SITE SURVEY DETAILS			
Permit number	WA-499-P, TL/5, TP/27 and TP/8		
Survey duration	Up to 10 days (allowing for potential downtime such as weather) operating 24 hours per day		
Survey Timing	Between Q2 2020 and Q2 2021		
Location	Approx. 7km west of the Montebello Islands, approx. 93km from Dampier		
Water depth	Approx. 40 m to 50 m		
Exclusion zone	500 m around the survey vessel at all times		
Operational area		Latitude (GDA 94)	Longitude (GDA 94)
	Point 1	20º 18' 14.091" S	115º 49' 27.225" E
	Point 2	20º 22' 31.040" S	115º 52' 22.838" E
	Point 3	20º 28' 20.586" S	115º 42' 47.392" E
	Point 4	20º 24' 22.273" S	115º 40' 04.766" E
	Point 5	20º 23' 55.584" S	115º 40' 04.762" E
Vessels	A single survey vessel approx. 60 m long.		
Description of natural environment	The activity overlaps the Northwest Shelf Provincial Bioregion (based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0).		
Nearest proximity to key regional features	Regional Feature		Yoorn-1
	Barrow Island		34.3 km SW
	Varanus Island		24.1 km SW
	Closest Montebello Island		6.9 km W
	Dampier		93.1 km SE
	Onslow		143.3 km SW
	Closest mainland point		61.3 km SE (Cape Preston)
	Montebello Marine Park (Australian Marine Park)		0 km (intersects)
	Montebello Islands Marine Park (State)		1.3 km
	Barrow Island Marine Management Area (State)		15.8 km
	Barrow Island Marine Park (State)		46.5 km
Worst case hydrocarbon spill scenario	250 m^3 marine diesel from a vessel collision.		
Response tier required	In the event of a diesel spill, a Tier 3 response would be implemented as defined in the activity-specific Oil Pollution Emergency Plan.		

Site Survey Potential Environmental Risks and Impacts

COMMERCIAL FISHING SPECIFIC POTENTIAL RISKS AND/OR IMPACTS	MANAGEMENT MEASURES
	• Relevant stakeholders will be notified prior to the commencement and on cessation of the survey. • Relevant maritime notices issued. • A visual and radar watch will be maintained on the vessel bridge at all times. • Santos will not restrict commercial fishing access to the operational area and is committed to concurrent operations. • Survey vessel will avoid commercial vessels that are actively fishing and avoid schooling fish in the vicinity of active commercial fishing. • Survey vessel personnel will be prohibited from recreational fishing activities.
OTHER POTENTIAL RISKS AND/OR IMPACTS	**MANAGEMENT MEASURES**
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, which includes the following controls: - Vessel will not travel at greater than 6 knots within 300 m of a whale. - Vessel will not approach within 100 m of a whale.
Light emissions	• 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. • 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 Santos WA OPEP requirements are implemented to mitigate environmental impacts.

Exploration Well Drilling

EXPLORATION WELL DRILLING ACTIVITY DETAILS			
Permit number	Yoorn location in WA-499-P		
Indicative Yoorn-1 well location	Latitude 20° 20' 32" S	Longitude 115° 47' 14" E	Approx. 21 km west of the Montebello Islands, approx. 102 km from Dampier
Water depth	Approx. 40 m to 50 m		
Exclusion zone	500 m around MODU at all times		
Equipment	MODU with at least two support vessels and helicopters		
Description of natural environment	The activity overlaps the Northwest Shelf Provincial Bioregion (based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0)		
Timing	Targeting a commencement window between Q4 2020 to Q3 2021		
Duration	MODU to be on location for up to 60 days, dependant on operational down time and weather delays		
Nearest proximity to key regional features	**Regional Feature**		**Yoorn-1**
	Barrow Island		50.2 km SW
	Varanus Island (Santos operated)		40.4 km SW
	Closest Montebello Island		21.4 km WSW
	Dampier		102.5 km SE
	Onslow		159.7 km SW
	Closest Mainland Point		69.4 km SE (Cape Preston)
	Montebello Marine Park (Australian Marine Park)		0 km (intersects)
	Montebello Islands Marine Park (State)		15.6 km
	Barrow Island Marine Management Area (State)		31.4 km
	Barrow Island Marine Park (State)		62.0 km
Hydrocarbon type	Gas condensate		
Worst case hydrocarbon spill scenario	311,456 m^3 condensate loss of well control		
Oil spill response level required	In the event of a hydrocarbon spill, a Level 1, 2 or 3 response would be implemented as defined in the activity-specific Oil Pollution Emergency Plan		

Exploration Well Drilling Potential Environmental Risks and Impacts

COMMERCIAL FISHING SPECIFIC POTENTIAL RISKS AND/OR IMPACTS	MANAGEMENT MEASURES
	• Relevant commercial fishing stakeholders will be notified prior to commencement and on cessation of the activity. • Relevant maritime notices issued. • A 500 m radius exclusion zone will be in place around the MODU for the duration of the activity. The temporary exclusion zone will cease on MODU departure. • A visual and radar watch will be maintained on the support vessel bridge at all times. • Support vessels transiting from the coast to the well location will avoid commercial vessels that are actively fishing and avoid schooling fish in the vicinity of active commercial fishing. • Site and support vessel personnel will be prohibited from any recreational fishing activities.

OTHER POTENTIAL RISKS AND/OR IMPACTS	MANAGEMENT MEASURES
Hydrocarbon release	• NOPSEMA-accepted MODU safety case and Santos Well Operations Management Plan (WOMP) in place. • Prior to exploration drilling there will be a relief well plan in place. • Appropriate refuelling procedures and equipment will be used to prevent spills to the marine environment. • Appropriate spill response plans (OPEP), equipment and materials will be in place and maintained.
Drilling discharge	• Drilling and cement chemicals potentially discharged to sea are Gold/Silver/D or E rated through OCNS, or PLONOR substances listed by OSPAR, or have a completed Santos risk assessment so that only environmentally acceptable products are used. • Only water-based drilling fluid systems will be used.
Marine fauna interactions	• Implementation of EPBC Regulations (Part 8) for interacting with cetaceans to minimise the disturbance to fauna caused by marine vessels and helicopters.
Light emissions	• MODU/vessels navigation lighting and equipment are compliant with SOLAS/AMSA Marine Orders.
Atmospheric emissions	• MODU/vessels marine diesel (fuel oil) sulphur content is compliant with MARPOL/AMSA Marine Order.
Seabed disturbance	• Site survey prior to MODU arrival to identify and avoid any environmentally sensitive seabed features. • No vessel anchoring, unless in an emergency. • Objects dropped overboard are recovered (where possible) to mitigate the environmental consequences from objects remaining in the marine environment.
Operational MODU and vessel discharges	• Routine MODU and 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	• MODU and vessels are managed to low risk in accordance with the Santos Invasive Marine Species Management Plan prior to movement/transit into or within the invasive marine species management zone, which requires: - assessment of applicable MODU/vessels using the DPIRD Vessel Check Tool; and - the management of immersible equipment to low risk.
Spill response operations	• In the event of a hydrocarbon spill, the Santos WA OPEP requirements are implemented to mitigate environmental impacts.

Consultation

Before Santos can undertake the site survey and then drill the exploration well, they must prepare, and have accepted, separate Environment Plans (EPs) for the site survey and the exploration well. Before Santos can submit the two EPs for assessment, it must have consulted with relevant stakeholders. The commercial fishing sector is a key relevant and potentially affected party to these activities.

The EPs will be developed and implemented in accordance with the following Commonwealth and Western Australian (WA) State environmental regulations:

+ Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R) for acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).
+ WA State Petroleum (Submerged Lands) (Environment) Regulations 2012 (P(SL)(E)R) for acceptance by the Department of Mines, Industry Regulation and Safety (DMIRS).

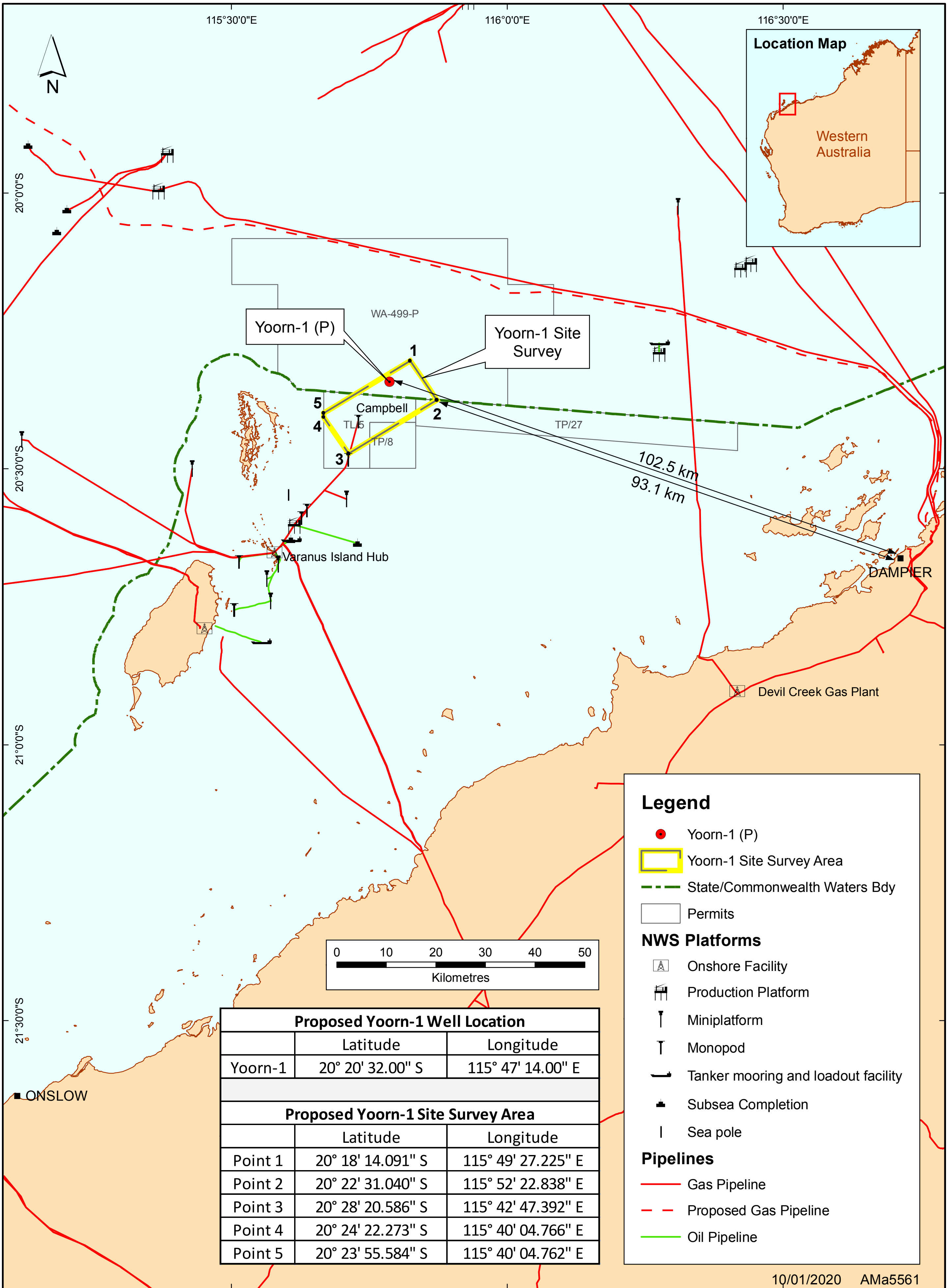
Relevant commercial fishing industry stakeholders have been provided information to assist in the assessment of potential impacts and risks to fishing functions, interests or activities. The feedback you provide will assist Santos in preparing a better EP.

If you wish to comment on the drilling and site survey activities or have any concern that these activities may impact your commercial fishing activities, the targeted resource and the broader marine environment then please respond by **Monday 10 February 2020**, to the contact details below.

[redacted]
Santos
PO Box 5624, Perth, 6831
Telephone: [redacted]
Email: [redacted]

STAKEHOLDER CONSULTATION

Consultation Maps



Proposed Yoorn-1 Well Location

	Latitude	Longitude
Yoorn-1	20° 20' 32.00" S	115° 47' 14.00" E

Proposed Yoorn-1 Site Survey Area

	Latitude	Longitude
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Point 5	20° 23' 55.584" S	115° 40' 04.762" E

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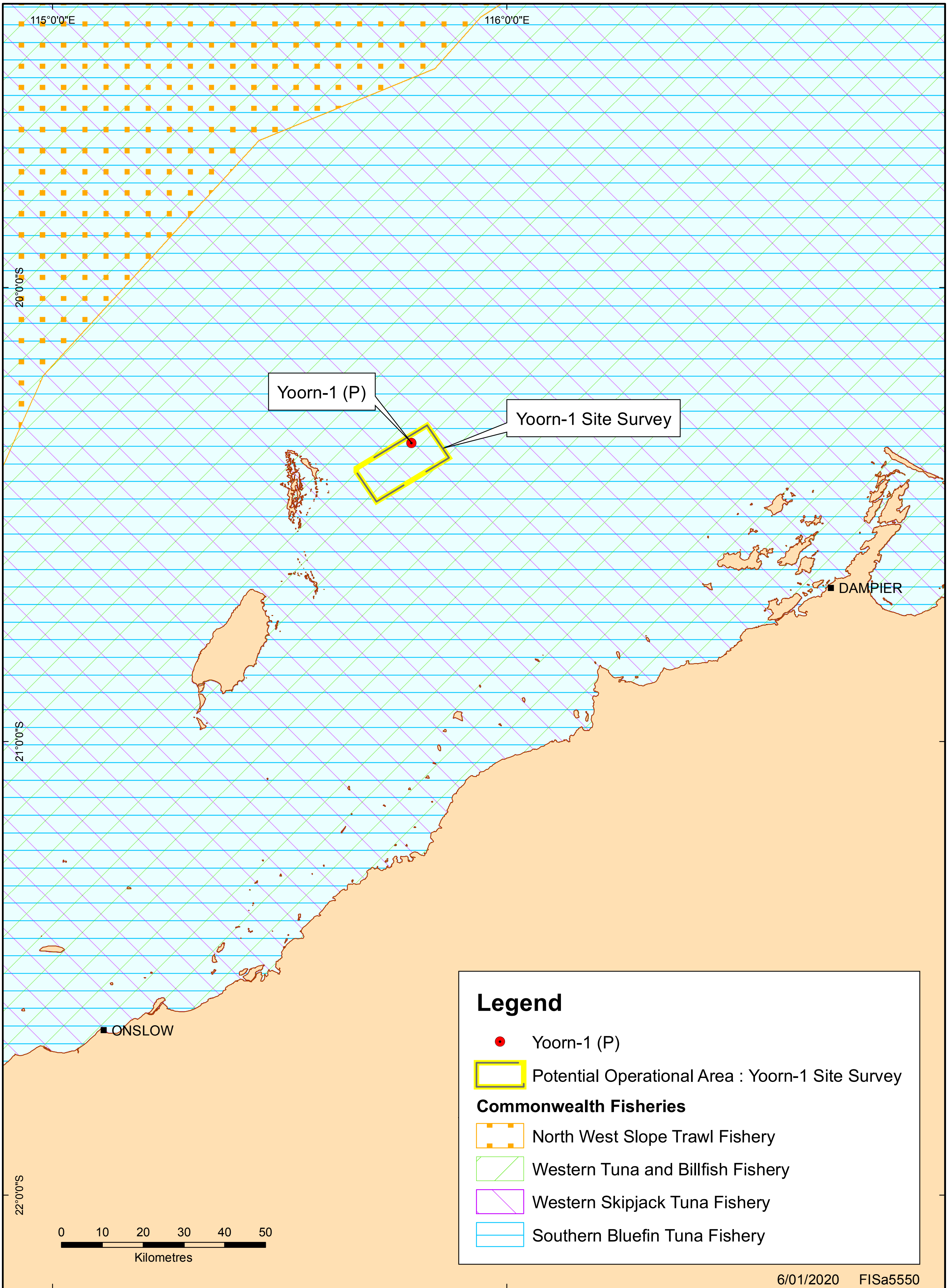
YOORN-1 DRILLING LOCATION + SITE SURVEY
LOCATION MAP



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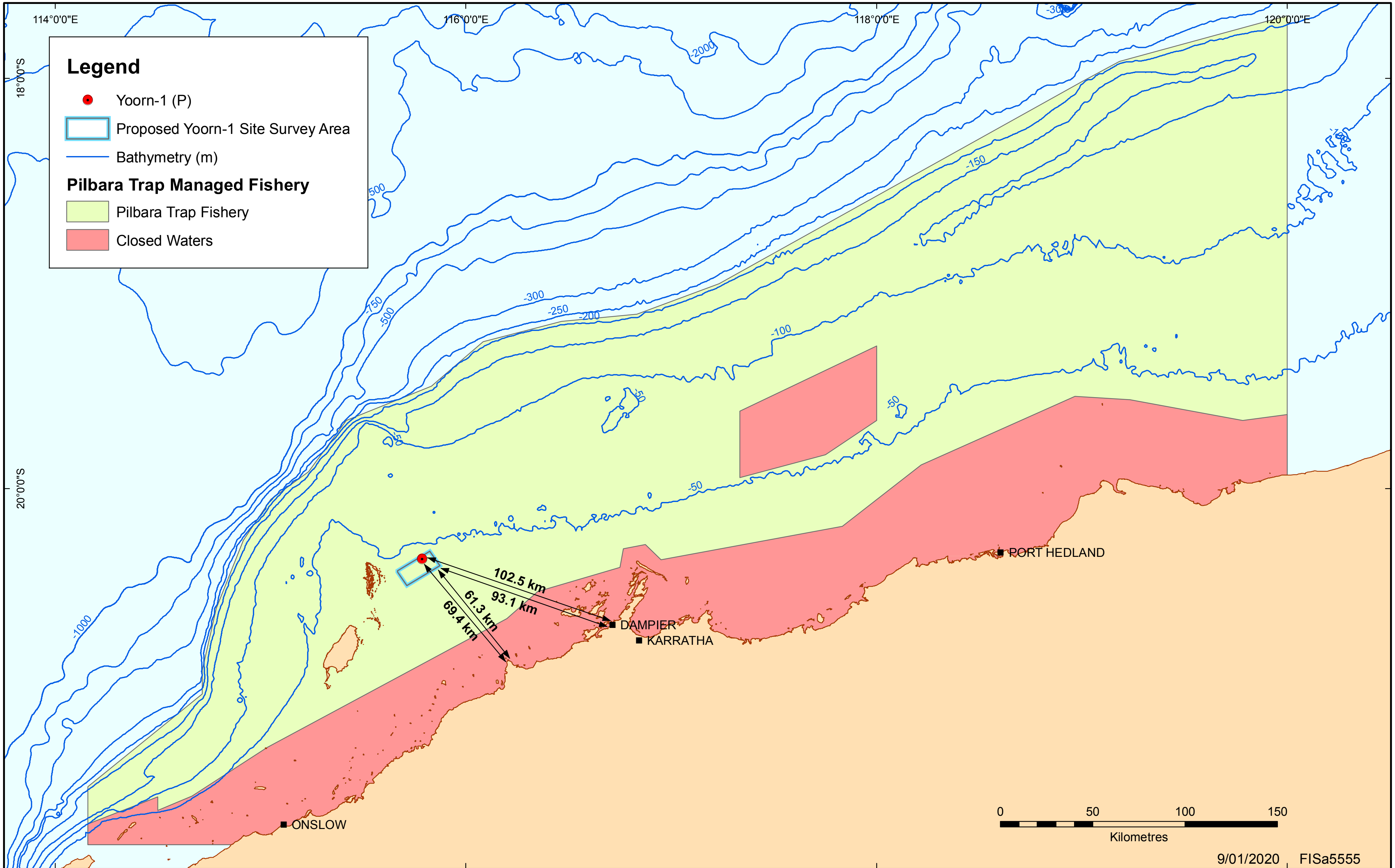
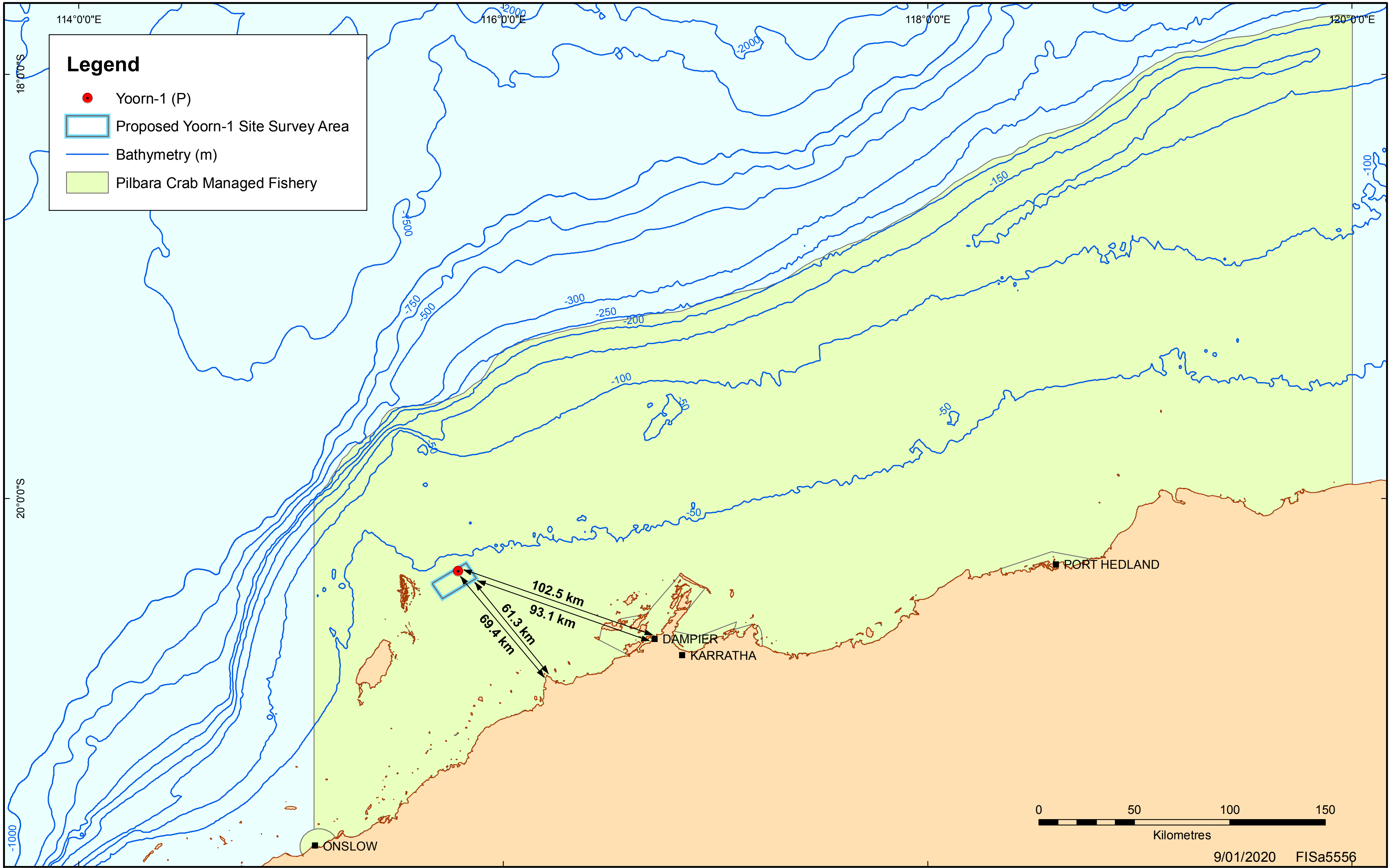
YOORN-1 DRILLING LOCATION + SITE SURVEY
COMMONWEALTH FISHERIES



Santos

YOORN-1 DRILLING LOCATION + SITE SURVEY

PILBARA TRAP MANAGED FISHERY



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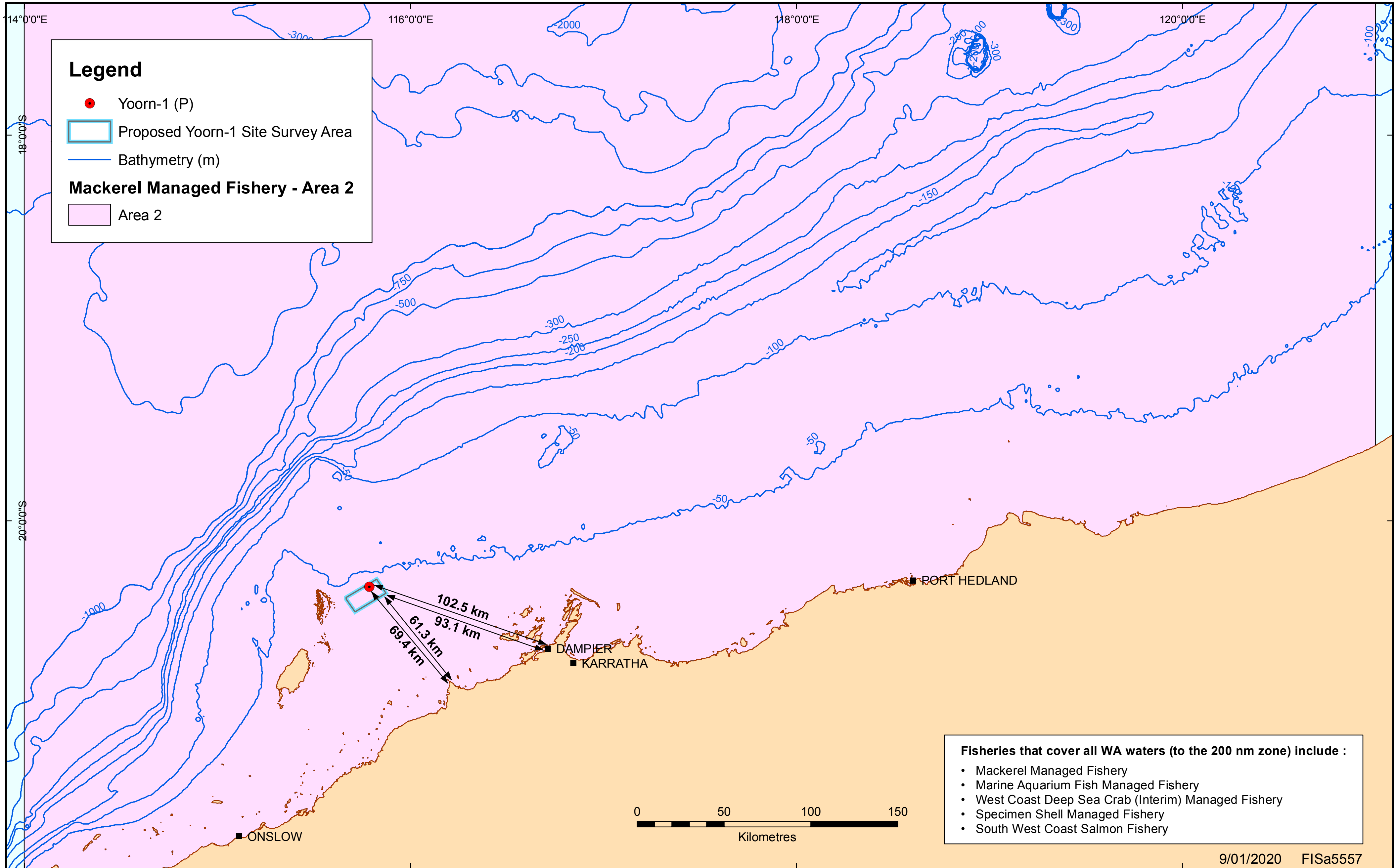
YOORN-1 DRILLING LOCATION + SITE SURVEY

PILBARA CRAB MANAGED FISHERY



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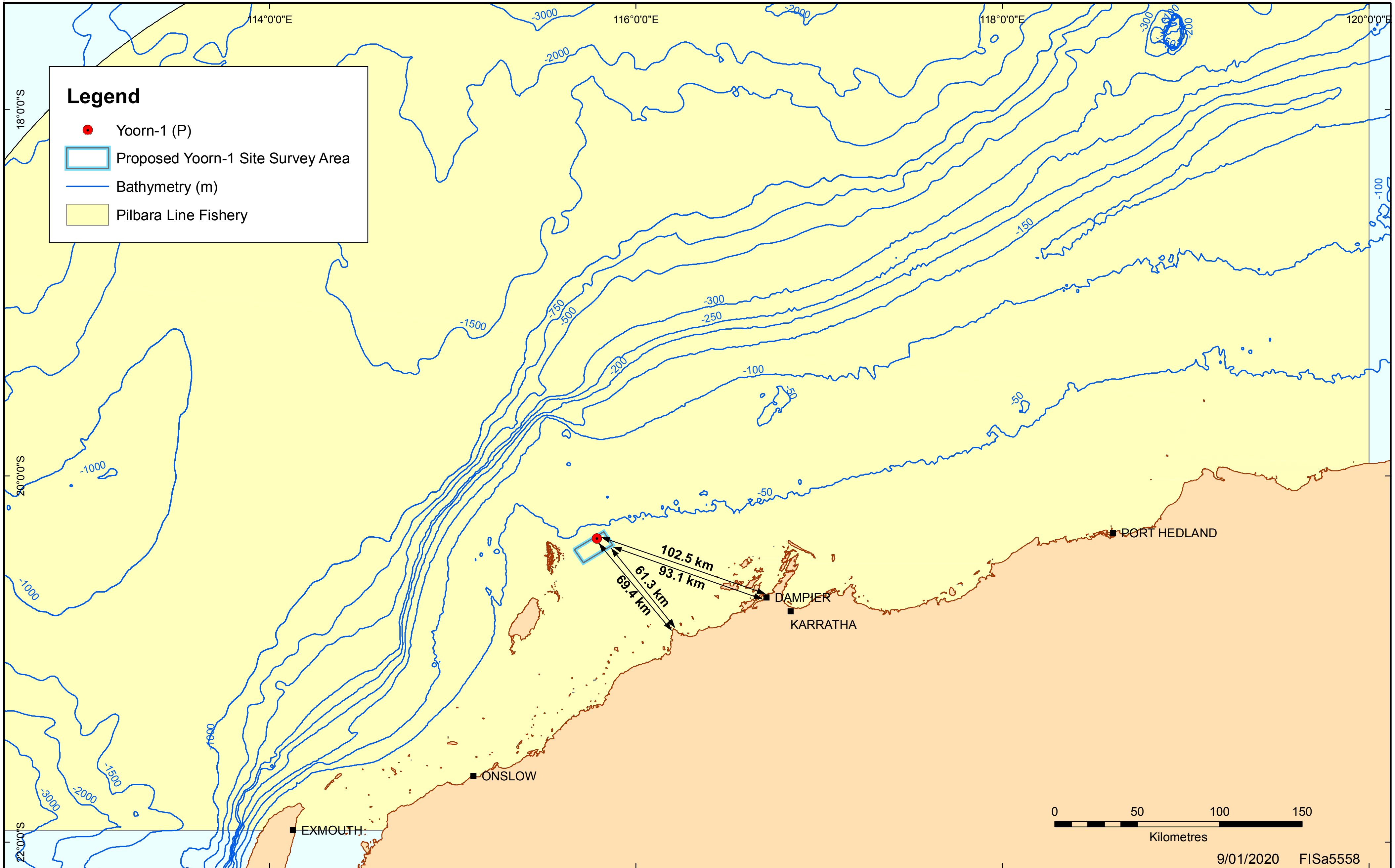
YOORN-1 DRILLING LOCATION + SITE SURVEY

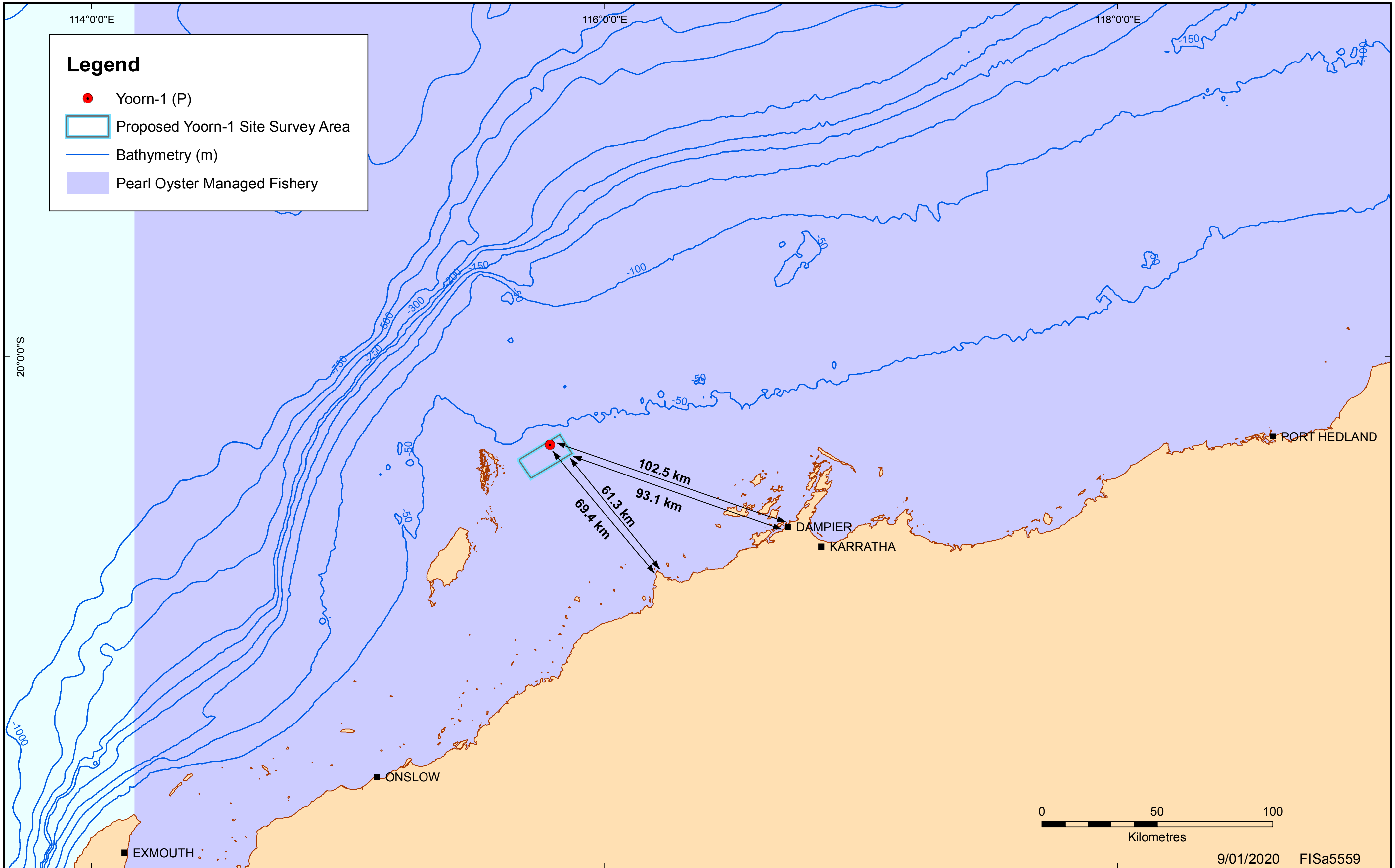
MACKEREL MANAGED FISHERY - AREA 2



Santos

YOORN-1 DRILLING LOCATION + SITE SURVEY

PILBARA LINE FISHERY



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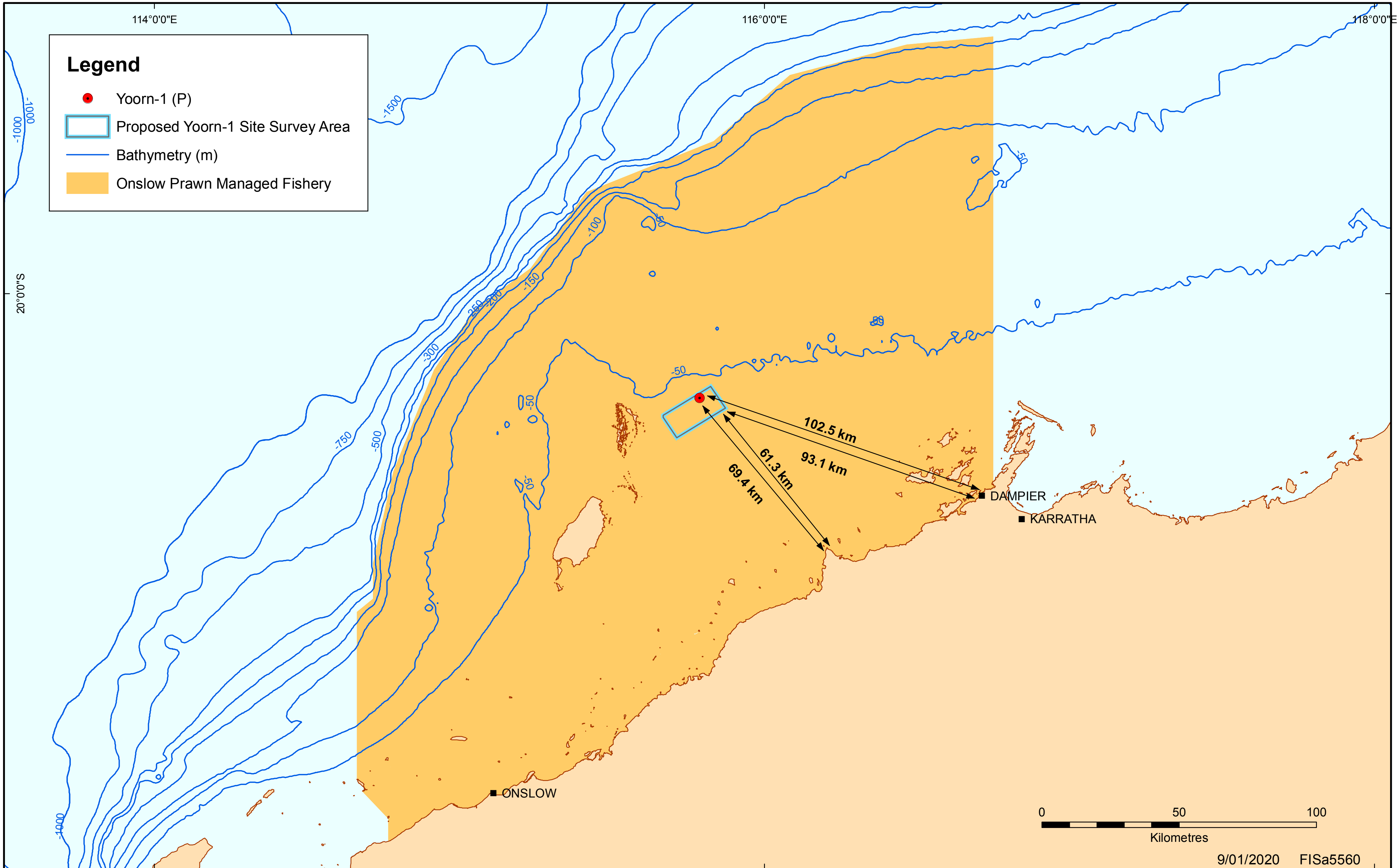
YOORN-1 DRILLING LOCATION + SITE SURVEY

PEARL OYSTER MANAGED FISHERY



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YOORN-1 DRILLING LOCATION + SITE SURVEY
ONSLOW PRAWN MANAGED FISHERY

STAKEHOLDER CONSULTATION

Quarterly

Consultation Updates

Consultation, [redacted]

From: Consultation, [redacted]
Sent: Thursday, 16 January 2020 10:14 AM
Subject: Santos Limited | Quarterly Consultation Update
Attachments: Santos Quarterly Consultation Update January 2020.pdf

Good morning,

Please find attached Santos' *Quarterly Consultation Update*, a document providing details of activities Santos plans to undertake from Q1 2020 to Q2 2020.

This document is intended to provide **advanced notification to allow stakeholders to identify activities that may impact them or for which more information is sought**. Information of interest to other marine users (such as commercial fishers), including water depth and exclusion zones, are provided within and a map is provided at the rear of the document.

If you have questions regarding any projects included in this document, please be in touch as soon as possible. If you would like to arrange to meet with Santos staff for a briefing session regarding the upcoming projects program, please do not hesitate to contact us and that meeting will be arranged.

I thank you for your time and continued support, your acknowledgment of receipt of this email is appreciated.

Thank you

Kind regards

Santos

[redacted]
Santos Limited, Level 7 100 St Georges Tce, Perth WA 6000
t: +61 8 6218 [redacted] m: +61 [redacted]
https://www.santos.com/

Quarterly Consultation Update

January 2020

This update outlines planned activities by Santos Limited (Santos) in Western Australia through Q1 2020 to Q2 2020. It is intended to provide advance notification to enable stakeholders to identify activities that may impact them, or for which more information is sought.

This document is provided in accordance with State and Commonwealth regulatory consultation guidelines, and can be supplemented with detailed project information packages or briefing sessions from Santos by request, using the contact details provided below.

Please note that scheduling of the activities described in this update is subject to vessel and equipment availability and receipt of all necessary approvals, therefore the timing indicated may be subject to change. If there are any significant changes made to the scheduling indicated, stakeholders will be advised.

A summary of Santos' current operating facilities is also provided.

The spatial locations of activities described throughout this document can be found in the tables within, and in figures at the end of, this update.

Potential impact to stakeholder interests

When reviewing Santos' activities within this document, please consider how they may impact your area of interest as an individual stakeholder.

Impacts to stakeholders may include exclusion zones for short and long term projects. For example, the gazetted exclusion zone around a drilling rig is 500 metres (m), while the exclusion zone around a slow-moving vessel, towing seismic streamers, can be larger.

This may impact access to an area by mariners during a proposed activity. Santos recommends stakeholders assess all information provided and seek additional information if required.

Operational activities relate to operations at the Varanus Island, Burrup Pipeline, Devil Creek and the *Ningaloo Vision* Floating Production Storage and Offloading (FPSO) facilities. These facilities have an existing exclusion zone which has been in place for an extended period of time.

Thank you for taking the time to review this update. Stakeholder feedback is valuable before, during and after activities, so if you have any concerns or queries relating to the activities described in this document, please feel free to contact us at the email below.

Contact Us
Santos
Ph: [redacted]
Email: [redacted]
Web: http://Santos.com/

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Proposed Western Australia offshore activities

This table gives key information on upcoming activities that are proposed to occur from Q1 2020

Activity Name	Type of Activity	Permit Number	Latitude	Longitude	Water Depth (approx.)	Start date estimate	End date estimate	Exclusion zone details
***Ningaloo Vision* FPSO** (Commonwealth Waters)	Shipyard Campaign (International)	WA-35-L	Coordinates available on request		N/A	Planned departure Q2 2020	Estimated return Q3/Q4 2020	500m while on station
Keraudren Extension (Commonwealth Waters)	Seismic Survey	WA-435-P WA-436-P WA-437-P WA-438-P	Coordinates available on request		>50 – 200 m	Q2 2020	31July 2020 (Stage 1)	3 nautical miles around vessel
Yoorn-1 (Commonwealth and State waters)	Geophysical & Geotechnical Site Survey	WA-499-P TL-5 TP-27 TP-8	Coordinates available on request		40 – 50 m	Window between Q2 2020 to Q2 2021	2-10 days after start date	500m around survey vessel
Yoorn-1 (Commonwealth waters)	Exploration Drilling	WA-499-P	20° 20' 32" S	115° 47' 14" E	40 – 50 m	Window between Q4 2020 to Q3 2021	Estimated completion up to 60 days after start date	500m around MODU

Current offshore activities

Santos provides an update on ongoing activities in Q1 2020.

Activity Name	Type of Activity	Permit Number	Latitude	Longitude	Water Depth (approx.)	Start date	End date estimate	Exclusion zone details
Varanus Island Power Optimisation Project (Onshore)	Compression Facility Installation	PL-29 PL-12	Coordinates available on request		N/A	Commenced Q3 2019	Estimated Completion Q1/Q2 2021	N/A

Completed offshore activities

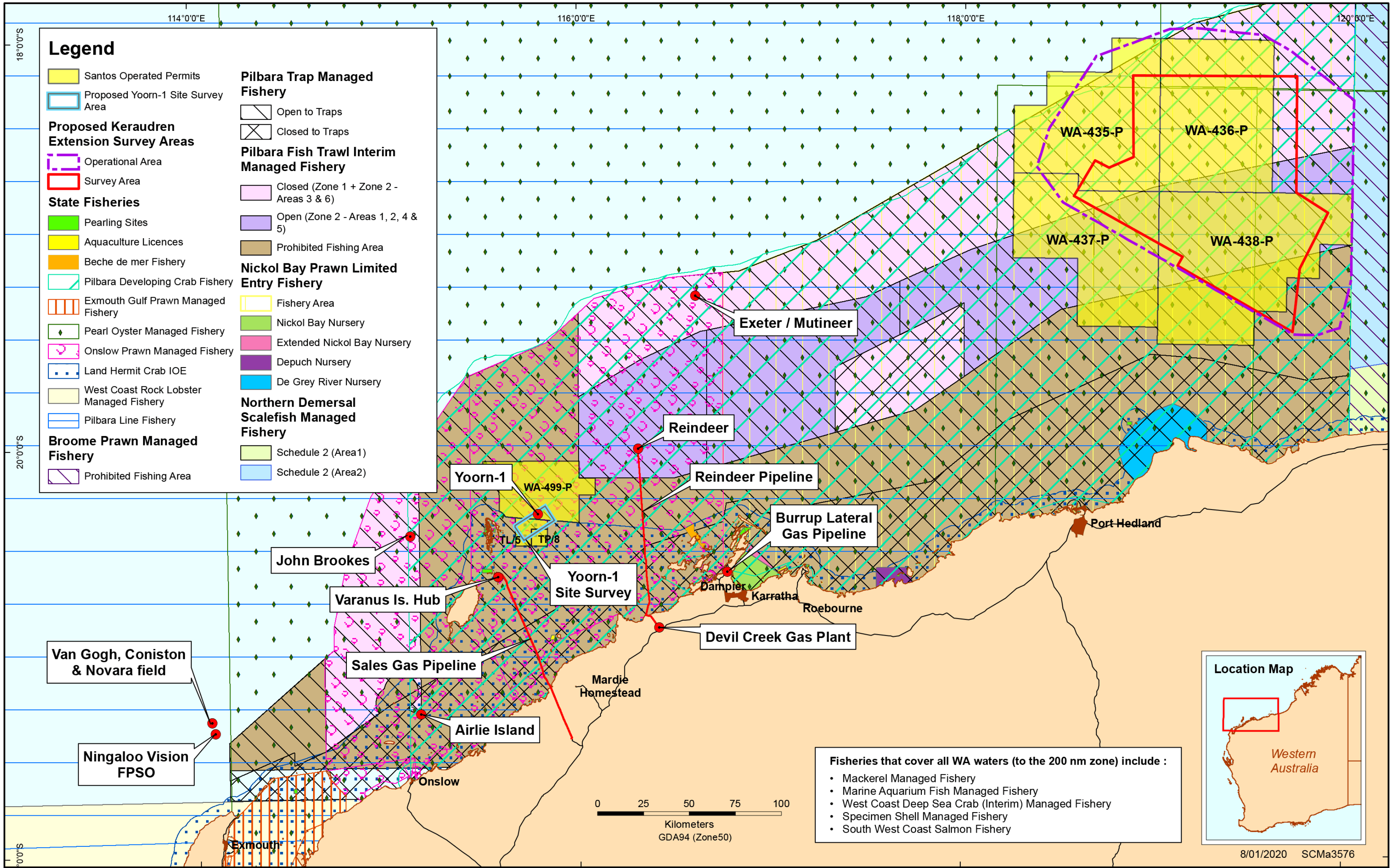
Santos provides an update on activities previously consulted and now completed.

Activity Name	Type of Activity	Permit Number	Water Depth	Latitude	Longitude
Van Gogh Field (Commonwealth Waters)	Inspection Maintenance and Repair (IMR)	WA-35-L	340 m	21° 20' 57.29"S	114° 04' 23.613" E
John Brookes / Greater East Spar (Commonwealth waters)	Inspection Maintenance and Repair (IMR)	WA-29-L WA-45-L	48 – 110 m	115° 07' 12.624 E 114° 54' 22.08 E	20° 26' 50.445 S 20° 36' 31.95 S

Santos' West Australian operations

Santos provides an overview of existing operations on the North West Shelf.

Operational Activity Name	Type of Activity	Water depth	Exclusion zone	Update
Devil Creek Gas Plant (Reindeer facility, pipeline and gas plant)	Gas Production	Reindeer platform at 61 m	500 m around Reindeer Platform	Ongoing operations The five yearly regulatory revision of the two Environment Plans (EPs) which govern activities for the Reindeer Wellhead Platform and associated infrastructure have been completed and submitted to the regulators.
Varanus Island Hub (State and Commonwealth waters)	Oil & Gas Production	Various offshore platforms from	500 m around all offshore platforms (coordinates available on request)	Ongoing operations Environmental monitoring program ongoing at Varanus Island. The five yearly regulatory revision of the two Environment Plans (EPs) which govern activities at the Varanus Island Hub have been completed and submitted to the regulators.
Mutineer-Exeter Field	Ceased production	130 – 160 m	None	Production from the field has ceased and subsea infrastructure is currently preserved.
Burrup Lateral Gas	Gas Supply	Onshore	Onshore	Ongoing operations.
***Ningaloo Vision* FPSO**	Oil Production	340 m	500 m around FPSO	Ongoing operations. The five yearly regulatory revision of the *Ningaloo Vision* Operations Environment Plan (EP) is currently underway and due for submission Q2 2020.



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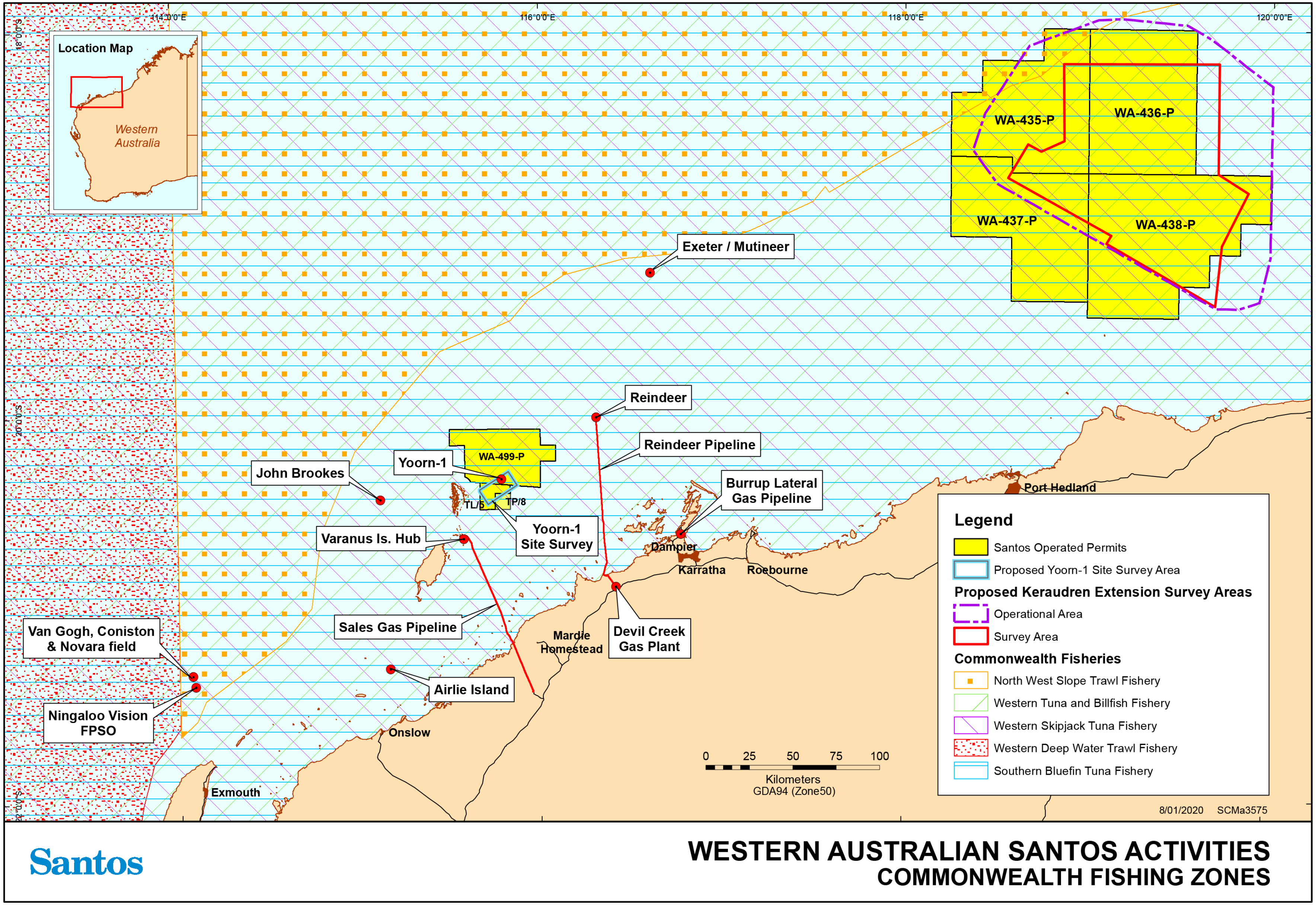
WESTERN AUSTRALIAN SANTOS ACTIVITIES
STATE FISHING ZONES


Location Map
Western Australia
114°0'0"E
116°0'0"E
118°0'0"E
120°0'0"E
WA-435-P
WA-436-P
WA-437-P
WA-438-P
Exeter / Mutineer
Reindeer
Reindeer Pipeline
WA-499-P
Yoorn-1
John Brookes
TL/5
TP/8
Yoorn-1
Site Survey
Burrup Lateral
Gas Pipeline
Port Hedland
Varanus Is. Hub
Dampier
Karratha
Roebourne
Sales Gas Pipeline
Van Gogh, Coniston
& Novara field
Mardie
Homestead
Devil Creek
Gas Plant
Airlie Island
Ningaloo Vision
FPSO
Onslow
Exmouth
0 25 50 75 100
Kilometers
GDA94 (Zone50)
Legend
Santos Operated Permits
Proposed Yoorn-1 Site Survey Area
Proposed Keraudren Extension Survey Areas
Operational Area
Survey Area
Commonwealth Fisheries
North West Slope Trawl Fishery
Western Tuna and Billfish Fishery
Western Skipjack Tuna Fishery
Western Deep Water Trawl Fishery
Southern Bluefin Tuna Fishery
8/01/2020 SCMa3575
Santos
WESTERN AUSTRALIAN SANTOS ACTIVITIES
COMMONWEALTH FISHING ZONES

Appendix D - Environment Consequence Descriptors

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	Consequence level	A – Negligible	B – Minor	C – Moderate	D – Major	E – Critical
	Acceptability	Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable
	Severity	*No impact or negligible impact.* *Environmental impact lasting days up to 1 week*	*Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect* *Environmental impact lasting weeks up to 12 months*	*Significant impact to local population, industry or ecosystem factors.* *Environmental impact lasting 1 to 10 years*	*Major long-term effect on local population, industry or ecosystem factors.* *Environmental impact lasting 10 to 20 years*	*Complete loss of local population, industry or ecosystem factors AND/ OR major wide-spread regional impacts with slow to no full recovery.* *Environmental impact lasting more than 20 years to no recovery*
Environmental Receptors	**Fauna** In particular, EPBC Act listed threatened/migratory fauna or WA Wildlife Conservation Act 1950 specially protected fauna	Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity; No decrease in local population size; No reduction in area of occupancy of species; No loss/disruption of habitat critical to survival of a species; No disruption to the breeding cycle of any individual; No introduction of disease likely to cause a detectable population decline.	Detectable but insignificant decrease in local population size (excluding protected species); Insignificant reduction in area of occupancy of species; Insignificant loss/disruption of habitat critical to survival of a species; Insignificant disruption to the breeding cycle of local population.	Significant decrease in local population size but no threat to overall population viability; Significant behavioural disruption to local population; Significant disruption to the breeding cycle of a local population; Significant reduction in area of occupancy of species; Significant loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a significant decline in local population is likely; Introduce disease likely to cause a significant population decline.	Long term decrease in local population size and threat to local population viability; Major disruption to the breeding cycle of local population; Major reduction in area of occupancy of species; Fragmentation of existing population; Major loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a long term decline in local population is likely; Introduce disease likely to cause a long term population decline	Complete loss of local population; Complete loss of habitat critical to survival of local population; Wide spread (regional) decline in population size or habitat critical to regional population.
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[4]; habitat within a protected area; habitats that include benthic primary producers[5] and/ or epi-fauna[6]	No or negligible reduction in physical environment / habitat area/function.	Detectable but localised and insignificant loss of area/function of physical environment / habitat. Rapid recovery evident within ~ 1 year (seasonal recovery)	Significant loss of area and/or function of local physical environment / habitat. Recovery over medium term (2–10 years)	Major, large-scale loss of area and/or function of physical environment / local habitat. Slow recovery over decades.	Complete destruction of local physical environment / habitat with no recovery; Long term (decades) and wide spread loss of area or function primary producers on a regional scale
Environmental Receptors	**Threatened ecological communities** (EPBC Act listed ecological communities)	No decline in threatened ecological community population size, diversity or function; No reduction in area of threatened ecological community; No introduction of disease likely to cause decline in threatened ecological community population size, diversity or function.	Detectable but insignificant decline in threatened ecological community population size, diversity or function; Insignificant reduction in area of threatened ecological community.	Significant decline in threatened ecological community population size, diversity or function; Significant reduction in area of threatened ecological community; Introduction of disease likely to cause significant decline in threatened ecological community population size, diversity or function.	Major long term decline in threatened ecological community population size, diversity or function Major reduction in area of threatened ecological community Fragmentation of threatened ecological community Introduce disease likely to cause long term decline in threatened ecological community population size, diversity or function	Complete loss of threatened ecological community
Environmental Receptors	**Protected Areas** Includes: World Heritage Properties; Ramsar wetlands; Commonwealth/ National Heritage Areas; Land/ Marine Conservation Reserves.	No or negligible impact on protected area values; No decline in species population within protected area; No or negligible alteration, modification, obscuring or diminishing of protected area values.*	Detectable but insignificant impact on one of more of protected area's values. Detectable but insignificant decline in species population within protected area. Detectable but insignificant alteration, modification, obscuring or diminishing of protected area values*	Significant impact on one of more of protected area's values; Significant decrease in population within protected area; Significant alteration, modification, obscuring or diminishing of protected area values.	Major long term effect on one of more of protected area's values Long term decrease in species population contained within protected area and threat to that population's viability Major alteration, modification, obscuring or diminishing of protected area values	Complete loss of one of more of protected area's values; Complete loss of species population contained within protected area.
Environmental Receptors	**Socio-economic receptors** Includes: fisheries (commercial and recreational); tourism; oil and gas; defence; commercial shipping.	No or negligible loss of value of the local industry; No or negligible reduction in key natural features or populations supporting the activity.	Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local activity.	Significant loss of value of the local industry; Significant medium term reduction of key natural features or populations supporting the local activity.	Major long-term loss of value of the local industry and threat to viability. Major reduction of key natural features or populations supporting the local activity.	Shutdown of local industry or widespread major damage to regional industry; Permanent loss of key natural features or populations supporting the local industry.

* Excluding World Heritage Areas

[4] As defined by the Department of Environment (DoE)
[5] Benthic photosynthetic organisms such as seagrass, algae, hard corals and mangroves
[6] Fauna attached to the substrate including sponges, soft corals and crinoids.