

# Mardie Project: Marine Fauna Review

Mardie Minerals Limited



**CLIENT:** Mardie Minerals Pty Ltd  
**STATUS:** Rev 1      **REPORT No.:** R190012  
**ISSUE DATE:** 27<sup>th</sup> February 2020





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## Acronyms and Abbreviations

Acronyms/Abbreviation	Description
BC	Biodiversity Conservation
BCH	Benthic Community Habitat
BCI	BCI Minerals Ltd
CAMBA	The China-Australia Migratory Bird Agreement
CE or CR	Critically Endangered
CD	Conservation Dependent
CWR	Centre for Whale Research
DBCA	Department of Biodiversity Conservation and Attractions
DD	Data Deficient
DoE	Department of Environment
DoEE	Department of the Environment and Energy
DoF	Department of Fisheries
DPaW	Department of Parks and Wildlife
E	East
E	Endangered
EIA	Environmental Impact Assessment
EP	Environmental Protection
EPA	Environmental Protection Authority
ESD	Environmental Scoping Document
EPBC	Environmental Protection Biodiversity and Conservation
EW	Extinct in the Wild
Ex	Extinct
GLpa	Gigalitre per annum
ha	Hectare
IA	Migratory birds
IMP	Introduced Marine Pests
IMS	Introduced Marine Species
IUCN	International Union for Conservation of Nature
JAMBA	The Japan-Australia Migratory Bird Agreement
Km	Kilometers
Km <sup>2</sup>	Square Kilometers

Acronyms/Abbreviation	Description
Ktpa	Kilo tonnes per annum
L	Least Concern
LR	Lower Risk
M <sup>3</sup>	Meter cubed
M	Migratory
Ma	Listed Marine
MM	Migratory Marine
MNES	Matters of National Environmental Significance
MT	Migratory Terrestrial
Mtpa	Million tonnes per annum
MW	Migratory Wetlands
NaCl	Salt
NE	North East
NIMPCG	National Introduced Pests Coordination Group
NT	Near Threatened
NW	North West
NWMR	North West Management Region
NWSJEMS	North West Shelf Joint Environmental Management Study
OPMF	Onslow Prawn Managed Fishery
OS	Other Specially Protected
P1-P5	Priority Species
PMST	Protected Matters Search Tool
Pty Ltd	Proprietary Limited
ROKAMBA	The Republic of Korea-Australia Migratory Bird Agreement
S	South
SW	South West
SoP	Sulfate of Potash
TECs	Threatened Ecological Communities
V or VU	Vulnerable
WAFIC	Western Australian Fisheries Industry Council
WA	Western Australia
WC	Wildlife Conservation

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# 1. Introduction

## 1.1. Project Description

### 1.1.1. Proposal Summary

**Table 1** Proposal Summary

Proposal Title	Mardie Project
Proponent Name	Mardie Minerals Pty Ltd
Short Description	<p>Mardie Minerals Pty Ltd is seeking to develop a greenfields high quality salt and sulphate of potash (SOP) project and associated export facility at Mardie, approximately 80 km south west of Karratha, in the Pilbara region of WA. The Proposal will utilise seawater to produce a high purity salt product, SOP and other products derived from sea water.</p> <p>The Proposal includes the development of a seawater intake, concentrator and crystalliser ponds, processing facilities and stockpile areas, bitterns disposal pipeline and diffuser, trestle jetty export facility, transshipment channel, drainage channels, access / haul roads, causeway, desalination (reverse osmosis) plant, borrow pits, pipelines, and associated infrastructure (power supply, communications equipment, offices, workshops, accommodation village, laydown areas, sewage treatment plant, landfill facility, etc.).</p>

### 1.1.2. Proposal Description

Mardie Minerals Pty Ltd (Mardie Minerals) seeks to develop the Mardie Project (the Proposal), a greenfields high-quality salt project in the Pilbara region of Western Australia (Figure 1) Mardie Minerals is a wholly-owned subsidiary of BCI Minerals Limited.

The Proposal is a solar salt project that utilises seawater and evaporation to produce raw salts as a feedstock for dedicated processing facilities that will produce a high purity salt, industrial grade fertiliser products, and other commercial by-products. Production rates of 4.0 Million tonnes per annum (Mtpa) of salt (NaCl), 100 kilotonnes per annum (ktpa) of Sulphate of Potash (SoP), and up to 300 ktpa of other salt products are being targeted, sourced from a 150 Gigalitre per annum (GLpa) seawater intake. To meet this production, the following infrastructure will be developed:

- > Primary seawater intake pump station;
- > Concentrator ponds;
- > Crystalliser ponds;
- > Processing facilities and stockpiles;
- > Causeway, trestle jetty and transshipment berth/channel;
- > Bitterns disposal pipeline, seawater intake (for dilution) and diffuser;
- > Drainage channels and flood protection levees;
- > Administration buildings;
- > Accommodation village;
- > Access / haul roads;

- > Desalination plant for freshwater production;
- > Boat launching facility and port stockyard; and
- > Associated infrastructure including power supply, communications, workshop, laydown, landfill facility, sewage treatment plant.

Seawater for the process will be pumped from a large tidal creek into the concentrator ponds. All pumps will be screened and operated accordingly to minimise entrapment of marine fauna and any reductions in water levels in the tidal creek.

Concentrator and crystalliser ponds will be developed behind low permeability walls engineered from local clays and soils and rock armoured to protect against erosion. The height of the walls varies across the project and is matched to the storm risk for the area.

Potable water will be required for the production plants and the village. The water supply will be sourced from desalination plants across the Proposal. The high salinity brine output from the plants will be directed to concentrator ponds or a lined process pond.

A trestle jetty will be constructed to convey salt (NaCl) from the salt production stockpile to the transshipment berth pocket, approximately 2.2 km offshore. The jetty will not impede coastal water or sediment movement, thus ensuring coastal processes are maintained.

Dredging of up to 850,000 m<sup>3</sup> will be required to ensure sufficient depth for the transhipper berth pocket at the end of the trestle jetty, as well as along a 4.5 km long channel out to deeper water. The average depth of dredging is approximately 1 m below the current sea floor. The dredge spoil is inert and will be transported to shore for use within the development.

The production process will produce a high-salinity bittern that, prior to its discharge through a diffuser at the far end of the trestle jetty, will be diluted with seawater to bring its salinity closer to that of the receiving environment.

Access to the project from North West Coastal Highway will be based on an existing public road alignment that services the Mardie Station homestead and will require upgrading..

The majority of the power required for the project (i.e. approximately 95%) is provided by the sun and the wind, which drives the evaporation and crystallisation processes. In addition, the Proposal will require diesel and gas to provide additional energy for infrastructure, support services and processing plant requirements.

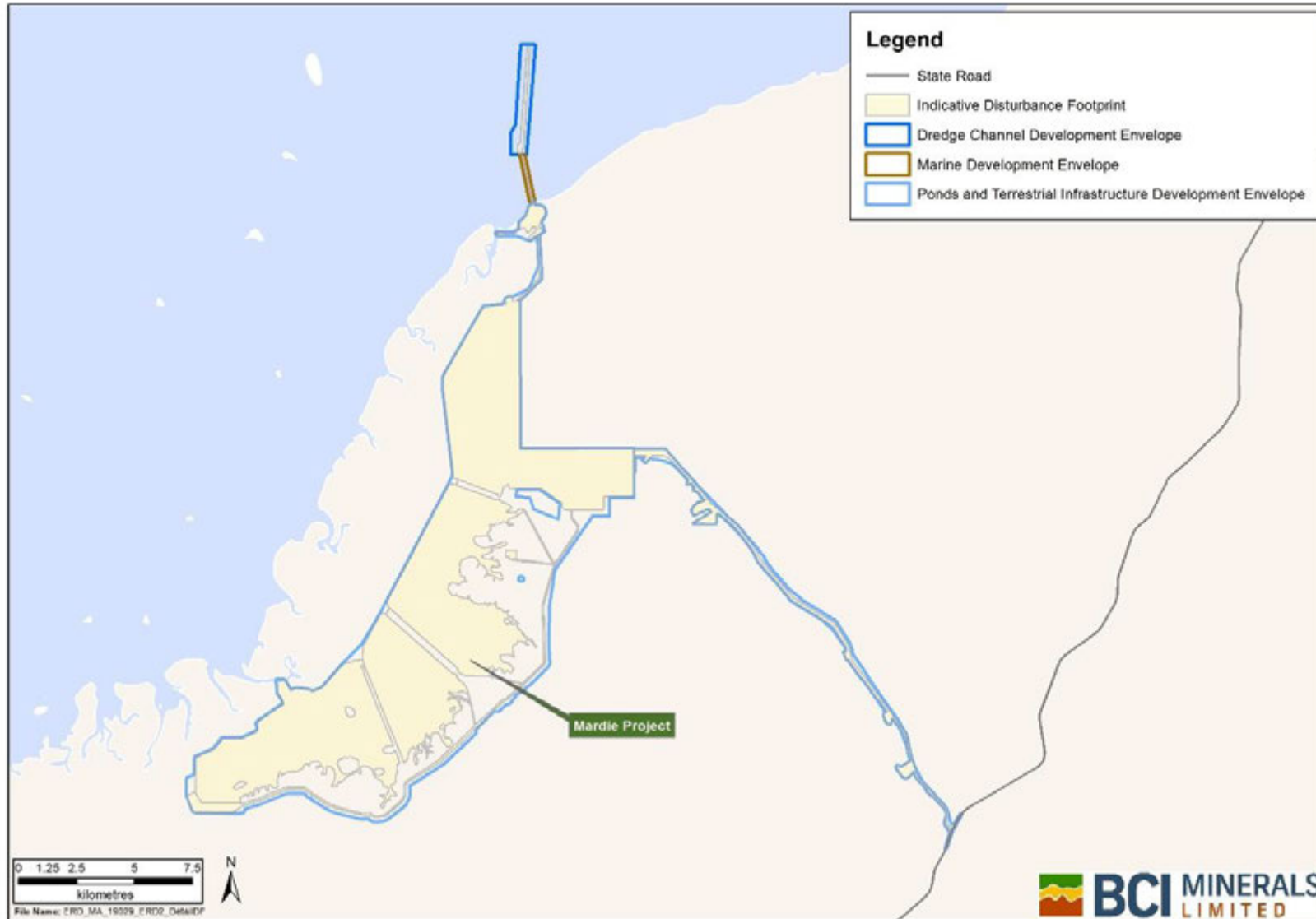
The Proposal will be developed within three development envelopes. The boundaries of these development envelopes are shown in Figure 1 & Figure 2 and described in Table 2.

**Table 2 Location and proposed extent of physical and operational elements**

Element	Ref.	Proposed Extent
<b>Physical Elements</b>		
1. Ponds & Terrestrial Infrastructure Development Envelope – concentrator and crystalliser ponds, processing plant, access / haul road, desalination plant, causeway, administration, accommodation village, laydown, other infrastructure.	Fig. 2	Disturbance of no more than 11,142 ha within the 15,667 ha Ponds & Terrestrial Infrastructure Development Envelope.
2. Marine Development Envelope – trestle jetty, seawater intake and pipelines.	Fig. 2	Disturbance of no more than 7 ha within the 53 ha Marine Development Envelope.
3. Dredge Channel Development Envelope – berth pocket, channel to allow access for transshipment vessels, bitterns outfall diffuser.	Fig. 2	Disturbance of no more than 66 ha within the 304 ha Dredge Channel Development Envelope.
4. Mangrove Disturbance	Fig. 2	Disturbance of mangrove communities limited to 20 ha of Scattered Canopy mangroves and no Closed Canopy mangroves
<b>Operational Elements</b>		
Desalination Plant discharge	Fig. 2	Discharge to ponds or bitterns stream
Dredge volume	Fig. 2	Dredging is only to occur within the Dredge Channel Development Envelope. Dredging of no more than 850,000 m <sup>3</sup> of material from the berth pocket and high points within the dredge channel, with the material to be deposited within the Ponds & Terrestrial Infrastructure Development Envelope.
Bitterns discharge	Fig. 2	Discharge of up to 3.6 gigalitres per annum (GLpa) of bitterns with a specific gravity of no more than 1.25 via a diffuser within a Low Ecological Protection Area.  Bitterns will be diluted prior to discharge.
Pond seawater intake		Up to 150 GL per annum, from a screened intake with a maximum average intake flow rate at the screen of less than 0.15 m/s.  Seawater abstraction will only occur when water levels are at mean sea level or higher.



Figure 1 Mardie Proposal Regional Location



**Figure 2 Mardie Proposal Development Envelopes**



## 1.2. Scope and Objectives

This document provides an account of the marine fauna of the project area using a combination of desktop investigations and opportunistic field observations. The specific objectives of this Report are to address the ESD Items outlined in **Table 3**.

**Table 3 Environmental Scoping Document Requirement including Considerations and Limitations**

ESD Requirement	Considerations / Limitations
<p><b>ESD Item 50.</b> Discuss the likely presence of listed threatened species or their habitat within/near the proposed project area, in addition to any other EPBC Act listed species identified during the proposed faunal surveys.</p>	<p>Refer <b>Appendix B</b>.</p> <p>Marine turtles and shorebirds are excluded from discussion in this report as these are presented in Pendoley (2019) and Phoenix (2020) respectively.</p>
<p><b>ESD Item 52.</b> Undertake a desktop review to identify what marine fauna species would be expected to utilise marine waters surrounding the Proposal, including those protected under the <i>EPBC Act</i> and those that may inhabit the Montebello Marine Park.</p>	<p>Refer <b>Sections 2.1, 2.2 &amp; 3</b></p> <p>The Montebello Marine Park is located over 60 km from the Mardie Project. Therefore, whilst species which may utilise the marine park waters may occasionally occur the vicinity of the Project area, the habitats of these two areas are vastly different and it is not reasonable to assume that all species would be present in both areas.</p>
<p><b>ESD Item 54.</b> Undertake a marine mammal field survey to identify the potential species present and populations.</p>	<p>Refer <b>Section 2.3 &amp; Section 3.1.2</b>.</p> <p>No habitats of significant value to marine mammal species were identified during concurrent surveys of the project area. Therefore surveys for marine mammals were limited to opportunistic observations only.</p>
<p><b>ESD Item 60.</b> Identify any significant marine fauna (as well as ecological 'keystone' species, species important to commercial and recreational fishers) likely to be found in the area of influence of the Proposal, including commercially important species, species protected under the EPBC Act and migratory species.</p>	<p>Refer <b>Section 3</b>.</p> <p>Marine turtles and shorebirds are excluded from discussion in this report as these are presented in Pendoley (2019) and Phoenix (2020) respectively.</p>
<p><b>ESD Item 61.</b> Identify any critical periods for key environmental / life cycle events for marine fauna (e.g. turtle nesting).</p>	<p>Refer <b>Section 3.5</b></p> <p>Marine turtles and shorebirds are excluded from discussion in this report as these are presented in Pendoley (2019) and Phoenix (2020) respectively.</p>
<p><b>ESD Item 62.</b> Identify likelihood of significant marine fauna species occurring near the development envelopes, including:</p>	<p>Refer <b>Appendix B</b></p>

ESD Requirement	Considerations / Limitations
<ul style="list-style-type: none"> <li>a. Information on the abundance, distribution, ecology and habitat preferences of any significant species;</li> <li>b. Information on the conservation value of each habitat type from a local and regional perspective;</li> <li>c. If a population of a significant species is present and may be impacted by the Proposal, its size and the importance of that population from a local and regional perspective;</li> <li>d. Baseline mapping of local occurrences;</li> <li>e. An assessment of the risk of impact to any listed threatened species as a result of project activities;</li> <li>f. For any impact identified, appropriate mitigation/management measures to reduce the level of impact; and</li> <li>g. An assessment of residual impact to each species after all avoidance and mitigation measures are undertaken</li> </ul>	<p>This report does not address any of the potential impacts to marine fauna (i.e. Items e, f &amp; g) that may arise as a result of the proposal.</p>
<p><b>ESD Item 63.</b> Characterise the ecological values and significance of marine fauna and habitat in the area that may be directly or indirectly impacted by the Proposal.</p>	<p>Marine turtles and shorebirds are excluded from discussion in this report as these are presented in Pendoley (2019) and Phoenix (2020) respectively.</p>

### 1.3. Study Area

The study area focusses on the area of potential influence of proposal activities, which includes the nearshore marine waters and creeks from the coastal mainland of Mardie, extending seawards to include the marine waters surrounding the nearby inshore Islands. Marine fauna utilising these areas are also discussed in the broader context of the Pilbara coastal region (nominally extending from North west cape in the south to Port Hedland in the North). Due to the migratory nature of the majority of marine mammals, consideration has been placed on the Mardie study area in terms of its role as a migratory stopover point.

### 1.4. Legislation and Regulatory Guidance

This study has been aligned with relevant state and federal legislation and technical guidance that will be applicable to Marine Fauna in the Project area. The relevant legislation specific to Marine Fauna, includes:

- > Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act);
- > Western Australian *Environmental Protection Act 1986* (EP Act);
- > Western Australian *Biodiversity Conservation Act 2016* (BC Act);
- > Western Australian *Conservation and Land Management Act 1984* (CALM Act); and
- > Western Australian *Fish Resources Management Act 1994* (FRM Act).

The EPA provides guidance on how an Environmental Impact Assessment (EIA) will be evaluated when determining whether or not an assessed proposal may be implemented. The EPA uses environmental principles, factors and associated objectives as defined within the Statement of Environmental Principles, Factors and Objectives (EPA 2018) as the basis for assessing whether a proposal's impact on the environment is acceptable. These principles, factors and objectives therefore underpin the EIA process.

#### 1.4.1. Environmental Principles

The object of the EP Act is to protect the environment of the State and identifies five environmental principles. The third principle of the conservation of biological diversity and ecological integrity is directly relevant to Marine Fauna and is therefore a fundamental consideration for the EIA.

#### 1.4.2. Environmental Factors and Objectives

The EPA list 13 environmental factors, which are organised into five themes: Sea, Land, Water, Air and People. The environmental factors are those parts of the environment that may be impacted by an aspect of a proposal. An environmental objective has been established for each environmental factor. The EPA will then make judgements against these objectives on whether the environmental impact of a proposal may be significant. Marine Fauna was identified by the EPA as one of the key environmental factors for the Project. The objective for Marine Fauna is *'to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained'*.

The EPA provides the following guidelines to explain how impacts on Marine Fauna are considered during EIA and to set out the type and form of the information that should be presented to facilitate the assessment of impacts on Marine Fauna in Western Australia's marine environment:

- > Environmental Factor Guideline - Marine Fauna (EPA, 2016a);
- > Technical Guidance – Protection of BCH (EPA, 2016b);
- > Technical Guidance – Protecting the Quality of Western Australia's Marine Environment (EPA, 2016c); and
- > Technical Guidance – Environmental Impact Assessment of Marine Dredging Proposals (EPA, 2016d).

The Commonwealth Department of Environment and Energy (DoEE) also provides the following technical guidance to inform impact assessment for conservation significant marine fauna species:

- > Relevant EPBC Act listed species survey guidelines and protocols;
- > Relevant EPBC Act listed species Recovery plans, Threat Abatement Plans and Approved Conservation Advice Statements;
- > Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012); and
- > National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE 2017).

#### 1.4.3. Threatened and Priority Fauna

##### Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

On behalf of the Minister for Environment, the Department of Environment and Energy (DoEE) publishes a list of fauna and flora species regarded as threatened, rare, likely to become extinct, or

presumed extinct. These taxa are protected under the EPBC Act and are listed in specific categories such as Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, or Extinct in the Wild (**Table 8 in Appendix One**).

Migratory species are categorised under the EPBC Act as Matters of National Environmental Significance (MNES). Recognised migratory species include any native species identified in an international agreement approved by the Minister and those listed under:

- > The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention);
- > The China-Australia Migratory Bird Agreement (CAMBA);
- > The Japan-Australia Migratory Bird Agreement (JAMBA); and
- > The Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

### **Western Australian Biodiversity Conservation Act 2016 (BC Act)**

The Western Australian Biodiversity Conservation Act 2016 (BC Act, the Act), parts of which were enacted on 21 September 2016, provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. The BC Act replaces the Wildlife Conservation Act 1950. Threatened species (both flora and fauna) that meet the categories listed within the Act are highly protected and require authorisation by the Ministerial to take or disturb. Seven categories have been devised that include Threatened Fauna conservation categories of critically endangered, endangered, vulnerable and presumed extinct have been aligned with those detailed in the EPBC Act. Additional categories cover migratory species, conservation dependent species and other specially protected species. Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that 'taking' may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as specially protected species. Threatened Ecological Communities (TECs) are also protected under the Act and are categorised using the same criteria as threatened species. At the time of writing this report, some sections of the BC Act had not been yet been proclaimed, including those relating to species of conservation interest (Specially Protected Species) and TECs. During this transition period the WC Act is still in effect where relevant. The current listings were published in the Government Gazette on 3 November 2015.

### **Department of Biodiversity, Conservation and Attractions (DBCA) Priority Species**

In addition to these statutory listings, DBCA maintains a list of 'Priority' species (P1-P5) that are also of conservation interest. Any fauna survey conducted for the purposes of environmental impact assessment (EIA) must include an assessment of presence/absence potential for these species. There is also a requirement for an impact assessment (due to the proposed action) and an expectation all appropriate sources of information are investigated.

## **1.5. Marine Fauna Definition**

For the purposes of EIA, marine fauna are defined as: Animals that live in the ocean or rely on the ocean for all or part of their lives. Marine fauna are highly diverse and range in size from microscopic zooplankton to the blue whale. Marine fauna that live their entire life in the ocean such as sharks,

whales, dolphins, dugongs, sea snakes, most fish, invertebrates and crustaceans. Marine fauna are also animals that either leave or enter the ocean for breeding or resting purposes, such as turtles, seals and sea lions, penguins, and crabs. Other animals such as seabirds can also be considered as marine fauna as they rely on fish and other marine life for food. While animals such as sponges and corals that are attached to the seabed are also marine fauna, they are typically considered under the environmental factor of Benthic Communities and Habitats (EPA 2016b).



## 2. Methods

### 2.1. Database Searches

O2 Marine undertook a comprehensive desktop review to identify conservation significant marine fauna species that are known to occur or that could potentially occur within the Project area. A likelihood of occurrence assessment was then undertaken for the species identified in the searches. **Table 4** lists the database searches performed.

**Table 4** Details of Database Searches

Field	Database Title	Custodian	Search Details
Conservation Fauna	Significant Commonwealth Protected Matters Search (PMST)	Department of the Environment and Energy (DoEE)	Date: 14 <sup>th</sup> Feb 2019 Buffer: 50km Lat: 20°59'27" S Long: 115°.54'21"E
Conservation Fauna	Significant DPaW database	Department of Biodiversity Conservation and Attractions (DBCA)	Date: 14 <sup>th</sup> Feb 2019 Buffer: 50km
Marine Fauna	Nature Map	DBCA	Date: 14 <sup>th</sup> Feb 2019 Buffer: 50km Lat: 20°59'27" S Long: 115°. 54'21"E

### 2.2. Literature Review

A comprehensive literature review was undertaken which focussed on marine fauna surveys undertaken for previous coastal development projects in the Pilbara and relevant scientific journal literature on marine fauna in the Pilbara region and globally. Particular emphasis was placed on species of conservation significance. The following studies comprised the majority of the review:

- > Onslow Salt ERMP Volume 2 Technical Appendix C Report on the Biological Environments near Onslow, Western Australia (Paling, 1990);
- > The draft EIS for Chevron Australia's Wheatstone project (Chevron Australia, 2010);
- > Intertidal Habitats of the Onslow Coastline (URS, 2010);
- > Biota of subtidal habitats in the Pilbara Mangroves, with reference to the Ashburton Delta and Hooley Creek (URS, 2010a);
- > Sea Noise Logger Deployment: Wheatstone and Onslow – April to July 2009 Preliminary Analysis (McCauley & Kent, 2010);
- > A Description of Mega Fauna Distribution and Abundance in the SW Pilbara Using Aerial and Acoustic Surveys –Final Report 2010 (CWR, 2010);
- > Draft Protected Marine Fauna Management Plan (Chevron, 2010);
- > Wheatstone Project Literature Review of Listed Marine Fauna (URS, 2010b);
- > Possible Effects of Underwater Noise on Marine Fauna and Fish in the Wheatstone Project Area (URS, 2010c);
- > Potential Interactions with the Onslow Prawn Managed Fishery (URS, 2011b);

- > Marine Mammals Technical Report (RPS 2010b);
- > Dugong Aerial Survey Report (RPS 2010a);
- > Identification and Risk Assessment of Marine Matters of National Environmental Significance (RPS 2010b) and
- > Seagrass Dynamics and the Consequence of Seagrass Loss on Marine Megafauna: A Briefing Note (Chevron 2010a).

Data from other studies being completed to inform the Project EIA or as relevant to the Project were also utilised in the preparation of this report. The most directly relevant documents included:

- > Shorebird, Marine Turtle and other Conservation significant fauna survey December 2017. Phoenix Environmental Services (2018);
- > Marine turtle surveys of Mardie Salt Project area – December 2017, January 2018, and January 2019 (Pendoley 2019)
- > Assessment of mangal and algal communities for the Mardie Solar Salt Project (Stantec (2018)
- > Mardie Project Subtidal Benthic Communities and Habitat (O2 Marine 2020a); and
- > Mardie Project Intertidal Benthic Communities and Habitat (O2 Marine 2020b).

### 2.3. Opportunistic Site Observations

A comprehensive desktop review was undertaken to identify conservation significant marine fauna species known or likely to occur within the Project area. Following, initial desktop review and likelihood of occurrence assessment it was determined that the Proposal activities posed a relatively low risk to marine fauna species other than Turtles. Therefore, specific surveys targeting marine fauna species other than Turtles were not undertaken for the Mardie Project. However, all incidental observations of marine fauna were recorded by experienced marine scientists during extensive field surveys undertaken by O2 Marine and Stantec in delivering other work scopes. The details of these surveys (including observer hours) are summarised in **Table 5**.

**Table 5 Mardie marine field surveys which included incidental observations of marine fauna**

Field Survey	Company	Survey Dates	Observer Hours
Water Quality Maintenance	O2 Marine	15 <sup>th</sup> – 16 <sup>th</sup> March 2018	264 Hours (Vessel-based)
		3 <sup>rd</sup> – 4 <sup>th</sup> April 2018	
		5 <sup>th</sup> – 6 <sup>th</sup> May 2018	
		25 <sup>th</sup> – 26 <sup>th</sup> May 2018	
		5 <sup>th</sup> – 6 <sup>th</sup> July 2018	
		20 <sup>th</sup> – 21 <sup>st</sup> August 2018	
		14 <sup>th</sup> – 15 <sup>th</sup> October 2018	
		10 <sup>th</sup> – 11 <sup>th</sup> December 2018	
		12 <sup>th</sup> – 13 <sup>th</sup> January 2019	

Field Survey	Company	Survey Dates	Observer Hours
		4 <sup>th</sup> – 5 <sup>th</sup> February 2019	
		14 <sup>th</sup> – 15 <sup>th</sup> March 2019	
Bathymetry Surveys	O2 Marine	22 <sup>nd</sup> – 25 <sup>th</sup> August 2018 16 <sup>th</sup> – 22 <sup>nd</sup> October 2018	60 Hours (Vessel-based)
Benthic Habitat Surveys	O2 Marine	8 <sup>th</sup> – 14 <sup>th</sup> March 2018 12 <sup>th</sup> – 15 <sup>th</sup> December 2018 14 <sup>th</sup> – 18 <sup>th</sup> January 2019 6 <sup>th</sup> – 8 <sup>th</sup> February 2019 16 <sup>th</sup> – 18 <sup>th</sup> March 2019	264 Hours (Vessel-based)
Sediment Sampling Surveys	O2 Marine	9 <sup>th</sup> – 12 <sup>th</sup> December 2018 12 <sup>th</sup> – 13 <sup>th</sup> January 2019 14 <sup>th</sup> – 15 <sup>th</sup> March 2019	108 Hours (Vessel-based)
Mangrove & Intertidal Surveys	O2 Marine	17 <sup>th</sup> – 18 <sup>th</sup> March 2018 12 <sup>th</sup> December 2018	18 Hours (Vessel-based)
	Stantec	August 2017 October 2017	Hours Unknown (Aerial)

## 2.4. Likelihood of Occurrence Assessment

An assessment was undertaken of the likelihood of occurrence for threatened species identified through the desktop review. The DoE and DBCA do not have prescriptive likelihood of occurrence guidelines within their policies but rather clarify the scale of assessment required to determine the level of impact (e.g. level of assessment, previous record searches, and distribution maps). The following criteria have been developed by O2 Marine with the aim of considering the assessment classifications to identify the likelihood of occurrence for threatened species:

- **Low potential to occur** – the species has not been recorded in the region (no records from desktop searches) and/or current known distribution does not encompass project area and/or suitable habitat is generally lacking from the project area;
- **Moderate potential to occur** – the species has been recorded in the region (desktop searches) however suitable habitat is generally lacking from the project area OR species has not been recorded in the region (no records from desktop searches) but potentially suitable habitat occurs at the project area;
- **High potential to occur** – the species has been recorded in the region (desktop searches) and suitable habitat is present at the project area; and
- **Known to occur** – the species has been recorded on-site in the recent past (i.e. last 5-10 years) and the site provides suitable habitat for it.

The results for the fauna likelihood of occurrence assessment are presented in **Appendix B**.

## 3. Marine Fauna

### 3.1. Results

#### 3.1.1. Database Searches

Database searches identified a total of 18 conservation significant species (**Table 6**) and a further 55 listed Marine or Marine Migratory Species (**Appendix B**) as potentially occurring within the study area.

As identified in **Section 1.2** Turtles, Marine Migratory birds and terrestrial fauna identified in the database search results are excluded from this report, as these are discussed in other reports.

**Table 6 Conservation Significant Species Returned by the Database Searches**

Class	Species Name	Common Name	EPBC Act Status	BC Act Status	IUCN Status
SHARK	<i>Pristis zijsron</i>	Green sawfish	V, M	VU	CR
SHARK	<i>Pristis clavata</i>	Dwarf sawfish	V, MM	P1	EN
SHARK	<i>Anoxypristis cuspidata</i>	Narrow sawfish	MM		EN
SHARK	<i>Carcharias taurus</i>	Grey Nurse Shark	V	VU	
SHARK	<i>Rhincodon typus</i>	Whale Shark	V	MM	OS
SHARK	<i>Carcharodon carcharias</i>	White Shark, Great White Shark	V	MM	VU
RAY	<i>Manta birostris</i>	Giant Manta Ray	MM	MM	VU
RAY	<i>Manta alfredi</i>	Reef Manta Ray	MM	MM	VU
MAMMAL	<i>Dugong dugon</i>	Dugong	MM, Ma	OS	VU
MAMMAL	<i>Megaptera novaeangliae</i>	Humpback whale	V, MM	CD	LC
MAMMAL	<i>Balaena glacialis australis</i>	Southern Right Whale	EN, MM, Ma	VU	LC
MAMMAL	<i>Balaenoptera musculus</i>	Blue Whale	EN, MM, Ma	EN	EN
MAMMAL	<i>Orcaella heinsohni</i>	Australian snubfin dolphin	M	P4	NT
MAMMAL	<i>Sousa sahalensis</i>	Australian humpback dolphin	M	P4	
MAMMAL	<i>Stenella longirostris</i>	Australian spinner dolphin	M	P4	LC
MAMMAL	<i>Tursiops aduncus</i>	Spotted Bottlenose Dolphin	MM		
MAMMAL	<i>Sousa chinensis</i>	Indo-Pacific Humpback Dolphin	MM	P4	VU
REPTILE	<i>Aipysurus apraefrontalis</i>	Short-nosed Seasnake	CE, Ma	CR	CR

- EPBC Act (species listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999): Ex = Extinct, CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, MM = Migratory Marine, MT = Migratory Terrestrial, MW = Migratory Wetlands, Ma = Listed Marine
- BC Act Status (species listed under the Western Australian *Wildlife Conservation Act 1950*):
  - Threatened Species: EX = Presumed Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, IA = Migratory birds protected under an International Agreement, CD = Conservation Dependent, OS = Other Specially Protected
  - Priority Species: P1 = Priority 1, P2 = Priority 2, P3 = Priority 3, P4 = Priority 4
  - IUCN (species listed under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species): EX = Extinct, EW = Extinct in the Wild, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, LR = Lower Risk, DD = Data Deficient.

### 3.1.2. Opportunistic Observations

A specific survey targeting marine fauna (other than Turtles and Shorebirds) was not undertaken for the Mardie Project. However, incidental sightings of marine fauna were recorded during field surveys completed by O2 Marine and Stantec.

**Table 7** lists the marine fauna that were observed during field surveys in the Mardie area.

**Table 7** Incidental sightings of marine fauna during surveys within the coastal environment of the Mardie area.

Author	Study	Marine Fauna	Quantity	Date Observed	Location and activity of fauna	Comments
O2 Marine (2018a)	BCI Minerals – Mardie Project – Project Report #1 for Metocean Data Collection	Humpback Whale	1x Adult 1x Calf	5 <sup>th</sup> July 2018	200m from ADCP (9nm off-shore and 3nm to the West Passage Island to an approximate depth of 8m). Inside waters around Passage Island. Mother swimming with calf headed northward.	
		Turtles (Species unknown)	Numbers not recorded although numerous sightings were noted	5 <sup>th</sup> July 2018	Inshore waters around survey ADCP and Aqua drop (2nm off-shore to an approximate depth of 3m) locations. Turtles sighted at water’s surface to breathe.	
O2 Marine (2018b)/ (2020b)	Mardie Project – Intertidal Benthic Communities and Habitat of the Mardie Coastline.	Turtles (Species Unknown)	Numbers not recorded although numerous sightings were noted.	March 2018	Sighted near the mouth of a nearshore Creek located North of the project area. Turtles swimming on surface of the water to breathe.	
			1x Turtle	March 2019	Turtle was sighted on the inside southern waters of Sholl Island. Depth 2.4m with dense coral, macro algae and non-coral species. Turtle was on the surface of the water coming up to breath.	
		Crustaceans	9 taxa	March 2018	<i>Sesarmidae</i> was the most dominant of the crustaceans.  Grapsidae and Ocypodidae (recorded at more than one site although low proportions).	227 organisms from 12 taxa within 40 fauna quadrats at the five site locations were recorded for this survey. North Creek and Robe river had the highest fauna densities. Central Creek had lowest densities. The Taxa recorded and the findings of dense fauna of limited diversity represent typical ecological
		Molluscs	2 taxa	March 2018		



Author	Study	Marine Fauna	Quantity	Date Observed	Location and activity of fauna	Comments
		Fish	1 taxon	March 2018	Gobidae (mudskipper) recorded at three (3) sites (37% abundance at one site).	trends and taxa expected to occur in tropical arid zone mangroves of the Pilbara Coastline.
		Dolphins (species unknown)	2 x adults	March 2019	Sighted on the outside edge of Sholl Island. Depth on sounder 12.9m. Habitat bare sand. Dolphins surfaced twice to breathe and then did not resurface. Distance from vessel made it difficult to identify.	
Stantec Environmental (2018)	Assessment of Mangal and Algal communities for the Mardie Solar Salt Project.	<b>Elasmobranches</b> -Whitetip reef shark -Blacktip reef shark -Grey Reef Shark -Bull Shark -Tiger Shark -Stingray -Eagle ray -Shovelnose ray -Giant Manta Ray -Reef Manta Ray				Locations and number of individuals observed was not recorded.
		<b>Reptilia</b> -Seasnake -Green turtle				Locations and number of individuals observed was not recorded.
		<b>Teleostei (Bony fish)</b> - Serranidae - Lutjanidae - Lethrinidae - Mullidae - Carangidae - Siganidae				Locations and number of individuals observed was not recorded.
		<b>Mammalia</b> Dugong Dolphins (Species unknown)				Locations and number of individuals observed was not recorded.

## 3.2. Likelihood of Occurrence Assessment

A likelihood of occurrence assessment was undertaken for all conservation significant species identified through desktop searches (**Table 6**). The results of the assessment are presented in **Appendix B**. The assessment determine that the following conservation significant species are 'known to occur' or have a 'high potential to occur' in the Project area:

- > Three marine mammals:
  - Humpback Whale;
  - Dugong; and
  - Australian Humpback Dolphin
- > One marine reptile (Excluding Turtles):
  - Short-nosed sea snake
- > One elasmobranch:
  - Green Sawfish.

These conservation species, together with other species which have a lower potential to occur are discussed further below.

## 3.3. Conservation Significant Species

### 3.3.1. Marine Mammals

Conservation significant marine mammals species known to occur or have a high potential to occur in the Project area include the humpback whale (*Megaptera novaeangliae*), Dugong (*Dugong dugon*), Australian humpback dolphin (*Sousa sahalensis*). A further two whale species and four dolphin species were also recorded in database searches for the area but were considered to have a lower likelihood of occurrence.

#### Whales

Humpback Whales (*Megaptera novaeangliae*) have a global distribution and are found in all the major oceans. Six separate populations have been identified in the southern hemisphere, with the Group IV population being associated with Australia's North West Shelf (NWS) bioregion. This WA population is thought to have been recovering at an annual rate of between 7 and 12 percent since the cessation of whaling in 1963 (CWR 2010).

Humpback whales migrate annually from Antarctic feeding grounds to the Kimberley coast for calving during the winter. Humpback whales predominantly occur offshore in open oceanic environments. However, they are known to stopover in the lee of the offshore islands and have been observed on several occasions during the humpback southerly migration, within 5 km of the Mardie Project Marine Development Envelope, by O2M staff in 2018. The southern migration is the period when they are closest to shore at an average of 36 km although are often recorded in waters less than 10 m deep during the latter part of the migration (September to November). The Project area is a shallow embayment (i.e. generally <5m deep) and could not be considered critical habitat for any whale species.

The most intensive study in the region was undertaken by the Centre for Whale Research (CWR) in 2010, which involved a 12-month program of fortnightly aerial surveys over the Onslow region. In addition, sea noise loggers were deployed at nearshore and offshore locations in Onslow (CWR 2010). During 26 surveys, 801 pods containing 1221 individual whales were recorded. A total of 95 cow-calf pairs were sighted, predominantly from September to October. Humpback whales first appeared in the Onslow region from early to mid-June. Humpback whales were typically observed seaward of Thevenard Island and over the continental slope at an average of 49 km offshore (CWR 2010). Migration patterns changed from predominantly northward to southward bound in mid-August. Higher proportions of resting/milling pods were sighted during the southern migration, at an average of 36 km offshore. Cows and Calves predominantly rest when inside of the 50 m isobaths (CWR 2010), with some whales recorded in waters less than 10 m deep during the latter part of the migration. The data indicates that the Mardie area does not represent the same importance for resting or calving as Exmouth Gulf or Camden Sound (CWR 2010).

Seven other species of toothed whale and three species of baleen whale have been recorded from the Montebello region (DEC 2007). Further evidence from aerial surveys and acoustic surveys supports this, as sightings further offshore indicated a greater range of species existing in small numbers that included species of Bryde's Whales, Minke Whales, Pygmy Blue Whales, Killer Whales, Southern Right Whales, Pilot Whales and Sperm Whales. However, these whales are believed to only transit through oceanic waters well offshore from the shallow waters of the Mardie Project area (CWR 2010; RPS 2010).

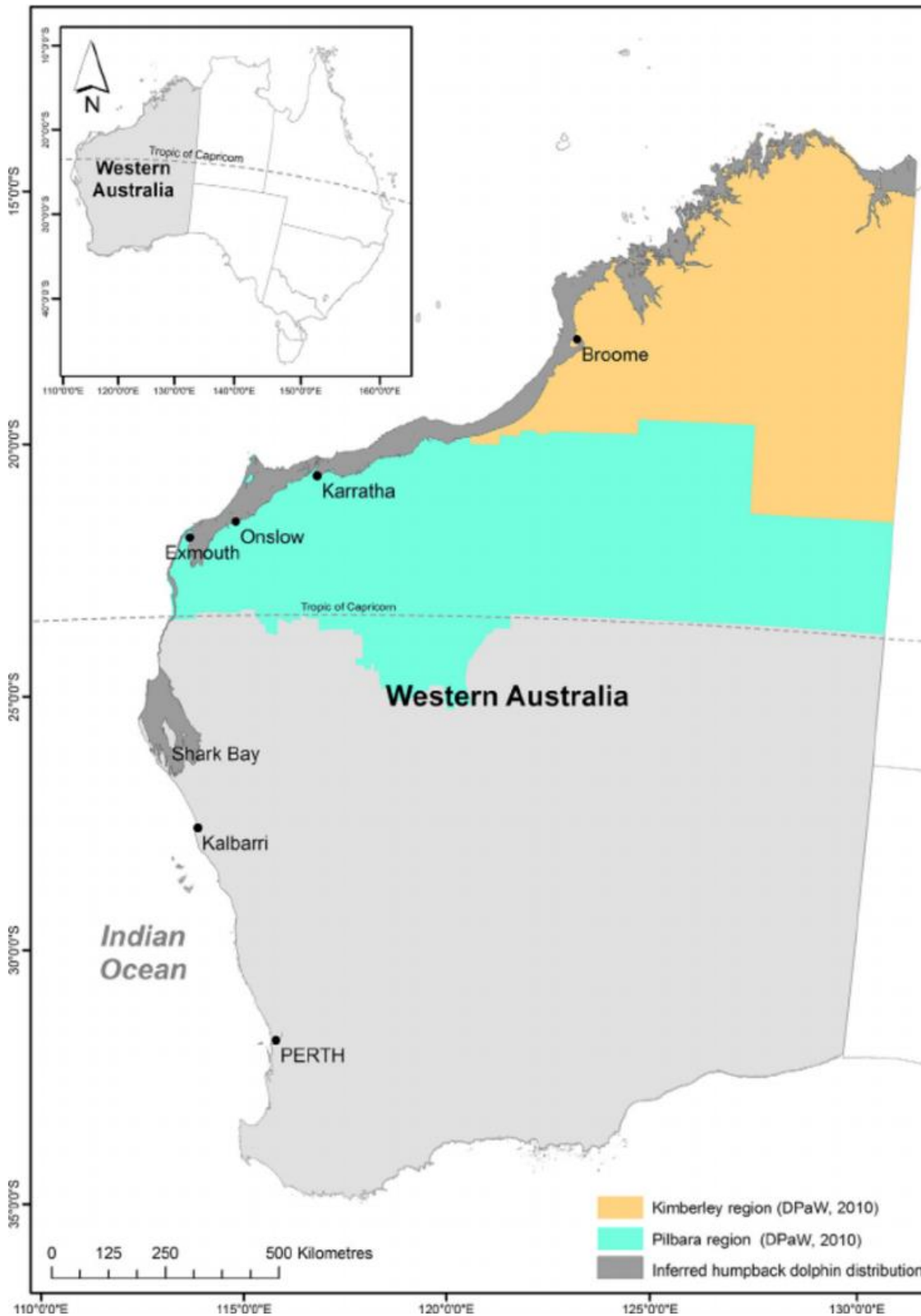
## Dolphins

Seven species of pelagic dolphin potentially occur in the region, many of which occur in mixed schools or cetacean communities (DSWEP 2012). The coastal dolphins in the Pilbara region are generally known to inhabit estuarine areas with mangrove forests and shallow coastal waters with seagrass, rock and/or coral reefs, sandy embayment's, coastal islands with fringing reefs, sheltered lagoons and offshore islands with associated reef which all appear to be important habitat to the species. The Project area contains suitable habitat for several species of dolphin, most notably the Australian Humpback and Indo-pacific bottle-nose dolphin. Both species have previously been recorded in the project area.

The abundance of dolphins in nearshore areas surrounding the Mardie coast is likely to be highest during winter and the distribution of dolphins is likely influenced by prey availability (RPS 2010). Dolphins will move inshore or offshore dependant on prey availability. Oceanographic currents, areas of upwelling, eddies, and increased nutrients all affect the abundance of zooplankton and transport of larval recruitment of finfish, which therefore have a seasonal effect on dolphin distribution (Hanf 2015).

The Australian humpback dolphin was the only conservation significant species known to occur in the Project area (**Appendix B**), with records of Australian humpback dolphins (*Sousa sahalensis*) reported throughout the year at the Montebello Islands (Raudino *et al* 2018) and in the Mardie Project area. They are likely to be one of the most common dolphin species occurring in the Project area. This species together with the Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*) are likely to be the most abundant dolphin species in the Mardie Project area inside the 20 m isobath (DSWEP 2012).

In Australia, the species' range extends from Shark Bay in Western Australia north and east to southern Queensland (**Figure 3**). In WA waters, less than 1% of the distribution of humpback dolphins has been surveyed adequately enough to assess their abundance (Parra *et al.* 2017).



**Figure 3** Distribution of Australian humpback dolphins, *Sousa sahulensis*, in Western Australia (WA), the Kimberley and Pilbara regions. Source: Parra *et al.* 2016.

Other species of dolphins are likely to be present further offshore. During aerial surveys of the Pilbara coast by CWR between May 2009 and April 2010, dolphins were spotted during almost every survey (CWR 2010). A total of 1681 dolphins were sighted with peak numbers observed in late May. Dolphins were predominantly sighted in the South-west portion of the Onslow region in water depths less than 50 m (i.e. towards Exmouth Gulf). Coastal dolphins were documented in varying abundance levels, with group sizes varying from seven to over 200 dolphins during the 12-month survey, although smaller groups (1-20 animals) were observed less than 5 km from shore (CWR 2010).

## Dugong

Dugong (*Dugong dugong*) are found throughout the Pilbara region (**Figure 4**), particularly close to the coast or in the lee of reef-fringed islands, typically in areas where seagrass has previously been recorded (CWR 2010). Dugong aggregations typically occur in large seagrass meadows, a subtidal BCH type not identified within the Project area.

Although Dugong have been previously recorded in the nearshore waters of the Mardie Coastline (Bayliss 2017; CWR 2010; RPS 2010), the nearest known Dugong aggregations have been recorded near Cape Preston in the north and Regnard Island in the north (50km north) and Coolgra Point in the South (100km south), generally in areas that consistently support extensive seagrass meadows (Bayliss 2017; CWR 2010; RPS 2010).

Historic studies further south of Mardie, estimated dugong population sizes for Exmouth Gulf at 95 animals and the Pilbara coastline at 2046 animals in 2000 (Prince 2001). This equated to density estimates of up to 9.1 individuals per 100 km of coastline in the Onslow to Dampier onshore sector. The low number of dugongs within the Exmouth Gulf area was attributed to the removal of seagrass by Cyclone Vance, causing animals to move to Shark Bay in search of new foraging ground (Prince 2001, Gales et al. 2004). Prince's (2001) Pilbara survey block encompassed coastal waters to the 20 m isobath north to the Montebello Islands, 20 km east of Robe River and 10 km west of Serrurier Island. Most dugongs were found to be distributed east of Barrow Island and Mary Anne Passage (Prince 2001). Following Cyclone Vance in the Exmouth Gulf and Ningaloo Reef are recognised as biologically important Dugong habitats, each with about 1,000 individuals (Grech, 2012). Recent evidence suggests that some populations have strong patterns of migration, which are thought to be driven by variations in food availability (Gales, 2004) and possibly by water temperature at the higher end of their latitudinal distribution (Sheppard *et al.* 2006).

Stantec (2018) recorded Dugong during aerial surveys in 2017 in the vicinity of the project area. However, no Dugong were observed in the Project area during over 700 hours of vessel-based observations, which is likely due to the lower value of the subtidal BCH in the Project area as suitable feeding or foraging habitat for Dugong. Specifically, at the time of the Mardie BCH surveys (i.e. March 2018), O2 Marine also conducted BCH surveys of the 40-mile beach area, located to the north of Mardie, near Cape Preston. These surveys identified extensive seagrass meadows with cover of *Halophila sp.* up to 50%, and four individual dugong were observed in this area over two days. This observation was considered to represent a significant contrast with the Mardie Project area, which did not support any seagrass meadows (O2 Marine 2020a), and no Dugong were observed in over 700 hours of vessel-based observations.



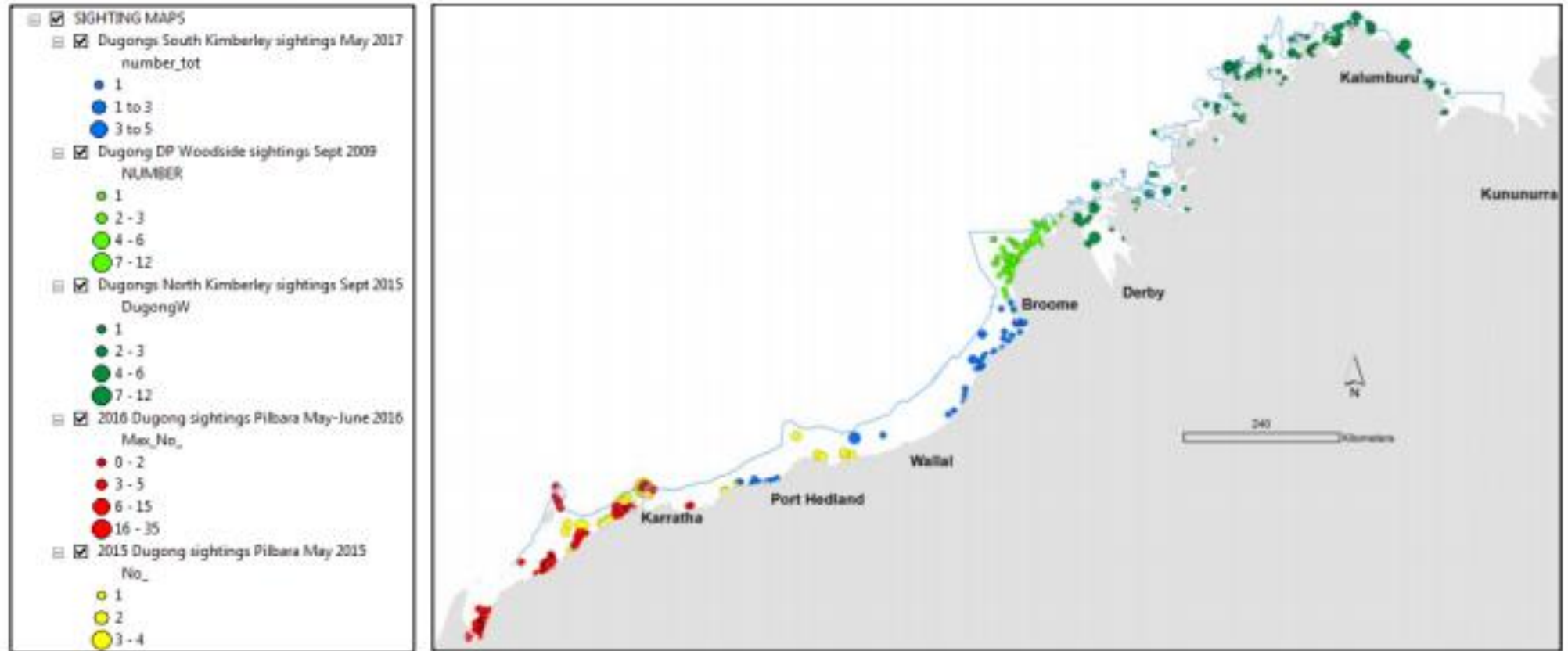


Figure 4 Dugong distribution and relative abundance of dugong sightings (Bayliss 2017).

### 3.3.2. Marine Reptiles (Excluding Turtles)

Other than marine turtles, the only threatened marine reptile species known to occur in the Project area is the short-nosed sea snake (*Aipysurus apraefrontalis*) which is listed as Critically Endangered. Sixteen (16) other species of seasnake were identified as potentially occurring in the Project area but not listed as threatened.

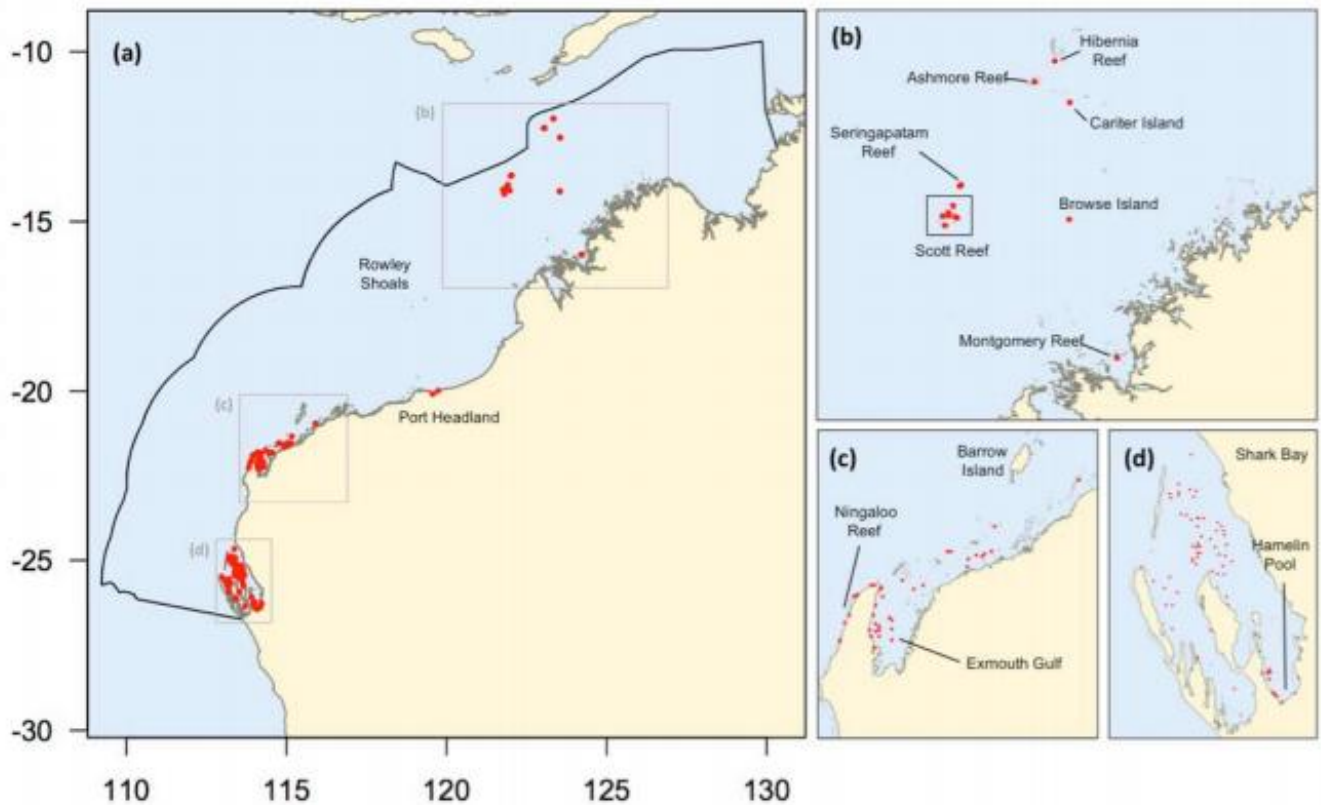
The North West Marine Region (NWMR) is considered a biodiversity hotspot for 'true' sea snakes within Australia and globally (CWR 2010) (**Figure 5**). As much of the Pilbara waters are quite turbid, sea snakes are infrequently encountered, and in many cases data deficient species are only known from a few specimens collected as fisheries bycatch and lack basic biological data. With little biological data available, the effects of anthropogenic threats are unknown.

All true sea snake species are strongly associated with benthic habitats, and occur in coastal, shallow water habitats (typically <100m depth). The Short-nosed sea snake (*Aipysurus apraefrontalis*) is typically found in reef flats or shallow waters along the outer reef edge in water depths to 10m (Cogger 2000; Guinea 1993, 1995; McCosker 1975). 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.”

Based on the above habitat description and the mapped subtidal BCH types within the project impact area, suitable habitat for the Short-nosed Sea Snake is unlikely to occur. Coral habitat comprises < 1% of the available habitat within the project area and is not predicted to be impacted. The nearest suitable habitat is located >5km away from any impacts. Given the Short-Nosed Sea Snake is predicted to remain within 50m of the reef flat, it is considered unlikely that it would be observed on a low-profile reef system >5km away that provides little to no refuge.

It is noted that whilst coral species are present in the Project area, they do not form a complex reef system with a reef edge, reef flat and lagoon. Rather sediment tolerant coral species are present in low abundance in areas where low profile limestone is exposed.

In studies done in the nearby Exmouth Gulf and Onslow region, a total of 17 sea snakes were captured via trawl net from three surveys between March and November 2004 (Kangas et al. 2006). Thirteen sea snakes were captured from sites located in the southern part of Exmouth Gulf, and a further three sea snakes species were caught in the central area of Exmouth Gulf. Five species of sea snake were recorded which included the Critically Endangered short-nosed sea snake (*Aipysurus apraefrontalis*) and listed marine species dubois' sea snake (*Aipysurus duboisii*), olive sea snake (*Aipysurus laevis*), olive-headed sea snake (*Disteira major*) and stoke's sea snake (*Disteira stokesii*). Thirteen sea snakes were caught during the March survey, the stoke's sea snake was the only sea snake caught during July and three dubois' sea snakes were caught in November 2004. No sea snakes were caught from the OPMF area during surveys undertaken in 2004 (Kangas et al. 2006), thus indicating that the Onslow region does not have the same importance for seas snakes as the Exmouth Gulf.



**Figure 5** Locations of geo-referenced surveys conducted focusing on sea snakes between 1973 and 2015. The surveys include snorkel, SCUBA, reef walks and trawl sampling conducted by multiple authors and institutions. Source: Udyawer, 2016.

### 3.3.3. Elasmobranchs

Listed threatened elasmobranchs identified through desktop assessment as potentially occurring in the Project area include three sawfish species, the Whale Shark (*Rhincodon typus*), Great White Shark (*Carcharodon carcharias*) and the Grey Nurse Shark (*Carcharias Taurus*). Two Manta Ray species, Giant Manta Ray (*Manta birostris*) and Reef Manta Ray (*Manta alfredi*) were also identified in the desktop searches. However, the likelihood of occurrence assessment (**Appendix B**) determined that only the green sawfish (*Pristis zijsron*) was known to occur in the project area.

The Northwest Marine Region is considered a particularly important area for sawfish species because the region and adjacent inshore coastal waters and riverine environments contain nationally and globally significant populations of sawfish species (DSEWPac 2012). However, relatively little is known about the distribution and abundance of sawfish species in north-western Australia (Morgan *et al* 2012).

In the Pilbara green sawfish are known to utilise the mouths of major river systems (i.e. Ashburton River) as pupping grounds and nursery areas, before juveniles migrate into adjacent creeks at approximately 3 to 6 months old, and then further offshore to mature at a length of about 3 m (Morgan *et al.* 2012). Acoustic tracking of green sawfish from the Ashburton shows that the species does not travel more than 700m upstream from the mouth of the river. In the Western Pilbara they are assumed to be present in all tidal creeks. In the Project area larger systems are represented by the Robe River and Fortescue River. Green sawfish are currently known from Exmouth Gulf, Whim Creek, Beagle Bay, Pender Bay, King Sound in Western Australia. Tidal mangrove systems, river estuaries, and rivers of

the King Sound provide ideal nursery habitat for juveniles <0.5m (Whitty et al, 2011 and Whitty, 2017, Elhassan 2018). Studies also indicate movement of the species away from turbid areas and low-salinity areas i.e. when rainfall flushes estuaries etc. mangrove and inshore areas used as nurseries where they spend their first few years of life and then move to deeper waters (Elhassan 2018).

Green sawfish are expected to be present in the creeks and rivers of the Mardie coastline. The habitats present within the intake creek are well represented in the region with as many as a dozen smaller size creeks within 100km.

In addition to the Green Sawfish, two other sawfish species, being the narrow sawfish (*Anoxypristis cuspidata*) and the dwarf sawfish (*Pristis clavata*) were also considered to potentially occur in the Project area. Although, the western extent of the dwarf sawfish's (*Pristis clavata*) range has not been fully resolved, therefore there is less certainty regarding the likelihood of this species occurring.

Other elasmobranch species such as the whale shark are mostly observed offshore in oceanic environments, however, they have also been observed inshore in coral areas, sometimes entering coral lagoons. The typical habitat for whale sharks is not present in the Project area (i.e. open oceanic environments), although is present within shipping routes. Previous aerial surveys of the region have not detected whale sharks in the project area, excluding the shipping area.

#### 3.3.4. Finfish

Desktop assessments identified 31 listed marine species from the order of ray finned fishes, syngnathiformes which includes the family Syngnathidea (seahorses, pipefishes, pipe horses and sea dragons). Most species are considered migratory and not threatened. Seahorse preferences for suitable habitat can be very diverse, although four species reported from the region each have individual preferences for suitable habitat ranging from soft bottom debris, algal rubble reefs, seagrass beds and coral reefs (Kangas *et al.* 2006). This information suggests there is a moderate potential that some of these species may occur in the Mardie Project area.

Although limited information exists regarding seahorses in the Mardie Project area, a trawl net study of the Exmouth gulf and Onslow region identified a total of 19 seahorses from four species between March and November 2004 (Kangas et al. 2006). The species included the western spiny seahorse (*Hippocampus angustus*) (11), the flat-faced seahorse (*Hippocampus planifrons*) (5), winged seahorse (*Hippocampus alatus*) (2) and zebra seahorse (*Hippocampus zebra*) (1). Two of these species were not identified within the EPBC desktop searches and the record for the zebra seahorse in the 2004 survey is notable given the species is known only from north eastern Australia and the west-central pacific (Fishbase 2017).

Finfish diversity in the region is high with at least 456 species known to exist in the Montebello/Mardie region (DEC 2007). Mangrove communities are particularly important in the region as they play a role in providing suitable habitat and nursery areas for fishes and crustaceans, including commercially important species (DEC 2007).

## 3.4. Other Marine Fauna

### 3.4.1. Subtidal Marine Fauna Community

The majority of the seabed substrate of Mardie Project area is comprised of bare sand/silt, with patches of sand and limestone veneer which support sparse (<5%) to moderate (10-25%) cover of filter feeders, macroalgae, seagrass and coral Benthic communities and habitat (BCH) (**Figure 6**). Many of the coastal islands also support large expanses of macroalgal dominated limestone reef, with isolated areas of dense hard coral occurring on the reef slope.

These nearshore habitats support a low to moderate abundance of fish and invertebrates, with species richness typically ranging from low in the nearshore areas to high further offshore and surrounding the reef-fringed islands. Marine species within the nearshore area are predominantly tropical and are short lived with high productivity, resulting in life-history traits of high fecundity and high productivity and high input into reproduction during their relatively short life spans. Most species are locally and regionally widespread with dominant species comprising a high proportion (i.e. ~80-90%) of marine fauna present. Dominant fishes and invertebrates typically recorded are those known to inhabit muddy/sediment (trawling grounds) habitats which include ponyfish, goatfish, flathead or crabs and prawns, and the mantis shrimp. However, some dominant fish also suit reef and weed habitat (Kangas *et al.* 2006).

### 3.4.2. Intertidal Marine Fauna Community

The Mardie Project area, supports intertidal habitats ranging from inland areas of mud flat / salt flat and algal mat communities, before extending towards the coast into samphire and mangrove communities along the coastal fringe and tidal creeks (**Figure 6**). The mangrove communities are recognised as regionally significant (EPA 2011) across much of the Mardie Project area and, as such are considered to represent the most significant habitat for marine fauna in the Mardie Project area.

In addition to migratory birds and turtles, the mangrove communities are known to provide important nursery and feeding areas for numerous fish and invertebrate species. Conspicuous among these are fishes known as mud-skippers, certain gastropod molluscs of the families Neritidae, Littorinidae, Potamididae and Ellobiidae, some barnacles, sesarmid and ocypodid crabs and several species of mud lobster and ghost shrimps. All species belong to taxa that are widespread in the Indo-Pacific region or are endemic to shores of the NW Shelf but have biogeographic affinities with that region. Many of the fish in mangrove creeks are occasional and sporadic visitors to the system that enter opportunistically during high tides and include groups such as sharks, longtoms, trevallies, queenfish, mackerel, pike and flatheads (URS 2010a, URS 2010b, URS 2010c).

Marine fauna in the algal mat zone are rare, although insects and insect larvae are sometimes seen under the algal mats. The salt flats are predominantly devoid of marine invertebrates (URS 2010a).



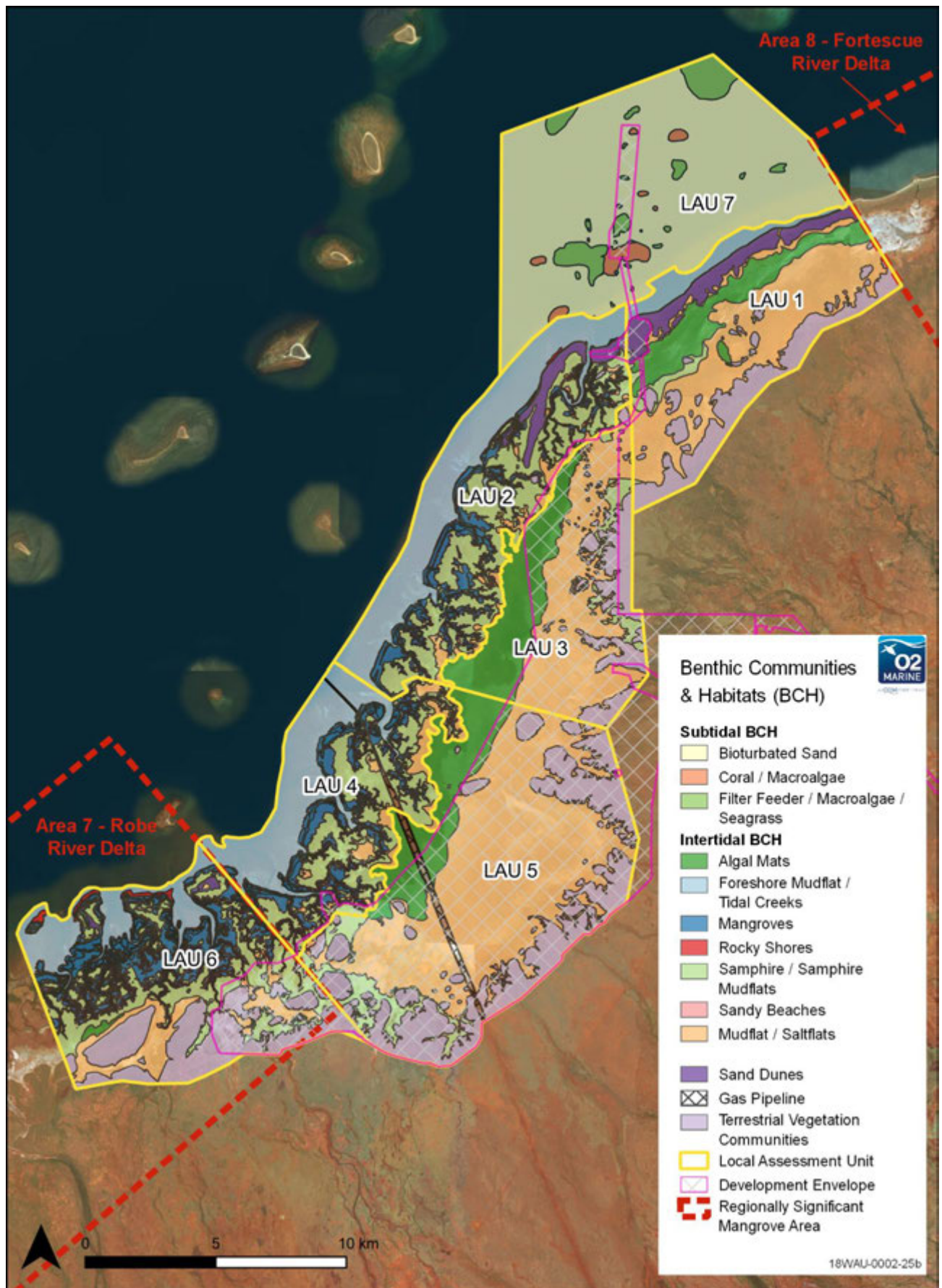


Figure 6 Benthic Communities and Habitat of the Mardie Project area



### 3.4.3. Introduced Marine Species

This section has been sourced from O2 Marine (2020c) unless stated otherwise.

Invasive Marine Species (IMS) are animals, plants, algae and other biota existing in a region beyond their natural geographical range, to which they have generally been translocated by human activity. Australia currently has over 250 known IMS but only a small proportion have become Introduced Marine Pests (IMP). IMPs are IMS that harm the marine environment, social amenity or industries that use the marine environment, or have the potential to do so if they were to be introduced, established, or spread in Australia's marine environment (DAWR 2018).

In 2008, Huisman et al. reported on 102 marine and estuarine species that were known to be introduced and established in WA at the time. Sixty species were considered to have been introduced by anthropogenic activity. Three of these species introduced to WA were listed on the Australian National IMS list (NIMPCG (2009a, 2009b): the dinoflagellate *Alexandrium minutum*, the bivalve *Musculista senhousia* and the polychaete *Sabella spallanzanii* (Wells 2018).

Six IMP alerts for WA were current at the time of the O2 Marine (2020c) report, including observations of Asian Green Mussel *Perna viridis* on a vessel at Barrow Island, Asian Paddle Crab *Charybdis japonica* in the Swan Estuary, Perth, Black Striped Mussel *Mytilopsis sallei*, European green crab *Carcinus maenas*, Japanese Kelp *Undaria pinnatifida* and Northern Pacific seastar *Asterias amurensis*. None of these species are known to have established self-sustaining populations in WA waters but all represent a serious threat.

Wells (2018) conducted a review of IMS in the Pilbara (based on results of publicly available studies) and found that 15 IMS are present, however only one species listed on the Australian National IMS list, the ascidian *Didemnum perlucidum*, has established a self-sustaining population.

The Mardie area has not been surveyed for IMPs in the past. However, nearby at Cape Preston, URS conducted an IMP survey in 2009 and found no IMP species listed by the NIMPCG (URS 2007). The IMP species *Didemnum perlucidum* is found at Barrow Island, approximately 50 km to the north-west of the Proposal (O2 Marine 2020c).

### 3.4.4. Commercial & Recreational Fisheries

Mardie sits within the Pilbara which is part of the North Coast Bioregion. One of the principal commercial fisheries in the North Coast bioregion focuses on tropical finfish such as emperors, snappers and cods and is considered the most valuable finfish sector in the state. Pearling and prawn trawling are also significant commercial fisheries in the region.

The numerous creek systems, mangroves, rivers and beaches provide shore and small boat fishing for a variety of finfish species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, cods, catfish, and invertebrate species including the blue swimmer crab, mud crabs and squid. Offshore islands and coral reef systems provide recreationally caught species including tropical snappers, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerel and billfish (URS 2011).

Details of spawning/aggregation times of key finfish species in the North Coast Bioregion are provided in **Table 8** (DoF 2011).

**Table 8** Spawning/aggregation times for key finfish species in the North Coast Bioregion.

Bioregion	Key Fish Species within zone	Spawning / Aggregation times
North Coast	Blacktip shark ( <i>Carcharhinus tilstoni</i> and <i>C. limbatus</i> )	November - December
North Coast	Goldband snapper ( <i>Pristipomoides multidens</i> )	January - April
North Coast	Pink snapper ( <i>Chrysophrys auratus</i> )	May - July
North Coast	Rankin cod ( <i>Epinephelus multinotatus</i> )	August - October
North Coast	Red emperor ( <i>Lutjanus sebae</i> )	October - March
North Coast	Sandbar shark ( <i>Carcharhinus plumbeus</i> )	October - January
North Coast	Spanish mackerel ( <i>Scomberomorus commerson</i> )	August - November

The commercial fisheries possibly occurring in the proposal area include:

- > Onslow Prawn Trawl Managed Fishery (OPMF);
- > Sea Cucumber (Beche de Mer) Fishery;
- > Marine Aquarium Fish Managed Fishery;
- > Pearl Oyster Managed Fishery (Zone 1);
- > Pilbara Line Fishery;
- > Pilbara Developmental Crab Fishery; and
- > Specimen Shell Managed Fishery.

Ongoing consultation with the Western Australian Fishing Industries Council (WAFIC) is being undertaken by Mardie Minerals Pty Ltd. This consultation is expected to confirm which fisheries are currently operating and how potential impacts (if any) to these fisheries may be mitigated.

Of the fisheries identified above, the Mardie Project area is known to be contained within the OPMF 'Fortescue Nursery Area' (**Figure 7**). Therefore, the OPMF may be at the greatest risk from the proposed activities and is discussed further below.

### Onslow Prawn Trawl Managed Fishery

The OPMF is located on the north coast of WA and encompasses approximately ~39,748 km<sup>2</sup>. The waters within the fishery are further divided into three fishing areas: Area 1, Area 2 and Area 3 (**Figure 7**). In addition, there are also three dedicated nurseries Ashburton Nursery, Coolgra Point Nursery and Fortescue Nursery (**Figure 7**), of which the Mardie Project is located within the Fortescue Nursery area.

The average catch of 96.8 tonnes is dominated by Tiger Prawns (*Penaeus esculentus*) and King Prawns (*P. latisulcatus*), with significant contributions from Endeavour Prawns (*Metapenaeus endeavouri*) and Banana Prawns (*P. merguensis*). Minor species in the fishery include Moreton Bay Bugs, Squid, Blue Swimmer Crabs, Cuttlefish, other prawn species (i.e. coral prawns), and some finfish

species. Consistent annual fishing effort occurs mostly between the Ashburton River and Onslow (Area 1) for banana and king prawns, and in the Mangrove Passage (Area 2) for tiger prawns. The nursery areas are managed as Size Management Fishery Grounds to allow sections of these areas to be fished on a seasonal basis when prawns are considered to have grown to an appropriate size and the area deemed suitable. The fishing season typically operates between March and November (URS 2011).

Fertilisation of the egg in penaeid prawns occurs while it is still attached to the female. Approximately one month after mating, the female prawns migrate into deeper offshore waters predominantly between August to October to spawn the fertilised eggs. The eggs hatch within 24 hours and the free-swimming nauplii have a relatively short 2-4 week planktonic larval stage before settling to the bottom and developing into juvenile prawns in shallow coastal areas. The young grow rapidly, reaching adult size within 3- 6 months. As they near the adult stage, the young prawns migrate offshore into the fishery area (URS 2011). Adult and juvenile prawns are thus spatially separated. Estuaries represent an important habitat for banana prawns. Post larvae settle in the upper reaches of small creek systems and the success of juvenile populations emigrating from the creeks correlates positively with rainfall during the wet season (Vance 1998).

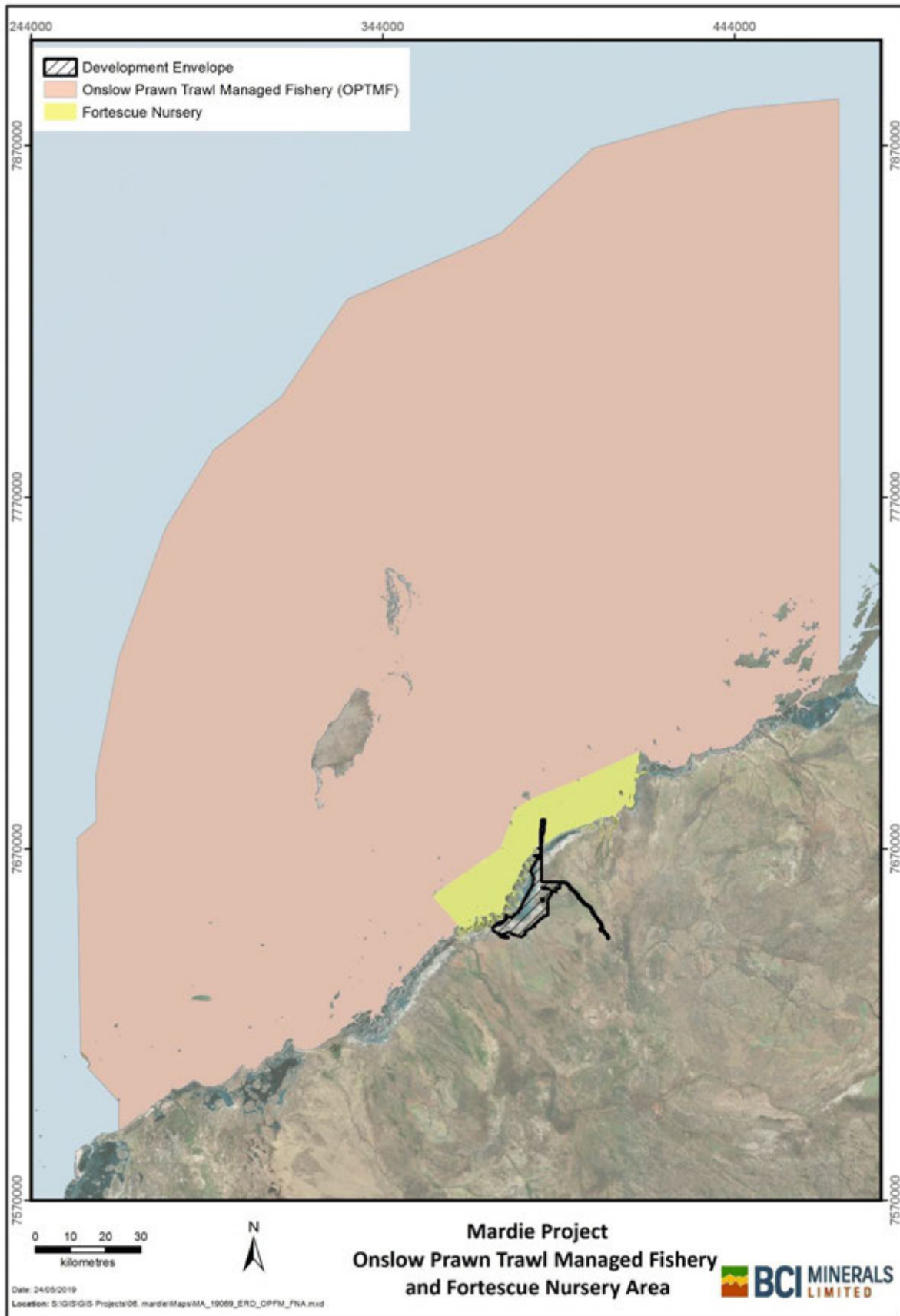


Figure 7 Onslow Prawn Managed Fishery Licence Areas and Nursery Grounds (URS 2011).

### 3.5. Environmental Windows and Key Habitat

A summary of the environmental windows and key habitat for conservation significant species relevant to the proposed Mardie Project is provided in **Table 9**. Key environmental windows that should be considered in evaluating impacts from the Mardie Project include:

- > The southern migration represents the time when humpback whales with their calves have a higher potential to occur within the Mardie Project area, although 5 km from the coastline would represent the boundary limit of their nearshore distribution due to the shallow nature of the intertidal mudflats;
- > Dolphins and Dugong generally are known to occur all year round however higher abundances are around June-September;
- > Sawfish pupping in the tidal creeks generally occurs between September and October and relies on sandy substrates between <1 m water depths.

**Table 9 Summary of Environmental Windows and Key Habitats**

Conservation Significant Species	Environmental Window	Key Habitat	Reference
Humpback Whales (nearshore Southern Migration)	Aug – Nov	Offshore -Typically 36 km from the coast	CWR (2010)
Dolphins (abundance)	Unknown	Coastal waters	CWR (2010)
Dugong (abundance)	June – Sept	<10 m NE & SW of Project area	CWR (2010)
Sawfish (pupping)	Sept - Oct	Tidal Creeks	Morgan (2017)

## 4. Conclusion

A combination of desktop review identified the five, conservation significant marine fauna (excluding turtles) that are either 'known to occur' or have a 'high potential to occur' in the Mardie Project area. These included:

- > Three marine mammals:
  - Humpback Whale;
  - Dugong; and
  - Australian Humpback Dolphin.
- > One marine reptile (excluding turtles):
  - Short-nosed Sea Snake; and
- > One Elasmobranch:
  - Green Sawfish

The following key conclusions are made with respect to these conservation significant species:

- > Humpback whales were considered to be transient and are only likely to use the Project area as a stopover point during the southern migration period (i.e. September). However, they have been observed previously within 5km of the Project and as such management measures should consider impacts to this species;
- > Dugong have been observed in the vicinity of the Project area. However, the project area is considered to be of limited value to dugong populations due to lack of important feeding and foraging habitat (i.e. seagrass meadows). This conclusion is supported by aerial surveys and vessel-based observations which identified Coolgra Point to the south and Cape Preston to the north as supporting greater number of dugong. Nevertheless, dugong may be present in the Project area, particularly between June – September and management measures should consider impacts to this species;
- > Australian Humpback dolphins have previously been recorded in the Project area and as such management measures should consider impacts to this and other dolphin species;
- > The Short-nosed sea snake has not been previously recorded in the Mardie Project area. This species is typically found in coral reef habitats, which in the waters of the Project area are largely confined to the nearshore islands with fringing coral reefs and/or isolated reef patches. It is therefore unlikely the project would disturb or alter the habitat of this species and therefore it is unlikely any impact is expected to occur to this species as a result of the project; and
- > Two species of sawfish have been recorded in similar tidal creeks located to both the north and south of the Mardie Project area and appropriate management measures should be considered to avoid impacts to this species, including consideration of impacts to pupping in the tidal creeks between September to October.

In addition to conservation significant species, the Onslow Prawn Managed Fishery (OPMF) Fortescue Nursery Area was identified as a commercially important area which encompasses the entire Mardie Project area. Therefore, ongoing consultation with WAFIC is considered important to informing the development of any appropriate management strategies to mitigate impacts on this important nursery area.



The extensive mangrove habitats of the Project area were recognised as the most important habitat feature of the Project area for marine fauna as these provide important nursery and feeding areas for a range of species, including fish, turtles, invertebrates and migratory birds. However, overall the Mardie Project area was not considered to be of particular significance to any conservation significant marine fauna species (with the exception of marine migratory birds and marine turtles which are discussed in other reports).

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## Appendix A Database Searches

## Appendix B Likelihood of Occurrence Assessment

Codes used in the following likelihood of occurrence tables:

- > EPBC Act (species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*): Ex = Extinct, CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, MM = Migratory Marine, MT = Migratory Terrestrial, MW = Migratory Wetlands, Ma = Listed Marine
- > BC Act (species listed under the Western Australian *Biodiversity Conservation Act 2016*):
- > Threatened Species: EX = Presumed Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, IA = Migratory birds protected under an International Agreement, CD = Conservation Dependent, OS = Other Specially Protected
- > Priority Species: P1 = Priority 1, P2 = Priority 2, P3 = Priority 3, P4 = Priority 4
- > IUCN (species listed under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species): EX = Extinct, EW = Extinct in the Wild, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern

## Mammals

Species Name	EPBC Status	Act	WC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
<u>Dugong dugon</u> Dugong	MM, Ma		OS	VU	Dugongs undertake long-distance movements, which means Australia shares populations with other neighbouring countries. In Australia, dugongs occur in the shallow coastal waters of northern Australia from the Queensland/New South Wales border in the east to Shark Bay on the Western Australian coast. They are also found in other parts of the Indian and Pacific Oceans in warm shallow seas in areas where seagrass is found.	Record 2014 <b>Known to occur</b> The species has been recorded in the region (desktop searches) and suitable habitat is present at the project area.
<u>Sousa sahalensis</u> Australian humpback dolphin	MM, C		P4	NT	In Australia, Indo-Pacific Humpback Dolphins are known to occur along the northern coastline, extending to Exmouth Gulf on the west coast (25° S), and the Queensland/NSW border region on the east coast (34° S) (Corkeron et al. 1997). There are few records between the Gulf of Carpentaria in the north and Exmouth Gulf in the west, this is probably due to a lack of research effort and the remoteness of the area (Bannister et al. 1996; Parra et al. 2002).	Record 2014 <b>Known to occur</b> The species has been recorded in the region (desktop searches) and suitable habitat is present at the project area
<u>Megaptera novaeangliae</u> Humpback Whale	V, MM		CD	LC	Humpback whales utilising Australian waters currently have tropical calving grounds along the mid and northern parts of the east and west coasts of Australia, with feeding grounds in the Southern Ocean. The majority of humpbacks in Australian waters migrate north to tropical calving grounds from June to August, and south to the Southern Ocean feeding areas from September to November. The migratory habitat for the humpback whale around mainland Australia is primarily coastal waters less than 200 m in depth and generally within 20 km of the coast.	Record 2014 <b>Known to occur</b> The species has been recorded in the region (desktop searches). Typically occur further offshore (>35 km) during migratory routes, although some whales recorded in <10m during southern migration (i.e. September).
<u>Stenella longirostris</u> Spinner dolphin	C		P4	DD	Long-snouted Spinner Dolphins are found in tropical, subtropical and, less frequently, in warm temperate waters. Their global range is between approximately 30–40° N and 20–30° S (DEWHA 2008a) in the Indian, Pacific and Atlantic Oceans (DEWHA 2008) In Australia, there are records of Long-snouted Spinner Dolphins from Western Australia, as far south as Bunbury (33°19' S), as well as from the Northern Territory (including numerous records of these dolphins caught in the Arafura and Timor seas as bycatch in the gillnet fishing industry during 1981–85). Their primary distribution is in pelagic zones, but they are frequently found over shelf waters. Some	Record 2013 <b>Low potential to occur</b> The species has been recorded in the region (desktop searches), however are primarily pelagic (occurring in open ocean) but they can be neritic (occurring over the continental shelf) in some regions, therefore suitable

Species Name	EPBC Status	Act	WC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
					forms are regularly found in shallow waters, particularly near islands and shallow reefs (Leatherwood & Reeves 1983; Perrin 2002).	habitat is generally lacking from the project area.
<u>Balaenoptera musculus</u> Blue Whale	E, C		MM	EN	The blue whale is a cosmopolitan species, found in all oceans except the Arctic, but absent from some regional seas such as the Mediterranean, Okhotsk and Bering seas. Blue whales feed almost exclusively on krill, with a variety of species being taken by different blue whale populations. They feed both at the surface and also at depth, following the diurnal vertical migrations of their prey to at least 100 m. The migration patterns of blue whales are not well understood, but appear to be highly diverse. (Reilly et al., 2008)	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches), however is known to occur in the area and in similar habitats to the project area (Commonwealth of Australia, 2015).
<u>Tursiops aduncus</u> Indo-Pacific/Spotted Bottlenose Dolphin	MM, C		MM		At species level, the Indian Ocean Bottlenose Dolphins are found in tropical and sub-tropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific Region and the western Pacific Ocean (Möller & Beheregaray 2001). Bottlenose dolphins are distributed continuously around the Australian mainland, but the taxonomic status of many populations is unknown. Indian Ocean Bottlenose Dolphins have been confirmed to occur in estuarine and coastal waters of eastern, western and northern Australia (Möller & Beheregaray 2001).	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches) however suitable habitat occurs at the project area.
<u>Sousa sahalensis</u> Indo-Pacific Humpback Dolphin	MM, C		P4	NT	Australian humpback dolphins are found in tropical/subtropical waters of the Sahul Shelf from northern Australia to the southern waters of the island of New Guinea (Jefferson and Rosenbaum, 2014). In Australia, humpback dolphins are thought to be widely distributed along the northern Australian coastline from approximately the Queensland–New South Wales border to western Shark Bay, Western Australia (Parra & Cagnazzi 2016). Most studies to date indicate that Australian humpback dolphins occur mostly close to the coast (within 20 km from land) and in relatively sheltered offshore waters near reefs or islands (Parra & Cagnazzi 2016)	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches) however suitable habitat occurs at the project area.
<u>Eubalaena australis</u> Southern Right Whale	E, MM, C		VU	LC	In Australian coastal waters, southern right whales occur along the southern coastline including Tasmania, generally as far north as Sydney on the east coast and Perth on the west coast. There are occasional	<b>Low potential to occur</b> The species has not been recorded in the region (no records from desktop searches) and the distribution for this

Species Name	EPBC Status	Act	WC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
					occurrences further north, with the extremities of their range recorded as Hervey Bay (25°00'S, 152°50'E) and Exmouth (22°23'S, 114°07'E).	species occurs significantly south of the survey area.
<u>Orcaella heinsohni</u> Australian snubfin dolphin	MM, C		P4	VU	Stranding and museum specimen records indicate that Australian Snubfin Dolphins occur only in waters off the northern half of Australia, from approximately Broome (17° 57' S) on the west coast to the Brisbane River (27° 32' S) on the east coast (Parra et al. 2002a). Aerial and boat-based surveys indicate that Australian Snubfin Dolphins occur mostly in protected shallow waters close to the coast, and close to river and creek mouths (Parra et al. 2002a).	Record 2013 <b>Low potential to occur</b> The species has been recorded in the region (desktop searches), however suitable habitat is generally lacking from the project area.

## Reptiles

Species Name	EPBC Act Status	BC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
<u>Aipysurus apraefrontalis</u> Short-nosed Seasnake	CE, Ma	CR	CR	The Short-nosed Seasnake is endemic to Western Australia, and has been recorded from Exmouth Gulf, Western Australia to the reefs of the Sahul Shelf, in the eastern Indian Ocean. The species prefers the reef flats or shallow waters along the outer reef edge in water depths to 10 m (McCosker 1975).	<b>High potential to occur</b> The species has not been recorded in the region (desktop searches). The project area contains suitable habitat and is within the known distribution of the species.

## Sharks and Rays

Species Name	EPBC Act Status	BC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
<u>Pristis clavata</u> Dwarf Sawfish	V, MM	P1	EN	The species' Australian distribution has previously been considered to extend north from Cairns around the Cape York Peninsula in Queensland, across northern Australian waters to the Pilbara coast in Western Australia (Last & Stevens 1994). The Dwarf Sawfish usually inhabits shallow (2–3 m) coastal waters and estuarine habitats.	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches). The western extent of this species range has not been fully resolved, however suitable habitat is present in the project area.
<u>Pristis zijsron</u> Green Sawfish	V, MM	VU	CR	The green sawfish inhabit shallow coastal marine and estuarine waters of northern Australia, from about Eighty Mile Beach, Western Australia, to the Cairns region, Queensland. It has been occasionally been caught as far south as Sydney. Green sawfish are known to be pupped near the Ashburton River mouth and utilise the estuary and nearby mangrove creeks, before moving offshore to mature at a length of about 3 m (Morgan et al. 2017).	<b>High potential to occur</b> The species is known to occur in the region from recent scientific studies (Morgan et al 2017). Suitable habitat is also present in the project area, however no records exist from within the Project area.
<u>Carcharias taurus</u> Grey Nurse Shark	V	VU		The Grey Nurse Shark (west coast population) has a broad inshore distribution, primarily in sub-tropical to cool temperate waters. The population of Grey Nurse Shark (west coast population) is predominantly found in the south-west coastal waters of Western Australia and has been recorded as far north as the North West Shelf (Last & Stevens 1994).	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches). Predominantly found in cooler coastal waters further south, however, has been found at Muiron



Species Name	EPBC Act Status	BC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
					Islands and potential suitable habitat does exist in project area.
<u>Anoxypristis cuspidate</u> Narrow Sawfish	MM		EN	The Narrow Sawfish is an Indo-West Pacific species occurring from the northern Persian (Arabian) Gulf to Australia and north to Japan. It is a benthic-pelagic species that occurs from inshore and estuarine areas to offshore habitats in depths of up to 100 m (Anastasi et al 2013) Common in sheltered bays with sandy bottoms and feed on small fish and cuttlefish (Compagno and Last 1999).	<b>Moderate potential to occur</b> The species has not been recorded in the region (desktop searches) and the exact distribution is uncertain. The project area contains suitable habitat.
<u>Rhincodon typus</u> Whale Shark	V, MM	OS	EN	Found worldwide in tropical and subtropical oceans. (OzFishNet, 2016). In Australia, the Whale Shark is known from NSW, Queensland, Northern Territory, Western Australia and occasionally Victoria and South Australia, but it is most commonly seen in waters off northern Western Australia, Northern Territory and Queensland (Compagno and Last 1999). Yearly numbers of Whale Sharks in Ningaloo Marine Park are estimated to vary between 300 and 500 individuals Research conducted in 2003 on Whale Sharks aggregating at Ningaloo Reef found that this species routinely moved between the sea surface and depth. Sharks spent at least 40% of their time in the upper 15 m of the water column and at least 50% of their time at depths equal to or less than 30 m (Wilson et al. 2006).	<b>Low potential to occur</b> The species has not been recorded in the region (no records from desktop searches) and are generally found in waters deeper than present at the project area.
<u>Carcharodon carcharias</u> Great White Shark	V, MM	VU	VU	In Australia, Great White Sharks have been recorded from central Queensland around the south coast to north-west Western Australia but may occur further north on both coasts (Bonfil et al. 2005). They inhabit inshore waters around rocky reefs, surf beaches and shallow coastal bays; waters on the outer continental shelf and slope; and the open ocean. These sharks most commonly live in depths above 100 m.	<b>Low potential to occur</b> The species has not been recorded in the region (no records from desktop searches). Has been found to Muiron Islands although predominantly found in cooler coastal waters further south, suitable habitat is lacking from project area.
<u>Manta birostris</u> Giant Manta Ray	MM		VU	The Manta Ray lives in tropical, marine waters worldwide, but is also found occasionally in temperate seas. In Australia it is recorded from south-western Western Australia, around the tropical north of the country and south to the southern coast of New South Wales (DBCA, 2017). The species is known to occur in the Ningaloo Marine Park, Muiron Islands Marine Management Area, Montebello Islands Marine Park, Eighty Mile Beach	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches). Potential habitat does occur near the project area.

Species Name	EPBC Act Status	BC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
				Marine Park, Lalang-garram / Camden Sound Marine Park and Rowley Shoals Marine Park (Last & Stevens 1994).	
<u>Manta alfredi</u> Reef Manta Ray	MM		VU	Reef manta rays are found primarily in the Indian and Pacific Oceans, including coastal waters surrounding Australia, Japan, South Africa, Thailand and Hawaii (Fabrice, et al., 2012). This species is generally found in inshore habitats (within a few kilometers of land) in tropical and subtropical latitudes. They are often sighted near coral and rocky reefs in atolls and bays, likely due to the high densities of zooplankton associated with these areas (Anderson, et al., 2011).	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches). Potential habitat does occur near the project area.

## Migratory/Marine Species

Class	Species	Common Name	EPBC Status	Act	BC Act Status	IUCN	Record in searches
Fish	<i>Acentronura larsonae</i>	Helen's Pygmy Pipehorse	Ma			DD	
Fish	<i>Bulbonaricus brauni</i>	Braun's Pughead Pipefish, Pug-headed Pipefish	Ma		Ma	LC	
Fish	<i>Campichthys tricarinatus</i>	Three-keel Pipefish	Ma		Ma	DD	
Fish	<i>Choeroichthys brachysoma</i>	Pacific Short-bodied Pipefish, Short-bodied Pipefish	Ma		Ma	LC	
Fish	<i>Choeroichthys latispinosus</i>	Murion Island Pipefish	Ma		Ma	DD	
Fish	<i>Choeroichthys suillus</i>	Pig-snouted Pipefish	Ma		Ma	LC	
Fish	<i>Doryrhamphus dactyliophorus</i>	Banded Pipefish, Ringed Pipefish	Ma		Ma	DD	
Fish	<i>Doryrhamphus janssi</i>	Cleaner Pipefish, Janss' Pipefish	Ma		Ma	LC	
Fish	<i>Doryrhamphus multiannulatus</i>	Many-Banded Pipefish	Ma		Ma		
Fish	<i>Doryrhamphus negrosensis</i>	Flagtail Pipefish, Masthead Island Pipefish	Ma		Ma	LC	
Fish	<i>Festucalex scalaris</i>	Ladder Pipefish	Ma		Ma		
Fish	<i>Filicampus tigris</i>	Tiger Pipefish	Ma		Ma	LC	
Fish	<i>Halicampus brocki</i>	Brock's Pipefish	Ma		Ma	LC	
Fish	<i>Halicampus grayi</i>	Mud Pipefish, Gray's Pipefish	Ma		Ma	LC	
Fish	<i>Halicampus nitidus</i>	Glittering Pipefish	Ma		Ma	LC	
Fish	<i>Halicampus spinirostris</i>	Spiny-snout Pipefish	Ma		Ma		
Fish	<i>Haliichthys taeniophorus</i>	Ribboned Pipehorse, Ribboned Seadragon	Ma		Ma	LC	
Fish	<i>Hippichthys penicillus</i>	Beady Pipefish, Steep-nosed Pipefish	Ma		Ma	LC	
Fish	<i>Hippocampus angustus</i>	Western Spiny Seahorse, Narrow-bellied Seahorse	Ma		Ma	DD	
Fish	<i>Hippocampus histrix</i>	Spiny Seahorse, Thorny Seahorse	Ma		Ma	VU	
Fish	<i>Hippocampus kuda</i>	Spotted Seahorse, Yellow Seahorse	Ma		Ma	VU	
Fish	<i>Hippocampus planifrons</i>	Flat-face Seahorse	Ma		Ma		
Fish	<i>Hippocampus trimaculatus</i>	Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse	Ma		Ma	VU	
Fish	<i>Micrognathus micronotopterus</i>	Tidepool Pipefish	Ma		Ma	LC	
Fish	<i>Phoxocampus belcheri</i>	Black Rock Pipefish	Ma		Ma	LC	
Fish	<i>Solegnathus hardwickii</i>	Pallid Pipehorse, Hardwick's Pipehorse	Ma		Ma	DD	

Class	Species	Common Name	EPBC Status	Act	BC Act Status	IUCN	Record in searches
Fish	<i>Solegnathus lettiensis</i>	Gunther's Pipehorse, Indonesian Pipefish	Ma		Ma	DD	
Fish	<i>Solenostomus cyanopterus</i>	Robust Ghostpipefish, Blue-finned Ghost Pipefish,	Ma		Ma	LC	
Fish	<i>Solenostomus paegnius</i>	Rough-snout Ghost Pipefish	Ma		Ma	LC	
Fish	<i>Syngnathoides biaculeatus</i>	Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish	Ma		Ma	DD	
Fish	<i>Trachyrhamphus bicoarctatus</i>	Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish	Ma		Ma	LC	
Fish	<i>Trachyrhamphus longirostris</i>	Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish	Ma		Ma	LC	
Mammal	<i>Balaenoptera acutorostrata</i>	Minke Whale	C		Whales & Cetaceans	LC	
Mammal	<i>Delphinus delphis</i>	Common Dolphin, Short-beaked Common Dolphin	C		Whales & Cetaceans	LC	
Mammal	<i>Grampus griseus</i>	Risso's Dolphin, Grampus	C		Whales & Cetaceans	LC	
Mammal	<i>Stenella attenuata</i>	Spotted Dolphin, Pantropical Spotted Dolphin	C		Whales & Cetaceans	LC	
Mammal	<i>Tursiops truncatus s. str.</i>	Bottlenose Dolphin	C		Whales & Cetaceans		
Mammal	<i>Balaenoptera edeni</i>	Bryde's Whale	MM, C		MM	DD	
Mammal	<i>Orcinus orca</i>	Killer Whale, Orca	MM, C		MM	DD	
Reptile	<i>Hydrelaps darwiniensis</i>	Black-ringed Seasnake	Ma		Ma	LC	
Reptile	<i>Acalyptophis peronii</i>	Horned Seasnake	Ma		Ma	LC	
Reptile	<i>Aipysurus duboisii</i>	Dubois' Seasnake	Ma		Ma	LC	
Reptile	<i>Aipysurus eydouxii</i>	Spine-tailed Seasnake	Ma		Ma	LC	
Reptile	<i>Aipysurus laevis</i>	Olive Seasnake	Ma		Ma	LC	
Reptile	<i>Astrotia stokesii</i>	Stokes' Seasnake	Ma		Ma	LC	
Reptile	<i>Disteira kingii</i>	Spectacled Seasnake	Ma		Ma		
Reptile	<i>Disteira major</i>	Olive-headed Seasnake	Ma		Ma		
Reptile	<i>Emydocephalus annulatus</i>	Turtle-headed Seasnake	Ma		Ma	LC	
Reptile	<i>Ephalophis greyi</i>	North-western Mangrove Seasnake	Ma		Ma		
Reptile	<i>Hydrophis czeblukovi</i>	Fine-spined Seasnake	Ma		Ma	DD	
Reptile	<i>Hydrophis elegans</i>	Elegant Seasnake	Ma		Ma	LC	
Reptile	<i>Hydrophis macdowelli</i>	Small headed Seasnake	Ma		Ma	LC	
Reptile	<i>Hydrophis ornatus</i>	Spotted Seasnake, Ornate Reef Seasnake	Ma		Ma	LC	
Reptile	<i>Pelamis platurus</i>	Yellow-bellied Seasnake	Ma		Ma		

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## Acronyms and Abbreviations

Acronyms/Abbreviation	Description
BC	Biodiversity Conservation
BCH	Benthic Community Habitat
BCI	BCI Minerals Ltd
CAMBA	The China-Australia Migratory Bird Agreement
CE or CR	Critically Endangered
CD	Conservation Dependent
CWR	Centre for Whale Research
DBCA	Department of Biodiversity Conservation and Attractions
DD	Data Deficient
DoE	Department of Environment
DoEE	Department of the Environment and Energy
DoF	Department of Fisheries
DPaW	Department of Parks and Wildlife
E	East
E	Endangered
EIA	Environmental Impact Assessment
EP	Environmental Protection
EPA	Environmental Protection Authority
ESD	Environmental Scoping Document
EPBC	Environmental Protection Biodiversity and Conservation
EW	Extinct in the Wild
Ex	Extinct
GLpa	Gigalitre per annum
ha	Hectare
IA	Migratory birds
IMP	Introduced Marine Pests
IMS	Introduced Marine Species
IUCN	International Union for Conservation of Nature
JAMBA	The Japan-Australia Migratory Bird Agreement
Km	Kilometers
Km <sup>2</sup>	Square Kilometers



Acronyms/Abbreviation	Description
Ktpa	Kilo tonnes per annum
L	Least Concern
LR	Lower Risk
M <sup>3</sup>	Meter cubed
M	Migratory
Ma	Listed Marine
MM	Migratory Marine
MNES	Matters of National Environmental Significance
MT	Migratory Terrestrial
Mtpa	Million tonnes per annum
MW	Migratory Wetlands
NaCl	Salt
NE	North East
NIMPCG	National Introduced Pests Coordination Group
NT	Near Threatened
NW	North West
NWMR	North West Management Region
NWSJEMS	North West Shelf Joint Environmental Management Study
OPMF	Onslow Prawn Managed Fishery
OS	Other Specially Protected
P1-P5	Priority Species
PMST	Protected Matters Search Tool
Pty Ltd	Proprietary Limited
ROKAMBA	The Republic of Korea-Australia Migratory Bird Agreement
S	South
SW	South West
SoP	Sulfate of Potash
TECs	Threatened Ecological Communities
V or VU	Vulnerable
WAFIC	Western Australian Fisheries Industry Council
WA	Western Australia
WC	Wildlife Conservation

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### **Appendix A Database Searches**

### **Appendix B Likelihood of Occurrence Table**

# 1. Introduction

## 1.1. Project Description

### 1.1.1. Proposal Summary

**Table 1 Proposal Summary**

Proposal Title	Mardie Project
Proponent Name	Mardie Minerals Pty Ltd
Short Description	<p>Mardie Minerals Pty Ltd is seeking to develop a greenfields high quality salt and sulphate of potash (SOP) project and associated export facility at Mardie, approximately 80 km south west of Karratha, in the Pilbara region of WA. The Proposal will utilise seawater to produce a high purity salt product, SOP and other products derived from sea water.</p> <p>The Proposal includes the development of a seawater intake, concentrator and crystalliser ponds, processing facilities and stockpile areas, bitterns disposal pipeline and diffuser, trestle jetty export facility, transshipment channel, drainage channels, access / haul roads, causeway, desalination (reverse osmosis) plant, borrow pits, pipelines, and associated infrastructure (power supply, communications equipment, offices, workshops, accommodation village, laydown areas, sewage treatment plant, landfill facility, etc.).</p>

### 1.1.2. Proposal Description

Mardie Minerals Pty Ltd (Mardie Minerals) seeks to develop the Mardie Project (the Proposal), a greenfields high-quality salt project in the Pilbara region of Western Australia (Figure 1) Mardie Minerals is a wholly-owned subsidiary of BCI Minerals Limited.

The Proposal is a solar salt project that utilises seawater and evaporation to produce raw salts as a feedstock for dedicated processing facilities that will produce a high purity salt, industrial grade fertiliser products, and other commercial by-products. Production rates of 4.0 Million tonnes per annum (Mtpa) of salt (NaCl), 100 kilotonnes per annum (ktpa) of Sulphate of Potash (SoP), and up to 300 ktpa of other salt products are being targeted, sourced from a 150 Gigalitre per annum (GLpa) seawater intake. To meet this production, the following infrastructure will be developed:

- > Primary seawater intake pump station;
- > Concentrator ponds;
- > Crystalliser ponds;
- > Processing facilities and stockpiles;
- > Causeway, trestle jetty and transshipment berth/channel;
- > Bitterns disposal pipeline, seawater intake (for dilution) and diffuser;
- > Drainage channels and flood protection levees;
- > Administration buildings;
- > Accommodation village;
- > Access / haul roads;

- > Desalination plant for freshwater production;
- > Boat launching facility and port stockyard; and
- > Associated infrastructure including power supply, communications, workshop, laydown, landfill facility, sewage treatment plant.

Seawater for the process will be pumped from a large tidal creek into the concentrator ponds. All pumps will be screened and operated accordingly to minimise entrapment of marine fauna and any reductions in water levels in the tidal creek.

Concentrator and crystalliser ponds will be developed behind low permeability walls engineered from local clays and soils and rock armoured to protect against erosion. The height of the walls varies across the project and is matched to the storm risk for the area.

Potable water will be required for the production plants and the village. The water supply will be sourced from desalination plants across the Proposal. The high salinity brine output from the plants will be directed to concentrator ponds or a lined process pond.

A trestle jetty will be constructed to convey salt (NaCl) from the salt production stockpile to the transshipment berth pocket, approximately 2.2 km offshore. The jetty will not impede coastal water or sediment movement, thus ensuring coastal processes are maintained.

Dredging of up to 850,000 m<sup>3</sup> will be required to ensure sufficient depth for the transhipper berth pocket at the end of the trestle jetty, as well as along a 4.5 km long channel out to deeper water. The average depth of dredging is approximately 1 m below the current sea floor. The dredge spoil is inert and will be transported to shore for use within the development.

The production process will produce a high-salinity bittern that, prior to its discharge through a diffuser at the far end of the trestle jetty, will be diluted with seawater to bring its salinity closer to that of the receiving environment.

Access to the project from North West Coastal Highway will be based on an existing public road alignment that services the Mardie Station homestead and will require upgrading..

The majority of the power required for the project (i.e. approximately 95%) is provided by the sun and the wind, which drives the evaporation and crystallisation processes. In addition, the Proposal will require diesel and gas to provide additional energy for infrastructure, support services and processing plant requirements.

The Proposal will be developed within three development envelopes. The boundaries of these development envelopes are shown in Figure 1 & Figure 2 and described in Table 2.

**Table 2 Location and proposed extent of physical and operational elements**

Element	Ref.	Proposed Extent
<b>Physical Elements</b>		
1. Ponds & Terrestrial Infrastructure Development Envelope – concentrator and crystalliser ponds, processing plant, access / haul road, desalination plant, causeway, administration, accommodation village, laydown, other infrastructure.	Fig. 2	Disturbance of no more than 11,142 ha within the 15,667 ha Ponds & Terrestrial Infrastructure Development Envelope.
2. Marine Development Envelope – trestle jetty, seawater intake and pipelines.	Fig. 2	Disturbance of no more than 7 ha within the 53 ha Marine Development Envelope.
3. Dredge Channel Development Envelope – berth pocket, channel to allow access for transshipment vessels, bitterns outfall diffuser.	Fig. 2	Disturbance of no more than 66 ha within the 304 ha Dredge Channel Development Envelope.
4. Mangrove Disturbance	Fig. 2	Disturbance of mangrove communities limited to 20 ha of Scattered Canopy mangroves and no Closed Canopy mangroves
<b>Operational Elements</b>		
Desalination Plant discharge	Fig. 2	Discharge to ponds or bitterns stream
Dredge volume	Fig. 2	Dredging is only to occur within the Dredge Channel Development Envelope. Dredging of no more than 850,000 m <sup>3</sup> of material from the berth pocket and high points within the dredge channel, with the material to be deposited within the Ponds & Terrestrial Infrastructure Development Envelope.
Bitterns discharge	Fig. 2	Discharge of up to 3.6 gigalitres per annum (GLpa) of bitterns with a specific gravity of no more than 1.25 via a diffuser within a Low Ecological Protection Area.  Bitterns will be diluted prior to discharge.
Pond seawater intake		Up to 150 GL per annum, from a screened intake with a maximum average intake flow rate at the screen of less than 0.15 m/s.  Seawater abstraction will only occur when water levels are at mean sea level or higher.

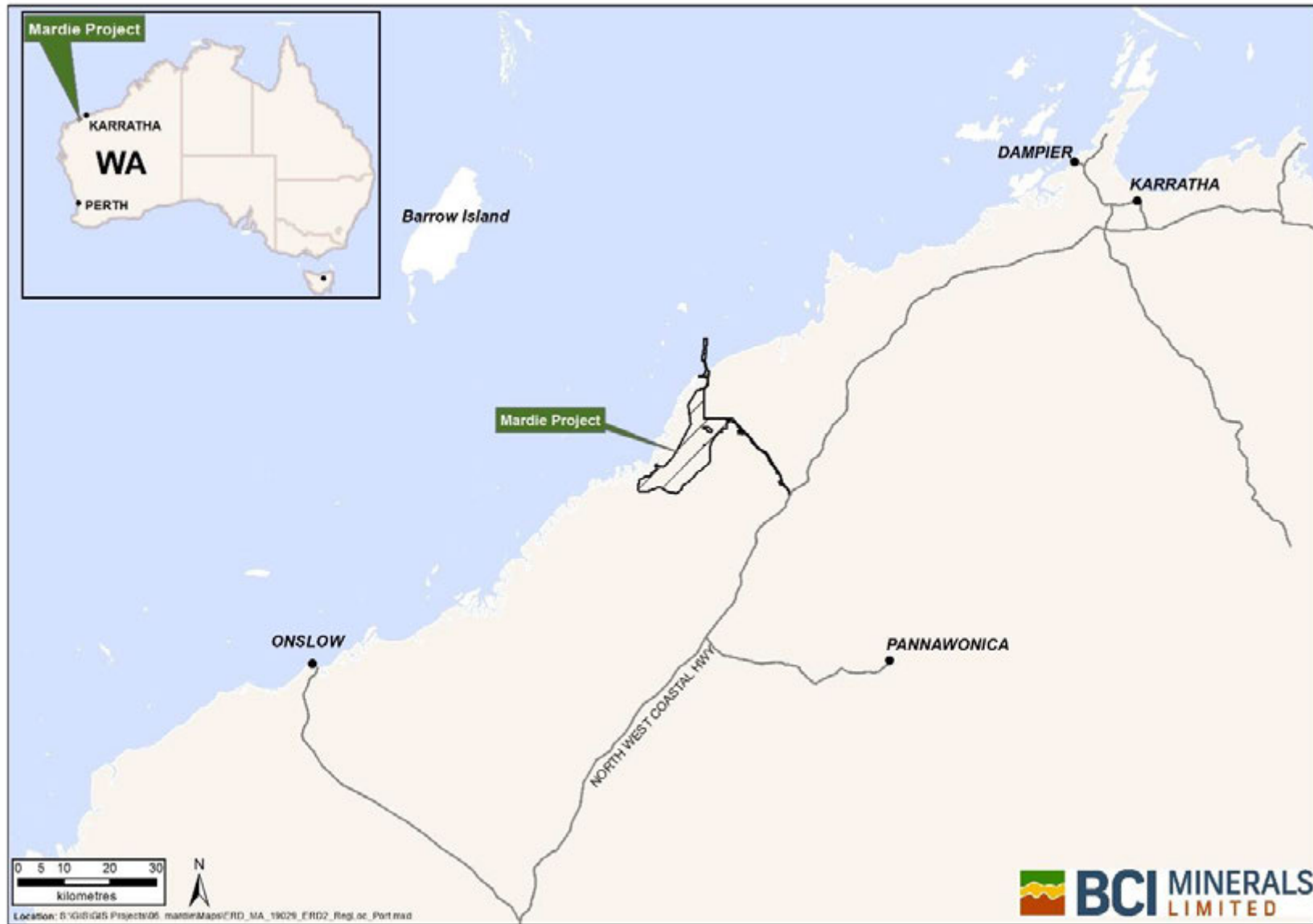


Figure 1 Mardie Proposal Regional Location



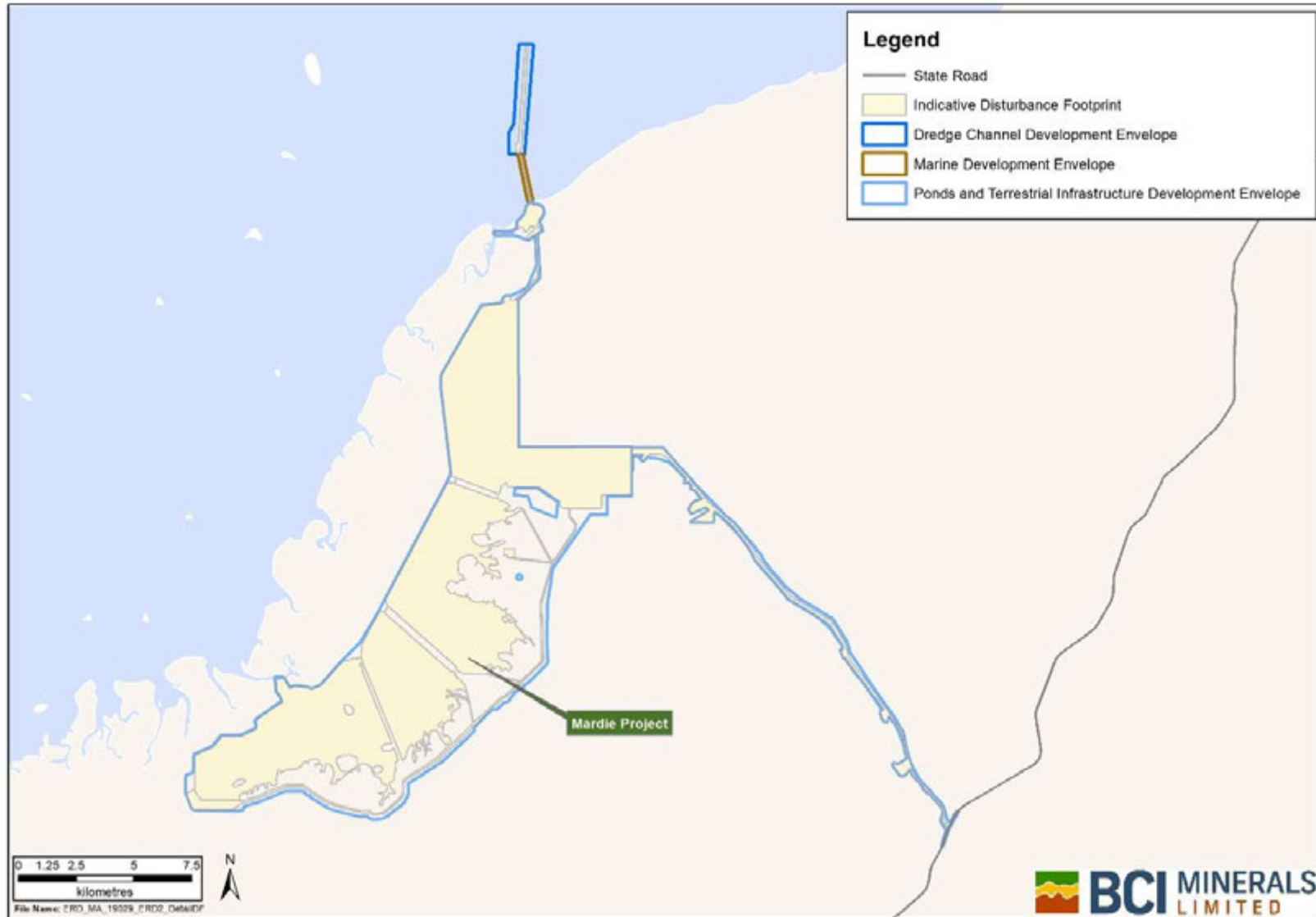


Figure 2 Mardie Proposal Development Envelopes

## 1.2. Scope and Objectives

This document provides an account of the marine fauna of the project area using a combination of desktop investigations and opportunistic field observations. The specific objectives of this Report are to address the ESD Items outlined in **Table 3**.

**Table 3 Environmental Scoping Document Requirement including Considerations and Limitations**

ESD Requirement	Considerations / Limitations
<p><b>ESD Item 50.</b> Discuss the likely presence of listed threatened species or their habitat within/near the proposed project area, in addition to any other EPBC Act listed species identified during the proposed faunal surveys.</p>	<p>Refer <b>Appendix B</b>.</p> <p>Marine turtles and shorebirds are excluded from discussion in this report as these are presented in Pendoley (2019) and Phoenix (2020) respectively.</p>
<p><b>ESD Item 52.</b> Undertake a desktop review to identify what marine fauna species would be expected to utilise marine waters surrounding the Proposal, including those protected under the <i>EPBC Act</i> and those that may inhabit the Montebello Marine Park.</p>	<p>Refer <b>Sections 2.1, 2.2 &amp; 3</b></p> <p>The Montebello Marine Park is located over 60 km from the Mardie Project. Therefore, whilst species which may utilise the marine park waters may occasionally occur the vicinity of the Project area, the habitats of these two areas are vastly different and it is not reasonable to assume that all species would be present in both areas.</p>
<p><b>ESD Item 54.</b> Undertake a marine mammal field survey to identify the potential species present and populations.</p>	<p>Refer <b>Section 2.3 &amp; Section 3.1.2</b>.</p> <p>No habitats of significant value to marine mammal species were identified during concurrent surveys of the project area. Therefore surveys for marine mammals were limited to opportunistic observations only.</p>
<p><b>ESD Item 60.</b> Identify any significant marine fauna (as well as ecological 'keystone' species, species important to commercial and recreational fishers) likely to be found in the area of influence of the Proposal, including commercially important species, species protected under the EPBC Act and migratory species.</p>	<p>Refer <b>Section 3</b>.</p> <p>Marine turtles and shorebirds are excluded from discussion in this report as these are presented in Pendoley (2019) and Phoenix (2020) respectively.</p>
<p><b>ESD Item 61.</b> Identify any critical periods for key environmental / life cycle events for marine fauna (e.g. turtle nesting).</p>	<p>Refer <b>Section 3.5</b></p> <p>Marine turtles and shorebirds are excluded from discussion in this report as these are presented in Pendoley (2019) and Phoenix (2020) respectively.</p>
<p><b>ESD Item 62.</b> Identify likelihood of significant marine fauna species occurring near the development envelopes, including:</p>	<p>Refer <b>Appendix B</b></p>

ESD Requirement	Considerations / Limitations
<ul style="list-style-type: none"> <li>a. Information on the abundance, distribution, ecology and habitat preferences of any significant species;</li> <li>b. Information on the conservation value of each habitat type from a local and regional perspective;</li> <li>c. If a population of a significant species is present and may be impacted by the Proposal, its size and the importance of that population from a local and regional perspective;</li> <li>d. Baseline mapping of local occurrences;</li> <li>e. An assessment of the risk of impact to any listed threatened species as a result of project activities;</li> <li>f. For any impact identified, appropriate mitigation/management measures to reduce the level of impact; and</li> <li>g. An assessment of residual impact to each species after all avoidance and mitigation measures are undertaken</li> </ul>	<p>This report does not address any of the potential impacts to marine fauna (i.e. Items e, f &amp; g) that may arise as a result of the proposal.</p>
<p><b>ESD Item 63.</b> Characterise the ecological values and significance of marine fauna and habitat in the area that may be directly or indirectly impacted by the Proposal.</p>	<p>Marine turtles and shorebirds are excluded from discussion in this report as these are presented in Pendoley (2019) and Phoenix (2020) respectively.</p>

### 1.3. Study Area

The study area focusses on the area of potential influence of proposal activities, which includes the nearshore marine waters and creeks from the coastal mainland of Mardie, extending seawards to include the marine waters surrounding the nearby inshore Islands. Marine fauna utilising these areas are also discussed in the broader context of the Pilbara coastal region (nominally extending from North west cape in the south to Port Hedland in the North). Due to the migratory nature of the majority of marine mammals, consideration has been placed on the Mardie study area in terms of its role as a migratory stopover point.

### 1.4. Legislation and Regulatory Guidance

This study has been aligned with relevant state and federal legislation and technical guidance that will be applicable to Marine Fauna in the Project area. The relevant legislation specific to Marine Fauna, includes:

- > Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act);
- > Western Australian *Environmental Protection Act 1986* (EP Act);
- > Western Australian *Biodiversity Conservation Act 2016* (BC Act);
- > Western Australian *Conservation and Land Management Act 1984* (CALM Act); and
- > Western Australian *Fish Resources Management Act 1994* (FRM Act).

The EPA provides guidance on how an Environmental Impact Assessment (EIA) will be evaluated when determining whether or not an assessed proposal may be implemented. The EPA uses environmental principles, factors and associated objectives as defined within the Statement of Environmental Principles, Factors and Objectives (EPA 2018) as the basis for assessing whether a proposal's impact on the environment is acceptable. These principles, factors and objectives therefore underpin the EIA process.

#### 1.4.1. Environmental Principles

The object of the EP Act is to protect the environment of the State and identifies five environmental principles. The third principle of the conservation of biological diversity and ecological integrity is directly relevant to Marine Fauna and is therefore a fundamental consideration for the EIA.

#### 1.4.2. Environmental Factors and Objectives

The EPA list 13 environmental factors, which are organised into five themes: Sea, Land, Water, Air and People. The environmental factors are those parts of the environment that may be impacted by an aspect of a proposal. An environmental objective has been established for each environmental factor. The EPA will then make judgements against these objectives on whether the environmental impact of a proposal may be significant. Marine Fauna was identified by the EPA as one of the key environmental factors for the Project. The objective for Marine Fauna is *'to protect benthic communities and habitats so that biological diversity and ecological integrity are maintained'*.

The EPA provides the following guidelines to explain how impacts on Marine Fauna are considered during EIA and to set out the type and form of the information that should be presented to facilitate the assessment of impacts on Marine Fauna in Western Australia's marine environment:

- > Environmental Factor Guideline - Marine Fauna (EPA, 2016a);
- > Technical Guidance – Protection of BCH (EPA, 2016b);
- > Technical Guidance – Protecting the Quality of Western Australia's Marine Environment (EPA, 2016c); and
- > Technical Guidance – Environmental Impact Assessment of Marine Dredging Proposals (EPA, 2016d).

The Commonwealth Department of Environment and Energy (DoEE) also provides the following technical guidance to inform impact assessment for conservation significant marine fauna species:

- > Relevant EPBC Act listed species survey guidelines and protocols;
- > Relevant EPBC Act listed species Recovery plans, Threat Abatement Plans and Approved Conservation Advice Statements;
- > Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012); and
- > National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE 2017).

#### 1.4.3. Threatened and Priority Fauna

##### Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

On behalf of the Minister for Environment, the Department of Environment and Energy (DoEE) publishes a list of fauna and flora species regarded as threatened, rare, likely to become extinct, or

presumed extinct. These taxa are protected under the EPBC Act and are listed in specific categories such as Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct, or Extinct in the Wild (**Table 8 in Appendix One**).

Migratory species are categorised under the EPBC Act as Matters of National Environmental Significance (MNES). Recognised migratory species include any native species identified in an international agreement approved by the Minister and those listed under:

- > The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention);
- > The China-Australia Migratory Bird Agreement (CAMBA);
- > The Japan-Australia Migratory Bird Agreement (JAMBA); and
- > The Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

### **Western Australian Biodiversity Conservation Act 2016 (BC Act)**

The Western Australian Biodiversity Conservation Act 2016 (BC Act, the Act), parts of which were enacted on 21 September 2016, provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. The BC Act replaces the Wildlife Conservation Act 1950. Threatened species (both flora and fauna) that meet the categories listed within the Act are highly protected and require authorisation by the Ministerial to take or disturb. Seven categories have been devised that include Threatened Fauna conservation categories of critically endangered, endangered, vulnerable and presumed extinct have been aligned with those detailed in the EPBC Act. Additional categories cover migratory species, conservation dependent species and other specially protected species. Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that 'taking' may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as specially protected species. Threatened Ecological Communities (TECs) are also protected under the Act and are categorised using the same criteria as threatened species. At the time of writing this report, some sections of the BC Act had not been yet been proclaimed, including those relating to species of conservation interest (Specially Protected Species) and TECs. During this transition period the WC Act is still in effect where relevant. The current listings were published in the Government Gazette on 3 November 2015.

### **Department of Biodiversity, Conservation and Attractions (DBCA) Priority Species**

In addition to these statutory listings, DBCA maintains a list of 'Priority' species (P1-P5) that are also of conservation interest. Any fauna survey conducted for the purposes of environmental impact assessment (EIA) must include an assessment of presence/absence potential for these species. There is also a requirement for an impact assessment (due to the proposed action) and an expectation all appropriate sources of information are investigated.

## **1.5. Marine Fauna Definition**

For the purposes of EIA, marine fauna are defined as: Animals that live in the ocean or rely on the ocean for all or part of their lives. Marine fauna are highly diverse and range in size from microscopic zooplankton to the blue whale. Marine fauna that live their entire life in the ocean such as sharks,

whales, dolphins, dugongs, sea snakes, most fish, invertebrates and crustaceans. Marine fauna are also animals that either leave or enter the ocean for breeding or resting purposes, such as turtles, seals and sea lions, penguins, and crabs. Other animals such as seabirds can also be considered as marine fauna as they rely on fish and other marine life for food. While animals such as sponges and corals that are attached to the seabed are also marine fauna, they are typically considered under the environmental factor of Benthic Communities and Habitats (EPA 2016b).

## 2. Methods

### 2.1. Database Searches

O2 Marine undertook a comprehensive desktop review to identify conservation significant marine fauna species that are known to occur or that could potentially occur within the Project area. A likelihood of occurrence assessment was then undertaken for the species identified in the searches. **Table 4** lists the database searches performed.

**Table 4** Details of Database Searches

Field	Database Title	Custodian	Search Details
Conservation Fauna	Significant Commonwealth Protected Matters Search (PMST)	Department of the Environment and Energy (DoEE)	Date: 14 <sup>th</sup> Feb 2019 Buffer: 50km Lat: 20°59'27" S Long: 115°.54'21"E
Conservation Fauna	Significant DPaW database	Department of Biodiversity Conservation and Attractions (DBCA)	Date: 14 <sup>th</sup> Feb 2019 Buffer: 50km
Marine Fauna	Nature Map	DBCA	Date: 14 <sup>th</sup> Feb 2019 Buffer: 50km Lat: 20°59'27" S Long: 115°. 54'21"E

### 2.2. Literature Review

A comprehensive literature review was undertaken which focussed on marine fauna surveys undertaken for previous coastal development projects in the Pilbara and relevant scientific journal literature on marine fauna in the Pilbara region and globally. Particular emphasis was placed on species of conservation significance. The following studies comprised the majority of the review:

- > Onslow Salt ERMP Volume 2 Technical Appendix C Report on the Biological Environments near Onslow, Western Australia (Paling, 1990);
- > The draft EIS for Chevron Australia's Wheatstone project (Chevron Australia, 2010);
- > Intertidal Habitats of the Onslow Coastline (URS, 2010);
- > Biota of subtidal habitats in the Pilbara Mangroves, with reference to the Ashburton Delta and Hooley Creek (URS, 2010a);
- > Sea Noise Logger Deployment: Wheatstone and Onslow – April to July 2009 Preliminary Analysis (McCauley & Kent, 2010);
- > A Description of Mega Fauna Distribution and Abundance in the SW Pilbara Using Aerial and Acoustic Surveys –Final Report 2010 (CWR, 2010);
- > Draft Protected Marine Fauna Management Plan (Chevron, 2010);
- > Wheatstone Project Literature Review of Listed Marine Fauna (URS, 2010b);
- > Possible Effects of Underwater Noise on Marine Fauna and Fish in the Wheatstone Project Area (URS, 2010c);
- > Potential Interactions with the Onslow Prawn Managed Fishery (URS, 2011b);



- > Marine Mammals Technical Report (RPS 2010b);
- > Dugong Aerial Survey Report (RPS 2010a);
- > Identification and Risk Assessment of Marine Matters of National Environmental Significance (RPS 2010b) and
- > Seagrass Dynamics and the Consequence of Seagrass Loss on Marine Megafauna: A Briefing Note (Chevron 2010a).

Data from other studies being completed to inform the Project EIA or as relevant to the Project were also utilised in the preparation of this report. The most directly relevant documents included:

- > Shorebird, Marine Turtle and other Conservation significant fauna survey December 2017. Phoenix Environmental Services (2018);
- > Marine turtle surveys of Mardie Salt Project area – December 2017, January 2018, and January 2019 (Pendoley 2019)
- > Assessment of mangal and algal communities for the Mardie Solar Salt Project (Stantec (2018)
- > Mardie Project Subtidal Benthic Communities and Habitat (O2 Marine 2020a); and
- > Mardie Project Intertidal Benthic Communities and Habitat (O2 Marine 2020b).

### 2.3. Opportunistic Site Observations

A comprehensive desktop review was undertaken to identify conservation significant marine fauna species known or likely to occur within the Project area. Following, initial desktop review and likelihood of occurrence assessment it was determined that the Proposal activities posed a relatively low risk to marine fauna species other than Turtles. Therefore, specific surveys targeting marine fauna species other than Turtles were not undertaken for the Mardie Project. However, all incidental observations of marine fauna were recorded by experienced marine scientists during extensive field surveys undertaken by O2 Marine and Stantec in delivering other work scopes. The details of these surveys (including observer hours) are summarised in **Table 5**.

**Table 5 Mardie marine field surveys which included incidental observations of marine fauna**

Field Survey	Company	Survey Dates	Observer Hours
Water Quality Maintenance	O2 Marine	15 <sup>th</sup> – 16 <sup>th</sup> March 2018	264 Hours (Vessel-based)
		3 <sup>rd</sup> – 4 <sup>th</sup> April 2018	
		5 <sup>th</sup> – 6 <sup>th</sup> May 2018	
		25 <sup>th</sup> – 26 <sup>th</sup> May 2018	
		5 <sup>th</sup> – 6 <sup>th</sup> July 2018	
		20 <sup>th</sup> – 21 <sup>st</sup> August 2018	
		14 <sup>th</sup> – 15 <sup>th</sup> October 2018	
		10 <sup>th</sup> – 11 <sup>th</sup> December 2018	
		12 <sup>th</sup> – 13 <sup>th</sup> January 2019	

Field Survey	Company	Survey Dates	Observer Hours
		4 <sup>th</sup> – 5 <sup>th</sup> February 2019	
		14 <sup>th</sup> – 15 <sup>th</sup> March 2019	
Bathymetry Surveys	O2 Marine	22 <sup>nd</sup> – 25 <sup>th</sup> August 2018 16 <sup>th</sup> – 22 <sup>nd</sup> October 2018	60 Hours (Vessel-based)
Benthic Habitat Surveys	O2 Marine	8 <sup>th</sup> – 14 <sup>th</sup> March 2018 12 <sup>th</sup> – 15 <sup>th</sup> December 2018 14 <sup>th</sup> – 18 <sup>th</sup> January 2019 6 <sup>th</sup> – 8 <sup>th</sup> February 2019 16 <sup>th</sup> – 18 <sup>th</sup> March 2019	264 Hours (Vessel-based)
Sediment Sampling Surveys	O2 Marine	9 <sup>th</sup> – 12 <sup>th</sup> December 2018 12 <sup>th</sup> – 13 <sup>th</sup> January 2019 14 <sup>th</sup> – 15 <sup>th</sup> March 2019	108 Hours (Vessel-based)
Mangrove & Intertidal Surveys	O2 Marine	17 <sup>th</sup> – 18 <sup>th</sup> March 2018 12 <sup>th</sup> December 2018	18 Hours (Vessel-based)
	Stantec	August 2017 October 2017	Hours Unknown (Aerial)

## 2.4. Likelihood of Occurrence Assessment

An assessment was undertaken of the likelihood of occurrence for threatened species identified through the desktop review. The DoE and DBCA do not have prescriptive likelihood of occurrence guidelines within their policies but rather clarify the scale of assessment required to determine the level of impact (e.g. level of assessment, previous record searches, and distribution maps). The following criteria have been developed by O2 Marine with the aim of considering the assessment classifications to identify the likelihood of occurrence for threatened species:

- **Low potential to occur** – the species has not been recorded in the region (no records from desktop searches) and/or current known distribution does not encompass project area and/or suitable habitat is generally lacking from the project area;
- **Moderate potential to occur** – the species has been recorded in the region (desktop searches) however suitable habitat is generally lacking from the project area OR species has not been recorded in the region (no records from desktop searches) but potentially suitable habitat occurs at the project area;
- **High potential to occur** – the species has been recorded in the region (desktop searches) and suitable habitat is present at the project area; and
- **Known to occur** – the species has been recorded on-site in the recent past (i.e. last 5-10 years) and the site provides suitable habitat for it.

The results for the fauna likelihood of occurrence assessment are presented in **Appendix B**.

## 3. Marine Fauna

### 3.1. Results

#### 3.1.1. Database Searches

Database searches identified a total of 18 conservation significant species (**Table 6**) and a further 55 listed Marine or Marine Migratory Species (**Appendix B**) as potentially occurring within the study area.

As identified in **Section 1.2** Turtles, Marine Migratory birds and terrestrial fauna identified in the database search results are excluded from this report, as these are discussed in other reports.

**Table 6 Conservation Significant Species Returned by the Database Searches**

Class	Species Name	Common Name	EPBC Act Status	BC Act Status	IUCN Status
SHARK	<i>Pristis zijsron</i>	Green sawfish	V, M	VU	CR
SHARK	<i>Pristis clavata</i>	Dwarf sawfish	V, MM	P1	EN
SHARK	<i>Anoxypristis cuspidata</i>	Narrow sawfish	MM		EN
SHARK	<i>Carcharias taurus</i>	Grey Nurse Shark	V	VU	
SHARK	<i>Rhincodon typus</i>	Whale Shark	V	MM	OS
SHARK	<i>Carcharodon carcharias</i>	White Shark, Great White Shark	V	MM	VU
RAY	<i>Manta birostris</i>	Giant Manta Ray	MM	MM	VU
RAY	<i>Manta alfredi</i>	Reef Manta Ray	MM	MM	VU
MAMMAL	<i>Dugong dugon</i>	Dugong	MM, Ma	OS	VU
MAMMAL	<i>Megaptera novaeangliae</i>	Humpback whale	V, MM	CD	LC
MAMMAL	<i>Balaena glacialis australis</i>	Southern Right Whale	EN, MM, Ma	VU	LC
MAMMAL	<i>Balaenoptera musculus</i>	Blue Whale	EN, MM, Ma	EN	EN
MAMMAL	<i>Orcaella heinsohni</i>	Australian snubfin dolphin	M	P4	NT
MAMMAL	<i>Sousa sahalensis</i>	Australian humpback dolphin	M	P4	
MAMMAL	<i>Stenella longirostris</i>	Australian spinner dolphin	M	P4	LC
MAMMAL	<i>Tursiops aduncus</i>	Spotted Bottlenose Dolphin	MM		
MAMMAL	<i>Sousa chinensis</i>	Indo-Pacific Humpback Dolphin	MM	P4	VU
REPTILE	<i>Aipysurus apraefrontalis</i>	Short-nosed Seasnake	CE, Ma	CR	CR

- EPBC Act (species listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999): Ex = Extinct, CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, MM = Migratory Marine, MT = Migratory Terrestrial, MW = Migratory Wetlands, Ma = Listed Marine
- BC Act Status (species listed under the Western Australian *Wildlife Conservation Act 1950*):
  - Threatened Species: EX = Presumed Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, IA = Migratory birds protected under an International Agreement, CD = Conservation Dependent, OS = Other Specially Protected
  - Priority Species: P1 = Priority 1, P2 = Priority 2, P3 = Priority 3, P4 = Priority 4
  - IUCN (species listed under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species): EX = Extinct, EW = Extinct in the Wild, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, LR = Lower Risk, DD = Data Deficient.

### 3.1.2. Opportunistic Observations

A specific survey targeting marine fauna (other than Turtles and Shorebirds) was not undertaken for the Mardie Project. However, incidental sightings of marine fauna were recorded during field surveys completed by O2 Marine and Stantec.

**Table 7** lists the marine fauna that were observed during field surveys in the Mardie area.

**Table 7** Incidental sightings of marine fauna during surveys within the coastal environment of the Mardie area.

Author	Study	Marine Fauna	Quantity	Date Observed	Location and activity of fauna	Comments
O2 Marine (2018a)	BCI Minerals – Mardie Project – Project Report #1 for Metocean Data Collection	Humpback Whale	1x Adult 1x Calf	5 <sup>th</sup> July 2018	200m from ADCP (9nm off-shore and 3nm to the West Passage Island to an approximate depth of 8m). Inside waters around Passage Island. Mother swimming with calf headed northward.	
		Turtles (Species unknown)	Numbers not recorded although numerous sightings were noted	5 <sup>th</sup> July 2018	Inshore waters around survey ADCP and Aqua drop (2nm off-shore to an approximate depth of 3m) locations. Turtles sighted at water’s surface to breathe.	
O2 Marine (2018b)/ (2020b)	Mardie Project – Intertidal Benthic Communities and Habitat of the Mardie Coastline.	Turtles (Species Unknown)	Numbers not recorded although numerous sightings were noted.	March 2018	Sighted near the mouth of a nearshore Creek located North of the project area. Turtles swimming on surface of the water to breathe.	
			1x Turtle	March 2019	Turtle was sighted on the inside southern waters of Sholl Island. Depth 2.4m with dense coral, macro algae and non-coral species. Turtle was on the surface of the water coming up to breath.	
		Crustaceans	9 taxa	March 2018	<i>Sesarmidae</i> was the most dominant of the crustaceans.  Grapsidae and Ocypodidae (recorded at more than one site although low proportions).	227 organisms from 12 taxa within 40 fauna quadrats at the five site locations were recorded for this survey. North Creek and Robe river had the highest fauna densities. Central Creek had lowest densities. The Taxa recorded and the findings of dense fauna of limited diversity represent typical ecological
		Molluscs	2 taxa	March 2018		

Author	Study	Marine Fauna	Quantity	Date Observed	Location and activity of fauna	Comments
		Fish	1 taxon	March 2018	Gobidae (mudskipper) recorded at three (3) sites (37% abundance at one site).	trends and taxa expected to occur in tropical arid zone mangroves of the Pilbara Coastline.
		Dolphins (species unknown)	2 x adults	March 2019	Sighted on the outside edge of Sholl Island. Depth on sounder 12.9m. Habitat bare sand. Dolphins surfaced twice to breathe and then did not resurface. Distance from vessel made it difficult to identify.	
Stantec Environmental (2018)	Assessment of Mangal and Algal communities for the Mardie Solar Salt Project.	<b>Elasmobranches</b> -Whitetip reef shark -Blacktip reef shark -Grey Reef Shark -Bull Shark -Tiger Shark -Stingray -Eagle ray -Shovelnose ray -Giant Manta Ray -Reef Manta Ray				Locations and number of individuals observed was not recorded.
		<b>Reptilia</b> -Seasnake -Green turtle				Locations and number of individuals observed was not recorded.
		<b>Teleostei (Bony fish)</b> - Serranidae - Lutjanidae - Lethrinidae - Mullidae - Carangidae - Siganidae				Locations and number of individuals observed was not recorded.
		<b>Mammalia</b> Dugong Dolphins (Species unknown)				Locations and number of individuals observed was not recorded.

## 3.2. Likelihood of Occurrence Assessment

A likelihood of occurrence assessment was undertaken for all conservation significant species identified through desktop searches (**Table 6**). The results of the assessment are presented in **Appendix B**. The assessment determine that the following conservation significant species are 'known to occur' or have a 'high potential to occur' in the Project area:

- > Three marine mammals:
  - Humpback Whale;
  - Dugong; and
  - Australian Humpback Dolphin
- > One marine reptile (Excluding Turtles):
  - Short-nosed sea snake
- > One elasmobranch:
  - Green Sawfish.

These conservation species, together with other species which have a lower potential to occur are discussed further below.

## 3.3. Conservation Significant Species

### 3.3.1. Marine Mammals

Conservation significant marine mammals species known to occur or have a high potential to occur in the Project area include the humpback whale (*Megaptera novaeangliae*), Dugong (*Dugong dugon*), Australian humpback dolphin (*Sousa sahulensis*). A further two whale species and four dolphin species were also recorded in database searches for the area but were considered to have a lower likelihood of occurrence.

#### Whales

Humpback Whales (*Megaptera novaeangliae*) have a global distribution and are found in all the major oceans. Six separate populations have been identified in the southern hemisphere, with the Group IV population being associated with Australia's North West Shelf (NWS) bioregion. This WA population is thought to have been recovering at an annual rate of between 7 and 12 percent since the cessation of whaling in 1963 (CWR 2010).

Humpback whales migrate annually from Antarctic feeding grounds to the Kimberley coast for calving during the winter. Humpback whales predominantly occur offshore in open oceanic environments. However, they are known to stopover in the lee of the offshore islands and have been observed on several occasions during the humpback southerly migration, within 5 km of the Mardie Project Marine Development Envelope, by O2M staff in 2018. The southern migration is the period when they are closest to shore at an average of 36 km although are often recorded in waters less than 10 m deep during the latter part of the migration (September to November). The Project area is a shallow embayment (i.e. generally <5m deep) and could not be considered critical habitat for any whale species.

The most intensive study in the region was undertaken by the Centre for Whale Research (CWR) in 2010, which involved a 12-month program of fortnightly aerial surveys over the Onslow region. In addition, sea noise loggers were deployed at nearshore and offshore locations in Onslow (CWR 2010). During 26 surveys, 801 pods containing 1221 individual whales were recorded. A total of 95 cow-calf pairs were sighted, predominantly from September to October. Humpback whales first appeared in the Onslow region from early to mid-June. Humpback whales were typically observed seaward of Thevenard Island and over the continental slope at an average of 49 km offshore (CWR 2010). Migration patterns changed from predominantly northward to southward bound in mid-August. Higher proportions of resting/milling pods were sighted during the southern migration, at an average of 36 km offshore. Cows and Calves predominantly rest when inside of the 50 m isobaths (CWR 2010), with some whales recorded in waters less than 10 m deep during the latter part of the migration. The data indicates that the Mardie area does not represent the same importance for resting or calving as Exmouth Gulf or Camden Sound (CWR 2010).

Seven other species of toothed whale and three species of baleen whale have been recorded from the Montebello region (DEC 2007). Further evidence from aerial surveys and acoustic surveys supports this, as sightings further offshore indicated a greater range of species existing in small numbers that included species of Bryde's Whales, Minke Whales, Pygmy Blue Whales, Killer Whales, Southern Right Whales, Pilot Whales and Sperm Whales. However, these whales are believed to only transit through oceanic waters well offshore from the shallow waters of the Mardie Project area (CWR 2010; RPS 2010).

## Dolphins

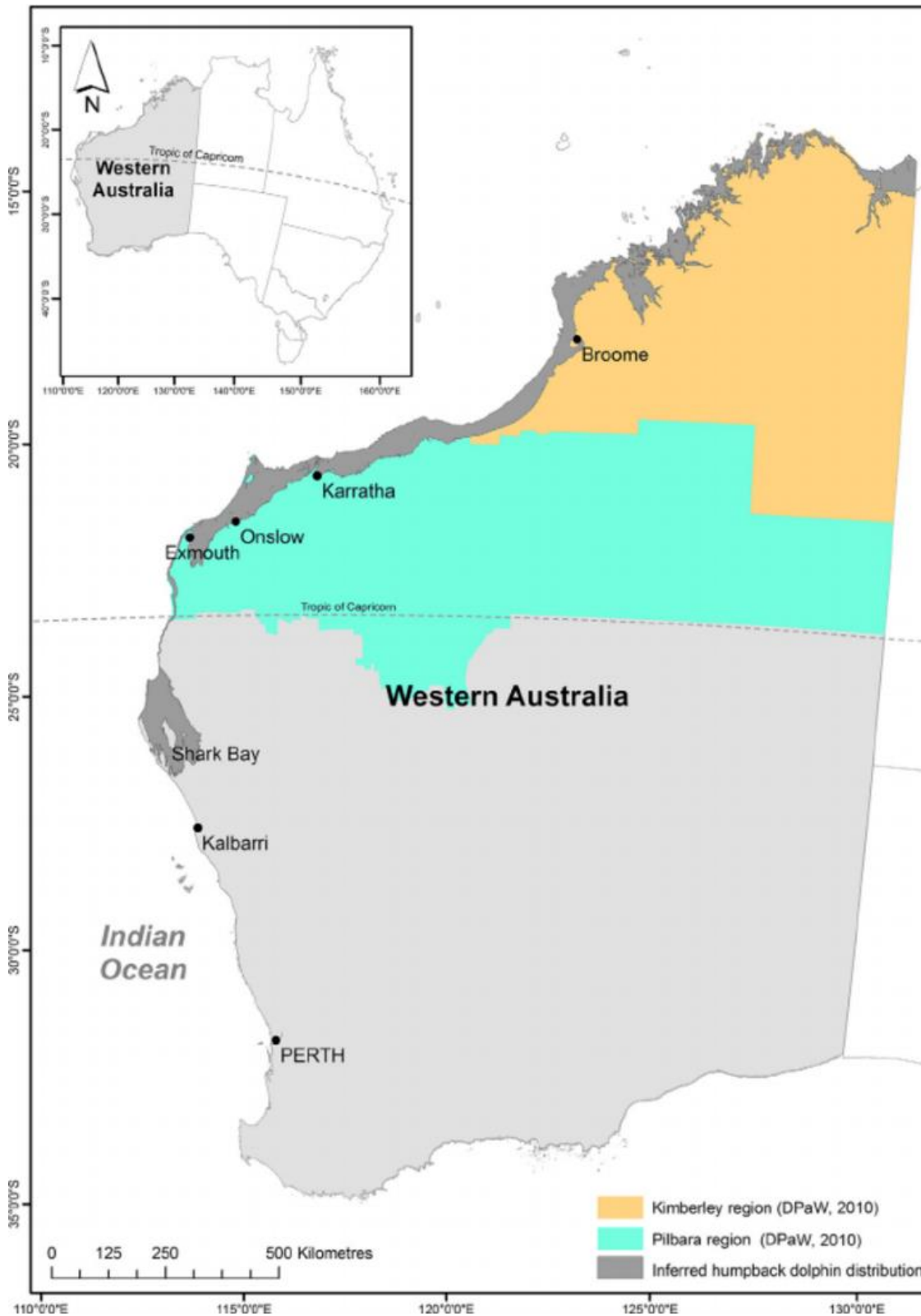
Seven species of pelagic dolphin potentially occur in the region, many of which occur in mixed schools or cetacean communities (DSWEP 2012). The coastal dolphins in the Pilbara region are generally known to inhabit estuarine areas with mangrove forests and shallow coastal waters with seagrass, rock and/or coral reefs, sandy embayment's, coastal islands with fringing reefs, sheltered lagoons and offshore islands with associated reef which all appear to be important habitat to the species. The Project area contains suitable habitat for several species of dolphin, most notably the Australian Humpback and Indo-pacific bottle-nose dolphin. Both species have previously been recorded in the project area.

The abundance of dolphins in nearshore areas surrounding the Mardie coast is likely to be highest during winter and the distribution of dolphins is likely influenced by prey availability (RPS 2010). Dolphins will move inshore or offshore dependant on prey availability. Oceanographic currents, areas of upwelling, eddies, and increased nutrients all affect the abundance of zooplankton and transport of larval recruitment of finfish, which therefore have a seasonal effect on dolphin distribution (Hanf 2015).

The Australian humpback dolphin was the only conservation significant species known to occur in the Project area (**Appendix B**), with records of Australian humpback dolphins (*Sousa sahuensis*) reported throughout the year at the Montebello Islands (Raudino *et al* 2018) and in the Mardie Project area. They are likely to be one of the most common dolphin species occurring in the Project area. This species together with the Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*) are likely to be the most abundant dolphin species in the Mardie Project area inside the 20 m isobath (DSWEP 2012).



In Australia, the species' range extends from Shark Bay in Western Australia north and east to southern Queensland (**Figure 3**). In WA waters, less than 1% of the distribution of humpback dolphins has been surveyed adequately enough to assess their abundance (Parra *et al.* 2017).



**Figure 3** Distribution of Australian humpback dolphins, *Sousa sahulensis*, in Western Australia (WA), the Kimberley and Pilbara regions. Source: Parra *et al.* 2016.

Other species of dolphins are likely to be present further offshore. During aerial surveys of the Pilbara coast by CWR between May 2009 and April 2010, dolphins were spotted during almost every survey (CWR 2010). A total of 1681 dolphins were sighted with peak numbers observed in late May. Dolphins were predominantly sighted in the South-west portion of the Onslow region in water depths less than 50 m (i.e. towards Exmouth Gulf). Coastal dolphins were documented in varying abundance levels, with group sizes varying from seven to over 200 dolphins during the 12-month survey, although smaller groups (1-20 animals) were observed less than 5 km from shore (CWR 2010).

## Dugong

Dugong (*Dugong dugong*) are found throughout the Pilbara region (**Figure 4**), particularly close to the coast or in the lee of reef-fringed islands, typically in areas where seagrass has previously been recorded (CWR 2010). Dugong aggregations typically occur in large seagrass meadows, a subtidal BCH type not identified within the Project area.

Although Dugong have been previously recorded in the nearshore waters of the Mardie Coastline (Bayliss 2017; CWR 2010; RPS 2010), the nearest known Dugong aggregations have been recorded near Cape Preston in the north and Regnard Island in the north (50km north) and Coolgra Point in the South (100km south), generally in areas that consistently support extensive seagrass meadows (Bayliss 2017; CWR 2010; RPS 2010).

Historic studies further south of Mardie, estimated dugong population sizes for Exmouth Gulf at 95 animals and the Pilbara coastline at 2046 animals in 2000 (Prince 2001). This equated to density estimates of up to 9.1 individuals per 100 km of coastline in the Onslow to Dampier onshore sector. The low number of dugongs within the Exmouth Gulf area was attributed to the removal of seagrass by Cyclone Vance, causing animals to move to Shark Bay in search of new foraging ground (Prince 2001, Gales et al. 2004). Prince's (2001) Pilbara survey block encompassed coastal waters to the 20 m isobath north to the Montebello Islands, 20 km east of Robe River and 10 km west of Serrurier Island. Most dugongs were found to be distributed east of Barrow Island and Mary Anne Passage (Prince 2001). Following Cyclone Vance in the Exmouth Gulf and Ningaloo Reef are recognised as biologically important Dugong habitats, each with about 1,000 individuals (Grech, 2012). Recent evidence suggests that some populations have strong patterns of migration, which are thought to be driven by variations in food availability (Gales, 2004) and possibly by water temperature at the higher end of their latitudinal distribution (Sheppard *et al.* 2006).

Stantec (2018) recorded Dugong during aerial surveys in 2017 in the vicinity of the project area. However, no Dugong were observed in the Project area during over 700 hours of vessel-based observations, which is likely due to the lower value of the subtidal BCH in the Project area as suitable feeding or foraging habitat for Dugong. Specifically, at the time of the Mardie BCH surveys (i.e. March 2018), O2 Marine also conducted BCH surveys of the 40-mile beach area, located to the north of Mardie, near Cape Preston. These surveys identified extensive seagrass meadows with cover of *Halophila sp.* up to 50%, and four individual dugong were observed in this area over two days. This observation was considered to represent a significant contrast with the Mardie Project area, which did not support any seagrass meadows (O2 Marine 2020a), and no Dugong were observed in over 700 hours of vessel-based observations.

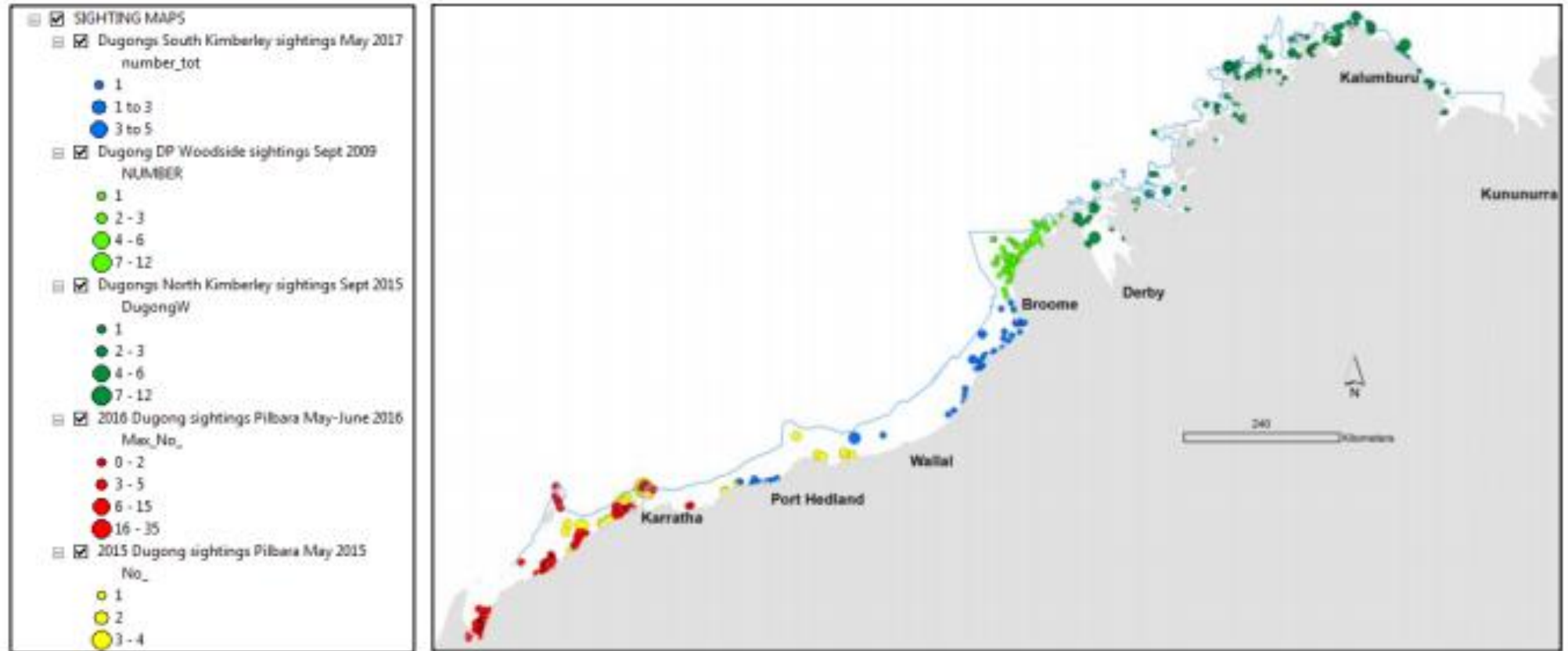


Figure 4 Dugong distribution and relative abundance of dugong sightings (Bayliss 2017).

### 3.3.2. Marine Reptiles (Excluding Turtles)

Other than marine turtles, the only threatened marine reptile species known to occur in the Project area is the short-nosed sea snake (*Aipysurus apraefrontalis*) which is listed as Critically Endangered. Sixteen (16) other species of seasnake were identified as potentially occurring in the Project area but not listed as threatened.

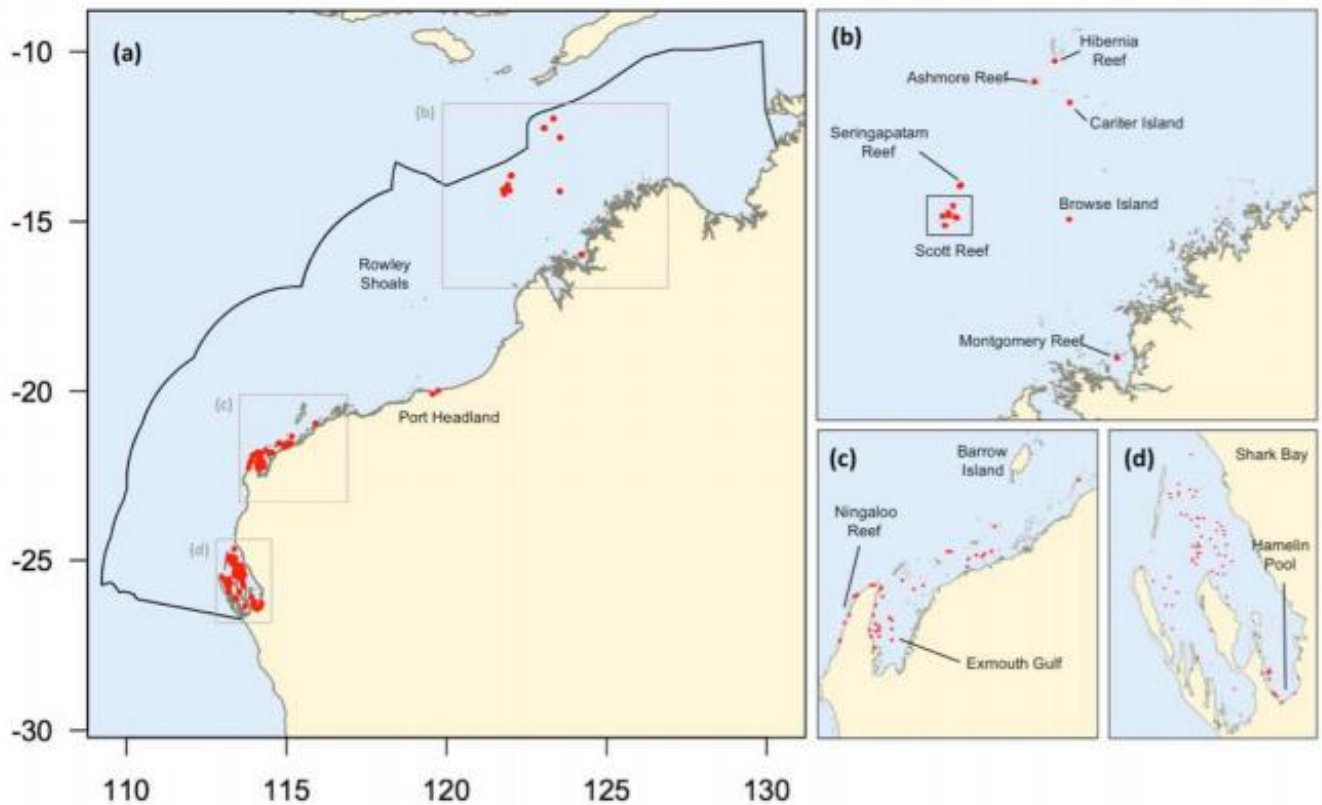
The North West Marine Region (NWMR) is considered a biodiversity hotspot for 'true' sea snakes within Australia and globally (CWR 2010) (**Figure 5**). As much of the Pilbara waters are quite turbid, sea snakes are infrequently encountered, and in many cases data deficient species are only known from a few specimens collected as fisheries bycatch and lack basic biological data. With little biological data available, the effects of anthropogenic threats are unknown.

All true sea snake species are strongly associated with benthic habitats, and occur in coastal, shallow water habitats (typically <100m depth). The Short-nosed sea snake (*Aipysurus apraefrontalis*) is typically found in reef flats or shallow waters along the outer reef edge in water depths to 10m (Cogger 2000; Guinea 1993, 1995; McCosker 1975). 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.”

Based on the above habitat description and the mapped subtidal BCH types within the project impact area, suitable habitat for the Short-nosed Sea Snake is unlikely to occur. Coral habitat comprises < 1% of the available habitat within the project area and is not predicted to be impacted. The nearest suitable habitat is located >5km away from any impacts. Given the Short-Nosed Sea Snake is predicted to remain within 50m of the reef flat, it is considered unlikely that it would be observed on a low-profile reef system >5km away that provides little to no refuge.

It is noted that whilst coral species are present in the Project area, they do not form a complex reef system with a reef edge, reef flat and lagoon. Rather sediment tolerant coral species are present in low abundance in areas where low profile limestone is exposed.

In studies done in the nearby Exmouth Gulf and Onslow region, a total of 17 sea snakes were captured via trawl net from three surveys between March and November 2004 (Kangas et al. 2006). Thirteen sea snakes were captured from sites located in the southern part of Exmouth Gulf, and a further three sea snakes species were caught in the central area of Exmouth Gulf. Five species of sea snake were recorded which included the Critically Endangered short-nosed sea snake (*Aipysurus apraefrontalis*) and listed marine species dubois' sea snake (*Aipysurus duboisii*), olive sea snake (*Aipysurus laevis*), olive-headed sea snake (*Disteira major*) and stoke's sea snake (*Disteira stokesii*). Thirteen sea snakes were caught during the March survey, the stoke's sea snake was the only sea snake caught during July and three dubois' sea snakes were caught in November 2004. No sea snakes were caught from the OPMF area during surveys undertaken in 2004 (Kangas et al. 2006), thus indicating that the Onslow region does not have the same importance for seas snakes as the Exmouth Gulf.



**Figure 5** Locations of geo-referenced surveys conducted focusing on sea snakes between 1973 and 2015. The surveys include snorkel, SCUBA, reef walks and trawl sampling conducted by multiple authors and institutions. Source: Udyawer, 2016.

### 3.3.3. Elasmobranchs

Listed threatened elasmobranchs identified through desktop assessment as potentially occurring in the Project area include three sawfish species, the Whale Shark (*Rhincodon typus*), Great White Shark (*Carcharodon carcharias*) and the Grey Nurse Shark (*Carcharias Taurus*). Two Manta Ray species, Giant Manta Ray (*Manta birostris*) and Reef Manta Ray (*Manta alfredi*) were also identified in the desktop searches. However, the likelihood of occurrence assessment (**Appendix B**) determined that only the green sawfish (*Pristis zijsron*) was known to occur in the project area.

The Northwest Marine Region is considered a particularly important area for sawfish species because the region and adjacent inshore coastal waters and riverine environments contain nationally and globally significant populations of sawfish species (DSEWPac 2012). However, relatively little is known about the distribution and abundance of sawfish species in north-western Australia (Morgan *et al* 2012).

In the Pilbara green sawfish are known to utilise the mouths of major river systems (i.e. Ashburton River) as pupping grounds and nursery areas, before juveniles migrate into adjacent creeks at approximately 3 to 6 months old, and then further offshore to mature at a length of about 3 m (Morgan *et al.* 2012). Acoustic tracking of green sawfish from the Ashburton shows that the species does not travel more than 700m upstream from the mouth of the river. In the Western Pilbara they are assumed to be present in all tidal creeks. In the Project area larger systems are represented by the Robe River and Fortescue River. Green sawfish are currently known from Exmouth Gulf, Whim Creek, Beagle Bay, Pender Bay, King Sound in Western Australia. Tidal mangrove systems, river estuaries, and rivers of



the King Sound provide ideal nursery habitat for juveniles <0.5m (Whitty et al, 2011 and Whitty, 2017, Elhassan 2018). Studies also indicate movement of the species away from turbid areas and low-salinity areas i.e. when rainfall flushes estuaries etc. mangrove and inshore areas used as nurseries where they spend their first few years of life and then move to deeper waters (Elhassan 2018).

Green sawfish are expected to be present in the creeks and rivers of the Mardie coastline. The habitats present within the intake creek are well represented in the region with as many as a dozen smaller size creeks within 100km.

In addition to the Green Sawfish, two other sawfish species, being the narrow sawfish (*Anoxypristis cuspidata*) and the dwarf sawfish (*Pristis clavata*) were also considered to potentially occur in the Project area. Although, the western extent of the dwarf sawfish's (*Pristis clavata*) range has not been fully resolved, therefore there is less certainty regarding the likelihood of this species occurring.

Other elasmobranch species such as the whale shark are mostly observed offshore in oceanic environments, however, they have also been observed inshore in coral areas, sometimes entering coral lagoons. The typical habitat for whale sharks is not present in the Project area (i.e. open oceanic environments), although is present within shipping routes. Previous aerial surveys of the region have not detected whale sharks in the project area, excluding the shipping area.

#### 3.3.4. Finfish

Desktop assessments identified 31 listed marine species from the order of ray finned fishes, sygnathiformes which includes the family Sygnathidea (seahorses, pipefishes, pipe horses and sea dragons). Most species are considered migratory and not threatened. Seahorse preferences for suitable habitat can be very diverse, although four species reported from the region each have individual preferences for suitable habitat ranging from soft bottom debris, algal rubble reefs, seagrass beds and coral reefs (Kangas *et al.* 2006). This information suggests there is a moderate potential that some of these species may occur in the Mardie Project area.

Although limited information exists regarding seahorses in the Mardie Project area, a trawl net study of the Exmouth gulf and Onslow region identified a total of 19 seahorses from four species between March and November 2004 (Kangas et al. 2006). The species included the western spiny seahorse (*Hippocampus angustus*) (11), the flat-faced seahorse (*Hippocampus planifrons*) (5), winged seahorse (*Hippocampus alatus*) (2) and zebra seahorse (*Hippocampus zebra*) (1). Two of these species were not identified within the EPBC desktop searches and the record for the zebra seahorse in the 2004 survey is notable given the species is known only from north eastern Australia and the west-central pacific (Fishbase 2017).

Finfish diversity in the region is high with at least 456 species known to exist in the Montebello/Mardie region (DEC 2007). Mangrove communities are particularly important in the region as they play a role in providing suitable habitat and nursery areas for fishes and crustaceans, including commercially important species (DEC 2007).

## 3.4. Other Marine Fauna

### 3.4.1. Subtidal Marine Fauna Community

The majority of the seabed substrate of Mardie Project area is comprised of bare sand/silt, with patches of sand and limestone veneer which support sparse (<5%) to moderate (10-25%) cover of filter feeders, macroalgae, seagrass and coral Benthic communities and habitat (BCH) (**Figure 6**). Many of the coastal islands also support large expanses of macroalgal dominated limestone reef, with isolated areas of dense hard coral occurring on the reef slope.

These nearshore habitats support a low to moderate abundance of fish and invertebrates, with species richness typically ranging from low in the nearshore areas to high further offshore and surrounding the reef-fringed islands. Marine species within the nearshore area are predominantly tropical and are short lived with high productivity, resulting in life-history traits of high fecundity and high productivity and high input into reproduction during their relatively short life spans. Most species are locally and regionally widespread with dominant species comprising a high proportion (i.e. ~80-90%) of marine fauna present. Dominant fishes and invertebrates typically recorded are those known to inhabit muddy/sediment (trawling grounds) habitats which include ponyfish, goatfish, flathead or crabs and prawns, and the mantis shrimp. However, some dominant fish also suit reef and weed habitat (Kangas *et al.* 2006).

### 3.4.2. Intertidal Marine Fauna Community

The Mardie Project area, supports intertidal habitats ranging from inland areas of mud flat / salt flat and algal mat communities, before extending towards the coast into samphire and mangrove communities along the coastal fringe and tidal creeks (**Figure 6**). The mangrove communities are recognised as regionally significant (EPA 2011) across much of the Mardie Project area and, as such are considered to represent the most significant habitat for marine fauna in the Mardie Project area.

In addition to migratory birds and turtles, the mangrove communities are known to provide important nursery and feeding areas for numerous fish and invertebrate species. Conspicuous among these are fishes known as mud-skippers, certain gastropod molluscs of the families Neritidae, Littorinidae, Potamididae and Ellobiidae, some barnacles, sesarmid and ocypodid crabs and several species of mud lobster and ghost shrimps. All species belong to taxa that are widespread in the Indo-Pacific region or are endemic to shores of the NW Shelf but have biogeographic affinities with that region. Many of the fish in mangrove creeks are occasional and sporadic visitors to the system that enter opportunistically during high tides and include groups such as sharks, longtoms, trevallies, queenfish, mackerel, pike and flatheads (URS 2010a, URS 2010b, URS 2010c).

Marine fauna in the algal mat zone are rare, although insects and insect larvae are sometimes seen under the algal mats. The salt flats are predominantly devoid of marine invertebrates (URS 2010a).



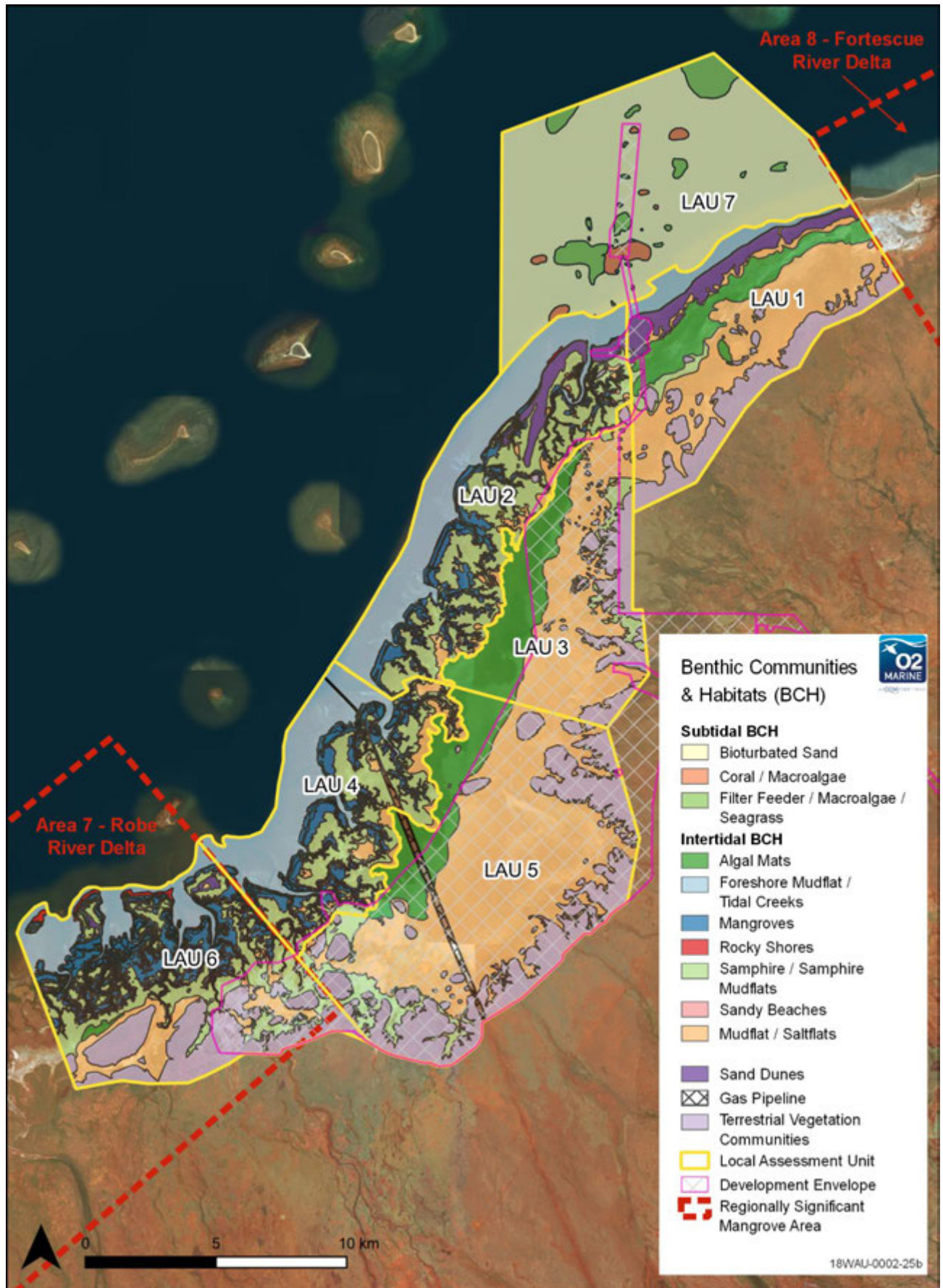


Figure 6 Benthic Communities and Habitat of the Mardie Project area

### 3.4.3. Introduced Marine Species

This section has been sourced from O2 Marine (2020c) unless stated otherwise.

Invasive Marine Species (IMS) are animals, plants, algae and other biota existing in a region beyond their natural geographical range, to which they have generally been translocated by human activity. Australia currently has over 250 known IMS but only a small proportion have become Introduced Marine Pests (IMP). IMPs are IMS that harm the marine environment, social amenity or industries that use the marine environment, or have the potential to do so if they were to be introduced, established, or spread in Australia's marine environment (DAWR 2018).

In 2008, Huisman et al. reported on 102 marine and estuarine species that were known to be introduced and established in WA at the time. Sixty species were considered to have been introduced by anthropogenic activity. Three of these species introduced to WA were listed on the Australian National IMS list (NIMPCG (2009a, 2009b): the dinoflagellate *Alexandrium minutum*, the bivalve *Musculista senhousia* and the polychaete *Sabella spallanzanii* (Wells 2018).

Six IMP alerts for WA were current at the time of the O2 Marine (2020c) report, including observations of Asian Green Mussel *Perna viridis* on a vessel at Barrow Island, Asian Paddle Crab *Charybdis japonica* in the Swan Estuary, Perth, Black Striped Mussel *Mytilopsis sallei*, European green crab *Carcinus maenas*, Japanese Kelp *Undaria pinnatifida* and Northern Pacific seastar *Asterias amurensis*. None of these species are known to have established self-sustaining populations in WA waters but all represent a serious threat.

Wells (2018) conducted a review of IMS in the Pilbara (based on results of publicly available studies) and found that 15 IMS are present, however only one species listed on the Australian National IMS list, the ascidian *Didemnum perlucidum*, has established a self-sustaining population.

The Mardie area has not been surveyed for IMPs in the past. However, nearby at Cape Preston, URS conducted an IMP survey in 2009 and found no IMP species listed by the NIMPCG (URS 2007). The IMP species *Didemnum perlucidum* is found at Barrow Island, approximately 50 km to the north-west of the Proposal (O2 Marine 2020c).

### 3.4.4. Commercial & Recreational Fisheries

Mardie sits within the Pilbara which is part of the North Coast Bioregion. One of the principal commercial fisheries in the North Coast bioregion focuses on tropical finfish such as emperors, snappers and cods and is considered the most valuable finfish sector in the state. Pearling and prawn trawling are also significant commercial fisheries in the region.

The numerous creek systems, mangroves, rivers and beaches provide shore and small boat fishing for a variety of finfish species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, cods, catfish, and invertebrate species including the blue swimmer crab, mud crabs and squid. Offshore islands and coral reef systems provide recreationally caught species including tropical snappers, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerel and billfish (URS 2011).

Details of spawning/aggregation times of key finfish species in the North Coast Bioregion are provided in **Table 8** (DoF 2011).

**Table 8** Spawning/aggregation times for key finfish species in the North Coast Bioregion.

Bioregion	Key Fish Species within zone	Spawning / Aggregation times
North Coast	Blacktip shark ( <i>Carcharhinus tilstoni</i> and <i>C. limbatus</i> )	November - December
North Coast	Goldband snapper ( <i>Pristipomoides multidens</i> )	January - April
North Coast	Pink snapper ( <i>Chrysophrys auratus</i> )	May - July
North Coast	Rankin cod ( <i>Epinephelus multinotatus</i> )	August - October
North Coast	Red emperor ( <i>Lutjanus sebae</i> )	October - March
North Coast	Sandbar shark ( <i>Carcharhinus plumbeus</i> )	October - January
North Coast	Spanish mackerel ( <i>Scomberomorus commerson</i> )	August - November

The commercial fisheries possibly occurring in the proposal area include:

- > Onslow Prawn Trawl Managed Fishery (OPMF);
- > Sea Cucumber (Beche de Mer) Fishery;
- > Marine Aquarium Fish Managed Fishery;
- > Pearl Oyster Managed Fishery (Zone 1);
- > Pilbara Line Fishery;
- > Pilbara Developmental Crab Fishery; and
- > Specimen Shell Managed Fishery.

Ongoing consultation with the Western Australian Fishing Industries Council (WAFIC) is being undertaken by Mardie Minerals Pty Ltd. This consultation is expected to confirm which fisheries are currently operating and how potential impacts (if any) to these fisheries may be mitigated.

Of the fisheries identified above, the Mardie Project area is known to be contained within the OPMF 'Fortescue Nursery Area' (**Figure 7**). Therefore, the OPMF may be at the greatest risk from the proposed activities and is discussed further below.

### Onslow Prawn Trawl Managed Fishery

The OPMF is located on the north coast of WA and encompasses approximately ~39,748 km<sup>2</sup>. The waters within the fishery are further divided into three fishing areas: Area 1, Area 2 and Area 3 (**Figure 7**). In addition, there are also three dedicated nurseries Ashburton Nursery, Coolgra Point Nursery and Fortescue Nursery (**Figure 7**), of which the Mardie Project is located within the Fortescue Nursery area.

The average catch of 96.8 tonnes is dominated by Tiger Prawns (*Penaeus esculentus*) and King Prawns (*P. latisulcatus*), with significant contributions from Endeavour Prawns (*Metapenaeus endeavouri*) and Banana Prawns (*P. merguensis*). Minor species in the fishery include Moreton Bay Bugs, Squid, Blue Swimmer Crabs, Cuttlefish, other prawn species (i.e. coral prawns), and some finfish

species. Consistent annual fishing effort occurs mostly between the Ashburton River and Onslow (Area 1) for banana and king prawns, and in the Mangrove Passage (Area 2) for tiger prawns. The nursery areas are managed as Size Management Fishery Grounds to allow sections of these areas to be fished on a seasonal basis when prawns are considered to have grown to an appropriate size and the area deemed suitable. The fishing season typically operates between March and November (URS 2011).

Fertilisation of the egg in penaeid prawns occurs while it is still attached to the female. Approximately one month after mating, the female prawns migrate into deeper offshore waters predominantly between August to October to spawn the fertilised eggs. The eggs hatch within 24 hours and the free-swimming nauplii have a relatively short 2-4 week planktonic larval stage before settling to the bottom and developing into juvenile prawns in shallow coastal areas. The young grow rapidly, reaching adult size within 3- 6 months. As they near the adult stage, the young prawns migrate offshore into the fishery area (URS 2011). Adult and juvenile prawns are thus spatially separated. Estuaries represent an important habitat for banana prawns. Post larvae settle in the upper reaches of small creek systems and the success of juvenile populations emigrating from the creeks correlates positively with rainfall during the wet season (Vance 1998).



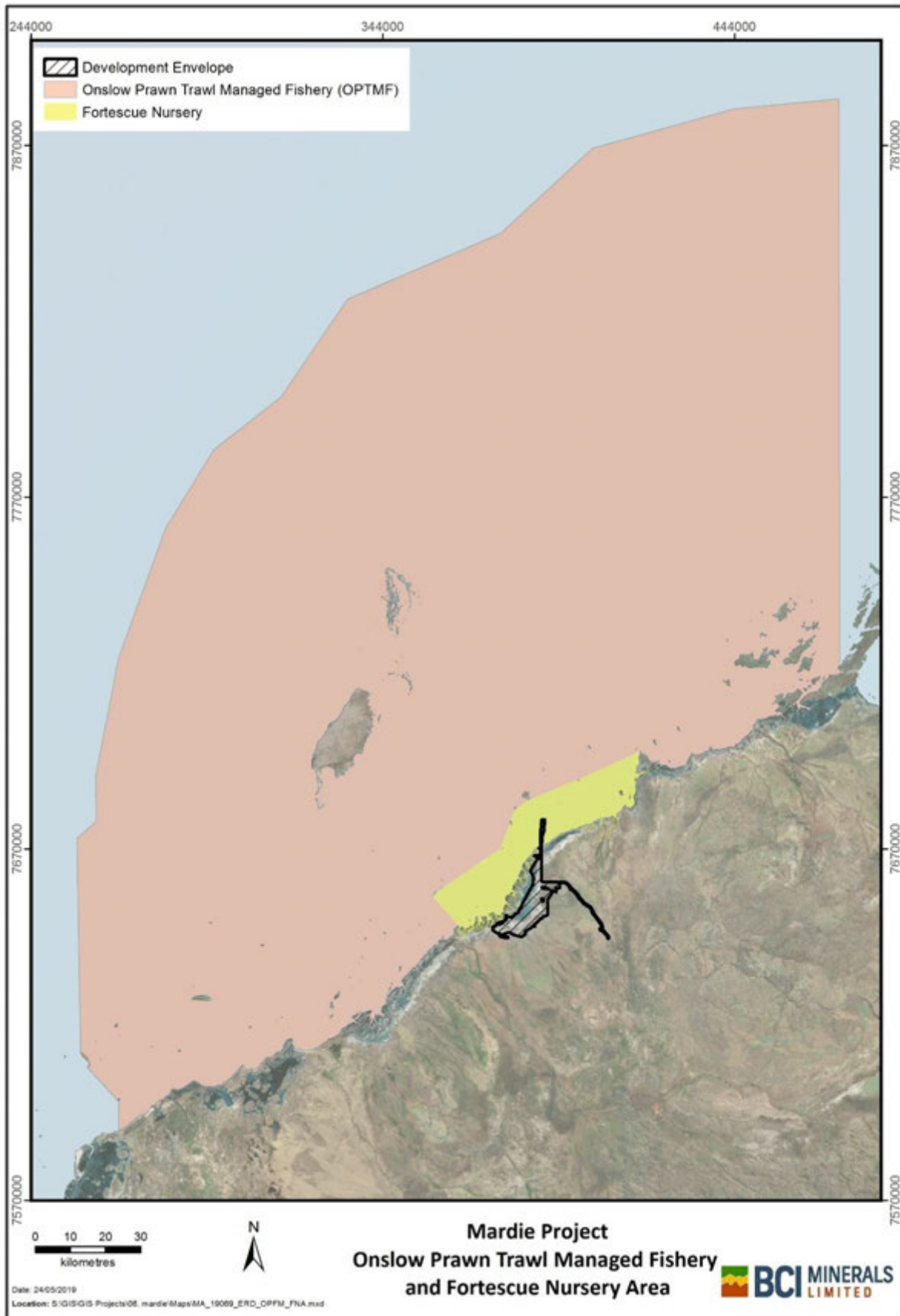


Figure 7 Onslow Prawn Managed Fishery Licence Areas and Nursery Grounds (URS 2011).

### 3.5. Environmental Windows and Key Habitat

A summary of the environmental windows and key habitat for conservation significant species relevant to the proposed Mardie Project is provided in **Table 9**. Key environmental windows that should be considered in evaluating impacts from the Mardie Project include:

- > The southern migration represents the time when humpback whales with their calves have a higher potential to occur within the Mardie Project area, although 5 km from the coastline would represent the boundary limit of their nearshore distribution due to the shallow nature of the intertidal mudflats;
- > Dolphins and Dugong generally are known to occur all year round however higher abundances are around June-September;
- > Sawfish pupping in the tidal creeks generally occurs between September and October and relies on sandy substrates between <1 m water depths.

**Table 9 Summary of Environmental Windows and Key Habitats**

Conservation Significant Species	Environmental Window	Key Habitat	Reference
Humpback Whales (nearshore Southern Migration)	Aug – Nov	Offshore -Typically 36 km from the coast	CWR (2010)
Dolphins (abundance)	Unknown	Coastal waters	CWR (2010)
Dugong (abundance)	June – Sept	<10 m NE & SW of Project area	CWR (2010)
Sawfish (pupping)	Sept - Oct	Tidal Creeks	Morgan (2017)

## 4. Conclusion

A combination of desktop review identified the five, conservation significant marine fauna (excluding turtles) that are either 'known to occur' or have a 'high potential to occur' in the Mardie Project area. These included:

- > Three marine mammals:
  - Humpback Whale;
  - Dugong; and
  - Australian Humpback Dolphin.
- > One marine reptile (excluding turtles):
  - Short-nosed Sea Snake; and
- > One Elasmobranch:
  - Green Sawfish

The following key conclusions are made with respect to these conservation significant species:

- > Humpback whales were considered to be transient and are only likely to use the Project area as a stopover point during the southern migration period (i.e. September). However, they have been observed previously within 5km of the Project and as such management measures should consider impacts to this species;
- > Dugong have been observed in the vicinity of the Project area. However, the project area is considered to be of limited value to dugong populations due to lack of important feeding and foraging habitat (i.e. seagrass meadows). This conclusion is supported by aerial surveys and vessel-based observations which identified Coolgra Point to the south and Cape Preston to the north as supporting greater number of dugong. Nevertheless, dugong may be present in the Project area, particularly between June – September and management measures should consider impacts to this species;
- > Australian Humpback dolphins have previously been recorded in the Project area and as such management measures should consider impacts to this and other dolphin species;
- > The Short-nosed sea snake has not been previously recorded in the Mardie Project area. This species is typically found in coral reef habitats, which in the waters of the Project area are largely confined to the nearshore islands with fringing coral reefs and/or isolated reef patches. It is therefore unlikely the project would disturb or alter the habitat of this species and therefore it is unlikely any impact is expected to occur to this species as a result of the project; and
- > Two species of sawfish have been recorded in similar tidal creeks located to both the north and south of the Mardie Project area and appropriate management measures should be considered to avoid impacts to this species, including consideration of impacts to pupping in the tidal creeks between September to October.

In addition to conservation significant species, the Onslow Prawn Managed Fishery (OPMF) Fortescue Nursery Area was identified as a commercially important area which encompasses the entire Mardie Project area. Therefore, ongoing consultation with WAFIC is considered important to informing the development of any appropriate management strategies to mitigate impacts on this important nursery area.



The extensive mangrove habitats of the Project area were recognised as the most important habitat feature of the Project area for marine fauna as these provide important nursery and feeding areas for a range of species, including fish, turtles, invertebrates and migratory birds. However, overall the Mardie Project area was not considered to be of particular significance to any conservation significant marine fauna species (with the exception of marine migratory birds and marine turtles which are discussed in other reports).

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## Appendix A Database Searches



## Appendix B Likelihood of Occurrence Assessment

Codes used in the following likelihood of occurrence tables:

- > EPBC Act (species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*): Ex = Extinct, CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, MM = Migratory Marine, MT = Migratory Terrestrial, MW = Migratory Wetlands, Ma = Listed Marine
- > BC Act (species listed under the Western Australian *Biodiversity Conservation Act 2016*):
- > Threatened Species: EX = Presumed Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, IA = Migratory birds protected under an International Agreement, CD = Conservation Dependent, OS = Other Specially Protected
- > Priority Species: P1 = Priority 1, P2 = Priority 2, P3 = Priority 3, P4 = Priority 4
- > IUCN (species listed under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species): EX = Extinct, EW = Extinct in the Wild, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern

## Mammals

Species Name	EPBC Status	Act	WC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
<u>Dugong dugon</u> Dugong	MM, Ma		OS	VU	Dugongs undertake long-distance movements, which means Australia shares populations with other neighbouring countries. In Australia, dugongs occur in the shallow coastal waters of northern Australia from the Queensland/New South Wales border in the east to Shark Bay on the Western Australian coast. They are also found in other parts of the Indian and Pacific Oceans in warm shallow seas in areas where seagrass is found.	Record 2014 <b>Known to occur</b> The species has been recorded in the region (desktop searches) and suitable habitat is present at the project area.
<u>Sousa sahalensis</u> Australian humpback dolphin	MM, C		P4	NT	In Australia, Indo-Pacific Humpback Dolphins are known to occur along the northern coastline, extending to Exmouth Gulf on the west coast (25° S), and the Queensland/NSW border region on the east coast (34° S) (Corkeron et al. 1997). There are few records between the Gulf of Carpentaria in the north and Exmouth Gulf in the west, this is probably due to a lack of research effort and the remoteness of the area (Bannister et al. 1996; Parra et al. 2002).	Record 2014 <b>Known to occur</b> The species has been recorded in the region (desktop searches) and suitable habitat is present at the project area
<u>Megaptera novaeangliae</u> Humpback Whale	V, MM		CD	LC	Humpback whales utilising Australian waters currently have tropical calving grounds along the mid and northern parts of the east and west coasts of Australia, with feeding grounds in the Southern Ocean. The majority of humpbacks in Australian waters migrate north to tropical calving grounds from June to August, and south to the Southern Ocean feeding areas from September to November. The migratory habitat for the humpback whale around mainland Australia is primarily coastal waters less than 200 m in depth and generally within 20 km of the coast.	Record 2014 <b>Known to occur</b> The species has been recorded in the region (desktop searches). Typically occur further offshore (>35 km) during migratory routes, although some whales recorded in <10m during southern migration (i.e. September).
<u>Stenella longirostris</u> Spinner dolphin	C		P4	DD	Long-snouted Spinner Dolphins are found in tropical, subtropical and, less frequently, in warm temperate waters. Their global range is between approximately 30–40° N and 20–30° S (DEWHA 2008a) in the Indian, Pacific and Atlantic Oceans (DEWHA 2008) In Australia, there are records of Long-snouted Spinner Dolphins from Western Australia, as far south as Bunbury (33°19' S), as well as from the Northern Territory (including numerous records of these dolphins caught in the Arafura and Timor seas as bycatch in the gillnet fishing industry during 1981–85). Their primary distribution is in pelagic zones, but they are frequently found over shelf waters. Some	Record 2013 <b>Low potential to occur</b> The species has been recorded in the region (desktop searches), however are primarily pelagic (occurring in open ocean) but they can be neritic (occurring over the continental shelf) in some regions, therefore suitable

Species Name	EPBC Status	Act	WC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
					forms are regularly found in shallow waters, particularly near islands and shallow reefs (Leatherwood & Reeves 1983; Perrin 2002).	habitat is generally lacking from the project area.
<u>Balaenoptera musculus</u> Blue Whale	E, C		MM	EN	The blue whale is a cosmopolitan species, found in all oceans except the Arctic, but absent from some regional seas such as the Mediterranean, Okhotsk and Bering seas. Blue whales feed almost exclusively on krill, with a variety of species being taken by different blue whale populations. They feed both at the surface and also at depth, following the diurnal vertical migrations of their prey to at least 100 m. The migration patterns of blue whales are not well understood, but appear to be highly diverse. (Reilly et al., 2008)	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches), however is known to occur in the area and in similar habitats to the project area (Commonwealth of Australia, 2015).
<u>Tursiops aduncus</u> Indo-Pacific/Spotted Bottlenose Dolphin	MM, C		MM		At species level, the Indian Ocean Bottlenose Dolphins are found in tropical and sub-tropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific Region and the western Pacific Ocean (Möller & Beheregaray 2001). Bottlenose dolphins are distributed continuously around the Australian mainland, but the taxonomic status of many populations is unknown. Indian Ocean Bottlenose Dolphins have been confirmed to occur in estuarine and coastal waters of eastern, western and northern Australia (Möller & Beheregaray 2001).	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches) however suitable habitat occurs at the project area.
<u>Sousa sahalensis</u> Indo-Pacific Humpback Dolphin	MM, C		P4	NT	Australian humpback dolphins are found in tropical/subtropical waters of the Sahul Shelf from northern Australia to the southern waters of the island of New Guinea (Jefferson and Rosenbaum, 2014). In Australia, humpback dolphins are thought to be widely distributed along the northern Australian coastline from approximately the Queensland–New South Wales border to western Shark Bay, Western Australia (Parra & Cagnazzi 2016). Most studies to date indicate that Australian humpback dolphins occur mostly close to the coast (within 20 km from land) and in relatively sheltered offshore waters near reefs or islands (Parra & Cagnazzi 2016)	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches) however suitable habitat occurs at the project area.
<u>Eubalaena australis</u> Southern Right Whale	E, MM, C		VU	LC	In Australian coastal waters, southern right whales occur along the southern coastline including Tasmania, generally as far north as Sydney on the east coast and Perth on the west coast. There are occasional	<b>Low potential to occur</b> The species has not been recorded in the region (no records from desktop searches) and the distribution for this

Species Name	EPBC Status	Act	WC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
					occurrences further north, with the extremities of their range recorded as Hervey Bay (25°00'S, 152°50'E) and Exmouth (22°23'S, 114°07'E).	species occurs significantly south of the survey area.
<u>Orcaella heinsohni</u> Australian snubfin dolphin	MM, C		P4	VU	Stranding and museum specimen records indicate that Australian Snubfin Dolphins occur only in waters off the northern half of Australia, from approximately Broome (17° 57' S) on the west coast to the Brisbane River (27° 32' S) on the east coast (Parra et al. 2002a). Aerial and boat-based surveys indicate that Australian Snubfin Dolphins occur mostly in protected shallow waters close to the coast, and close to river and creek mouths (Parra et al. 2002a).	Record 2013 <b>Low potential to occur</b> The species has been recorded in the region (desktop searches), however suitable habitat is generally lacking from the project area.

## Reptiles

Species Name	EPBC Act Status	BC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
<u><i>Aipysurus apraefrontalis</i></u> Short-nosed Seasnake	CE, Ma	CR	CR	The Short-nosed Seasnake is endemic to Western Australia, and has been recorded from Exmouth Gulf, Western Australia to the reefs of the Sahul Shelf, in the eastern Indian Ocean. The species prefers the reef flats or shallow waters along the outer reef edge in water depths to 10 m (McCosker 1975).	<b>High potential to occur</b> The species has not been recorded in the region (desktop searches). The project area contains suitable habitat and is within the known distribution of the species.

## Sharks and Rays

Species Name	EPBC Act Status	BC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
<u><i>Pristis clavata</i></u> Dwarf Sawfish	V, MM	P1	EN	The species' Australian distribution has previously been considered to extend north from Cairns around the Cape York Peninsula in Queensland, across northern Australian waters to the Pilbara coast in Western Australia (Last & Stevens 1994). The Dwarf Sawfish usually inhabits shallow (2–3 m) coastal waters and estuarine habitats.	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches). The western extent of this species range has not been fully resolved, however suitable habitat is present in the project area.
<u><i>Pristis zijsron</i></u> Green Sawfish	V, MM	VU	CR	The green sawfish inhabit shallow coastal marine and estuarine waters of northern Australia, from about Eighty Mile Beach, Western Australia, to the Cairns region, Queensland. It has been occasionally been caught as far south as Sydney. Green sawfish are known to be pupped near the Ashburton River mouth and utilise the estuary and nearby mangrove creeks, before moving offshore to mature at a length of about 3 m (Morgan et al. 2017).	<b>High potential to occur</b> The species is known to occur in the region from recent scientific studies (Morgan et al 2017). Suitable habitat is also present in the project area, however no records exist from within the Project area.
<u><i>Carcharias taurus</i></u> Grey Nurse Shark	V	VU		The Grey Nurse Shark (west coast population) has a broad inshore distribution, primarily in sub-tropical to cool temperate waters. The population of Grey Nurse Shark (west coast population) is predominantly found in the south-west coastal waters of Western Australia and has been recorded as far north as the North West Shelf (Last & Stevens 1994).	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches). Predominantly found in cooler coastal waters further south, however, has been found at Muiron

Species Name	EPBC Act Status	BC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
					Islands and potential suitable habitat does exist in project area.
<u>Anoxypristis cuspidate</u> Narrow Sawfish	MM		EN	The Narrow Sawfish is an Indo-West Pacific species occurring from the northern Persian (Arabian) Gulf to Australia and north to Japan. It is a benthic-pelagic species that occurs from inshore and estuarine areas to offshore habitats in depths of up to 100 m (Anastasi et al 2013) Common in sheltered bays with sandy bottoms and feed on small fish and cuttlefish (Compagno and Last 1999).	<b>Moderate potential to occur</b> The species has not been recorded in the region (desktop searches) and the exact distribution is uncertain. The project area contains suitable habitat.
<u>Rhincodon typus</u> Whale Shark	V, MM	OS	EN	Found worldwide in tropical and subtropical oceans. (OzFishNet, 2016). In Australia, the Whale Shark is known from NSW, Queensland, Northern Territory, Western Australia and occasionally Victoria and South Australia, but it is most commonly seen in waters off northern Western Australia, Northern Territory and Queensland (Compagno and Last 1999). Yearly numbers of Whale Sharks in Ningaloo Marine Park are estimated to vary between 300 and 500 individuals Research conducted in 2003 on Whale Sharks aggregating at Ningaloo Reef found that this species routinely moved between the sea surface and depth. Sharks spent at least 40% of their time in the upper 15 m of the water column and at least 50% of their time at depths equal to or less than 30 m (Wilson et al. 2006).	<b>Low potential to occur</b> The species has not been recorded in the region (no records from desktop searches) and are generally found in waters deeper than present at the project area.
<u>Carcharodon carcharias</u> Great White Shark	V, MM	VU	VU	In Australia, Great White Sharks have been recorded from central Queensland around the south coast to north-west Western Australia but may occur further north on both coasts (Bonfil et al. 2005). They inhabit inshore waters around rocky reefs, surf beaches and shallow coastal bays; waters on the outer continental shelf and slope; and the open ocean. These sharks most commonly live in depths above 100 m.	<b>Low potential to occur</b> The species has not been recorded in the region (no records from desktop searches). Has been found to Muiron Islands although predominantly found in cooler coastal waters further south, suitable habitat is lacking from project area.
<u>Manta birostris</u> Giant Manta Ray	MM		VU	The Manta Ray lives in tropical, marine waters worldwide, but is also found occasionally in temperate seas. In Australia it is recorded from south-western Western Australia, around the tropical north of the country and south to the southern coast of New South Wales (DBCA, 2017). The species is known to occur in the Ningaloo Marine Park, Muiron Islands Marine Management Area, Montebello Islands Marine Park, Eighty Mile Beach	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches). Potential habitat does occur near the project area.

Species Name	EPBC Act Status	BC Act Status	IUCN Status	Habitat Preference	Likelihood of Occurrence
				Marine Park, Lalang-garram / Camden Sound Marine Park and Rowley Shoals Marine Park (Last & Stevens 1994).	
<u>Manta alfredi</u> Reef Manta Ray	MM		VU	Reef manta rays are found primarily in the Indian and Pacific Oceans, including coastal waters surrounding Australia, Japan, South Africa, Thailand and Hawaii (Fabrice, et al., 2012). This species is generally found in inshore habitats (within a few kilometers of land) in tropical and subtropical latitudes. They are often sighted near coral and rocky reefs in atolls and bays, likely due to the high densities of zooplankton associated with these areas (Anderson, et al., 2011).	<b>Moderate potential to occur</b> The species has not been recorded in the region (no records from desktop searches). Potential habitat does occur near the project area.



## Migratory/Marine Species

Class	Species	Common Name	EPBC Status	Act	BC Act Status	IUCN	Record in searches
Fish	<i>Acentronura larsonae</i>	Helen's Pygmy Pipehorse	Ma			DD	
Fish	<i>Bulbonaricus brauni</i>	Braun's Pughead Pipefish, Pug-headed Pipefish	Ma		Ma	LC	
Fish	<i>Campichthys tricarinatus</i>	Three-keel Pipefish	Ma		Ma	DD	
Fish	<i>Choeroichthys brachysoma</i>	Pacific Short-bodied Pipefish, Short-bodied Pipefish	Ma		Ma	LC	
Fish	<i>Choeroichthys latispinosus</i>	Murion Island Pipefish	Ma		Ma	DD	
Fish	<i>Choeroichthys suillus</i>	Pig-snouted Pipefish	Ma		Ma	LC	
Fish	<i>Doryrhamphus dactyliophorus</i>	Banded Pipefish, Ringed Pipefish	Ma		Ma	DD	
Fish	<i>Doryrhamphus janssi</i>	Cleaner Pipefish, Janss' Pipefish	Ma		Ma	LC	
Fish	<i>Doryrhamphus multiannulatus</i>	Many-Banded Pipefish	Ma		Ma		
Fish	<i>Doryrhamphus negrosensis</i>	Flagtail Pipefish, Masthead Island Pipefish	Ma		Ma	LC	
Fish	<i>Festucalex scalaris</i>	Ladder Pipefish	Ma		Ma		
Fish	<i>Filicampus tigris</i>	Tiger Pipefish	Ma		Ma	LC	
Fish	<i>Halicampus brocki</i>	Brock's Pipefish	Ma		Ma	LC	
Fish	<i>Halicampus grayi</i>	Mud Pipefish, Gray's Pipefish	Ma		Ma	LC	
Fish	<i>Halicampus nitidus</i>	Glittering Pipefish	Ma		Ma	LC	
Fish	<i>Halicampus spinirostris</i>	Spiny-snout Pipefish	Ma		Ma		
Fish	<i>Haliichthys taeniophorus</i>	Ribboned Pipehorse, Ribboned Seadragon	Ma		Ma	LC	
Fish	<i>Hippichthys penicillus</i>	Beady Pipefish, Steep-nosed Pipefish	Ma		Ma	LC	
Fish	<i>Hippocampus angustus</i>	Western Spiny Seahorse, Narrow-bellied Seahorse	Ma		Ma	DD	
Fish	<i>Hippocampus histrix</i>	Spiny Seahorse, Thorny Seahorse	Ma		Ma	VU	
Fish	<i>Hippocampus kuda</i>	Spotted Seahorse, Yellow Seahorse	Ma		Ma	VU	
Fish	<i>Hippocampus planifrons</i>	Flat-face Seahorse	Ma		Ma		
Fish	<i>Hippocampus trimaculatus</i>	Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse	Ma		Ma	VU	
Fish	<i>Micrognathus micronotopterus</i>	Tidepool Pipefish	Ma		Ma	LC	
Fish	<i>Phoxocampus belcheri</i>	Black Rock Pipefish	Ma		Ma	LC	
Fish	<i>Solegnathus hardwickii</i>	Pallid Pipehorse, Hardwick's Pipehorse	Ma		Ma	DD	

Class	Species	Common Name	EPBC Status	Act	BC Act Status	IUCN	Record in searches
Fish	<i>Solegnathus lettiensis</i>	Gunther's Pipehorse, Indonesian Pipefish	Ma		Ma	DD	
Fish	<i>Solenostomus cyanopterus</i>	Robust Ghostpipefish, Blue-finned Ghost Pipefish,	Ma		Ma	LC	
Fish	<i>Solenostomus paegnius</i>	Rough-snout Ghost Pipefish	Ma		Ma	LC	
Fish	<i>Syngnathoides biaculeatus</i>	Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish	Ma		Ma	DD	
Fish	<i>Trachyrhamphus bicoarctatus</i>	Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish	Ma		Ma	LC	
Fish	<i>Trachyrhamphus longirostris</i>	Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish	Ma		Ma	LC	
Mammal	<i>Balaenoptera acutorostrata</i>	Minke Whale	C		Whales & Cetaceans	LC	
Mammal	<i>Delphinus delphis</i>	Common Dolphin, Short-beaked Common Dolphin	C		Whales & Cetaceans	LC	
Mammal	<i>Grampus griseus</i>	Risso's Dolphin, Grampus	C		Whales & Cetaceans	LC	
Mammal	<i>Stenella attenuata</i>	Spotted Dolphin, Pantropical Spotted Dolphin	C		Whales & Cetaceans	LC	
Mammal	<i>Tursiops truncatus s. str.</i>	Bottlenose Dolphin	C		Whales & Cetaceans		
Mammal	<i>Balaenoptera edeni</i>	Bryde's Whale	MM, C		MM	DD	
Mammal	<i>Orcinus orca</i>	Killer Whale, Orca	MM, C		MM	DD	
Reptile	<i>Hydrelaps darwiniensis</i>	Black-ringed Seasnake	Ma		Ma	LC	
Reptile	<i>Acalyptophis peronii</i>	Horned Seasnake	Ma		Ma	LC	
Reptile	<i>Aipysurus duboisii</i>	Dubois' Seasnake	Ma		Ma	LC	
Reptile	<i>Aipysurus eydouxii</i>	Spine-tailed Seasnake	Ma		Ma	LC	
Reptile	<i>Aipysurus laevis</i>	Olive Seasnake	Ma		Ma	LC	
Reptile	<i>Astrotia stokesii</i>	Stokes' Seasnake	Ma		Ma	LC	
Reptile	<i>Disteira kingii</i>	Spectacled Seasnake	Ma		Ma		
Reptile	<i>Disteira major</i>	Olive-headed Seasnake	Ma		Ma		
Reptile	<i>Emydocephalus annulatus</i>	Turtle-headed Seasnake	Ma		Ma	LC	
Reptile	<i>Ephalophis greyi</i>	North-western Mangrove Seasnake	Ma		Ma		
Reptile	<i>Hydrophis czeb lukovi</i>	Fine-spined Seasnake	Ma		Ma	DD	
Reptile	<i>Hydrophis elegans</i>	Elegant Seasnake	Ma		Ma	LC	
Reptile	<i>Hydrophis macdowellii</i>	Small headed Seasnake	Ma		Ma	LC	
Reptile	<i>Hydrophis ornatus</i>	Spotted Seasnake, Ornate Reef Seasnake	Ma		Ma	LC	
Reptile	<i>Pelamis platurus</i>	Yellow-bellied Seasnake	Ma		Ma		