

Marine Fauna Desktop and Impact Assessment

Onslow Recreational Jetty Project



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Acronyms and Abbreviations

| Term | Full term |
|-----------------|--|
| AHD | Australian Height Datum |
| ALA | Atlas of Living Australia |
| AMSIS | Australian Marine Spatial Information System |
| AUC | Area under the curve |
| BC Act | <i>Biodiversity Conservation Act 2016 (Western Australia)</i> |
| BCH | Benthic Communities and Habitats |
| BIA | Biological Important Area |
| Biosecurity Act | <i>Biosecurity Act 2015</i> |
| CALM Act | <i>Conservation and Land Management Act 1984 (Western Australia)</i> |
| CAMBA | China-Australia Migratory Bird Agreement |
| C | Concern |
| CE | Critically Endangered |
| CEMP | Construction Environmental Management Plan |
| CD | Conservation Dependent |
| cm | Centimetre |
| CR | Critically Endangered |
| CSMF | Conservation Significant Marine Fauna |
| Cth | Commonwealth |
| CT | Cetacean |
| DBCA | Department of Biodiversity, Conservation and Attractions. |
| DCCEEW | Department of Climate Change, Energy, the Environment and Water |
| DD | Data Deficient |
| DE | Development Envelope |
| DPIRD | Department of Primary Industries and Regional Development |
| EAAF | East Asian-Australasian Flyway |
| EIA | Environmental Impact Assessment |
| EN | Endangered |
| EP Act | <i>Western Australian Environmental Protection Act 1986</i> |
| EPA | Environmental Protection Authority |



| Term | Full term |
|-----------------|--|
| EPBC Act | <i>Environment Protection and Biodiversity Conservation Act 1999</i> |
| EW | Extinct in the wild |
| EX | Extinct |
| FRM Act | <i>Fish Resources Management Act 2016</i> |
| HAT | Highest Astronomical Tide |
| IMMA | Important marine mammal areas |
| IMP | Introduced marine pests |
| IUCN | International Union for the Conservation of Nature |
| JAMBA | Japan-Australia Migratory Bird Agreement |
| km | kilometre |
| km ² | square kilometre |
| LAT | Lowest Astronomical Tide |
| LC | Less Concern |
| m | metre |
| MA | Marine |
| MI | Migratory |
| MFO | Marine Fauna Observer |
| MNES | Matters of National Environmental Significance |
| MOF | Material offloading facility |
| MPA | Marine Protected Area |
| NA | Not Applicable |
| NC | No Concern |
| NSW | New South Wales |
| NT | Northern Territory |
| NWC | North West Cape |
| NWS | North West Shelf |
| OPMF | Onslow Prawn Managed Fishery |
| OS | Other specially protected |
| PC | Potential Concern |
| PMST | Protected Matters Search Tool |
| PoA | Port of Ashburton |

| Term | Full term |
|-------|--------------------------------------|
| PTS | Permanent Threshold Shift |
| QLD | Queensland |
| SE | Standard Error |
| SPRAT | Species profile and threats database |
| TEC | Threatened ecological communities |
| TTS | Temporary Threshold Shift |
| VU | Vulnerable |
| WA | Western Australia |
| WEPL | Western Environmental Pty Ltd |

Contents

| | |
|--|------------|
| Acronyms and Abbreviations..... | 4 |
| 1. Introduction | 1 |
| 1.1. Project description | 1 |
| 1.2. Proposed construction works..... | 1 |
| 1.3. Scope and objectives | 5 |
| 1.4. Relevant marine fauna legislation | 5 |
| 2. Existing environment | 6 |
| 2.1. Climate..... | 6 |
| 2.2. Geology and geomorphology..... | 6 |
| 2.3. Tidal Regime..... | 6 |
| 2.4. Waves..... | 7 |
| 2.5. Coastal Processes | 7 |
| 2.6. Benthic communities and habitats..... | 7 |
| 3. Conservation Significant Species | 10 |
| 3.1. Methods | 10 |
| 3.2. Results..... | 15 |
| 4. Key species descriptions | 33 |
| 4.1. Mammals | 33 |
| 4.2. Reptiles | 51 |
| 4.3. Sharks and Rays..... | 63 |
| 4.4. Seabirds..... | 68 |
| 4.5. Migratory Shorebirds..... | 73 |
| 5. Impact assessment | 79 |
| 5.1. Potential impacts..... | 79 |
| 5.2. Ecological windows | 83 |
| 5.3. Impact assessment relevant to Project activities | 86 |
| 6. Recommended mitigation for impacts | 101 |
| 7. Environmental outcomes and likelihood of significant impacts | 107 |
| 8. References..... | 111 |
| Appendix A. PMST search results | 128 |

| | |
|--|------------|
| Appendix B. Summary of database information and likelihood of occurrence assessment | |
| | 129 |
| Mammals | 130 |
| Reptiles | 134 |
| Fish and sharks | 138 |
| Birds | 143 |
| Appendix C. Literature review summary | 159 |
| Appendix D. Onslow recreational Jetty Underwater Piling Noise Modelling Report (ANV Consultants 2024) | 171 |

Tables

| | |
|---|----|
| Table 1: databases and repots relevant to CSMF searches..... | 10 |
| Table 2: Literature review parameters for key conservation significant species..... | 14 |
| Table 3: Species likelihood of occurrence definitions..... | 15 |
| Table 4: Outline of distances to the protected conservation significant elements that were not within or adjacent to the Project site | 16 |
| Table 5: Summary of CSMF species listed within PMST results | 17 |
| Table 6: Summary of CSMF species listed within DBCA results..... | 18 |
| Table 7: Number of recorded sightings for all marine fauna species identified in the DBCA search and year of last sighting..... | 20 |
| Table 8: Biologically Important Areas that spatially overlap with all marine elements of the Project (DCCEEW 2024a;b) | 24 |
| Table 9: Critical habitat for the survival of marine turtles that overlap the Project search area..... | 28 |
| Table 10: IMMAs relevant to the Project | 30 |
| Table 11: Population estimates and trends of key seabird species | 69 |
| Table 12: Key seabird distributions | 70 |
| Table 13: Habitat and breeding habitat/timing for key seabird species..... | 71 |
| Table 14: Key shorebirds species population summaries..... | 73 |
| Table 15: Migratory shore distribution summary | 75 |
| Table 16: Migratory shorebird habitat summary | 77 |
| Table 17: Summary of key species, their habitat and potential stressors related to the Project..... | 80 |
| Table 18: Key pressures and threats as identified in the North-west bioregional plan (DSEWPC 2012a) relevant to the Project..... | 82 |

Table 19: Key Species’ Ecological Windows (Dark blue represent- full duration of presence. Light blue – represents timing of specific behaviours. Diagonal shading represents peak timing of specific behaviours)..... 84

Table 20: Potential impacts of underwater noise to marine fauna 86

Table 21: Cumulative impacts from impulsive noise under multiple piling pulses for PTS and TTS, end of jetty at Highest Astronomical Tide (HAT) and LAT (modified from ANV Consultants 2024) 91

Table 22: Zones of cumulative impact from impulsive noise number multiple piling pulses for mortality and recovery injury, fish, fish eggs and larvae (modified from ANV Consultant 2024) 92

Table 23: Zones of immediate impact from a single impact piling pulses for behavioural changes for marine mammals and turtles (ANV Consultants 2024) 92

Table 24: Summary of impact assessment for marine fauna 101

Table 25: Marine fauna vessel controls (DoEE 2017b; c) 107

Table 26: Summary of nature and magnitude of the Project and potential impacts on marine fauna 108

Table 27: Assessment of significant impacts..... 109

Figures

Figure 1: Project Location and indicative Development Envelope 2

Figure 2: Concept design plan (Burbury Consulting 2024a)..... 3

Figure 3: Jetty Concept Design (Burbury Consulting 2024b) 4

Figure 4: BCH map of the Project Development Envelope (O2 Marine 2024)..... 9

Figure 5: PMST search area with a 20km buffer 12

Figure 6: Dolphin sightings as recorded in DBCA (2024) 21

Figure 7: Dugong sightings as recorded in DBCA (2024) 22

Figure 8: Whale sightings as recorded in DBCA (2024) 22

Figure 9: Turtle sightings as recorded in DBCA (2024)..... 23

Figure 10: Ray sightings as recorded in DBCA (2024)..... 23

Figure 11: Bird sightings as recorded in DBCA (2024) 24

Figure 12: Humpback whale BIAs near the Project..... 25

Figure 13: Turtle BIAs..... 26

Figure 14: Bird BIAs 27

Figure 15: Critical habitat for the survival of marine turtles within the region of the Project area 29

Figure 16: Humpback dolphin sightings distribution over a four-year survey program (Hanf et al. 2022) 35

Figure 17: Habitat suitability for humpback dolphins at 500 x 500 m gride cell resolution (Hanf et al. 2022) 37

Figure 18: Bottlenose dolphin sightings distribution over a four-year survey program (Hanf et al. 2022) 40

Figure 19: Habitat suitability for bottlenose dolphins at 500 x 500 m gride cell resolution (Hanf et al. 2022) 42

Figure 20: Distribution of dugongs recorded in the waters surrounding the Chevron Wheatstone Project Area from 17 May 2009 to 29 April 2010 (Jenner et al. 2010a)..... 45

Figure 21: Swim direction reported for humpback whale pods sighted during the southern migratory phase (September 3 to December 24) (Jenner and Jenner 2009) 48

Figure 22: Satellite-tag record locations of pygmy blue and humpback whales (n = 155, teal circles). State and national marine parks of Australia are overlaid in red. Areas exposed to >365 vessels per year per 10-km radius is shown in yellow marine parks in red (Raoult et al. 2022) 49

Figure 23: Flatback turtle stocks in a grid cell throughout northern Western Australia delimited from occupancy indices (i.e. relative amount of time spent per grid cell; a, c, e) or the number of tagged flatbacks moving through grid cells (b, d, f). Inter-nesting behavioural phase (a, b), and at the 75% contour on a 10 x 10 km grid at a stock-level for migration (c, d) and foraging (e, f). (Peel et al 2024). .57

Figure 24: Sea snake habitat suitability (Udyawer et al. 2020). Modelled habitat suitability for sea snakes in northern WA, a) short-nosed sea snake, b) leaf-scaled sea snake (Udyawer et al. 2020) 61

Figure 25: Maps A - D showing D'Anastasi et al. (2016) survey locations. Figures E and F display new sightings from D'Anastasi study..... 62

Figure 26: Modelled stock-structure scenarios for the scalloped hammerhead shark (TSSC 2024) 64

Figure 27: Scalloped hammerhead distribution (Chin et al. 2017). 66

Figure 28: Spatial distribution of commercial catch and scientific observations (Bartes and Braccini 2021). 67

Figure 29: The East Asian Australasian Flyaway zone (Bamford et al. 2008) 75

Figure 30: Generalised ranges from a noise source, at which different types of impacts to marine fauna may occur (Erbe 2022) 87

Figure 31: Population consequences of disturbances (PCoD) conceptual framework (Pirotta et al. 2018) 88

Figure 32: Noise contour figure from modelling scenario - worst case scenario – high tide at the end of the jetty (ANV 2024)..... 93

1. Introduction

1.1. Project description

The Shire of Ashburton (SoA) propose to build a new Onslow Recreational Jetty (the Project) at Beadon Point, northwest of the main township of Onslow, Western Australia (WA). The regional location and an indicative Project Development Envelope (DE) is shown in Figure 1. The proposed jetty will be a pedestrian accessible fixed jetty design, intended to provide access for deeper water fishing at low tide, with usage limited to walking and recreational fishing with no vehicle or vessel access (except for ad-hoc maintenance vehicles/vessels).

The jetty is likely to extend 210 meters (m) from the vegetation line (252 m total) with a width of 4 m, located adjacent the old Onslow jetty site (remains are visible to the east of the proposed site, shown in Figure 1).

1.2. Proposed construction works

The concept designs were prepared by Burbury Consulting as shown in Figure 2 and Figure 3 and a summary of this information is provided below.

The concept work indicates that the seaward end of the jetty will have a “T” shaped end (Figure 2 and Figure 3) and split into 2 levels, with a lower landing running parallel to the main jetty to provide greater functionality to the jetty (main jetty will be concrete and the lower landing constructed from permeable grated decking to limit uplift loads) (MP Rogers & Associates 2020). The main deck level will be at +8 m Australian Height Datum (AHD) with the lower-level platform down to +2 m AHD (final levels to be confirmed following detailed metocean analysis). It is envisaged that this would provide a reasonable level of access to the water during the full tidal range in this area. It is estimated that most of the jetty would have at least 0.5 m of water depth over 50% of the time with the jetty head is positioned to be within water at Lowest Astronomical tide (LAT) (MP Rogers & Associates 2020).

Modifications to this concept are expected as the preliminary design is finalised to address additional planning and engineering considerations (e.g. costing, constructability and availability of materials); however, these modifications are expected to be minor.

The jetty will be constructed using piles driven into the sediment and landings constructed. Currently there are no roads or access to the site, and therefore land clearing is likely to be required to gain access for the building materials and equipment. A small excavator may also be required to track over the seabed at low tide within the development envelope to facilitate pre-drilling at the pile locations in the event of pile refusal. It is unlikely this will be needed but has been considered for the Proposal as an option.

Construction may be built from the land and progressively work seaward using a mobile construction rig that is moved along the jetty as the structure is progressively built (preferred approach). The additional weight from a mobile construction setup will need to be considered during design (MP Rogers & Associates 2020). A secondary construction option is to build a small temporary access structure from the landside over the beach and intertidal zone.



Figure 1: Project Location and indicative Development Envelope

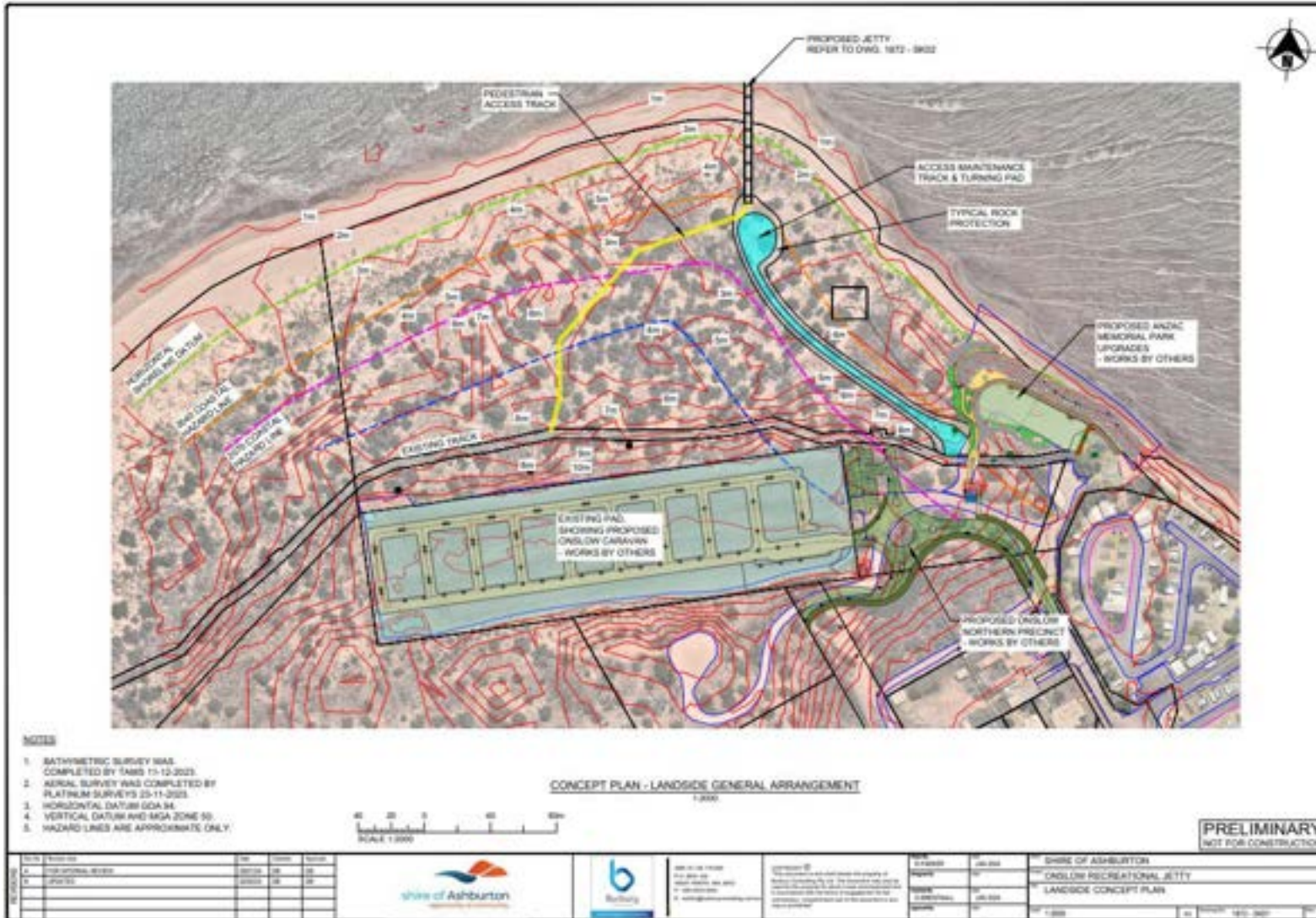


Figure 2: Concept design plan (Burbury Consulting 2024a)

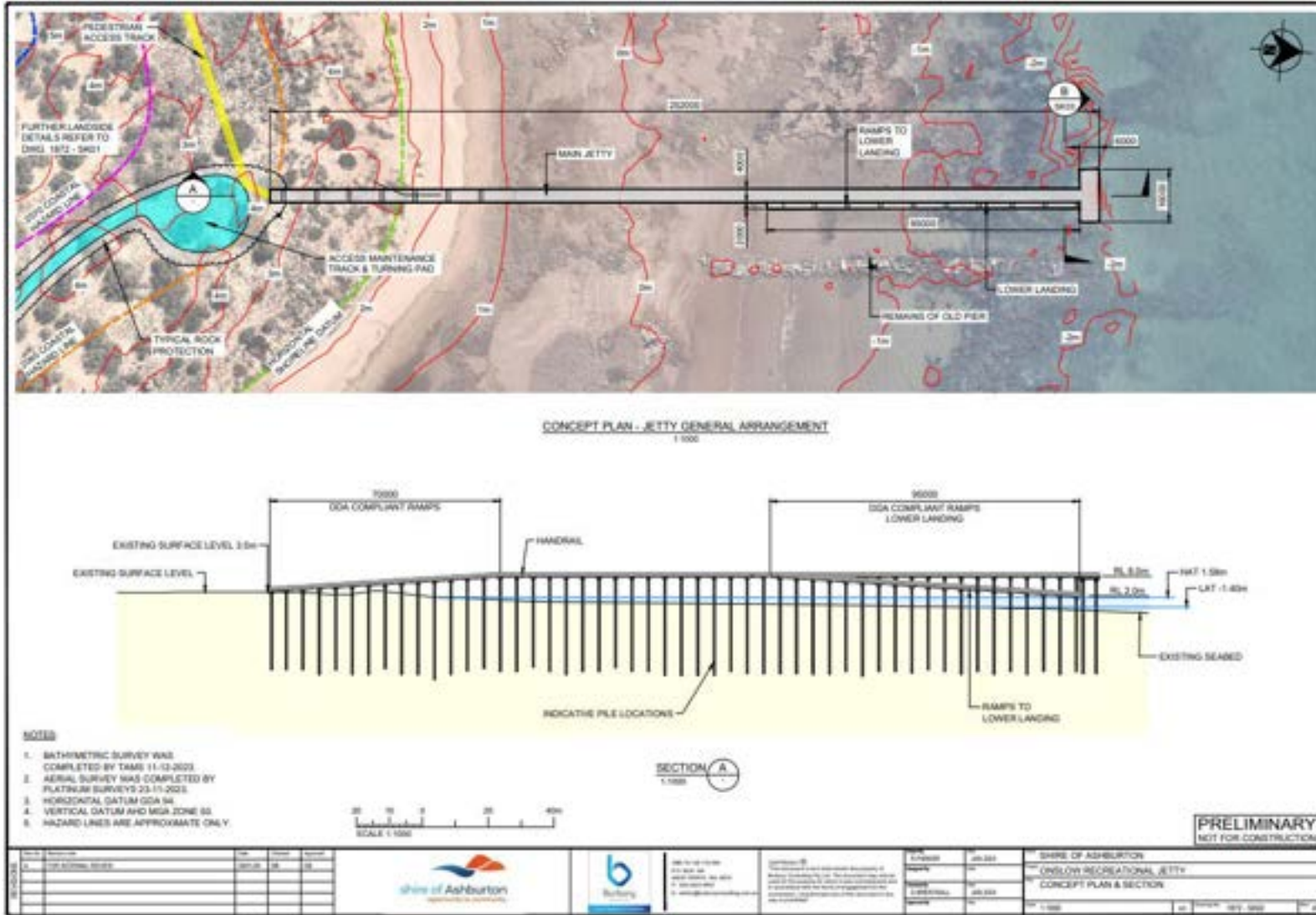


Figure 3: Jetty Concept Design (Burbury Consulting 2024b)

1.3. Scope and objectives

This Project will be referred under the *WA Environmental Protection Act 1986* and the information in this desktop study will be used to inform the environmental impact assessment (EIA) and formulation of related management measures.

The objectives of this report are to:

- Identify key species based on their conservation status and their likelihood of occurrence in Project-impacted areas
- Summarise key species' ecological characteristics (i.e. population, distribution, habitat use, life history characteristics and ecological windows)
- Identify key knowledge gaps for key marine fauna
- Identify potential threats and impacts to marine fauna associated with the Project.

1.4. Relevant marine fauna legislation

Key legislation governing the protection of conservation significant marine fauna and their habitats in WA are:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cth)
- *Environmental Protection Act 1986* (EP Act) (WA)
- *Biodiversity Conservation Act 2016* (BC Act) (WA)
- *Conservation and Land Management Act 1984* (CALM Act) (WA)
- *Fish Resources Management Act 1994* (FRM Act) (WA)
- *Biosecurity Act 2015* (Biosecurity Act) (Cth).

The EPBC Act and EP Act govern the environmental approval process. They aim to support environmentally sustainable development while protecting environmental values, including biodiversity. Proposals referred under the EP Act are assessed by the WA Environmental Protection Authority (EPA).

2. Existing environment

2.1. Climate

Located in the Pilbara, Onslow experiences two seasons: a dry season between April and October and wet season between November and March. The dry season is characterised by warm temperatures with the average daily minimum and maximum temperatures of 14.3°C and 26.1°C respectively (BoM 2024). The wet season is characterised by hot temperatures, long sunny days (with more than 10 hours of sunlight per day), and variable rainfall (BoM 2024). February holds the average monthly maximum temperature and highest rainfall (35.3°C and 86 mm). The coolest average monthly maximum temperatures are experienced in July (25.4°C), with the lowest average rainfall in October (0.8mm) (BoM 2024). Onslow is often impacted by cyclones as the Pilbara is the most cyclone prone area along the Australian coastline (DPIRD 2016). Cyclones are attributed as the source of 25 to 34% of the total annual rainfall (DPIRD 2016). The annual mean rainfall for Onslow is 328.8 mm. In the wet season, winds are typically stronger and from a southwest, west, or northwest direction creating a sea-breeze effect (DoT 2017).

2.2. Geology and geomorphology

The Pilbara coast is described as a riverine coastal plain in a tropical arid setting. The Onslow coast lies at the western end of the Pilbara and is part of the Carnarvon Basin facing northeast (Semeniuk 1993). The modern shore is developed on Quaternary sediments overlying Tertiary sedimentary rocks at shallow depth. The geomorphic structures of the coastline reflect the repeated rise and fall of sea level and repositioning of the coastline during that period, and the modern complex coastal geomorphology and habitats are a direct outcome of those events reflecting historic environmental conditions, centuries or millennia before present (Eliot et al. 2013; Semeniuk 1993). In places the riverine sediments have been lithified. Along with old reef structures and beach rock, these now form coastal limestones outcropping along the shore (O2 Marine 2017). More mobile sediments are intermittently delivered to the coast by numerous rivers and flowing streams, the largest being the Ashburton (adjacent to the Project), Fortescue and De Grey Rivers (Eliot et al. 2013).

Nearshore sediments are predominantly silty sandy substrate that extends out seaward to the 10 m isobath (which extends at least 10 kilometres (km) offshore) (O2 Marine 2017). The offshore bathymetry is characterised by a wide continental shelf that extends out to the Exmouth Plateau further characterising shallow bathymetry along the North-West Shelf (DEWHA 2007).

2.3. Tidal Regime

Numerous islands (Muiron Islands, Serrurier Island, Thevenard Island, and Barrow Island) influence waves and tidal currents in the area. Tidal regimes in the Onslow area are semi-diurnal but also experience a monthly spring-neap cycle, a bi-annual cycle due to movement of the solar equator and a 4.4-year cycle developed from lunar elliptic motion with a mean spring tide range of 1.9 m and a neap tide range of 0.5 m (Baird 2020; Damara 2010). The seasonal variations of tides, surges and mean sea level do not generally occur in phase:

- Tidal peaks occur near the equinoxes in March and September

- Surge peaks mainly occur in January to March due to tropical cyclones, and from June to August due to mid-latitude systems
- The seasonal mean sea level peaks during April.

This relative timing means that there is opportunity for high water level events (>2.8 m Chart Datum) over most of the year. The relative timing of the tidal and mean sea level peaks provides increased potential for extreme water level events to occur as a result of late season tropical cyclones, in March or April (Damara 2010).

Currents are predominately influenced by the Leeuwin Current that flows from south along the WA coastline (DEWHA 2007). The current is driven by the Indonesian Throughflow current, which brings warm water down from the Pacific to the Indian Ocean (O2Marine and Teal Solutions 2021). The Leeuwin current is strongest during the dry season.

2.4. Waves

Wave conditions are relatively minor due to the shallow bathymetry, with the total wave height lower than 1 m and often less than 0.5 m throughout the year (DoT 2017). Waves along the northwest shelf (NWS) of WA originate from either the Indian Ocean swell, locally generated waves or from tropical cyclones (Baird 2020). During cyclonic events, strong winds can generate extreme wave conditions. The impact of these waves on the Project site is dependent on the prevailing water level conditions and the cyclones direction of approach.

2.5. Coastal Processes

The Onslow region is a highly dynamic coastline with both constructional and erosional processes ongoing (URS 2010a). Beadon Point is characterised by low easterly sediment transport (Damara 2010). However, large sediment erosive transport can occur during large storm surges that can accompany tropical low pressure and cyclone weather systems (Cardno 2017). For example, tropical Cyclone Vance in 1990 resulted in erosion at the western end of town beach (Cardno 2017). A seawall was constructed in 2002 running from the western end of town beach to Cameron Avenue to prevent the erosion inundating property and infrastructure. The beach width at the northern end of town beach is narrow with much of the sediment transported through eastern longshore sediment transport.

To maintain longshore sediment transport around the nearby Port of Ashburton (PoA) Material offloading facility (MOF), sand is excavated from a sand-trap on the west of the MOF and trucked to the beach on the eastern side of the MOF. This illustrates sediment transport in the Ashburton area is generally along the shore from west to east (O2Marine 2021a).

2.6. Benthic communities and habitats

Generally, the surrounding coastline of the Onslow region is comprised of sandy beaches with sand bars and shoals at the mouth of tidal creeks. Beaches are backed by coastal dunes, tidal flats, and limestone barriers and there are also pockets of mangroves lining the fringes of tidal creeks. The intertidal zone along the Beadon Point area is characterised by an extensive limestone pavement and rocky platforms (~300 m wide) partially covered by mud, which transitions to a steep beach slope (URS 2010a).

The mid littoral rocky platform is populated by low muddy algal turf with very little invertebrate fauna. However, the lower littoral rock platform has moderately diverse invertebrate fauna, particularly molluscs, with moderate patchy growth of leafy algae and low seagrasses. Some shallow lower littoral pools have small but numerous coral colonies (URS 2010a). The subtidal BCH composition around Beadon Point is dominated by unvegetated sand and silts (O2Marine 2021a).

A string of nearshore reefs forms a chain of shoals along the 10 m isobath to the northwest of Beadon Point. The closest of these reefs is Ward Reef, located 4.5 km northwest of Onslow. Ward Reef has previously been recognised as being regionally important for recreational fishing and conservation values (URS 2010b). However, widespread natural disturbance events including coral bleaching (Babcock et al. 2020), have resulted in a decline of coral cover by up to 97% at monitored reef locations (Chevron 2013). A state of the environment report indicated the coral cover on Ward Reef to be 2.2% in 2015 (Chevron 2017).

A benthic communities and habitat (BCH) study of the DE has been undertaken recently for the Project (O2 Marine 2024), which found bare sediment and intertidal reef dominated the area (39.7% and 38.5% respectively). BCH cover was low, with low cover macroalgae and seagrass areas covering only 0.8% and 0.1% of the area respectively. Except for oysters in the lower tidal zone, the intertidal area was largely devoid of encrusting or surface-dwelling marine flora and fauna due to the wide range of tidal inundation (~4.5 m) and associated impacts from exposure and desiccation.

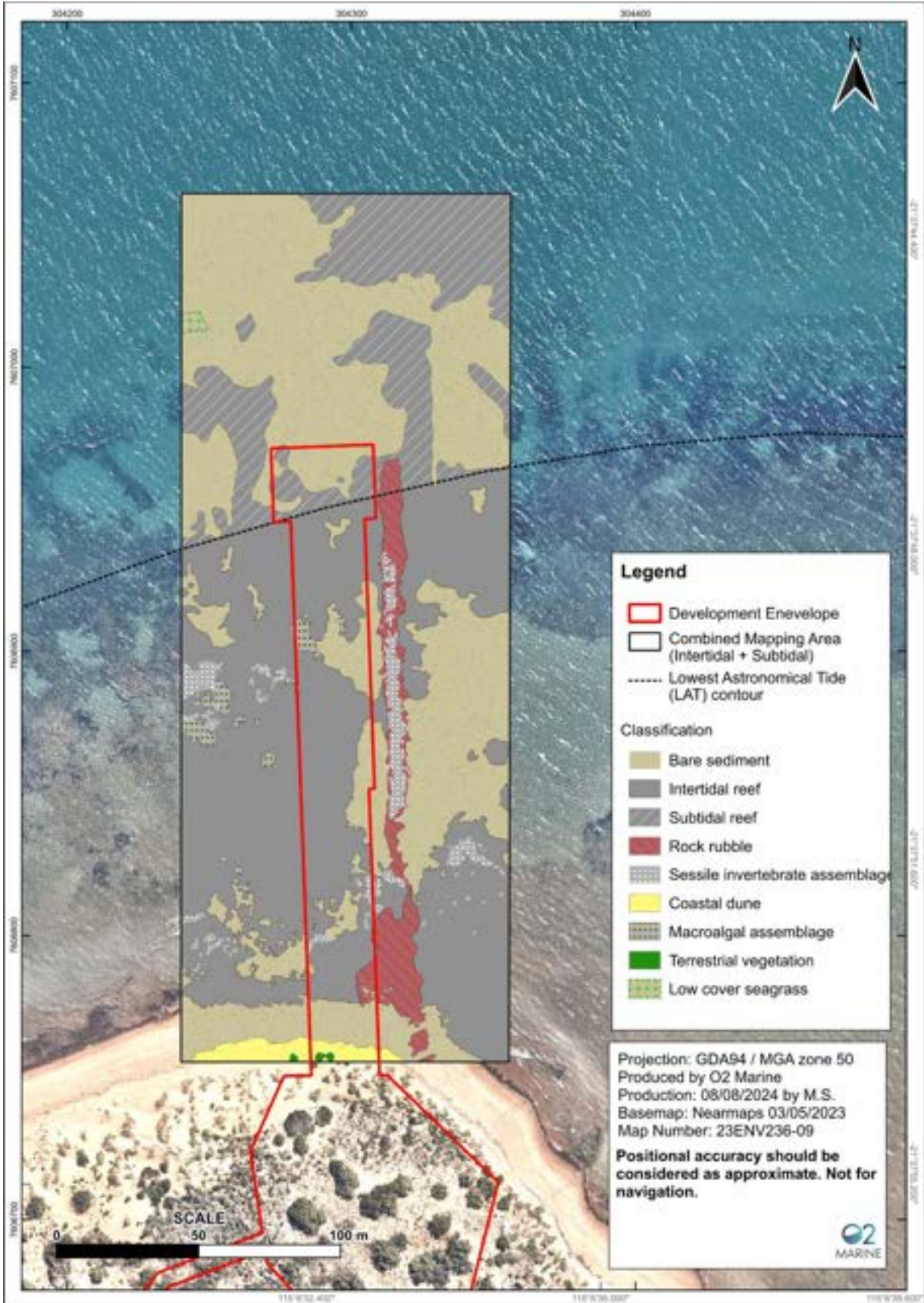


Figure 4: BCH map of the Project Development Envelope (O2 Marine 2024)

3. Conservation Significant Species

This chapter presents an evaluation of the potential conservation significant marine fauna (CSMF) applicable to the search area in and around the Project area. CSMF include marine mammals, reptiles, fish (collectively grouped for fish, sharks and rays) and birds.

3.1. Methods

3.1.1. Database searches

A search of databases relevant to CSMF was undertaken in June 2024 for marine fauna species, biologically important areas (BIAs) and critical habitats in and around the Project area (Table 1). The search area was composed of the Project area at Beadon Point and a 20 km buffer, including marine and terrestrial areas (Figure 5).

Table 1: databases and reports relevant to CSMF searches

| Target | Database/report | Organisation | Citation |
|---|---|--|----------------|
| Conservations significant species (species listed as threatened or other MNES under the EPBC Act) | Commonwealth Protected Matters Search (PMST) | Department of Climate Change, Energy, the Environment and Water (DCCEEW) | DCCEEW (2024a) |
| Conservation significant species | Department of Biodiversity, Conservation, and Attractions (DBCAs) threatened species database | DBCAs | DBCAs (2024) |
| BIAs and critical habitats | Australian Marine Spatial Information System (AMSIS) | DCCEEW | DCCEEW (2024b) |
| EPBC Legal status and documents | Species profile and threats database (SPRAT) | DCCEEW | DCCEEW (2024c) |
| Internationally conservation significant species | IUCN Red List of threatened species | IUCN | IUCN (2024) |

3.1.1.1. Protected matters search tool

The protected matters search tool (PMST) provided by the DCCEEW was used to identify Matters of National Environmental Significance (MNES) within the search area. MNES are defined as ‘nationally significant’

animals, plants, habitats, and places listed under the EPBC Act. The PMST identifies listed species and communities that have a 'moderate potential to occur' based on broad species ranges, bioclimatic modelling and scientific expert advice. The database search results include the species, listing categories and probability of species presence, including a ranked order (DCCEEW 2024c).

Threatened species from the PMST search are reported using the following categories:

- EX: extinct
- EW: extinct in the wild
- CE: critically endangered
- EN: endangered
- VU: vulnerable
- CD: conservation dependent

Other protected species are reported with the following categories:

- MI: Migratory
- CT: Cetacean
- MA: Marine

The area searched within the PMST is presented in Figure 5, and included the Project disturbance footprint and the 20 km buffer area.

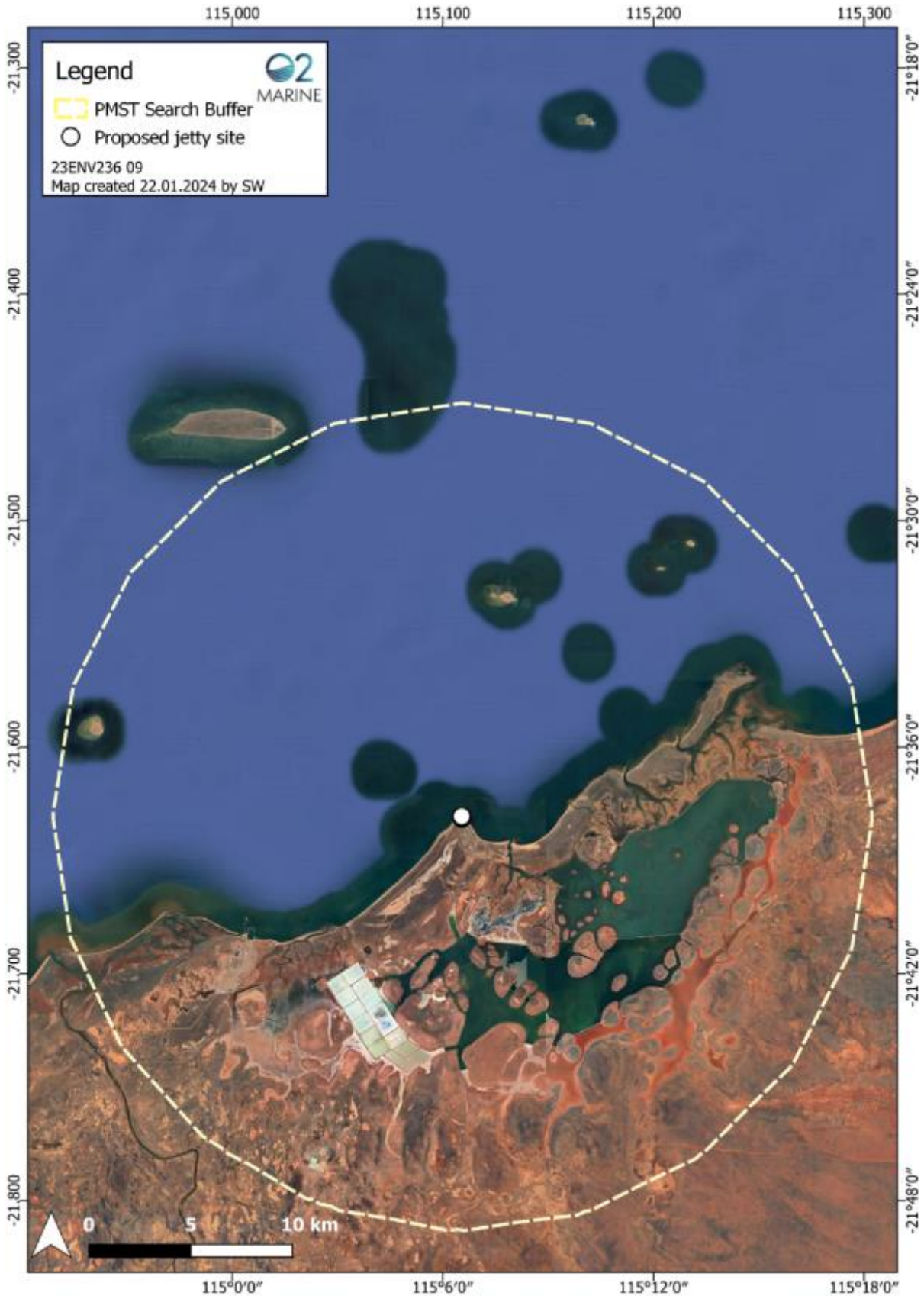


Figure 5: PMST search area with a 20km buffer

3.1.1.2. DBCA threatened species database

The DBCA provides a database search service for sightings of identified threatened and priority plants, animals and ecological communities that have been made and reported to the DBCA. An email request needs to be sent to the DBCA with a request and a shapefile or coordinates of the area of interest, and then the DBCA provides any recorded sighting within that area. The database search results include available information relevant such as coordinates of sightings within the search area.

Threatened species are reported with the following categories:

- CR: critically endangered
- EN: endangered
- VU: vulnerable
- CD: conservation dependent

Specially protected species are reported with the following categories:

- MI: Migratory
- OS: other specially protected.

Priority species classifications also exist for species that may possibly be threatened species that do not meet the criteria for listing under the BC Act due to insufficient survey information or are otherwise data deficient. Priorities 1,2 or 3 are ranked in order of prioritisation for survey and evaluation of conservation status so that consideration can be given to potential threatened listings. Species that are adequately known, meet criteria for near threatened, are rare but not threatened, have recently been removed from the threatened species list, conservation dependent or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring (DBCA 2023).

The search results are to be interpreted with caution, as they represent a presence-only dataset. The Threatened and Priority Fauna Database contains data from a combination of sources (e.g. surveys, monitoring programs, translocations, opportunistic sightings, evidence/secondary signs, museum specimens or historical documents). Locational accuracy varies across records, not all records are verified and there may be repeated sightings of the same individual. The number of records may also vary depending on the remoteness of their distribution and the survey effort within that area.

3.1.1.3. Australian Marine Spatial Information System (AMSIS)

BIAs and “habitat critical” areas for conservation significant species were identified from the PMST results and a search on the AMSIS (DCCEEW 2024b). BIAs are spatially defined zones where aggregations of individuals of a species are known to display biologically important behaviours such as breeding, foraging, resting or migration (DCCEEW 2024b). BIAs were first identified on a regional basis as they were developed as part of the Commonwealth Marine Bioregional Plans and have been identified using expert scientific knowledge about species’ distribution, abundance, and behaviour in the region, to inform decisions made under the EPBC Act. Nesting and inter-nesting areas for marine turtles are identified in the AMSIS as habitat critical to the survival of marine turtles, which were derived from the Recovery Plan for Marine Turtles in Australia (DoEE 2017a). Inter-nesting sites are buffer areas immediately seaward of the important nesting sites and have been defined as follows (DoEE 2017a):

- Northwest Shelf green turtle stock: 20 km
- Pilbara flatback turtle stock: 60 km
- WA hawksbill: 20 km.

These buffer zones have been taken into account within the defined inter-nesting zones. These areas should be considered when assessing significance of potential impacts, but they are not “Critical Habitat” as defined under Section 207A of the EPBC Act (Register of Critical Habitat).

3.1.1.4. Species profile and threats database

The DCCEEW’s species profile and threats database (SPRAT) (DCCEEW 2024c) was consulted in order to confirm the current status of Threatened and Migratory species and identify relevant documents relating to the EPBC Act for protection of those species.

3.1.2. Desktop literature review

A literature review of recent marine fauna studies undertaken within or near the Project area was also undertaken. This included publicly available peer reviewed articles and government publications. A list of these and the findings are presented in the Results section of this report (Section 3.2). The purpose of the literature review was to compile as much contemporary relevant information as outlined in Table 2 as possible.

Table 2: Literature review parameters for key conservation significant species.

| Topic | Parameters |
|--|---|
| Population | <ul style="list-style-type: none"> • Abundance • Trends |
| Distribution | <ul style="list-style-type: none"> • Range and area of occupancy (State, regional and local) • Local patterns • Animal movement • Temporal occurrence |
| Habitat use and life history | <ul style="list-style-type: none"> • Longevity and fecundity • Breeding • Foraging • Ecological windows • Critical habitat • Biologically important areas • Habitat availability |
| Relevant guidance and policies (including threats and pressures) | <ul style="list-style-type: none"> • Recovery plans and conservation actions • Threat abatement plans • Relevant pressures and threats (direct and indirect) as outlined in the North-west Marine Bioregional Plan (DSEWPaC 2012a) • Conservation status (State, Federal and International) |

3.1.3. Likelihood of occurrence assessment

The likelihood of occurrence of CSMF within the search area was determined following the definitions presented in Table 3. These definitions involve consideration of the PMST ranking, number of sightings within the search area, the reliability of the sightings and whether the records are recent or historical. The sightings used for the assessment were derived from the DBCA threatened species database search relevant to this search area and a search of the Atlas of Living Australia (ALA) database.

Table 3: Species likelihood of occurrence definitions

| Likelihood | Definition |
|---------------|--|
| High | Species presence under MNES classified as ‘known’ or ‘likely’ and individuals of the species have been repeatedly recorded in the search area recently. The search area is within the species’ known range and habitat is expected to support populations of the species (e.g. BIAs exist). |
| Medium | Species presence under MNES classified as ‘known’ or ‘likely’ and individuals of the species have been infrequently recorded in the search area. The high likelihood of occurrence criteria has not been met, however suitable (not necessarily preferred) habitat may occur within the search area, or nearby. The habitat may support individuals or populations of the species. |
| Low | Included in database search results although the search area is well outside of the species’ range, or the species has not been recorded there. Suitable habitat is not likely to be present. |

3.1.4. Key species

‘Key’ species were identified to ensure that species with the greatest chance of being impacted by Project activities to give the most accurate characterisation of the marine fauna within the environment. Identified key species are effectively ‘umbrella’ species – when they are protected, others will also be indirectly protected.

Key species were defined as those with:

- A high conservation status under the EPBC Act as MNES or the BC Act as threatened or migratory species, and a high likelihood of occurrence within the Project disturbance footprint determined through the process described above in Section 3.1.3.
- Important species for industry, such as a key indicator species for any fishing industries within the area.

3.2. Results

The full PMST report is given in Appendix A, which provides information about threatened species within the Project area, but also provides information about the habitat as well including key ecological features and features of conservation significance which are described below.

3.2.1. Key ecological features

Key ecological features are elements of the Commonwealth marine environment that are considered to be of regional importance for either a regions’ biodiversity or its ecosystem function and integrity. The PMST

(DCCEEW 2024a) provides spatial information about these features and using this tool and the search area as shown in Figure 5 it was found there were no key ecological features that overlap the Project area.

3.2.2. Features of conservation significance

The presence or absence of key features of conservation significance were also assessed using the PMST with the search area shown in Figure 5. There were several within or adjacent to the Project area that are protected by Commonwealth and State Government legislation (Table 4). Where there were no features within or adjacent to the Project area in the conservation element listed, an approximate distance to the nearest feature has also been presented in Table 4.

Table 4: Outline of distances to the protected conservation significant elements that were not within or adjacent to the Project site

| Conservation Element | Approximate Distance (km) | Description |
|---|---------------------------|---|
| Commonwealth | | |
| World Heritage Areas | 68 | The Ningaloo Coast World Heritage Area is the closest World Heritage Area and is located to the west. |
| National Heritage Places | 68 | The Ningaloo Coast is also classed as a National Heritage Place, and is the closest to the Project. |
| RAMSAR Wetlands | 107 | Millstream Pools located east of the Project site. |
| Commonwealth Marine Area | 89 | Montebello Islands Marine Park located north northeast of Project site. |
| Threatened ecological communities (TEC) | | There were none listed within the search area. The only TEC within the Shire of Ashburton is the Themeda Grasslands at Hamersley Station approximately 280 km inland. |
| Listed Threatened species | NA | 36 listed threatened species including: <ul style="list-style-type: none"> • 16 bird species • 1 fish species • 5 mammal species • 7 reptile species • 7 shark and ray species |
| Listed Migratory species | NA | There were also 50 listed migratory species including: <ul style="list-style-type: none"> • 27 bird species • 9 mammal species • 5 reptile species • 9 shark and ray species |
| Commonwealth Reserves - Terrestrial | 23 | Cane River (Mount Minnie and Nanutarra) Conservation Park located south of the Project site |

| Conservation Element | Approximate Distance (km) | Description |
|---------------------------------|---------------------------|--|
| Shipwrecks | 3 | Beadon Creek Shipwreck southeast of the Project site |
| State | | |
| Marine Management Area | 58 | Barrow Island Marine Management Area located northeast of the Project site |
| Marine Park | 84 | Ningaloo Marine Park located west of the Project site |
| National Park | 114 | Cape Range National Park located west southwest of the Project site |
| Nature Reserve | 20 | Thevenard Island Nature Reserve located north of the Project site |
| Important Wetlands in Australia | 39 | Exmouth Gulf East Wetland located west southwest of Project site |
| Significant estuaries | 7 | Coolgra Point is the closest regionally significant mangrove, which is located to the east-northeast of the Project site. The Ashburton River Delta is also close-by, located 13 km west southwest of the Project site |
| Fish Habitat Protection Area | 361 | Point Quobba Fish Protection Area located southwest of the Project site. |

3.2.3. Marine Fauna database search results

Conservation significant marine fauna (CSMF) are those species listed as Threatened or Migratory under the EPBC Act, or Threatened or Priority Species under the BC Act. The results from the PMST search as described previously are presented in 3.2.2. A summary of the status of the species from the PMST under the EPBC Act are presented in Table 5, and the species listed from the DBCA search under the BC Act are presented in Table 6.

Table 5: Summary of CSMF species listed within PMST results

| Fauna group | Threatened | Migratory | Marine | Cetacean |
|--------------|------------|-----------|-----------|-----------|
| Mammals | 5 | 9 | 1 | 14 |
| Reptiles | 7 | 5 | 20 | 0 |
| Fish | 1 | 0 | 0 | 0 |
| Sharks | 7 | 9 | 0 | 0 |
| Birds | 17 | 27 | 37 | 0 |
| Total | 37 | 50 | 89 | 14 |

Table 6: Summary of CSMF species listed within DBCA results

| Fauna group | Critically Endangered | Endangered | Vulnerable | Conservation Dependent | Migratory | Priority |
|--------------|-----------------------|------------|------------|------------------------|-----------|----------|
| Mammals | 0 | 1 | 1 | 1 | 5 | 3 (P4) |
| Reptiles | 0 | 2 | 4 | 0 | 4 | 1 (P1) |
| Fish | 0 | 0 | 0 | 0 | 0 | 0 |
| Sharks | 0 | 0 | 0 | 0 | 0 | 0 |
| Birds | 3 | 0 | 1 | 0 | 20 | 0 |
| Total | 3 | 3 | 6 | 1 | 29 | 4 |

Of those species summarised in the Table 5, only a proportion of those are listed as ‘known’ or ‘likely’ to occur within the area. Species that ‘may’ occur within the area are not considered likely to be key species, and any terrestrial species (such as the ghost bat or northern quoll and birds with mainly terrestrial distribution such as the black-eared cuckoo) are also not considered in this marine fauna assessment. Therefore, the species ‘known’ or ‘likely’ are as follows:

Known

- Australian humpback dolphin (*Sousa sahalensis*) (Migratory and Cetacean)
- Australian snubfin dolphin (*Orcaella heinshohni*) (Migratory and Cetacean)
- Dugong (*dugong dugon*) (Migratory and Marine)
- Humpback whale (*Megaptera novaengliae*) (Migratory and Cetacean)
- Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) (Arafura/Timor Sea populations) (Migratory and Cetacean)
- Hawksbill turtle (*Eretmochelys imbricata*) (Vulnerable, Migratory and Marine)
- Flatback turtle (*Natator depressus*) (Vulnerable, Migratory and Marine)
- Green turtle (*Chelonia mydas*) (Vulnerable, Migratory and Marine)
- Leaf-scaled seasnake (*Aipysurus foliosquama*) (Critically Endangered and Marine)
- Loggerhead turtle (*Caretta caretta*) (Endangered, Migratory and Marine)
- Dwarf sawfish (*Pristis clavata*) (Vulnerable and Migratory)
- Freshwater sawfish (*Pristis pristis*) (Vulnerable and Migratory)
- Green sawfish (*Pristis zijsron*) (Vulnerable and Migratory)
- Reef manta ray (*Mobula alfredi*) (Migratory)
- Australian fairy tern (*Sternula nereis nereis*) (Vulnerable)
- Bar-tailed godwit (northern Siberian) (*Limosa lapponica menzbieri*) (Endangered and Migratory)
- Bridled tern (*Onychoprion anaethetus*) (Migratory)
- Caspian tern (*Hydroprogne caspia*) (Migratory)
- Common sandpiper (*Actitis hypoleucos*) (Migratory)

- Curlew sandpiper (*Calidris ferruginea*) (Critically Endangered and Migratory Marine)
- Eastern curlew (*Numenius madagascariensis*) (Critically Endangered and Marine)
- Osprey (*Pandion haliaetus*) (Migratory)
- Fairy tern (*Sterna albifrons*) (Marine)
- Greater sand plover (*Charadrius leschenaultia*) (Vulnerable and Migratory)
- Lesser crested tern (*Thalasseus/sterna bengalensis*) (Marine and Migratory)
- Little tern (*Sternula albifrons*) (Migratory Marine)
- Sharp-tailed sandpiper (*Calidris acuminata*) (Vulnerable and Migratory)
- Silver gull (*Larus novaehollandiae*) (Marine)
- Sooty tern (*Onychoprion fuscatus*) (Marine)
- White bellied Sea Eagle (*Haliaeetus leucogaster*) (Marine).

Likely

- Indian Ocean bottlenose dolphin (*Tursiops aduncus*) (Migratory and Cetacean)
- Blue Whale (*Balaenoptera musculus*) (Endangered and Migratory)
- Leatherback turtle (*Dermochelys coriacea*) (Endangered, Migratory and Marine)
- Short-nosed seasnake (*Aipysurus apraefrontalis*) (Critically Endangered and Marine)
- Narrow sawfish (*Anoxypristis cuspidate*) (Migratory)
- Giant manta ray (*Mobula birostris*) (Migratory)
- Grey falcon (*Falco hypoleucos*) (Vulnerable)
- Grey nurse shark (*Carcharias taurus*) (Vulnerable)
- Scalloped hammerhead (*Sphyrna lewini*) (Conservation Dependent)
- Southern bluefin tuna (*Thunnus maccoyii*) (Conservation Dependent)
- Common greenshank (*Tringa nebularia*) (Endangered and Migratory)
- Fork-tailed swift (*Apus pacificus*) (Migratory Marine)
- Lesser frigatebird (*Fregata ariel*) (Migratory)
- Pectoral sandpiper (*Calidris melanotos*) (Migratory)
- Roseate tern (*Sterna dougallii*) (Migratory)
- Streaked Shearwater (*Calonectris leucomelas*) (Migratory Marine).

To further inform the identification of key species, the DBCA results were analysed to find recorded sightings of the species within the area. The number and age of recordings for each species within the DBCA (2024) results are given below in

Table 7. Most recent information for most species is from 2015, and many of the species identified as ‘known’ to occur within the area from the PMST results have not been recorded at the Project site (or within the buffer area). The locations of these sightings are also presented in Figure 6 to Figure 11.

Table 7: Number of recorded sightings for all marine fauna species identified in the DBCA search and year of last sighting

| Species | Number of recorded sightings | Year of last sighting |
|-----------------------------|------------------------------|--|
| Australian humpback dolphin | 626 | 2015 |
| Australian snubfin dolphin | 2 | 2014 (both sightings within the same year) |
| Barn swallow | 8 | 2015 |
| Bar-tailed godwit | 51 | 2015 |
| Bridled tern | 4 | 1988 |
| Caspian tern | 44 | 2017 |
| Common greenshank | 4 | 2019 |
| Common sandpiper | 14 | 2015 |
| Common tern | 29 | 2015 |
| Crested tern | 23 | 2015 |
| Curlew sandpiper | 1 | 1988 |
| Dugong | 96 | 2015 |
| Eastern curlew | 8 | 2017 |
| Fairy tern | 2 | 2000 |
| Flatback turtle | 90 | 2023 |
| Great knot | 1 | 2019 |
| Greater sand plover | 51 | 2015 |
| Green sawfish | 23 | 2022 |
| Green turtle | 109 | 2015 |
| Grey plover | 11 | 2015 |
| Grey-tailed tattler | 41 | 2015 |
| Hawksbill turtle | 11 | 2013 |
| Humpback whale | 620 | 2015 |
| Lesser sand plover | 4 | 2015 |

| Species | Number of recorded sightings | Year of last sighting |
|------------------------|------------------------------|-----------------------|
| Letter-winged kite | 1 | 1979 |
| Little tern | 18 | 2015 |
| Loggerhead turtle | 23 | 2015 |
| Olive ridley turtle | 1 | 2014 |
| Osprey | 29 | 2019 |
| Roseate tern | 1 | 2003 |
| Ruddy turnstone | 36 | 2015 |
| Sanderling | 37 | 2015 |
| Sharp-tailed sandpiper | 2 | 1901 |
| Southern right whale | 1 | 2013 |
| Whimbrel | 18 | 2017 |

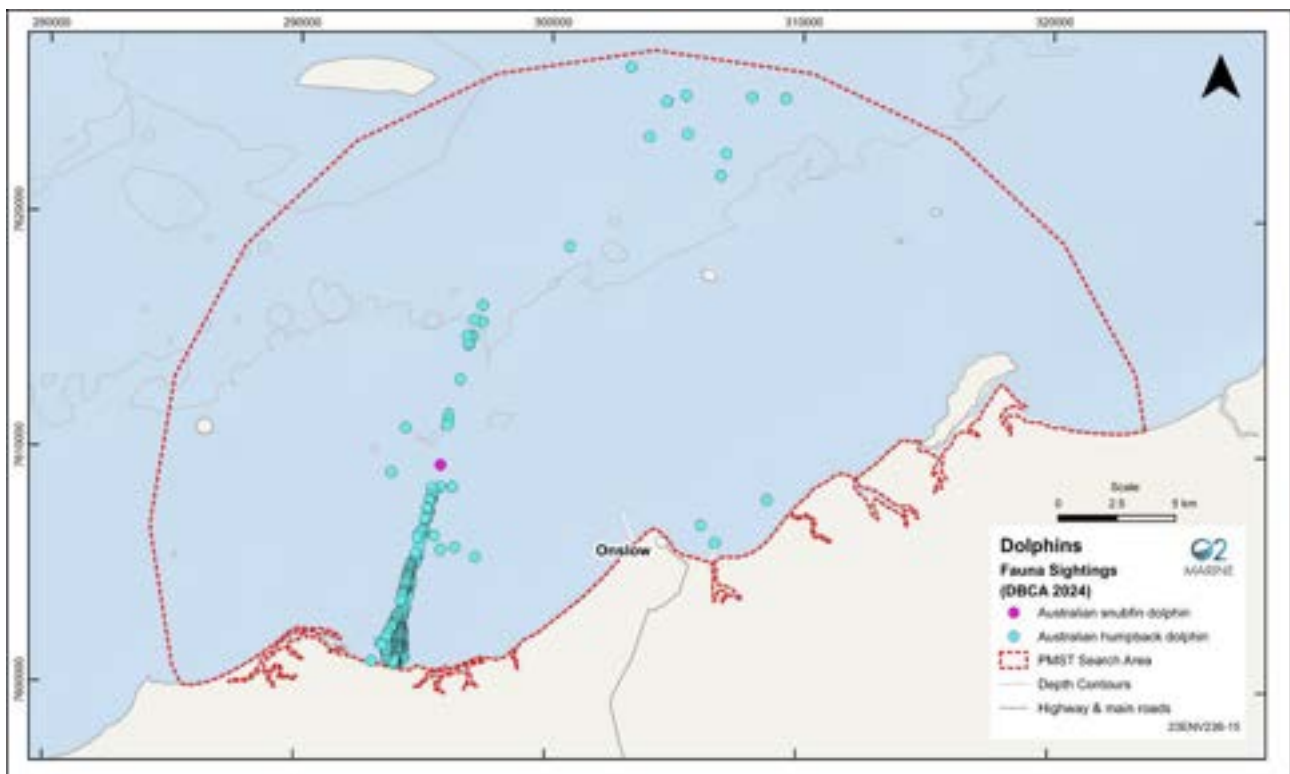


Figure 6: Dolphin sightings as recorded in DBCA (2024)

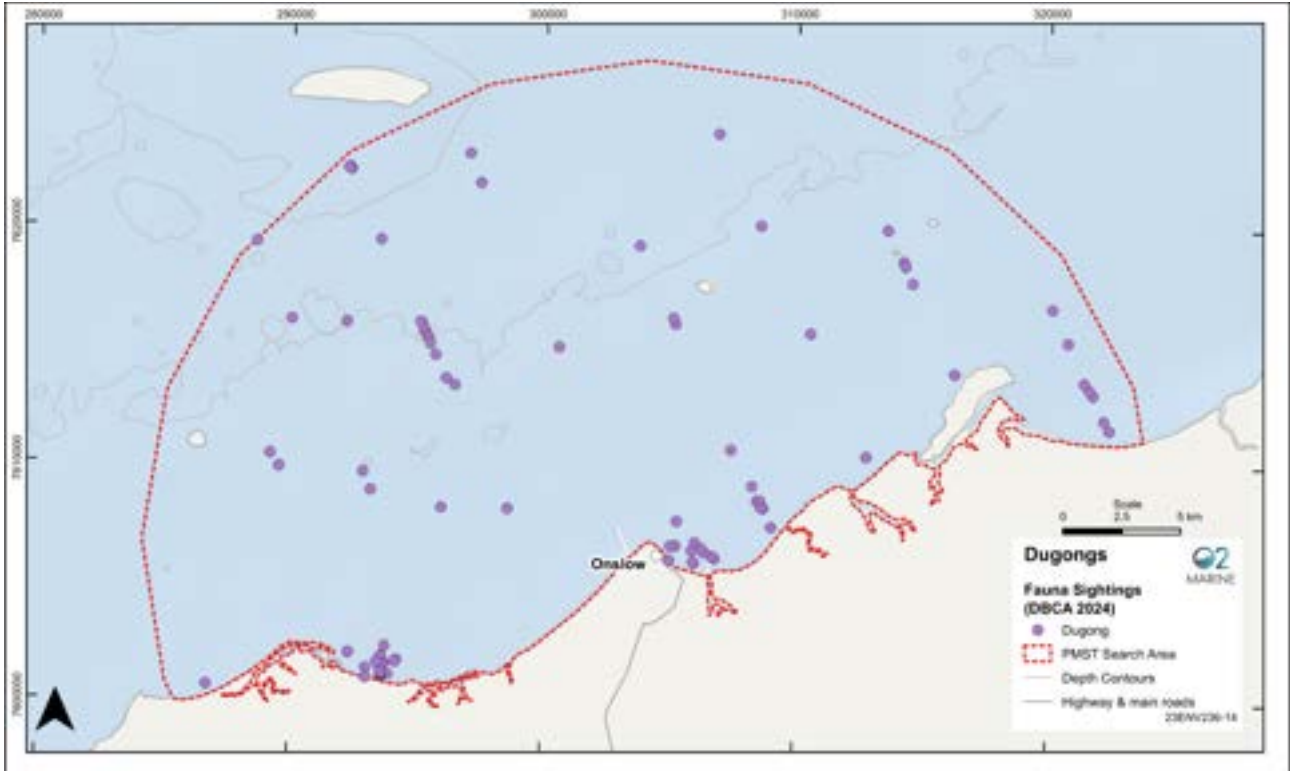


Figure 7: Dugong sightings as recorded in DBCA (2024)

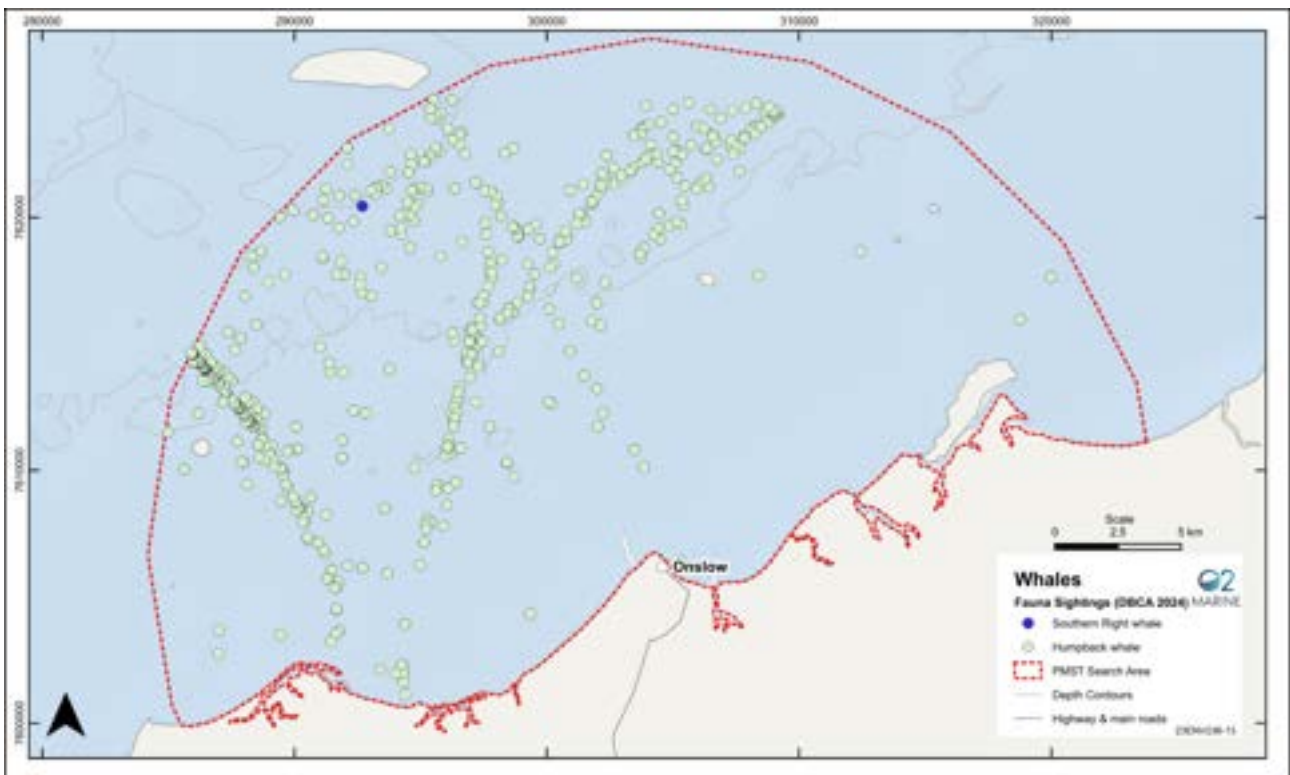


Figure 8: Whale sightings as recorded in DBCA (2024)

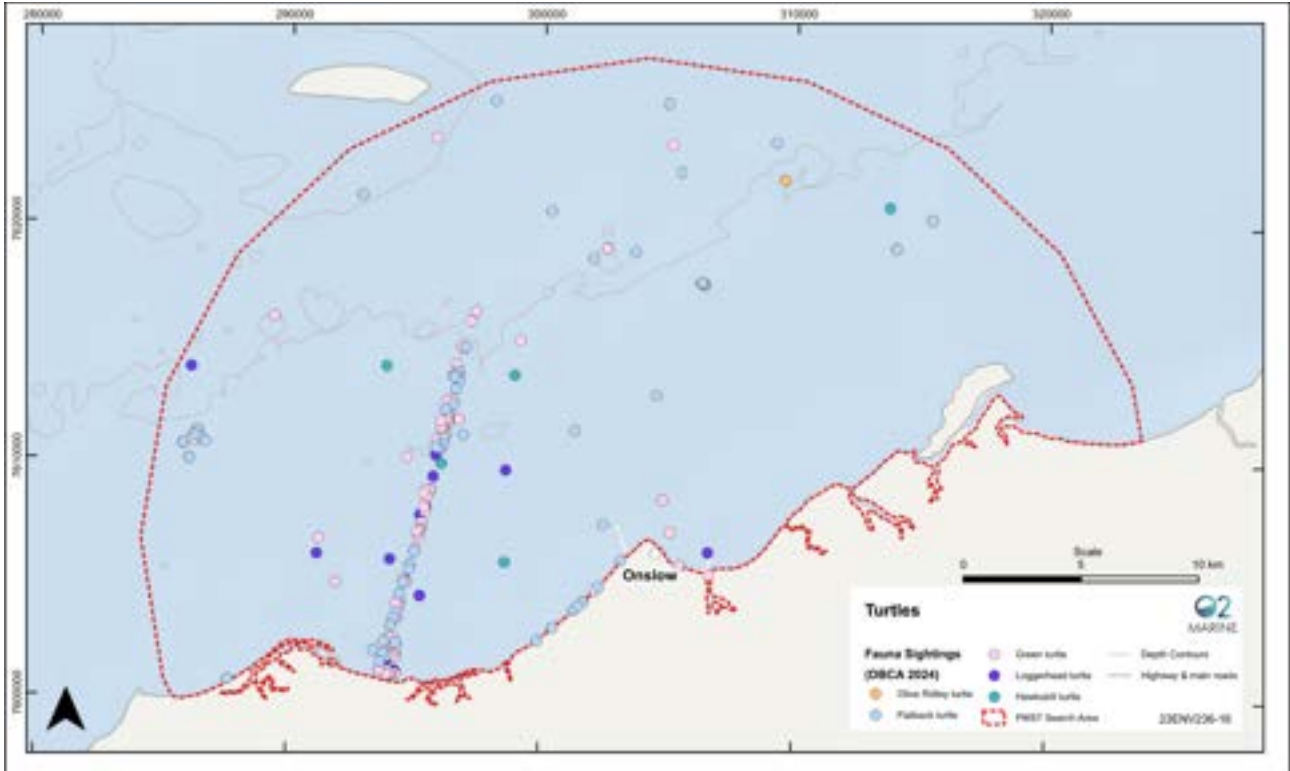


Figure 9: Turtle sightings as recorded in DBCA (2024)

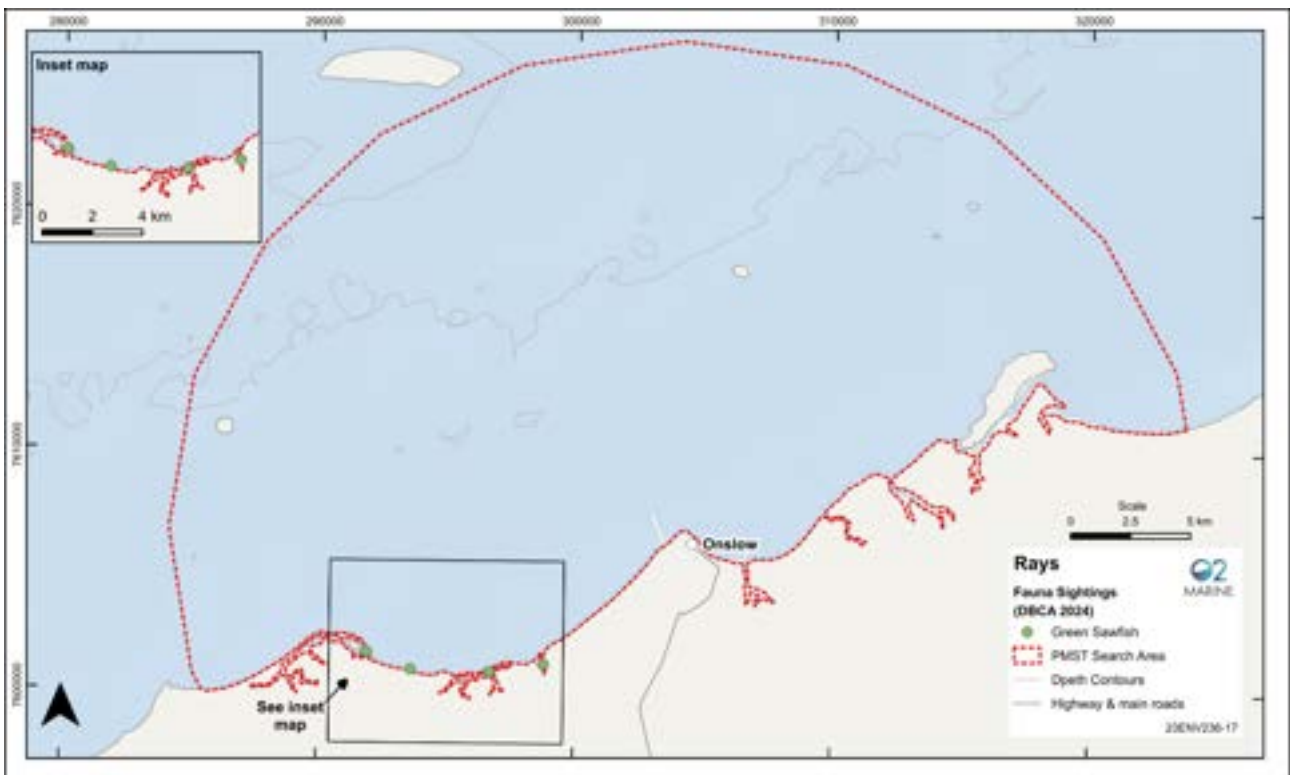


Figure 10: Ray sightings as recorded in DBCA (2024)

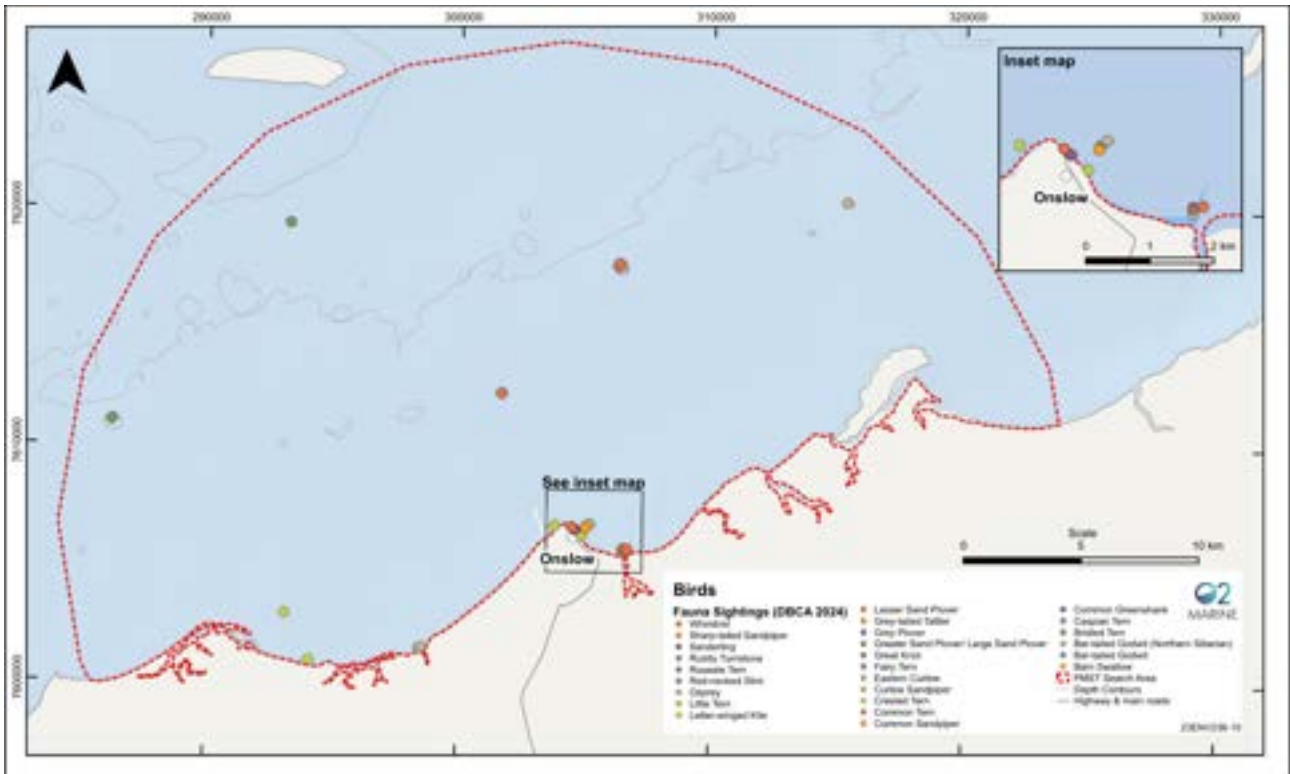


Figure 11: Bird sightings as recorded in DBCA (2024)

3.2.4. Biologically important areas

BIAs that overlap the Project area are presented in Table 8 and Figure 12 to Figure 14.

Table 8: Biologically Important Areas that spatially overlap with all marine elements of the Project (DCCEEW 2024a;b)

| Species | Type |
|-------------------------|---|
| Whale | |
| Humpback whale | Migration (north and south) known to occur within the feature area (Project area) |
| Turtle | |
| Hawksbill turtle | Nesting known to occur within buffer area, Inter-nesting known to occur within feature area (Project area) |
| Flatback turtle | Nesting known to occur within feature area (Project area), Inter-nesting known to occur within feature area (Project area) |
| Bird | |
| Wedge-tailed shearwater | Breeding known to occur within feature area (Project area) |
| Lesser crested tern | Breeding known to occur within feature area (Project area) |
| Roseate Tern | Breeding known to occur within buffer area only |
| Fairy Tern | Breeding known to occur within buffer area only |

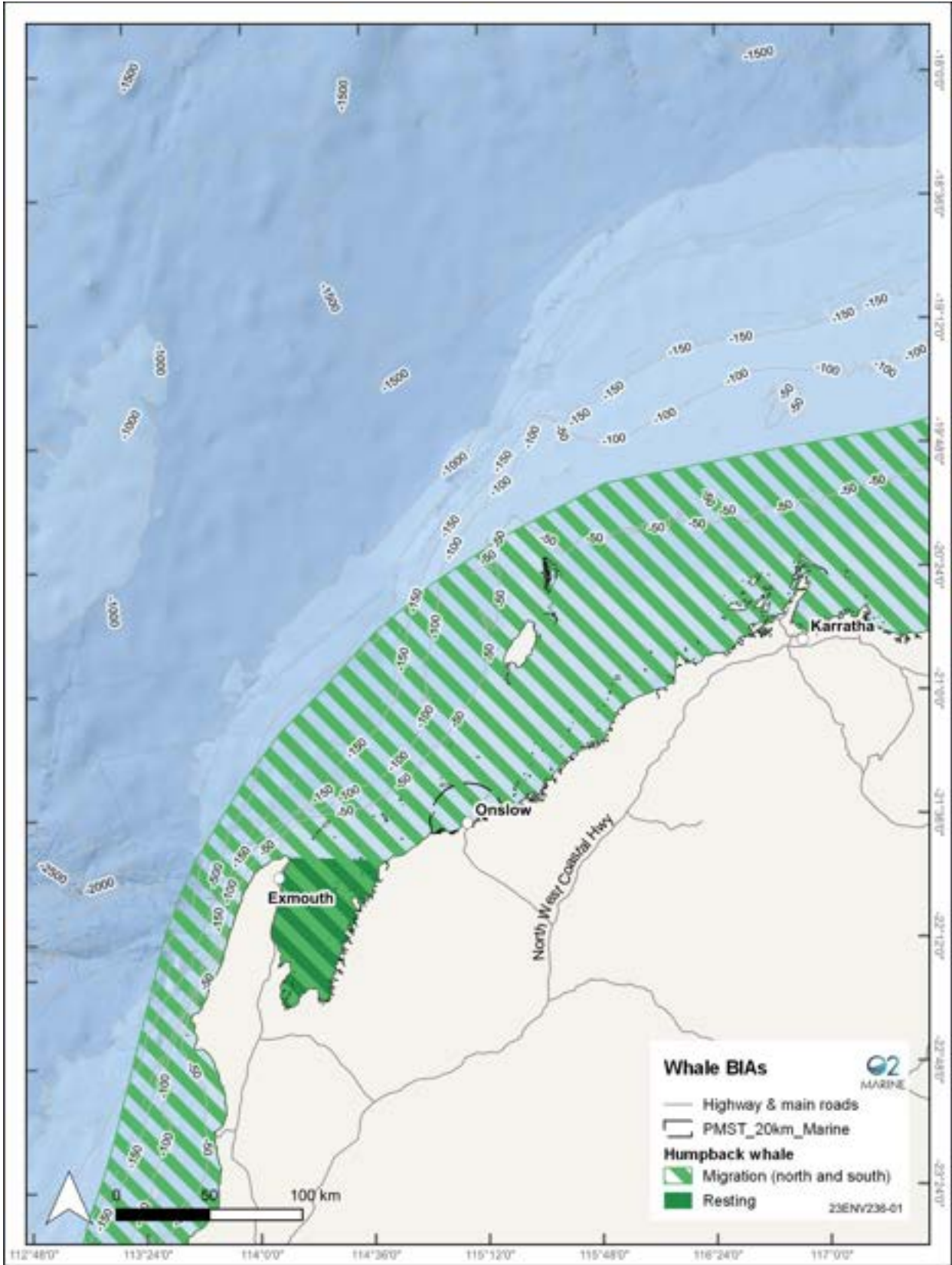


Figure 12: Humpback whale BIAs near the Project

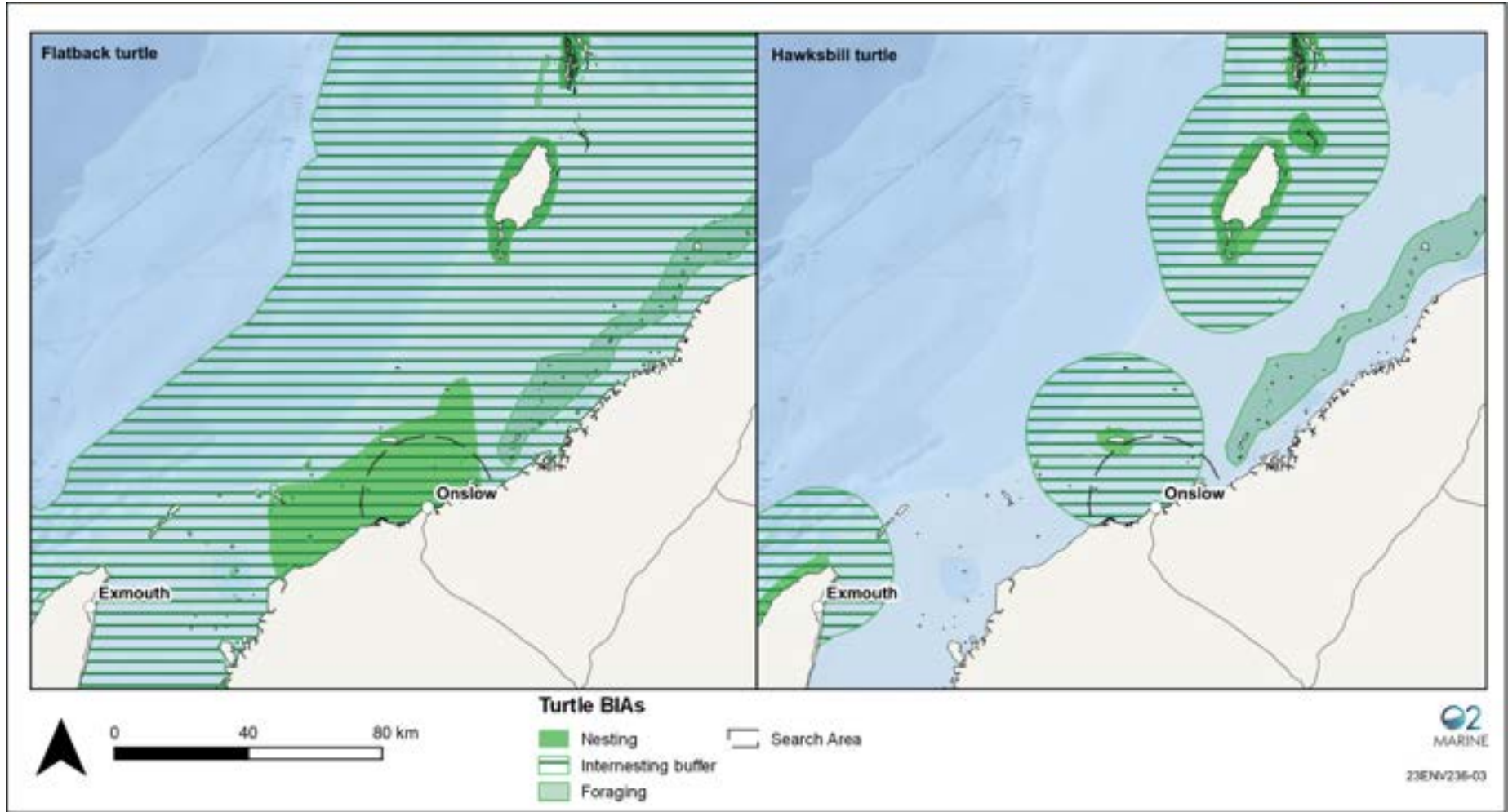


Figure 13: Turtle BIAs

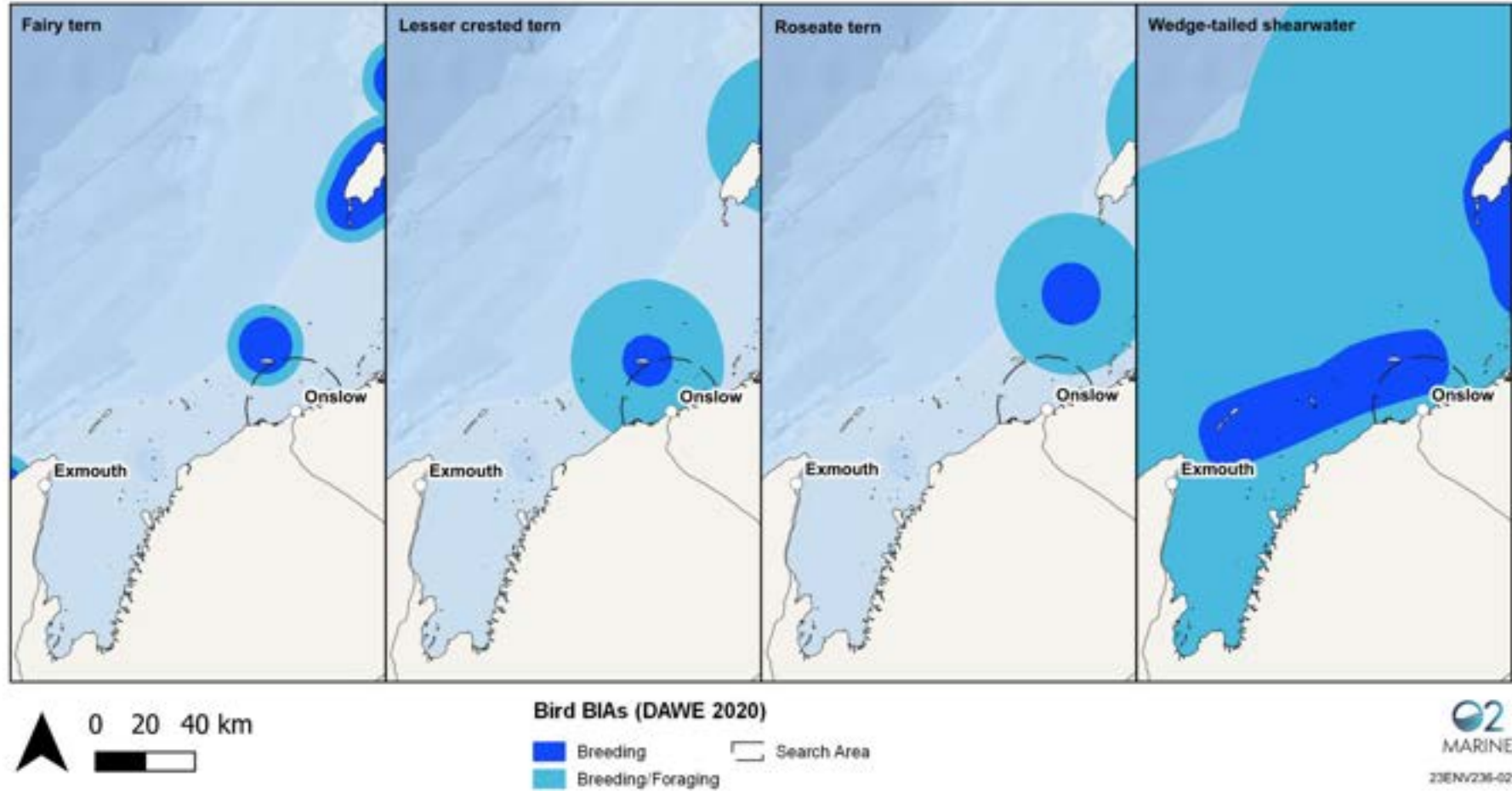


Figure 14: Bird BIAS

3.2.5. Habitat critical to the survival of marine turtles

Nesting and inter-nesting areas identified as habitat critical to the survival of marine turtles are listed for each genetic stock within the Recovery Plan for Marine Turtles in Australia (DoEE 2017a). The areas have been identified by a consensus panel of subject matter experts and include buffered areas around nesting sites. The following radii around important nesting sites are given:

- Green turtle (20 km)
- Loggerhead turtle (20 km)
- Flatback turtle (60 km)
- Hawksbill turtle (20 km)
- Leatherback turtle (20 km)
- Olive ridley turtle (20 km).

These areas should be considered when assessing significance of potential impacts, but they are not ‘Critical Habitat’ as defined under Section 207A of the EPBC Act (Register of Critical Habitat). The habitats critical for turtle species that overlap the Project area as given in the PMST results are presented in Table 9. These habitats are also presented in Figure 15, showing the extent of these areas across the region. The loggerhead turtle critical habitat was also presented to show the distance from the Project area.

Table 9: Critical habitat for the survival of marine turtles that overlap the Project search area

| Species | Type |
|------------------|---|
| Flatback turtle | Nesting known to occur between August and September within the Project area |
| Green turtle | Nesting known to occur between December and January within the Project area |
| Hawksbill turtle | Nesting known to occur between November and May within the Project area |

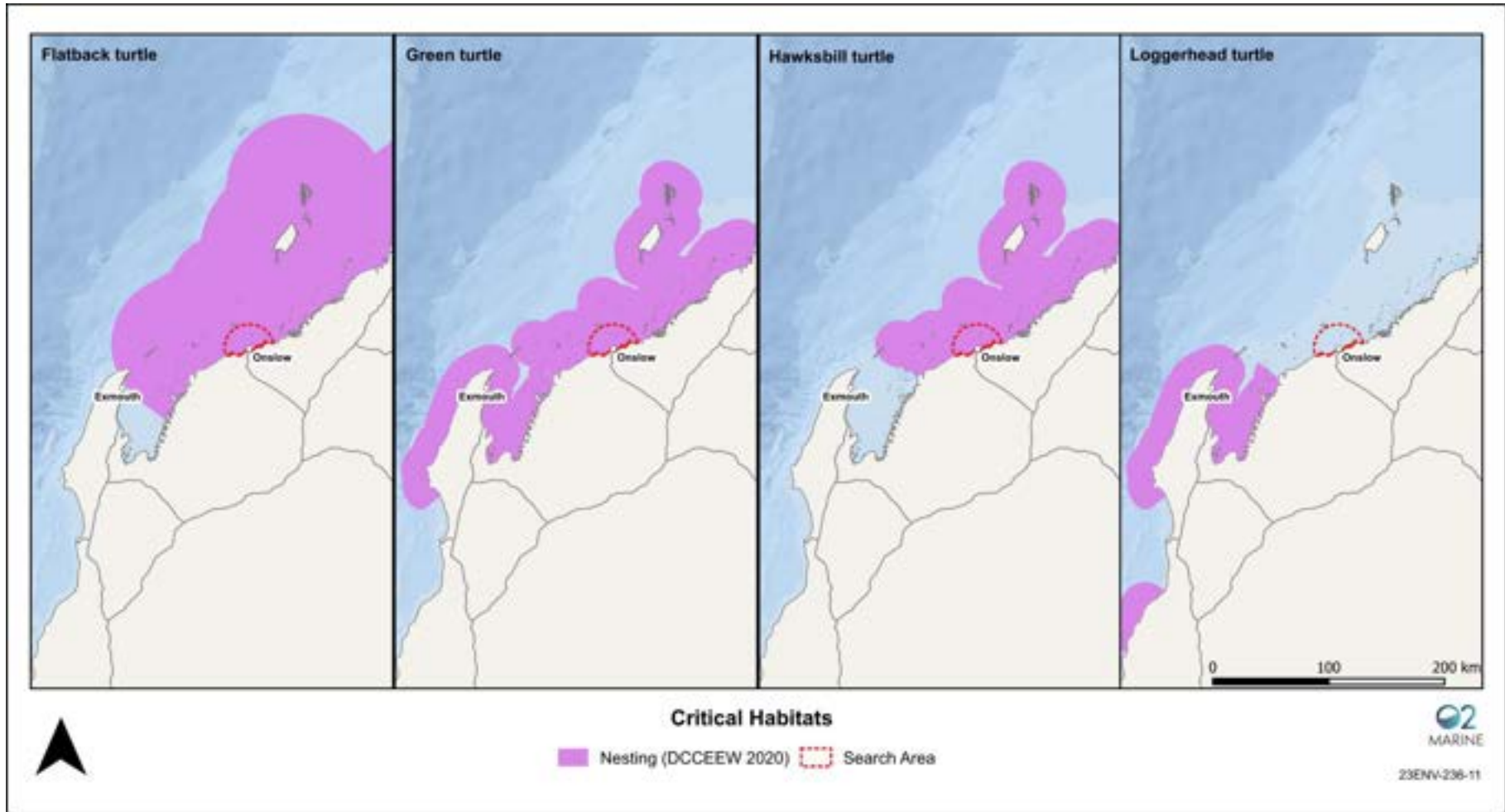


Figure 15: Critical habitat for the survival of marine turtles within the region of the Project area

3.2.6. Important Marine Mammal Areas

Important marine mammal areas (IMMAs) are defined areas where discrete portions of habitat, important to marine mammal species, have the potential to be delineated and managed for conservation. Although they are non-statutory, these areas have been developed by the IUCN Joint SSC/WCPA Marine Mammal Protection Areas Task Force. The Project overlaps with two IMMAs which are summarised in Table 10.

Table 10: IMMAs relevant to the Project

| Name | Qualifying species and criteria | Marine mammal diversity |
|--|---|--|
| Western Australian Humpback Whale Migration Route IMMA | Humpback whale: C1 and C3 | <i>Dugong dugon</i> , <i>Orcaella heinsohni</i> , <i>Sousa sahalensis</i> , <i>Stenella longirostris</i> , <i>Tursiops aduncus</i> , <i>Tursiops truncatus</i> , <i>Orcinus orca</i> , <i>Pseudorca crassidens</i> , <i>Balaenoptera musculus</i> , <i>brevicauda</i> , <i>Eubalaena australis</i> , <i>Balaenoptera physalus</i> , <i>Physeter macrocephalus</i> , <i>Balaenoptera eden</i> |
| Ningaloo Reef to Montebello Islands IMMA | Dugong: A, B1 & C2 Australian humpback dolphin: A & B1 Humpback whale: C1 | <i>T. aduncus</i> , <i>B. musculus</i> , <i>O. heinsohni</i> , <i>Balaenoptera acutorostrata</i> , <i>Orcinus orca</i> , <i>E. australis</i> , <i>Balaenoptera omurai</i> , <i>Balaenoptera physalus</i> , <i>Peudorca crassidens</i> |

3.2.7. Seabird and shorebird survey results

The Shire of Ashburton commissioned Western Environmental Pty Ltd (WEPL) to undertake a detailed flora and vegetation, and basic terrestrial fauna survey for the proposed development of the ‘Onslow Headland Plan’ (WEPL 2022). The survey area for the ‘Onslow Headland Plan’. As part of this survey, fauna species and their habitats were surveyed within the terrestrial area for this Project area including migratory shorebirds and waders.

Results indicated that the Acacia and Spinifex beach/primary dunes occurring directly adjacent to the Onslow Town Beach and the Beadon Point tidal flats habitats may be infrequently utilised for shelter or resting, however the habitat was not considered likely to be significant in supporting the local population of the species. No nesting areas were identified within the survey area, with an artificial nest platform for ospreys located within the survey area south of the Project footprint.

Onslow Town Beach is regionally well-known as a shorebird and wader observation site and therefore it is considered that the species are more likely to use this area as opposed to the sites proposed for the Project.

3.2.8. Literature review results

In addition to the database searches and the survey undertaken by WEPL (2022) a literature review of relevant articles and research was conducted to understand more about the distribution, life history and any more contemporary information regarding population and distribution within the Project area. A summary of the key research papers that relate to the Project and the surrounding environment is given in Appendix C.

3.2.9. Fish and Fisheries

3.2.9.1. Aquatic Resources

The Project is located within the North Coast Bioregion which extends from Onslow to the WA/Northern Territory (NT) border. The Department of Primary Industries and Regional Development (DPIRD) manages WA Aquatic Resources which include the ecosystems and their constituent habitats, captured species and listed species, including commercial recreational, and customary fisheries. Given the complexity of WA Aquatic Resources DPIRD apply an ecosystem-based fisheries management to assess risks using indicator species. Indicator species are used to evaluate the status of an aquatic resources and have been selected based on their inherent vulnerability, management importance and overall risk to sustainability.

The Project area is within the North Coast Bioregion, where the main commercial fisheries focus primarily on tropical fish, in particular high-value snappers, cods, and emperors (Newman et al. 2023). There are 8 Aquatic Resources that overlap the Project area, and within these Aquatic Resources there are 11 managed commercial fisheries that may operate in the waters adjacent to the Project area (Newman et al. 2023):

- The Northern Demersal Scalefish Resource has three commercial fisheries; Pilbara Trap Managed Fishery, Pilbara Fish Trawl (Interim) Managed Fishery and Pilbara Line Fishery that occur within the vicinity of the Project. The indicator species are the bluespotted emperor, red emperor and Rankin cod, which are taken both commercially and recreationally.
- The Northern Invertebrate Resource has four commercial fisheries, though the Onslow Prawn Managed Fishery (OPMF) is the only fishery which operational area overlaps the Project area. The Project area is not heavily used by the fishery, with only one boat fished in the OPMF as the other operators decided they were more likely to more profitable fishing elsewhere. Ashburton Nursery extends to Beadon Point and includes waters ~2.5 km north of the Beadon Point. The fishery has limited recreational catch and indicator species are the western king and brown tiger prawn.
- The North Coast Crab Resource has one commercial that overlaps the Project area which is the Pilbara Crab Managed Fishery. Blue swimmer crabs are the target and indicator species for both commercial and recreational fisheries. This fishery is considered relatively small.
- The Statewide Large Pelagic Scalefish Resource includes a range of commercial, recreational and charter fisheries that utilise a range of tropical and temperate pelagic species. One commercial fishery overlapping the Project area; the Mackerel Managed Fishery. Spanish mackerel and grey mackerel are the indicator species, which are taken both commercially and recreationally, Spanish mackerel dominates the retained recreational and charter catch. Fishing is generally further offshore than the Project area.
- Statewide Hand Collection resource has one commercial fishery that overlaps the Project area which is the Western Australian Sea Cucumber Fishery. Commercial fishing primarily operates in the northern half of WA, from Exmouth to the Northern Territory border. Limited recreational and customary fishing occurs.
- Pearl Oyster (*Pinctada maxima*) Resource manages the Pearl Oyster Wildstock Fishery (MSC). The fishery targets silver lipped pearl oysters. There is no authorised recreational fishing, and customary fishing is concentrated to the West Kimberly region.
- Statewide Marine Aquarium Fish and Hermit Crab Resource manages two commercial fisheries that operate within WA waters, namely the Marine Aquarium Fish Managed Fishery and Hermit Crab Fishery.

These fisheries are thought to be minor in the area and are more active Capes region, Perth, Geraldton, Exmouth, Dampier and Broome in shallow water (<30 m depth).

- Statewide Specimen Shell Resource manages the commercial Specimen Shell Managed Fishery, and there is no documented recreational fishing of the aquatic resource. Commercial fishing is concentrated adjacent to population centres such as Broome, Exmouth, Shark Bay, Geraldton, Perth, Mandurah, the Capes area, Albany, and Esperance.

Recreational fishing in the North Coast Bioregion generally has a seasonal peak in winter, when a significant number of intra- and inter-state recreational fishers travel to Onslow, Dampier, Archipelago and Broome. These fishers predominantly engage in boat-based fishing. Recreational fishers utilise the numerous creek system, mangroves, rivers, and beaches which provide shore and small boat fishing opportunities. Recreational fishers primarily target finfish species such as barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, cods, catfish, and invertebrate species including blue swimmer crabs, mud crabs and squid (Newman et al. 2023). Shore-based fishing spots are focused on small creek mouths with Beadon Creek being the closest site to the Project area (Fishing Spots n.d.).

3.2.9.2. Fish communities

The Onslow area has low to moderate fish abundance, with species richness typically low in the nearshore environment and higher offshore (Kangas et al. 2006; Kangas et al. 2015). The species found in the nearshore environment 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 (Kangas et al. 2015). Finfish species caught in the nearshore environment of the North Coast bioregion (Pilbara and Kimberley) are often juveniles that are targeted by commercial and/or recreational fisheries (Newman et al. 2004). As the species mature, they emigrate into the deeper offshore waters where they fished targeted by commercial trawl and trap fisheries (Newman et al. 2004).

3.2.9.3. Aquaculture

There are no aquaculture leases within the Project area. The closest aquaculture lease is offshore north of Thevenard Island (DPIRD 2024).

3.2.10. Key marine fauna species for the Project

The Key Species for this Project were identified based on methods presented in Section 3.1.3 and 3.1.4. A summary of information for each species identified in the PMST or DBCA fauna searches is presented in Appendix B.

Based on this information, the key species for this Project for marine fauna identified for their high likelihood of occurrence within the area are:

- Mammals
 - Australian humpback dolphin
 - Indo-pacific bottlenose dolphin
 - Dugong
 - Humpback whale
- Reptiles

- Hawksbill turtle
- Flatback turtle
- Green turtle
- Sharks and rays
 - Scalloped hammerhead
- Birds
 - Australian fairy tern
 - Bar-tailed godwit
 - Caspian tern
 - Common greenshank
 - Common sandpiper
 - Greater crested tern
 - Eastern curlew
 - Eastern osprey
 - Greater sand plover
 - Grey-tailed tattler
 - Lesser crested tern
 - Red-necked stint
 - Roseate tern
 - Silver gull.

Other key species for the Project which were not identified through this process include the short-nosed sea snake due to importance of conservation (classified as Critically Endangered).

4. Key species descriptions

The key species identified above are described further in this section. Other species that were identified as having a moderate or low likelihood of occurrence within the Project area are described in more detail in Appendix C.

4.1. Mammals

4.1.1. Australian humpback dolphin

Population

There is currently no complete range-wide population estimate for the Australian humpback dolphin (*S. sahulensis*, herein ‘humpback dolphin’) though the total number is unlikely to exceed 10,000 (Parra and Cagnazzi 2016). Across Australia, the population structure of the humpback dolphin indicates a metapopulation, consisting of small and relatively isolated populations of 54 to 89 individuals, with limited gene flow and low levels of migration between locations (Brown et al. 2014; Parra and Cagnazzi 2016).

Along the WA coastline, humpback dolphins exhibit low genetic connectivity between Exmouth and the Dampier region, with limited movement between the two regions (Brown et al. 2014; Raudino et al. 2018). Sparse data available in WA indicates similar population structures to that nationally, with localised populations in low numbers. WA populations occur within a range of inshore habitats, including both clear and turbid coastal waters (Brown et al. 2014; Hunt et al. 2017; Raudino et al. 2018; Hanf et al. 2022). A high population estimate from the North–West Cape suggests that this area may be a stronghold toward the south-west extent of the species’ range (Hunt et al. 2017).

Distribution

Humpback dolphins are found in tropical waters of southern Papua New Guinea and northern Australia to ~22 to 23°S latitude (Parra et al. 2004). They generally reside in shallow coastal waters in depths of less than 30 m and in the Pilbara, they have been recorded up to 50 km from the mainland around offshore islands as shown in Figure 16 (Hanf et al. 2022). Humpback dolphins do not appear to undergo large-scale seasonal migrations, although seasonal shifts in abundance have been observed (Parra and Cagnazzi 2016).

In Onslow the humpback dolphin density has been estimated to be 0.36 humpback dolphins per km² and 0.38 humpback dolphins per km² at Thevenard Island, which are low but comparable across their range (Raudino et al. 2018). Humpback dolphin hotspots in the Pilbara have been identified at Exmouth Gulf, the Dampier Archipelago, and the Great Sandy Islands (Raudino et al. 2023).

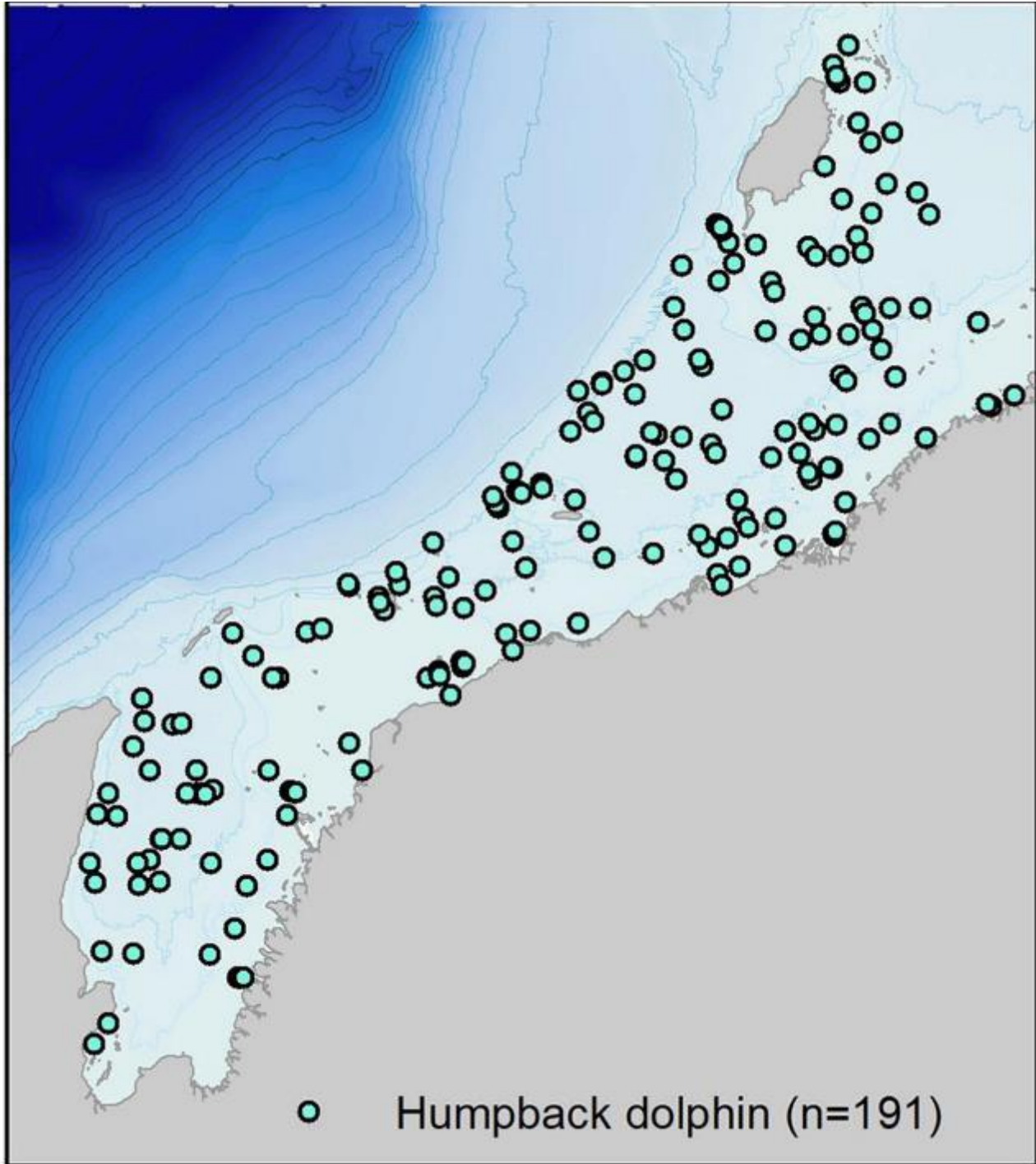


Figure 16: Humpback dolphin sightings distribution over a four-year survey program (Hanf et al. 2022)

Habitat use and life history

Humpback dolphins are opportunistic, generalist feeders. They prey on a wide variety of both schooling, bottom-dwelling and pelagic fish and cephalopods that are generally associated with mangroves, seagrass, sandy bottom or rocky coral reefs in shallow coastal waters and estuaries of tropical regions (Parra and Jedensjö 2013). Humpback dolphins inhabit shallow, coastal waters, typically within 20 km of land and in

water depths of less than 30 m (Parra and Jedensjö 2013; Hunt et al. 2017; Hanf et al. 2022). In WA, they have been associated with coral reefs and within intertidal areas with observations of foraging in rivers in the Pilbara, indicating that rivers may be an important habitat at a local scale and possibly used intermittently (Hunt et al. 2017; Hanf et al. 2022). In Queensland (QLD) humpback dolphins have also been found to be associated with estuaries and river mouths (Parra and Cagnazzi 2016).

The North West Cape (NWC) is thought to be an important habitat for the species, with high levels of site fidelity and residence patterns observed (Hunt et al. 2017). Habitat suitability modelling has been undertaken for the species between the NWC and east of Barrow Island (Hanf et al 2022). Figure 17 presents the results from the modelling, with blue zones being less suitable (zero suitability) and the red being higher suitability (up to 0.71). Area under the curve (AUC) shown on the figure indicates model performance and Marine Protected Areas (MPAs) are also outlined on the figure (Figure 17). Results indicated that highest habitat suitability occurred in shallower intertidal areas along the mainland coast and offshore islands.

There is limited knowledge on the life history characteristics of the humpback dolphin. However, they are thought to be similar to that of the Indo-Pacific humpback dolphin, where female sexual maturity is reached between the ages of 9 and 10 and males between the ages of 12 and 14 (Parra and Cagnazzi 2016; DCCEEW 2024c). Gestation is thought to last 10 to 12 months and the lactation period lasts for more than 2 years (Parra and Cagnazzi 2016). Humpback dolphins have an expected lifespan of over 40 years (Parra and Cagnazzi 2016).

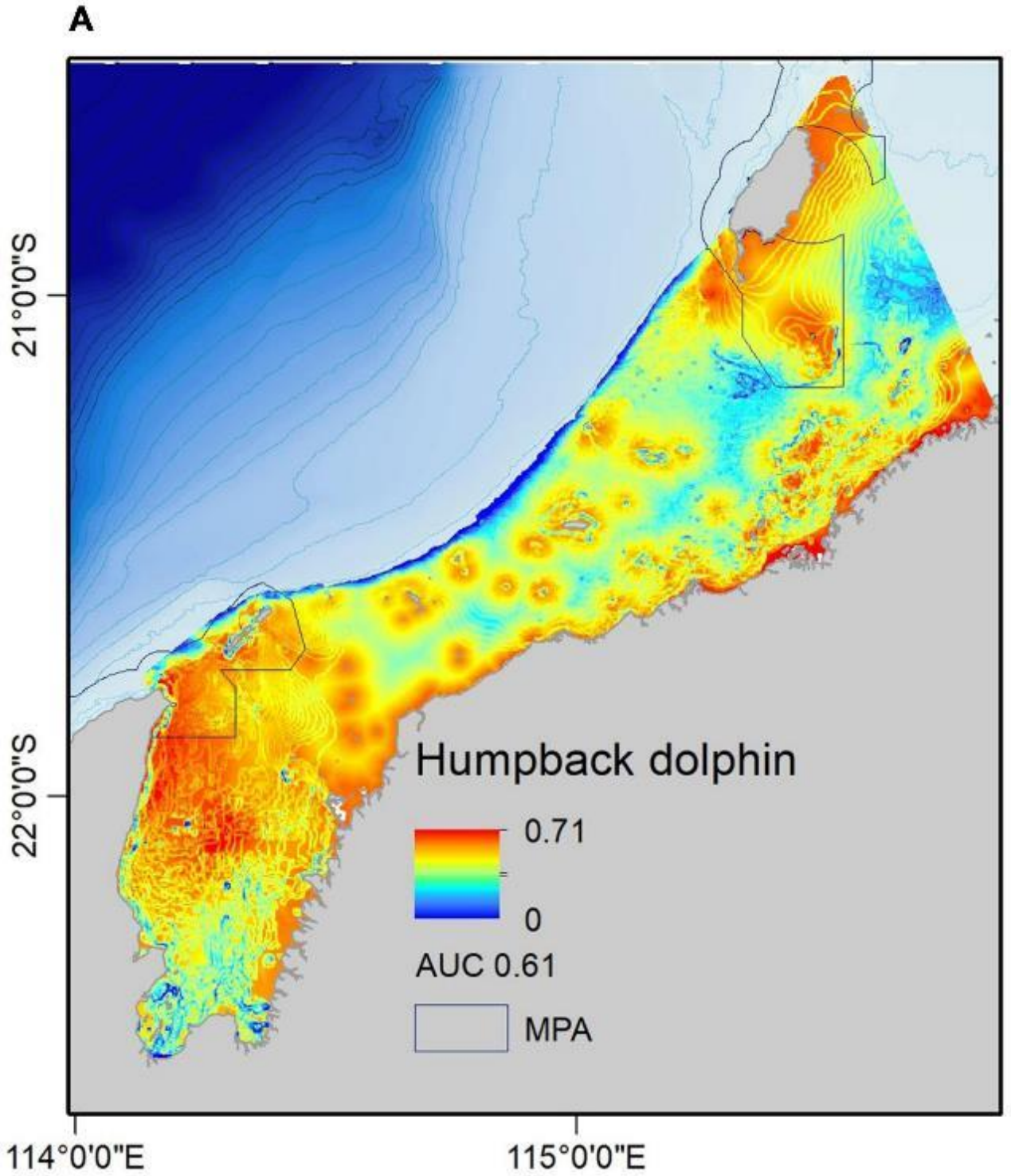


Figure 17: Habitat suitability for humpback dolphins at 500 x 500 m gride cell resolution (Hanf et al. 2022)

Relevant guidance and policies

Humpback dolphins are listed as Migratory, Marine, and Cetacean under the EPBC Act, however they are currently undergoing a threatened listing assessment which had been due for completion on 30 October 2024 (not yet released as of December 2024). Under the BC Act humpbacks dolphin are listed as priority (P4) species, which means the species lack evidence for Threatened status listing and the P4 listing is for species that are rare, near threatened and other species in need of monitoring. Their global (non-statutory) listing by the IUCN is 'Vulnerable'. Other relevant EPBC Act documents are as follows:

- Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018)
- Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a)
- National Guidelines for the Survey of Cetaceans, Marine turtles and the Dugong (DCCEEW 2024d).

Threats and pressures

Humpback dolphins can be directly impacted by vessel strike and indirectly from vessel presence, including high risk from sub-lethal effects of habitat disturbance due to their high site fidelity and small, discrete populations that spatially overlap with human activity (i.e. coastal development, petroleum exploration, commercial fishing, recreational boating) (Allen et al. 2012; Hanf et al. 2016; Smith et al. 2016). Habitat loss and fragmentation due to coastal development and activities (DCCEEW 2024c) pose a threat to the population structure of the humpback dolphins, as they have small densities, strong population genetic structure and limited gene flow so they are at risk of loss of genetic variation (Parra and Cagnazzi 2016). This may result in the species experiencing a reduced ability to adapt to changing environments, inbreeding, and reduction in survival and reproduction (Brown et al. 2014; Parra and Cagnazzi 2016).

Based on the North-west Marine Bioregional Plan (DSEWPaC 2012a) chemical spills, litter debris, nutrient pollution, hydrology changes, human presence, habitat modification, and underwater noise have been identified as existing threats that may be relevant to consider when assessing the impacts of the Project.

Relevance to the Project area

Australian humpback dolphins were identified as a key species with a high likelihood of occurrence within the Project area. The species has been frequently sighted near the Project area and surrounding waters (DBCA 2024; Hanf et al 2022). Suitable habitat for the species has been identified along the Pilbara coastline. The greatest habitat suitability occurs within shallow intertidal areas, including waters of the Project (Figure 17). Humpback dolphins may be present in the Project area at any time of year, with no ecological windows for the species having been identified as they are unlikely to migrate to other regions. The species is likely to be present travelling or foraging through the Project area and management measures should be made to mitigate potential impacts to the species.

4.1.2. Indo-pacific bottlenose dolphin

Population

Estimates for the total population size of Indo-Pacific bottlenose dolphins (*T. aduncus*, herein ‘bottlenose dolphin’) globally and in Australia is unknown. The bottlenose dolphin population in the Onslow coastal waters has been estimated to be $79 \text{ SE} \pm 24$ (confidence interval (CI) 43-148) (Raudino et al. 2018). The density of bottlenose dolphins in Onslow coastal waters appears to be comparable to Cygnet Bay in WA, Claren River and Port Stephens in New South Wales (NSW) (Raudino et al. 2018).

Distribution

Bottlenose dolphins occur in tropical and sub-tropical shallow waters from South Africa to the Red Sea and eastwards to the Arabian Gulf, India, China, and Japan, southwards to Indonesia and New Guinea, and New Caledonia. In Australian waters, bottlenose dolphins are known to occur around eastern Indian Ocean, Tasman Sea, Coral Sea, and Arafura/Timor Seas (DCCEEW 2024c). The species is restricted to inshore areas such as bays and estuaries, nearshore waters, open coast environments, and shallow offshore waters (Allen et al. 2012). Bottlenose dolphins are widespread across the Pilbara coastline, including near the Onslow coast (Figure 18; Hanf et al 2022). Around the Onslow area the species densities have been estimated to be 0.59 bottlenose dolphins per km^2 and around Thevenard Island to be 0.83 bottlenose dolphins per km^2 (Raudino et al. 2018).

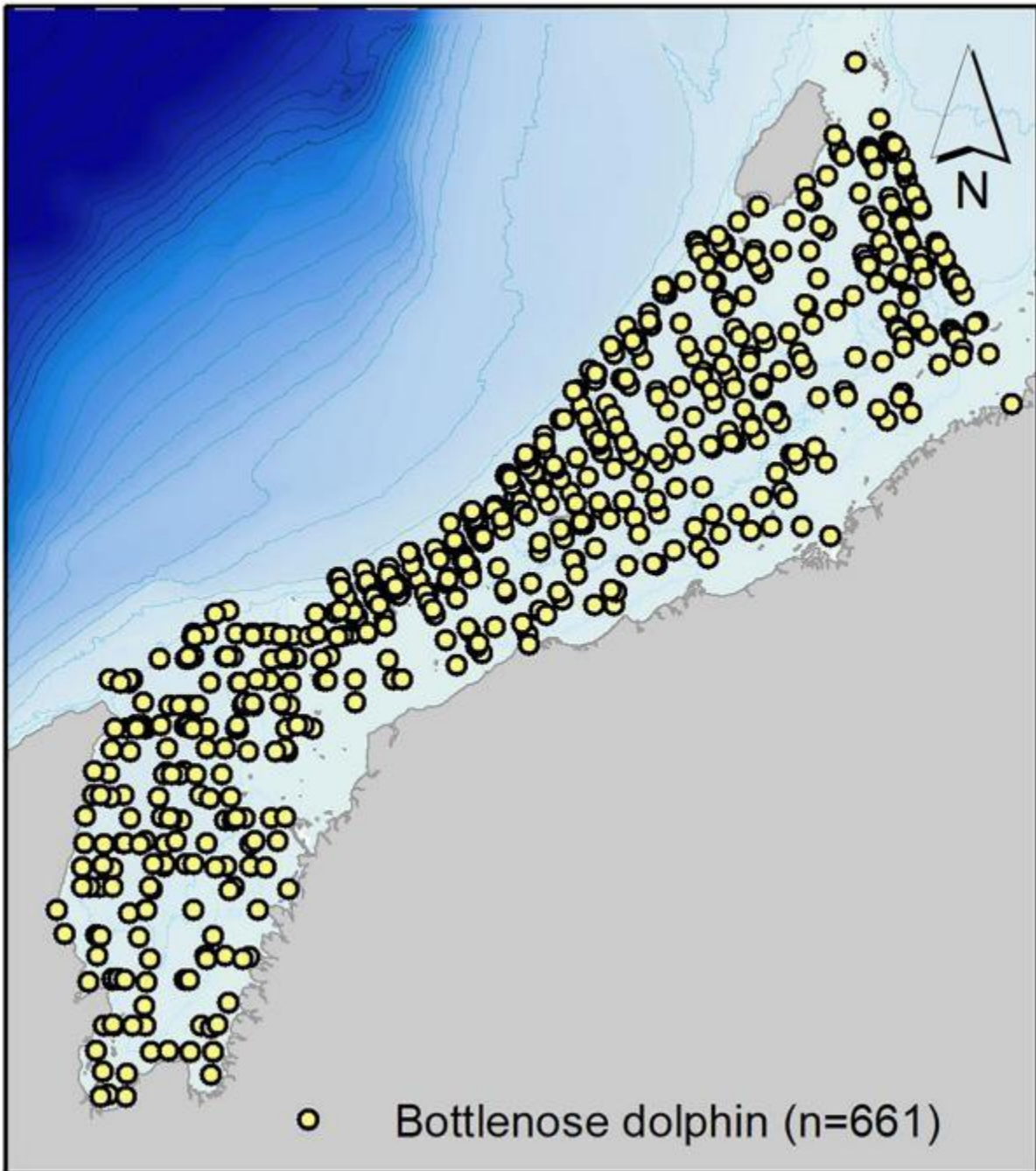


Figure 18: Bottlenose dolphin sightings distribution over a four-year survey program (Hanf et al. 2022)

Habitat use and life history

Bottlenose dolphins share similar behavioural activities with the humpback dolphin, with some degree of spatial overlap. At a regional scale, there may be some partitioning between the species with bottlenose dolphins preferring deeper waters close to sloping bathymetry (Hanf et al. 2022). Finer scale studies support this, with significant differences in habitat use and fine-scale habitat selection (Hunt et al. 2017). Habitat suitability modelling has been undertaken for the species between the NWC and east of Barrow Island (Hanf et al 2022). Figure 19 presents the results from the modelling, with blue zones being less suitable (zero suitability) and the red being higher suitability (up to 0.79). The figure also presents the AUC which indicates

model performance and MPAs in the region. Results indicated that the most suitable habitat for the bottlenose dolphin was in greater water depths than the humpback dolphin, and generally further offshore.

Bottlenose dolphins feed on a variety of fish and cephalopods, including feeding sightings on mullet (*Mugilidae*), long tom (*Belonidae*), and garfish (*Hemiramphus robustus*) (Sprogis and Parra 2022). Female Indo-pacific bottlenose dolphins reach sexual maturity between the ages of 9 and 11, whereas males reach sexual maturity between the ages of 11 and 15 (DCCEEW 2024c). The gestation period is 12 months and the period between pregnancies ranges from 3 to 6 years (Mann et al. 2000; DCCEEW 2024c). Peak calving season for the Indo-pacific bottlenose dolphin varies depending on the geographical location. Calving in the tropical region (21°57'S) occurs in autumn and winter, whereas in northern WA peak calving occurs through spring and summer (October to December).

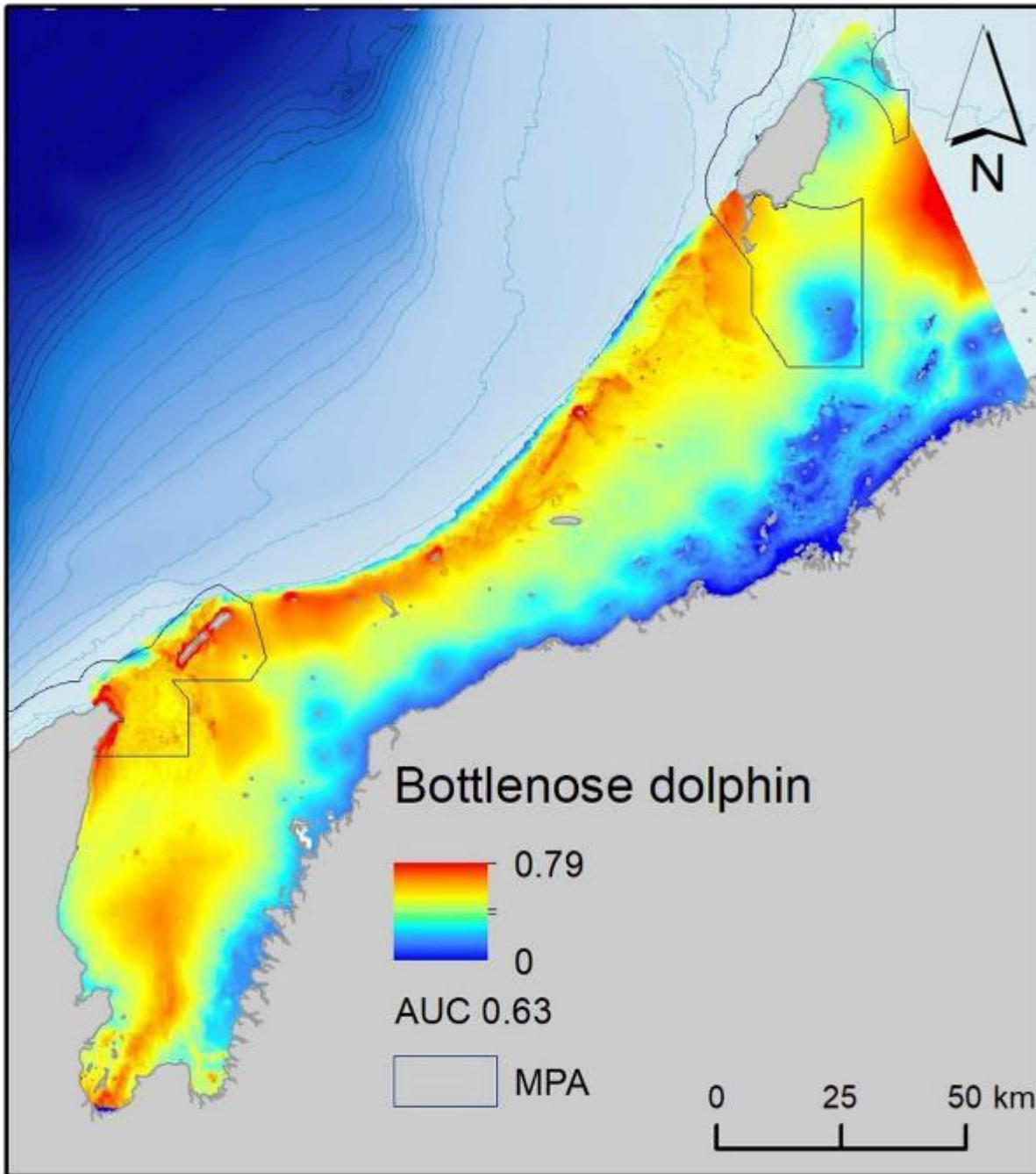


Figure 19: Habitat suitability for bottlenose dolphins at 500 x 500 m gride cell resolution (Hanf et al. 2022)

Relevant policy and guidance

Indo-Pacific bottlenose dolphins are listed as Migratory, Marine and Cetacean under the EPBC Act. They have no threatened listing under both the EPBC Act and the BC Act and there is no adopted or developed Recovery Plan for this species. Their global (non-statutory) listing by the IUCN is 'Near Threatened'. Other relevant EPBC Act documents are as follows:

- Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018)

- National Guidelines for the Survey of Cetaceans, Marine turtles and the Dugong (DCCEEW 2024d)
- Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a).

Threats and Pressures

The species preference for coastal habitats overlaps with human activity and coastal development which exposes them to repeated and cumulative stressors that have potential to disrupt and displace individuals (Bejder et al. 2006; Smith et al. 2016). The life history traits of low reproductive rate and high calf mortality make the bottlenose dolphins population recovery slow (DCCEEW 2024c). Bycatch through trawling and gillnets are other notable threats to the species (Shaughnessy et al 2003).

Underwater noise has the potential to cause direct harm, or affect hearing through masking and hindering communication which is important for maintaining social structure and natural behaviours. Other threats on a global scale include entanglements, overfishing, habitat degradation and destruction (DSEWPaC 2012b; DCCEEW 2024c). Based on the North-west Marine Bioregional Plan (DSEWPaC 2012a) chemical spills, litter debris, nutrient pollution, hydrology changes, human presence, habitat modification and underwater noise have been identified as existing threats that may be relevant to consider when assessing impacts of the Project.

Relevance to the Project area

Indo-Pacific bottlenose dolphins were identified as a key species with a high likelihood of occurrence within the Project area. The species is known to occur in the Project area and though there were no DBCA recorded sightings, recent studies have recorded frequent sightings near the Project area (Figure 18). Bottlenose dolphins may be present in the Project area at any time of year, with no ecological windows for the species having been identified as they are unlikely to migrate to other regions. The species is likely to be present transiting or foraging in the Project area, though habitat suitability suggests the species prefers offshore waters (Hanf et al. 2022; Figure 19) and therefore may not remain in the shallower areas near the Project for long periods of time.

4.1.3. Dugong

Population

The dugong is the only species of its genus and its family Dugongidae (monospecific). It is a species of high cultural and conservation significance in Australia and many other coastal regions internationally. Australia, Bahrain, Papua New Guinea, Qatar and the United Arab Emirates support substantial subpopulations of dugongs though globally, populations are decreasing (Marsh and Sobotzick 2019). Dugong populations in Australia represent the last great global stronghold (Marsh et al 2012). Within Australia, there are two distinct maternal lineages of dugong, with evidence to suggest separate populations on the west and east coasts (Blair et al 2014). In WA, dugongs are present at Shark Bay, Ningaloo, Exmouth Gulf and the Pilbara and Kimberley coasts. The largest dugong population in WA is at Shark Bay, WA, (18,555 (\pm 3,396)) followed by Exmouth Gulf (4,831 (\pm 1,965)) according to population estimates from 2018 (Bayliss et al 2018). The dugong population in Onslow was last estimated for the Chevron Wheatstone Project and was estimated to be 287 (CI 176-340) individuals (RPS 2010) representing a smaller proportion of dugongs in WA.

Distribution

The global distribution of dugongs extends from east Africa to the western Pacific (Groom et al 2017). In Australia, dugong distribution and abundance vary along the northern coastline from Shark Bay, WA, into the Northern Territory (NT) and around to Moreton Bay near Brisbane, Queensland (Qld) (Holley and Prince 2008; DCCEEW 2024c; Groom et al 2017). A significant proportion of the Australian dugong are found in the north WA coastal waters from Shark Bay through to the Kimberley (Bayliss et al. 2019). From satellite tracking of individuals and aerial surveys it appears that dugongs, like many other marine mammals, can move long distances, but the timing and length of movements vary individually.

Historic surveys completed for the Chevron Wheatstone Project frequently sighted dugongs within the Chevron survey area (which overlaps the current Project area) and there were more sightings south-west of the Project area (Figure 20). The aerial surveys identified 148 dugongs from May to December in 2009, and the peak number of dugongs was observed in late June and primarily in shallow waters (<10 m). Of these sightings dugong 10% of the dugong herds were observed with cow-calf pairs (Jenner and Jenner 2009; Jenner et al. 2010a). The dugong density in the Wheatstone survey area was estimated to be 0.11 dugongs per km² (95% CI: 0.07–0.13) in 2010 (RPS 2010).

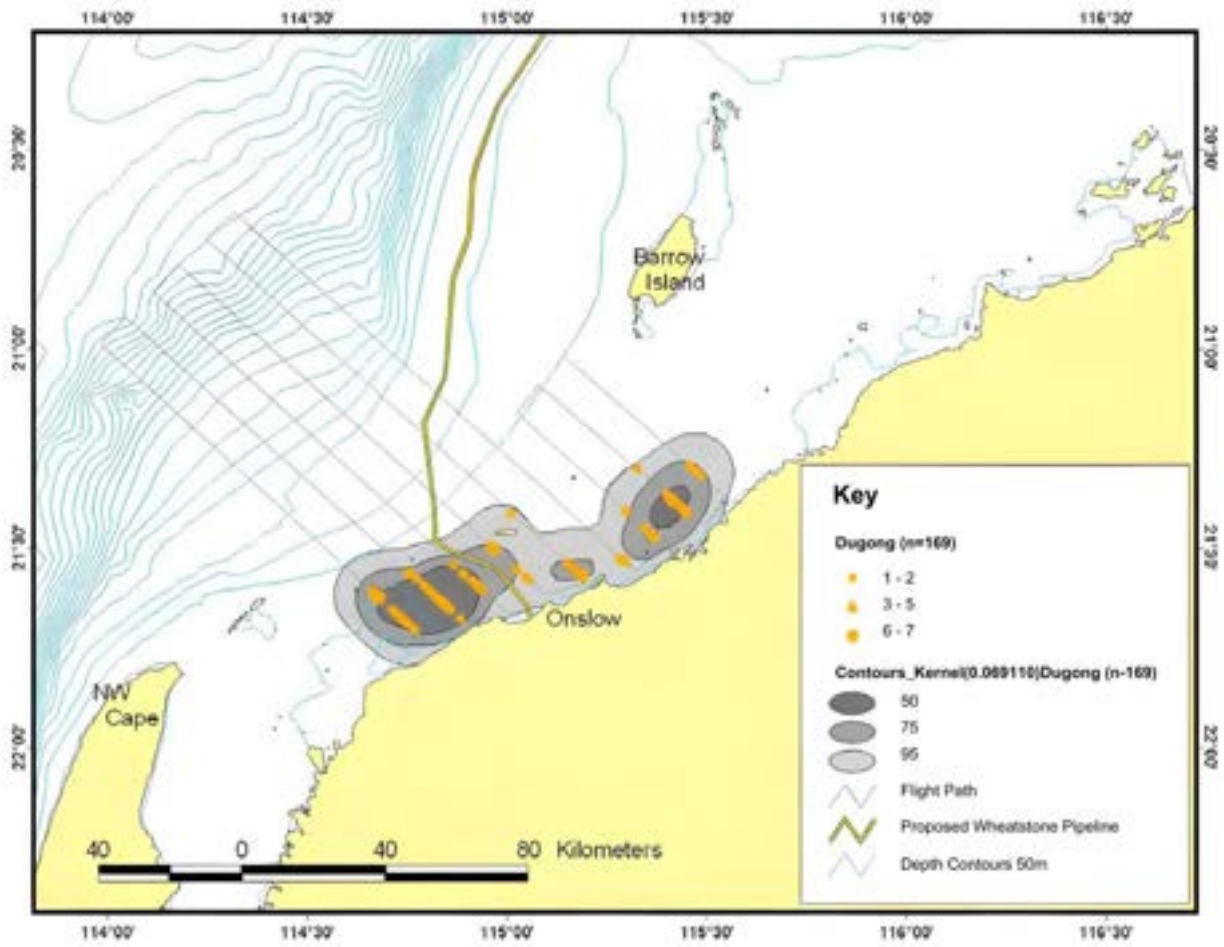


Figure 20: Distribution of dugongs recorded in the waters surrounding the Chevron Wheatstone Project Area from 17 May 2009 to 29 April 2010 (Jenner et al. 2010a)

Habitat use and life history

Dugongs are long-lived, living to over 70 years of age, with a very slow and highly variable reproductive rate of approximately one calf produced every 3 to 6 years (DCCEEW 2024c). Males reach sexual maturity between the ages of 4 and 13 years old with a body length range from 220 to 250 cm. Female dugongs reach sexual maturity and can bear their first calf from the ages of 6 to 17 years (DCCEEW 2024c). Reproduction of dugongs is highly seasonal and competitive, during which reproductive females are pursued by a group of mounting males (generally four to five) (DCCEEW 2024c). Population simulations indicate that even with the most optimistic combinations of life-history parameters (e.g. low natural mortality and no human-induced mortality) a dugong population is unlikely to increase by more than 5% per year (Marsh 1999).

Dugongs are herbivores, feeding extensively on seagrass, with a preference for feeding on sparse seagrass beds (Bayliss et al. 2019), consisting of ephemeral species such as *Halophila ovalis*, known to grow amongst sparse *Posidonia australis* and *Amphibolis antarctica* meadows. Results from Bayliss et al. (2019) indicate that dugongs may prefer feeding on sparse seagrass habitats as it may be easier to graze on the ephemeral species when the canopy forming species are less dense.

Dugong bones are among the heaviest and densest in the animal kingdom which may act as a ballast and help them remain suspended as they graze seagrasses. Dugongs can weigh over 400 kg and are relatively slow moving. As they graze on seagrass and while feeding remaining suspended underwater, they are often difficult to detect, which makes them susceptible to vessel strikes.

Relevant guidance and policy

Dugongs are listed as Migratory and Marine under the EPBC Act and as Other Protected Fauna under the BC Act. Their global (non-statutory) listing by the IUCN is 'Vulnerable'. There is no adopted or made Recovery Plan for this species. Other relevant EPBC Act documents are:

- Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018)
- National Guidelines for the Survey of Cetaceans, Marine turtles and the Dugong (DCCEEW 2024d)
- Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a).

Threats and pressures

Historically, loss of seagrass habitat has resulted in the collapse of breeding recruitment, with populations after a heat wave in 2010/11 having significantly reduced juvenile recruitment in northern Australia (Bayliss et al. 2018) and previously similar effects were observed after extensive seagrass dieback (Preen and Marsh 1995). Habitat degradation including coastal development, port expansion and aquaculture, resulting in a loss of critical food resource seagrass habitat, has been identified as a moderate to severe threat to dugongs (Woinarski et al. 2014). Vessel strike, habitat loss and habitat degradation have been identified as key threats for dugongs and require special management considerations during coastal development and port expansion (DSEWPaC 2012c). Pollution, entanglement, indigenous hunting, underwater noise, and climate variability have also been identified as additional threats by DCCEEW (2024c) and should be considered when assessing the impacts on the species.

Based on the North-west Marine Bioregional Plan, invasive species, habitat modification, litter debris, vessel strike and increased turbidity have been identified as existing threats that may be relevant to consider when assessing impacts of the Project.

Relevance to the Project area

Dugongs were identified as a key species with a high likelihood of occurrence within the Project area. Dugong are known to be present within the area, with a high number of recorded sightings (DBCA 2024). It is likely that dugongs would be present within the Project area and adjacent waters foraging in areas where suitable seagrass habitat exists or transiting through the area. Seagrass is variable across the Pilbara but has been recorded at Thevenard Island which is located 20 km directly offshore from the proposed Project DE (Vanderklift et al. 2017). Dugongs may be present in the Project area at any time of year, with no ecological windows for the species having been identified. The species is likely to be present travelling or foraging through the Project DE and management measures should be made to mitigate potential impacts to the species. BCH results showed only a small area of sparse seagrass near the development envelope of the Project, and therefore are unlikely to be foraging within the Project area.

4.1.4. Humpback whale

Population

Humpback whales have a global distribution consisting of 16 distinct populations currently recognised (Jackson et al. 2015). Humpback whales in WA waters represent Population IV, or Breeding Stock D, which annually migrate from their feeding grounds in Antarctica to their breeding grounds in northern WA (Jenner et al. 2001; Salgado Kent et al. 2012). Breeding Stock D is the largest population of humpback whales worldwide and is estimated at ~20,000 to 30,000 animals (Salgado Kent et al. 2012). The humpback whale was a targeted species for the commercial whaling industry in WA until it was shut down in 1978. When the population was last assessed in 2008, they were the fastest recovering population, with annual recovery rates estimated at between 9.7 to 13% (Hedley et al. 2008; Hedley et al. 2011; Salgado Kent et al. 2012). The species was delisted from its previous threatened species status in 2022, though it is still a species considered a MNES under the EPBC Act as a listed Migratory species. It is also listed as a Cetacean under EPBC Act Division 3 where it is an offence to kill, injure, take, trade, keep, move or interfere with a cetacean (TSSC 2022).

Distribution

The distribution of humpback whale populations throughout the world is severely fragmented. In Australian waters, humpback whales annually migrate between breeding areas in tropical waters along the east and west coast of Australia (DCCEEW 2024c). The humpback whale migration route is generally within 200 km from shore (Jenner et al. 2010a). Important resting areas have been identified during the southern migration (TSSC 2022) and include:

- Augusta
- Geographe Bay
- Shark Bay
- Exmouth Gulf
- The southern Kimberley region.

Within the Onslow region, humpback whales have been detected during aerial and acoustic survey offshore during the baseline surveys for the Chevron Wheatstone Project (RPS 2010a). The aerial surveys identified 1,221 humpback whales in the waters offshore of Onslow, with an average distance of 50 km from shore during the northbound migration and 35 km during the southbound migration (RPS 2010a). Only isolated individuals were found inshore of Thevenard Island (RPS 2010a).

The whales were present between early to mid-June and mid-December, with numbers increasing in mid-June to late August. The southward shift in the migration was observed in mid-August and at this time there was also an increase in the number of whales resting and milling in the survey area. Cow-calf pairs were primarily observed resting and most frequently within the 50 m depth contour and within 35 km of the coastline and (Jenner and Jenner 2009; Figure 21).

More recently, a study on widespread exposure to shipping on marine parks, whales and whale sharks also recorded locations of tagged humpback whales and found their distribution to be closer to shore along the Ningaloo coast and within Exmouth Gulf, and slightly further offshore as they move further north of WA (Figure 22; Raoult et al 2022).

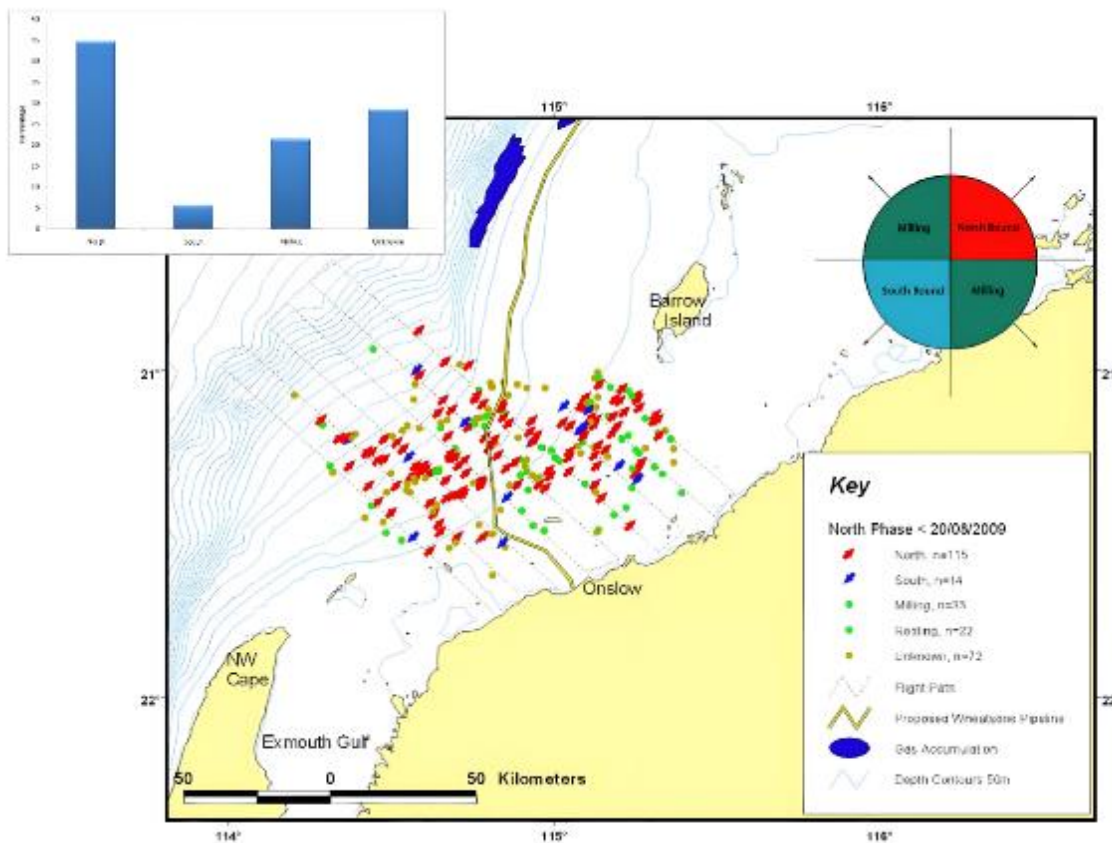


Figure 21: Swim direction reported for humpback whale pods sighted during the southern migratory phase (September 3 to December 24) (Jenner and Jenner 2009)

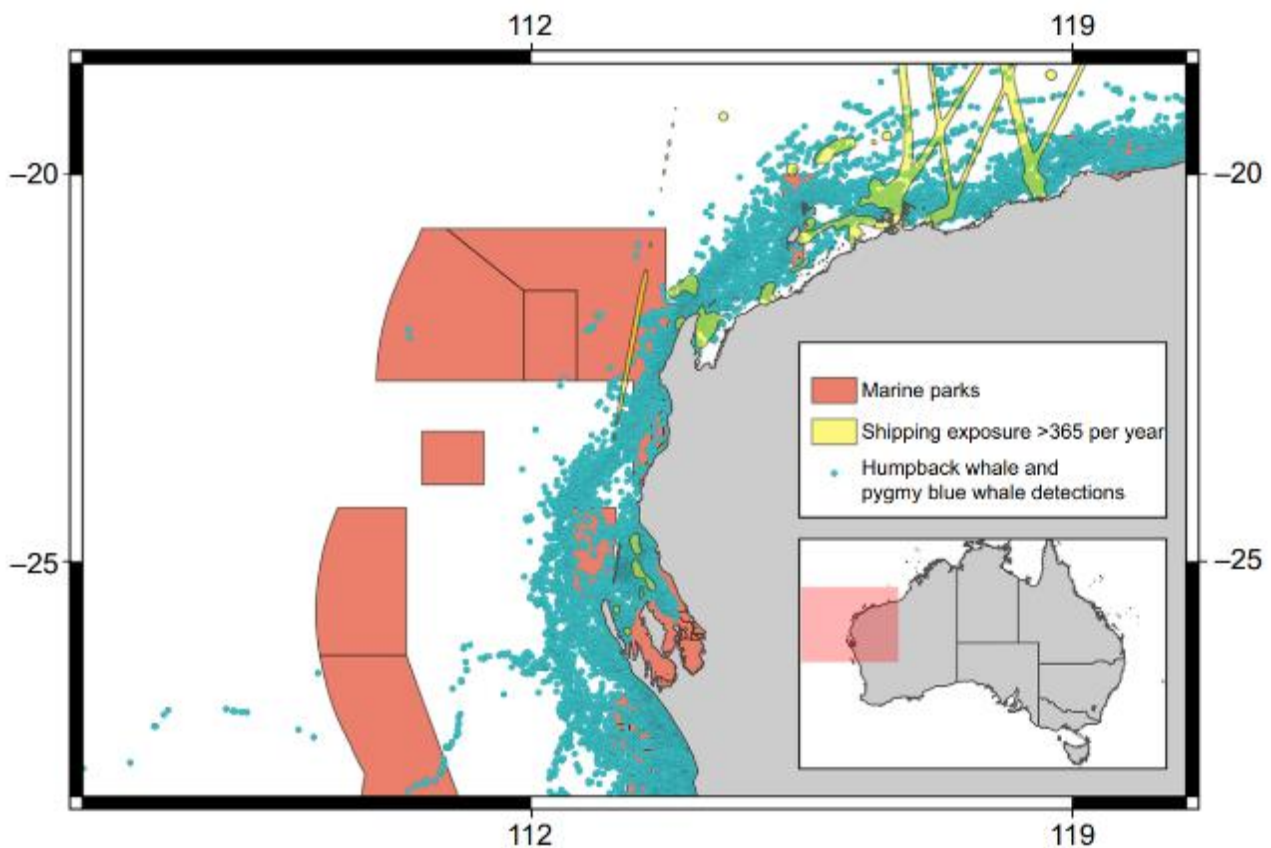


Figure 22: Satellite-tag record locations of pygmy blue and humpback whales (n = 155, teal circles). State and national marine parks of Australia are overlaid in red. Areas exposed to >365 vessels per year per 10-km radius is shown in yellow marine parks in red (Raoult et al. 2022)

Habitat use and life history

Humpback whales live to around 48 years old, with a mean sexual maturity age of five years. They undergo seasonal migrations between summer foraging grounds in cold productive waters to winter breeding grounds in warm waters of low latitudes. Breeding Stock D whales migrate annually from the southern Antarctic feeding grounds to the north, entering the North-west Marine Region waters around June, to breed and give birth to their calves, until later returning to the southern waters of the Antarctic around October (DSEWPac 2012b).

Humpback whale calves remain with their mothers for the first year of their lives who provide the calves with food, protection and help their development (Seary et al. 2022). Female humpback whales calve every 2 to 3 years, allowing time for the previous years' calf to be weaned. This mother-calf association is thought to increase the calves' reproductive success due to the mother teaching essential skills, therefore making this mother-calf association a pivotal time in the species' life cycle. Occasionally mother-calf pairs will be escorted along their migratory route by male humpback whales (Seary et al. 2022).

Humpback whale calving grounds extend south from Camden Sound in the Kimberley to at least the NWC (Irvine et al. 2018). Recent work and identification of neonates at NWC, 1,000 km southwest of the recognised calving area, suggest that the species calving areas are poorly defined, with a minimum of 20% of the calves born near or south of NWC (Irvine et al. 2018). There have been no comprehensive surveys along the WA

coastline to define the current calving area, and it is not certain whether the calving range is expanding to areas where it occurred in prior to whaling or if the calf number are sufficiently high enough, they can now be observed throughout their entire range (Irvine et al. 2018; Irvine and Salgado Kent 2019). Lactating whales save energy by devoting a significant amount of time to rest while stationary at shallow depths, which is within reach of hulls of commercial ships, increasing the potential for ship strike collisions (Bejder et al 2019). Noise, even that considered to be moderate, will likely decrease the communication range of humpback whales (Bejder et al 2019).

Relevant guidance and policies

As mentioned above, humpback whales have been removed from their 'Vulnerable' status as of the 26 February 2022 though they are still considered MNES under the EPBC Act. They are also classified as 'Conservation Dependant' fauna under the BC Act. Their global (non-statutory) listing by the IUCN is 'Least Concern'. Other relevant EPBC Act documents are:

- Listing Advice *Megaptera novaeangliae* Humpback Whale (TSSC 2022)
- Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018)
- National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE 2017b)
- Australian National Guidelines for Whale and Dolphin Watching 2017 (DoEE 2017c)
- National Guidelines for the Survey of Cetaceans, Marine Turtles and the Dugong (DCCEE 2024d)
- Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a).

Threats and pressures

The greatest threats to humpback whales in WA are from human-made underwater noise (resulting in hearing impairment, organ damage, communication interference, elevated stress levels and/or avoidance of important habitat), vessel strike, entanglement in lobster pot lines and marine debris (TSSC 2022). Neonate calves are particularly vulnerable to vessel strikes, as they have limited swimming and diving abilities and low breath-hold capacity (Irvine and Salgado Kent 2019). Based on the North-west Marine Bioregional Plan (DSEWPaC 2012a), underwater noise and vessel strike have been identified as existing threats that may be relevant to consider when assessing impacts of the Proposal and when developing mitigation and management measures.

Relevance to the Project area

Humpback whales were identified as a key species with a high likelihood of occurrence within the Project area. Humpback whales are known to be present within the area, with a high number of recorded sightings (DBCA 2024). Additional literature also shows high numbers of recordings in the waters surrounding the Project area, with highest numbers from mid-June with the peak abundance being in August (Jenner and Jenner 2009). The species migration BIA and IMMA overlap the proposal area. The species is likely to be present in the waters adjacent to the Proposal seasonally, especially during their southern migration July to November, when they are closer to the coast and in shallower water. It is highly likely that humpback whales would be present milling or resting, especially mother-calf pairs during the southern migration period.

4.2. Reptiles

4.2.1. Green turtle

Population

There are approximately more than 70 000 individuals of green turtles across Australia (DCCEEW 2024c) across 9 genetically distinct stocks (DoEE 2017a). The green turtles present within the Project area and surrounding environment are part of the North West Shelf (NWS) stock, which extends from the Ningaloo Reef in the Pilbara to the Maret Islands in the Kimberley. They are one of the largest green turtle stocks in the world and the largest in the Indian Ocean.

Distribution

Green turtles are distributed across tropical northern Australian waters. Nesting distribution of the NWS stock has been identified at Adele Island, Maret Island, Cassini Island, Lacepede Islands, Barrow Island, Montebello Islands (all with sandy beaches), Serrurier Island, Dampier Archipelago, Thevenard Island, North-West Cape, and the Ningaloo coast (DoEE 2017a).

Habitat and life history

Green turtles are primarily herbivorous, feeding on seagrass, macroalgae and mangroves, and potentially jellyfish and ctenophores (Vanderklift et al. 2021). In their pelagic juvenile stage, they feed on algae, pelagic crustaceans, and molluscs (DoEE 2017a).

Juvenile and adult turtles are regularly seen foraging and resting in coastal and offshore waters of the Pilbara. Adult green turtles foraging habitat is largely concentrated in shallow waters ranging from 1 to 104.5 m (Ferreira et al. 2021). Around the Muiron Island and Ningaloo Reef, Ferreira et al (2021) found that the mean foraging depth was 4.9 m and 17 m respectively. Post-hatchling and young juvenile habitats are currently unknown, but they are likely to disperse through much of the Indian Ocean and Arafura Sea. Juvenile turtles forage in tidal/subtidal habitats generally with coral reefs, mangroves, sand, rocky reefs, and mudflats where algal turfs or seagrass meadows are present (DoEE 2017a).

Female green turtles may reach sexual maturity between 25 and 50 years of age, depending on the different foraging grounds they inhabit (DCCEEW 2024c). Breeding male and female green turtles move from their feeding grounds to areas near nesting beaches for mating, then females move onto the beach to lay their eggs, usually on several different nights.

The current foraging BIAs for green turtles are largely underestimated, with green turtle movements only overlapping with 5% of the existing BIAs (Ferreira et al. 2021). The foraging movements of the NWS Pilbara stock overlapped with the 20 km inter-nesting buffer, and therefore were still foraging within protected areas. Green turtles from the NWS Pilbara rookeries have been found to travel a median distance of 306 km (with a range of 60-2,683 km) to foraging areas (Ferreira et al. 2021).

Nesting habitat

Green turtles breed extensively across the WA coastlines. The major/important nesting area for green turtles in the NWS stock are located at Lacepedes, Montebello, Barrow, Muiron, Browse Islands, and North West Cape (DoEE 2017a). The mating period for the NWS stock typically ranges from September to December, with

nesting occurring from November to March (peak December to February) (DoEE 2017a; Fossette et al. 2021a). Green turtle hatchlings typically emerge from January to May with peak hatching during February to March (DoEE 2017a). They do not nest on the mainland beaches around the Project area but are known to nest on offshore islands adjacent to the Project, including Ashburton, Bessieres, Thevenard, and Tortoise Islands (Fossette et al. 2021a). Bessieres Island has had the greatest overnight tracks reported, with 24.2 tracks per km per night, which correspond to between 11 and 100 overnight tracks (Pendoley et al. 2016; Pendoley Environmental 2022). Green turtles primarily nest on the west side of Thevenard Island, with 20 to 32 overnight turtle tracks recorded in December 2016 (Fossette et al. 2021a; Pendoley Environmental 2022). Tortoise and Ashburton Islands have lower track counts compared to the other islands (Pendoley et al. 2016; Pendoley Environmental 2022).

NWS stock green turtles mating period typically ranges from September to December, with nesting occurring from November to March (peak December to February) (DoEE 2017a; Fossette et al. 2021a). Green turtle hatchlings typically emerge from January to May with peak hatching during February to March (DoEE 2017a).

Inter-nesting habitat

During the inter-nesting period (November to March), green turtles appear to remain within shallow nearshore waters (<20 m), with results from Ferreira et al. (2021) showing a median water depth of 9 m for inter-nesting green turtles (range= 4 – 62 m). Inter-nesting green turtles generally remain close to their rookery, found to generally utilise an area smaller than the 20 km inter-nesting buffer (Ferreria et al. 2021). Tagging studies have shown that distances between nesting and feeding areas can range from 2 to 2,600 km (DSEWPac 2012d).

Relevant guidance and policies

Green turtles are listed 'Vulnerable', Migratory, and Marine under the EPBC Act and 'Vulnerable' under the BC Act. Green turtles are globally (non-statutory) listed as 'Endangered' by the IUCN. Other relevant EPBC Act documents are as follows:

- Recovery Plan for Marine Turtles in Australia (DoEE 2017a)
- Threat abatement plan for predation, habitat degradation, competition, and disease transmission by feral pigs (*Sus scrofa*) (DoEE 2017d)
- Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018)
- National Guidelines for the Survey of Cetaceans, Marine turtles and the Dugong (DCCEE 2024d)
- Threat abatement plan for predation by the European red fox (DEWHA 2008a)
- Marine bioregional plan for the North-west Marine Region (DSEWPac 2012a).

Threats and pressures

In relation to coastal development, key threats to turtles are light pollution (i.e. disturbance to nesting behaviour and misorientation of turtle hatchlings), reduced water quality, direct habitat removal, degradation of nesting and foraging areas, vessel strike, underwater noise, and entrainment from dredgers. Based on the North-west Marine Bioregional Plan (DSEWPac 2012a) habitat modification, human presence, litter debris, light pollution, invasive species, underwater noise, increased turbidity, vessel strike and dredge entrainment have been identified as existing threats that may be relevant to consider when assessing impacts of the Project.

Relevance to the Project area

Green turtles were identified as a key species with a high likelihood of occurrence within the Project area. Green turtles are known to be present within the area (DCCEEW 2024a), with a high number of recorded sightings (DBCA 2024). The Project area overlaps with the species critical habitat (habitat critical for the survival of species (DoEE 2017a)), though the species BIA does not overlap. The species is known to nest on the offshore islands in the vicinity of the Proposal and therefore it is likely that the species utilises the waters of the Project for foraging and nesting/inter-nesting on offshore islands.

4.2.2. Hawksbill turtle

Population

The total population of the hawksbill turtle is unknown though it is likely to be below 25,000 females nesting annually worldwide (Fossette et al 2021b). There are three genetically distinct stocks in Australia with approximately 4,000 females nesting annually in QLD, over 2,500 in the Northern Territory (NT) and approximately 2,000 in WA (DCCEEW 2024c). The Project area overlaps the WA hawksbill turtle stock which is one of the largest in the world and the largest in the Indian Ocean.

Distribution

Hawksbill turtles are distributed globally in tropical, subtropical, and temperate waters. Most of the nesting for this stock is in the Pilbara within the Dampier Archipelago (including Rosemary Island and Delambre Island), Montebello Islands (including Ah Chong Island, Southeast Island and Trimouille Island), Lowendal Islands (including Varanus Island, Beacon Island and Bridled Island) and Sholl Island.

Habitat and life history

Hawksbill turtles grow slowly, with sexual maturity not reached until after 31 years of age (DCCEEW 2024c). They are omnivorous, feeding on algae, sponges, soft corals, and other soft-bodied invertebrates. Important foraging habitat has not been identified for the WA stock (DoEE 2017a). They inhabit tidal and sub-tidal coral and rocky reefs in clear or turbid waters where they feed on algae, sponges, and soft corals. They can also be found in seagrass meadows or on soft-bottom habitats (DoEE 2017a). Hawksbill turtles migrate between Dampier Archipelago and Onslow, with individuals migrating up to 2,400 km between their nesting and foraging grounds (DSEWPac 2012e). Recent tagging studies have found that WA hawksbill turtles migrate through shallow continental-shelf waters (<200 m) and primarily follow the coastline while dispersing in a north-easterly direction (Fossette et al. 2021a).

Hawksbill foraging habitat ranges from 1-20 m depth, but most foraging occurs in water depths between 10 and 20 m with a strong affinity for shallow coral reefs and intertidal reef habitats (Fossette et al. 2021a).

Nesting habitat

Important nesting locations for hawksbill turtles include the Montebello Islands, Mundabullangana Beach, Barrow Island, Cemetery Beach, Dampier Archipelago (including Delambre Island and Hauy Island), coastal islands from Cape Preston to Locker Island. The most significant hawksbill turtle rookery in WA is located on Rosemary Island in the Dampier Archipelago. In the Pilbara region, hawksbill turtles have been found to nest primarily (42%) within the Onslow subregion (Pendoley et al. 2016).

Hawksbill turtles are not known to nest on the mainland beaches of the Project area, though there is recorded hawksbill nesting nearby offshore at Ashburton, Bessieres, and Thevenard Islands. At Bessieres Island, one record of hawksbill turtle nesting was recorded as part of the baseline surveys for the Wheatstone Project (Jenner et al. 2010a; RPS 2010). Pendoley et al. (2016) also recorded the presence of hawksbill nesting activity at the island (though no actual overnight track count was reported). Elsewhere, Thevenard Island recorded 1 – 10 overnight tracks and the presence of hawksbill activity was also reported for Ashburton Island (Pendoley et al. 2016). In WA, hawksbill turtles mate between September and January, and nest between October and March, with peak nesting from November to January (DoEE 2017a; Fossette et al. 2021a). Hatchlings emerge in February and March (DoEE 2017a).

Inter-nesting habitat

The WA hawksbill turtle stock inter-nesting period is from October to February. Recent tagging studies in WA have found that during this time female inter-nesting hawksbill turtles remain relatively close to nesting beaches (0.97 ± 0.81 km) and have a small area of occupancy during this time (38.7 ± 27.5 km² (50% distribution) and 242.8 ± 231.8 km² (95% distribution) (Fossette et al. 2021b). Fossette et al (2021b) also found that 95% of hawksbill turtle inter-nesting distribution occurred within the inter-nesting Habitat Critical Areas (a 20 km buffer around known rookeries) as defined in the Recovery Plan (DoEE 2017a). The Project area overlaps this habitat.

Relevant guidance and policies

Hawksbill turtles are listed as ‘Vulnerable’, Migratory and Marine under the EPBC Act and ‘Vulnerable’ under the BC Act. Hawksbill turtles are globally (non-statutory) listed as ‘Critically Endangered’ by the IUCN. Other relevant EPBC Act documents are as follows:

- Recovery Plan for Marine Turtles in Australia (DoEE 2017a)
- Threat abatement plan for predation, habitat degradation, competition, and disease transmission by feral pigs (*Sus scrofa*) (DoEE 2017d)
- Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018)
- National Guidelines for the Survey of Cetaceans, Marine turtles and the Dugong (DCCEEW 2024d)
- Threat abatement plan for predation by feral cats (DoE 2015a)
- Marine bioregional plan for the North-west Marine Region (DSEWPac 2012a).

Threats and pressures

In relation to coastal development, key threats to turtles are light pollution (i.e. disturbance to nesting behaviour and misorientation of turtle hatchlings), reduced water quality, direct habitat removal, degradation of nesting and foraging areas, vessel strike, underwater noise, and entrainment from dredgers. Based on the North-west Marine Bioregional Plan (DSEWPac 2012a) habitat modification, human presence, litter debris, light pollution, invasive species, underwater noise, increased turbidity, vessel strike and dredge entrainment have been identified as existing threats that may be relevant to consider when assessing impacts of the Project.

Relevance to the Project area

Hawksbill turtles were identified as a key species with a high likelihood of occurrence within the Project area. Hawksbill turtles are known to be present within the area (DCCEEW 2024a) with 11 recorded sightings (DBCA 2024). The nesting BIA and habitat critical for the survival of the species also overlaps with the Project area. However, the species is known to nest on offshore islands adjacent to the Project area rather than on the beach of the Project area. It is highly likely that the species would be present within the vicinity of the Proposal, likely using the waters for foraging and inter-nesting, though nesting is more likely to occur on the offshore islands.

4.2.3. Flatback turtle

Population

The population of the flatback turtle is unknown, and the IUCN have classed the species as “data deficient” (IUCN 2024). There is also no population trend data existing for WA. Four genetic stocks are recognized in Australia with those within the Project area and surrounding environment part of the Western Australia stock.

Distribution

Flatback Turtles have a restricted distribution and are endemic to Australia, found only to reside in northern Australia, Papua New Guinea and Irian Jaya. The species is one of only two species of sea turtle without a global distribution. The nesting distribution of the WA stock include Cape Dommit and Lacrosse Island, the Mid-eastern coast of Barrow Island, and near Eighty Mile Beach (DoEE 2017a).

Habitat and life history

The flatback turtle is carnivorous, feeding mostly on soft bodied prey such as sea cucumbers, soft corals and jellyfish. (DCCEEW 2024c). Flatback turtles that nest on the Pilbara coast disperse to feeding areas extending from Exmouth Gulf to the Tiwi islands in the NT (DSEWPaC 2012d). They feed mainly in subtidal, soft-bottomed habitats and benthic geomorphology is a strong indicator of flatback turtles foraging ground, with preference for terraces, deep holes and valleys (DCCEEW 2024c; Thums et al 2017). Flatback turtle hatchlings grow to maturity in shallow coastal waters likely to be close to their natal beaches (DSEWPaC 2012d).

Post-hatchling/young juvenile habitat is currently unknown, but it is likely they remain in waters over the Australian continental shelf (DoEE 2017a). Juvenile and adult turtles prefer soft sediment habitats which support benthic invertebrates. Post-nesting satellite tracking research has indicated that foraging areas for the species are present along the WA coastline in shallow waters (<130 m) and within 315 km of the shore (Richards et al 2006; DoEE 2017a). The foraging behavioural phase was associated with the widest range of water column depths (with a range of 0–730 m), although generally they remain in shallower depths (typically <50 m with median depth of 28 m and mean depth of 34 ± 29.6 m) (Peel et al. 2024). Migrating flatback turtles tend to occupy shallow, inshore waters with a median water column depth of 25 m.

Nesting habitat

In WA, the Pilbara stock of flatback turtles nesting ranges from Y Island (Exmouth Gulf) to Bedout Island in the north and Mulla Mulla Downs Creek in the east (Fossette et al. 2021a). They have been identified at the Montebello Islands, Mundabullangana Station, Barrow Island, Cemetery Beach, Dampier Archipelago (including Delambre Island and Huay Island), and coastal islands from Cape Preston to Locker Island (DoEE

2017a). Flatback turtle nesting occurs predominantly on islands (>85%; Fossette et al. 2021a). The Dampier Archipelago accounts for >50% of the flatback turtle nesting. The largest Pilbara stock flatback rookeries are located at Delmabra Island, Mundabullangana, Barrow Island, and Rosemary Island which account for 50 to 60% of the stocks nesting.

Flatback turtles are known to nest within the Project search area, with nesting occurring on the nearby Thevenard Island and others including Ashburton, Direction, and Tortoise Islands, and on the mainland beach, including Ashburton River Delta (Pendoley Environment 2022). Ashburton, Direction, and Thevenard Islands have recorded 'very high' overnight track counts, 50-249 tracks per night, and Ashburton River Delta 'high' overnight track counts, 10-49 tracks per night (Fossette et al. 2021a; Pendoley Environment 2022). Fossette et al. (2021a) did not record any flatback nesting activity at mainland nesting habitat to the east of Beadon Creek in Onslow and west of Ashburton River Delta. Two sightings of flatback turtle nests in 2008/09 were recorded at Onslow Back beach (Pendoley Environmental 2009a,b) and therefore nesting may occur close to the Project site.

Inter-nesting habitat

The inter-nesting period is between each successive clutch, during which the inter-nesting turtles remain close to the nesting beach or rookery (DoEE 2017a). Flatback turtles have a high level of nest site fidelity and have wide-ranging inter-nesting movements within the Pilbara region (DSEWPaC 2012d; Whittock et al. 2016; Peel et al 2024). A recent study has shown during the inter-nesting period flatback turtles are primarily found within their BIA (>98% overlap) (Figure 23; Peel et al. 2024). While inter-nesting females' turtles spend majority (89.6%) of their time in a median water depth of 9 m (range=0-229 m, average=12.7± 12.8 m) and 95% of the time this inter-nesting behaviour occurred within 54.2 km of the nesting beaches (Peel et al. 2024). Peel et al. (2024) also found that the NSW flatback stock had the lowest level of overlap with marine reserves, and Barrow Island and Roebuck Bay were identified as areas of importance for the species. During the species inter-nesting period (October to March) the turtles present in the waters of the Project area would be from the Pilbara/North West Shelf stock (Peel et al. 2024).

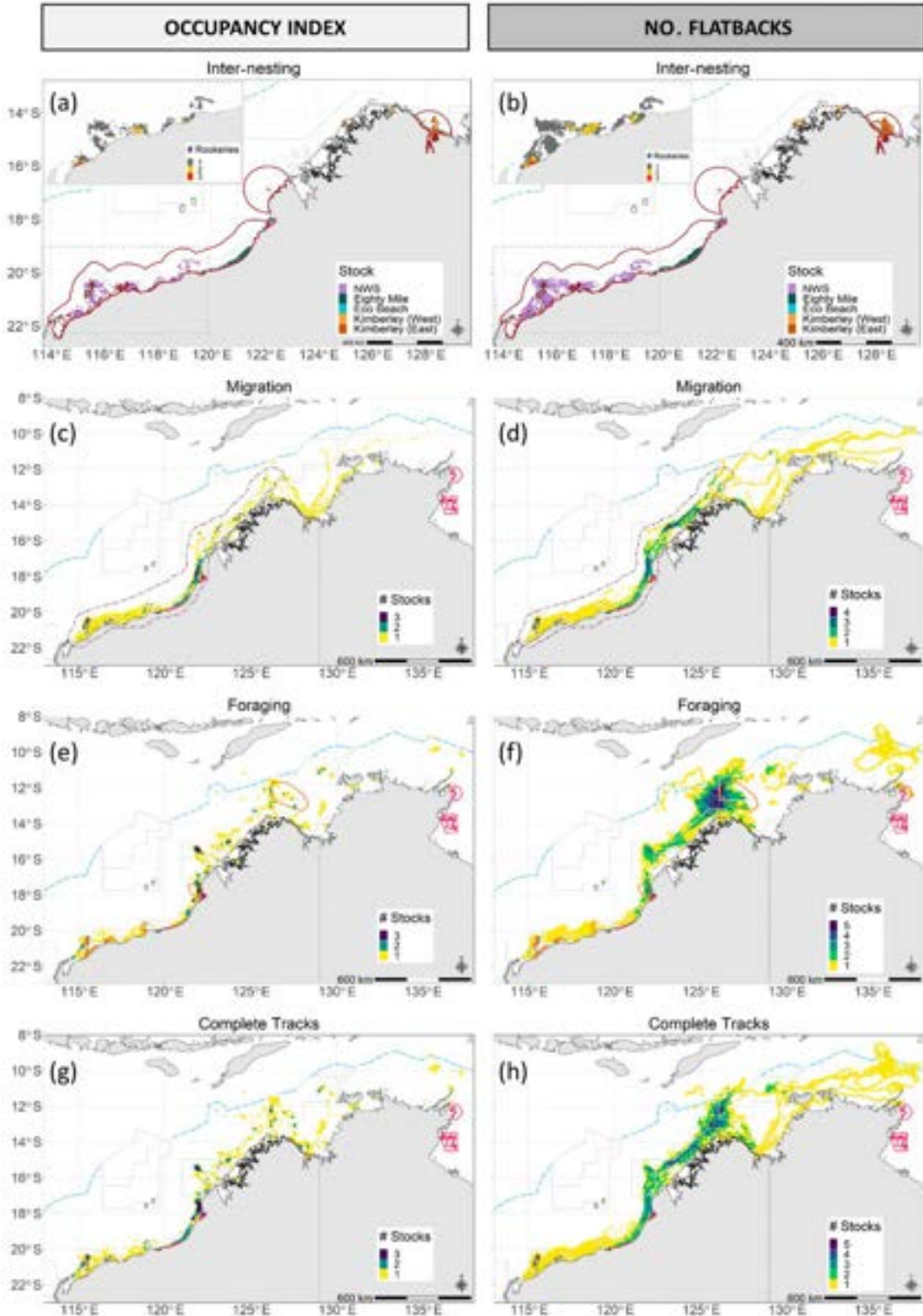


Figure 23: Flatback turtle stocks in a grid cell throughout northern Western Australia delimited from occupancy indices (i.e. relative amount of time spent per grid cell; a, c, e) or the number of tagged flatbacks moving through grid cells (b, d, f). Inter-nesting behavioural phase (a, b), and at the 75% contour on a 10 × 10 km grid at a stock-level for migration (c, d) and foraging (e, f). (Peel et al 2024).

Relevant guidance and policies

Flatback turtles are listed 'Vulnerable', Migratory and Marine under the EPBC Act and 'Vulnerable' under the BC Act. Hawksbill turtles are globally (non-statutory) listed as 'Data Deficient' by the IUCN. Other relevant EPBC Act documents are as follows:

- Recovery Plan for Marine Turtles in Australia (DoEE 2017a)
- Threat abatement plan for predation, habitat degradation, competition, and disease transmission by feral pigs (*Sus scrofa*) (DoEE 2017c)
- Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018)
- National Guidelines for the Survey of Cetaceans, Marine turtles and the Dugong (DCCEEW 2024d)
- Threat abatement plan for predation by the European red fox (DEWHA 2008A)
- Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a).

Threats and pressures

In relation to coastal development, key threats to turtles are light pollution (i.e. disturbance to nesting behaviour and misorientation of turtle hatchlings), reduced water quality, direct habitat removal, degradation of nesting and foraging areas, vessel strike, underwater noise, and entrainment from dredgers. Based on the North-west Marine Bioregional Plan (DSEWPaC 2012a) habitat modification, human presence, litter debris, light pollution, invasive species, underwater noise, increased turbidity, vessel strike and dredge entrainment have been identified as existing threats that may be relevant to consider when assessing impacts of the Project.

Relevance to the Project area

Flatback turtles were identified as a key species with a high likelihood of occurrence within the Project area. Flatback turtles are known to be present within the area (DCCEEW 2024a), and there have been 90 recorded sightings on the DBCA database (DBCA 2024). The species BIA (Figure 13; reproduction (nesting and inter-nesting buffer)) and the species habitat critical for the survival also overlaps with the Project development envelope. Recent research (Peel et al. 2024) indicates that flatback turtles of the NWS stock use the waters of the Pilbara, including the Proposal area, for inter-nesting, migration, and foraging. The species is known to nest on Ashburton, Direction, Thevenard, and Tortoise Islands, and on mainland beach, including Ashburton River Delta (Pendoley Environmental 2022). It is likely that flatback turtles would be present in the Project area and adjacent waters, using the area for a variety of different behaviours.

4.2.4. Short-nosed sea snake

Population

The population estimates for short-nosed sea snakes are inadequately studied due to the remoteness of some locations in their known range. Morphological and mitochondrial analysis suggests separate breeding populations occur in coastal WA (Sanders et al. 2015). Short-nosed sea snakes were presumed to be extinct in the region by 1998. However, it has since been found in the mesophotic zone in water depths of 67 m (Liston 2021).

Distribution

Short-nosed sea snakes are known to have a restricted range and have undergone a very severe reduction in numbers in the late 1990s and 2000s. Previously they were rarely seen in locations other than Ashmore Reef but more recent extensive field surveys have recorded the species in waters in along the northwest coast, from the Exmouth Gulf and offshore from Roebourne and Broome (Sanders et al. 2015; D’Anastasi et al. 2016; Udyawer et al. 2020). Habitat suitability threshold modelling by Udyawer et al. (2020) has identified a new potential distribution that extends from Exmouth Gulf and around the Muiron Island to the Montebello Islands Marine Park, including the waters of the Project area (Figure 24; Udyawer et al. 2020).

Habitat and life history

Short-nosed sea snakes occur primarily on the reef flats or in the shallow water (<10 m depth) of outer reefs (~70 km offshore). The species has a restricted geographical range of <10 km² and a depth range generally from 50 to 100 m, though recent recording have found them in the mesophotic zone at depths of approximately 250 m (Crowe-Riddell et al. 2019; Liston 2021). During daylight hours sea snakes have been observed resting underneath small coral overhangs or coral heads in around 1 to 2 m of water. Sea snakes rarely move more than 50 m away from the reef flats.

Generally, sea snakes are long-lived and slow growing, they have small broods and high juvenile mortality (DSEWPaC 2011a). Sightings and reports of courting sea snakes have been recorded in late April (D’Anastasi et al. 2016), winter and late spring (Sanders et al. 2015), which is consistent with sea snake biology, of winter mating and parturition in spring or early summer.

Relevant guidance and policy

The short-nosed sea snake is currently listed as ‘Critically Endangered’ under both the EPBC and BC Act. The global (non-statutory) listing by the IUCN for the species is ‘Data Deficient’. Under DCCEEW a recovery plan is not required as further research is needed to fully understand the threats and ecological requirements of the short-nosed sea snake to determine the most appropriate management strategies. Other relevant EPBC Act documents are as follows:

- Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake) (DSEWPaC 2011a)
- Commonwealth Listing Advice on *Aipysurus apraefrontalis* (Short-nosed Sea snake) (TSSC 2011a)
- Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a).

Threats and pressures

The severe population decline of the short-nosed sea snake has been observed in the Ashmore and Hibernia Reefs subpopulations, though the cause of this decline is unknown. The major threats to the sea snakes are thought to be direct take from commercial fisheries and reef habitat degradation through coral bleaching and industrial operations (DCCEEW 2024c). Based on the North-west Marine Bioregional Plan (DSEWPaC 2012a), habitat modification and chemical spills have been identified as existing threats that may be relevant to consider when assessing impacts of the Project

Relevance to the Proposal

The short-nosed sea snake may be ‘likely’ to occur within the Project area, though no sightings have been recorded on the DBCA database (DBCA 2024). Sea snakes are common within the environment surrounding

the Project though most sightings have not been identified to the species level. The main sightings of the short-nosed sea snakes have been recorded at Ashmore Reef, Exmouth Gulf and around Muiron Island to Montebello Islands (Figure 25; D’Anastasi et al. 2016). However, the species habitat suitability and revised species distribution extends from Exmouth Gulf and around the Muiron Island to the Montebello Islands Marine Park, including the Project area. Given the habitat suitability, preferred habitat, and conservation status of the species, a precautionary approach has been applied and the species could potentially be present within the Project area, and therefore considered a key species requiring consideration during the impact assessment.

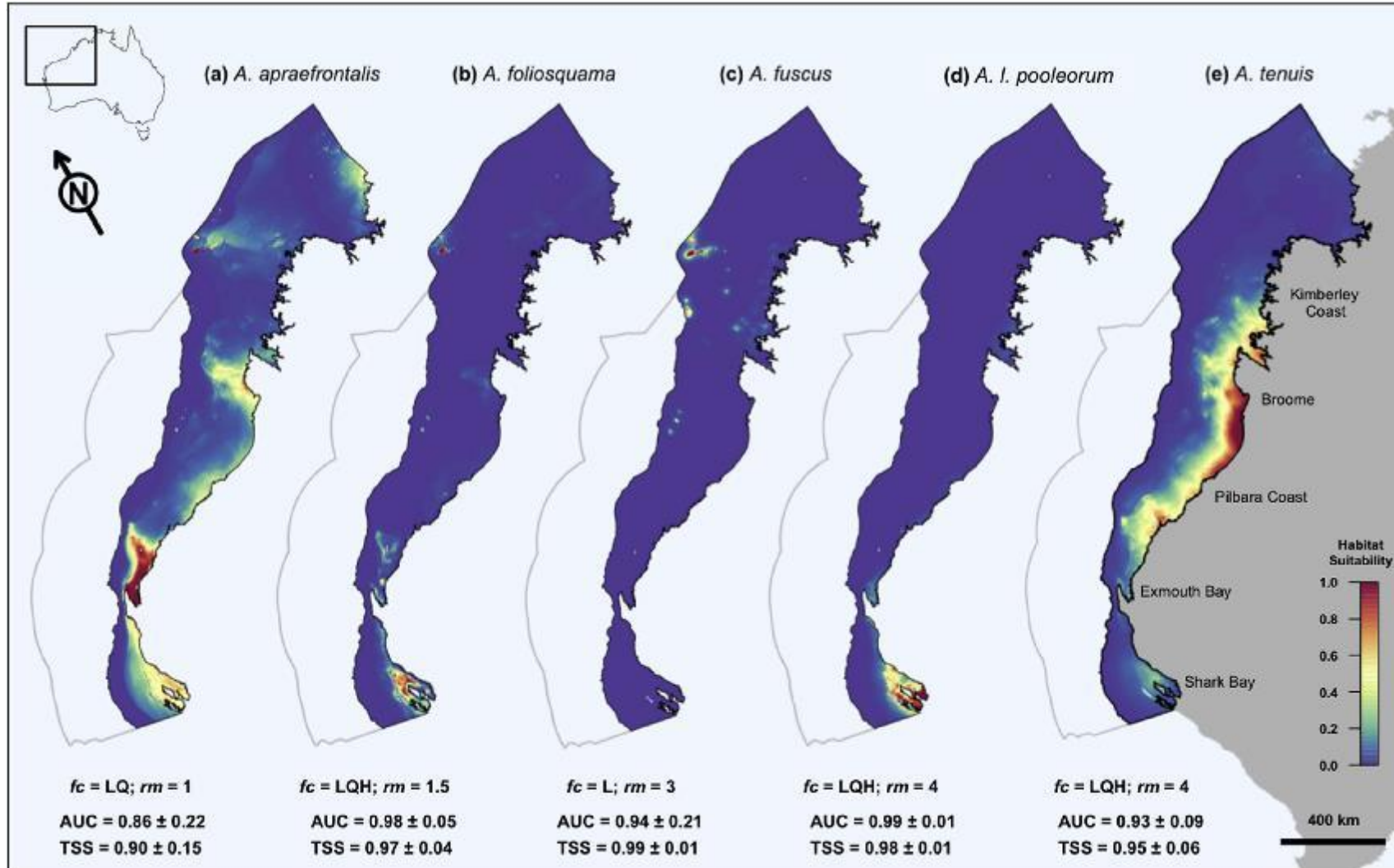


Figure 24: Sea snake habitat suitability (Udyawer et al. 2020). Modelled habitat suitability for sea snakes in northern WA, a) short-nosed sea snake, b) leaf-scaled sea snake (Udyawer et al. 2020)

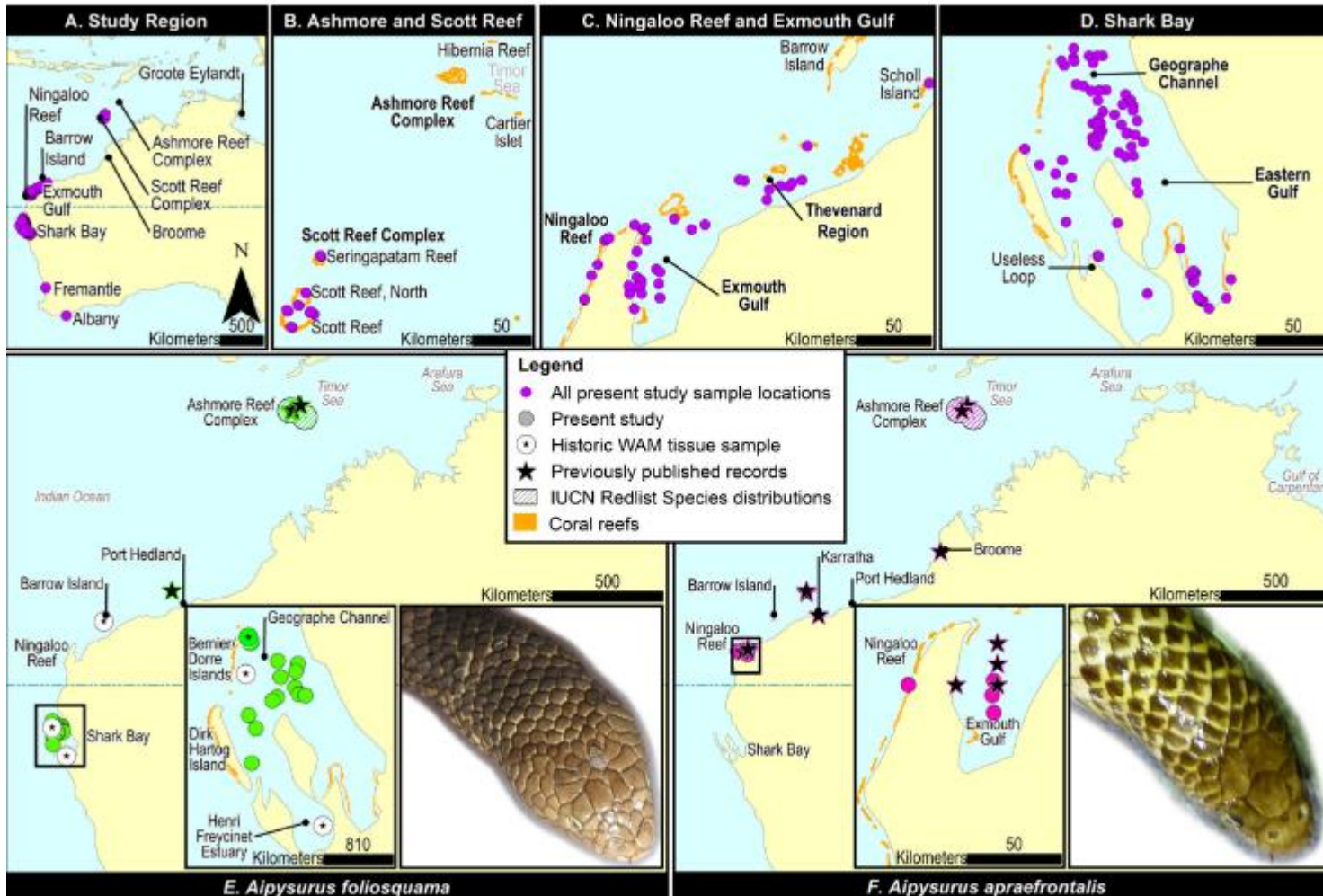


Figure 25: Maps A - D showing D'Anastasi et al. (2016) survey locations. Figures E and F display new sightings from D'Anastasi study.

Locations of previously published records (stars) and new records from this study (filled circles) for E) *Aipysurus foliosquama* (green) and F) *Aipysurus apraefrontalis* (pink), including two WAM samples initially identified as *A. pooleorum*, but reassigned to *A. foliosquama* (circled star).

4.3. Sharks and Rays

The scalloped hammerhead shark was the only shark and/or ray species identified to be a key species for the Project.

4.3.1. Scalloped hammerhead shark

Population

Globally, the scalloped hammerhead has undergone severe population decline with an estimated population loss of >80% in the last seven decades (IUCN 2024). The global population of scalloped hammerheads appear to form genetically distinct groups in the Northwest Atlantic, Caribbean Sea, and Southwest Atlantic (Simpfendorfer et al. 2019).

In Australia, the scalloped hammerhead sharks are part of the Indo-Pacific stock, though there is evidence suggesting that WA may have its own stock or represent a sub-population of the Indo-Pacific stock (Heupel et al 2020). Limited gene flow in the WA population in comparison to the populations in northern Australia, Papua New Guinea and Indonesia suggests very little movement/exchange of sharks to or from WA, and connectivity to WA is limited (Heupel et al. 2020). Modelling of the stock structures has been undertaken (Figure 26; Heupel et al 2020; TSSC 2024) indicating three different scenarios:

- A) Continental shelf movements but with stock divide around the WA-NT border
- B) Continental shelf movements but with stock divides at (1) the Torres Strait land bridge and (2) around the WA-NT border
- C) Limited movement beyond the offshore areas of Australia.

More information is likely to be required to determine the distinct stocks.

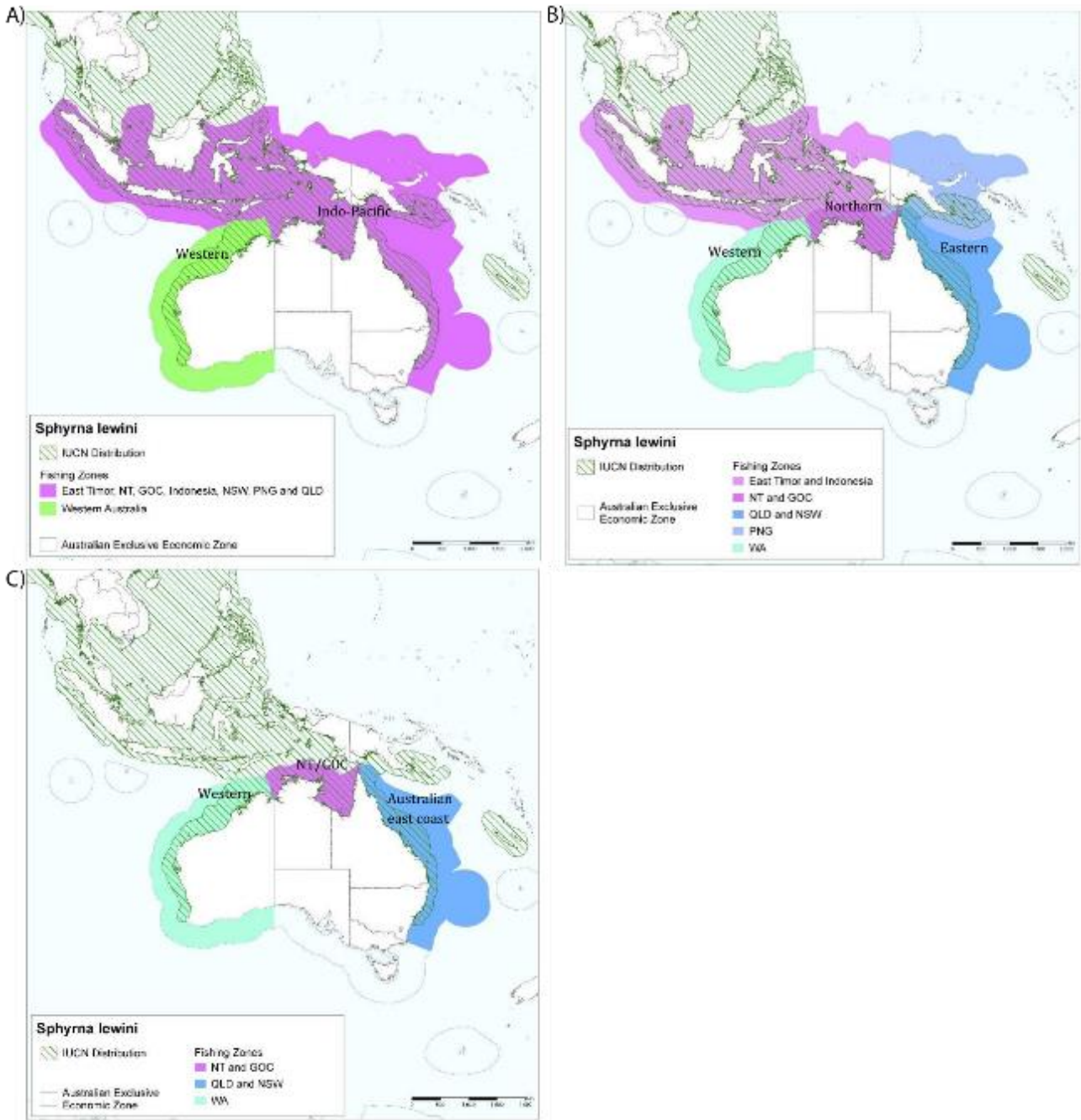


Figure 26: Modelled stock-structure scenarios for the scalloped hammerhead shark (TSSC 2024)

Distribution

Scalloped hammerheads occur globally in coastal warm temperate and tropical waters (TSSC 2024). In Australia, the species is recorded around the northern coastline to ~34°S on both east and west coasts, from Sydney, NSW to Geographe Bay, WA (TSSC 2024). Scalloped hammerhead distribution and populations are segregated by size and sex and in Australia, the population is primarily small adult males and juveniles (Figure 27). Adult females are predominantly found in the waters off Indonesia and Papua New Guinea (Chin et al. 2017). This suggests a population structure where the female scalloped hammerhead sharks migrate back to Australia to give birth in northern Australia nurseries (Chin et al. 2017). In WA, the scalloped hammerhead is most commonly seen along the NWC, Exmouth, and along the southern Pilbara coastline (Bartes and Braccini 2021; Figure 28).

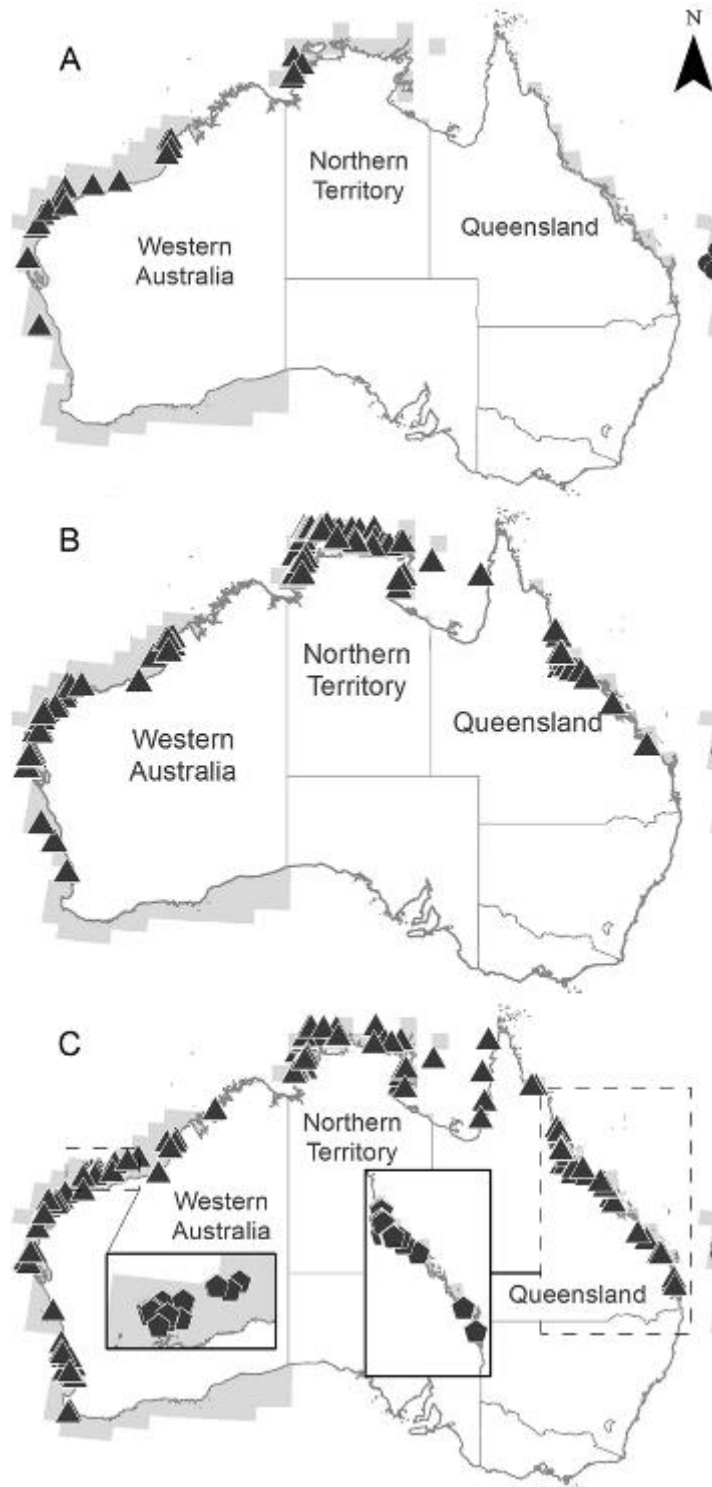


Figure 27: Scalloped hammerhead distribution (Chin et al. 2017).

Indicative distribution of scalloped hammerhead (triangles) sharks for sex and size categories from sampled locations. a) adult females, b) adult males, c) immature and neonate individuals of both sexes (inserts show indicative distribution of neonates). Grey shading denotes spatial grids where fishing and sampling effort occurred (Chin et al. 2017).

Scalloped hammerhead

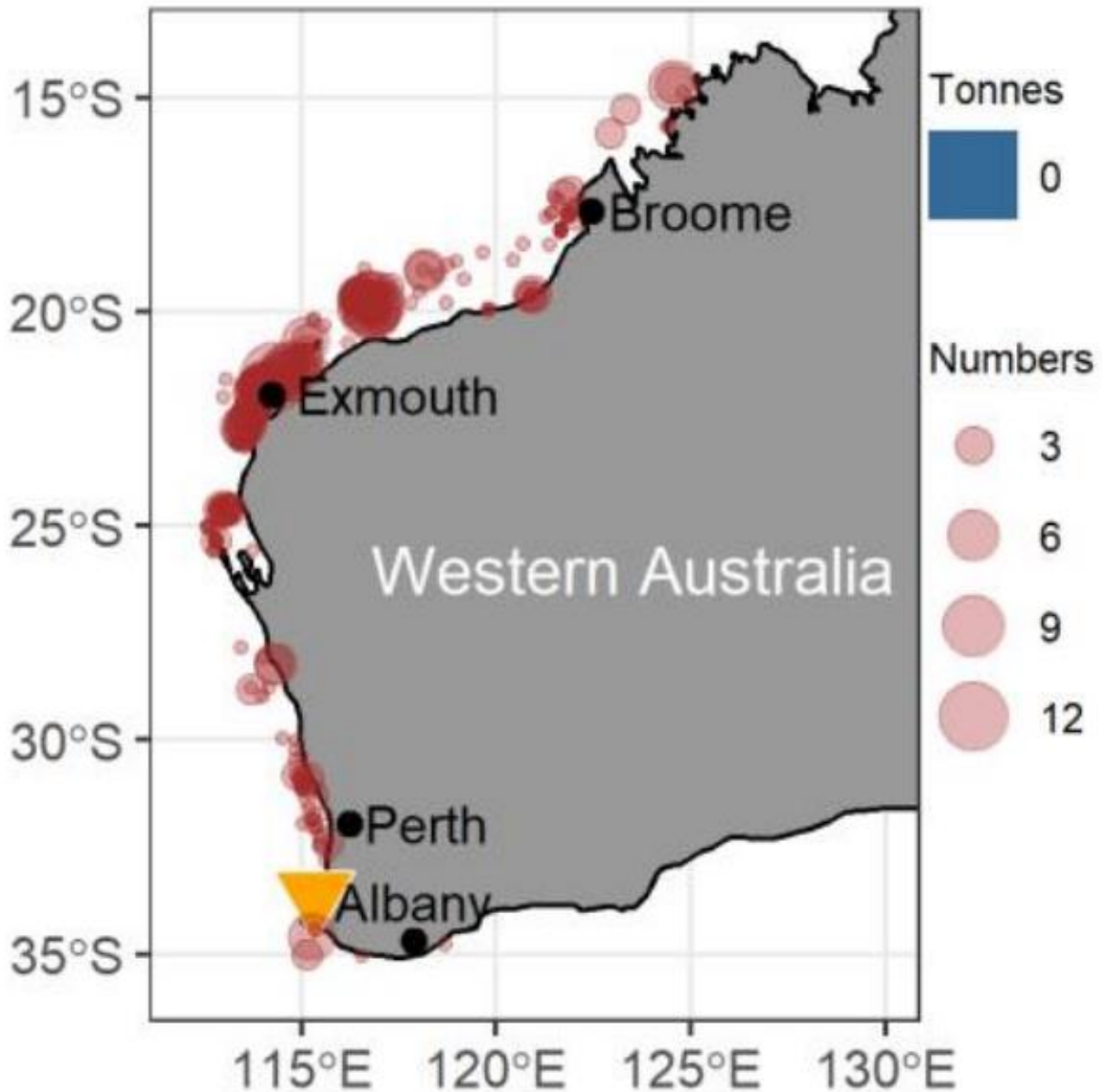


Figure 28: Spatial distribution of commercial catch and scientific observations (Bartes and Braccini 2021). Blue squares reported catch (tonnes) by spatial block (all financial years aggregated); red bubbles, number of individuals observed by scientific personnel; yellow triangle, edge for the distribution reported by Last and Stevens (2009).

Habitat use and life history

Scalloped hammerheads are typically found in continental shelf waters, but also regularly enter estuaries and open ocean environments, ranging in depths from the intertidal zone to at least 275 m deep (Compagno 1984) but has been recorded in water depths up to 1,042 m (TSSC 2024). Scalloped hammerheads form aggregations found generally along the continental shelf and in shallow inshore waters.

Female scalloped hammerheads are reproductively philopatric (i.e. they return to the nursery in which they were born to give birth). It is thought that scalloped hammerhead sharks display similar behaviours as other hammerhead sharks, giving birth in shallow nursery areas. The demographic structure of the Australian population of scalloped hammerhead are dominated by juveniles and small adult males, with few records of pregnant females (Figure 27), suggesting that a proportion of adult females may migrate from Australia to Indonesia/Papua New Guinea and return to give birth to their young in nursery areas in coastal areas of northern Australia (Chin et al. 2017; TSSC 2024). This could also suggest that the waters of northern Australia may provide important nursery habitat for the scalloped hammerhead sharks (TSSC 2024). This is supported by Traditional Ecological Knowledge that identifies the importance of shallow inshore habitats for immature hammerhead sharks (TSSC 2024). Newborn scalloped hammerhead sharks tend to stay in coastal zones.

The sharks are known to partake in long distance migrations and can be found in open oceanic waters (Chin et al. 2017). Their lifespan is estimated at 21 years for males and up to 35 years for females (FRDC 2019). Males reach maturity between 5.7 to 8.9 years and females reach maturity when they reach approximately 200 cm in length, however it can take females up to 15 years to reach reproductive age (FRDC 2019). Their diet consists of a variety of fish, squid, crustaceans, other small shark species and rays (FRDC 2019; DCCEEW 2024c).

Relevant guidance and policy

Scalloped hammerheads are listed as ‘Conservation dependant’ under the EPBC Act and they are not listed under the BC Act. The global (non-statutory) listing by the IUCN is ‘Critically Endangered’. Other relevant EPBC Act documents are as follows:

- Listing Advice for *Sphyrna lewini* (scalloped hammerhead) (TSSC 2024).

Threats and pressures

Globally, recreational fishing, commercial fishing, net entanglements, and illegal shark finning are threats to the scalloped hammerhead shark (FRDC 2019). Based on the North-west Marine Bioregional Plan (DSEWPaC 2012a) only chemical spills have been identified as an existing threat that may be relevant to consider when assessing impacts of the Project.

Relevance to the Project area

Scalloped hammerheads are likely to occur in close proximity to the Project area, though there are no recorded sightings on the DBCA database (DBCA 2024) and therefore are considered to have a moderate likelihood of occurrence within the area. The species prefers shallow waters (Heupel et al. 2020; Bartes and Braccini 2021) and the waters of the Project area present suitable habitat for the species for adult, immature juveniles, and neonates. The species is not restricted to the waters of the Project though it is likely that scalloped hammerheads will be present within the area, with northern Australia potentially providing nursery habitat, and should be considered in the impact assessment.

4.4. Seabirds

Seabirds are a taxonomically varied group of nearly 350 bird species (around 3.5% of all birds) that depend on the marine environment for at least part of their life cycle (DAWE 2020a). Thirty-four species of seabird are

listed as threatened, migratory and/or marine under the EPBC Act and are known to occur regularly in the North-west Marine Region, with seven listed species possibly occurring infrequently (DSEWPaC 2012a). Seabirds spend most of their lives at sea, ranging over large distances to forage over the open ocean. Many seabird species, including significant populations of terns, shearwaters and boobies, breed in and adjacent to the nearby North-west Marine Region (DSEWPaC 2012a). Six conservation significant seabirds have been classified as having a ‘High’ likelihood of occurrence in the Project search area (See Section 3.2.10).

The Australian fairy tern is the only species that is listed as Threatened under the EPBC Act (Vulnerable) and that has a listing under the BC Act (Vulnerable). The EPBC Act is Australia’s primary legislation for meeting international conservation commitments, including those related to the IUCN, all species except the Australian fairy tern are listed as Least Concern, except the streaked shearwater which is Near Threatened.

The EPBC Act provides for protection of migratory species as an MNES. Three of the five key species are listed as migratory under the EPBC Act, excluding the Australian fairy tern and lesser crested tern. Two species are included in the appendices to the Bonn Convention (little tern, osprey), two species are included in annexes established under the China-Australia Migratory Bird Agreement (CAMBA; little tern, roseate tern), and three species are included under the Japan-Australia Migratory Bird Agreement (JAMBA; Caspian tern, greater crested tern and roseate tern). BIAs for breeding for the lesser-crested tern and wedge-tailed shearwater overlap with the Project search area, and the BIAs for breeding for the Australian fairy tern, roseate tern overlap with the buffer area outside the Project area.

In addition to threatened and migratory species, the EPBC Act also protects species listed as ‘Marine’, which describes Commonwealth waters from the three nautical mile state waters limit out to the boundary of the Exclusive Economic Zone (i.e. out to 200 nautical miles and further in some places). All species except for the Australian fairy tern are listed as marine under the EPBC Act.

Population

A summary of the population details for each key seabird species is presented in Table 11.

Table 11: Population estimates and trends of key seabird species

| Species name | Population Summary |
|--|---|
| Australian fairy tern | There are three subspecies of fairy terns recognised. The Australian fairy terns population was estimated to be ~6,300 to 7,000 mature individuals in 2020 and the population in WA was estimated to be 5,000 to 6,000 mature individuals (Dunlop and Greenwell 2023). The population in the north-west region of WA, Exmouth to Dampier is thought to be resident population. |
| Caspian tern | The global population is estimated to number between 250,000–470,000 individuals (Wetlands International 2015). The overall global population trend is increasing, although some populations are decreasing, stable, or have unknown trends (Delany and Scott 2006). The Australian population estimates and trends are unknown. |
| Greater crested tern <i>Thalasseus bergii</i> | The global population is estimated to number 150,000–1,100,000 individuals (Delany and Scott 2006). The overall population trend is stable, although some populations have unknown trends (Delany and Scott 2006). Significant breeding populations occur in the Great Barrier Reef and Coral Sea Marine Park islands. The Australian population estimate and trends are unknown. |

| Species name | Population Summary |
|---|--|
| Lesser crested tern | The global population estimate is estimated to number 225,000 pairs, more than half occur in Australia (BirdLife International 2024). An estimated 10,000 pairs occur in the South Pacific and 8,000 in Indonesia. The overall population trend is stable, although some populations have unknown trends (Delany and Scott 2006). There is estimated to be 8,170 pairs that occur in and adjacent to the North-west marine region (DSEWPaC 2012e). With 200 pairs regularly nesting as the Lowendal Islands (DSEWPaC 2012e). |
| Osprey (Eastern osprey) | The global population is estimated to be between 100,000 to 1,200,000 mature individuals (BirdLife International 2024). Global trends have not been quantified. The osprey is moderately common in Australia (Olsen 1998), being most abundant in northern Australia, where high population densities occur in remote areas (Garnett 1993; Johnstone and Storr 1998). The species is rare to uncommon in southern WA (Johnstone and Storr 1998) and occurs in low numbers in South Australia (~52 pairs in 2005; Dennis 2007), and NSW (~100 pairs in 1996; Clancy 2006) |
| Roseate tern <i>Sterna dougallii</i> | The global population is estimated to be 200,000–220,000 individuals (Delany and Scott 2006). The overall population trend is uncertain, as some populations are decreasing, while others are increasing or stable (Delany and Scott 2006). There are four recognised subspecies of the roseate tern, the one relevant to Australia, and the Proposal area, is the <i>S. dougallii gracillis</i> , which breeds in Australia and New Caledonia (DCCEEW 2024c). The Australian population has been estimated to be at least 15,000 pairs (Milton et al. 1996). Recent Australian population estimates and trends are unknown. |

Distribution

A summary of the key seabird distribution is presented below in Table 12.

Table 12: Key seabird distributions

| Species name | Distribution summary |
|--|---|
| Australian Fairy Tern | In Australia, the species is found in WA from the Dampier Archipelago south to Israelite Bay, and into South Australia, NSW, Victoria, and Tasmania (Dunlop and Greenwell 2023). The species has a patchy distribution in these areas and extends across >2,700 km of the Australian coastline (Dunlop and Greenwell 2023). Various sightings been recorded within 10 km of the Project area (ALA 2024) though it is known to be found in larger numbers at nearby Thevenard Island. |
| Caspian tern | This species has a cosmopolitan but scattered distribution. Their breeding habitat is large lakes and ocean coasts in North America (including the Great Lakes), and locally in Europe (mainly around the Baltic Sea and Black Sea), Asia, Africa, and Australasia. The African and Australasian birds are resident or disperse over short distances (del Hoyo et al. 1996). In Australia, the species are broadly found in coastal regions, ranging from the Great Australia Bight to the Dampier Peninsula. |
| Greater crested tern/crested tern | The species is distributed through tropical and subtropical areas, where it is found on islands and coastlines of the Atlantic Coast of South Africa, along the south coast of Africa, and almost continuously to south-east Asia and Australia (BirdLife International 2024). Outside the breeding season it can be found at sea throughout this range, except for the central Indian Ocean (del Hoyo et al. 1996). The species is commonly found along coastal areas of the Australian mainland and Tasmania. |
| Lesser crested tern | The species breeds in subtropical coastal parts of the world mainly from the Red Sea across the Indian Ocean to the western Pacific, and Australia, with a significant population on the southern coast of the Mediterranean, on two islands off the coast of Libya. Outside the breeding season it ranges on the north African coast (both Mediterranean and Atlantic), on much of the Indian Ocean nearby continents, and in the western Pacific north of Australia up to New Guinea and Vietnam. Details of this species movements are poorly known. |

| Species name | Distribution summary |
|---------------------|---|
| Osprey | Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia (Johnstone and Storr 1998; Marchant and Higgins 1993; Olsen 1995). In Australia, their breeding range extends from Albany, WA to Lake Macquarie, NSW. In distribution of the species along the northern coast in Australia appears to be continuous except for a gap at Eighty Mile Beach (DCCEEW 2024). The species area of occupancy in Australia is ~117,400 km ² . During the (WEPL 2022) survey for the Project, one old osprey nest was found near the Project site, and nearly 200 sightings have been recorded on ALA (2024) and 29 records on DBCA (2024) within the Project area. |
| Roseate Tern | The species has an almost cosmopolitan distribution. In Australia the species can be found in subtropical and tropical waters from south-west WA to south-east Qld. In WA, the species is found north from Mandurah to Eighty Mile Beach, there are sparse sites north to the Bonaparte Archipelago. Breeding colonies are located on Lancelin Island and Second Rock, WA. Only one sighting has been recorded on the DBCA database (2024) and 4 on the ALA database (ALA 2024). |

Habitat use and life history

In general, seabirds are long lived (up to 60 years) have delayed breeding (up to 10 years) and invest more effort into fewer young (many species, only one egg a year). Both parents participate in caring for the young, and pairs are typically at least seasonally monogamous. Most species nest in colonies, which can vary in size from a few dozen birds to millions, with the birds displaying strong site fidelity (DAWE 2020a). Many species can undertake long migrations; however, some remain close to breeding colony sites. Seabirds can nest in trees or shrubs (if any are available), on the ground (with or without nests), on cliffs, in burrows under the ground and in rocky crevices. They have a range of feeding strategies (pursuit diving, plunge diving and kleptoparasitism), feed both at the ocean's surface and below it, and can feed on other seabirds.

Seabirds can be oceanic, coastal, or spend parts of the year away from the sea (DAWE 2020a). Salt glands are used by seabirds to deal with the salt they ingest by drinking and feeding (particularly on crustaceans), and to help them osmoregulate (Harrison 1990). The excretions from these glands (which are positioned in the head of the birds, emerging from the nasal cavity) are almost pure sodium chloride. Species specific habitat associations are presented in Table 13.

Table 13: Habitat and breeding habitat/timing for key seabird species

| Species | Preferred habitat and breeding habitat/timing |
|------------------------------|--|
| Australian fairy tern | Australian fairy terns utilise a variety of habitats including offshore, estuarine, lacustrine (lake) islands, wetlands, beaches and sandpits (DAWE 2020b). In Australia, the subspecies breed in colonies of various sizes up to 700 pairs. In WA, the subpopulation found from Exmouth Gulf to the Dampier Archipelago breed from June to March and nest from late July to late September (DAWE 2020b). Breeding colonies are located on coral shingle on coastal islands, or coral cays, on sandy islands and beaches inside estuaries, and open sandy beaches. Each season they lay 1 to 2 eggs in a shallow nest scrape in the sand, incubation lasts between 18 to 22 days and fledging about 20 days (DAWE 2020b). Breeding BIA for the species is located at Thevenard Island. |
| Caspian tern | Caspian terns are generally found in sheltered coastal embayments with sandy or muddy margins. They are also commonly found in coastal or inland wetlands, either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers, and creeks. Breeding and nesting periods for caspian terns in the Pilbara region has been recorded from late April to August (DCCEEW 2024c). Breeding occurs across a variety of habitats from low |

| Species | Preferred habitat and breeding habitat/timing |
|-----------------------------|--|
| | islands, cays, spits, banks, ridges, sand or shell beaches, terrestrial wetlands and stony or rocky islets or banks. Nests can be found in the open or among sparse to low density vegetation such as herbfield, tussocks, samphire or other prostrate sand-binding plants variable types of sites including low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony. |
| Greater crested tern | The species breeds in large colonies and generally remains sedentary to their breeding areas or locally disperse. The species forages in shallow waters such as lagoons, coral reefs, estuaries, bays, harbours and inlets. They can also forage along sandy, rocky, coral or muddy shores, on rock outcrops and in mangroves. Primarily they feed on pelagic fish, but also on cephalopods, crustaceans, prawns and opportunistically on turtle hatchlings (BirdLife International 2024). No important bird and biodiversity areas (IBA) for the greater crested tern have been identified in the Project area, with the closest located at Lowendal Islands which regularly supports more than 1% of the global population of crested tern and bridled tern (BirdLife International 2024). |
| Lesser crested tern | Lesser crested terns inhabit tropical and subtropical sand and coral coasts, and are also found in estuarine environments. They breed on low-lying offshore islands, coral flats, sandbanks, and flat sandy beaches. Breeding has been recorded on islands of Ashmore Reef and Kimberley islands, Bedout Island and islands south to Shark Bay. The species primarily feeds on small pelagic fish and shrimp (DSEWPaC 2012e). |
| Osprey | Osprey are found in littoral and coastal habitats, terrestrial wetlands and offshore islands, but a generally found in coastal areas. Ospreys are diurnally foragers and require extensive areas of open water which can be fresh, brackish or saline, where they primarily feed on fish (mullet), and occasionally on molluscs, crustaceans, insects, reptiles, birds and mammals. In Australia the Osprey breed from April to February and their breeding range extends from Albany, WA around the north and back south to Lake Macquarie, NSW (DCCEEW 2024c). |
| Roseate tern | Roseate terns inhabit rock and sandy beaches, coral reefs, sandy cays, and offshore islands. The species is rarely seen in inshore waters or near the mainland and forage over coral reefs, along the seaward margin of coral reefs or lagoons (Higgins and Davies 1996; DCCEEW 2024c). In WA roseate terns breeding occurs from Second Rock (near penguin island) to Lacepede Island in the Kimberley and generally nest in colonies often with other species of terns and sliver gulls. The peak breeding season is from April to November and when nesting the species does not forage far from the breeding colonies. |

Relevant guidance and policy

- Wildlife Conservation Plan for Seabirds (DAWE 2020a)
- Approved Conservation Advice for *Sternula nereis nereis* (fairy tern) (DSEWPaC 2011b)
- Commonwealth Listing Advice on *Sternula nereis nereis* (fairy tern) (TSSC 2011b)
- National Recovery Plan for the Australian Fairy Tern (*Sternula nereis nereis*) (DAWE 2020b)
- Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a)
- Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018)
- Threat Abatement Plan for the incidental catch (or bycatch) of seabirds during oceanic longline fishing operations (CoA 2018)
- Threat abatement plan for predation by feral cats (DoE 2015a)
- Threat abatement plan for predation by the European red fox (DEWHA 2008A).

Threats and pressures

Based on the North-west Marine Bioregional Plan (DSEWPaC 2012a), the following threats have been identified as existing threats to seabirds that may be relevant to the Project:

- Physical habitat modification
- Light pollution
- Human presences
- Hydrocarbon spills
- Invasive species.

Relevance to the Proposal area

All five species have been frequently sighted within the Project search area and are considered to have a ‘high’ likelihood of occurrence within the Project area. They breed predominantly on offshore islands and forage in nearshore shallow waters. BIAs for breeding for the Australian fairy tern and roseate tern are known to occur on offshore islands in the area. Therefore, they are unlikely to breed at the Project area, however they may transit through and may forage close by.

4.5. Migratory Shorebirds

Australia is geographically and ecologically an important location for migratory shorebirds within the East Asian–Australasian flyway (the flyway; EAAF). Thirty-six of the 37 Australian migratory shorebird species breed in the northern hemisphere and migrate annually to southern nonbreeding areas including Australia.

Seven conservation significant migratory shorebird species have been classified as having a ‘High’ likelihood of occurrence and key species in the Project search area. Of these species, all are listed as Marine and/or migratory, 4 are listed as threatened under the EPBC Act:

- Critically Endangered: Eastern curlew
- Endangered: Bar-tailed godwit, common greenshank
- Vulnerable: Greater sand plover.

Three are listed under the BC Act:

- Critically Endangered: Bar-tailed godwit, eastern curlew
- Endangered: N/A
- Vulnerable: Greater sand plover

All species are included in the appendices to the Bonn Convention, are included in annexes established under the JAMBA, CAMBA and ROKAMBA. The only difference being that eastern curlew is a species listed explicitly in Appendix 1 of the Bonn Convention while all remaining migratory shoreline species occur as the member of a family listed in appendix 2.

Population

A summary of the population of the key shorebird species are presented in Table 14.

[Table 14: Key shorebirds species population summaries](#)

| Species name | Population summary |
|---|--|
| Bar-tailed godwit | The population of the bar-tailed godwit is estimated to be between 1.06 million and 1.11 million individuals (DCCEEW 2024e). |
| Common greenshank, greenshank | The global population is estimated to be 440,000–1,500,000 (BirdLife International 2024). The EAAF population is estimated to be 110,00 individuals (Hansen et al. 2016). The Australian population in 2020 was estimated to be 23,700 (range=16,200-33,400) mature individuals, and the population appears to be declining (DCCEEW 2024c). |
| Common sandpiper | The common sandpiper has several distinct flyway populations, and the EAAF is estimated to be 190,000 of the 2.455-4.03 million global population. During the non-breeding season, approximately 3,000 remain in Australia (DCCEEW 2024c). |
| Eastern curlew, far eastern curlew | The global population is estimate is 22,550 individuals (range= 22,000-24,100) and is declining (Lilleyman et al. 2021). The EAAF population is estimated to be 35,000 individuals in 2016 (Hansen et al. 2016) and 22,500 in 2020 (DCCEEW 2023a). This population estimate is out of date given the ongoing population declines and in Australia population decline over the last three generation lengths is estimated to be between -52% and -82% (DCCEEW 2023a). |
| Greater sand plover, large sand plover | The total population of the greater sand plover in the EAAF has been previously recorded to be between 200,000 to 300,000 individuals (Hansen et al. 2016), and of these 126,616 (range=108,400-172,400) individuals within Australia (DCCEEW 2023b). The species population appears to be on a downward trend (DCCEEW 2023b). There are three subspecies of which only the <i>C.l. leschenaultii</i> occurs in Australia. |
| Grey-tailed tattler | The global population of the grey-tailed tattler is estimated to be ~29,500 mature individuals (BirdLife International 2024). The population appears to be declining with Eighty Mile Beach, WA experiencing a 46% decline from 1999/2001 to 2008 (7,950 birds). The grey-tailed tattler EAAF population was estimated to be 70,000 individuals (Hansen et al. 2016). Australia has eight important sites in the non-breeding season. |
| Red-necked Stint | There are approximately 475,000 red-necked stints within the EAAF (Hansen et al. 2016). During the non-breeding season, over 80% (260,000) of the global population resides in Australia. Important breeding sites occur exclusively in Russia and Alaska. During the non-breeding season, over 80% (260,000) of the global population resides in Australia. All of the important migration sites during the non-breeding period are in Australia. |

Distribution

Of the 37 shorebird species listed as migratory under the EPBC Act, 30 of these have been recorded in the North-west Marine Region at Ashmore Reef and 27 species identified occurring within 50 km of the search area. These migratory species breed and nest in the northern hemisphere including northern Asia, Siberia, and Alaska, and migrate each year during the Northern Hemisphere late summer and autumn to Australia, where they spend up to six months before returning north in March and April (Figure 29). The migration occurs within the EAAF, which is one of ten migratory bird flyway zones that supports groups of migratory waterbirds throughout their annual cycle (Bamford et al. 2008). Additional species distribution information is summarised in Table 15.



Figure 29: The East Asian Australasian Flyaway zone (Bamford et al. 2008)

Table 15: Migratory shore distribution summary

| Species name | Distribution summary |
|---|--|
| Bar-tailed godwit | Bar-tailed godwits are common in coastal areas around Australia. They are social birds and often seen in large flocks and in the company of other waders. They have been recorded in the coastal areas of all Australian states. In WA, it is widespread from Eyre to Derby with a few scattered records further north in the Kimberley Division. |
| Common greenshank, greenshank | Common greenshank are globally widespread, found in Europe, Africa, Asia, Melanesia, and Australasia (DCCEEW 2024c). In Australia, the species has one of the widespread shorebird distributions in coastal regions. In WA, the species is found along the coast from Cape Arid in the south to Carnarvon, and through the Pilbara and Kimberley regions (DCCEEW 2024c). |
| Common sandpiper | Found along all coastlines of Australia and in many areas inland in wetlands, the common sandpiper is widespread in small numbers. The population when in Australia is concentrated in northern and western Australia (Higgins and Davies 1996). The species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins of rocky shores and rarely on mudflats. They have been recorded in estuaries and deltas of streams, as well as on banks further upstream, around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags (Higgins and Davies 1996). |
| Eastern curlew, far eastern curlew | Eastern curlews have been recorded in all Australian states and territories during the non-breeding season and has an occurrence extent of 10,400,000 km ² (DCCEEW 2023a). The species distribution is continuous from Barrow Island and the Dampier Archipelago, WA, through the Kimberley, along the NT and QLD coastlines to NSW. |
| Greater sand plover, large sand plover | Australia represents a non-breeding destination where the species occurs from December to February (Bamford et al. 2008), widespread from North West Cape to Roebuck Bay. No Internationally important sites for the species overlap the Project area, the sites in WA are Eighty Mile Beach, Roebuck Bay and Ashmore Reef. |

| Species name | Distribution summary |
|----------------------------|--|
| Grey-tailed tattler | In Australia, the species is primarily found in the coastal areas of northern regions of the country. There are five sites of international importance for the species in WA; Eighty Mile Beach, Roebuck Bay, Barrow Island, Ashmore Reef and Lacepede Island (Bamford et al. 2008), none of which overlap the Project area. |
| Red-necked Stint | In the non-breeding season, the species is primarily found in all states of Australia, with a smaller number of birds in New Guinea and NZ. In Australia. Recognised sites of international importance in WA include: Eighty Mile Beach, Port Headland Saltworks, Roebuck Bay, Wilson Inlet, Alfred Cover Nature Reserve and Lake Macleod (Bamford et al. 2008). |

Habitat use and life history

Migratory shore birds are long-lived (over 20 years for some species) and display site fidelity to sites yearly for feeding, roosting, breeding or staging. Migratory shorebird species are mostly present in Australia during the non-breeding period, from as early as August to as late as April/May each year. After arrival in Australia at the end of long migrations they disperse throughout the country to a wide variety of habitats (DAWE 2020a). These habitats include:

- coastal wetlands, estuaries, mudflats, rocky inlets, reefs and sandy beaches, often supporting mangroves.
- Inland wetlands, floodplains and grassland areas, often with ephemeral water sources.

These important habitats in Australia allow adult birds to build up the energy reserves necessary to support northward migration and subsequent breeding. In addition to supporting large numbers of adult shorebirds during the non-breeding period, many of these habitats also support smaller numbers of juvenile shorebirds of many species which remain in Australia for several years before reaching maturity and migrating north to breed for the first time. Relative amounts of time spent feeding and resting, and distances between feeding and roosting areas, are important factors relating to the energy budgets of individual shorebirds (DAWE 2020a). Disturbance at feeding or roosting sites can have significant impacts to migratory birds as the birds fly off when disturbed, using the energy they are trying to store for migration.

Roebuck Bay and Eighty Mile Beach, which are located adjacent to the North-west Marine Region are amongst the most significant shorebird sites in Australia due to high species diversity and populations of shorebirds recorded (Bamford et al. 2008). Barrow Island located 80 km from Onslow is also a site of international significance for shorebirds (DSEWPaC 2012e).

Many species have current Conservation Advice (see section below- Relevant guidance and policy), which define habitat critical to the survival of the species refers to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species (including maintenance of species essential to the survival of the species (e.g. far eastern curlew, such as macrobenthos))
- To maintain genetic diversity and long-term evolutionary development
- For the re-introduction of populations or recovery of the species.

A summary of the habitat requirements, including roosting, foraging and habitat requirements (in Australian/non-breeding season) are presented in Table 16.

Table 16: Migratory shorebird habitat summary

| Species name | Habitat summary |
|---|--|
| Bar-tailed godwit | Bar-tailed godwits inhabit estuarine mudflats, beaches and mangroves. They wade through the shallows or exposed mud and probe their long bills rapidly into the bottom to find food (Birdlife Australia 2024). The bar-tailed godwit is a non-breeding migrant in Australia. |
| Common greenshank, greenshank | The species arrives in Australia during August and September, with peak numbers recorded in October and November. When leaving Australia there appears to be two northward migration waves, first wave from late-February and early-March and the second wave in late-March and early-April (DCCEEW 2024f). Common greenshank forage on the edges of wetlands, on mudflats, in channels or shallow edges of waterbodies, which are often near or within mangroves and saltmarshes. The species occasionally feed on seagrass beds. The species feeds on insects and their larvae (especially beetles), crustaceans, annelids, molluscs, amphibian, and small fish. The species roosts in multiple locations including estuaries, mudflats, mangroves, swamps and lagoons (DCCEEW 2024f). |
| Common sandpiper | The common sandpiper utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. They have been recorded in estuaries and deltas of streams, as well as on banks further upstream, around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. They are often associated with mangroves, and sometimes in areas of mud littered with rocks or snags (Higgins and Davies 1996). |
| Eastern curlew, far eastern curlew | Eastern curlews inhabit Australia during the non-breeding season where they are found in coastal areas associated with mangroves, estuaries, saltmarshes and intertidal flats which contain extensive seagrass beds (Zosteraceae) (DCCEEW 2023a). The species roosts on sandy spits and islets, on beaches at the high-water mark and within low saltmarshes or mangroves. The species forages along sheltered intertidal sandflats or mudflats where they prey on crustaceans (crabs, shrimps, and prawns) and occasionally on small molluscs and insects (DCCEEW 2023a). In the non-breeding season, eastern curlews are also dependent on networks of suitable habitat, including freshwater lake shores and various wetlands. |
| Greater sand plover, large sand plover | The species primarily inhabits coastal, littoral and estuarine environments, where they forage in sheltered sandy, shelly, or muddy coastal areas. They are also know to feed in larger intertidal mudflats, sandbanks, saltmarshes, estuaries, coral reefs, rocking island and near coastal dunes. Their diet primarily consists of marine invertebrates including molluscs, worms, and crustaceans. Greater sand plovers roost on sand-spits and banks of beaches and tidal lagoons. Habitat critical to the survival of greater sand plover includes a mosaic of feeding and roosting habitat. |
| Grey-tailed tattler | Grey-tailed tattler inhabit sheltered coasts with reefs and rock platforms or intertidal mudflats. The species forages in shallow waters often over hard intertidal substrates (i.e. reefs, rock platforms, rock pools and coral rubble) where they feed on polychaetes, molluscs, crustaceans, insects, and occasionally fish. The species are diurnal forages and roosts at night in mangroves (DCCEEW 2024c). |
| Red-necked stint | In Australia, the species inhabits coastal areas such as inlet, bays, lagoons, and estuaries. Red-necked stints forage on bare wet mud on intertidal mudflats and sandflats. |

Relevant guidance and policy

- Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b)
- Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (CoA 2017)

- Threat abatement plan for predation by European red fox (DEWHA 2008A)
- Threat abatement plan for predation by feral cats (CoA 2015a)
- Threat abatement plan for the impacts of marine debris on vertebrate marine life (DoEE 2018)
- Threat abatement plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100 000 hectares (DEWHA 2009a)
- Conservation Advice for *Limosa lapponica menzbieri* (Yakutian bar-tailed godwit) (DCCEEW 2024e)
- Conservation Advice for *Tringa nebularia* (common greenshank) (DCCEEW 2024f)
- Conservation Advice for *Numenius madagascariensis* (far eastern curlew) (DCCEEW 2023a)
- Conservation Advice for *Charadrius leschenaultia* (greater sand plover) (DCCEEW 2023b).

Threats and pressures

Based on the North-west Marine Bioregional Plan (DSEWPaC 2012a), the following threats have been identified as existing threats of potential concern to migratory shorebirds that may be relevant to the Project:

- Physical habitat modification
- Light pollution
- Human presence
- Hydrocarbon spills
- Invasive species.

Marine debris and noise pollution as considered to of less concern for migratory shorebirds (DSEWPaC 2012a).

Relevance to the Proposal area

All seven species have been frequently sighted within the Project search area and are considered to have a 'high' likelihood of occurrence within the Project area. Onslow is within a defined shorebird area which is considered a major stop-over for migratory shorebirds in the EAAF (Weller et al. 2020). The area has also been identified of national significance for the red-necked stint. Migratory shorebirds are known to congregate in larger numbers in areas further south and north than Onslow, however there is a high likelihood that smaller numbers will forage within or near the Project area.

5. Impact assessment

5.1. Potential impacts

Project activities including piling and vessel movement during construction, and recreational fishing (operations) of the Jetty may both directly and indirectly impact marine fauna species including commercially and recreationally important fish species. Potential impacts may include (but are not limited to):

- Propagation of underwater noise from pile installation of the jetty which may lead to:
 - Permanent threshold shift (PTS), temporary threshold shift (TTS), or stress response to marine fauna
 - Avoidance of important habitat
 - Injury or mortality, avoidance behaviour and potential displacement of prey
- Construction activities on the beach including moving equipment and materials to the jetty site, possibly leading to disruption of behaviour, injury or death of marine turtles including disturbance of nests.
- Vessels and other construction activities (other than piling) generating underwater noise, which may lead to:
 - Avoidance behaviour by marine fauna
 - Disruption to marine fauna migratory or foraging behaviours
- Introduction of invasive marine species from construction equipment and jetty structure creating a new niche for introduced marine pests to be established resulting in:
 - Competition with native species for food and/or habitat, potentially leading to the displacement of native species
 - Predation of native species
 - Alteration of trophic interactions and food-webs
 - Loss of commercial and recreational fishery harvests
- Project vessel movements during construction increasing the chance of vessel strikes that may cause marine fauna injuries, displacement, or death.
- Direct and indirect impacts from artificial light during construction and operations resulting in potential light spills impacts on marine turtles and migratory and marine shorebirds
- Entanglement with marine debris during construction and operations (i.e. fishing gear) resulting in injury or mortality to marine fauna
- Impacts associated with habitat modification, waste or hydrocarbon spills and litter and debris during construction and operations
- Impacts associated with recreational fishing at a different location given the new jetty location.

The significance of impacts to marine fauna associated with the Project should be assessed in accordance with the requirements for an EIA in the Environmental Factor Guideline – Marine Fauna (EPA 2016). This impact assessment will focus on the interactions between stressors with key species and their habitat as summarised in Table 17. The impact assessment also includes the consideration of existing threats and pressures, including those identified in the North-west bioregional plan and species

report cards (DSEWPaC 2012a; Table 18) species recovery plans, conservation advice and threat abatement plans which have been discussed in Section 4 for each of the key species and summarised in Table 18.

Table 17: Summary of key species, their habitat and potential stressors related to the Project

| Species | Key habitats/core use of waters within and adjacent to the Project | Potential stressors related to the Project |
|---------------------------------|--|--|
| Dugong | Foraging habitat Distribution | <ul style="list-style-type: none"> Underwater noise Vessel strike Loss or degradation of foraging habitat |
| Australian humpback dolphin | Foraging habitat | <ul style="list-style-type: none"> Underwater noise Vessel strike Loss of foraging habitat/prey displacement Human presence |
| Indo-Pacific bottlenose dolphin | Foraging habitat | <ul style="list-style-type: none"> Underwater noise Vessel strike Loss of foraging habitat/prey displacement Human presence |
| Humpback whale | Migration, and resting BIA overlap with the Project Potential calving habitat | <ul style="list-style-type: none"> Underwater noise Vessel strike |
| Green turtle | Foraging, nesting, inter-nesting and hatchling habitat | <ul style="list-style-type: none"> Artificial light Hatchling predation Vessel strike Underwater noise Habitat modification Reduced water quality Invasive species Human presence (shoreline activities) |
| Flatback turtle | Foraging, nesting, inter-nesting and hatchling habitat | <ul style="list-style-type: none"> Artificial light Hatchling predation Vessel strike Underwater noise Habitat modification Invasive species Human presence (shoreline activities) |
| Hawkbill turtle | Foraging, nesting, inter-nesting and hatchling habitat | <ul style="list-style-type: none"> Artificial light Hatchling predation Vessel strike Underwater noise |

| Species | Key habitats/core use of waters within and adjacent to the Project | Potential stressors related to the Project |
|----------------------------|--|--|
| | | <ul style="list-style-type: none"> • Habitat modification • Invasive species • Human presence (shoreline activities) |
| Short-nosed sea snake | Distribution, remnant population | <ul style="list-style-type: none"> • Habitat loss/degradation (coral reefs) • Chemical spills |
| Scalloped hammerhead shark | Distribution | <ul style="list-style-type: none"> • Barriers to movement • Habitat loss or degradation • Changes in hydrology |
| Seabirds | Nesting Breeding Foraging | <ul style="list-style-type: none"> • Artificial light • Habitat loss or degradation • Invasive species • Human presence (shoreline activities) |
| Migratory shorebirds | Migration habitat Foraging and roosting | <ul style="list-style-type: none"> • Artificial light • Habitat loss or degradation • Invasive species • Human presence (shoreline activities) |

Table 18: Key pressures and threats as identified in the North-west bioregional plan (DSEWPC 2012a) relevant to the Project

(C= Concern (red shading), PC=Potential Concern (gold shading), LC=Less Concern (Green shading), NC=No Concern (blue shading), DD=Data deficient or not assessed (White shading) (adapted from DSEWPac 2012a))

| Marine Fauna | Underwater Noise | Habitat Modification | Human Presence | Vessel Strike | Chemical pollution/contaminants | Marine debris | Light Pollution | Invasive Species | Oil spills/hydrocarbon | Climate change/sea temperature changes |
|---------------------------------|------------------|----------------------|----------------|---------------|---------------------------------|---------------|-----------------|------------------|------------------------|--|
| Humpback whale | PC | DD | DD | PC | LC | DD | DD | DD | LC | DD |
| Dugong | LC | PC | LC | PC | LC | PC | DD | PC | PC | PC |
| Australian humpback dolphin | PC | PC | PC | PC | PC | PC | DD | DD | PC | PC |
| Indo-pacific bottlenose dolphin | PC | PC | PC | PC | PC | PC | DD | DD | PC | PC |
| Hawksbill turtle | PC | PC | LC | PC | LC | C | C | NC | LC | PC |
| Flatback turtle | PC | C | C | NC | LC | C | C | C | LC | PC |
| Green turtle | PC | PC | C | PC | LC | C | C | C | LC | PC |
| Sharks | DD | NC | NC | DD | DD | DD | DD | DD | DD | DD |
| Sea snakes | DD | PC | NC | LC | DD | DD | DD | DD | PC | PC |
| Shorebirds | LC | PC | PC | NC | LC | LC | PC | LC | PC | PC |
| Wedge-tailed shearwater | DD | PC | PC | DD | DD | DD | PC | PC | PC | PC |
| Seabirds | DD | PC | PC | DD | DD | DD | PC | PC | PC | PC |

5.2. Ecological windows

Several key species are present throughout the year; however, some species are only present within or near the Project area during certain month or seasons. Ecological windows have been identified for key species and are given in Table 13. By referring to these ecological windows and undertaking certain construction activities during certain times of the year (for example piling with underwater noise during times of the year when migrating marine fauna are not present) the impacts can be minimised.

Certain activities of species may also require further management and monitoring considerations due to different impacts, and therefore activities including migrations, nesting, inter-nesting and foraging have been assessed separately for certain species.

Due to the presence of certain species throughout the year, construction activities associated with the Project should then be undertaken to minimise the risks to particularly sensitive marine fauna activities. Following an assessment of the ecological windows shown in Table 17, the peak turtle nesting and humpback whale southern migration should be avoided as priority (August and February and October and February respectively). This would also reduce the impacts to green sawfish and scalloped hammerhead pupping.

Table 19: Key Species' Ecological Windows (Dark blue represent- full duration of presence. Light blue – represents timing of specific behaviours. Diagonal shading represents peak timing of specific behaviours)

| Species presence | J | F | M | A | M | J | J | A | S | O | N | D | Data Source |
|---------------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|---|
| Humpback whale* | | | | | | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Irvine and Salgado Kent (2019); Jenner et al. (2010a) |
| Northern migration | | | | | | Light Blue | Light Blue | Light Blue | | | | | Jenner et al. (2010a) |
| Southern Migration | | | | | | | | Light Blue | Light Blue | Light Blue | Light Blue | | Irvine and Salgado Kent (2019); Jenner et al. (2010a) |
| Southern migration – peak mother calf | | | | | | | | Light Blue | Light Blue | Light Blue | | | Irvine and Salgado Kent (2019); Jenner et al. (2010a) |
| Australia humpback dolphin | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Hanf et al. (2022) |
| Indo-Pacific bottlenose dolphin | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Hanf et al. (2022) |
| Dugong | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Hodgson (2007) |
| Hawksbill turtle | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | DoEE (2017a) |
| -Foraging | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | DoEE (2017a) |
| -Nesting | Dark Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | DoEE (2017a) |
| -Inter-nesting | Light Blue | Light Blue | | | | | | | | Light Blue | Light Blue | Light Blue | DoEE (2017a) |
| -hatchlings emerging | Dark Blue | Dark Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | DoEE (2017a) |
| Flatback turtle | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | DoEE (2017a) |
| -Foraging | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | DoEE (2017a) |
| -Nesting | Dark Blue | Light Blue | Light Blue | | | | | | | Light Blue | Light Blue | Light Blue | DoEE (2017a) |
| - Inter-nesting | Light Blue | Light Blue | Light Blue | | | | | | | Light Blue | Light Blue | Light Blue | DoEE (2017a) |
| -hatchlings emerging | | Light Blue | Light Blue | | | | | | | | | | DoEE (2017a) |
| Green turtle | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | Dark Blue | DoEE (2017a) |

| Species presence | J | F | M | A | M | J | J | A | S | O | N | D | Data Source |
|--|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Foraging | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | DoEE (2017a) |
| -Nesting | ■ | ■ | ■ | | | | | | | | ■ | ■ | DoEE (2017a) |
| -Inter-nesting | ■ | ■ | ■ | | | | | | | | ■ | ■ | DoEE (2017a) |
| -hatchlings emerging | ■ | ■ | ■ | ■ | ■ | | | | | | | | DoEE (2017a) |
| Loggerhead turtle | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | DoEE (2017a) |
| -Foraging | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | DoEE (2017a) |
| -Nesting | ■ | ■ | ■ | | | | | | | | ■ | ■ | DoEE (2017a) |
| -Inter-nesting | ■ | ■ | ■ | ■ | ■ | | | | | | ■ | ■ | DoEE (2017a) |
| -hatchlings emerging | ■ | ■ | ■ | ■ | ■ | | | | | | | | DoEE (2017a) |
| Green sawfish | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Bateman et al. (2024); Lear et al. (2023); Morgan et al. (2017) |
| -Pupping | | | | | | | | ■ | ■ | ■ | ■ | ■ | Lear et al. (2023) |
| Scalloped hammerhead | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Bartes and Braccini (2021); Chin et al. (2017); TSSC (2024) |
| -Pupping* | ■ | ■ | | | | | | | | ■ | ■ | ■ | TSSC (2024) |
| Reef manta ray | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | Armstrong et al. (2020) |
| Seabirds | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | DCCEEW (2024c) |
| -Nesting across species | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | DCCEEW (2024c) |
| Migratory Shorebirds (Non-breeding migration) | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ | ■ | DoEE(2015b); Bamford et al. (2008) |
| *Pupping can occur throughout the year but predominantly occurs between October and January/February | | | | | | | | | | | | | |

5.3. Impact assessment relevant to Project activities

5.3.1. Underwater noise from piling

Underwater noise is categorised as either being impulsive (with a sudden onset, e.g. piling) or continuous (e.g. part of the ambient, or background soundscape like shipping and dredging). There is unlikely to be an increase in continuous underwater noise attributable to the Project as it does not involve dredging and with no vessel access to the jetty, there is no expected increased sources of underwater noise during the operational phase. The Project will involve impact hammer piling, which is the most significant noise from the Project during the construction phase and has the greatest risk of auditory injury to the species.

Underwater noise has the potential to travel large distances, so potential impacts on marine fauna can be widespread. The degree of impacts from underwater noise is dependent on the sound's duration, amplitude, and frequency, the distance between the sound source, marine species present and the sensitivity of the marine species to the site-specific combination of these factors (Salgado Kent et al. 2016). The potential impacts to marine fauna from underwater noise is presented in Table 20 and Figure 30. From a population conservation perspective, the most significant consequence could be marine fauna behaviour changes like avoidance of critical habitat (e.g. foraging, breeding or resting ground; Figure 31).

Table 20: Potential impacts of underwater noise to marine fauna

| Impact/response | Explanation |
|--|--|
| Permanent threshold shift (PTS) | Permanent reduction in the sensitivity of hearing, decreased ability to detect sound, permanent damage to ear hair cells or attached neurons, irreversible hearing loss, and/or damage to and around hearing structures and haemorrhaging of the ear (Salgado Kent et al. 2016). |
| Temporary threshold shift (TTS) | Temporary hearing loss or impairment following exposure to high level of noise. Previously been thought of as reversible damage but be irreversible (Kujawa and Liberman 2009; Salgado Kent et al. 2016). TTS can reduce individuals' communication, ability to detect prey or predators and/or assess environment (Popper and Hawkins 2019). |
| Behavioural | Behavioural responses can vary and include changes in swimming (speed and/or direction), diving (frequency and duration), breathing rates, communication, foraging, mating, resting, socialising, defensive behaviours and/or moving towards or away from the source. Sometimes behavioural responses can result in secondary organ or tissue damage (e.g. rapid rise from a dive or response by moving directly in line with other threats) (Salgado Kent et al. 2016). |
| Masking | When anthropogenic noise is at a sufficiently high level and similar frequency and timing to a signal of interest, it can mask the signal affecting the perception of the signal of interest. Masking is problematic when communication between animals or the ability to sense predators is disrupted. |

| Impact/response | Explanation |
|-----------------------------------|--|
| Stress and physiological response | Can occur at long and short ranges (Erbe et al. 2022) and can potentially occur across all the theoretical zones of impact. Stress can include hormonal, autonomic, immune, and behavioural responses (Popper and Hawkins 2019). Prolonged, and repeated stress responses can be deleterious to an individual’s health (Purser and Radford 2011; Salgado Kent et al. 2016). The stress response is intended to increase the probability of survival from an immediate threat but prolonged or repeated stress responses can be deleterious to health. Further, stress may also result in the individual spending less time foraging or spawning, in turn leading to condition loss/deterioration (Salgado Kent et al. 2016). |

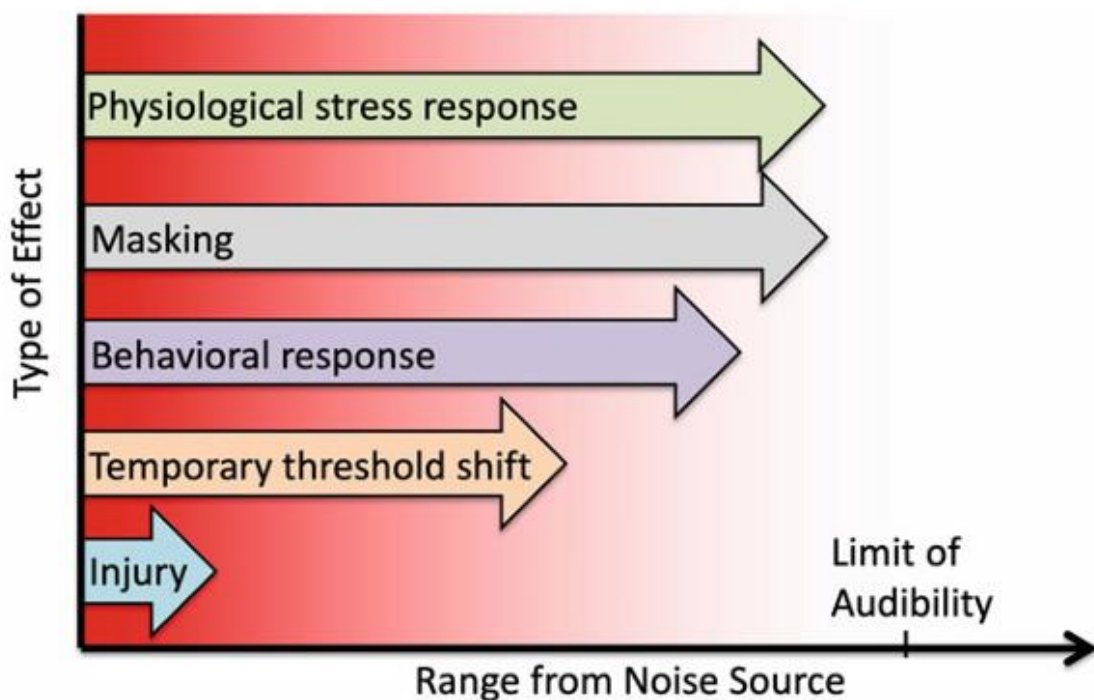


Figure 30: Generalised ranges from a noise source, at which different types of impacts to marine fauna may occur (Erbe 2022)

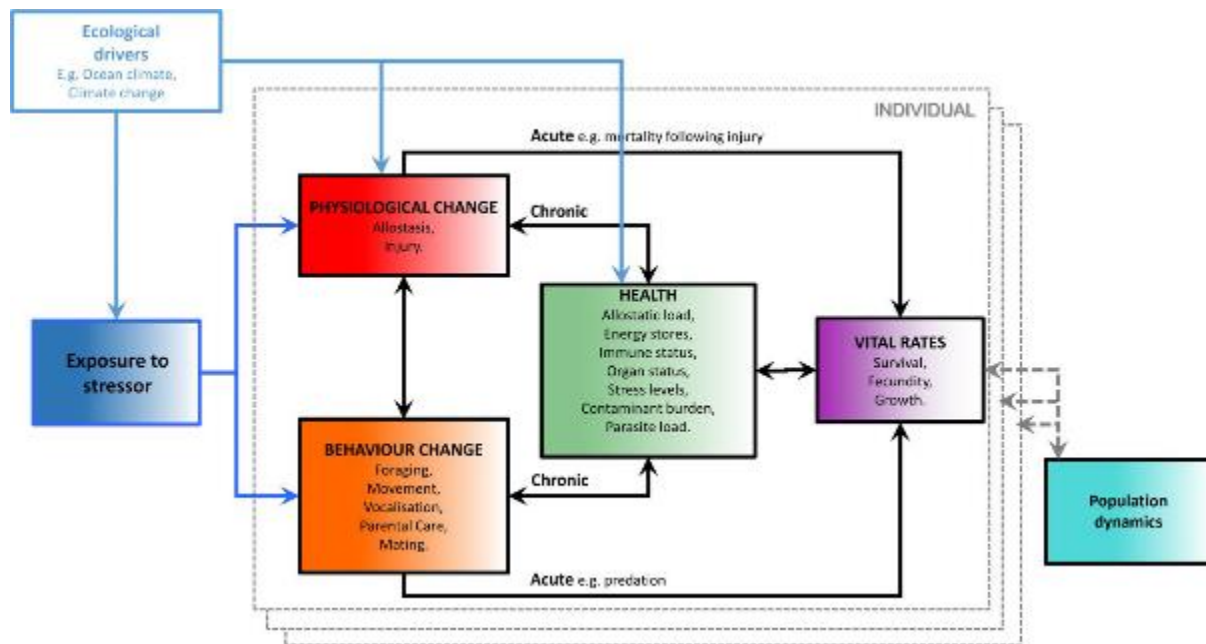


Figure 31: Population consequences of disturbances (PCoD) conceptual framework (Pirodda et al. 2018)

The potential impacts and current knowledge on the effect of underwater noise on key species (identified in Section 4) are discussed below to adequately understand the potential for behavioural change, death or injury for each hearing groups. This was then used to inform the underwater noise modelling (Section 5.3.1.1)

Mammals

Marine mammals are highly reliant on underwater sounds, using sound for spatial orientation, communication, foraging, and detecting predators, and therefore are sensitive to changes in ocean soundscapes and anthropogenic noise sources (Haver et al. 2018; Huang et al. 2023). The most significant population level effect from anthropogenic noise (i.e. pile driving) to marine mammals is more likely to occur from behavioural responses rather than from direct injury or mortality (Parnum et al. 2018). Studies on Indo-pacific bottlenose dolphins' response to pile driving for example, found the dolphins had a reduced occurrence during pile driving activities (Salgado Kent et al. 2012; Paiva 2015).

Reptiles

Low-frequency sounds and continuous noise sources overlap with marine turtle hearing ranges and are potentially vulnerable to anthropogenic noise pollution (Willis 2016; Díaz et al. 2024). These lower frequency continuous noise sources can potentially result in behavioural and masking effects (Suedel et al. 2019). Impact noise source effects on marine turtles is not well understood but it is thought that the species generally demonstrate a startled response to impulsive noise, including temporary behavioural response, such as avoidance of an area (McCauley et al. 2000).

The effects of underwater noise on sea snakes are poorly understood but they could potentially respond in a similar way to turtles, including behavioural avoidance. Sea snakes may also be vulnerable to impulsive noise (i.e. piling noise) due to the species having sealed nostrils and air-filled lungs which extends the length of their bodies and their slow swimming speed. Research on the Stoke's sea snake

(*Hydrophis stokesi*) found the species underwater noise sensitivities were most like fish species without swim bladders e.g. elasmobranchs, meaning the species may be sensitive to sound pressure. It is unlikely sea snakes would experience injury or mortality from underwater noise but could experience behavioural effects (Parnum et al. 2018).

Sharks and rays

Elasmobranchs (sharks) lack a swim bladder and therefore are thought to be less susceptible to noise sound pressures than other fish species, but instead are more sensitive to the particle aspect of sound, which is a measure of the vibrations (Salgado Kent et al. 2016). Anthropogenic underwater noise exposure can lead to changes in movement patterns, feeding behaviours, social interactions, and antipredator behaviours in bony fish (Chapuis et al. 2019).

Shorebirds and seabirds

Noise travels through water five times faster than it travels through air and therefore the energy or intensity (loudness) of sound is greater in water than in air (Webb 2023). It is unlikely that noise generated by piling in the air will cause significant injury or mortality to bird species, however, may result in temporary disturbance or avoidance, depending on weather conditions. Migratory shorebirds and seabirds are not likely to be directly impacted by underwater noise, but they could be indirectly impacted by effects on their prey species present within the water column.

5.3.1.1. Underwater noise modelling and impacts from piling

Underwater noise modelling was undertaken for the piling activities for the Project, to determine the potential impacts on marine fauna (ANV Consultants 2024; Appendix D). Piling was assumed to be hammer piling due to the likely presence of rock and/or limestone within the area and is a more conservative approach as vibration piling is likely to have less impact.

Underwater noise is a known threat to marine fauna. Injury to marine fauna from exposure to underwater noise has been observed in the forms of auditory injury from impulsive sounds (pile driving and seismic surveys) and continuous sound exposure. Underwater noise was identified as a threat of Potential Concern to humpback whales, Australian humpback dolphin, Indo-pacific bottlenose dolphin, hawksbill turtle, flatback turtle, and green turtle, and a threat of Least Concern for dugongs and shorebirds as described in the sections above (DSEWPac 2012a). The key marine fauna species used for this assessment included the following:

- Humpback whale (low-frequency cetacean)
- Australian humpback dolphin and Indo-pacific/ spotted bottlenose dolphin (high-frequency cetaceans)
- Dugong (sirenians)
- Sharks, rays, sea snakes and sawfish (fish species without swim bladder)
- Flatback, green and hawksbill turtles.

These were grouped into the animal hearing type, which can be impacted differently. The noise modelling modelled both immediate impacts (one strike) and cumulative (multiple hammer strikes over 24 hours), the results of the cumulative noise modelling are presented in Table 21, Table 22 and

Table 23, and Figure 32 presents the noise contours from the worst case scenario (high tide - Highest Astronomical Tide (HAT)). The full report is presented in Appendix D.

Table 21: Cumulative impacts from impulsive noise under multiple piling pulses for PTS and TTS, end of jetty at Highest Astronomical Tide (HAT) and LAT (modified from ANV Consultants 2024)

| Marine fauna hearing group | Number of pulses modelled | Criteria – Weighted SEL24-hr dB re 1 µPa2·s | PTS (onset) | | Criteria – Weighted SEL24-hr dB re 1 µPa2·s | TTS (onset) | |
|-------------------------------------|---------------------------|---|----------------------|-----------|---|----------------------|-----------|
| | | | Maximum distance (m) | threshold | | Maximum distance (m) | threshold |
| | | | HAT | LAT | | HAT | LAT |
| Low frequency cetaceans (whales) | 1 | 183 | <10 | <10 | 168 | 45 | 35 |
| | 10 | | 25 | 20 | | 180 | 145 |
| | 100 | | 90 | 75 | | 750 | 560 |
| | 500 | | 240 | 185 | | 2,080 | 1,500 |
| | 1,000 | | 370 | 280 | | 3,240 | 2,300 |
| | 2,000 | | 560 | 430 | | 5,050 | 3,550 |
| High frequency cetaceans (dolphins) | 1 | 185 | - | - | 170 | <10 | <10 |
| | 10 | | - | - | | <10 | |
| | 100 | | <10 | <10 | | 35 | |
| | 500 | | 10 | 10 | | 103 | |
| | 1,000 | | 16 | 15 | | 164 | |
| | 2,000 | | 26 | 25 | | 260 | |
| Sirenians (dugongs) | 1 | 190 | - | | 175 | <10 | |
| | 10 | | - | | | 11 | |
| | 100 | | <10 | | | 48 | |
| | 500 | | 15 | | | 144 | |
| | 1,000 | | 22 | | | 230 | |
| | 2,000 | | 35 | | | 360 | |
| Turtles | 1 | 204 | - | | 189 | <10 | |
| | 10 | | <10 | | | 20 | |
| | 100 | | 10 | | | 60 | |
| | 500 | | 25 | | | 145 | |
| | 1,000 | | 35 | | | 205 | |
| | 2,000 | | 50 | | | 300 | |

Table 22: Zones of cumulative impact from impulsive noise number multiple piling pulses for mortality and recovery injury, fish, fish eggs and larvae (modified from ANV Consultant 2024)

| | Number of pulses | Mortality and potential mortal injury | | Recoverable injury | | TTS | |
|--|------------------|---|--------------------------------|---|--------------------------------|---|--------------------------------|
| | | Criteria – SEL _{24hr} dB re 1µPa ² -s | Maximum threshold distance (m) | Criteria – SEL _{24hr} dB re 1µPa ² -s | Maximum threshold distance (m) | Criteria – SEL _{24hr} dB re 1µPa ² -s | Maximum threshold distance (m) |
| Fish - no swim bladder (particle motion detection) | 1 | 219 | - | 216 | - | 186 | <10 |
| | 10 | | - | | - | | 25 |
| | 100 | | <10 | | <10 | | 85 |
| | 500 | | <10 | | <10 | | 210 |
| | 1,000 | | <10 | | <10 | | 280 |
| | 2,000 | | <10 | | 12 | | 450 |
| Fish eggs and fish larvae | 1 | 210 | - | | - | | - |
| | 10 | | <10 | | - | | - |
| | 100 | | <10 | | - | | - |
| | 500 | | 12 | | - | | - |
| | 1,000 | | 16 | | - | | - |
| | 2,000 pulses | | 25 | | - | | - |

Table 23: Zones of immediate impact from a single impact piling pulses for behavioural changes for marine mammals and turtles (ANV Consultants 2024)

| Marine fauna group | Criteria – SPL RMS, dB re 1 µPa | Behavioural response maximum threshold distance (m) | |
|-------------------------------------|---------------------------------|---|----------|
| | | High tide | Low tide |
| Low frequency cetaceans (whales) | 160 | 1,130 | 840 |
| High frequency cetaceans (dolphins) | | 1,130 | 840 |
| Sirenians (dugongs) | | 1,130 | 840 |
| Turtles | 166 | 550 | 410 |

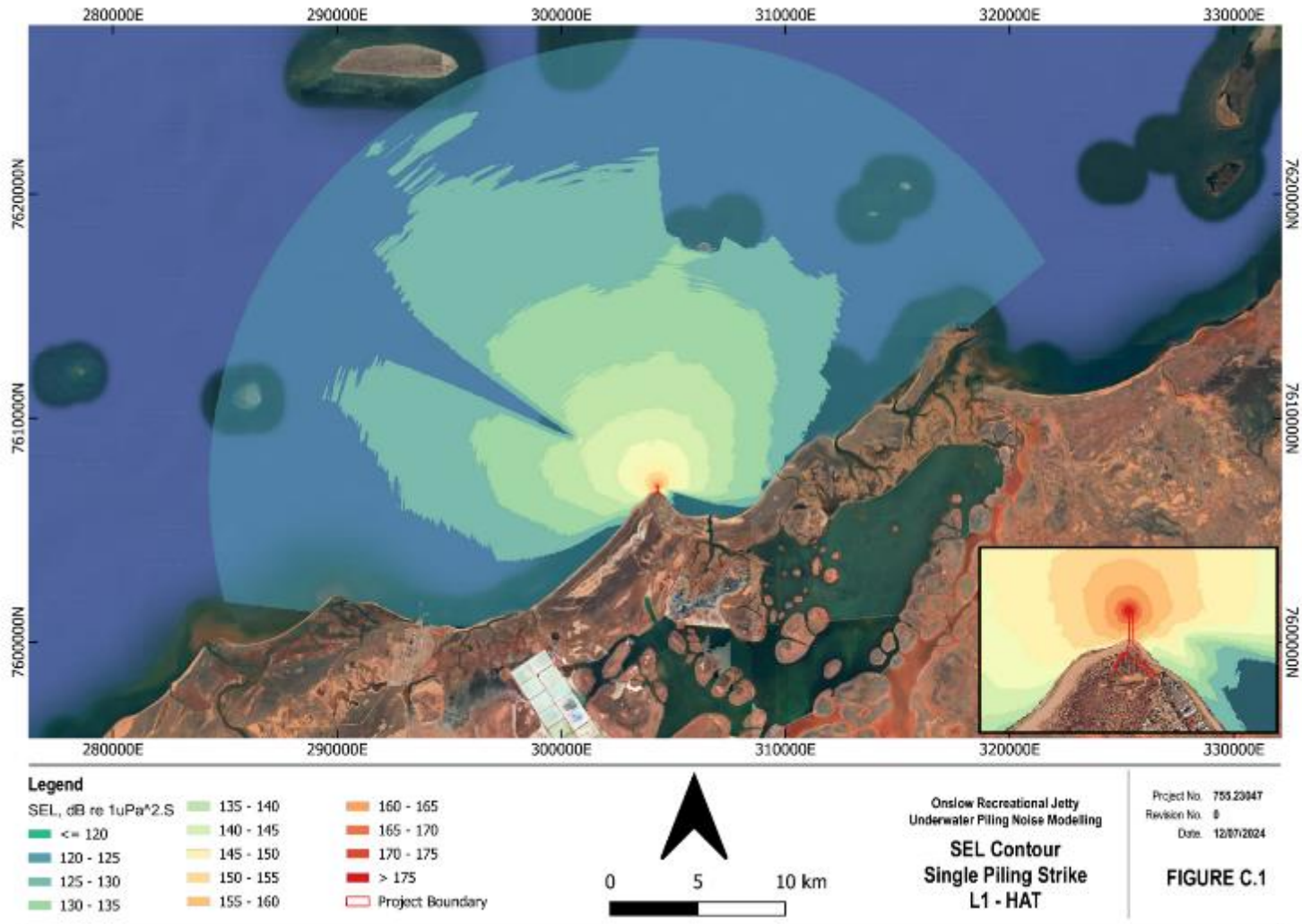


Figure 32: Noise contour figure from modelling scenario - worst case scenario – high tide at the end of the jetty (ANV 2024)

The modelling results found that low frequency cetaceans, namely humpback whales, have the greatest potential to be impacted by underwater noise generated by piling, for both immediate and cumulative impact. The results indicate that PTS threshold would be exceeded within 250 m of the piling when exposed to 500 piling pulses and within 560 m with 2,000 piling pulses, for HAT at the end of the jetty (worst-case). TTS had the largest potential impact zones with exceedance expected within 2 km of piling when whales are exposed to 500 piling pulses and if exposed to 2,000 piling pulses TTS could occur within 5 km (ANV Consultants 2024). These zones were lower for the modelling scenario at LAT (see Table 21). Humpback whales have been infrequently sighted within 5 km of the Project (Figure 8), however given the species population expansion and possible extension of calving habitat (Bedjer et al. 2019) during their southern migration humpback whales may infrequently be present within 5 km of the Project area.

Dolphins (high frequency) and dugongs (sirenians) had much lower threshold distances for both PTS and TTS for the worst-case scenario (HAT, 2,000 pulses), with PTS <35 m and TTS <360 m. Modelling results were similar for turtles which had a max PTS distance of 50 m and 300 m for TTS. Underwater noise modelling results shows that fish (no swim bladder) and fish eggs and larvae had a maximum TTS distance of 450 m and mortality and potential mortal injury distance of <10 m and 25 m respectively (2,000 pulses). It is likely that fish species that are close (near and intermediate) distance from the pile location will experience temporary masking and behavioural response.

The noise modelling assumed a hydraulic hammer energy of 120 KJ and pile diameter of 750 mm diameter, however it is likely that smaller piles (600 mm diameter) and a smaller hydraulic hammer (55-70 KJ) will be sufficient for the Project. Therefore, the noise modelling maximum distances are likely to represent a precautionary approach and appropriate management actions can be implemented including pre-start, soft-start, and stop work procedures to ensure that individuals are unlikely to be exposed to 2,000 pulses at the maximum hammer energies presented in the noise model.

The residual impacts from underwater noise from piling are considered minor with temporary disturbance of marine fauna present in the vicinity during piling, possibly resulting in temporary behavioural changes to avoid noise-affected areas. Therefore, it is expected that the jetty construction will not cause population level consequences.

5.3.2. Vessel strike from construction vessels

Marine fauna may be impacted by vessel strike during construction, potentially resulting in injury or death. As identified in the sections above, the North-west Marine Bioregional Plan (DSEWPaC 2012a) identifies strike as a threat of Potential Concern for the humpback whale, Australian humpback dolphin, Indo-pacific bottlenose dolphin, dugongs, hawksbill and green turtles, and a threat of Least Concern for sea snakes (DSEWPaC 2012a). Marine mammals and turtles are susceptible to vessel strike as they are air breathers and known to spend prolonged periods at the surface. Previous studies have found dugongs spend 47% of their time within 1.5 m of the surface and 3.5% of this time they are resting at the surface (Hodgson 2004; CoA 2017b). This same study found calves spend 13% of their time travelling or resting on their mother's back. Vessel and dugong interactions have also been found to increase in shallow waters at low-tide which have large intertidal areas (Groom et al. 2004; CoA 2017b).

The speed that a vessel is travelling has an influence on the extent of injury to fauna, with Laist (2021) finding a significant increase in the risk of vessel collision between marine megafauna and vessels at speeds >10 knots. Speeds >14 knots significantly increase the chance of lethal injury from a vessel collision. Further, the increase in speed of a vessel reduces the ability for dugongs and turtles to flee (Hodgson 2004; DoEE 2017b). Reduced speeds provide greater reaction time and therefore restricting vessel speeds during construction activities would also decrease the likelihood of vessel strike.

Marine fauna exposed to persistent interruptions from vessel movements and noise can also result in disruptions to important behaviours (e.g. feeding, mating, courtship) which can in turn impact the reproductive success and ultimately population levels (Hodgson and Marsh 2007).

The likelihood of vessel strike during construction from the Project is low due to the scale (i.e. spatial movements) and nature of the piling (i.e. slow-moving and small support vessels). The Project activities are unlikely to result in significant declines in the local or regional populations of marine fauna and their distribution, or reductions in the diversity of species.

5.3.3. Disturbance of marine fauna from construction activities

The Project will involve construction activities on the beach and within sand dunes, including moving equipment and materials to the jetty site which could lead to disturbance of turtle nesting (i.e. nesting attempts aborted), disturbance of turtle nests, disturbance to migratory shore bird roosting and foraging behaviours, or even injury or death of marine turtles. Human presence at sensitive (i.e. nesting or roosting sites) is a threat of concern for flatback, green and loggerhead turtles, migratory shorebirds, and seabirds (DSEWPac 2012b; c).

Marine turtles have high nesting beach fidelity, returning to the same beach from where they were born to lay their eggs. Nesting sites are selected carefully as nests can be disrupted by flooding or erosion (as well as feral animals such as cats (DoE 2015), foxes (DEWHA 2008A) and pigs (DoEE 2017d)). When turtles are onshore for nesting, they are particularly sensitive and can be disturbed by movements (i.e. people walking or driving along beaches) and light (DSEWPac 2012d)

Further, marine turtles' eggs are buried ~50 cm deep meaning that eggs are susceptible to being crushed by vehicles driving on the beach. Vehicle presence on beaches can also reduce emergence success via compacting sand over nests, eroding dunes (reducing suitable nesting habitat), and/or creating tyre ruts that can impede hatchling's ability to reach the ocean (DoE 2017a).

Turtles, seabirds and shorebirds are known to be present within the Project area though no nesting or roosting for any seabird or shorebird species has been identified within the Project area and turtles infrequently nest along the beach adjacent to the Project.

With the avoidance of construction activities during peak nesting (October to February) and limited use of the area by the species it is anticipated that impacts can be appropriately managed (see Section 6). Therefore, the likelihood of disturbance from construction activities on turtles (nesting turtles, eggs, and emerging turtles), migratory shorebirds (foraging and roosting), and seabirds (foraging) is low. The Project activities are unlikely to result in significant declines in the local or regional populations of marine fauna and their distribution, or reductions in the diversity of species.

5.3.4. Habitat loss, degradation and modification

Habitat degradation and modification has been identified as a threat of Concern for the flatback turtle, and a threat of Potential Concern for the dugong, Australian humpback dolphin, Indo-pacific bottlenose dolphin, hawksbill turtle, green turtle, sea snakes, shorebirds, and seabirds (including wedge-tailed shearwaters) (DSEWPaC 2012a).

5.3.4.1. Loss of habitat

The Project does not require any dredging and therefore the direct loss of BCH from the pile installation will be minor and localised to the pile footprints. The BCH present within the Project DE does not represent important habitat for marine mammals and given the tidal ranges it is unlikely to provide important habitat for other key species.

The Project involves minor clearing of sandy beaches and dunes. These habitat types are known to provide nesting habitat for turtles and seabirds, and roosting habitat for migratory shorebirds and seabirds. Given the lack of turtle nesting activity on the sandy beaches surrounding the Project (See Section 4.2.1, 4.2.2, and 4.2.3) it is unlikely that minor loss or restricted of sandy beaches in the Project DE would impact turtle nesting in the region.

Seabirds and shorebirds were identified to be present within the Project area and the survey by WEPL (2022) indicated that that Project area and surrounding areas surveyed were likely to be infrequently visited, with no nesting or roosting identified within the area for any species. An artificial nesting platform was present to the south of the Project area which had evidence of possible or past nesting by osprey but was not being used at the time of the survey. Therefore, it is unlikely that this loss of habitat will result in significant impacts to migratory shorebirds and seabird species as this habitat is well represented in the area, and surveys of the terrestrial vegetation found that the area has previously been disturbed with evidence of weed invasion, vehicle tracks, previous clearing, and historical infrastructure.

Therefore, loss of habitat, intertidal and subtidal and terrestrial, is not expected to lead to significant declines in the local or regional populations of marine fauna and their distribution, or reductions in the diversity of species.

5.3.4.2. Habitat modification

Artificial structures, including jetties, create new niches for species with the new piles offering a hard substrate for benthic communities to colonise. This provides habitat for fish species, including predatory fish species and therefore can increase the risk of predation of marine fauna, namely turtle hatchlings. This has been observed at Thevenard Island (Wilson et al. 2019). Given the lack of turtle nesting activity on the sandy beaches surrounding the Project and the tidal ranges, it is unlikely that the jetty structure will increase predation on turtle hatchlings.

5.3.5. Artificial light pollution

Light pollution has been identified as a threat of Concern for the flatback and green turtle, and a threat of Potential Concern for shorebirds and seabirds (including wedge-tailed shearwaters) (DSEWPaC 2012a). Artificial light can impact turtles throughout their life cycle, including nesting adult females and

hatchlings (Lohmann et al. 1997; Salmon 2003; Witherington and Martin 2003). A summary of the potential impacts of artificial light pollution is presented below:

- Impacts on recently emerged turtle hatchling impeding sea finding ability from beach. Greater risk of predation.
- Increased hatchling risk to predation through due to increased visibility at night from artificial light.
- Female turtle disturbance during nesting, discouraging turtles to nest on certain parts of the beach.
- Females searching for other parts of the beach may cause nest destruction of other nests.
- Reliance on other beaches for nesting increases vulnerability of a population to environmental change.
- Interactions between seabirds or shorebirds and artificial light sources, causing disorientation or grounding of fledglings.
- Mortality or injury caused from seabird or shorebird collision with artificially lit infrastructure.
- Starvation due to disruptions in the ability of seabirds and shorebirds to forage at sea and onshore.

Unmitigated direct light may illuminate foraging habitat, influencing foraging behaviour, or displacing waterbirds from potential habitat. Given the small scale of the Project, artificial light modelling was not deemed necessary and the potential impacts during construction and operational phases of the Project are presented in the sections below.

5.3.5.1. Light pollution during construction

Potential light sources during construction include potential vessels, support vehicles and construction equipment. Given the lack of turtle nesting (See Section 4.2.1, 4.2.2, and 4.2.3), migratory shorebirds, and seabird activity (WEPL (2022) surrounding the Project, the size of the construction activities and the location of the Project within the Onslow township the risk of turtles, seabirds and migratory shorebirds being affected is low. Further, with the appropriate management (Table 24) significant impacts to marine turtles, seabirds and shorebirds are not expected.

5.3.5.2. Light pollution during operations

During operations the Project will likely require lighting to ensure the safety of the public using the facility, and it is expected that the jetty will utilise solar powered lights. Without appropriate mitigation this lighting could potentially affect marine fauna, namely turtles (nesting females and hatchlings), seabirds, and migratory shorebirds. The lighting design for the Project should be developed in accordance with the National Lighting Pollution Guidelines and control measures to minimise light emissions can be implemented to ensure light pollution does not significantly impact marine turtles, seabirds and shorebirds.

5.3.6. Invasive species

An invasive species is one occurring beyond its accepted normal distribution as a result of human activities, and which threatens valued environmental, agricultural or other social resources by the damage it causes. Invasive species have been identified as a threat of Concern for the green and flatback turtles, and a threat of Potential Concern for dugongs, shorebirds, and seabirds (including

wedge-tailed shearwaters) (DSEWPaC 2012a). Invasive species include both introduced marine pest (IMP) species and invasive terrestrial species/predators, which could occur during construction and operations.

5.3.6.1. Introduced marine pests

IMPs are animals, plants, algae, and other biota that exist in an area outside their natural geographical range, to which they have generally been translocated by human activity. The National Marine Pest Plan 2018-2023 defines IMPs as an introduced species that causes harm to the environment, social amenity, or industry, or have the potential to do so if they were to be introduced, established, or spread in Australia's marine environment (DAWR 2018). Marine pests can be introduced via ballast water exchange or biofouling, and examples of the impacts of IMPs in relation to the Project area include:

- Competition with native species for food and/or habitat, potentially leading to the displacement of native species
- Predation of native species
- Alternation of trophic interactions and food-webs
- Loss of commercial and recreational fisheries harvests
- Alteration of ecosystem processes (e.g. nutrient cycling and sedimentation)
- Reduced coastal aesthetics
- Damage to marine and industrial infrastructure
- Reduced aquaculture productivity.

The Project is expected to have limited construction vessels, though a piling barge is likely to be used which has a moderate risk and support vessels which are low risk for marine pest introduction (McDonald et al. 2015). The Project does not include dredging, which is considered the highest risk vector for marine pests. The piles could provide new substrate for pest establishment however there are no expected operational vessels or vectors for IMPs during operations and therefore it is unlikely that pests will be introduced and established. It is important to note that the white colonial sea squirt (*D. perlucidum*), a recognised IMP, is now widespread in the Pilbara and has been reported from Exmouth Boat Harbour, Port of Ashburton, Port of Onslow, Barrow Island, and Dampier (Bridgwood et al. 2014, DPIRD 2017). The species has only been recorded on artificial surfaces and without a vector for translocation it is unlikely to occur on the Projects infrastructure.

Given the likelihood of the introduction of marine pest during construction from Project vessels is low (i.e. short construction timeframe, small development envelope and no dredging), it is unlikely that IMPs will become established and effect the biodiversity and/or ecological integrity of local marine fauna and ecosystems. The risk of marine pest incursion during construction and operations is considered to be negligible.

5.3.6.2. Invasive terrestrial species

In northern WA predation of turtle eggs and seabirds from foxes and pigs is considered a significant threat. Infrastructure development may facilitate the expansion, however foxes are known to occur in Onslow and it is understood that foxes are known to predate on turtle nests on back beach in Onslow. Given the Project is located in the already developed Onslow Township, and the lack of risk species

activity around the Project area, it is unlikely that the construction and operations of the recreational fishing jetty will increase the occurrence of feral predators and increase predation on marine species. Further, with the appropriate waste management and existing fox control measures in Onslow it is the risk of invasive terrestrial incursion during construction and operations is considered to be negligible.

5.3.7. Hydrocarbon spill causing marine fauna injury or fatality and/or impacts on critical habitat

Hydrocarbon/oil spills has been a threat of Potential Concern for the dugong, Australian humpback dolphin, Indo-pacific bottlenose dolphin, sea snakes, shorebirds, and seabirds (including wedge-tailed shearwaters) (DSEWPaC 2012a).

In the event of a hydrocarbon spill, there is a risk of marine fauna being exposed to surface oil or ingesting small amounts. The impact on marine fauna is dependent on the extent of the spill and the sensitivity of the receptor. Oil spills can potentially affect all levels of marine life from zooplankton, invertebrates, and vertebrates (Yuewen and Adzibil 2018). Potential impacts to marine fauna relevant to the Project may include (Yuewen and Adzibil 2018):

- Loss and degradation of important habitats (e.g. foraging habitat, nesting beaches, nursery habitats, seagrass and macroalgae nursery habitats, key fishing ground and aquaculture farms)
- Mass mortality of fish species (e.g. important recreational and commercial species, loss of important marine fauna prey species)
- impaired physiological functions such as reduced feeding, growth and development affecting recruitment of species
- reduced fitness including reproduction impairment and development defects
- respiration problems
- loss of locomotion, balance, and swimming.

Hydrocarbon spills may enter the marine environment via construction vessels and equipment. The primary substance from these sources could be diesel and small amounts of hydraulic oil (i.e. from hydraulic failure including o-ring, pipe, fitting), lubricating oil and grease for maintenance of vessel equipment, which may be accidentally spilled during regular vessel activities (i.e. accidental discharge, collision, deck drain and refuelling). With management measures in place, the risk of a hydrocarbon spill during the construction phase of the Project the risk of a hydrocarbon spill is low and therefore the threat to marine fauna is considered very low.

5.3.8. Entanglement/ingestion of marine debris

The injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris is listed as a key threatening process under the EPBC Act, and as such the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018) has been developed. Marine debris has been identified as a threat of concern to hawksbill, green and flatback turtles, and of potential concern for dugongs, Australia humpback dolphin, and Indo-pacific bottlenose dolphin (DSEWPaC 2012a). Sources of waste and marine debris

from the Project may occur during construction and operational phases, which are discussed in the sections below.

5.3.8.1. Entanglement/ingestion of marine debris during construction phase

General waste is expected with any construction activity and sources of marine debris from the Project activities include direct disposal into the marine environment or wind borne litter from vessels or landside infrastructure. Marine fauna can be impacted by debris entering the marine environment potentially leading to injury or mortality, through entanglement or plastic ingestion. With all waste and debris being appropriately disposed of, stored and managed the likelihood of waste and debris entering the marine environment can be prevented. Therefore, it is unlikely to result in declines in the local or regional populations of species and their distribution, or reduction in the diversity of species.

5.3.8.2. Entanglement/ingestion of marine debris/fishing gear during operational phase

Derelict and active fishing areas are known to pose threats to marine fauna (Nicholson 2023) and interactions with fishing gear can pose a threat to marine fauna including marine mammals, turtles, sharks, and seabirds (Parton et al. 2019). The impacts of entanglement or ingestion of fishing gear can result in drowning, amputation of body parts, infections, reduced mobility, and reduce ability to forage or engage in other normal behaviour. Recreational fishing gear that is commonly involved in dolphin entanglement includes monofilament and braided fishing line, crab trap float lines, fishing hooks, and other debris (Butterworth et al. 2012; Nicholson 2023). Interactions, including entanglement or ingestions, with fishing gear can occur from active fishing, or from lost or inappropriately disposed of fishing gear (Nicholson 2023).

Given the small scale of the Project and the current fishing effort by recreational fishers in Onslow, it is unlikely that the Project will increase human interactions with marine mammals.

6. Recommended mitigation for impacts

The impact assessment in Section 5 described the likelihood of impacts to species related to activities involved with the Project. However, mitigation measures can be implemented to reduce the likelihood and severity of these impacts, and these are recommended for this Project. A summary of the application mitigation hierarchy and summary of the impact assessment to marine fauna is presented below in Table 24. Construction phase impacts will be managed through the development and implementation of a Construction Environmental Management Plan (CEMP), which will be developed prior to the commencement of construction works. The following mitigation measures outlined in this table will be included within the CEMP to mitigate the impact on marine fauna during construction. Operational activities will be managed through the Shire of Ashburton and all maintenance will be completed in accordance with the Shire of Ashburton’s conditions and regulations.

Table 24: Summary of impact assessment for marine fauna

| Marine fauna | Relevant Project activity and potential impact | Application of mitigation hierarchy | Outcomes and residual impact |
|---|---|---|---|
| Construction phase impacts | | | |
| Marine mammals Reptiles Sharks and rays | <ul style="list-style-type: none"> Injury, death or behavioural response from underwater noise from piling (See Section 5.3.1) | <u>Avoid:</u> <ul style="list-style-type: none"> Avoid piling works during sensitive: <ul style="list-style-type: none"> Humpback whale southern migration (August to November) Construction (e.g. piling) to occur during day light hours only <u>Minimise</u> <ul style="list-style-type: none"> Dedicated marine fauna observers (MFOs) for piling (marine piling) Piling during daylight hours only Marine piling should aim to avoid high tide where practicable. Develop and implement Management Zones (Exclusion and Observation Zones) for key marine species based on underwater noise modelling Develop and implement Management Zones (Exclusion and Observation Zones) for key marine species based on underwater noise modelling <ul style="list-style-type: none"> These zones are intended to act as the key mitigation measure for protecting marine fauna and as such need to be designed to prevent | Minor residual impacts <ul style="list-style-type: none"> Humpback whales are the most sensitive species to underwater noise and construction activities will be undertaken to avoid the key ecological window (August to November). Therefore it is unlikely that the species would be present and impacted by underwater noise from piling Temporary disturbance of marine fauna present in the vicinity of piling, possibly resulting in temporary behavioural changes to avoid noise- affected areas No population level consequences |

| Marine fauna | Relevant Project activity and potential impact | Application of mitigation hierarchy | Outcomes and residual impact |
|---|---|--|--|
| | | <p>TTS and PTS impacts on marine fauna (i.e. i.e. not define the outer boundaries of a threshold exceedance distance per se), therefore, to achieve this outcome, the zones need to be broader than the modelled outputs.</p> <ul style="list-style-type: none"> 30-minute pre-start, 30-minute soft-start, shut-down, and low-visibility conditions to be applied. | |
| <p>Marine mammals Reptiles Sharks and rays</p> | <ul style="list-style-type: none"> Injury or death of marine mammals due to vessel movement (strike) from construction vessels (See Section 5.3.2) | <p><u>Avoid:</u></p> <ul style="list-style-type: none"> Avoid piling works during sensitive ecological windows: <ul style="list-style-type: none"> Humpback whale southern migration (August to November) All construction vessel restricted to max speed of <8 knots within the Project area <p><u>Minimise:</u></p> <ul style="list-style-type: none"> Piling to occur from land where possible The Project will be completed using a small number of small vessels (e.g. a tender and/or a barge). Adhere to vessel caution and approach zones (Table 25) | <p>No residual impacts – no vessel strike on marine fauna are predicted</p> <ul style="list-style-type: none"> Avoiding key ecological windows, abiding by the Australian national Guidelines for Whale and Dolphin Watching 2017 (DoEE 2017a) and National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE 2017b) and the development of a CEMP. It is expected that the potential impacts are expected to be minimal, and it is not expected to result in significant impacts to fauna. No vessel strikes on marine fauna are predicted No population level consequences |
| <p>Reptiles (turtles) Migratory shorebirds Seabirds</p> | <ul style="list-style-type: none"> Disturbance to marine turtles and migratory shorebirds on the beach and within the sand dunes from construction works | <p><u>Avoid:</u></p> <ul style="list-style-type: none"> Construction activities to be undertaken outside of peak turtle nesting periods (October to February) Construction (e.g. piling) to occur during day light hours only <p><u>Minimise:</u></p> <ul style="list-style-type: none"> Landside piling to have trained MFOs present to avoid turtle nests | <p>Minor residual impacts</p> <ul style="list-style-type: none"> Temporary disturbance of migratory shorebirds and seabirds present in the vicinity of piling is possible, possibly resulting in temporary behavioural changes to avoid noise- affected areas No destruction or disturbance to turtle nests/nesting are predicted |

| Marine fauna | Relevant Project activity and potential impact | Application of mitigation hierarchy | Outcomes and residual impact |
|---|--|---|--|
| | | <ul style="list-style-type: none"> Adhere to the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) provide a guide to turtle watching and a turtle watching code of conduct (DBCA 2020a;b) Movement of equipment etc on the beach will be restricted to a small area rather than travelling along the beach, avoiding dunes as much as possible | <ul style="list-style-type: none"> No population level consequences |
| Reptiles (marine turtles) Migratory shorebirds Seabirds | <ul style="list-style-type: none"> Artificial light pollution during construction (See Section 5.3.5.1) | <u>Avoid:</u> <ul style="list-style-type: none"> Construction (e.g. piling) to occur during day light hours only Only install and use lighting as required <u>Minimise:</u> <ul style="list-style-type: none"> Construction lighting to be minimal and in accordance with the National Light Pollution Guidelines for Wildlife (DCCEEW 2023c) Use wildlife friendly lights where practicable Consideration to whether activities requiring illumination (landside construction works) can be undertaken during daylight hours only | No residual impacts are predicted. |
| Reptiles Migratory shorebirds Seabirds | <ul style="list-style-type: none"> Loss of marine fauna habitat during construction | <u>Avoid:</u> <ul style="list-style-type: none"> Project DE to avoid significant marine fauna habitat Construction activities to be undertaken outside of peak turtle nesting periods (October to February) <u>Minimise:</u> <ul style="list-style-type: none"> Undertake construction operations as efficiently as possible Movement of equipment etc on the beach will be restricted to a small area rather than travelling along the beach, avoiding dunes as much as possible | No residual impacts are predicted <ul style="list-style-type: none"> No benthic habitat significant to marine fauna will be affected as a result of the Projects construction activities |
| Marine mammals Reptiles Sharks and rays | <ul style="list-style-type: none"> Hydrocarbon spills and/or other waste discharge during construction | <u>Avoid:</u> <ul style="list-style-type: none"> Ensure all construction vessels are compliant with the International Maritime Organisation International Convention for the Prevention of Pollution from ships (MARPOL) | No residual impacts are predicted. |

| Marine fauna | Relevant Project activity and potential impact | Application of mitigation hierarchy | Outcomes and residual impact |
|---|--|---|------------------------------------|
| Migratory shorebirds Seabirds | <ul style="list-style-type: none"> works Injury or mortality to marine fauna and/or loss or degradation of critical or important marine fauna habitat | <ul style="list-style-type: none"> Construction vessels speeds restricted to 8 knots within the Project area, to limit the potential for vessel collisions <p><u>Minimise:</u></p> <ul style="list-style-type: none"> Ensure all construction vessels and equipment supply and maintain adequate hydrocarbon spill kits on site during construction and within immediate access during refuelling Implement procedures for safe storage and handling of all hydrocarbons and chemicals | |
| Marine mammals Reptiles Sharks and rays Migratory shorebirds Seabirds | <ul style="list-style-type: none"> Entanglement and/or ingestion of marine debris during construction and from public use of the jetty | <p><u>Avoid:</u></p> <ul style="list-style-type: none"> All waste and rubbish will be appropriately stored and managed to prevent debris and waste from entering the marine environment. <p><u>Minimise:</u></p> <ul style="list-style-type: none"> NA | No residual impacts are predicted. |
| Marine mammals Reptiles Migratory shorebirds Seabirds | <ul style="list-style-type: none"> Introduced marine pests from construction vessels and equipment | <p><u>Avoid:</u></p> <ul style="list-style-type: none"> NA <p><u>Minimise:</u></p> <ul style="list-style-type: none"> All construction vessels to comply with biosecurity requirements If vessels come from interstate or international waters vessels are required to completed the WA DPIRD 'Vessel Check' risk assessment Where possible construction method to limit the number of vessels required | No residual impacts are predicted. |
| Operational phase impacts | | | |
| Reptiles | <ul style="list-style-type: none"> Artificial pollution light | <p><u>Avoid:</u></p> <ul style="list-style-type: none"> All non-essential lighting to be switched off when not in use | No residual impacts are predicted. |

| Marine fauna | Relevant Project activity and potential impact | Application of mitigation hierarchy | Outcomes and residual impact |
|---|---|---|------------------------------------|
| Migratory shorebirds Seabirds | during operations | <u>Minimise:</u> <ul style="list-style-type: none"> Lighting to adhere the National Light Pollution Guidelines for Wildlife (DCCEEW 2023c) Minimum number of lights to meet occupational health and safety standards Light installed on the jetty to be solar powered lights. | |
| Reptiles Migratory shorebirds Seabirds | <ul style="list-style-type: none"> Habitat modification - jetty structure increasing the risk predation they pose to marine turtle hatchlings, modified shoreline and dunes | <u>Avoid:</u> <ul style="list-style-type: none"> Jetty location outside of important habitat for turtles, migratory shorebirds, and seabirds <u>Minimise:</u> <ul style="list-style-type: none"> Lighting to adhere the National Light Pollution Guidelines for Wildlife (DCCEEW 2023c) Minimum number of lights to meet occupational health and safety standards and utilise solar powered lights | No residual impacts are predicted. |
| Marine mammals Reptiles Sharks and rays Migratory shorebirds Seabirds | <ul style="list-style-type: none"> Entanglement and/or ingestion of marine debris operations and from public use of the jetty, including fishing gear Increased waste from public uses and access | <u>Avoid:</u> <ul style="list-style-type: none"> All waste will be appropriately stored and managed to prevent marine debris from entering the marine environment <u>Minimise:</u> <ul style="list-style-type: none"> Educational signage will be installed on the on the jetty advising users of: <ul style="list-style-type: none"> Local fauna presence/significance and how to report injured, deceased or sick fauna Importance of responsible rubbish management, including not allowing fishing line to be disposed into the marine environment where it has the potential to result in fauna entanglement. | No residual impacts are predicted. |

| Marine fauna | Relevant Project activity and potential impact | Application of mitigation hierarchy | Outcomes and residual impact |
|---|---|---|---|
| | | <ul style="list-style-type: none"> Jetty infrastructure to be maintained and inspected in accordance with Shire procedures. | |
| Marine mammals Reptiles Sharks and rays Migratory shorebirds Seabirds | <ul style="list-style-type: none"> Introduction and establishment of marine pests Incursion of terrestrial pest species | <u>Avoid:</u> <ul style="list-style-type: none"> All waste will be appropriately stored and managed to prevent marine debris from entering the marine environment <u>Minimise:</u> <ul style="list-style-type: none"> Jetty infrastructure to be maintained and inspected in accordance with Shire procedures, including inspection on marine infrastructure for pests Shire to maintain current terrestrial pest management | No residual impacts are predicted. |

Table 25: Marine fauna vessel controls (DoEE 2017b; c)

| Marine fauna group | Vessel speed | Caution zone (m) | No approach zone (metres) | Distress/disturbance |
|---|---|------------------|--|---|
| Adult whales | No faster than 6 knots within 300 m | 300 | 100 m to the side of the whale 300 m in front or to rear of the whale | Withdraw from caution zone at speed less than 6 knots |
| Whale calf* present | No faster than 6 knots within 300 m | - | 300 m | Withdraw from No approach zone at speed less than 6 knots |
| Adult dolphins | No faster than 6 knots within 150 m, with the exception of animals bow-riding | 150 | 50 m to the side of the dolphin 150 m in front or to rear of the dolphin with the exception of animals bow-riding | Withdraw from caution zone at speed less than 6 knots |
| Dolphin calf* present | No faster than 6 knots within 150 m, with the exception of animals bow-riding | - | 150 m | Withdraw from No approach zone at speed less than 6 knots |
| Dugong | No faster than 6 knots within 100 m | 300 | 100 m | Withdraw from caution zone at speed less than 6 knots |
| Turtle | No faster than 6 knots within 150 m | 300 | 150 m | Withdraw from caution zone at speed less than 6 knots |
| *A calf is defined as half the length of the mother/nearest adult | | | | |

7. Environmental outcomes and likelihood of significant impacts

This document has been prepared to identify the key species and assess the potential impacts associated with the Project through understanding the key species' ecological characteristics. Based on the database searches and literature review, it is considered that sufficient information was available to make the assessment. Therefore, no relevant data gaps regarding knowledge of key species were identified through this process and any lack of information (for example information on sea snakes) did not affect the ability to assess the impacts of this Project.

Overall, significant impacts to Marine Fauna are not anticipated and it is expected that the Project will meet the EPA Objective for Marine Fauna.

Consideration of the potential impacts to MNES has been based on the nature and magnitude of the activities associated with the Project (Table 26). Assessment of the significant impact criteria, as defined in MNES Significant Impact Guidelines (DoE 2013), in relation to the Project is presented in Table 27. With the proposed avoidance of ecological windows and other mitigation measures (Table 24), it is expected that the Project will result in acceptable impacts to marine fauna.

Therefore, the environmental outcome proposed to be achieved by the Proposal is ‘no reported negative impacts on marine fauna attributable to construction works’.

Table 26: Summary of nature and magnitude of the Project and potential impacts on marine fauna

| Criteria | Nature/magnitude |
|--|---|
| Sensitivity of the receiving environment | <p>Sensitive receptors include several marine fauna species, discussed in Section 4, may transit through the marine environment.</p> <p>The Project is of small scale, small DE and relatively small and manageable underwater noise PTS, TTS and behavioural response distances.</p> <p>No important habitats are restricted to the Project DE and all habitat within the DE is widely represented throughout the region.</p> |
| Timing, duration, and frequency of the Project and its impact | <p>The Project construction period is expected to be small given the size of the construction elements (e.g. jetty and access). Key ecological windows are presented in Table 19 Error! Not a valid result for table. and the Project construction activities will be planned with consideration to these windows, in particular the humpback whale southern migration and turtle nesting.</p> |
| On-site and off-site impacts | <p>As shown in the impact assessment (Section 5 and 6) residual impacts from underwater noise can be managed appropriately and onsite impacts can be managed appropriately.</p> |
| Direct and indirect impacts | <p>With the appropriate management measures in place, the residual risk of impacts to marine fauna is low.</p> <p>As presented in the impact assessment (Section 5 and 6 Error! Reference source not found.), direct impacts could include:</p> <ul style="list-style-type: none"> • Underwater noise emissions from piling causing behavioural disturbance, PTS or TTS • Injury or morality from vessel strike • Light pollution disrupting turtle, shorebird and seabird behaviours <p>Indirect impacts could include</p> <ul style="list-style-type: none"> • Entanglement and/or plastic ingestion from marine debris • Introduction of marine pest species resulting in decline in local marine fauna populations • Hydrocarbon spills causing marine fauna injury or mortality, and/or impacts to critical habitat |
| Total impacts which can be attributed to the Project over the entire geographic area affects, and over time | <p>The combined impact of the Project activities and the consequent Environmental Outcomes are not considered to pose any significant residual risk to the protection of marine fauna and therefore biological diversity and ecological integrity can be maintained.</p> |

| Criteria | Nature/magnitude |
|---|--|
| Existing level of impacts from other sources | <p>Existing environmental pressures may arise from the existing Ports south of the Project and the Onslow township. These pressures include but are not limited to:</p> <ul style="list-style-type: none"> • Lighting from Onslow township and Onslow Salt • The white colonial sea squirt presences at Port of Onslow • Vessel activity – hydrocarbon use, light, noise and movements • Waste and marine debris pollution from the Onslow township. <p>The Project will contribute a very small increase to these stressors, primarily during construction, and will not increase the residual risks.</p> |
| Degree of confidence with which the impacts of the action are known and understood. | <p>The impact assessment has been completed with a high degree of confidence based on comprehensive field and desktop-based study (Section 3 and 4).</p> |

Table 27: Assessment of significant impacts

| Significant criteria | Assessment of significance |
|--|---|
| Lead to a long-term decrease in the size of a population | No long-term decreases in population size of MNES is expected from the Project. |
| Reduced the area of occupancy of the species | Individuals or populations are not expected to be displaced from existing habitat and therefore the area of occupancy is not expected to be reduced for any MNES. |
| Fragment an existing population into two or more populations | The Project is not expected to create a barrier to movement of individuals, or displace individuals and/or population which could cause population fragmentation. |
| Adversely affect habitat critical to the survival of a species | <p>No habitat on the Register of Critical Habitat under the EPBC Act are located within the Project DE or in the adjacent areas.</p> <p>Management measures will reduce the likelihood of artificial light pollution and it is not expected to have adverse effect on the flatback, green, and hawksbill nesting habitat critical for the survival of the species as defined in the Turtle Recovery Plan (DoEE 2017).</p> |
| Disrupt the breeding cycle of a population | Breeding cycles of MNES have been identified in Section 5.2. The Project is not expected to disrupt the breeding cycle of any marine fauna species identified in the desktop assessment. |



| Significant impact criteria | Assessment of significance |
|--|--|
| Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that a species is likely to decline | The Project DE is small, and includes minimal loss of intertidal and subtidal habitats, and the area does not support important for marine fauna species. It is not expected the Project will result in species population declines. |
| Result in invasive species that are harmful to a species becoming established in the endangered or vulnerable species' habitat | The risk of marine pests and terrestrial pests during construction and operational phases of the Project is considered to be negligible. |
| Introduce disease that may cause the species to decline | No vectors for introduction of disease have been identified. |
| Interfere with the recovery of the species | The impact assessment determined that the potential for residual impacts to marine fauna is low and it is not expected to result in significant impacts in the above criteria. Therefore, the Project is not expected to interfere with the recovery of species. |

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Appendix A. PMST search results



Australian Government

Department of Climate Change, Energy,
the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 04-Jul-2024

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

| | |
|---|------|
| World Heritage Properties: | None |
| National Heritage Places: | None |
| Wetlands of International Importance (Ramsar) | None |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Area: | None |
| Listed Threatened Ecological Communities: | None |
| Listed Threatened Species: | 37 |
| Listed Migratory Species: | 50 |

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <https://www.dcceew.gov.au/parks-heritage/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

| | |
|---|------|
| Commonwealth Lands: | 3 |
| Commonwealth Heritage Places: | None |
| Listed Marine Species: | 89 |
| Whales and Other Cetaceans: | 14 |
| Critical Habitats: | None |
| Commonwealth Reserves Terrestrial: | None |
| Australian Marine Parks: | None |
| Habitat Critical to the Survival of Marine Turtles: | 3 |

Extra Information

This part of the report provides information that may also be relevant to the area you have

| | |
|---|------|
| State and Territory Reserves: | 1 |
| Regional Forest Agreements: | None |
| Nationally Important Wetlands: | None |
| EPBC Act Referrals: | 16 |
| Key Ecological Features (Marine): | None |
| Biologically Important Areas: | 9 |
| Bioregional Assessments: | None |
| Geological and Bioregional Assessments: | None |

Details

Matters of National Environmental Significance

Listed Threatened Species

[\[Resource Information \]](#)

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.

Number is the current name ID.

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|-----------------------|--|-----------------|
| BIRD | | | |
| Calidris acuminata Sharp-tailed Sandpiper [874] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Calidris canutus Red Knot, Knot [855] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Calidris ferruginea Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area | In feature area |
| Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Erythrotriorchis radiatus Red Goshawk [942] | Endangered | Species or species habitat may occur within area | In feature area |
| Falco hypoleucos Grey Falcon [929] | Vulnerable | Species or species habitat likely to occur within area | In feature area |
| Limnodromus semipalmatus Asian Dowitcher [843] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432] | Endangered | Species or species habitat known to occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|------------------------|--|-----------------|
| Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area | In feature area |
| Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area | In feature area |
| Pezoporus occidentalis Night Parrot [59350] | Endangered | Species or species habitat may occur within area | In feature area |
| Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021] | Endangered | Species or species habitat may occur within area | In feature area |
| Phaethon rubricauda westralis Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824] | Endangered | Species or species habitat may occur within area | In feature area |
| Rostratula australis Australian Painted Snipe [77037] | Endangered | Species or species habitat may occur within area | In feature area |
| Sternula nereis nereis Australian Fairy Tern [82950] | Vulnerable | Breeding known to occur within area | In feature area |
| Thalassarche carteri Indian Yellow-nosed Albatross [64464] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Tringa nebularia Common Greenshank, Greenshank [832] | Endangered | Species or species habitat likely to occur within area | In feature area |
| FISH | | | |
| Thunnus maccoyii Southern Bluefin Tuna [69402] | Conservation Dependent | Species or species habitat likely to occur within area | In feature area |
| MAMMAL | | | |
| Balaenoptera musculus Blue Whale [36] | Endangered | Species or species habitat likely to occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|-----------------------|--|---------------------|
| Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331] | Endangered | Species or species habitat known to occur within area | In feature area |
| Eubalaena australis Southern Right Whale [40] | Endangered | Species or species habitat may occur within area | In buffer area only |
| Macroderma gigas Ghost Bat [174] | Vulnerable | Species or species habitat likely to occur within area | In feature area |
| Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790] | Vulnerable | Species or species habitat may occur within area | In buffer area only |
| REPTILE | | | |
| Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115] | Critically Endangered | Species or species habitat likely to occur within area | In feature area |
| Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118] | Critically Endangered | Species or species habitat known to occur within area | In feature area |
| Caretta caretta Loggerhead Turtle [1763] | Endangered | Species or species habitat known to occur within area | In feature area |
| Chelonia mydas Green Turtle [1765] | Vulnerable | Breeding known to occur within area | In feature area |
| Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Breeding likely to occur within area | In feature area |
| Eretmochelys imbricata Hawksbill Turtle [1766] | Vulnerable | Breeding known to occur within area | In feature area |
| Natator depressus Flatback Turtle [59257] | Vulnerable | Breeding known to occur within area | In feature area |

SHARK

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|--|------------------------|--|-----------------|
| Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752] | Vulnerable | Species or species habitat likely to occur within area | In feature area |
| Carcharodon carcharias White Shark, Great White Shark [64470] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Rhincodon typus Whale Shark [66680] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Sphyrna lewini Scalloped Hammerhead [85267] | Conservation Dependent | Species or species habitat likely to occur within area | In feature area |

Listed Migratory Species [[Resource Information](#)]

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|--|---------------------|--|-----------------|
| Migratory Marine Birds | | | |
| Anous stolidus Common Noddy [825] | | Species or species habitat may occur within area | In feature area |
| Apus pacificus Fork-tailed Swift [678] | | Species or species habitat likely to occur within area | In feature area |
| Calonectris leucomelas Streaked Shearwater [1077] | | Species or species habitat likely to occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|--|---------------------|--|---------------------|
| Fregata ariel Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat likely to occur within area | In feature area |
| Hydroprogne caspia Caspian Tern [808] | | Breeding known to occur within area | In buffer area only |
| Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area | In feature area |
| Onychoprion anaethetus Bridled Tern [82845] | | Breeding known to occur within area | In buffer area only |
| Phaethon lepturus White-tailed Tropicbird [1014] | | Species or species habitat may occur within area | In feature area |
| Sterna dougallii Roseate Tern [817] | | Foraging, feeding or related behaviour likely to occur within area | In buffer area only |
| Sternula albifrons Little Tern [82849] | | Breeding known to occur within area | In feature area |
| Thalassarche carteri Indian Yellow-nosed Albatross [64464] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Migratory Marine Species | | | |
| Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448] | | Species or species habitat likely to occur within area | In feature area |
| Balaenoptera edeni Bryde's Whale [35] | | Species or species habitat may occur within area | In feature area |
| Balaenoptera musculus Blue Whale [36] | Endangered | Species or species habitat likely to occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|---------------------|--|---------------------|
| Carcharhinus longimanus Oceanic Whitetip Shark [84108] | | Species or species habitat may occur within area | In feature area |
| Carcharodon carcharias White Shark, Great White Shark [64470] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Caretta caretta Loggerhead Turtle [1763] | Endangered | Species or species habitat known to occur within area | In feature area |
| Chelonia mydas Green Turtle [1765] | Vulnerable | Breeding known to occur within area | In feature area |
| Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Breeding likely to occur within area | In feature area |
| Dugong dugon Dugong [28] | | Species or species habitat known to occur within area | In feature area |
| Eretmochelys imbricata Hawksbill Turtle [1766] | Vulnerable | Breeding known to occur within area | In feature area |
| Eubalaena australis as Balaena glacialis australis Southern Right Whale [40] | Endangered | Species or species habitat may occur within area | In buffer area only |
| Megaptera novaeangliae Humpback Whale [38] | | Breeding known to occur within area | In feature area |
| Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033] | | Species or species habitat known to occur within area | In feature area |
| Mobula birostris as Manta birostris Giant Manta Ray [90034] | | Species or species habitat likely to occur within area | In feature area |
| Natator depressus Flatback Turtle [59257] | Vulnerable | Breeding known to occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|--|---------------------|---|-----------------|
| Orcaella heinsohni Australian Snubfin Dolphin [81322] | | Species or species habitat known to occur within area | In feature area |
| Orcinus orca Killer Whale, Orca [46] | | Species or species habitat may occur within area | In feature area |
| Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Rhincodon typus Whale Shark [66680] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Sousa sahalensis as Sousa chinensis Australian Humpback Dolphin [87942] | | Species or species habitat known to occur within area | In feature area |
| Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900] | | Species or species habitat known to occur within area | In feature area |
| Migratory Terrestrial Species | | | |
| Hirundo rustica Barn Swallow [662] | | Species or species habitat may occur within area | In feature area |
| Motacilla cinerea Grey Wagtail [642] | | Species or species habitat may occur within area | In feature area |
| Motacilla flava Yellow Wagtail [644] | | Species or species habitat may occur within area | In feature area |

Migratory Wetlands Species

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|--|-----------------------|--|-----------------|
| Actitis hypoleucos Common Sandpiper [59309] | | Species or species habitat known to occur within area | In feature area |
| Calidris acuminata Sharp-tailed Sandpiper [874] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Calidris canutus Red Knot, Knot [855] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Calidris ferruginea Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area | In feature area |
| Calidris melanotos Pectoral Sandpiper [858] | | Species or species habitat likely to occur within area | In feature area |
| Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Charadrius veredus Oriental Plover, Oriental Dotterel [882] | | Species or species habitat may occur within area | In feature area |
| Glareola maldivarum Oriental Pratincole [840] | | Species or species habitat may occur within area | In feature area |
| Limnodromus semipalmatus Asian Dowitcher [843] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Limosa lapponica Bar-tailed Godwit [844] | | Species or species habitat known to occur within area | In feature area |
| Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|---------------------|--|-----------------|
| Pandion haliaetus Osprey [952] | | Breeding known to occur within area | In feature area |
| Tringa nebularia Common Greenshank, Greenshank [832] | Endangered | Species or species habitat likely to occur within area | In feature area |

Other Matters Protected by the EPBC Act

Commonwealth Lands [\[Resource Information \]](#)

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

| Commonwealth Land Name | State | Buffer Status |
|-----------------------------|-------|---------------------|
| Unknown | | |
| Commonwealth Land - [50385] | WA | In buffer area only |
| Commonwealth Land - [51887] | WA | In buffer area only |
| Commonwealth Land - [51104] | WA | In buffer area only |

Listed Marine Species [\[Resource Information \]](#)

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|---------------------|--|-----------------|
| Bird | | | |
| Actitis hypoleucos Common Sandpiper [59309] | | Species or species habitat known to occur within area | In feature area |
| Anous stolidus Common Noddy [825] | | Species or species habitat may occur within area | In feature area |
| Apus pacificus Fork-tailed Swift [678] | | Species or species habitat likely to occur within area overfly marine area | In feature area |
| Bubulcus ibis as Ardea ibis Cattle Egret [66521] | | Species or species habitat may occur within area overfly marine area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|-----------------------|--|---------------------|
| Calidris acuminata Sharp-tailed Sandpiper [874] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Calidris canutus Red Knot, Knot [855] | Vulnerable | Species or species habitat may occur within area overfly marine area | In feature area |
| Calidris ferruginea Curlew Sandpiper [856] | Critically Endangered | Species or species habitat known to occur within area overfly marine area | In feature area |
| Calidris melanotos Pectoral Sandpiper [858] | | Species or species habitat likely to occur within area overfly marine area | In feature area |
| Calonectris leucomelas Streaked Shearwater [1077] | | Species or species habitat likely to occur within area | In feature area |
| Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425] | | Species or species habitat known to occur within area overfly marine area | In feature area |
| Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877] | Vulnerable | Species or species habitat known to occur within area | In feature area |
| Charadrius veredus Oriental Plover, Oriental Dotterel [882] | | Species or species habitat may occur within area overfly marine area | In feature area |
| Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326] | | Breeding known to occur within area | In buffer area only |
| Fregata ariel Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat likely to occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|--|---------------------|--|---------------------|
| Glareola maldivarum Oriental Pratincole [840] | | Species or species habitat may occur within area overfly marine area | In feature area |
| Haliaeetus leucogaster White-bellied Sea-Eagle [943] | | Species or species habitat known to occur within area | In feature area |
| Hirundo rustica Barn Swallow [662] | | Species or species habitat may occur within area overfly marine area | In feature area |
| Hydroprogne caspia as Sterna caspia Caspian Tern [808] | | Breeding known to occur within area | In buffer area only |
| Limnodromus semipalmatus Asian Dowitcher [843] | Vulnerable | Species or species habitat may occur within area overfly marine area | In feature area |
| Limosa lapponica Bar-tailed Godwit [844] | | Species or species habitat known to occur within area | In feature area |
| Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area | In feature area |
| Merops ornatus Rainbow Bee-eater [670] | | Species or species habitat may occur within area overfly marine area | In feature area |
| Motacilla cinerea Grey Wagtail [642] | | Species or species habitat may occur within area overfly marine area | In feature area |
| Motacilla flava Yellow Wagtail [644] | | Species or species habitat may occur within area overfly marine area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|--|-----------------------|--|---------------------|
| Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area | In feature area |
| Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845] | | Breeding known to occur within area | In buffer area only |
| Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682] | | Breeding known to occur within area | In buffer area only |
| Pandion haliaetus Osprey [952] | | Breeding known to occur within area | In feature area |
| Phaethon lepturus White-tailed Tropicbird [1014] | | Species or species habitat may occur within area | In feature area |
| Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021] | Endangered | Species or species habitat may occur within area | In feature area |
| Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037] | Endangered | Species or species habitat may occur within area overfly marine area | In feature area |
| Sterna dougallii Roseate Tern [817] | | Foraging, feeding or related behaviour likely to occur within area | In buffer area only |
| Sternula albifrons as Sterna albifrons Little Tern [82849] | | Breeding known to occur within area | In feature area |
| Sternula nereis as Sterna nereis Fairy Tern [82949] | | Breeding known to occur within area | In buffer area only |
| Thalassarche carteri Indian Yellow-nosed Albatross [64464] | Vulnerable | Species or species habitat may occur within area | In feature area |
| Thalasseus bengalensis as Sterna bengalensis Lesser Crested Tern [66546] | | Breeding known to occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|--|---------------------|--|---------------------|
| Tringa nebularia Common Greenshank, Greenshank [832] | Endangered | Species or species habitat likely to occur within area overfly marine area | In feature area |
| Fish | | | |
| Acentronura larsonae Helen's Pygmy Pipehorse [66186] | | Species or species habitat may occur within area | In buffer area only |
| Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189] | | Species or species habitat may occur within area | In feature area |
| Campichthys tricarinatus Three-keel Pipefish [66192] | | Species or species habitat may occur within area | In feature area |
| Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194] | | Species or species habitat may occur within area | In feature area |
| Choeroichthys latispinosus Muiron Island Pipefish [66196] | | Species or species habitat may occur within area | In buffer area only |
| Choeroichthys suillus Pig-snouted Pipefish [66198] | | Species or species habitat may occur within area | In feature area |
| Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210] | | Species or species habitat may occur within area | In buffer area only |
| Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212] | | Species or species habitat may occur within area | In feature area |
| Doryrhamphus multiannulatus Many-banded Pipefish [66717] | | Species or species habitat may occur within area | In buffer area only |
| Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213] | | Species or species habitat may occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|---------------------|--|-----------------|
| Festucalex scalaris Ladder Pipefish [66216] | | Species or species habitat may occur within area | In feature area |
| Filicampus tigris Tiger Pipefish [66217] | | Species or species habitat may occur within area | In feature area |
| Halicampus brocki Brock's Pipefish [66219] | | Species or species habitat may occur within area | In feature area |
| Halicampus grayi Mud Pipefish, Gray's Pipefish [66221] | | Species or species habitat may occur within area | In feature area |
| Halicampus nitidus Glittering Pipefish [66224] | | Species or species habitat may occur within area | In feature area |
| Halicampus spinostris Spiny-snout Pipefish [66225] | | Species or species habitat may occur within area | In feature area |
| Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226] | | Species or species habitat may occur within area | In feature area |
| Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231] | | Species or species habitat may occur within area | In feature area |
| Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234] | | Species or species habitat may occur within area | In feature area |
| Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236] | | Species or species habitat may occur within area | In feature area |
| Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237] | | Species or species habitat may occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|---------------------|---|---------------------|
| Hippocampus planifrons Flat-face Seahorse [66238] | | Species or species habitat may occur within area | In feature area |
| Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720] | | Species or species habitat may occur within area | In feature area |
| Micrognathus micronotopterus Tidepool Pipefish [66255] | | Species or species habitat may occur within area | In feature area |
| Phoxocampus belcheri Black Rock Pipefish [66719] | | Species or species habitat may occur within area | In buffer area only |
| Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272] | | Species or species habitat may occur within area | In feature area |
| Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273] | | Species or species habitat may occur within area | In feature area |
| Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183] | | Species or species habitat may occur within area | In feature area |
| Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279] | | Species or species habitat may occur within area | In feature area |
| Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280] | | Species or species habitat may occur within area | In feature area |
| Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281] | | Species or species habitat may occur within area | In feature area |
| Mammal | | | |
| Dugong dugon Dugong [28] | | Species or species habitat known to occur within area | In feature area |

Reptile

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|--|-----------------------|--|-----------------|
| Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115] | Critically Endangered | Species or species habitat likely to occur within area | In feature area |
| Aipysurus duboisii Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116] | | Species or species habitat may occur within area | In feature area |
| Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118] | Critically Endangered | Species or species habitat known to occur within area | In feature area |
| Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120] | | Species or species habitat may occur within area | In feature area |
| Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261] | | Species or species habitat may occur within area | In feature area |
| Caretta caretta Loggerhead Turtle [1763] | Endangered | Species or species habitat known to occur within area | In feature area |
| Chelonia mydas Green Turtle [1765] | Vulnerable | Breeding known to occur within area | In feature area |
| Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Breeding likely to occur within area | In feature area |
| Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125] | | Species or species habitat may occur within area | In feature area |
| Ephalophis greyae as Ephalophis greyi Mangrove Sea Snake [93738] | | Species or species habitat may occur within area | In feature area |
| Eretmochelys imbricata Hawksbill Turtle [1766] | Vulnerable | Breeding known to occur within area | In feature area |
| Hydrophis czeblukovi Fine-spined Sea Snake [59233] | | Species or species habitat may occur within area | In feature area |

| Scientific Name | Threatened Category | Presence Text | Buffer Status |
|---|---------------------|--|-----------------|
| Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104] | | Species or species habitat may occur within area | In feature area |
| Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511] | | Species or species habitat may occur within area | In feature area |
| Hydrophis major as Disteira major Olive-headed Sea Snake [93512] | | Species or species habitat may occur within area | In feature area |
| Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111] | | Species or species habitat may occur within area | In feature area |
| Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509] | | Species or species habitat may occur within area | In feature area |
| Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746] | | Species or species habitat may occur within area | In feature area |
| Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510] | | Species or species habitat may occur within area | In feature area |
| Natator depressus Flatback Turtle [59257] | Vulnerable | Breeding known to occur within area | In feature area |

Whales and Other Cetaceans [Resource Information]

| Current Scientific Name | Status | Type of Presence | Buffer Status |
|--|------------|--|-----------------|
| Mammal | | | |
| Balaenoptera acutorostrata Minke Whale [33] | | Species or species habitat may occur within area | In feature area |
| Balaenoptera edeni Bryde's Whale [35] | | Species or species habitat may occur within area | In feature area |
| Balaenoptera musculus Blue Whale [36] | Endangered | Species or species habitat likely to occur within area | In feature area |

| Current Scientific Name | Status | Type of Presence | Buffer Status |
|---|------------|--|---------------------|
| Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60] | | Species or species habitat may occur within area | In feature area |
| Eubalaena australis Southern Right Whale [40] | Endangered | Species or species habitat may occur within area | In buffer area only |
| Grampus griseus Risso's Dolphin, Grampus [64] | | Species or species habitat may occur within area | In feature area |
| Megaptera novaeangliae Humpback Whale [38] | | Breeding known to occur within area | In feature area |
| Orcaella heinsohni Australian Snubfin Dolphin [81322] | | Species or species habitat known to occur within area | In feature area |
| Orcinus orca Killer Whale, Orca [46] | | Species or species habitat may occur within area | In feature area |
| Sousa sahalensis Australian Humpback Dolphin [87942] | | Species or species habitat known to occur within area | In feature area |
| Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51] | | Species or species habitat may occur within area | In feature area |
| Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418] | | Species or species habitat likely to occur within area | In feature area |
| Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900] | | Species or species habitat known to occur within area | In feature area |
| Tursiops truncatus s. str. Bottlenose Dolphin [68417] | | Species or species habitat may occur within area | In feature area |

Habitat Critical to the Survival of Marine Turtles [\[Resource Information \]](#)

| Scientific Name | Behaviour | Presence | Buffer Status |
|--|-----------|----------------|-----------------|
| Aug - Sep | | | |
| Natator depressus | | | |
| Flatback Turtle [59257] | Nesting | Known to occur | In feature area |
| Dec - Jan | | | |
| Chelonia mydas | | | |
| Green Turtle [1765] | Nesting | Known to occur | In feature area |
| Nov - May | | | |
| Eretmochelys imbricata | | | |
| Hawksbill Turtle [1766] | Nesting | Known to occur | In feature area |

Extra Information**State and Territory Reserves** [\[Resource Information \]](#)

| Protected Area Name | Reserve Type | State | Buffer Status |
|---------------------|----------------|-------|---------------------|
| Thevenard Island | Nature Reserve | WA | In buffer area only |

EPBC Act Referrals [\[Resource Information \]](#)

| Title of referral | Reference | Referral Outcome | Assessment Status | Buffer Status |
|--|-----------|-----------------------|-------------------|---------------------|
| Ashburton Infrastructure Project | 2021/9064 | | Completed | In buffer area only |
| Controlled action | | | | |
| Construct and operate LNG & domestic gas plant including onshore and offshore facilities - Wheatston | 2008/4469 | Controlled Action | Post-Approval | In feature area |
| Greater Gorgon Development - Optical Fibre Cable, Mainland to Barrow Island | 2005/2141 | Controlled Action | Completed | In feature area |
| Proposed West Pilbara Iron Ore Project | 2009/4706 | Controlled Action | Post-Approval | In buffer area only |
| Not controlled action | | | | |
| Baniyas-1 Exploration Well, EP-424, near Onslow | 2007/3282 | Not Controlled Action | Completed | In buffer area only |
| Construct 110km buried natural gas pipeline from Onslow, connecting to Dampier/Bunbury natural gas p | 2013/7039 | Not Controlled Action | Completed | In buffer area only |
| Improving rabbit biocontrol: releasing another strain of RHDV. | 2015/7522 | Not Controlled Action | Completed | In feature area |

| Title of referral | Reference | Referral Outcome | Assessment Status | Buffer Status |
|--|-----------|-----------------------|-------------------|---------------------|
| Not controlled action | | | | |
| sthrn two thirds of Australia | | | | |
| Onslow Power Infrastructure Upgrade Project, Onslow, WA | 2014/7314 | Not Controlled Action | Completed | In buffer area only |
| Onslow Rare Earths Plant | 2021/9046 | Not Controlled Action | Completed | In buffer area only |
| Onslow Water Supply Infrastructure Upgrade Project, Onslow, WA | 2014/7329 | Not Controlled Action | Completed | In buffer area only |
| Thevenard Island Retirement Project | 2015/7423 | Not Controlled Action | Completed | In buffer area only |
| To construct and operate an offshore submarine fibre optic cable, WA | 2014/7373 | Not Controlled Action | Completed | In buffer area only |

| | | | | |
|---|-----------|---|---------------|---------------------|
| Not controlled action (particular manner) | | | | |
| 2D and 3D seismic surveys | 2005/2151 | Not Controlled Action (Particular Manner) | Post-Approval | In feature area |
| Macedon Gas Field Development | 2008/4605 | Not Controlled Action (Particular Manner) | Post-Approval | In buffer area only |
| Ocean Bottom Cable Seismic Survey | 2005/2017 | Not Controlled Action (Particular Manner) | Post-Approval | In feature area |
| Onslow Seawater Desalination Plant Marine Geophysical Investigation | 2020/8794 | Not Controlled Action (Particular Manner) | Post-Approval | In buffer area only |

| Biologically Important Areas | | | [Resource Information] | |
|---|---------------------|----------------|--------------------------|--|
| Scientific Name | Behaviour | Presence | Buffer Status | |
| Marine Turtles | | | | |
| Eretmochelys imbricata Hawksbill Turtle [1766] | Internesting buffer | Known to occur | In feature area | |
| Eretmochelys imbricata Hawksbill Turtle [1766] | Nesting | Known to occur | In buffer area only | |
| Natator depressus Flatback Turtle [59257] | Internesting buffer | Known to occur | In feature area | |

| Scientific Name | Behaviour | Presence | Buffer Status |
|---|--------------------------------|----------------|---------------------|
| Natator depressus Flatback Turtle [59257] | Nesting | Known to occur | In feature area |
| Seabirds | | | |
| Ardena pacifica Wedge-tailed Shearwater [84292] | Breeding | Known to occur | In feature area |
| Sterna dougallii Roseate Tern [817] | Breeding | Known to occur | In buffer area only |
| Sternula nereis Fairy Tern [82949] | Breeding | Known to occur | In buffer area only |
| Thalasseus bengalensis Lesser Crested Tern [66546] | Breeding | Known to occur | In feature area |
| Whales | | | |
| Megaptera novaeangliae Humpback Whale [38] | Migration (north and south) | Known to occur | In feature area |

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact us](#) page.

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Appendix B. Summary of database information and likelihood of occurrence assessment

Mammals

| Species | Conservation Status | Relevant EPBC policy and guidance | Species information | Likelihood of Occurrence |
|---|---|---|--|--|
| Australian humpback dolphin (<i>Sousa sahulensis</i>) | EPBC Act: Migratory Cetacean BC Act: P4 Migratory IUCN Status: Vulnerable | <ul style="list-style-type: none"> Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.1.1 | <p>High potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Known' Many sightings within the Project area and surrounds (DBCA 2024; Hanf et al 2022) |
| Australian snubfin dolphin (<i>Orcaella heinshohni</i>) | EPBC Act: Migratory Cetacean BC Act: P4 Migratory IUCN Status: Vulnerable | <ul style="list-style-type: none"> Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>Populations of the Australian snubfin dolphin (snubfin dolphin) have been estimated as likely to be less than 10,000 individuals, spread across northern Australia from Broome in WA to the Brisbane River in Qld (DCCEEW 2024c), however there have been recorded sightings around Onslow (Hanf et al. 2022; DBCA 2024). They are generally found in water depths less than 20 m deep, often close to the coast, rivers, or creek mouths (Parra et al. 2022).</p> <p>The species have similar habitats to the Indo-pacific humpback dolphin, with evidence the species are sympatric (occurring in the same area) throughout their</p> | <p>Moderate potential of occur</p> <ul style="list-style-type: none"> PMST ranking 'known' Only 2 recorded sightings, both within 2014 and 8.8 km from the Project (DBCA 2024) The project area is outside of their recognised range (SSC Cetacean Specialist Group 2017) and the Project site is not located close to an estuary. |

| Species | Conservation Status | Relevant EPBC policy and guidance | Species information | Likelihood of Occurrence |
|---|--|--|---|---|
| | | | Australian range, exhibiting resource partitioning in areas where they co-occur (Parra et al 2006; Hanf et al. 2022). | |
| Blue whale (<i>Balaenoptera musculus</i>) Pygmy blue whale (<i>B. m. breviceuda</i>) | EPBC Act: Migratory Cetacean BC Act: Endangered IUCN Status: Endangered | <ul style="list-style-type: none"> Conservation Management Plan for the Blue Whale (DoE 2015a) Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | 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. Population sizes are difficult to estimate due to the large range and aggregation locations are generally unknown (Thums et al. 2022). 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 (Cooke 2018). | <p>Low potential to occur</p> <ul style="list-style-type: none"> PMST ranking ‘likely’ The species has not been recorded in depths of <10 m and is only located in deep waters of the continental slope generally >200 km offshore (Thums et al. 2022) The BIA migration BIA is approximately 100 km offshore along the Onslow coast. The species has not been recorded in the Project area (no records from desktop searches) |
| Dugong (<i>Dugong dugon</i>) | EPBC Act: Migratory Marine BC Act: Migratory IUCN Status: Vulnerable | <ul style="list-style-type: none"> Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.1.3 | <p>High potential to occur</p> <ul style="list-style-type: none"> PMST ranking ‘Known’ Over 95 records within the region, including records within a 1 km of the proposed Project DE (DBCA 2024) Seagrass is variable across the Pilbara but has been recorded at Thevenard Island which is located 20 km directly offshore from the proposed Project DE (Vanderklift et al. 2017) |

| Species | Conservation Status | Relevant EPBC policy and guidance | Species information | Likelihood of Occurrence |
|--|---|--|---|---|
| Humpback whale (<i>Megaptera novaeangliae</i>) | <p>EPBC Act: Migratory Cetacean</p> <p>BC Act: Conservation dependent Migratory</p> <p>IUCN Status: Least Concern</p> | <ul style="list-style-type: none"> • Listing Advice <i>Megaptera novaeangliae</i> Humpback Whale (TSSC 2022) • Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018) • National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE 2017a) • Australian National Guidelines for Whale and Dolphin Watching 2017 (DoEE 2017b) • Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.1.4 | <p>High potential to occur</p> <ul style="list-style-type: none"> • PMST ranking 'breeding known to occur' • Have been recorded in high numbers throughout the search area • Humpback whale migration BIA overlaps with the Project area • Typically occur further offshore (>35 km) during migratory routes, although some whales recorded in <10 m during southern migration (i.e. July to September). |
| Southern right whale (<i>Eubalaena australis</i>) | <p>EPBC Act: Cetacean</p> <p>BC Act: Vulnerable</p> <p>IUCN Status:</p> | <ul style="list-style-type: none"> • National Recovery Plan for the Southern Right Whale <i>Eubalaena australis</i> (DCCEEW 2024g) | Late 20th century sightings of Australian right whales have been concentrated in coastal waters of Western and South Australia, and to a lesser extent off Victoria, Tasmania and New South Wales . There have been records as far north as Exmouth, WA (22°23'S, 114°07'E), on the north west coast, | <p>Low potential to occur</p> <ul style="list-style-type: none"> • PMST ranking 'May' • Project location is northern fringe of where the species or species habitat may occur |

| Species | Conservation Status | Relevant EPBC policy and guidance | Species information | Likelihood of Occurrence |
|--|---|---|---|--|
| | Least Concern | <ul style="list-style-type: none"> Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018). | <p>and north of Sydney (33°53'S, 151°12'E) to Cape Byron, NSW (28°39'S, 153°37'E), on the east coast, but in general animals are concentrated along the south coast from west of Albany, WA to the Head of the Bight, SA (DCCEEW 2024g)</p> <p>They feed in deep oceanic waters in summer and move into coastal waters during summer months (DCCEEW 2024g).</p> | <ul style="list-style-type: none"> Not preferred habitat (cooler waters preferred) One unverified sighting within 20 km of the Project area |
| Indo-Pacific/ spotted bottlenose dolphin (<i>Tursiops aduncus</i>) | <p>EPBC Act: Cetacean</p> <p>BC Act: Migratory</p> <p>IUCN Status: Threatened</p> | <ul style="list-style-type: none"> Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.1.2 | <p>High potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'likely' Sightings have been recorded within 10 km of the Project area (Hanf et al 2022) Australian humpback and Indo-Pacific bottlenose dolphins are both found throughout the study area. They share similar behavioural activities, with some degree of spatial overlap, though are generally located in slightly deeper waters. |

Reptiles

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|---|--|---------------------|---|
| Flatback turtle (<i>Natator depressus</i>) | EPBC Act: Vulnerable Migratory Marine BC Act: Vulnerable IUCN Status: Data deficient | <ul style="list-style-type: none"> Recovery Plan for Marine Turtles in Australia (CoA 2017a) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). Threat abatement plan for predation, habitat degradation, competition, and disease transmission by feral pigs (<i>Sus scrofa</i>) (DoEE 2017d) Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018) Threat abatement plan for predation by the European red fox (DEWHA 2008A). | See Section 4.2.3 | High potential to occur <ul style="list-style-type: none"> PMST ranking 'breeding known to occur' Within nesting and interesting BIAs This species has been recorded many times in the Project region (DBCA 2024) Known presence on mainland Australian beaches and offshore islands, such as Thevenard Island (Pendoley Environmental 2022) |
| Green turtle (<i>Chelonia mydas</i>) | EPBC Act: Vulnerable Migratory Marine BC Act: Vulnerable | <ul style="list-style-type: none"> Recovery Plan for Marine Turtles in Australia (DoEE 2017c) Threat abatement plan for predation, habitat degradation, competition, and disease transmission by feral pigs (<i>Sus scrofa</i>) (DoEE 2017d) Threat Abatement Plan for the impacts of marine debris on the | See Section 4.2.1 | High potential to occur <ul style="list-style-type: none"> Sighted within 20 km of Project area (DBCA 2024) PMST ranking 'Known' Suitable foraging habitat overlap No BIAs though the Project site is within Habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|---|--|---|--|
| | IUCN Status: Endangered | vertebrate wildlife of Australia's coasts and oceans (DoEE 2018) <ul style="list-style-type: none"> Threat abatement plan for predation by the European red fox (DEWHA 2008A) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | | Critical to Green Turtle survival |
| Hawksbill turtle (<i>Eretmochelys imbricata</i>) | EPBC Act: Vulnerable Migratory Marine BC Act: Vulnerable IUCN Status: Critically endangered | <ul style="list-style-type: none"> Recovery Plan for Marine Turtles in Australia (DoEE 2017c) Threat abatement plan for predation, habitat degradation, competition, and disease transmission by feral pigs (<i>Sus scrofa</i>) (DoEE 2017d) Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018) Threat abatement plan for predation by feral cats (DoE 2015a) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.2.2 | High potential to occur <ul style="list-style-type: none"> PMST ranking 'Known' Sighted within nearshore elements of the search area (within 20 km) (DBCA 2024) Habitat critical to the survival of marine turtles overlap with the nearshore elements of the search area (DCCEEW 2024c). Interesting buffer BIAs overlapping the Project site with a Nesting BIA at Thevenard Island approximately 20 km north of Project site |
| Leaf-scaled sea snake (<i>Aipysurus foliosquama</i>) | EPBC Act: Critically Endangered Marine | <ul style="list-style-type: none"> Approved Conservation Advice for <i>Aipysurus foliosquama</i> (Leaf-scaled Sea Snake) (DSEWPaC 2011c) | Population numbers of the leaf-scaled sea snake are unknown and are only found in a number of areas within the North-West bioregion of Western Australia (DCCEEW 2024c). Suitable habitats have | Moderate potential to occur <ul style="list-style-type: none"> PMST ranking 'Known' Low numbers of species recorded in the region and |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|---|---|---|---|
| | <p>BC Act: Critically endangered</p> <p>IUCN Status: Data deficient</p> | <ul style="list-style-type: none"> Commonwealth Listing Advice on <i>Aipysurus foliosquama</i> (Leaf-scaled Sea snake) (TSSC 2011c) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>been found to be coral reefs around islands in the Pilbara region (Udyawer et al. 2020) and can also include seagrass meadows in subtropical Shark Bay (D'Anastasi et al. 2016). They occur primarily on the reef flats or in shallow waters of the outer reef edges to depths of 10 m, and very few move even 50 m away from the reef flat.</p> | <p>none recoded within the search area</p> <ul style="list-style-type: none"> Moderate habitat suitability within the search area (Udyawer et al. 2020) |
| <p>Leatherback turtle (<i>Dermochelys coriacea</i>)</p> | <p>EPBC Act: Endangered Migratory Marine</p> <p>BC Act: Vulnerable</p> <p>IUCN Status: Vulnerable</p> | <ul style="list-style-type: none"> Recovery Plan for Marine Turtles in Australia (DoEE 2017a) Approved Conservation Advice for <i>Dermochelys coriacea</i> (Leatherback Turtle) (DEWHA 2008b) Commonwealth Listing Advice on <i>Dermochelys coriacea</i> (TSSC 2009a) Threat abatement plan for predation, habitat degradation, competition, and disease transmission by feral pigs (<i>Sus scrofa</i>) (DoEE 2017d) Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018) Threat abatement plan for predation by the European red fox (DEWHA 2008a) | <p>There are potentially three distinct leatherback turtle stocks in the Indo-pacific region. Leatherback turtle that nest in Australia area all part of the Australian stock (DoEE 2017a).</p> <p>Leatherback turtles forage throughout Australian waters and predominantly found in central eastern Australia, southern-east Australia and south-western WA (DoEE 2017a).</p> | <p>Low potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Likely' Species has not been recorded in the region (no records from desktop searches and no known nesting sites within the Pilbara region) No BIAs in the region Given the species wide geographical range they may occur infrequently |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|--|--|---|--|
| | | <ul style="list-style-type: none"> Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | | |
| Loggerhead turtle (<i>Caretta caretta</i>) | EPBC Act: Endangered Migratory Marine BC Act: Endangered IUCN Status: Vulnerable | <ul style="list-style-type: none"> Recovery Plan for Marine Turtles in Australia (DoEE 2017a) Threat abatement plan for predation, habitat degradation, competition, and disease transmission by feral pigs (<i>Sus scrofa</i>) (DoEE 2017d) Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018) Threat abatement plan for predation by the European red fox (DEWHA 2008a) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | In Australia there are two distinct loggerhead turtle genetic stocks. Those found in the Pilbara region are part of the Western Australian stock. They live at or near the surface of the ocean and move with the ocean currents, choosing a wide variety of tidal and sub-tidal habitat as feeding areas and showing fidelity to both their foraging and breeding areas nesting on open, sandy beaches and (DoEE 2017a). | Moderate potential to occur <ul style="list-style-type: none"> PMST ranking 'Known' for species or species habitat Infrequently spotted around the area during nesting with majority of their nesting occurring on beaches on offshore islands. Migrate along the coast to their Kimberley foraging grounds No BIAs that overlap with the search area, closest BIA is ~55 km west |
| Short-nosed sea snake (<i>Aipysurus apraefrontalis</i>) | EPBC Act: Critically Endangered Marine BC Act: Critically endangered IUCN Status: Data deficient | <ul style="list-style-type: none"> Approved Conservation Advice for <i>Aipysurus apraefrontalis</i> (Short-nosed Sea Snake) (DSEWPaC 2011a) Commonwealth Listing Advice on <i>Aipysurus apraefrontalis</i> (Short-nosed Sea snake) (TSSC 2011a) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.2.4 – this species was identified as a key species due to its conservation significance | Moderate potential to occur <ul style="list-style-type: none"> PMST ranking 'Likely' The species has not been recorded in the region (desktop searches) Suitable habitat is present within the Project area |

Fish and sharks

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|--|---|---|---|
| Dwarf sawfish (<i>Pristis clavata</i>) | EPBC Act: Vulnerable Migratory BC Act: P1 Migratory IUCN Status: Critically endangered | <ul style="list-style-type: none"> Approved Conservation Advice for <i>Pristis clavata</i> (Dwarf Sawfish) (DEWHA 2009b) Commonwealth Listing Advice on <i>Pristis clavata</i> (Dwarf Sawfish) (TSSC 2009b) Sawfish and River Sharks Multispecies Recovery Plan (DoE 2015c) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>Currently the populations of dwarf sawfish are unknown. The species' Australian distribution has previously been considered to extend north from Cairns around the Cape York Peninsula in Qld, across northern Australian waters to the Pilbara coast in WA (Last and Stevens 1994; Stevens et al. 2008).</p> <p>The dwarf sawfish usually inhabits shallow (2–3 m) coastal waters and estuarine habitats.</p> | <p>Low potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Known' for species or species habitat The species has not been recorded in the region (no records from desktop searches) One sighting recorded over 20 km away in an estuarine system, however unlikely to be present in open waters |
| Narrow sawfish (<i>Anoxypristis cuspidata</i>) | EPBC Act: Migratory BC Act: Migratory IUCN Status: Critically endangered | N/A The species is currently undergoing a threatened listing assessment which is due for completion on 30 October 2024. | <p>Genetic analysis indicates that narrow sawfish form one global population (Feutry et al 2021). The adults predominantly occupy offshore habitat with water depths of at least 40 m, and estuarine and inshore waters are important habitats for pupping females and juveniles</p> <p>Narrow sawfish have been found from Onslow through to the northern Kimberley.</p> | <p>Low potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Likely' Predominantly in deeper offshore waters, depths greater than 40 m The species has not been recorded in the region (no records from desktop searches) No identified BIAs |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|---|---|--|
| Freshwater sawfish (<i>Pristis pristis</i>) | EPBC Act: Vulnerable Migratory BC Act: P3 Migratory IUCN Status: Critically endangered | <ul style="list-style-type: none"> Approved Conservation Advice for <i>Pristis pristis</i> (argetooth sawfish) (DoE 2014a) Sawfish and River Sharks Multispecies Recovery Plan (DoE 2015c) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>The Australian freshwater sawfish (or theargetooth sawfish) are part of the Indo-West Pacific population and make up a large proportion of the global population (DoE 2014a). They should however be considered as independent demographic units, as they don't tend to travel large distances. They may potentially occur in all large rivers of northern Australia from the Fitzroy River, WA, to the western side of Cape York Peninsula, Qld.</p> <p>It is mainly confined to the main channels of large rivers. Recorded within Ashburton River from the Onslow area and at the Ashburton Infrastructure Project (AIP) project area (O2 Marine 2021b; Bateman et al. 2024).</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Known' The species has been recorded at the AIP Project approximately 10 km away from the Search area (O2 Marine 2021b) No identified BIAs |
| Giant manta ray (<i>Mobula birostris</i>) | EPBC Act: Migratory BC Act: Migratory IUCN Status: Endangered | N/A | <p>The giant manta ray is the world's largest ray with a wide global distribution, and its overall population is unknown (NOAA 2024)</p> <p>Giant manta rays are rarely seen close to the coast due to their preference for offshore waters. They tend to aggregate around cleaning stations adjacent to deep water (Armstrong et al. 2020).</p> <p>There have been sighted close to the coast in Karratha</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Likely' No sightings data in project search area Preferred habitat offshore (Armstrong et al. 2020) |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|---|---|--|---|
| Green sawfish (<i>Pristis zijsron</i>) | EPBC Act: Vulnerable Migratory BC Act: Vulnerable IUCN Status: Critically endangered | <ul style="list-style-type: none"> Approved Conservation Advice for Green Sawfish (DEWHA 2008c) Listing Advice for <i>Pristis zijsron</i> (Green Sawfish) (TSSC 2008) Sawfish and River Sharks Multispecies Recovery Plan (DoE 2015c) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>There is limited information on the current population size and trends of the green sawfish in Australian waters (DoE 2015c). Their preferred habitat is generally shallow estuarine waters, mangroves and mudflats (DoE 2015c). They forage in shallow, sandy, or muddy substrate, and hunting on the low tide and incoming tide and leaving on the outgoing.</p> <p>Movement between areas also uses tide cycles with individuals occupying shallow depths up to two metres, moving up to 10 km during each tidal cycle (Morgan et al. 2017). However, generally they stay within 500-700 m of the mouth of tidal creeks and avoid the upper reaches of these systems, with repeated use of habitat (Stevens et al. 2008).</p> <p>The green sawfish populations near the Project area have been identified to congregate in areas to the west, and in smaller groups to the east of the Project area. There may be some movement between the two areas, however it is unlikely that</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Known' Potential pupping nearby in the Ashburton River Few coastal sightings to the west of Project site (DBCA 2024) May travel through the area to get to other creeks. |
| Grey nurse shark (<i>Carcharias taurus</i>) | EPBC Act: Vulnerable BC Act: Vulnerable IUCN Status: | <ul style="list-style-type: none"> Recovery Plan for the Grey Nurse Shark (<i>Carcharias taurus</i>) (DoE 2014b) Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE 2018) | <p>The grey nurse shark west coast population is predominantly found in the south-west coastal waters of WA and has been recorded as far north as the North West Shelf and south to Esperance (DCCEEW 2024c). It has a broad inshore distribution, primarily in sub-</p> | <p>Low potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Likely' The species has not been recorded in the region (no records from desktop searches) |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|--|---|---|--|
| | Critically endangered | <ul style="list-style-type: none"> Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | tropical to cool temperate waters (Last and Stevens 1994). | <ul style="list-style-type: none"> Possible suitable habitat but limited information available |
| Reef manta ray (<i>Mobula alfredi</i>) | EPBC Act: Migratory BC Act: Migratory IUCN Status: Vulnerable | N/A | Little is known about population sizes of the reef manta ray, and distribution is generally thought to be throughout the Pacific and Indian Ocean. They utilise coastal shelf waters, showing preference for shallow depths of less than 20 m, though they also exhibit diel movements, spending daylight hours inshore in shallow waters, then moving back offshore to deeper waters at night. Juveniles have been observed using lagoons and shorelines. | Moderate potential to occur <ul style="list-style-type: none"> PMST ranking 'Known' No sightings data Known to utilise inshore areas (Armstrong et al. 2020) |
| Scalloped hammerhead (<i>Sphyrna lewini</i>) | EPBC Act: Conservation dependent BC Act: N/A IUCN Status: Critically endangered | <ul style="list-style-type: none"> <i>Listing Advice for Sphyrna lewini (scalloped hammerhead)</i> (TSSC 2024) | See Section 4.3.1 | Moderate potential to occur <ul style="list-style-type: none"> No sightings data PMST ranking 'likely' Suitable habitat is further offshore than the project site for adults, though juveniles are closer to shore and adult females are thought to move into shallower waters to give birth |
| Southern bluefin tuna | EPBC Act: Conservation dependent | <ul style="list-style-type: none"> Commonwealth Listing Advice on <i>Thunnus maccoyii</i> (Southern Bluefin Tuna) (TSSC 2010). | The southern bluefin tuna are widely distributed in southern, temperate oceans, with a population | Low potential to occur |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---------------------------|---|-------------------------------|--|--|
| <i>(Thunnus maccoyii)</i> | (Likely to become Threatened in Oct 2024) BC Act: N/A IUCN Status: Endangered | | estimate of 460,000 in 2009 (CCSBT 2009). Spawning takes place between September and April in warm waters south of Java, Indonesia and then juveniles migrate down to the coast of Western Australia. Surface schooling is seen in the summer months (December to April) in southern Australia (CCSBT 2009). Individuals over 5 years of age are seldom nearshore, preferring deeper waters. | <ul style="list-style-type: none"> • 'likely' to be within Project area • Southern bluefin tuna are a deep-water/pelagic migratory species and therefore suitable habitat is not common in the project area • No sightings data within the Project area |

Birds

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|--|---------------------|--|
| Australian Fairy Tern (<i>Sternula nereis nereis</i>) | EPBC Act: Vulnerable BC Act: Vulnerable IUCN Status: Vulnerable | <ul style="list-style-type: none"> Approved Conservation Advice for <i>Sternula nereis nereis</i> (Fairy Tern) (DSEWPaC 2011b) Commonwealth Listing Advice on <i>Sternula nereis nereis</i> (Fairy Tern) (TSSC 2011b) National Recovery Plan for the Australian Fairy Tern (<i>Sternula nereis nereis</i>) (DAWE 2020b) Threat abatement plan for predation by feral cats (DoE 2015a) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.4 | High potential to occur <ul style="list-style-type: none"> PMST rank 'Known' Breeding BIA within search area Historical sighting near Beadon Point (DBCA 2024) Suitable habitat within the Project area |
| Bar-tailed Godwit (northern Siberian) (<i>Limosa lapponica menzbieri</i>) | EPBC Act: Endangered Migratory BC Act: Critically Endangered Migratory IUCN Status: Near Threatened | <ul style="list-style-type: none"> Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.5 | High potential to occur <ul style="list-style-type: none"> PMST ranking 'Known' Recorded within 1 km of the Project site (unknown date) Suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|--|--|--|---|
| Bridled Tern (<i>Onychoprion anaethetus</i>) | <p>EPBC Act: Marine Migratory</p> <p>BC Act: Migratory</p> <p>IUCN Status: Least Concern</p> | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020b) Threat abatement plan for predation by the European red fox (DEWHA 2008a). | <p>There is no current estimate for population size of the bridled tern, though it is distributed over tropical and subtropical waters with several apparently discrete populations (DCCEEW 2024c). In Australia, bridled terns are widespread, breeding on offshore islands in western, northern and north-eastern Australia, extending from Cape Leeuwin in the south-west, around northern Australia to north-eastern and mid-eastern Qld.</p> <p>In WA, breeding is widespread from islands off Cape Leeuwin (extending round the southern coast to Seal Rocks) north to Shark Bay and in Pilbara region and Kimberley Division. At sea, distribution extends from Cape Leeuwin north to Dirk Hartog Island, with isolated mainland coastal records at Point Maud and Ningaloo, and from Barrow Island to the Dampier Archipelago, and at sea off the Kimberley coast from waters west of the Dampier Peninsula to Ashmore Reef and Joseph Bonaparte Gulf (Barrett et al. 2003; Higgins and Davies 1996).</p> <p>Bridled terns occupy tropical and subtropical seas, breeding on islands, including vegetated coral cays, rocky continental islands and rock stacks (Higgins and Davies 1996). Bridled terns are only rarely found in inshore continental waters and along mainland coastlines, though the species is reported to breed on</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Known' Historically recorded on Ashburton Island (~18 km from Project site) Less suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|---|--|--|--|
| | | | the mainland of far southern WA (Higgins and Davies 1996; Johnstone and Storr 1998). | |
| Caspian Tern (<i>Hydroprogne caspia</i>) | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020b) | See Section 4.4 | High potential to occur <ul style="list-style-type: none"> PMST ranking 'Known' Multiple recorded sightings at Beadon Point in last 2 years (DBCA 2024) Suitable habitat |
| Common Greenshank (<i>Tringa nebularia</i>) | EPBC Act: Marine Endangered Migratory BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Conservation Advice for <i>Tringa nebularia</i> (common greenshank) (DCCEEW 2024f) Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) Marine bioregional plan for the North-west Marine Region (DSEWPac 2012a). | See Section 4.5 | High potential to occur <ul style="list-style-type: none"> PMST rank 'Likely' Sighting recorded at Beadon Point, and recent sighting at Bedon Creek (DBCA 2024) Suitable habitat |
| Common Sandpiper (<i>Actitis hypoleucos</i>) | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) | See Section 4.5 | High potential to occur <ul style="list-style-type: none"> PMST ranking 'Known' Sightings recorded at Beadon Point in last 2 years (DBCA 2024) Suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|---|--|--|--|
| Common tern (<i>Sterna hirundo</i>) | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020a) | <p>The common tern is a non-breeding migrant to Australia, mainly found along the eastern coast, where they are widespread and common from south-eastern Qld to eastern Victoria. Its global population is estimated to be 1.1 – 4.5 million individuals (DCCEEW 2024c).</p> <p>In WA, the species is rarely recorded south of approximately 30°S, with only scattered records north of there to the Kimberley Division. (Barrett et al. 2003).</p> <p>They are commonly observed in near-coastal waters and all marine zones, including beaches, platforms and headlands to more sheltered environments (DCCEEW 2024c).</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> Not listed on PMST Historical sightings recorded at Beadon Point (DBCA 2024) ALA sightings within the last 6 years Generally recorded offshore and in association with pelagic waters (DCCEEW 2024) |
| Greater crested tern/ crested tern (<i>Thalasseus bergii</i>) | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020a) | See Section 4.4 | <p>High potential to occur</p> <ul style="list-style-type: none"> Not listed on PMST Sightings recorded at Beadon Creek in last 7 years (DBCA 2024) ALA sightings recorded at Beadon Point in last 2 years Suitable habitat |
| Curlew Sandpiper (<i>Calidris ferruginea</i>) | EPBC Act: Critically Endangered Migratory BC Act: Critically | <ul style="list-style-type: none"> Conservation Advice for <i>Calidris ferruginea</i> (curlew sandpiper) (DCCEEW 2023d) Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b). | <p>The population of the curlew sandpiper is currently unknown, as it travels from the northern hemisphere after breeding to the southern hemisphere (Birdlife International 2024). They inhabit coastal intertidal zones Inland saline and freshwater marshes and in</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Known' Historically recorded on Ashburton Island (~18 km from Project site) (DBCA 2024) |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|---|--|---|--|
| | <p>Endangered</p> <p>IUCN Status: Near Threatened</p> | | <p>Australia, occur around the coasts and are also quite widespread inland, though in smaller numbers.</p> <p>Records occur in all states during the non-breeding period, and also during the breeding season when many non-breeding one year old birds remain in Australia rather than migrating north.</p> <p>In WA, they are widespread around coastal and subcoastal plains from Cape Arid to south-west Kimberley Division but are more sparsely distributed between Carnarvon and Dampier Archipelago.</p> <p>They occur in large numbers, in thousands to tens of thousands, at Port Hedland Saltworks, 80 Mile Beach, Roebuck Bay and Lake Macleod.</p> <p>Curlew sandpipers forage on mudflats and nearby shallow water. In non-tidal wetlands, they usually wade, mostly in water 15–30 mm, but up to 60 mm, deep. They forage at the edges of shallow pools and drains of intertidal mudflats and sandy shores. At high tide, they forage among low sparse emergent vegetation, such as saltmarsh, and sometimes forage in flooded paddocks or inundated salt flats (DCCEEW, 2024c).</p> | <ul style="list-style-type: none"> Suitable habitat |
| <p>Eastern Curlew (<i>Numenius madagascariensis</i>)</p> | <p>EPBC Act: Critically Endangered Migratory</p> | <ul style="list-style-type: none"> Conservation Advice for <i>Numenius madagascariensis</i> (far eastern curlew) (DCCEEW 2023a) | <p>See Section 4.5</p> | <p>High potential to occur</p> <ul style="list-style-type: none"> Historical sightings records at Beadon Point, one sighting at Beadon Creek |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|--|--|---|---|
| | BC Act: Critically Endangered IUCN Status: Endangered | | | within last 8 years (DBCA 2024) <ul style="list-style-type: none"> PMST ranking 'Known' Suitable habitat 59 sightings within 10 km of the Project area on the ALA database (ALA 2024) |
| Eastern Osprey (<i>Pandion haliaetus cristatus</i>) Listed under the EPBC Act as <i>Pandion haliaetus</i> | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020a) | See Section 4.4 | High potential to occur <ul style="list-style-type: none"> Historical sightings recorded at Beadon Point (DBCA 2024) ALA sightings recorded in last 2 years Suitable habitat PMST ranking 'Known' |
| Great Knot (<i>Calidris tenuirostris</i>) | EPBC Act: Vulnerable Marine Migratory BC Act: Critically Endangered IUCN Status: Endangered | <ul style="list-style-type: none"> <i>Conservation Advice for Calidris tenuirostris (great knot)</i> (DCCEEW 2024h) Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) Marine bioregional plan for the North-west Marine Region (DSEWPac 2012a). | The population of the great knot within the East Asian - Australasian Flyway was previously estimated at 425,000 (Hansen et al 2016). They inhabit coastal mudflats and sandy intertidal zones. Recorded around the entirety of the Australian coast, their greatest numbers are found in northern Australia where the species is common on the coasts of the Pilbara and Kimberley, from the Dampier Archipelago to the NT border (Higgins and Davies 1996) | Moderate potential to occur <ul style="list-style-type: none"> PMST ranking 'May' Sighted at Beadon Creek in 2019 (DBCA 2024) Suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|--|--|---|
| | | | <p>Prefers sheltered coastal habitats, with large intertidal mudflats or sandflats. This includes inlets, bays, harbours, estuaries and lagoons.</p> <p>They are occasionally found on exposed reefs or rock platforms, shorelines with mangrove vegetation, ponds in saltworks, at swamps near the coast, saltlakes and non-tidal lagoons (Higgins and Davies 1996).</p> | |
| Greater Sand Plover (<i>Charadrius leschenaultii</i>) | <p>EPBC Act: Vulnerable Marine Migratory</p> <p>BC Act: Vulnerable</p> <p>IUCN Status: Least Concern</p> | <ul style="list-style-type: none"> • Conservation Advice for <i>Charadrius leschenaultii</i> (greater sand plover) (DCCEEW 2023b) • Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) • Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.5 | <p>High potential to occur</p> <ul style="list-style-type: none"> • Historical sightings recorded at Beadon Point (DBCA 2024) • ALA sightings recorded in last 4 years • Suitable habitat • PMST ranking 'Known' |
| Grey plover (<i>Pluvialis squatarola</i>) | <p>EPBC Act: Vulnerable Marine Migratory</p> <p>BC Act: Migratory</p> <p>IUCN Status: Least Concern</p> | <ul style="list-style-type: none"> • Conservation Advice for <i>Pluvialis squatarola</i> (grey plover) (DCCEEW 2024i) • Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) • Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>The population of the grey plover within the East Asian - Australasian Flyway was previously estimated at 80,000 (Hansen et al 2016).</p> <p>In Australia, the grey plover has been recorded in all states, where it is found along the coasts, and it especially abundant on the coast of WA between Albany and the northern Kimberley coast (Barrett et al. 2003).</p> <p>In non-breeding grounds in Australia, grey plovers occur almost entirely in coastal areas, where they</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> • Historical sightings recorded at Beadon Point (DBCA 2024) • ALA sightings recorded in last 6 years • Suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|--|--|---|--|
| | | | usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes. The species is also very occasionally recorded further inland, where they occur around wetlands or salt-lakes (Marchant and Higgins 1993). | |
| Grey-tailed tattler (<i>Tringa brevipes</i>) | EPBC Act: Marine Migratory BC Act: P4 Migratory IUCN Status: Near Threatened | <ul style="list-style-type: none"> Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>The population of the grey-tailed tattler within the East Asian - Australasian Flyway was previously estimated at 70,000 (Hansen et al 2016).</p> <p>Within Australia, the grey-tailed tattler has a primarily northern coastal distribution and is found in most coastal regions.</p> <p>Often found on sheltered coasts with reefs and rock platforms or with intertidal mudflats. It can also be found at intertidal rocky, coral or stony reefs as well as platforms and islets that are exposed at low tide. It has been found around shores of rock, shingle, gravel or shells and also on intertidal mudflats in embayments, estuaries and coastal lagoons, especially fringed with mangroves (Higgins and Davies 1996)</p> | <p>High potential to occur</p> <ul style="list-style-type: none"> Not on PMST within area Sighted at Beadon Point in last 2 years Historical sightings at Beadon Point (DBCA 2024) Suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|--|--|--|
| Lesser Crested Tern (<i>Thalasseus bengalensis</i>) | EPBC Act: Marine BC Act: N/A IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020a) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>The lesser crested tern is present along coasts and coastal waters and are active during the day.</p> <p>They feed on fish and other small aquatic animals, capturing them by diving into the water. They nest in hollows in the sand, lined with coral bits or similar material on low-lying sandy and coral islands and coral flats. Australian population is probably sedentary.</p> <p>There is no distinct breeding season in Western Australia.</p> | <p>High potential to occur</p> <ul style="list-style-type: none"> PMST rank 'Known' Suitable habitat ALA sighting recorded at Beadon Point in last 2 years |
| Lesser Frigatebird (<i>Fregata ariel</i>) | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020a) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>Usually seen in tropical or warmer waters around the coast of north WA, the NT, Qld and northern NSW, the lesser frigatebird remains further out to sea during the day and in inshore waters during rough weather or in the late evening. Within the North-west Marine Region the lesser frigatebird is known to breed on Adele, Bedout and West Lacapede islands (Marchant and Higgins 1993), Ashmore Reef and Cartier Island.</p> | <p>Low potential to occur</p> <ul style="list-style-type: none"> PMST rank 'Likely' Not sightings recorded within search area |
| Little tern (<i>Sternula albifrons</i>) | EPBC Act: Marine Migratory (Predicted to be listed as Threatened in Oct 2024 assessment) | <ul style="list-style-type: none"> Threat abatement plan for predation by the European red fox (DEWHA 2008a) Threat abatement plan for predation by feral cats (DoE 2015b) Wildlife Conservation Plan for Seabirds (DAWE 2020a) | <p>The Australian breeding population can be divided into two major subpopulations: a northern subpopulation and an eastern subpopulation.</p> <p>The northern subpopulation breeds across northern Australia, from about Broome in north-western WA (where first recorded only in December 1995), through coastal NT (mainly from just west of Darwin</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> PMST rank 'May' ALA sightings recorded at Beadon Point in last 6 years Historical sightings recorded at Beadon Point (DBCA 2024) Suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|---|--|--|
| | BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>to the Qld border) to the Gulf of Carpentaria and eastern Cape York Peninsula.</p> <p>Inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits, and also on exposed ocean beaches. Little Terns are widespread on islands off the NT coast but appear to be less often on offshore continental islands or coral cays off Qld (Higgins and Davies 1996; DCCEEW 2024c)</p> | |
| Pectoral Sandpiper (<i>Calidris melanotos</i>) | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) | <p>The population of the pectoral sandpiper within the East Asian - Australasian Flyway was previously estimated at 1.22 – 1.93 million (Hansen et al 2016). However in WA, the species is rarely recorded.</p> <p>It has been observed at the Nullarbor Plain, Reid, Stoke's Inlet, Grassmere Lake, Warden Lake, Dalyup and Yellilup Swamp, Swan River, Bengier Swamp, Guraga Lake, Wittecarra, Harding River, coastal Gascoyne, the Pilbara and the Kimberley (Higgins and Davies 1996).</p> <p>In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal</p> | <p>Low potential to occur</p> <ul style="list-style-type: none"> PMST ranking 'Likely' Species has not been recorded in region Less suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|---|--|---|
| | | | habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire and forage in shallow water or soft mud at the edge of wetlands (Higgins and Davies 1996). | |
| Red-necked stint (<i>Calidris ruficollis</i>) | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Near Threatened | <ul style="list-style-type: none"> Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015)b Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.5 | High potential to occur <ul style="list-style-type: none"> Not on PMST ALA sightings recorded at Beadon Point in last 3 years Historical sightings recorded at Beadon Point (DBCA 2024) Suitable habitat |
| Roseate Tern (<i>Sterna dougallii</i>) | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020a) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | See Section 4.4 | High potential to occur <ul style="list-style-type: none"> PMST rank 'Likely' Nesting BIA within the search area Historical sightings at Beadon Point |
| Ruddy turnstone (<i>Arenaria interpres</i>) | EPBC Act: Vulnerable Marine Migratory BC Act: | <ul style="list-style-type: none"> Conservation Advice for <i>Arenaria interpres</i> (ruddy turnstone) (DCCEEW 2024j) Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) | The population of the ruddy turnstone within the East Asian - Australasian Flyway was previously estimated at 30,000 (Hansen et al 2016). | Moderate potential to occur <ul style="list-style-type: none"> ALA sightings recorded at Beadon Point in last 6 years |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|--|--|--|
| | Migratory IUCN Status: Least Concern | <ul style="list-style-type: none"> Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>The Ruddy Turnstone is widespread within Australia during its non-breeding period of the year, including from Tasmania in the south to Darwin in the north and many coastal areas in between. It is found in most coastal regions, with occasional records of inland populations (Higgins and Davies 1996).</p> <p>In Australasia, the Ruddy Turnstone is mainly found on coastal regions with exposed rock coastlines or coral reefs. It also lives near platforms and shelves, often with shallow tidal pools and rocky, shingle or gravel beaches. It can, however, be found on sand, coral or shell beaches, shoals, cays and dry ridges of sand or coral. It strongly prefers rocky shores or beaches where there are large deposits of rotting seaweed (DCCEEW 2024c).</p> <p>It has occasionally been sighted in estuaries, harbours, bays, and coastal lagoons, among low saltmarsh or on exposed beds of seagrass, around sewage ponds and on mudflats. In north Australia it is known to occur in a wide variety of habitats, and may prefer wide mudflats.</p> | <ul style="list-style-type: none"> Historical sightings recorded at Beadon Point (DBCA 2024) Suitable habitat Not on the PMST listing |
| Sanderling (<i>Calidris alba</i>) | EPBC Act: Marine Migratory BC Act: Migratory | <ul style="list-style-type: none"> Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | The population of the sanderling within the East Asian - Australasian Flyway was previously estimated at 30,000 (Hansen et al 2016). | <p>Low potential to occur</p> <ul style="list-style-type: none"> Not listed on PMST Historical sightings recorded at Beadon Point (DBCA 2024) |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|---|---|---|
| | IUCN Status: Least Concern | | <p>The Sanderling occurs in coastal areas around Australia and in WA they occur on most of the coast from Eyre to Derby and around Wyndham.</p> <p>They are more often recorded on the south and southwest coasts, north to around southern Shark Bay, with more sparsely scattered records further north in Gascoyne and Pilbara Regions and the Kimberley Division (Higgins & Davies 1996).</p> <p>They inhabit sandy ocean beaches, sandbars and mudflats, feeding along the surf and running up and down the beach with the waves.</p> | <ul style="list-style-type: none"> • ALA sightings recorded in last 7 years • Less suitable habitat |
| Sharp-tailed sandpiper (<i>Calidris acuminata</i>) | <p>EPBC Act: Vulnerable Marine Migratory</p> <p>BC Act: Migratory</p> <p>IUCN Status: Vulnerable</p> | <ul style="list-style-type: none"> • Conservation Advice for <i>Calidris acuminata</i> (sharp-tailed sandpiper) (DCCEE 2024k) • Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) | <p>The population of the sharp-tailed sandpiper within the East Asian - Australasian Flyway was previously estimated at 85,000 (Hansen et al 2016). They spend their non-breeding season in Australia, including coastal and subcoastal plains of the Pilbara region (Higgins and Davies 1996)</p> <p>Sharp-tailed sandpipers are flexible in their habitat choice during their non-breeding season, though prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation including includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. Also occur in saltworks and sewage farms.</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> • PMST ranking 'Known' • Few historical records near Project site (DBCA 2024) • Less suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|---|--|--|---|--|
| | | | They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. They tend to occupy coastal mudflats mainly after ephemeral terrestrial wetlands have dried out, moving back during the wet season. (Higgins and Davies 1996). | |
| Silver Gull (<i>Chroicocephalus novaehollandiae</i>) | EPBC Act: Marine BC Act: N/A IUCN Status: Least Concern | <ul style="list-style-type: none"> Threat abatement plan for the impacts of marine debris on vertebrate wildlife of Australia's coasts and oceans (DoEE 2018) Wildlife Conservation Plan for Seabirds (DAWE 2020a) | <p>The population of silver gulls is unknown, though it is the most common gull of Australia. They are found in both coastal and inland locations in a variety of habitats, including artificial habitats.</p> <p>A varied and opportunistic diet including fish, marine and terrestrial invertebrates, seeds, insects and bird eggs.</p> <p>Breeds on small islands and points, mainly offshore, but also on freshwater and brackish lakes, and on causeways in salt-pans.</p> | <p>High potential to occur</p> <ul style="list-style-type: none"> ALA sightings at Beadon Point in last 2 years PMST rank 'Known' Suitable habitat <p>Given the species low conservation status and it is commonly found throughout Australia it is not a key species, and mitigation for other bird species will also protect this species.</p> |
| Sooty Tern (<i>Onychoprion fuscatus</i>) | EPBC Act: Marine BC Act: N/A IUCN Status: Least Concern | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020a) Threat abatement plan for predation by feral cats (DoE 2015a) Threat abatement plan to reduce the impacts of exotic rodents on biodiversity on Australian offshore islands of less than 100,000 hectares 2009 (DEWHA 2009a) Wildlife Conservation Plan for Seabirds (DAWE 2020a) | <p>The global population of sooty terns are estimated to be 21 to 22 million individuals (DCCEE 2024c). They have a large range through tropical oceans and breed on flat, open, sparsely or heavily vegetated, oceanic or barrier islands of sand, coral or rock in productive tropical and subtropical offshore waters rich in plankton, fish and squid</p> <p>Outside of breeding, they are highly oceanic, their diet mainly consisting of fish and squid.</p> | <p>Low potential to occur</p> <ul style="list-style-type: none"> PMST rank 'Known' No sightings recorded Less suitable habitat |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|--|--|---|
| Streaked Shearwater (<i>Calonectris leucomelas</i>) | EPBC Act: Marine Migratory BC Act: Migratory IUCN Status: Near Threatened | <ul style="list-style-type: none"> Wildlife Conservation Plan for Seabirds (DAWE 2020a) Threat abatement plan for predation by feral cats (DoE 2015a) | <p>The population of the streaked shearwater is currently unknown, as they spend much of their time in the pelagic. They breed in the northern hemisphere and then migrates to the southern hemisphere during winter (including Australia).</p> <p>Feeds on fish and squid by surface seizing and/or plunging.</p> | <p>Low potential to occur</p> <ul style="list-style-type: none"> PMST rank 'Likely' No sightings recorded Less suitable habitat |
| Wedge-tailed shearwater (<i>Ardenna pacifica</i>) | EPBC Act: Marine Migratory BC Act: N/A IUCN Status: Least Concern | <ul style="list-style-type: none"> Threat Abatement Plan for the incidental catch (or bycatch) of seabirds during oceanic longline fishing operations (CoA 2018) Threat abatement plan for predation by feral cats (DoE 2015a) Threat Abatement Plan for the impacts marine debris on the vertebrate wildlife of Australia's coast and oceans (DoEE 2015) Threat abatement plan for predation by the European red fox (DEWHA 2008a) Wildlife Conservation Plan for Seabirds (DAWE 2020a) Marine bioregional plan for the North-west Marine Region (DSEWPaC 2012a). | <p>The population of the wedge-tailed shearwater is unknown, though it is thought to be decreasing.</p> <p>The Wedge-tailed Shearwater is a pelagic, marine bird known from tropical and subtropical waters. The species tolerates a range of surface-temperatures and salinities, but is most abundant where temperatures are greater than 21 °C and salinity is greater than 34.6 ‰. They breed on the east and west coasts of Australia and on off-shore islands.</p> <p>The species has been recorded in usually off the continental shelf in north-west Australia (Marchant & Higgins 1990). In tropical zones the species may feed over cool nutrient-rich waters.</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> PMST rank 'Likely' No sightings recorded Breeding BIA overlaps Project site |
| Whimbrel (<i>Numenius phaeopus</i>) | EPBC Act: Marine Migratory | <ul style="list-style-type: none"> Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015b) Marine bioregional plan for the North-west Marine Region | <p>The population of the whimbrel within the East Asian - Australasian Flyway was previously estimated at 65,000 (Hansen et al 2016).</p> | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> Not listed on PMST |

| Species | Conservation Status | EPBC Act Supporting Documents | Species information | Likelihood of Occurrence |
|--|--|--|---|---|
| | BC Act: Migratory IUCN Status: Least Concern | (DSEWPaC 2012a). | The Whimbrel is a regular migrant to Australia and New Zealand, with a primarily coastal distribution. It is common and widespread from Carnarvon to the north-east Kimberley Division, WA. Coastal mudflats Sandy intertidal zones (DSEWPaC 2012a). Found on the intertidal mudflats of sheltered coasts. It is also found in harbours, lagoons, estuaries and river deltas, often those with mangroves, but also open, unvegetated mudflats. It is occasionally found on sandy or rocky beaches, on coral or rocky islets, or on intertidal reefs and platforms. It has been infrequently recorded using saline or brackish lakes near coastal areas. It also used saltflats with saltmarsh, or saline grasslands with standing water left after high spring-tides, and in similar habitats in sewage farms and saltfields (Higgins and Davies 1996). | <ul style="list-style-type: none"> Historical sightings at Beadon Point, one sighting at Beadon Creek within 8 years (DBCA 2024) ALA sightings recorded in last 7 years |
| White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>) | EPBC Act: Marine BC Act: N/A IUCN Status: Least Concern | <ul style="list-style-type: none"> Threat abatement plan for predation by the European red fox (DEWHA 2008a) Wildlife Conservation Plan for Seabirds (DAWE 2020a). | The white-bellied sea eagle is a large diurnal bird of prey with an estimated population of 1,000 – 10,000 (DCCEEW 2024c). They inhabit coastal habitats (especially close to the sea-shore) on mainland Australia and its offshore islands and also areas with large open water (i.e. large rivers, ocean). Sightings have been recorded around bays, inlets, beaches, reefs, lagoons, estuaries and mangroves and they breed in tall open forest or woodland (Marchant and Higgins 1993). | <p>Moderate potential to occur</p> <ul style="list-style-type: none"> PMST ranking ‘Known’ ALA historical sightings at Beadon Point Suitable habitat |

Appendix C. Literature review summary

| Article Title | Survey/study effort | Key findings | Reference |
|---|---|---|----------------------|
| Mammals | | | |
| Wheatstone Conservation Significant Marine Fauna Interaction Management Plan - Appendix A Conservation Significant Marine Fauna: Baseline Summary | As part of Chevron Wheatstone project Murdoch university completed a compressive study on dugongs in the area. This involved both satellite tagging and aerial surveys to analyse the pattern and movements of Dugongs in the area. The report/data is not publicly available but a summary of it can be found in Wheatstone Conservation Significant Marine Fauna Interaction Management Plan. | <p>The key findings summarised in the baseline summary were:</p> <ul style="list-style-type: none"> • Dugongs were present yearly in nearshore waters in low densities (0.036 - 0265 dugong/km²) • They were sighted most often in water <10 m and close to costal Islands • Tagging data showed the distribution of dugongs was closely related to foraging habitat availability | Chevron (2016) |
| Migratory Movements of Pygmy Blue Whales (<i>Balaenoptera musculus brevicauda</i>) between Australia and Indonesia as Revealed by Satellite Telemetry | This publication summarises the movements of Pygmy Blue Whales (<i>Balaenoptera musculus brevicauda</i>) from satellite tags deployed in 2009 & 2011. The tags were deployed on 11 whales within the Perth Canyon in March & April with a track day ranged between 8–308. The study area extended along the Western Australian coast and is relevant to the Proposal area | <p>The key findings of this satellite survey documented in the paper were:</p> <ul style="list-style-type: none"> • Results showed that from March–April before reaching the North West Cape the whales stayed closer to the coast (100 ±1.7km). • After passing the North West Cape and travelling towards Indonesia they were further offshore (238.0 ±13.9km) <p>Pygmy blue whales occupied different water depths at different times of the year March-April (1369.5 ±47.4m), May (2617 ±143.5m), June–September (3788.5 ±66.4m).</p> | Double et al. (2014) |
| Demographic characteristics of Australian humpback dolphins reveal important habitat toward the southwestern limit of their range | This publication summaries photo-identification data collected via boat-base surveys conducted between 2013 and 2015. The aim was to estimate abundance, site fidelity and residence patterns of Australian humpback dolphins. The study is relevant to the Proposal area. | <p>The key findings of this report were:</p> <ul style="list-style-type: none"> • Abundance estimates varied from 65 to 102 individuals • Super-population size was estimated to be 129 individuals l the 130 km² survey area | Hunt et al. (2017) |

| Article Title | Survey/study effort | Key findings | Reference |
|--|--|--|-------------------------|
| | | <ul style="list-style-type: none"> Density estimated to be 1 humpback dolphin per km², which is the highest recorded for the species <p>High number of resighted individuals, 63% individuals exhibited high level of site fidelity.</p> | |
| Evidence for a widely expanded humpback whale calving range along the Western Australian coast | This publication summarises the sightings of neonate and post neonate humpback whale calves in North West Cape. Using the size, colour, and direction of the calf movements to suggest an expansion of the breeding area for the Humpback Whales. Surveys were completed in 2013 and 2015. This survey does not overlap with the Proposal, but the results are relevant to the Proposal area. | <p>The key findings of the aerial surveys documented in this paper were:</p> <ul style="list-style-type: none"> There was a high abundance of calves spotted on along North West Cape in both 2013 and 2015 with estimated abundances 463-603 and 557-725 respectively, with majority of the calves were neonates (85% in 2013; 94% in 2015) The majority of calves sighted in both years (85% in 2013; 94% in 2015) were neonates <p>The findings from these surveys suggest the breeding grounds for the breeding stock D population of the humpback whales extends at least 1,000km south to North West Cape (22°430S) then currently recognised.</p> | Irvine et al. (2018) |
| <p>A Description of Megafauna Distribution and Abundance in the SW Pilbara Using Aerial and Acoustic Surveys – Final Report 2010 (Jenner et al. 2010a)</p> <p>A Description of Megafauna Distribution and Abundance in the SW Pilbara Using Aerial and Acoustic Surveys – Mid-Study Field Report December 2010 (Jenner et al. 2010b)</p> | This report provided the supplementary information to complete the Final Response to Submissions on the Draft EIS/ERMP for the Wheatstone Project. It represents the final report of the aerial survey program, with two previous reports being submitted as Appendix 3 and 4 of the Draft EIS/ERMP. A series of aerial and acoustic surveys were completed near the proposed Project trunkline to determine megafauna distribution and abundance in this area and to relate the encounters to populations known to exist in the broader regional area. This report constitutes supplementary information required for the draft EIS/ERMP, appearing | <p>The key findings of the report were:</p> <ul style="list-style-type: none"> A total of 1221 Humpback Whales were sighted in 26 aerial surveys over the southwest Pilbara offshore region between May 2009 and May 2010 Nearshore waters (5-50 m depths) recorded lower densities of humpback whales than offshore waters (50-950 m depths) Pygmy blue whales, sperm whales, killer whales, minke whales and pilot whales were also sighted during aerial surveys Acoustic surveys conducted between May-December 2009 identified the presence of humpback whales, pygmy blue whales, Brydes whales and dwarf minke whales in the study area | Jenner et al. (2010a,b) |

| Article Title | Survey/study effort | Key findings | Reference |
|--|--|---|-----------------------------|
| | as an Appendix in the Technical Appendix – Marine Mammals for the Wheatstone Project. The report provides an initial examination of the data collected between May and December 2009 and constitutes the mid study field report of the aerial survey program. The report summarised the first 3 months of acoustic and 8 months of aerial survey data. Acoustic surveys began in mid-April 2009 and spanned 78 days at an offshore site and 94 days at an inshore site. Aerial surveys consisted of 17 flights beginning in mid-May and extending through to 24 December 2009. | <ul style="list-style-type: none"> Pygmy blue whales and dwarf minke whales were present in deeper waters of the offshore study area from mid-May onwards although, in the 2009 season, these species were recorded in lower numbers (based on call rates) than in previous seasons. Nearshore aerial surveys (restricted to depths less than 50 m) reported regular sightings of dugongs, dolphins, manta rays and turtles throughout the survey. Four whale sharks were recorded during aerial surveys conducted between May and December 2009 in the Project area <p>No high-density concentrations of megafauna were identified between May and December near the Ashburton North Strategic Industrial Area, where nearshore and offshore infrastructure were to be located.</p> | |
| A Description of Megafauna Distribution and Abundance in the SW Pilbara Using Aerial and Acoustic Surveys – Mid-Study Study Field Report August 2009 (Jenner and Jenner 2009) | This report constitutes supplementary information required for the draft EIS/ERMP, appearing as an Appendix in the Wheatstone Project Draft EIS/ERMP. The report provides an initial examination of the data collected between May and August 2009 and constitutes the mid study field report of the aerial and acoustic survey program. | <p>The key findings of the report were the same as those summarised in the Final Report (Jenner et al. 2010a).</p> <p>Humpback whales:</p> <ul style="list-style-type: none"> Cow/calf were observed mostly resting in shallow waters 50 m offshore <p>Pygmy blue whales:</p> <ul style="list-style-type: none"> Were detected in deeper waters offshore from mid-May, the whales could be completing either their north or southward migration | Jenner and Jenner (2009) |
| Sea noise logger deployment Wheatstone and Onslow, April to July 2009, Preliminary Analysis, undertaken by CMST for URS/Chevron | This report details the deployment of five sea noise loggers throughout the Wheatstone Project area and discusses the preliminary analysis of the data from the noise loggers. | <p>The key findings of the survey:</p> <ul style="list-style-type: none"> The noise loggers detected various whale species including pygmy blue, dwarf minke; brydes; and humpback whales, although seasonal patterns could not be delineated Offshore noise loggers recorded noises primarily from seismic survey and vessels over the course of deployment. The vessels and seismic surveys detected | McCauley and Salgado (2009) |

| Article Title | Survey/study effort | Key findings | Reference |
|--|--|---|------------------------------|
| | | <p>at the offshore deployment location, were believed to be associated with surveys of the deep waters adjacent to the continental shelf to the south of the Project area</p> <ul style="list-style-type: none"> Pygmy blue whales were present offshore from May to July and were believed to be north bound pygmy blue whales. The time integrated count of individual calling pygmy blue whales from the Project area from a nearby 2006 data set was compared with the similar count made in 2009 over the matching time period in Julian days. Six times fewer whales were recorded in 2009 compared with 2006. Dwarf Minke whales were detected and counted at the offshore site and were present over the April to July. The time integrated counts of individual calling dwarf minke whales in 2009 were compared with the same calculation for the nearby site made in 2006 and seven times fewer dwarf minke whale detections were made in 2009 Brydes whales were detected on once in April in 43 m of water at a site west of Onslow, humpback whales were present at the 43 m depth inshore site and at the offshore site | |
| <p>How many dolphins live near a coastal development?</p> | <p>This publication summaries the results of boat-based surveys completed near the town of Onslow in the Pilbara region from 2012 to 2015. The aim of the survey was to estimate abundance, density and movement patters of the Indo-pacific bottlenose dolphin and the Australian humpback dolphin. The survey overlaps with the Proposal area.</p> | <p>The key findings of the boat-based surveys were:</p> <ul style="list-style-type: none"> Indo-Pacific bottlenose dolphin (<i>Tursiops aduncus</i>) total abundance estimate corrected for the unmarked proportion of the population was 79 SE ± 24 (CI 43-148) for Onslow There were insufficient resighting's of Australian humpback dolphins (<i>Sousa sahalensis</i>) to model abundance accurately | <p>Raudino et al. (2018)</p> |

| Article Title | Survey/study effort | Key findings | Reference |
|--|---|--|--------------------|
| | | <ul style="list-style-type: none"> • The densities were similar between both sites for each species; 0.59 bottlenose dolphins per km² in coastal Onslow waters versus 0.83 bottlenose dolphins per km² around Thevenard Island and 0.36 humpback dolphins per km² at Onslow and 0.38 humpback dolphins per km² around Thevenard Island. The density of humpback dolphins, although low, is comparable to estimates across their range. • The study confirms that Indo-Pacific bottlenose and Australian humpback dolphins use the waters near Onslow • Low re-capture rates suggest that their home ranges are larger than, and only partially overlapping, the 128 km² area. • More intense sampling effort would be required to precisely estimate abundance for humpback dolphins. | |
| Technical Appendix Marine Mammals Wheatstone Project EIS/ERMP | <p>This report summaries the contextual and preliminary survey results from the Chevron Wheatstone surveys to support the assessment of the Project. The summary is related to marine mammals including a review of existing literature for marine mammals, aerial, and the acoustic surveys undertaken in the Project area to determine the distributions and abundances of identified fauna. The appendix summaries the preliminary results of these surveys.</p> | <p>Key findings included:</p> <ul style="list-style-type: none"> • Blue whales were identified by acoustic and aerial surveys in the Project area, in deep waters of the continental slope. Migratory blue whales may transit the area between October to December annually. • Humpback whales were observed in waters of the continental slope approximately 50 km west of Onslow when migrating north, and 35 km offshore in water waters of the continental slope when migrating south • Indo Pacific humpback dolphins and the spotted bottlenose dolphin were identified as occurring within the Project area, but were not detected in the aerial or the acoustic surveys • Dugongs were detected via aerial surveys in coastal waters of the continental shelf, but generally in waters less than 12 m in depth | <p>RPS (2010a)</p> |

| Article Title | Survey/study effort | Key findings | Reference |
|---|---|---|---------------------|
| Dugong Aerial Survey Report | This report outlines the results of supplementary aerial studies undertaken by RPS in 2010 to increase the certainty of the EIS/ERMP risk assessments and to inform the development of management measures in relation to dugongs. The dugong aerial survey was undertaken in both the immediate vicinity of the coastal site of the Wheatstone Project area and in Exmouth Gulf in 2010. | <p>The key findings of the survey were:</p> <ul style="list-style-type: none"> • The density of dugongs in the Wheatstone Project area was approximately one-fifth of that in Exmouth Gulf, with densities of 0.11 (95% CI: 0.07–0.13) and 0.59 (95% CI: 0.46–0.70) dugongs per km² respectively • No calves were recorded within the Wheatstone Project area, while six calves were recorded within Exmouth Gulf • Within the Wheatstone Project area, dugongs were primarily found in the north-west portion, often close to the coast or in the lee of reef-fringed islands and sometimes near areas where seagrass has previously been recorded • The estimated population size of the Wheatstone Project area is only 287 animals, the lowest recorded on the WA coastline • No dugong aggregations were observed within the Wheatstone Project area | RPS (2010b) |
| Pygmy blue whale movement, distribution, and important areas in the Eastern Indian Ocean | This publication summarises the movement of Pygmy Blue Whales (<i>Balaenoptera musculus brevicauda</i>) in the South-east Indian waters. The study area extended along the Western Australian coast and encapsulates the Potential vessel movement area. The study involved the combination of passive acoustic monitoring and satellite telemetry to quantify the pygmy blue whale distribution and important areas. | <p>The key findings of the acoustic monitoring and tagging surveys document in the paper were:</p> <ul style="list-style-type: none"> • showed extensive use of the slope habitat off WA, with minimal use of the shelf habitat, only 7% of tagged whales occupied shelf waters • During their northern migration (April to June) from Ningaloo up to the Rowley shoals the whale had high use and low move persistence supports possible Foraging BIA off Ningaloo <p>For the southern migration (November to December) the whales could be found north-west of WA.</p> | Thums et al. (2022) |
| Reptiles | | | |

| Article Title | Survey/study effort | Key findings | Reference |
|--|---|---|--------------------------------|
| New range and habitat records for threatened Australian sea snakes raise challenges for conservation | This report summarises extensive field surveys, habitat data and molecular genetics to document the first unequivocal records of living <i>A. foliosquama</i> and <i>A. apraefrontalis</i> since they were listed as Critically Endangered, in coastal WA. | The key findings of the paper that are relevant were: <ul style="list-style-type: none"> • Capture/records of living <i>A. foliosquama</i> (n = 16) and <i>A. apraefrontalis</i> (n = 7) • significantly increases the known geographic range and habitats of <i>A. foliosquama</i>. | D'Anastasi et al (2016) |
| Using aerial photogrammetry to assess stock-wide marine turtle nesting distribution, abundance and cumulative exposure to industrial activity | This publication summaries nesting distribution of the flatback turtles in the Pilbara region on WA, from Y Islands in the Exmouth Gulf to Bedout Island in the north and Mulla Mulla Downs Creek in the east. | The key findings of the paper that are relevant were: <ul style="list-style-type: none"> • Majority of nesting occurs on Islands (85.3%) • No flatback turtle nesting was observed on mainland southwest of Urala Beach, between Beadon Creek (Onslow) and Dampier • 77% of rookeries were in protected areas. | Fossette et al. (2021) |
| I still call Australia home: Satellite telemetry informs the protection of flatback turtles in Western Australian Waters | This report present the results of complied satellite tracking data of 280 flatback turtles deployed between 2005 and 2020. The aim of the research was to investigate movements and level of spatial protected to the five genetic stocks in WA during different behavioural phases. The report is relevant to the Proposal as identifies habitat use of the species in the waters adjacent to the Proposal. | Flatback turtle: <ul style="list-style-type: none"> • Flatback turtles spend 99.5% of their time in Australian water • >98% overlap with biologically important areas during the inter-nesting phase of their life cycle Up to 85.6% and 59.1% overlap between marine reserves and the foraging and migratory range. | Peel et al. (2024) |
| Marine Turtle Mainland Area and Nearby Island 25 January – 6 February 2009 | This report was completed to support the Chevron Wheatstone Project and involves marine turtle surveys conducted in the Onslow region and summarised grounds surveys completed from 24 Jan to 7 Feb 2009 at mainland beaches from Locker Point to Coolgara, and Ashburton, Bessieres, Direction, Flat, Locker, Round, Serrurier, Table, Thevenard, Tortoise, NE Twin and SW Twin Islands. | <ul style="list-style-type: none"> • Ashburton, Bessieres, Locker, Serrurier and Bessieres Island nesting was predominantly green turtles, with a small number of flatback turtles • Thevenard Island flatback turtle nesting was primarily recorded on the south-western coast and green turtles on the north-west coast • Ashburton and Locker Islands were dominated by flatback turtle nesting | Pendoley Environmental (2009a) |

| Article Title | Survey/study effort | Key findings | Reference |
|---|---|--|------------------------|
| | | <ul style="list-style-type: none"> • Small areas of suitable nesting and low to moderate density nesting were identified at Direction, Flat, NE Twin, Table, Tortoise, Round and SE Twin Islands. • 58 juvenile green turtles were sighted in shallow shore waters near the survey islands • One juvenile/sub-adult loggerhead turtle was sighted off the coast of SW Twin Island. • No sightings in inshore turbid waters. • Dolphins, sharks, rays and dugongs were also observed. | |
| Twenty years of turtle tracks: marine turtle nesting activity at remote locations in the Pilbara, Western Australia. | This publication summarises data collected on three species of marine turtle (flatback, green and hawksbill) between 1992 and 2012 to identify reproductive habitat and species-specific abundances at 154 locations in the Pilbara region. | <ul style="list-style-type: none"> • Green turtles most abundant, nesting at few sights but in greater numbers (1200.5 ±62.0) • Flatback abundance 877.4 ±29.5 • Hawksbill abundance 314.1 ±17.1, and least widespread – concentrated in the Onslow and Dampier subregions • Flatback and hawksbill nested primarily on islands (93%) • Flatback turtle nests more widely distributed | Pendoley et al. (2016) |
| Technical Appendix – Marine Turtles, Wheatstone Project EIS/ERMP | <p>This technical appendix provides a summary of studies related to marine turtles, including a review of existing literature for marine turtles, field studies by Pendoley Environmental (2009a) and field studies undertaken by RPS (2010). This technical appendix summarised and presented information collected from the following surveys:</p> <ul style="list-style-type: none"> • Satellite study of nesting flatback turtles in the vicinity of the Ashburton North SIA • Turtle nesting survey of mainland and island beaches in the vicinity of the Ashburton North SIA • Vessel-based survey of foraging marine turtles in the vicinity of the Ashburton North SIA | <p>The report outlined the following:</p> <ul style="list-style-type: none"> • Nesting: <ul style="list-style-type: none"> • The beach at Ashburton North is unsuitable for marine turtle nesting • Flatback turtles nest on the beach at the Ashburton River Delta • Green and flatback turtles nest on many of the islands adjacent to the Project area • Inter-nesting <ul style="list-style-type: none"> • Inter-nesting satellite data for tagged flatback turtles indicated that the species travel extensively during the inter-nesting period, with all tagged individuals passing through the Project area during the inter-nesting period • Hatching: | RPS (2010c) |

| Article Title | Survey/study effort | Key findings | Reference |
|--|--|--|-----------------------|
| | Report on turtle nesting and hatchling orientation surveys of mainland and island beaches around Ashburton North for AIP in January– March 2009 (Pendoley Environmental 2009b) | <ul style="list-style-type: none"> • There was a high hatching success for both green and flatback turtles on offshore islands within and adjacent to the Project area but low hatching success on the mainland due to predation (Pendoley Environmental 2009) • Foraging: • Most foraging turtles in the Project area were green turtles • • The RPS study found similar turtle numbers occupied reef and offshore non-reef habitats in the Project area during peak foraging season • Adult and juvenile foraging green turtles were believed to be resident individuals • No flatback turtles were observed foraging during either survey | |
| Prioritising search effort to locate previously unknown populations of endangered marine reptiles | This report used correlative modelling approach to understand habitat associations and identify suitable habitats for five of these species (<i>Aipysurus apraefrontalis</i> , <i>A. foliosquama</i> , <i>A. fuscus</i> , <i>A. l. pooleorum</i> and <i>A. tenuis</i>). With the aim to prioritise future survey regions to locate unknown populations. This reports mapped the habitat suitability for the Proposal area. | <p>The key findings of the paper that are relevant were:</p> <ul style="list-style-type: none"> • <i>A. apraefrontalis</i> key areas of suitable habitat: Ashmore Reef, Exmouth Gulf, Muiron and Montebello Islands • <i>A. foliosquama</i> key areas of suitable habitat: Ashmore Reef, Shark Bay, Exmouth Gulf, Barrow and Montebello Islands. | Udyawer et al. (2020) |
| Sharks and fish | | | |
| Collaborative methods identify a remote global diversity hotspot of threatened, large-bodied rhino rays | This publication identified 2,343 records of globally threatened rays of the order Rhinopristiformes from the Pilbara region of WA. The study location is an important refuge and pupping area for green sawfish (<i>Pristis zijsron</i>), bottlenose wedgefish (<i>Rhynchobatus australiae</i>), shark rays (<i>Rhina ancylostoma</i>) and eyebrow wedgefish (<i>Rhynchobatus palpebratus</i>). This study does overlap with the Proposal DE. | <p>The key findings of this paper:</p> <ul style="list-style-type: none"> • All eight species of the Australian rhino-rays are found along the Pilbara coastline, as well as seven of the eight in the Exmouth Gulf • The Ningaloo Coast World Heritage Area and adjacent Exmouth Gulf host all life stages of giant shovelnose ray (<i>Glaucostegus typus</i>). | Bateman et al. (2024) |

| Article Title | Survey/study effort | Key findings | Reference |
|---|---|--|----------------------|
| Trends in catch rates of sawfish on the Australian North West Shelf | This publication collects known data of sawfish bycatch by the Pilbara Trawl Fishery to verify populations of sawfish in the Pilbara region. The study hypothesizes sawfish populations are stabilizing or increasing due to a reduction of inshore fisheries. The critically endangered green sawfish are known to inhabit the waters adjacent to the Proposal area (offshore). | <p>The key findings of the paper:</p> <ul style="list-style-type: none"> • Sawfish population trends follow seasonal patterns that are hypothesized to be related to an annual migration • Green and narrow sawfish undergo a cross-shelf migration in their lifetime • No significant depth preference related trends for either species | Harry et al. (2024) |
| Examination of Connectivity of hammerhead sharks in Northern Australia | This publication is part of the Marine Biodiversity hub Proposal A5. The aim of this paper was to fill in management gap on whether Australian hammerhead shark stocks are shared with neighbouring countries. Using satellite tagging and tracking, genetic analysis and parasites. | <p>The key findings of the paper that are relevant were:</p> <ul style="list-style-type: none"> • sharks tagged in Exmouth Gulf showed movements restricted to the Gulf and adjacent island • Results for <i>S. lewini</i> revealed that Indo-Pacific populations (eastern and northern Australia, Papua New Guinea - PNG, Philippines, Taiwan, Fiji) are distinct from those from Western Australia (WA) and the Central Pacific <p>parasite assemblages of <i>S. lewini</i> from Australian waters were significantly different between the NT, QLD and NSW.</p> | Heupel et al. (2020) |
| Growth and morphology of Critically Endangered green sawfish <i>Pristis zijsron</i> in globally important nursery habitats | This publication assessed size development of Green Sawfish through recapture techniques in the Ashburton River and small tidal creeks surrounding Onslow, WA. The study hypothesizes the slower growth rate of green sawfish in this region, compared to the north-eastern population and nearby populations, potentially due to anthropogenic factors, differential productivity, environmental parameters, etc | <p>The key findings of the paper were:</p> <ul style="list-style-type: none"> • Growth of juvenile sawfish in WA coast is significantly slower compared to populations on the north-eastern coast of Australia • Juvenile sawfish growth rates in the mouth of the Ashburton River are much higher compared to nearby populations in the tidal creeks of Onslow, WA • Differences in the number of rostral teeth of green sawfish between the WA population and other populations throughout their current distribution indicate substantial genetic differentiation in this species globally | Lear et al. (2023) |

| Article Title | Survey/study effort | Key findings | Reference |
|---|---|---|----------------------|
| Effects of coastal development on sawfish movements and the need for marine animal crossing solutions | This publication assessed the effects of major anthropogenic development on the movement behaviour of juvenile green sawfish in the Ashburton river in WA. The study identified problems surrounding development that discourage sawfish residency and pupping, such as the deepening of channels deter juvenile sawfish as deeper waters may indicate more predators. The study suggested several potential structure-specific modifications that could enhance marine faunal passage through coastal developments | <p>The key findings of the paper:</p> <ul style="list-style-type: none"> • Pupping of green sawfish continues regardless of anthropogenic development • Juvenile sawfish were not detected in waters deeper than 7m | Lear et al. (2024) |
| North-western Australia as a hotspot for endangered elasmobranchs with reference to sawfishes and the Northern River Shark | This publication collected donated sawfish rostra for morphological examination. The rostras were identified to site location and further measured by length and weight. The study hypothesized species distribution and viable adult and pupping habitats. Through the study, the authors created a comprehensive distribution map of sawfish species in WA. | <p>The key findings of the paper:</p> <ul style="list-style-type: none"> • Species distribution throughout WA • Newborns pups appear to have different nursing locations; generally, locations are shallow, nearshore habitats • Knowledge gap of species distribution between King Sound and Ord River | Morgan et al. (2011) |
| Habitat use and site fidelity of neonate and juvenile green sawfish <i>Pristis zijsron</i> in a nursery area in Western Australia | This report presents the results from green sawfish surveys completed in 2011 within the Ashburton River and adjacent tidal mangrove areas. Captured green sawfish were measured, sexed and maturity status determined, and if large enough has a V13 acoustic transmitter (Vemco attached). | <ul style="list-style-type: none"> • 37 juvenile green sawfish were captured and tagged • Sawfish displayed high site fidelity near the mouth of the Ashburton River (<700 m upstream) or in the adjacent tidal mangrove creeks • Neonates stayed close to the river mouth for several months, with movement increasing with growth. <p>larger individuals, movement between the river mouth or creeks and nearshore coastal habitats was largely tidally driven, with nearshore coastal habitats used during low tide and protected tidal waters (mangrove creeks) used during high tide. Emigration from the river estuary appeared to be influenced by increases in freshwater discharge and high turbidity brought on by cyclonic rainfall events</p> | Morgan et al. (2017) |

| Article Title | Survey/study effort | Key findings | Reference |
|--|---|---|------------------------|
| Movement, distribution, and marine reserve use by an endangered migratory giant | This publication presents tracking data from 29 whale sharks tagged off Ningaloo tagged were deployed from 2010 to 2016 with a deployment range of 9–261 days. Tags tracked the sharks' movements from Ningaloo and their use of the south-eastern Indian Ocean. The tagging site does not overlap with the Proposal area but is relevant for whale shark movements along the WA coastline. | <p>The key findings of the satellite telemetry documented in the paper were:</p> <ul style="list-style-type: none"> • Movement of the whale sharks away from the Ningaloo Marine Protected area and returning intra-annually • A seasonal shift in Whale shark habitat suitability, highlighted areas of higher habitat suitability that are not protected between Onslow and Port Hedland • Sharks showed high site fidelity returning to the Ningaloo after traveling away, supporting evidence that Ningaloo is post-nurse location. | Reynolds et al. (2017) |
| Evidence for behavioural thermoregulation by the world's largest fish | This publication summarises the horizontal movement of 4 tagged whale sharks (<i>Rhincodon typus</i>) in 2008 to investigate the diving behaviour and vertical use of habitat. The tagging sites are adjacent to the Proposal, and the movements overlap with the potential vessel movement area. The vertical movements and prolonged periods spent at the surface are relevant to the Proposal. | <p>The key finding of the remote-sensing data documented in the paper were:</p> <ul style="list-style-type: none"> • The vertical movements showed that the sharks dive in three ways: Night-time bounce (i.e., rapid descent and ascent) dives; Day time bounce dives; Daytime deep and long (340m, 169min) dives, with extremely long (146 min) post dive surface intervals. • Bounce dives were the most common for the sharks tagged at Ningaloo and for the shark tagged off Christmas Island it travelled to Indonesia and 47% of its dives were daytime deep and long dives • Results support thermoregulatory behaviour of whale sharks, with a negative relationship observed between temperature and mean surface duration. This relationship breaks down at 25°C. | Thums et al. (2013) |

Appendix D. Onslow recreational Jetty Underwater Piling Noise Modelling Report (ANV Consultants 2024)

Onslow Recreational Jetty

Underwater Piling Noise Modelling

Prepared for:

O2 Marine

»» Providing 'Sound' Solutions



Picture Source: Google Earth

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Basis of Report

This report has been prepared by ANV Consultants Pty Ltd ('ANV') with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with O2 Marine (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from ANV Consultants.

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EXECUTIVE SUMMARY

The Shire of Ashburton proposes to build a new Onslow Recreational Jetty at Beadon Point, northwest of the main township of Onslow, Western Australia (WA).

ANV Consultants Pty Ltd (ANV Consultants) has been commissioned to undertake underwater noise modelling and an assessment of relevant zones of noise impacts on marine fauna species of concern as a result of the impact piling activities of the proposed jetty construction.

The study scope includes the following components:

- Identification of key marine fauna species potentially impacted by underwater piling noise emissions and their relevant assessment criteria.
- Investigation of the existing underwater noise environment through a review of general ocean noise conditions, as well as the site-specific shipping activities through the shipping traffic density data off the coast of North West Shelf of Western Australia.
- Characterization of piling noise sources and their spectral levels.
- Detailed modelling of underwater piling noise propagation.
- Assessment of potential zones of impact, and
- Discussion of potential management and mitigation measures to minimize noise impacts.

The major findings of each scope component are provided in the sections below, with corresponding sections of the report provided for reference.

The marine fauna species of concern include those with a high potential to occur within and around the project area, such as humpback whales, dolphin species, dugongs, turtles, sharks, rays and sea snakes (**Section 1.3**). The noise impact criteria, concerning both physiological and behavioural effects on corresponding hearing groups of these species, have been established through a review of the most recent relevant guidelines or literature (**Section 3**).

Based on the review of general ocean noise conditions and the site-specific shipping activities, it is expected that the existing marine ambient noise environment is predominantly comprised of local biological noise, wind and wave generated noise, and anthropogenic noise from the commercial and recreational marine traffic activities adjacent to the project area (**Section 2**).

The impact noise generated by pile driving has been characterized based on the proposed design specifications for the pile and impact hammer, as well as the reference impact piling source spectrum from existing literature (**Section 4.1**). Noise modelling predictions were then conducted using relevant modelling inputs, including the bathymetric dataset, source spectral levels, environmental parameters (such as temperature and salinity) across the water column, and the layered geo-acoustic properties of the seabed (**Section 4.2**).

The zones of noise impact for the specified piling scenarios have been predicted for marine fauna species of interest by comparing predicted noise levels with impact criteria. Based on the acoustic parameters used for the assessment, the impact zones have been categorized into:

- Immediate impact zones, which result from individual pile pulses (assessed by peak sound pressure level (Pk SPL) and root-mean-square sound pressure level (RMS SPL)), and
- Cumulative impact zones, which account for the effects of a certain number of piling pulses (assessed by sound exposure level (SEL)).

An assessment of relevant zones of impact are detailed in **Section 5.2**, with a brief summary provided below.

Immediate impact Zones from individual piling pulses

- PTS and TTS for marine mammals

Due to the high level of impulsive signal emissions from the impact piling, some marine mammal hearing groups are predicted to experience a permanent auditory threshold shift (PTS) and a temporary auditory threshold shift (TTS) at very close proximity to the piling source due to the immediate exposure to individual pulses.

Based on the predicted peak sound pressure level (Pk SPL) metric, only humpback whales are predicted to experience PTS within 10 meters of the piling locations. The zones where TTS from a single pulse exposure are predicted to occur for humpback whales, dolphins and dugongs within 10 meters of the piling locations.

- Behavioural disturbance for marine mammals and sea turtles

The zones of behavioural disturbance caused by the immediate exposure to individual pulses are predicted to be within 1.2 km for humpback whales, dolphins and dugongs and 550 meters for sea turtles and sea snakes from the piling locations.

- Mortality & recovery injury for fish and sea turtle species

The zones of mortality and recovery injury for sharks, rays, sea turtles and sea snakes caused by the immediate exposure to individual pulses are predicted to be within 15 meters of the piling locations.

Cumulative impact zones from multiple piling pulses

Due to the project being in its early stages, the exact number of piling strikes to be undertaken within a 24-hour period and the hammer energy to be used are not yet known. Consequently, the zones of cumulative impact from multiple piling pulses (up to 2,000) within a 24-hour period are predicted based on the assumed hammer energy. For the realistic piling scenarios during construction stage, the impact zones for any number of piling pulses within this range can be interpolated from the predicted results.

- PTS and TTS for marine mammals

Among marine mammals of all hearing groups, humpback whales are predicted to experience the largest zones of PTS and TTS impacts.

For humpback whales, the PTS impact zones are predicted to be within 250 meters from piling locations with exposure to 500 piling pulses and within 560 meters with exposure to 2,000 piling pulses within a 24-hour period. The TTS zones are predicted to be within 750 meters with exposure to 100 piling pulses, and around 2.0 km with exposure to 500 piling pulses within a 24-hour period.

In contrast, dolphins and dugongs, the PTS zones are predicted to be only a few tens of meters from the piling locations, even with exposure to 2,000 piling pulses within a 24-hour period. The TTS impact for these groups is predicted to be within two to three hundred meters from the piling locations with exposure up to 2,000 piling pulses within a 24-hour period.

- Mortal & recovery injury and TTS for fish and sea turtle species

For sharks, rays, sea turtles and sea snakes, the cumulative impact zones for mortality and recovery injury are predicted to be within tens of meters from the piling locations, even with exposure to up to 2,000 piling pulses within a 24-hour period. For TTS impact, the cumulative impact zones are predicted to extend to hundreds of meters.

To minimise the piling noise impact on assessed marine fauna species, relevant management and mitigation measure options are provided and discussed in **Section 5.3** of this report. Those options include:

- Safety zones (i.e., observation and shutdown zones) and standard procedures (including soft-start and shutdown procedures).

- Adaptive management and mitigation measures, such as model validation, safety zone adjustments based on realistic operation conditions, key marine ecological window avoidance, etc.
- Additional control measures (such as include bubble curtain, cofferdam, noise mitigation screen, etc.) to attenuate piling noise emissions at a near range and subsequently reduce impact zones.

CONTENTS

| | | |
|----------|--|-----------|
| 1 | INTRODUCTION | 1 |
| 1.1 | Background | 1 |
| 1.2 | Proposed construction works | 2 |
| 1.3 | Marine fauna species of concern for the project | 3 |
| 1.4 | Study objectives and methodologies..... | 3 |
| 2 | EXISTING MARINE NOISE ENVIRONMENT | 4 |
| 2.1 | General marine ambient noise | 4 |
| 2.2 | Site specific marine ambient noise | 7 |
| 3 | MARINE NOISE IMPACT ASSESSMENT CRITERIA | 8 |
| 3.1 | Impact of marine noise on marine fauna species..... | 8 |
| 3.2 | Marine mammals | 10 |
| 3.3 | Fish, fish eggs, fish larvae and sea turtles..... | 12 |
| 3.4 | Zones of noise impact | 14 |
| 4 | PILING NOISE MODELLING PREDICTION..... | 15 |
| 4.1 | Piling noise assessment scenarios and source levels | 15 |
| 4.2 | Modelling methodology and procedure..... | 16 |
| 5 | MODELLING RESULTS AND ZONES OF IMPACT ESTIMATES | 19 |
| 5.1 | Modelling prediction results | 19 |
| 5.2 | Estimated zones of impact | 19 |
| 5.3 | Discussion | 33 |
| 6 | CONCLUSION..... | 35 |
| 7 | REFERENCES | 36 |
| A | GLOSSARY | 39 |
| A.1 | Underwater Acoustics Terms | 40 |
| B | BATHYMETRY DATA CONTOUR FIGURE | 41 |
| C | PREDICTED SOUND EXPOSURE LEVEL (SEL) CONTOUR FIGURES..... | 42 |

DOCUMENT REFERENCES

TABLES

| | | |
|---------|--|----|
| Table 1 | Proposed pile driving construction and tide parameters | 2 |
| Table 2 | Marine fauna species of concern and their respective hearing groups..... | 3 |
| Table 3 | Parameters for the auditory weighting functions..... | 11 |
| Table 4 | PTS and TTS onset threshold levels for marine mammals exposed to impulsive noise | 12 |

CONTENTS

| | | |
|----------|---|----|
| Table 5 | The behavioural disturbance threshold level for marine mammals exposed to impulsive noise | 12 |
| Table 6 | Sound exposure criteria applicable for pile driving – Fishes and sea turtles | 13 |
| Table 7 | Revised sound exposure criteria for sea turtles – Impulsive sound | 14 |
| Table 8 | Proposed modelling scenarios with their pling source locations and tide conditions. | 15 |
| Table 9 | Geoacoustic parameters for the seafloor model | 18 |
| Table 10 | Zones of immediate impact from single impact piling pulses for PTS and TTS – marine mammals | 21 |
| Table 11 | Zones of immediate impact from single impact piling pulses for behavioural changes – marine mammals and sea turtles..... | 21 |
| Table 12 | Zones of immediate impact from single impact piling pulses for mortality and recovery injury– fish, turtles, fish eggs and fish larvae | 22 |
| Table 13 | Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – Marine Mammals - Scenario 2 End of Jetty HAT | 23 |
| Table 14 | Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – Marine Mammals - Scenario 1 End of Jetty LAT..... | 25 |
| Table 15 | Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – Marine Mammals - Scenario 3 Mid of Jetty HAT..... | 27 |
| Table 16 | Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – Marine Mammals - Scenario 4 Mid of Jetty MSL | 29 |
| Table 17 | Zones of cumulative impact from impulsive noise under multiple piling pulses for mortality and recovery injury– fish, turtles, fish eggs and fish larvae..... | 31 |
| Table 18 | Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – sea turtles..... | 32 |
| Table 19 | Example of management zones based on a scenario of 100 piling pulses | 33 |
| Table 20 | Mitigation options and their indicative marine piling noise reduction performance (ACCOBAMS, 2019, IQIP, 2022 and Greenov, 2024) | 34 |
| Table 21 | Underwater Acoustics Terms and their definitions | 40 |

FIGURES

| | | |
|----------|---|----|
| Figure 1 | Project Location and indicative Development Envelope (Source: O2 Marine)..... | 1 |
| Figure 2 | Jetty Concept Design (Source: O2 Marine) | 2 |
| Figure 3 | Levels and frequencies of anthropogenic and naturally occurring sound sources in the marine environment (from https://www.ospar.org/work-areas/eiha/noise). Natural physical noise sources represented in blue; marine fauna noise sources in green; human noise sources in orange | 5 |
| Figure 4 | Composite of ocean ambient noise spectra (Wenz, 1962) | 6 |
| Figure 5 | Summary of marine ambient noise spectra for the Australian Region (Cato, 1997) | 7 |
| Figure 6 | Shipping traffic density off the coast of North West Shelf of Western Australia (Source: http://www.marinetraffic.com/ , Traffic data: 2022)..... | 7 |
| Figure 7 | Theoretical zones of impact around a noise source, with stress potentially occurring across all levels of impact (Salgado Kent et al, 2016) | 8 |
| Figure 8 | Auditory weighting functions - LF, HF, VHF, SI, PCW and OCW | 11 |
| Figure 9 | One-third octave SEL source spectral levels (unweighted and M-weighted) for the piling noise | 15 |

CONTENTS

| | | |
|-----------|---|----|
| Figure 10 | Sound speed profiles derived from the WOA2023 seasonal temperature and salinity across the water column adjacent to the proposed project area | 17 |
|-----------|---|----|

1 Introduction

1.1 Background

The Shire of Ashburton proposes to build a new Onslow Recreational Jetty (the Project) at Beadon Point, northwest of the main township of Onslow, Western Australia (WA).

The proposed jetty will be a pedestrian accessible fixed jetty design, intended to provide access for deeper water fishing at low tide, with usage limited to walking and recreational fishing with no vehicle or vessel access (except for ad-hoc maintenance vehicles/vessels).

The jetty is likely to extend 210 m from the vegetation line (252 m total) with a width of 4 m, located adjacent to the old Onslow jetty site. The project location and indicative Development Envelope are shown in **Figure 1** below.



Figure 1 Project Location and indicative Development Envelope (Source: O2 Marine)

1.2 Proposed construction works

The preliminary concept design for the proposed jetty section is displayed in **Figure 2** below.

The jetty will be constructed using piles driven into the sediment and landings constructed. Currently there are no roads or access to the site, and therefore land clearing is likely to be required to gain access for the building materials and equipment. Construction may progressively work seaward using a mobile construction rig that is moved along the jetty as the structure is progressively built.

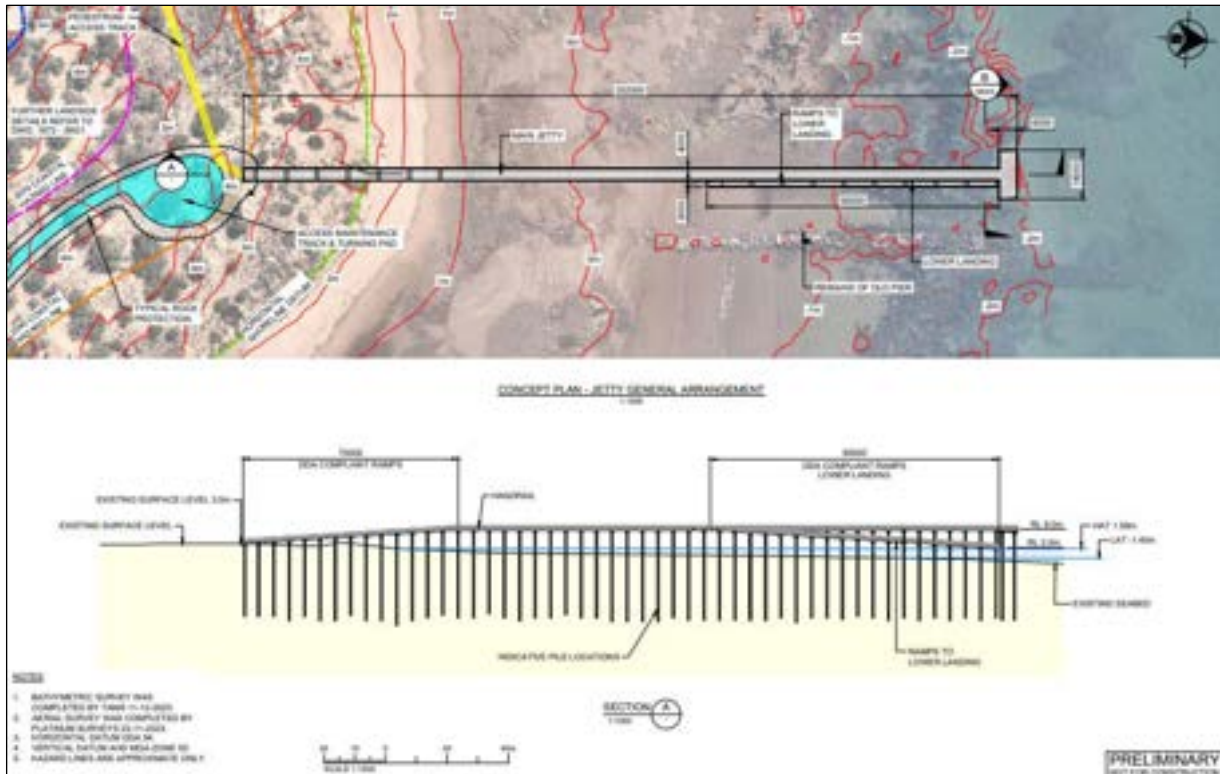


Figure 2 Jetty Concept Design (Source: O2 Marine)

Considering the likely presence of rock / limestone materials within the project area, a vibratory pile driving option may not be applicable for the project. Therefore, only a piling option using an impact hammer is considered for the piling works.

Some key parameters associated with the proposed pile driving construction are outlined in **Table 1**.

Table 1 Proposed pile driving construction and tide parameters

| Parameter | Value |
|---------------------------------|-----------------------------------|
| Pile arrangement per location | 1 raker, 1 vertical |
| Maximum pile size | 750 mm OD by 16 mm wall thickness |
| Penetration depth | Nominal 15 m |
| Number of piles in total | 110 |
| Maximum hammer energy | 120 KJ / KN·m |
| Highest Astronomical Tide (HAT) | 1.58 m |
| Lowest Astronomical Tide (LAT) | -1.40 m |

1.3 Marine fauna species of concern for the project

The impact piling activities associated with the marine jetty construction are expected to generate significant marine noise emissions, and they have the potential to cause adverse impact on marine fauna species within and adjacent to the project area.

The marine fauna species of concern that are of high potential to occur within and around the project area and their respective hearing groups in terms of sensitivity to noise impact are provided in **Table 2** below. Detailed information in relation to these hearing groups are provided in **Section 3.2** and **Section 3.3** of this report.

Table 2 Marine fauna species of concern and their respective hearing groups

| Marine fauna species | Hearing Group (refer to Section 3.2 & 3.3) |
|--|--|
| Humpback whale (<i>Megaptera novaeangliae</i>) | Low-frequency (LF) cetacean |
| Australian humpback dolphin (<i>Sousa sahalensis</i>) Indo-Pacific/ spotted bottlenose dolphin (<i>Tursiops aduncus</i>) | High-frequency (HF) cetacean |
| Dugongs | Sirenians (SI) |
| Sharks Rays Sawfish | Fish species (without swim bladder) |
| Flatback turtle (<i>Natator depressus</i>) Green turtle (<i>Chelonia mydas</i>) Hawksbill turtle (<i>Eretmochelys imbricata</i>) Sea snakes | Sea turtles |

1.4 Study objectives and methodologies

This modelling study is undertaken with consideration of the current best practice in assessing underwater noise impact on marine fauna species applied both nationally and internationally. The study methodology is detailed within the report structure below.

- **Section 2** demonstrates the generic characterisation of the baseline underwater noise environment, based on a review of the general ocean noise environment, as well as the site-specific shipping traffic conditions surrounding the project area.
- **Section 3** outlines the assessment criteria for generic marine fauna species, including marine mammal, fish and sea turtle species, based on relevant guidelines and criteria that represent current industry best practices.
- **Section 4** provides the detailed noise modelling prediction methodology and procedure, relevant modelling environmental inputs and assumptions, modelling source locations and scenarios associated with the impact piling activities, and source spectral levels of piling noise emissions.
- **Sections 5** presents the detailed modelling results and the subsequent zones of impact estimated for marine fauna species of concern based on criteria set out in **Section 3**. Discussions on the noise impact implications as well as relevant mitigation and measurement options are also provided.
- **Sections 6** provides a brief conclusion of this noise modelling study.

A glossary of relevant underwater acoustic terminologies used in the report is provided in **Appendix A**.

2 Existing marine noise environment

2.1 General marine ambient noise

Marine ambient noise poses a baseline limitation on the use of sound by marine animals as signals of interest that must be detected against background noise. The temporal and spectral level characteristics of the ambient noise environment are the two major factors that control how far away a given sound signal can potentially be detected (Richardson *et al.*, 1995).

Marine ambient noise is comprised of a variety of sounds of different origins at different frequency ranges, having both temporal and spatial variations. It primarily consists of noise from natural physical events, noise produced by marine biological species and anthropogenic noise (Carey and Evans, 2011). These sources are detailed as follows:

- Natural events: The major natural physical events contributing to marine ambient noise include, but are not limited to, wave/turbulence interactions, wind, precipitation (rain and hail), breaking waves and seismic events (e.g. earthquakes/tremors):
 - The interactions between waves/turbulence can cause very low frequency noise in the infrasonic range (below 20 Hz). Seismic events such as earthquakes/tremors and underwater volcanos also generate noise predominantly at low frequencies from a few Hz to a few hundred Hz.
 - Wind and breaking waves, as the prevailing noise sources in much of the world's oceans, generate noise across a very wide frequency range, typically dominating the ambient environment from 100 Hz to 20 kHz in the absence of biological noise sources. The wind dependent noise spectral levels also strongly depend on sea states which are essentially correlated with wind force, and
 - Precipitation, particularly heavy rainfall, can produce much higher noise levels over a wider frequency range of approximately 500 Hz to 20 kHz.
- Bioacoustic production: Some marine animals produce various sounds (e.g. whistles, clicks) for different purposes (e.g. communication, navigation or detection), including
 - Baleen whales (e.g. great whales like humpback whales) regularly produce intense low frequency sound (e.g. whale songs) that can be detected at long range in the open water. Odontocetes (toothed whales and dolphins) can produce rapid bursts of high frequency clicks (up to 150 kHz) that are primarily for echolocation purposes.
 - Some fish species produce sounds individually, and some species produce these in concert, which is known as chorusing. Typically, fish chorusing depends on species, and can be linked to diurnal, lunar, or seasonal cycles.
 - Snapping shrimp are important contributors among marine biological species to the marine ambient noise environment, particularly in shallow coastal waters. The noise from snapping shrimp is extremely broadband in nature, covering a frequency range from below 100 Hz to above 100 kHz. Snapping shrimp noise can interfere with other measurement and recording exercises, for example it can adversely affect sonar performance.
- Anthropogenic sources: Anthropogenic noise primarily consists of noise from shipping and other vessel activities, offshore seismic explorations, marine industrial developments and operations, as well as equipment such as sonar and echo sounders:

- Vessel traffic from various sizes of vessels is the prevailing man-made noise source around nearshore port areas. Shipping noise is typically due to cavitation from propellers and thrusters, with energy predominantly below 1 kHz.
- Pile driving and offshore seismic exploration generate repetitive pulse signals with intense energy at relatively low frequencies (hundreds of Hz) that can potentially cause physical injuries to marine species relatively close to the noise source. The full frequency range for these impulsive signals could be up to 10 kHz, and
- Dredging activities and other marine industry operations are additional man-made sources, generating broadband noise over relatively long durations.

Figure 3 provides an overview of the indicative noise spectral levels produced by various natural and anthropogenic sources, relative to typical background or ambient noise levels in the ocean. Human contributions to ambient noise are often significant at low frequencies, between about 20 Hz and 500 Hz, with ambient noise in this frequency range being predominantly from distant shipping (Hildebrand, 2009). In areas located away from anthropogenic sources, background noise at higher frequencies tends to be dominated by natural physical or bioacoustic sources such as rainfall, surface waves and spray, as well as fish choruses and snapping shrimp for coastal waters.

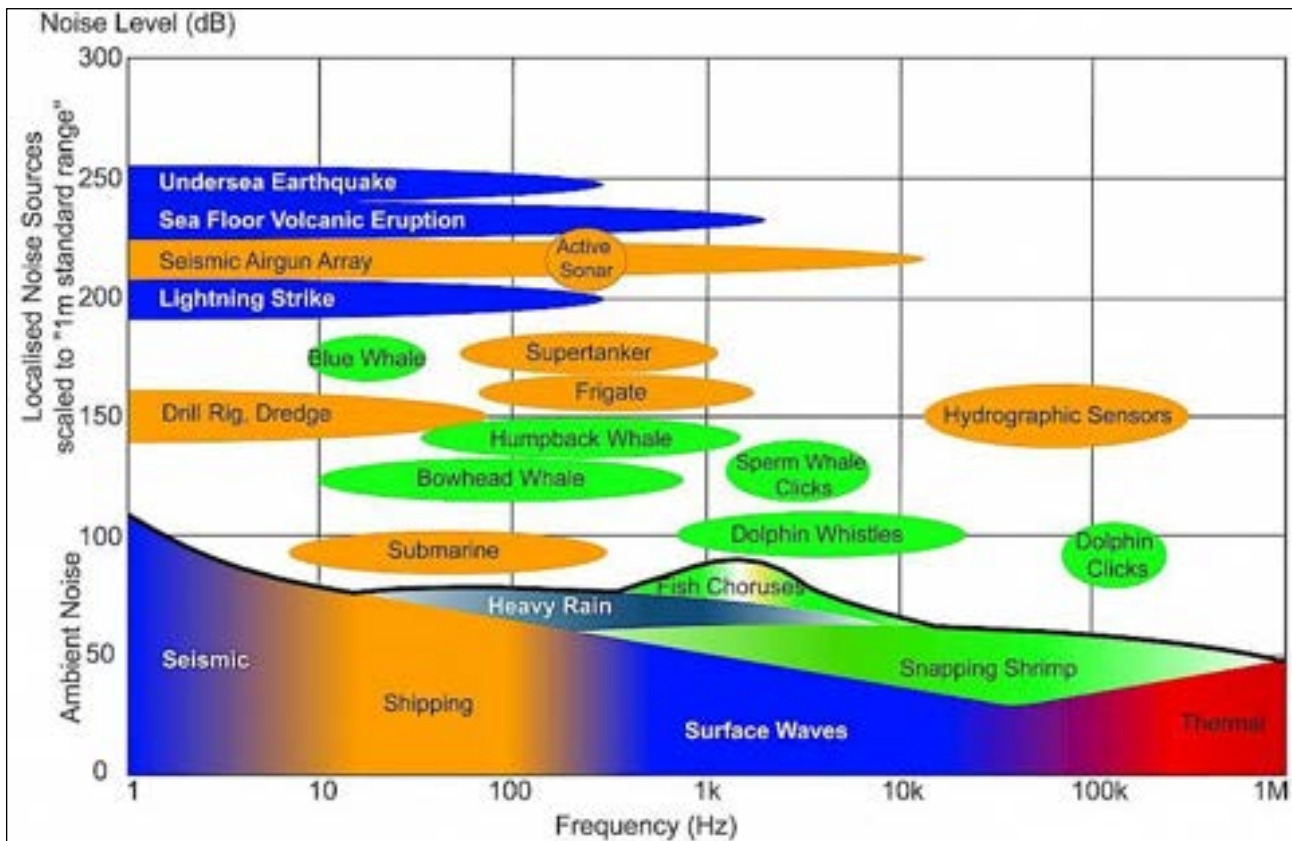


Figure 3 Levels and frequencies of anthropogenic and naturally occurring sound sources in the marine environment (from <https://www.ospar.org/work-areas/eiha/noise>). Natural physical noise sources represented in blue; marine fauna noise sources in green; human noise sources in orange

A summary of the spectra of various ambient noise sources based on a review study undertaken by Wenz (1962) is shown in **Figure 4**. It should be noted that although the spectral curves in the figure are based on average levels from reviewed references primarily for the North Atlantic Ocean region, they are regarded as representative in general for respective marine ambient noise spectral components.

Studies in Australian waters have shown that there are some significant differences in the ambient noise compared to the colder Northern Hemisphere waters where most existing measurements have been recorded. **Figure 5** summarises the main components of sea ambient noise for the Australian waters, where the differences from Wenz's ambient noise spectra are due to the different environment of tropical waters, particularly in respect to noise from marine fauna. Wind generated noise and traffic noise due to shipping activities are generally consistent in level range between the two studies (Wenz, 1962 and Cato, 1997).

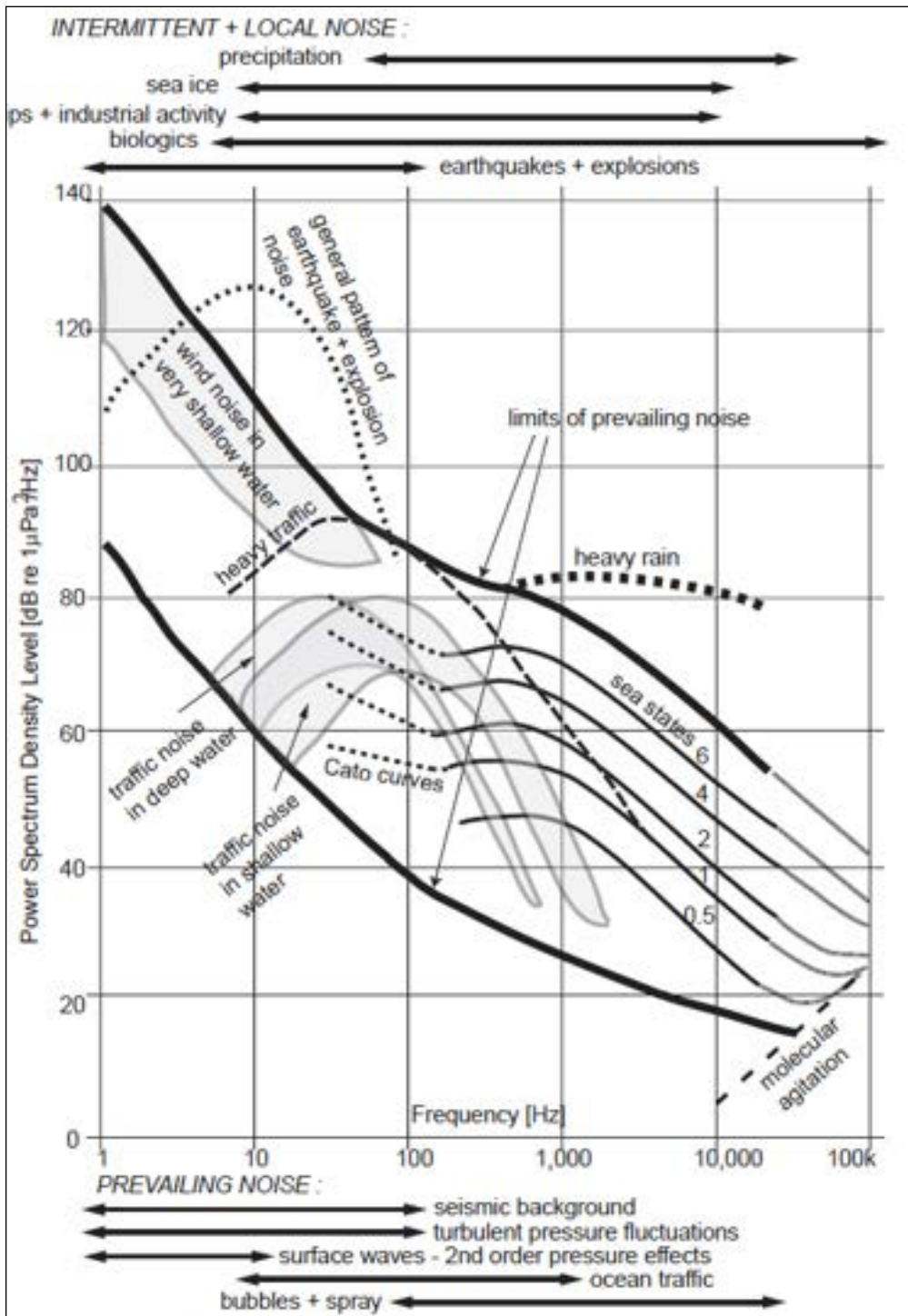


Figure 4 Composite of ocean ambient noise spectra (Wenz, 1962)

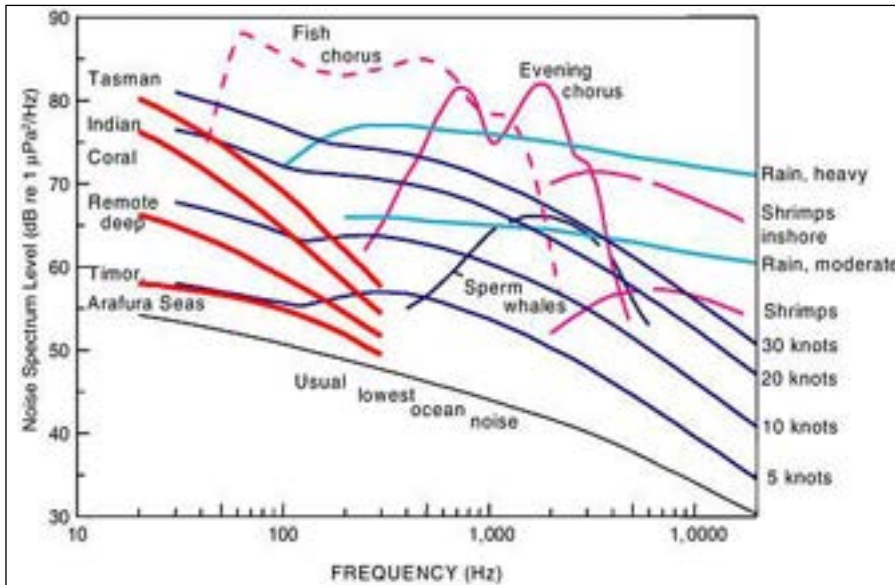


Figure 5 Summary of marine ambient noise spectra for the Australian Region (Cato, 1997)

2.2 Site specific marine ambient noise

Figure 6 shows the shipping traffic density off the coast of North West Shelf of Western Australia. There are major traffic routes further offshore as well as out of major ports with large cargo ships for commodity imports and exports. High density vessel traffic also occurs around the offshore oil and gas facilities. The project area has a relatively high density of shipping activities, predominantly for local commercial and recreational purposes. The project area is not directly exposed to major shipping traffic routes.

It is expected that the marine ambient noise environment is predominantly comprised of local biological noise, wind and wave generated noise and local shipping noise. The overall ambient noise levels for the project area are expected to be with or slightly above the typical baseline noise level range (i.e. 80 - 120 dB re 1 μPa RMS).

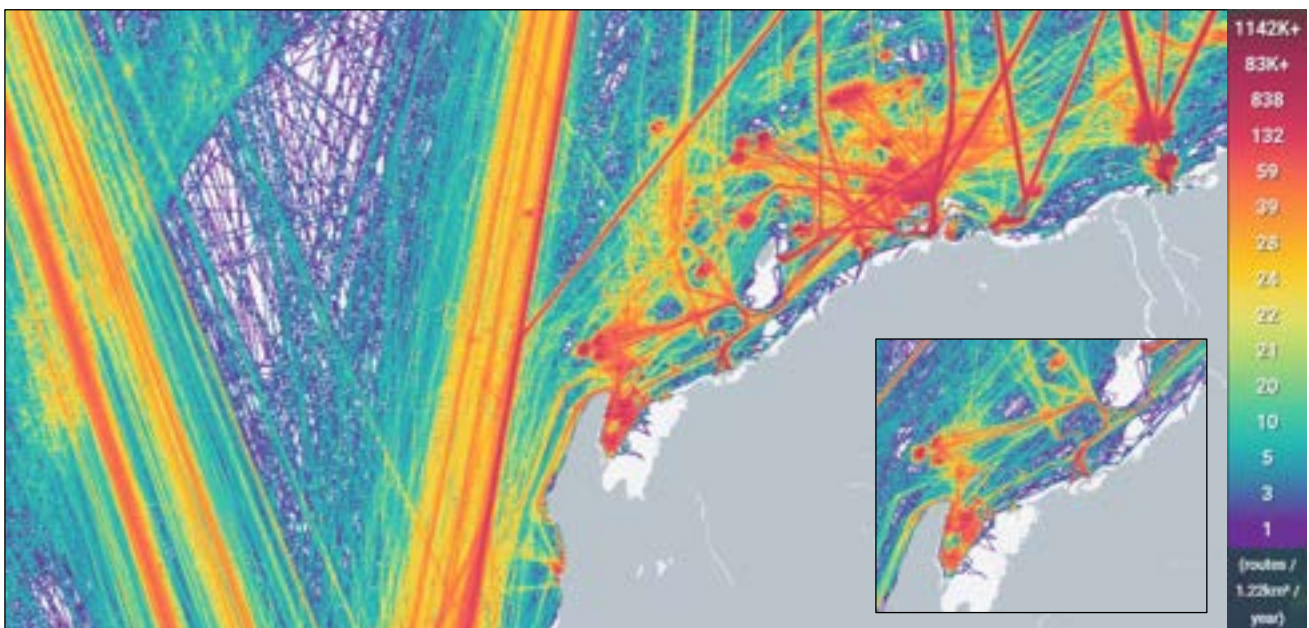


Figure 6 Shipping traffic density off the coast of North West Shelf of Western Australia (Source: <http://www.marinetraffic.com/>, Traffic data: 2022)

3 Marine noise impact assessment criteria

3.1 Impact of marine noise on marine fauna species

Underwater sound transmits efficiently within the water column and is an important sensory modality for many marine organisms. A variety of marine fauna species, including marine mammals, fish species and invertebrates, have special mechanisms both for emitting and detecting underwater sound (Richardson *et al.*, 1995; Popper *et al.*, 2001 and 2003).

Marine mammals, including cetaceans and pinnipeds, use underwater sound in communication, orientation, predator avoidance and foraging (Tyack, 1998; Tyack *et al.*, 2000; Janik, 2005). Many marine fish species produce sounds for communication (Fay and Popper, 1999; Popper *et al.*, 2003 and 2014; Ladich *et al.*, 2004 and 2006a and 2006b), and potentially they also use the acoustic environment for orientation (Montgomery *et al.*, 2006). Marine invertebrates are known to respond to sound particle motion rather than sound pressure (Salgado Kent *et al.*, 2016).

The effects of noise and the range over which these effects take place depend on the acoustic characteristics of the noise (e.g. source level, spectral content, temporal characteristics (e.g. impulsive^[1] or non-impulsive/continuous^[2]), directionality, etc.), the sound propagation environment as well as their sensitivity and physical response of individual marine fauna species. The potential impacts of noise on marine fauna species include masking of communication and other biological important sounds, behavioural responses and physiological impacts which generally include stress (elevating stress hormones and potentially impacting the immune system), hearing loss, physical injury and mortality (Richardson *et al.*, 1995; Hasting and Popper, 2005).

An example of the generalised theoretical zones of noise influence based on the severity of noise impact is illustrated in **Figure 7**.

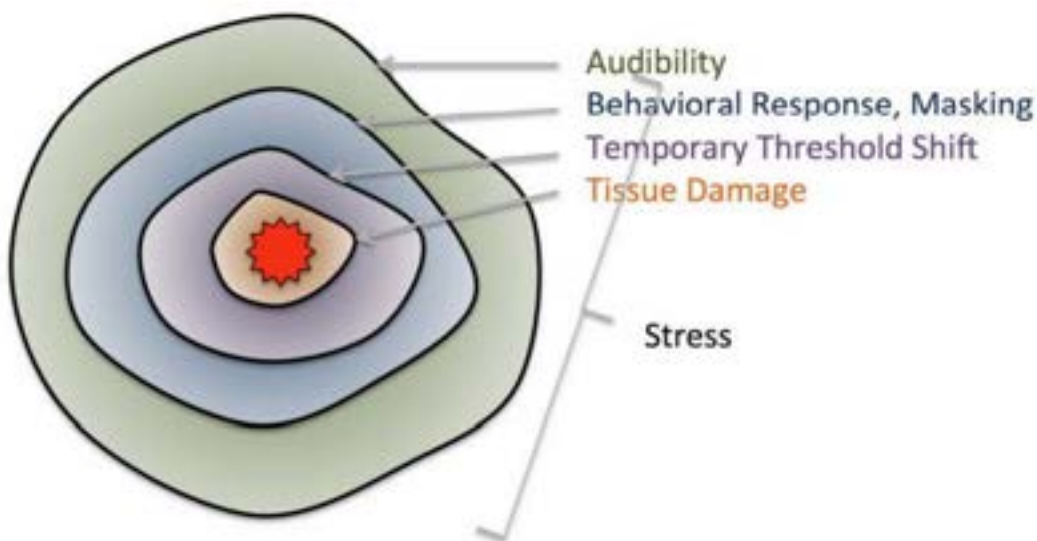


Figure 7 Theoretical zones of impact around a noise source, with stress potentially occurring across all levels of impact (Salgado Kent et al, 2016)

¹ Impulsive noise is typically very short (with seconds) and intermittent with rapid pressure rise time and decay back to ambient levels. E.g., noise from pile driving, seismic airguns and seabed survey sonar signals.

² Non-impulsive or continuous noise refers to a noise event with pressure level remains above ambient levels during an extended period of time (minutes to hours) but varies in intensity with time. E.g., noise from marine vessels.

3.1.1 Audibility/detection

A sound is audible when the receiver is able to perceive it over background noise. The audibility is also determined by the threshold of hearing that varies with frequency. The frequency dependant hearing sensitivity is expressed in the form of a hearing curve (i.e. audiogram). In general, marine mammals and fish species usually have U-shaped audiograms, meaning that within their respective hearing ranges, they are more sensitive to the sound energy component in the mid frequency range, and less sensitive to the energy components in the lower and upper frequency ranges (Whitlow et al., 2008; Southall et al., 2007; Popper et al., 2014).

For fish species, their sound detection is based on the response of the auditory portion of their ears (i.e. the otolithic organs) to particle motion of the surrounding fluid (Popper *et al.* 2014). Some fish species have the ability to detect sound pressure via gas filled structures near the ear and/or extensions of the swim bladder that functionally affect the ear, in addition to the fluid particle motion, which as a result increases hearing sensitivity and broaden the hearing bandwidth (Popper *et al.* 2014).

3.1.2 Masking

Masking occurs when the noise energy is high enough and frequencies overlap those of biologically relevant sound signals such that there is impaired detection. Biologically relevant signals may be communication signals, echolocation clicks and passive detection cues that are used for navigation and finding prey. The zone of masking is defined by the range at which sound levels from the noise source are received above threshold within the 'critical band'³ centred on the signal (Richardson *et al.*, 1995; NRC 2003), and therefore strongly dependent on the background noise environment.

The potential for masking can be reduced due to an animal's frequency and temporal discrimination ability, directional hearing, co-modulation masking release (if noise is amplitude modulated over a number of frequency bands) and multiple looks (if the noise has gaps or the signal is repetitive), as well as anti-masking strategies (increasing call level, shifting frequency, repetition, etc.) (Erbe, 2008).

3.1.3 Behavioural responses

Behavioural responses to noise include changes in vocalisation, resting, foraging, diving and breathing patterns, changes in social behaviours (e.g., cessation of suckling for mother-s and their dependents), and avoidance of or attraction to the noise sources.

The behavioural response effects can be very difficult to measure and depend on a wide variety of factors such as the physical characteristics of the signal, the behavioural and motivational state of the receiver, its age, sex and social and reproductive status and many others. Therefore, the extent of behavioural disturbance for any given signal can vary both within a population as well as within the same individual. Behavioural reactions can vary significantly, ranging from very subtle changes in behaviour to strong avoidance reactions (Richardson *et al.* 1995).

3.1.4 Physiological impacts / hearing loss and physical injury

Physiological effects of underwater noise are primarily associated with the auditory system which is likely to be most sensitive to noise. The exposure of the auditory system to a high level of noise for a specific duration can cause a reduction in the animal's hearing sensitivity, or an increase in hearing threshold. If the noise exposure is below some critical sound energy level, the hearing loss can be only temporary, and this effect is called temporary hearing threshold shift (TTS). If the noise exposure exceeds the critical sound energy level, the hearing loss can be permanent, and this effect is called permanent hearing threshold shift (PTS).

³ In biological hearing systems, noise is integrated over several frequency filters, called the critical bands.

In a broader sense, physiological impacts also include non-auditory physiological effects. Other physiological systems of marine animals potentially affected by noise include the vestibular system, reproductive system, nervous system, liver or organs with high levels of dissolved gas concentrations and gas filled spaces. Noise at high levels may cause concussive effects, physical damage to tissues and organs, cavitation or result in rapid formation of bubbles in venous system due to massive oscillations of pressure.

From an adverse impact assessment perspective, among the potential noise impacts above, physiological impacts are deemed as the primary adverse impact, and behavioural responses as the secondary adverse impact. However, it should be mindful that a lower-level effect can lead to a higher-level effect indirectly (e.g., a dredging activity which is stimulating fish activity may attract dolphins, placing it within closer proximity and increased risk of incurring TTS).

The following sub-sections outline the corresponding impact assessment criteria for marine mammals, fish and sea turtle species, as well as marine invertebrates, based on a review of relevant guidelines and/or literature published.

3.2 Marine mammals

There have been extensive efforts to develop noise exposure criteria for marine mammals. For example, Southall *et al.* (2007 and 2019) have proposed noise exposure criteria associated with various sound types, including impulsive noise (e.g. piling noise and seismic airgun noise) and non-impulsive noise (e.g. vessel and drilling noise) for certain marine mammal species (i.e. cetaceans, sirenians and carnivores), based on review of expanding literature on marine mammal hearing and on physiological and behavioural responses to anthropogenic sounds.

The following two subsections provide the recommended frequency weighting functions for use in assessing the effects of relatively intense sounds on hearing, as well as the noise exposure levels above which adverse effects on various groups of marine mammals occur, and they are derived based on all available relevant data and published literature (i.e., the state of current knowledge).

3.2.1 Marine mammal auditory weighting functions

Marine animals do not hear equally well at all frequencies within their functional hearing range. Based on the hearing range and sensitivities, Southall *et al.* (2019) have categorised marine mammal species (i.e. cetaceans and pinnipeds) into six underwater hearing groups: low frequency (LF), high frequency (HF) and very high frequency (VHF) cetaceans, Sirenians (SI), Phocid carnivores in water (PCW) and other marine carnivores in water (OCW). For each specific marine mammal species, refer to Appendix I – 6 within the reference document (Southall *et al.* 2019) for their corresponding hearing groups.

The potential noise effects on animals depend on how well the animals can hear the noise (i.e., its sensitivity). Frequency weighting is a method of quantitatively compensating for the differential frequency response of sensory systems (Southall *et al.* 2007 and 2019).

When developing updated scientific recommendations in marine mammal noise exposure criteria, Southall *et al.* (2019) adopt the auditory weighting functions as expressed in the equation below, which are based on the quantitative method by Finneran (2015 and 2016) and are consistent with the US National Oceanic and Atmospheric Administration (NOAA) technical guidance (NMFS, 2016 and 2018).

$$W(f) = C + 10 \log_{10} \left\{ \frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a [1+(f/f_2)^2]^b} \right\} \quad (2.1)$$

Where:

- **$W(f)$** is the weighting function amplitude (in dB) at frequency f (in kHz).

- f_1 represents the LF transition value (in kHz), i.e., the lower frequency at which the function amplitude begins to change from the flat, central portion of the curve.
- f_2 represents the HF transition value (in kHz), i.e., the upper frequency at which the function amplitude begins to change from the flat, central portion of the curve.
- a represents the LF exponent value (dimensionless) which defines the rate of decline of the weighting function amplitude at low frequencies. The change in weighting function amplitude with frequency at low frequencies (the LF slope) is $20a$ dB/decade.
- b represents the HF exponent value (dimensionless) which defines the rate of decline of weighting function amplitude at high frequencies, becoming linear with the logarithm of frequency. The change in weighting function amplitude with frequency at high frequencies (the HF slope) is $-20b$ dB/decade.
- C is the constant defines the vertical position of the curve. It is defined so that the maximum amplitude of the weighting function equals 0 dB (with all other values being negative).

Table 3 lists the auditory weighting parameters for the six hearing groups. The corresponding auditory weighting functions for all hearing groups are presented in **Figure 8**.

Table 3 Parameters for the auditory weighting functions

| Marine mammal hearing group | a | b | f_1 (Hz) | f_2 (Hz) | C (dB) |
|--|-----|-----|------------|------------|----------|
| Low frequency cetaceans (LF) | 1.0 | 2 | 200 | 19,000 | 0.13 |
| High frequency cetaceans (HF) | 1.6 | 2 | 8,800 | 110,000 | 1.20 |
| Very high frequency cetaceans (VHF) | 1.8 | 2 | 12,000 | 140,000 | 1.36 |
| Sirenians (SI) | 1.8 | 2 | 4,300 | 25,000 | 2.62 |
| Phocid carnivores in water (PCW) | 1.0 | 2 | 1,900 | 30,000 | 0.75 |
| Other marine carnivores in water (OCW) | 2.0 | 2 | 940 | 25,000 | 0.64 |

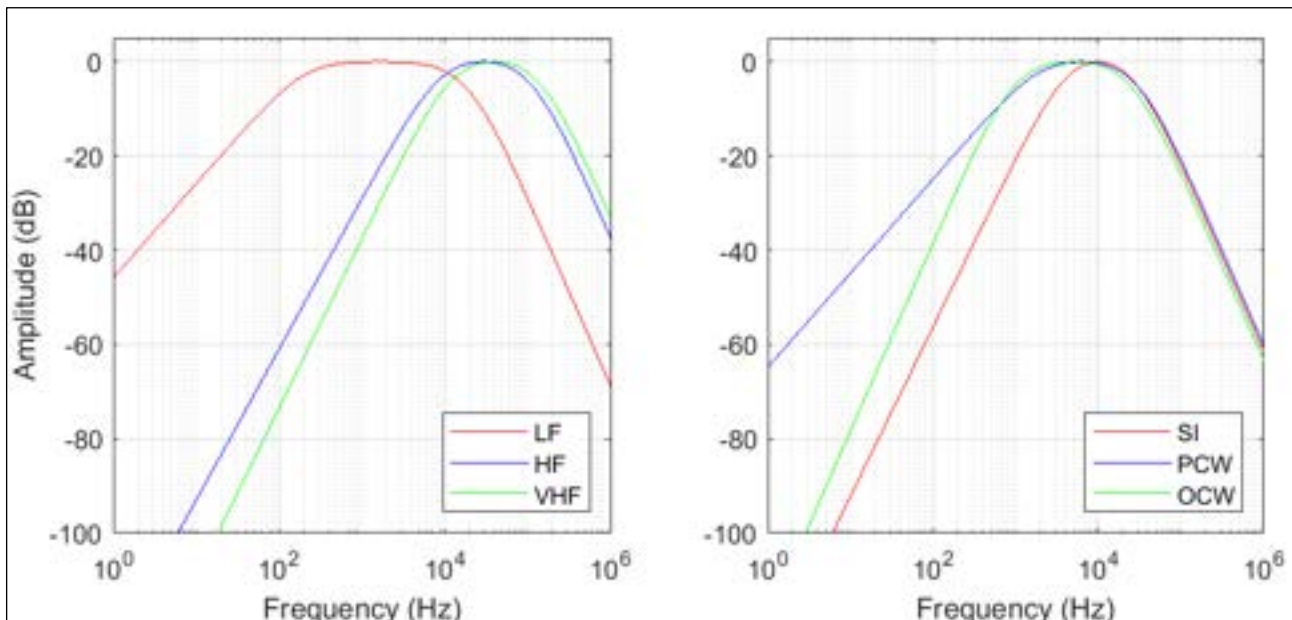


Figure 8 Auditory weighting functions - LF, HF, VHF, SI, PCW and OCW

3.2.2 Noise impact criteria for marine mammals

The recently updated scientific recommendations in marine mammal noise exposure criteria (Southall *et al.* 2019) propose PTS onset and TTS onset criteria for both impulsive noise and non-impulsive noise events. The PTS onset and TTS onset criteria for impulsive noise are outlined in **Table 4**, which incorporate a dual criteria approach, i.e., the immediate impact as a result of exposure to individual pulses assessed by peak sound pressure level (Pk SPL), and cumulative impact as a result of exposure to multiple pulses within a 24-hour period assessed by sound exposure level (SEL_{24hr}).

Table 4 PTS and TTS onset threshold levels for marine mammals exposed to impulsive noise

| Marine mammal hearing group | PTS and TTS threshold levels – Impulsive noise | | | |
|--|--|---|---------------------------------|---|
| | Injury (PTS) onset | | TTS onset | |
| | Pk SPL, dB re 1µPa (unweighted) | SEL _{24hr} , dB re 1µPa ² ·S (weighted) | Pk SPL, dB re 1µPa (unweighted) | SEL _{24hr} , dB re 1µPa ² ·S (weighted) |
| Low frequency cetaceans (LF) | 219 | 183 | 213 | 168 |
| High frequency cetaceans (HF) | 230 | 185 | 224 | 170 |
| Very high frequency cetaceans (VHF) | 202 | 155 | 196 | 140 |
| Sirenians (SI) | 226 | 190 | 220 | 175 |
| Phocid carnivores in water (PCW) | 218 | 185 | 212 | 170 |
| Other marine carnivores in water (OCW) | 232 | 203 | 226 | 188 |

For behavioural disturbance, the widely used assessment criterion for the onset of possible behavioural disruption in marine mammals is root-mean-square sound pressure level (RMS SPL) of 160 dB re 1µPa for impulsive noise, as shown in **Table 5**.

Table 5 The behavioural disturbance threshold level for marine mammals exposed to impulsive noise

| Marine mammal hearing group | Behavioural disruption threshold levels, RMS SPL, dB re 1µPa |
|-----------------------------|--|
| | Impulsive noise |
| All hearing groups | 160 |

3.3 Fish, fish eggs, fish larvae and sea turtles

In general, limited scientific data are available regarding the effects of sound for fishes and sea turtles. As such, assessment procedures and subsequent regulatory and mitigation measures are often severely limited in their relevance and efficacy. To reduce regulatory uncertainty for all stakeholders by replacing precaution with scientific facts, NOAA convened an international panel of experts to develop noise exposure criteria for fishes and sea turtles in 2004, primarily based on published scientific data in the peer-reviewed literature. The panel was organized as a Working Group (WG) under the ANSI-Accredited Standards Committee S3/SC 1, Animal Bioacoustics, which is sponsored by the Acoustical Society of America.

The outcomes of the WG are broadly applicable sound exposure guidelines for fishes and sea turtles (Popper *et al.*, 2014), considering the diversity of fish and sea turtle species, the different ways they detect sound, as well as various sound sources and their acoustic characteristics.

The sound exposure criteria for sound sources relevant to the project including impulsive noise from pile driving and non-impulsive noise from marine vessels and other sources are presented in **Table 6**.

Within the tables, where data exist that can be used to suggest provisional guidelines, received signal levels are reported in appropriate forms (e.g., peak, SEL). Where insufficient data exist to make a recommendation for guidelines, a subjective approach is adopted in which the relative risk of an effect is placed in order of rank at three distances from the source – near (N), intermediate (I), and far (F) (top to bottom within each cell of the table, respectively). In general, “near” might be considered to be in the tens of metres from the source, “intermediate” in the hundreds of metres, and “far” in the thousands of metres. The relative risk of an effect is then rated as being “high,” “moderate,” and “low” with respect to source distance and animal type. The rating for effects in these tables is highly subjective and represents general consensus within the WG.

It should be noted that the period over which the cumulative sound exposure level (SEL_{cum}) is calculated must be carefully specified. For example, SEL_{cum} may be defined over a standard period (e.g., 12 hours of pile driving) or for the duration of an activity (e.g., the full period of construction), or over the total period that the animal will be exposed. Whether an animal would be exposed to a full period of sound activity will depend on its behaviour, as well as the source movements.

Table 6 Sound exposure criteria applicable for pile driving – Fishes and sea turtles

| Type of animal | Mortality and potential mortal injury | Impairment | | | Behaviour |
|---|--|--|------------------------------------|--------------------------------------|--------------------------------------|
| | | Recovery injury | TTS | Masking | |
| Fish: no swim bladder (particle motion detection) | >219 dB SEL _{cum} , or >213 dB Pk SPL | >216 dB SEL _{cum} or >213 dB Pk SPL | >>186 dB SEL _{cum} | (N) Moderate (I) Low (F) Low | (N) High (I) Moderate (F) Low |
| Fish: swim bladder is not involved in hearing (particle motion detection) | 210 dB SEL _{cum} or >207 dB Pk SPL | 203 dB SEL _{cum} or >207 dB Pk SPL | >>186 dB SEL _{cum} | (N) Moderate (I) Low (F) Low | (N) High (I) Moderate (F) Low |
| Fish: swim bladder involved in hearing (primarily pressure detection) | 207 dB SEL _{cum} or >207 dB Pk SPL | 203 dB SEL _{cum} or >207 dB Pk SPL | 186 dB SEL _{cum} | (N) High (I) High (F) Moderate | (N) High (I) High (F) Moderate |
| Sea turtles | 210 dB SEL _{cum} or >207 dB Pk SPL | (N) High (I) Low (F) Low | (N) High (I) Low (F) Low | (N) High (I) Moderate (F) Low | (N) High (I) Moderate (F) Low |
| Fish eggs and fish larvae | >210 dB SEL _{cum} or >207 dB Pk SPL | (N) Moderate (I) Low (F) Low | (N) Moderate (I) Low (F) Low | (N) Moderate (I) Low (F) Low | (N) Moderate (I) Low (F) Low |

Notes: peak sound pressure levels (Pk SPL) dB re 1 µPa; Cumulative sound exposure level (SEL_{cum}) dB re 1 µPa²-s within a 24-hour period. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

For impulsive sound, Finneran *et al.* (2017) has provided further threshold updates for sea turtle injury and hearing impairment (TTS and PTS), on the basis that sea turtles have best sensitivity at low frequencies and are known to have poor auditory sensitivity (Bartol and Ketten 2006, Dow Piniak *et al.*, 2012).

Regarding thresholds for sea turtle behaviour changes, McCauley *et al.* (2000) observed the behavioural response of caged sea turtles – green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) – to an approaching seismic airgun. For received levels above RMS SPL 166 dB re 1 μ Pa, the sea turtles increased their swimming activity, and above RMS SPL 175 dB re 1 μ Pa they began to behave erratically, which was interpreted as an agitated state. The RMS SPL 166 dB re 1 μ Pa level has been used as the threshold level for a behavioural response by NMFS and applied in the Arctic Programmatic Environment Impact statement (PEIS) (NSF 2011). The Recovery Plan for Marine Turtles in Australia (Department of the Environment and Energy *et al.*, 2017) also acknowledges the 166 dB re 1 μ Pa SPL as the level that may result in a behavioural response to marine turtles.

Based the literature above, the revised sound exposure criteria for sea turtles as a result of the impulsive sound impact are presented in **Table 7**.

Table 7 Revised sound exposure criteria for sea turtles – Impulsive sound

| Type of animal | Impairment (Finneran <i>et al.</i> 2017) | | Behavioural response (McCauley <i>et al.</i> 2000; NSF, 2011) |
|----------------|--|--|---|
| | PTS Onset | TTS Onset | |
| Sea turtles | 204 dB SEL _{cum} or 232 dB Pk SPL | 189 dB SEL _{cum} or 226 dB Pk SPL | 166 dB RMS SPL |

Notes: peak sound pressure levels (Pk SPL) dB re 1 μ Pa; Cumulative sound exposure level (SEL_{cum}) dB re 1 μ Pa²·s within a 24-hour period. Root-mean-square sound pressure levels (RMS SPL) dB re 1 μ Pa.

3.4 Zones of noise impact

The received noise levels within and around the project area can be predicted using known source levels in combination with models of sound propagation transmission loss between the source and the receiver locations. Zones of impact can be determined by comparison of the predicted received levels to the noise exposure criteria.

Predicted zones of impact define the environmental footprint of the noise generating activities and indicate the locations within which the activities may have an adverse impact on a marine fauna species, either behaviourally or physiologically. This information can be used to assess the risk (likelihood) of potential adverse noise impacts, by combining the acoustic zones of impact with ecological information such as habitat significance and migratory routes in the affected area.

4 Piling noise modelling prediction

4.1 Piling noise assessment scenarios and source levels

Based on the proposed marine pile driving activities as described in Section 2.2, four noise modelling scenarios are proposed for this marine noise study. The four scenarios include the typical and the worst-case considerations in term of locations (i.e. mid-point and end of the jetty) and their tide conditions (HAT and LAT).

Table 8 below provides details of the four proposed modelling scenarios.

Table 8 Proposed modelling scenarios with their piling source locations and tide conditions.

| Scenario # | Piling source location | [Easting, Northing], GDA94 / MGA Zone 50, m | Tide Condition |
|------------|----------------------------------|--|----------------|
| 1 | End of the jetty (deepest point) | [304271.7, 7606971.4] | HAT |
| 2 | | | LAT |
| 3 | Mid-point of the jetty | [304308.2, 7606851.5] | HAT |
| 4 | | | LAT |

The source spectral curve (one-third octave spectra) for the proposed piling activities is based on reference piling signals of an overall SEL source level 199 dB re $\mu\text{Pa}^2\cdot\text{s}$ from a 49 kNm impact hammer (Salgado Kent et al, 2009) which were averaged to account for hammer energy variability. To scale the piling noise emissions with the smaller 49 kNm hammer to the noise emissions with the worst case 120 kNm impact hammer, it is assumed that the piling noise emissions from a piling strike is proportional to the energy delivered to the pile, according to the following relationship:

$$dB_o = 10 * \log_{10} (E/E_r) \tag{4.1}$$

where dB_o is the offset from the assessed pile to the reference pile in dB, E is the energy delivered to the assessed pile and E_r is the energy delivered to the reference pile (kNm).

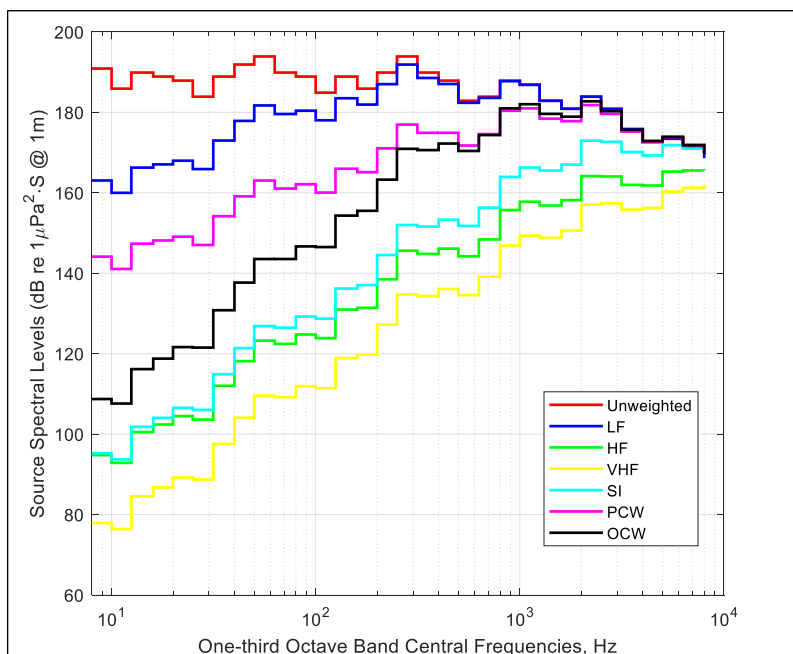


Figure 9 One-third octave SEL source spectral levels (unweighted and M-weighted) for the piling noise

Using this equation (4.1) the piling noise emissions under the impact hammer energy of 120 kNm would have 3.9 dB increase over the reference piling noise emissions under the impact hammer energy of 49 kNm.

The overall SEL source level is estimated as 203 dB re $\mu\text{Pa}^2\cdot\text{S}$, with a conversion factor of 24 dB between the source Pk SPL and SEL levels, based on the previous assessment prediction results for the piling noise created by a hammer of the same diameter for port facility constructions (Hastings and Popper, 2005). A conversion factor of 14 dB applied between the source RMS SPL and SEL levels is derived from historical measurements described in the literature (Salgado Kent et al, 2009).

4.2 Modelling methodology and procedure

Marine noise propagation models predict the sound transmission loss between the noise source and the receiver. When the source level (SL) of the assessed noise generating activity is known, the predicted transmission loss (TL) is then used to predict the received level (RL) at the receiver location as:

$$RL = SL - TL \quad (4.1)$$

The marine noise modelling was performed based on a matlab platform to calculate the transmission loss between the source and the receiver. A hybrid model approach was adopted, i.e. the fluid parabolic equation (PE) modelling algorithm (Collins, 1993) was used for the low frequency range 8 Hz to 2 kHz, and the ray tracing modelling algorithm Bellhop (Porter, 2011) for the higher frequency range 2 kHz to 10 kHz. PE and Bellhop algorithms are efficient and reliable algorithms for solving range-dependent acoustic problems with fluid seabed geoaoustic properties for low frequency and high frequency ranges respectively. The noise sources were assumed to be omnidirectional and modelled as point sources.

With the known noise source levels, either frequency weighted or unweighted, the received noise levels are calculated following the procedure outlined below.

- One third octave source spectral levels are sourced via empirical reference data out of the historical measurements (as detailed in Section 4.1).
- Transmission loss is calculated at one third octave band central frequencies from 8 Hz to 10 kHz, based on appropriate source depths corresponding to relevant source scenarios. The acoustic energy of higher frequency range is significantly lower, and therefore is not included in the modelling.
- Propagation paths for the TL calculation within the bathymetry data coverage provided with bearing angles of a 5-degree azimuth increment from 0 degrees to 355 degrees around the source locations. The bathymetry variation of the vertical plane along each modelling path is obtained via interpolation of the bathymetry dataset.
- The one third octave source levels and transmission loss are combined to obtain the received levels as a function of range, depth and frequency, and
- The overall received levels are calculated by summing all frequency band spectral levels.

4.2.1 Modelling input parameters

4.2.1.1 Bathymetry dataset

The bathymetry data input for the modelling study is based on a regional high-resolution bathymetry dataset for the North West Shelf of Australia. The dataset of the regional high-resolution digital elevation models (DEMs) is generated based on an integrated workflow that builds on Sentinel-2 satellite images, 3D seismic surveys, integrated with historical depth soundings for the region (Lebrec et al., 2021). The method was

applied to the southern half of Australia's North West Shelf and led to the creation of new high-resolution bathymetry grids, with a resolution of 10 × 10 m in nearshore areas and 30 × 30 m elsewhere.

The vertical and spatial accuracy of the datasets have been assessed using open-source Laser Airborne Depth Sounder (LADS) and multibeam echosounder (MBES) surveys as a reference. The comparison of the datasets indicates that the seismic-derived bathymetry has a vertical accuracy better than 1 m + 2 % of the absolute water depth, while the satellite-derived bathymetry has a depth accuracy better than 1 m + 5 % of the absolute water depth.

The contour of the high-resolution bathymetry dataset around the project area is presented in **Appendix B**.

The bathymetry data inputs can be adjusted accordingly to account for high tide (e.g. HAT) and low tide (e.g. LAT) conditions.

4.2.1.2 Sound speed profiles

The sound speed profiles were derived based on an empirical function of the three independent variables (temperature (T) in degrees centigrade, salinity (S) in parts per thousand, and depth (z) in metres) (Medwin *et al.*, 1997). Temperature and salinity data required to derive the sound speed profiles were obtained from the World Ocean Atlas 2023 (WOA23) (Locarnini *et al.*, 2024; Reagan *et al.*, 2024).

Figure 10 presents the derived typical seasonal sound speed profiles for deep and shallow water regions near the project area. The figure demonstrates that the most significant distinctions for the profiles of four seasons occur within the mixed layer near the surface. For the water depth beyond 200 m, the overall speed profiles of different seasons across the water column are quite similar.

For winter season, the surface water has lower temperature and salinity compared with the other seasons, and the speed profile generally has relatively stronger upward refraction characteristics than the other three seasons for the year. The summer season has the strongest downwardly refracting feature among the four seasons. As such, the winter season sound speed profile is expected to be most favourable to propagation of sound from acoustic sources within the water column and has been used for the modelling input for this study.

It is also noted that for the very shallow water environment (e.g. below 50 m), the water column in general is close to a well-mixed layer for all seasons, and the speed profiles are relatively consistent across the water column which is evident in **Figure 10** below.

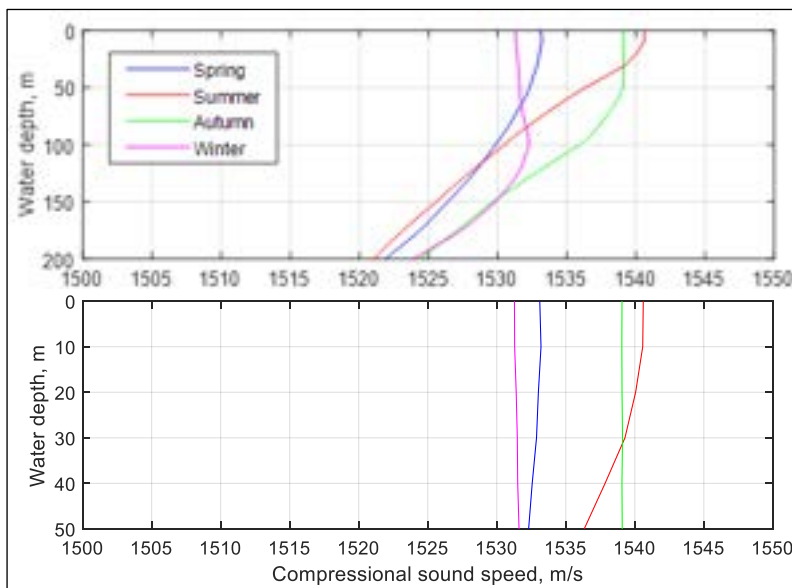


Figure 10 Sound speed profiles derived from the WOA2023 seasonal temperature and salinity across the water column adjacent to the proposed project area

4.2.1.3 Seafloor geoacoustic model

The geotechnical investigation specifically for the project site has not been carried out at the time of preparing this noise study. However, based on the general geotechnical characteristics within Western Australia’s continental shelf, as well as some nearshore site conditions that have been investigated, the seafloor materials in the North West Shelf of Australia are predominantly consistent with a type of limestone called calcarenite, overlain by a thin layer of unconsolidated sediment (Duncan *et al.*, 2009). The calcarenite seabed materials are acoustically more absorptive than sandy layers, particularly for the fully cemented calcarenite layers with high shear speeds (Duncan *et al.*, 2009).

For this project, it is assumed that the seafloor geoacoustic model for the entire project area comprises of a 5.0 m top sandy surface sediment layer, a slightly to semi cemented calcarenite layer down to 100 m, followed by a semi cemented sandy layer up to 200 m deep from the seabed surface, followed by a fully cemented limestone half space as detailed in **Table 9**. Based on a conservative approach, a fluid seafloor geoacoustic model with only compressional wave components is considered as the modelling inputs.

The geoacoustic properties for relevant sediments are as described in Hamilton (1980), Jensen *et al.*, (2011) and Duncan *et al.*, (2009). The elastic properties are treated as negligible in the noise model based on a conservative consideration.

Table 9 Geoacoustic parameters for the seafloor model

| Seafloor Materials | Depth, m | Density, ρ , (kg·m ⁻³) | Compressional Wave | | Shear Wave | |
|--|-----------|---|-------------------------------------|----------------------------------|-------------------------------------|----------------------------------|
| | | | Speed, C_p , (m·s ⁻¹) | Attenuation, α_p , (dB/λ) | Speed, C_s , (m·s ⁻¹) | Attenuation, α_s , (dB/λ) |
| Unconsolidated sandy sediment | 0 - 5 | 1,600 | 1,580 | 0.8 | - | - |
| Slightly to semi cemented sand/calcarenite layer | 5 - 100 | 1,600 – 18,00 | 1,580 – 1,800 | 0.8 – 0.4 | 250 - 550 | 0.2 |
| Semi cemented sand/calcarenite layer | 100 - 200 | 1,800 – 2,400 | 1,800 – 2,800 | 0.4 – 0.1 | 550 – 1,400 | 0.2 |
| Limestone half-space | > 200 | 2,400 | 2,800 | 0.1 | 1,400 | 0.2 |

5 Modelling results and zones of impact estimates

5.1 Modelling prediction results

The noise contour figures for all four modelling scenarios are presented in **Appendix C**. The contour figures are the modelling results based on linear SEL source level inputs in dB re $1\mu\text{Pa}^2\cdot\text{S}$ for a single piling strike as given in **Section 4.1**.

The weighted SEL modelling results for different marine mammal hearing groups are based on weighted SEL source level inputs which are derived by applying relevant auditory hearing functions as in **Figure 8** of **Section 3.2.1** to the unweighted SEL source levels.

For cumulative SEL estimates, the following cumulative factor (*CF*) is applied:

$$CF = 10 \times \log_{10} (N) \quad (6.1)$$

Where *N* is the number of pulses for piling noise.

Based on noise modelling prediction results and relevant post processing analysis as described above, the zones of impact for marine fauna species assessed from all modelling scenarios are detailed in the following section.

5.2 Estimated zones of impact

The predicted noise levels of considered modelling scenarios were compared with relevant threshold criteria as listed in **Section 3**. The zones of different levels of noise impact were calculated and all results are presented in **Table 10** to **Table 17**, including:

- Impact zones regarding immediate impact from single piling pulses, as shown in **Table 10** to **Table 12**, and
- Impact zones regarding cumulative impact from multiple piling pulses exposure (i.e. under single, 10, 100, 500, 1,000, 2,000 pulses exposure) within a 24-hour period, as shown in **Table 13** to **Table 18**.

5.2.1 Zones of impact for marine mammals

Immediate impact

Due to the high level of impulsive signal emissions from the impact piling, some marine mammal hearing groups are predicted to experience a permanent auditory threshold shift (PTS) and a temporary auditory threshold shift (TTS) at very close proximity to the piling source due to the immediate exposure to individual pulses. Based on zones of impact estimated Pk SPL metric criteria as in **Table 10**, only marine mammals of LF hearing groups of concern associated with the project are predicted to experience PTS effect within 10 m from the piling locations. The zones of a temporary auditory threshold shift (TTS) due to a single pulse exposure for marine mammals of LF, HF and SI hearing groups of concern are also predicted to be within 10 m from the piling locations.

The zones of behavioural disturbance for marine mammals of all hearing groups and sea turtles caused by the immediate exposure to individual pulses are predicted to be within 1.2 km and 550 m of the piling locations respectively, as presented in **Table 11**.

Cumulative impact

Due to the project being in its early stages, the exact number of piling strikes to be undertaken within a 24-hour period is not yet known. Consequently, the zones of cumulative impact from various piling pulses (up to 2,000) within a 24-hour period are predicted. For the realistic piling scenarios during construction stage, the impact zones for any number of piling pulses within this range can be interpolated from the predicted results.

The estimated zones of cumulative impact from multiple impulsive piling noise exposure for marine mammals are presented in **Table 13** to **Table 16** for the four scenarios as listed in **Table 8**. For each scenario, exposure to various number of different piling pulses (i.e., **1** pulse, **10** pulses, **100** pulses, **500** pulses, **1,000** pulses and **2,000** pulses) within a 24-hour period are considered.

Among marine mammals of LF and HF hearing groups of concern, LF cetaceans have the highest zones of PTS and TTS impact, as can be seen in zones of estimate for all scenarios. The zones of PTS impact for LF cetaceans are predicted to be within 250 m from piling locations with exposure to 500 piling pulses and within 560 m from piling locations with exposure to 2,000 piling pulses. The zones of TTS impact for LF cetaceans are predicted to be up to 750 m from piling locations with exposure to 100 piling pulses and up to 2.0 km from piling locations with exposure to 500 piling pulses.

Compared with the LF cetaceans, the HF cetaceans and Sirenians have much lower impact zones, with the TTS impact to be within two to three hundred meters from piling locations with exposure to 2,000 piling pulses.

5.2.2 Zones of impact for fish, fish eggs, fish larvae and sea turtles

The zones of mortal and recovery injury for fish species caused by the immediate exposure to individual pulses are predicted to be within 15 m of the piling locations, as presented in **Table 12**.

For cumulative piling noise impact, the estimated zones of impact under various piling pulses are summarised in **Table 17** and **Table 18**. For mortal and recovery injury, the impact zones for fish and sea turtles are estimated to be close approximation (tens of meters) to the piling locations, even under exposure to up to 2,000 piling pulses within a 24-hour period. For TTS impact, the impact zones are predicted to extent to hundreds of meters.

Table 10 Zones of immediate impact from single impact piling pulses for PTS and TTS – marine mammals

| Zones of impact – maximum horizontal distances, from source to impact threshold levels | | | | |
|--|------------------------------|-------------------------------|------------------------------|-------------------------------|
| Marine mammal hearing group | Injury (PTS) onset | | TTS onset | |
| | Criteria - Pk SPL dB re 1µPa | Maximum threshold distance, m | Criteria - Pk SPL dB re 1µPa | Maximum threshold distance, m |
| | | All four scenarios | | All four scenarios |
| Low-frequency cetaceans (LF) | 219 | < 10 | 213 | < 10 |
| High-frequency cetaceans (HF) | 230 | - | 224 | < 10 |
| <i>Very high-frequency cetaceans (VHF)</i> | <i>202</i> | | <i>196</i> | |
| Sirenians (SI) | 226 | < 10 | 220 | < 10 |
| <i>Phocid carnivores in water (PCW)</i> | <i>218</i> | | <i>212</i> | |
| <i>Other marine carnivores in water (OCW)</i> | <i>232</i> | | <i>226</i> | |

Notes: (1) a dash indicates the threshold level is not reached or not applicable; (2) greyed out animal groups are not relevant to the modelled location.

Table 11 Zones of immediate impact from single impact piling pulses for behavioural changes – marine mammals and sea turtles

| Zones of impact – maximum horizontal distances, from source to impact threshold levels | | | | | |
|--|--------------------------------|-------------------------------|----------|----------|----------|
| Type of animal | Criteria - SPL RMS, dB re 1µPa | Behavioural disturbance | | | |
| | | Maximum threshold distance, m | | | |
| | | L1 - HAT | L1 - LAT | L2 - HAT | L2 - MSL |
| Marine mammals – all hearing groups | 160 | 1,130 | 840 | 1,080 | 650 |
| Sea turtles | 166 | 550 | 410 | 520 | 310 |

Table 12 Zones of immediate impact from single impact piling pulses for mortality and recovery injury– fish, turtles, fish eggs and fish larvae

| Type of animal | Zones of impact – maximum horizontal distances from source to impact threshold levels | | | |
|--|---|-------------------------------|---------------------------------|-------------------------------|
| | Mortality and potential mortal injury | | Recovery injury | |
| | Criteria - Pk SPL dB re 1µPa | Maximum threshold distance, m | Criteria - Pk SPL dB re 1µPa | Maximum threshold distance, m |
| | | All four scenarios | | All four scenarios |
| Fish: no swim bladder (particle motion detection) | 213 | 15 | 213 | 15 |
| <i>Fish: swim bladder is not involved in hearing (particle motion detection)</i> | <i>207</i> | | <i>207</i> | |
| <i>Fish: swim bladder involved in hearing (primarily pressure detection)</i> | <i>207</i> | | <i>207</i> | |
| Sea turtles | 207 | <10 | - | - |
| Fish eggs and fish larvae | 207 | <10 | - | - |

Notes: (1) a dash indicates the threshold level is not reached or not applicable; (2) greyed out animal groups are not relevant to the modelled location.

Table 13 Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – Marine Mammals - Scenario 2 End of Jetty HAT

| Marine mammal hearing group | Zones of impact – Maximum horizontal perpendicular distances from source to cumulative impact threshold levels | | | | | |
|-------------------------------------|--|-------------------------------|-----|--|-------------------------------|-------|
| | Injury (PTS) onset | | | TTS onset | | |
| | Criteria – Weighted SEL _{24-hr} dB re 1 µPa ² ·s | Maximum threshold distance, m | | Criteria – Weighted SEL _{24-hr} dB re 1 µPa ² ·s | Maximum threshold distance, m | |
| Low frequency cetaceans (LF) | 183 | 1 pulse | <10 | 168 | 1 pulse | 45 |
| | | 10 pulses | 25 | | 10 pulses | 180 |
| | | 100 pulses | 90 | | 100 pulses | 750 |
| | | 500 pulses | 240 | | 500 pulses | 2080 |
| | | 1,000 pulses | 370 | | 1,000 pulses | 3,240 |
| | | 2,000 pulses | 560 | | 2,000 pulses | 5,050 |
| High frequency cetaceans (HF) | 185 | 1 pulse | - | 170 | 1 pulse | <10 |
| | | 10 pulses | - | | 10 pulses | <10 |
| | | 100 pulses | <10 | | 100 pulses | 35 |
| | | 500 pulses | 10 | | 500 pulses | 103 |
| | | 1,000 pulses | 16 | | 1,000 pulses | 164 |
| | | 2,000 pulses | 26 | | 2,000 pulses | 260 |
| Very high frequency cetaceans (VHF) | 155 | 1 pulse | | 140 | 1 pulse | |
| | | 10 pulses | | | 10 pulses | |
| | | 100 pulses | | | 100 pulses | |
| | | 500 pulses | | | 500 pulses | |
| | | 1,000 pulses | | | 1,000 pulses | |

| | | | | | | |
|---|------------|---------------------|----------------|------------|---------------------|----------------|
| | | <i>2,000 pulses</i> | | | <i>2,000 pulses</i> | |
| Sirenians (SI) | 190 | 1 pulse | - | 175 | 1 pulse | < 10 |
| | | 10 pulses | - | | 10 pulses | 11 |
| | | 100 pulses | < 10 | | 100 pulses | 48 |
| | | 500 pulses | 15 | | 500 pulses | 144 |
| | | 1,000 pulses | 22 | | 1,000 pulses | 230 |
| | | 2,000 pulses | 35 | | 2,000 pulses | 360 |
| <i>Phocid carnivores in water (PCW)</i> | <i>185</i> | <i>1 pulse</i> | | <i>170</i> | <i>1 pulse</i> | |
| | | <i>10 pulses</i> | | | <i>10 pulses</i> | |
| | | <i>100 pulses</i> | | | <i>100 pulses</i> | |
| | | <i>500 pulses</i> | | | <i>500 pulses</i> | |
| | | <i>1,000 pulses</i> | | | <i>1,000 pulses</i> | |
| | | <i>2,000 pulses</i> | | | <i>2,000 pulses</i> | |
| <i>Other marine carnivores in water (OCW)</i> | <i>203</i> | <i>1 pulse</i> | | <i>188</i> | <i>1 pulse</i> | |
| | | <i>10 pulses</i> | | | <i>10 pulses</i> | |
| | | <i>100 pulses</i> | | | <i>100 pulses</i> | |
| | | <i>500 pulses</i> | | | <i>500 pulses</i> | |
| | | <i>1,000 pulses</i> | | | <i>1,000 pulses</i> | |
| | | <i>2,000 pulses</i> | | | <i>2,000 pulses</i> | |

Notes: (1) a dash indicates the threshold level is not reached or not applicable; (2) greyed out animal groups are not relevant to the modelled location.

Table 14 Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – Marine Mammals - Scenario 1 End of Jetty LAT

| Marine mammal hearing group | Zones of impact – Maximum horizontal perpendicular distances from source to cumulative impact threshold levels | | | | | |
|-------------------------------------|--|-------------------------------|-----|--|-------------------------------|-------|
| | Injury (PTS) onset | | | TTS onset | | |
| | Criteria – Weighted SEL _{24-hr} dB re 1 µPa ² -s | Maximum threshold distance, m | | Criteria – Weighted SEL _{24-hr} dB re 1 µPa ² -s | Maximum threshold distance, m | |
| Low frequency cetaceans (LF) | 183 | 1 pulse | <10 | 168 | 1 pulse | 35 |
| | | 10 pulses | 20 | | 10 pulses | 145 |
| | | 100 pulses | 75 | | 100 pulses | 560 |
| | | 500 pulses | 185 | | 500 pulses | 1,500 |
| | | 1,000 pulses | 280 | | 1,000 pulses | 2,300 |
| | | 2,000 pulses | 430 | | 2,000 pulses | 3,550 |
| High frequency cetaceans (HF) | 185 | 1 pulse | - | 170 | 1 pulse | <10 |
| | | 10 pulses | - | | 10 pulses | <10 |
| | | 100 pulses | <10 | | 100 pulses | 35 |
| | | 500 pulses | 10 | | 500 pulses | 100 |
| | | 1,000 pulses | 15 | | 1,000 pulses | 155 |
| | | 2,000 pulses | 25 | | 2,000 pulses | 250 |
| Very high frequency cetaceans (VHF) | 155 | 1 pulse | | 140 | 1 pulse | |
| | | 10 pulses | | | 10 pulses | |
| | | 100 pulses | | | 100 pulses | |
| | | 500 pulses | | | 500 pulses | |
| | | 1,000 pulses | | | 1,000 pulses | |
| | | 2,000 pulses | | | 2,000 pulses | |

| | | | | | | |
|---|------------|---------------------|----------------|------------|---------------------|----------------|
| Sirenians (SI) | 190 | 1 pulse | - | 175 | 1 pulse | < 10 |
| | | 10 pulses | - | | 10 pulses | 10 |
| | | 100 pulses | < 10 | | 100 pulses | 45 |
| | | 500 pulses | 15 | | 500 pulses | 135 |
| | | 1,000 pulses | 20 | | 1,000 pulses | 215 |
| | | 2,000 pulses | 35 | | 2,000 pulses | 340 |
| <i>Phocid carnivores in water (PCW)</i> | 185 | <i>1 pulse</i> | | 170 | <i>1 pulse</i> | |
| | | <i>10 pulses</i> | | | <i>10 pulses</i> | |
| | | <i>100 pulses</i> | | | <i>100 pulses</i> | |
| | | <i>500 pulses</i> | | | <i>500 pulses</i> | |
| | | <i>1,000 pulses</i> | | | <i>1,000 pulses</i> | |
| | | <i>2,000 pulses</i> | | | <i>2,000 pulses</i> | |
| <i>Other marine carnivores in water (OCW)</i> | 203 | <i>1 pulse</i> | | 188 | <i>1 pulse</i> | |
| | | <i>10 pulses</i> | | | <i>10 pulses</i> | |
| | | <i>100 pulses</i> | | | <i>100 pulses</i> | |
| | | <i>500 pulses</i> | | | <i>500 pulses</i> | |
| | | <i>1,000 pulses</i> | | | <i>1,000 pulses</i> | |
| | | <i>2,000 pulses</i> | | | <i>2,000 pulses</i> | |

Notes: (1) a dash indicates the threshold level is not reached or not applicable; (2) greyed out animal groups are not relevant to the modelled location.

Table 15 Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – Marine Mammals - Scenario 3 Mid of Jetty HAT

| Marine mammal hearing group | Zones of impact – Maximum horizontal perpendicular distances from source to cumulative impact threshold levels | | | | | |
|-------------------------------------|--|-------------------------------|-----|--|-------------------------------|-------|
| | Injury (PTS) onset | | | TTS onset | | |
| | Criteria – Weighted SEL _{24-hr} dB re 1 µPa ² ·s | Maximum threshold distance, m | | Criteria – Weighted SEL _{24-hr} dB re 1 µPa ² ·s | Maximum threshold distance, m | |
| Low frequency cetaceans (LF) | 183 | 1 pulse | <10 | 168 | 1 pulse | 35 |
| | | 10 pulses | 20 | | 10 pulses | 140 |
| | | 100 pulses | 70 | | 100 pulses | 550 |
| | | 500 pulses | 185 | | 500 pulses | 1,440 |
| | | 1,000 pulses | 275 | | 1,000 pulses | 2,200 |
| | | 2,000 pulses | 415 | | 2,000 pulses | 3,380 |
| High frequency cetaceans (HF) | 185 | 1 pulse | - | 170 | 1 pulse | <10 |
| | | 10 pulses | - | | 10 pulses | <10 |
| | | 100 pulses | <10 | | 100 pulses | 35 |
| | | 500 pulses | 10 | | 500 pulses | 100 |
| | | 1,000 pulses | 15 | | 1,000 pulses | 150 |
| | | 2,000 pulses | 25 | | 2,000 pulses | 240 |
| Very high frequency cetaceans (VHF) | 155 | 1 pulse | | 140 | 1 pulse | |
| | | 10 pulses | | | 10 pulses | |
| | | 100 pulses | | | 100 pulses | |
| | | 500 pulses | | | 500 pulses | |
| | | 1,000 pulses | | | 1,000 pulses | |
| | | 2,000 pulses | | | 2,000 pulses | |

| | | | | | | |
|---|------------|---------------------|----------------|------------|---------------------|----------------|
| Sirenians (SI) | 190 | 1 pulse | - | 175 | 1 pulse | < 10 |
| | | 10 pulses | - | | 10 pulses | 10 |
| | | 100 pulses | < 10 | | 100 pulses | 45 |
| | | 500 pulses | 15 | | 500 pulses | 140 |
| | | 1,000 pulses | 20 | | 1,000 pulses | 210 |
| | | 2,000 pulses | 35 | | 2,000 pulses | 330 |
| <i>Phocid carnivores in water (PCW)</i> | 185 | <i>1 pulse</i> | | 170 | <i>1 pulse</i> | |
| | | <i>10 pulses</i> | | | <i>10 pulses</i> | |
| | | <i>100 pulses</i> | | | <i>100 pulses</i> | |
| | | <i>500 pulses</i> | | | <i>500 pulses</i> | |
| | | <i>1,000 pulses</i> | | | <i>1,000 pulses</i> | |
| | | <i>2,000 pulses</i> | | | <i>2,000 pulses</i> | |
| <i>Other marine carnivores in water (OCW)</i> | 203 | <i>1 pulse</i> | | 188 | <i>1 pulse</i> | |
| | | <i>10 pulses</i> | | | <i>10 pulses</i> | |
| | | <i>100 pulses</i> | | | <i>100 pulses</i> | |
| | | <i>500 pulses</i> | | | <i>500 pulses</i> | |
| | | <i>1,000 pulses</i> | | | <i>1,000 pulses</i> | |
| | | <i>2,000 pulses</i> | | | <i>2,000 pulses</i> | |

Notes: (1) a dash indicates the threshold level is not reached or not applicable; (2) greyed out animal groups are not relevant to the modelled location.

Table 16 Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – Marine Mammals - Scenario 4 Mid of Jetty MSL

| Marine mammal hearing group | Zones of impact – Maximum horizontal perpendicular distances from source to cumulative impact threshold levels | | | | | |
|-------------------------------------|--|-------------------------------|-----|--|-------------------------------|-------|
| | Injury (PTS) onset | | | TTS onset | | |
| | Criteria – Weighted SEL _{24-hr} dB re 1 µPa ² ·s | Maximum threshold distance, m | | Criteria – Weighted SEL _{24-hr} dB re 1 µPa ² ·s | Maximum threshold distance, m | |
| Low frequency cetaceans (LF) | 183 | 1 pulse | <10 | 168 | 1 pulse | 40 |
| | | 10 pulses | 20 | | 10 pulses | 140 |
| | | 100 pulses | 70 | | 100 pulses | 540 |
| | | 500 pulses | 186 | | 500 pulses | 1,430 |
| | | 1,000 pulses | 270 | | 1,000 pulses | 2,190 |
| | | 2,000 pulses | 410 | | 2,000 pulses | 3,360 |
| High frequency cetaceans (HF) | 185 | 1 pulse | - | 170 | 1 pulse | <10 |
| | | 10 pulses | - | | 10 pulses | <10 |
| | | 100 pulses | <10 | | 100 pulses | 35 |
| | | 500 pulses | 10 | | 500 pulses | 100 |
| | | 1,000 pulses | 20 | | 1,000 pulses | 150 |
| | | 2,000 pulses | 25 | | 2,000 pulses | 240 |
| Very high frequency cetaceans (VHF) | 155 | 1 pulse | | 140 | 1 pulse | |
| | | 10 pulses | | | 10 pulses | |
| | | 100 pulses | | | 100 pulses | |
| | | 500 pulses | | | 500 pulses | |
| | | 1,000 pulses | | | 1,000 pulses | |
| | | 2,000 pulses | | | 2,000 pulses | |

| | | | | | | |
|---|------------|---------------------|----------------|------------|---------------------|----------------|
| Sirenians (SI) | 190 | 1 pulse | - | 175 | 1 pulse | < 10 |
| | | 10 pulses | - | | 10 pulses | 10 |
| | | 100 pulses | < 10 | | 100 pulses | 45 |
| | | 500 pulses | 15 | | 500 pulses | 130 |
| | | 1,000 pulses | 20 | | 1,000 pulses | 210 |
| | | 2,000 pulses | 35 | | 2,000 pulses | 330 |
| <i>Phocid carnivores in water (PCW)</i> | 185 | <i>1 pulse</i> | | 170 | <i>1 pulse</i> | |
| | | <i>10 pulses</i> | | | <i>10 pulses</i> | |
| | | <i>100 pulses</i> | | | <i>100 pulses</i> | |
| | | <i>500 pulses</i> | | | <i>500 pulses</i> | |
| | | <i>1,000 pulses</i> | | | <i>1,000 pulses</i> | |
| | | <i>2,000 pulses</i> | | | <i>2,000 pulses</i> | |
| <i>Other marine carnivores in water (OCW)</i> | 203 | <i>1 pulse</i> | | 188 | <i>1 pulse</i> | |
| | | <i>10 pulses</i> | | | <i>10 pulses</i> | |
| | | <i>100 pulses</i> | | | <i>100 pulses</i> | |
| | | <i>500 pulses</i> | | | <i>500 pulses</i> | |
| | | <i>1,000 pulses</i> | | | <i>1,000 pulses</i> | |
| | | <i>2,000 pulses</i> | | | <i>2,000 pulses</i> | |

Notes: (1) a dash indicates the threshold level is not reached or not applicable; (2) greyed out animal groups are not relevant to the modelled location.

Table 17 Zones of cumulative impact from impulsive noise under multiple piling pulses for mortality and recovery injury– fish, turtles, fish eggs and fish larvae

| Zones of impact – maximum horizontal perpendicular distances from source to cumulative impact threshold levels | | | | | | | | | |
|--|--|-------------------------------|-----|--|-------------------------------|-----|--|-------------------------------|-----|
| Type of animal | Mortality and potential mortal injury | | | Recoverable injury | | | TTS | | |
| | Criteria - SEL _{24hr} dB re 1 μPa ² -s | Maximum threshold distance, m | | Criteria - SEL _{24hr} dB re 1 μPa ² -s | Maximum threshold distance, m | | Criteria - SEL _{24hr} dB re 1 μPa ² -s | Maximum threshold distance, m | |
| | | All four scenarios | | | All four scenarios | | | All four scenarios | |
| #1 – Fish: no swim bladder (particle motion detection) | 219 | 1 pulse | - | 216 | 1 pulse | - | 186 | 1 pulse | <10 |
| | | 10 pulses | - | | 10 pulses | - | | 10 pulses | 25 |
| | | 100 pulses | <10 | | 100 pulses | <10 | | 100 pulses | 85 |
| | | 500 pulses | <10 | | 500 pulses | <10 | | 500 pulses | 210 |
| | | 1,000 pulses | <10 | | 1,000 pulses | <10 | | 1,000 pulses | 280 |
| | | 2,000 pulses | <10 | | 2,000 pulses | 12 | | 2,000 pulses | 450 |
| #2 – Fish: swim bladder is not involved in hearing (particle motion detection) | 210 | 1 pulse | | 203 | 1 pulse | | 186 | | |
| | | 10 pulses | | | 10 pulses | | | | |
| | | 100 pulses | | | 100 pulses | | | | |
| | | 500 pulses | | | 500 pulses | | | | |
| | | 1,000 pulses | | | 1,000 pulses | | | | |
| | | 2,000 pulses | | | 2,000 pulses | | | | |
| #3 – | 207 | 1 pulse | | 203 | | | 186 | | |
| | | 10 pulses | | | | | | | |
| | | 100 pulses | | | | | | | |
| | | 500 pulses | | | | | | | |

| | | | | | | | |
|--|------------|--------------------|----|---|--|---|--|
| <i>Fish: swim bladder involved in hearing (primarily pressure detection)</i> | | 1,000 pulses | 22 | | | | |
| | | 2,000 pulses | 30 | | | | |
| #4 – Sea turtles | 210 | As #2 above | | - | | - | |
| #5 – Fish eggs and fish larvae | 210 | | | - | | - | |

Notes: (1) a dash indicates the threshold level is not reached or not applicable; (2) greyed out animal groups are not relevant to the modelled location.

Table 18 Zones of cumulative impact from impulsive noise under multiple piling pulses for PTS and TTS – sea turtles

| Zones of impact – maximum horizontal perpendicular distances from source to cumulative impact threshold levels | | | | | | |
|--|--|-------------------------------|-----|--|-------------------------------|-----|
| Type of animal | PTS Onset | | | TTS Onset | | |
| | Criteria - SEL _{24hr} dB re 1 μPa ² ·s | Maximum threshold distance, m | | Criteria - SEL _{24hr} dB re 1 μPa ² ·s | Maximum threshold distance, m | |
| | | All four scenarios | | | All four scenarios | |
| Sea turtles | 204 | 1 pulse | - | 189 | 1 pulse | <10 |
| | | 10 pulses | <10 | | 10 pulses | 20 |
| | | 100 pulses | 10 | | 100 pulses | 60 |
| | | 500 pulses | 25 | | 500 pulses | 145 |
| | | 1,000 pulses | 35 | | 1,000 pulses | 205 |
| | | 2,000 pulses | 50 | | 2,000 pulses | 300 |

5.3 Discussion

The estimated zones of impact presented in this report can be used for the development of a detailed underwater management plan to effectively manage and mitigate noise impacts from marine piling on marine fauna species of concern for the project.

A range of management, mitigation and control options can be considered and included in such a management plan. Those options include:

- **Management zones.** The management zones include observation and shut-down zones. These zones are to be determined based on the estimated impact zones as predicted by the modelling results detailed in **Section 5.2**, as well as the realistic piling operation conditions (particularly the number of piling strikes to be undertaken per pile during the operation phase of the project). These zones can be further refined based on the model validation potentially to be carried out during the early stage of the piling operations.

As an example, preliminary management zones for a scenario of 100 piling strikes over a period of 24 hours based on worst case scenario modelling results are provided in **Table 19** for reference.

Table 19 Management zones based on a scenario of 100 piling pulses

| Marine Fauna Group | Predicted PTS Zone, m | Predicted TTS Zone, m | Observation Zone, m | Shutdown Zone, m |
|--------------------------|-----------------------|-----------------------|---------------------|------------------|
| Whales | 90 | 750 | 1,500 | 750 |
| Dolphins | <10 | 35 | 500 | 150 |
| Dugongs | <10 | 48 | 500 | 150 |
| Sea turtles / sea snakes | 10 | 60 | 500 | 200 |

- **Standard management and mitigation procedures.** These procedures could include equipment selection, site crew training, operational procedures during piling activities (incl. pre-start, soft start, normal operation, stand-by operation, and shutdown procedures), coupled with independently trained marine fauna observers (MFOs), operation time and duration, as well as compliance reporting. These procedure elements are applicable for all piling activities, irrespective of location and time of year, when marine fauna species may potentially be present within the noise footprint of the piling activity (DIT, 2023).
- **Adaptive management and mitigation measures.** The following adaptive management and mitigation measures are recommended to be considered within the management plan, to minimise the impact zone uncertainties, and to mitigate the ecological impacts.
 - Model validation to be undertaken, to adjust impact zones based on site noise measurements under realistic site conditions and piling operation scenarios (e.g., number of piling pulses).
 - More impact factors with extended impact zones to be considered, such as behavioural disturbance (in addition to cumulative PTS and TTS), when biologically important habitats, including migratory, breeding, foraging and resting areas are within and /or adjacent to the project area, and when additional mitigation and control measures are to be investigated and justified to effectively manage these impacts.
 - Piling activities timed to avoid key ecological windows for key species, to reduce or remove impacts for migratory species or species with seasonal critical life stages .

- Additional control measures.** In the case when the impacts of the piling activity on marine fauna species are likely to be significant and the management and mitigation measures above do not sufficiently minimise the impact (e.g., the mitigation zones are beyond the range in which MFOs can reasonably detect target species), additional control measures to reduce the piling noise emissions are recommended. These measures include (but not limited to) bubble curtains, cofferdams, hydro sound dampers, noise mitigation screen (ACCOBAMS, 2019), and some emerging piling noise reduction technologies such as IQIP Pulse Technology (IQIP, 2022) and Subsea Quieter technology (Greenov, 2024).

The description of these control measures and their indicative noise reduction performance is presented in **Table 21**. The reduced impact zones resulting from the implementation of one of these control measures can be quantified based on further noise modelling iterations.

Table 20 Mitigation options and their indicative marine piling noise reduction performance (ACCOBAMS, 2019, IQIP, 2022 and Greenov, 2024)

| Mitigation technology | Description | Indicative noise reduction |
|-------------------------------|--|---|
| Big air bubble curtain | A large bubble curtain consists of a hose with drilled holes, supplied with compressed air. The hose is placed on the seabed and the air escaping from the holes forms the bubble screen. | SEL – up to 12 dB Pk SPL – up to 15 dB |
| Little air bubble curtain | A little bubble curtain can be customised and placed much closer to the noise source than the big bubble curtain. It may consist of a rigid frame placed around the source. Several configurations are possible. | SEL – up to 13 dB Pk SPL – up to 14 dB |
| Hydro sound damper | This technology consists of fishing nets with small balloon filled with gas and foam–tuned to resonant frequencies- fixed to it. It can be applied in different ways. | SEL – up to 14 dB |
| Cofferdam | The cofferdam consists of a rigid steel tube surrounding the pile. Once the pile is stabbed into the cofferdam, the water is pumped out | SEL – up to 22 dB Pk SPL – up to 18 dB |
| Noise mitigation screen (NMS) | The NMS is a double layered screen, filled with air. Between the pile and screen there is a multi level and multi size bubble injection system. | SEL – up to 20 dB |
| IQIP Pulse technology | Pulse is a modular add-on to the standard IQIP Hydrohammer. The unit is positioned between the pile driving hammer and sleeve and dampens the impact and noise with two steel plungers. | SEL – up to 10dB Pk SPL – up to 12 dB |
| Subsea Quieter technology | SubSea Quieter® system is based on a multi-layer membrane into which a fine particle of air is injected to create a barrier to the sound waves. | Spectral level reduction: 10 - 45 dB depending on frequencies. |

6 Conclusion

This study report presents underwater noise modelling and impact zone estimates regarding relevant noise impacts on marine fauna species of concern as a result of the construction piling activities associated with the Onslow Recreational Jetty development project.

The detailed noise modelling results show that impact piling activities during construction are predicted to result in adverse noise impacts on certain marine fauna species of concern within and around the project area, due to the high piling source noise emissions and the impulsive characteristics of the impact piling noise. The zones of noise impact from the proposed piling locations have been estimated based on comparisons between predicted noise levels and relevant impact criteria, with the zones of impact estimate results presented in **Section 5.2**.

Discussions on relevant management, mitigation and control measures are presented in **Section 5.3** in order to minimise the piling noise impact on marine fauna species of concern within and around the project area.

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APPENDIX A

A Glossary

A.1 Underwater Acoustics Terms

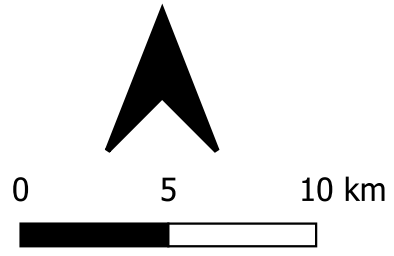
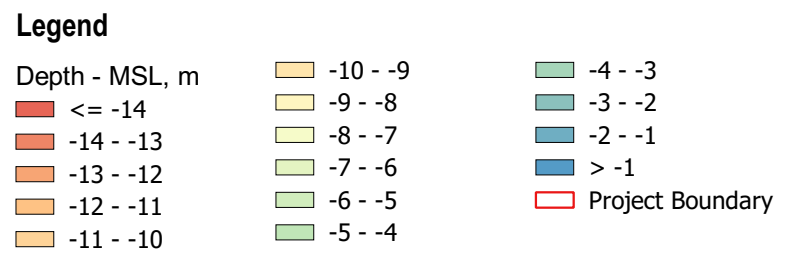
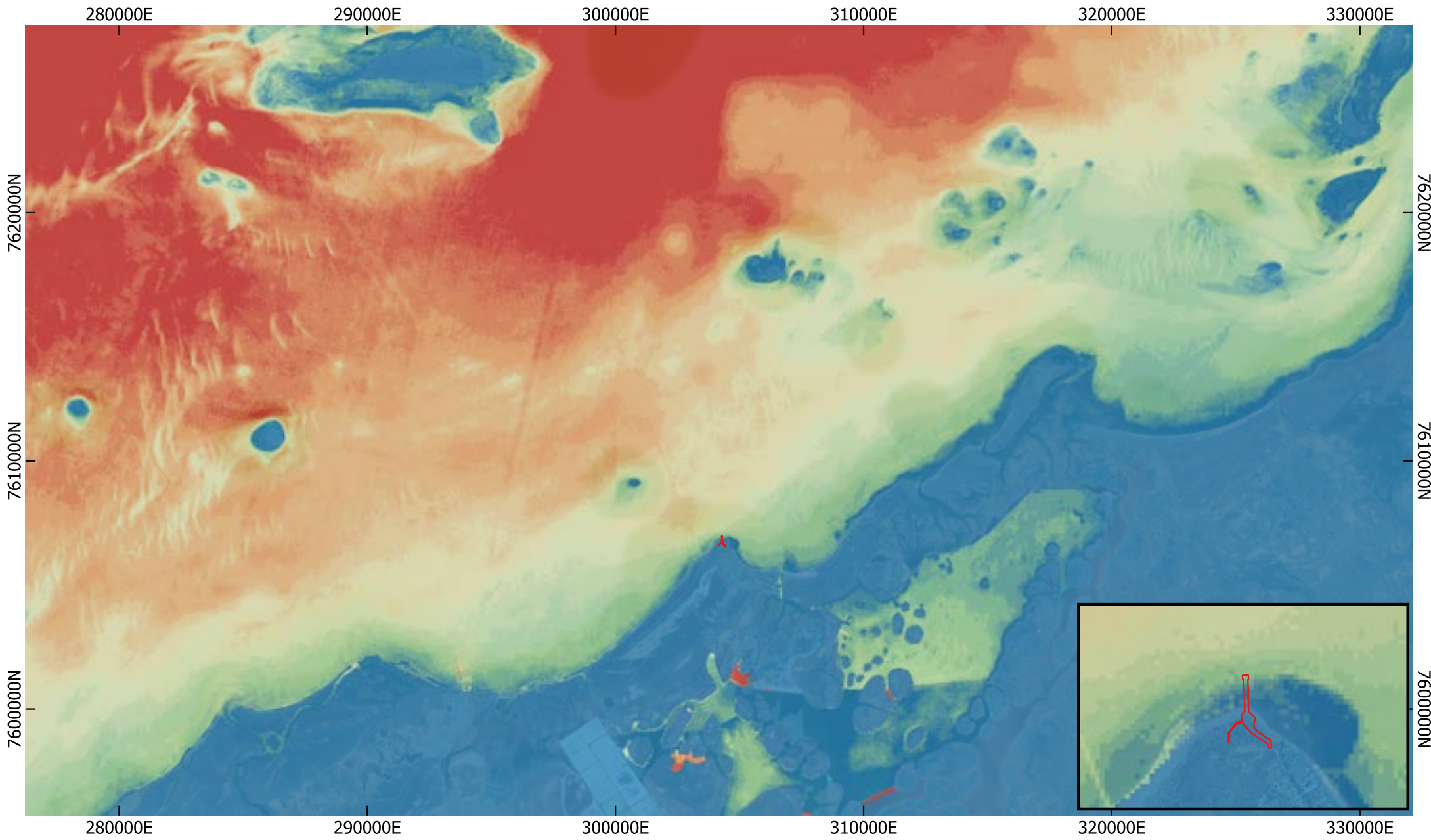
The following table describes key terms used in this report.

Table 21 Underwater Acoustics Terms and their definitions

| Term | Definition |
|---|---|
| 1/3 Octave Band Levels | The energy of a sound split into a series of adjacent frequency bands, each being 1/3 of an octave wide |
| Ambient noise | All-encompassing sound at a given place, usually a composite of sound from many sources near and far, e.g., shipping vessels, seismic activity, precipitation, sea ice movement, wave action, and biological activity |
| Impulsive noise | Noise signal that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels. For example, noise signals from seismic airguns and impact pile driving |
| Non-impulsive noise | Noise that is broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically does not have a high peak pressure with rapid rise time. For example, noise signals from marine vessels, aircraft, machinery, construction, and vibratory pile driving |
| Peak Sound Pressure Level (Pk SPL) | The peak sound pressure level is the logarithmic ratio of the peak pressure over the impulsive signal event to the reference pressure |
| Peak-to-Peak Sound Pressure Level (Pk-Pk SPL) | The peak-to-peak sound pressure level is the logarithmic ratio of the difference between the maximum and minimum pressure over the impulsive signal event to the reference pressure |
| Power Spectral Density (PSD) | PSD describes how the power of a signal is distributed with frequency |
| Permanent threshold shift (PTS) | A permanent loss of hearing sensitivity caused by excessive noise exposure |
| Received level (RL) | The sound level measured at a receiving location |
| Root-Mean-Square Sound Pressure Level (RMS SPL) | The mean-square sound pressure is the average of the squared pressure over the pulse duration. The root-mean-square sound pressure level is the logarithmic ratio of the root of the mean-square pressure to the reference pressure. Pulse duration is taken as the duration between the 5% and the 95% points on the cumulative energy curve |
| Source Level (SL) | The acoustic source level is the level referenced to a distance of 1m from a point source |
| Sound Exposure Level (SEL) | SEL is a measure of energy. Specifically, it is the dB level of the time integral of the squared instantaneous sound pressure normalised to a 1-s period |
| Sound Pressure | A deviation from the ambient hydrostatic pressure caused by a sound wave |
| Sound Pressure Level (SPL) | The logarithmic ratio of sound pressure to the reference pressure. The reference pressure underwater is $P_{ref} = 1 \mu\text{Pa}$ |
| Sound Speed Profile (SPP) | A graph of the speed of sound in the water column as a function of depth |
| spectrum | An acoustic signal represented in terms of its power, energy, mean-square sound pressure, or sound exposure distribution with frequency |
| Temporary threshold shift (TTS) | Temporary loss of hearing sensitivity caused by excessive noise exposure |
| Transmission loss (TL) | The decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment |

APPENDIX B

B Bathymetry Data Contour Figure



**Onslow Recreational Jetty
Underwater Piling Noise Modelling**

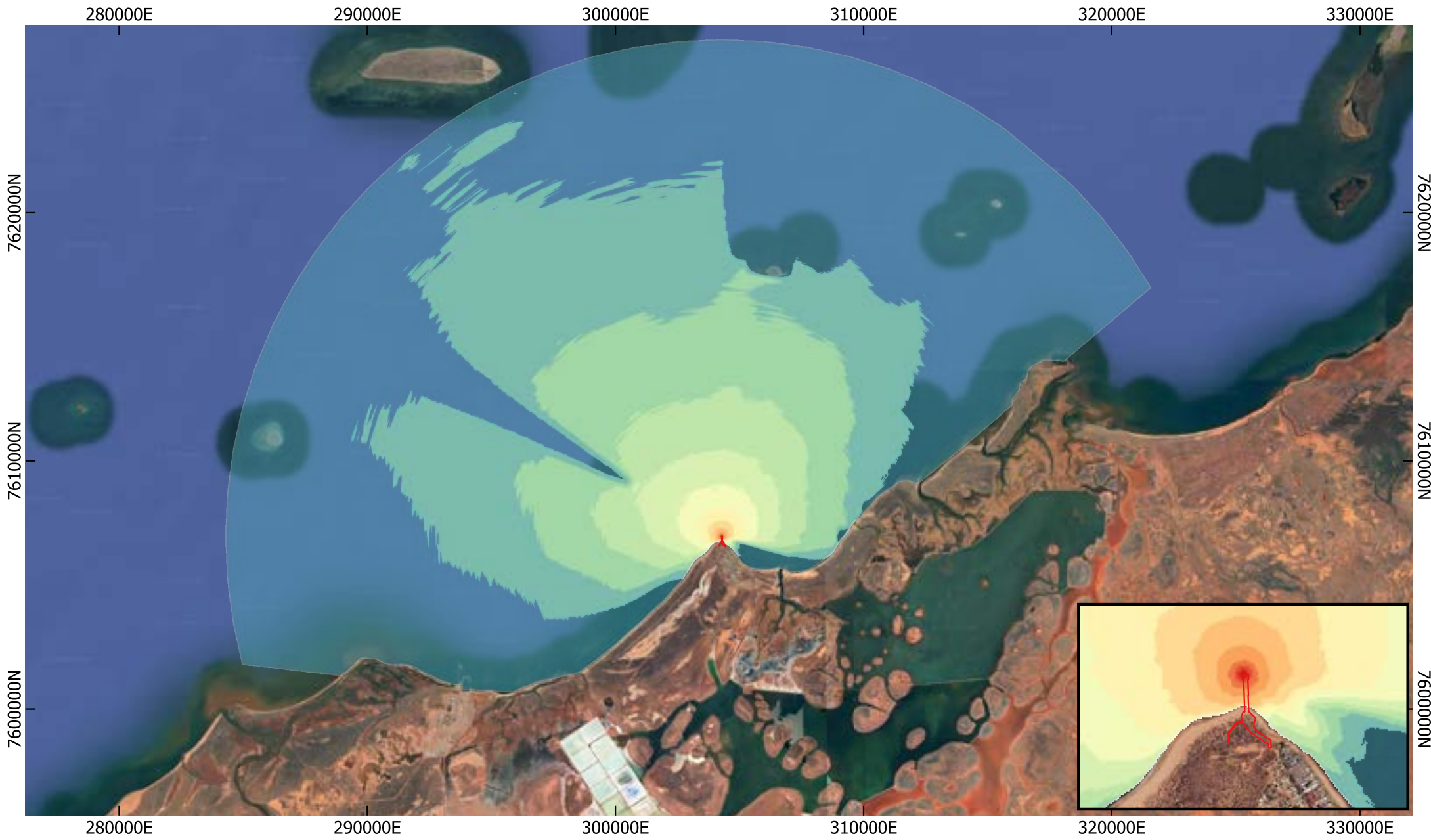
Bathymetry Data

Project No. 755.23047
 Revision No. 0
 Date. 12/07/2024

FIGURE B.1

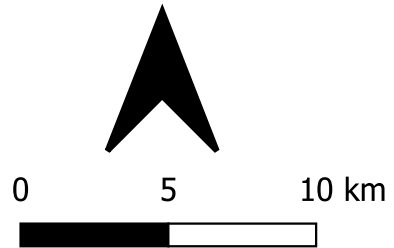
APPENDIX C

C Predicted Sound Exposure Level (SEL) Contour Figures



Legend

| | | |
|---------------------------------|-----------|------------------|
| SEL, dB re 1uPa ² .S | 135 - 140 | 160 - 165 |
| <= 120 | 140 - 145 | 165 - 170 |
| 120 - 125 | 145 - 150 | 170 - 175 |
| 125 - 130 | 150 - 155 | > 175 |
| 130 - 135 | 155 - 160 | Project Boundary |

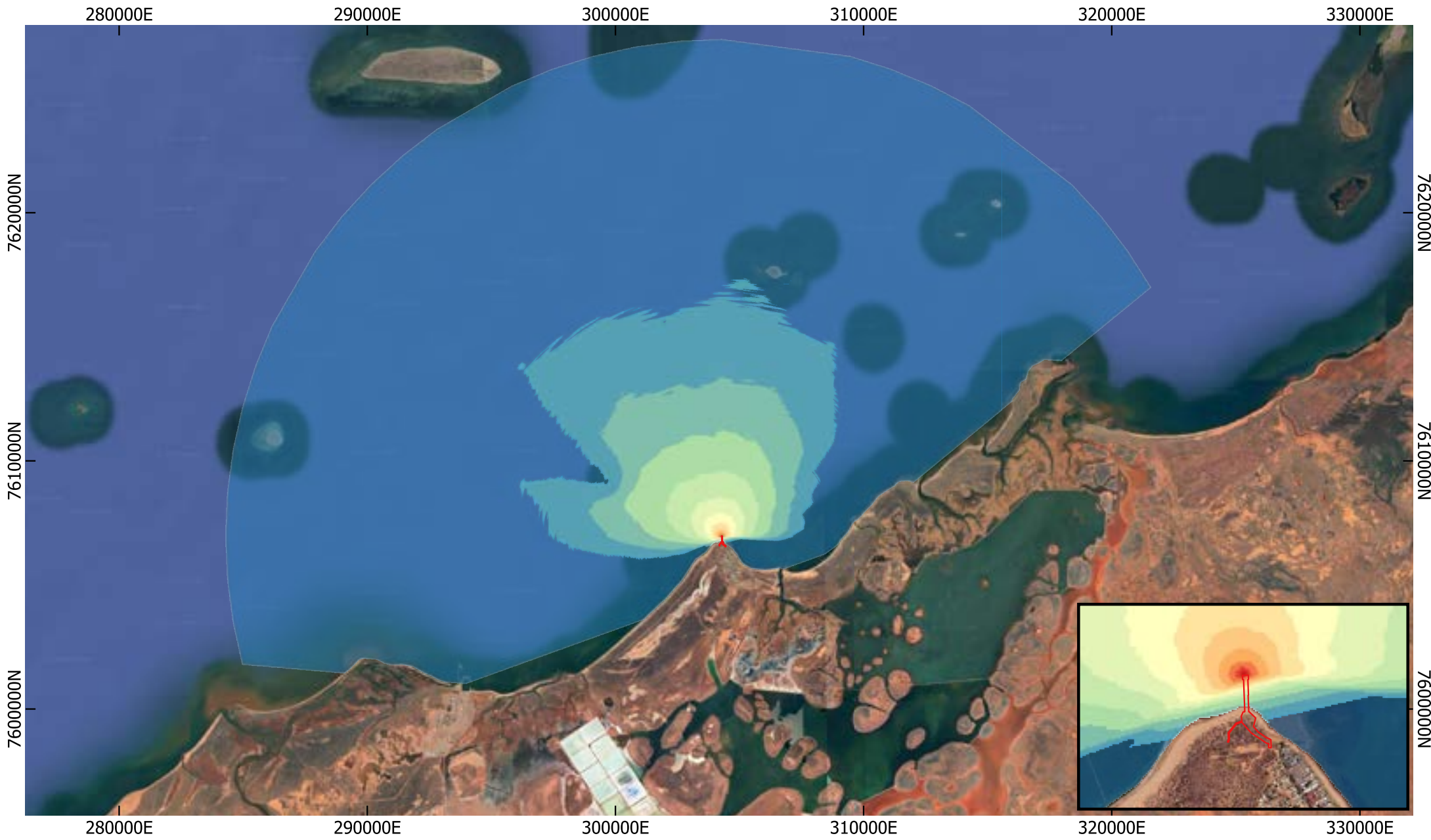


Onslow Recreational Jetty
Underwater Piling Noise Modelling

SEL Contour
Single Piling Strike
L1 - HAT

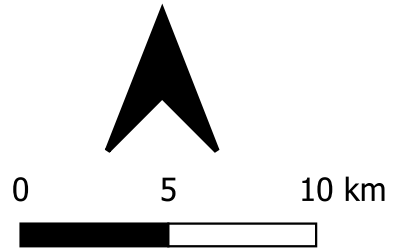
Project No. 755.23047
Revision No. 0
Date. 12/07/2024

FIGURE C.1



Legend

| | | |
|---------------------------------|-----------|------------------|
| SEL, dB re 1uPa ² .S | 135 - 140 | 160 - 165 |
| <= 120 | 140 - 145 | 165 - 170 |
| 120 - 125 | 145 - 150 | 170 - 175 |
| 125 - 130 | 150 - 155 | > 175 |
| 130 - 135 | 155 - 160 | Project Boundary |

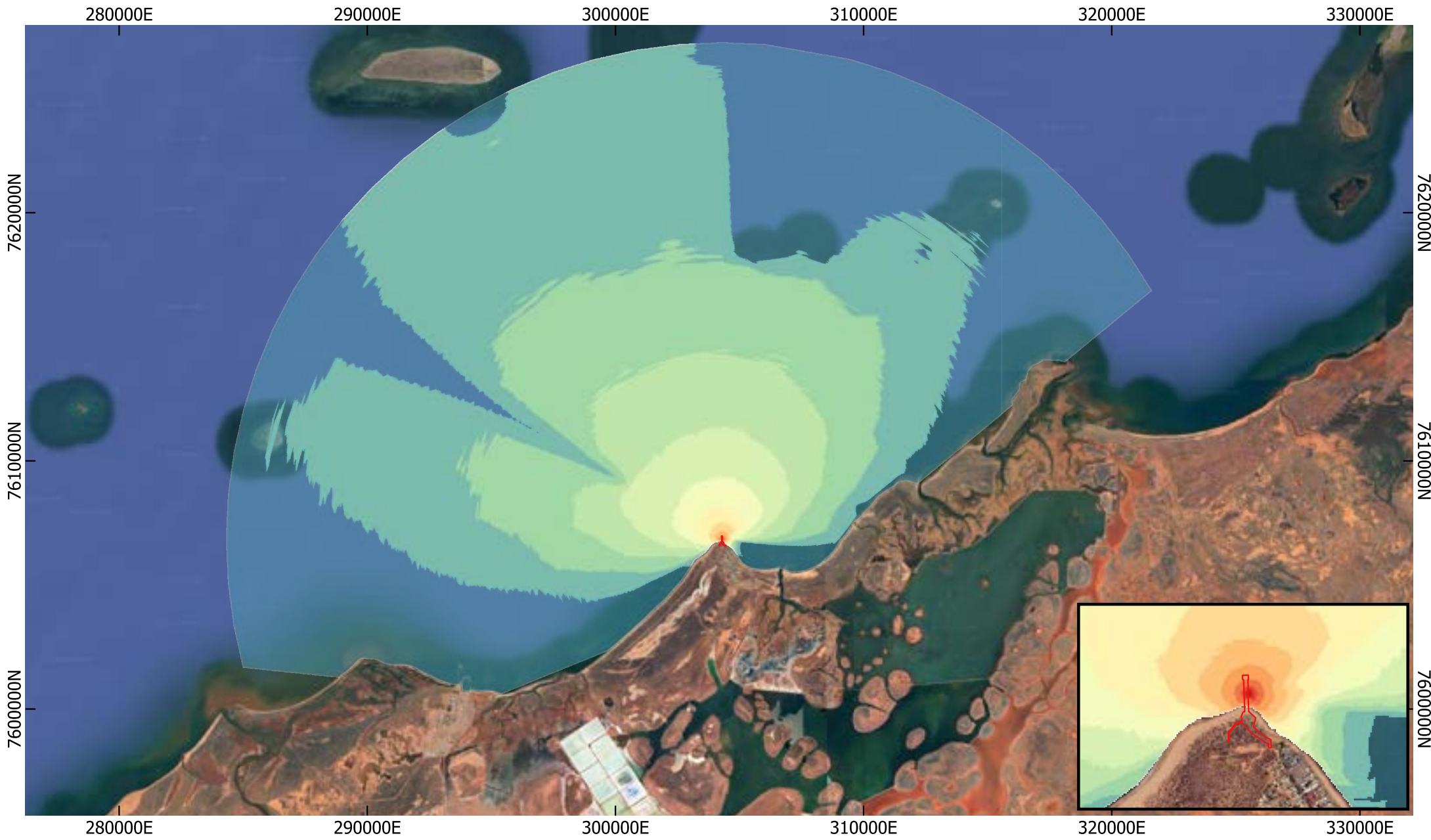


Onslow Recreational Jetty
Underwater Piling Noise Modelling

SEL Contour
Single Piling Strike
L1 - LAT

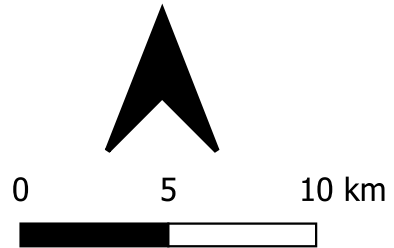
Project No. 755.23047
Revision No. 0
Date. 12/07/2024

FIGURE C.2



Legend

| | | |
|---------------------------------|-----------|------------------|
| SEL, dB re 1uPa ² .S | 135 - 140 | 160 - 165 |
| <= 120 | 140 - 145 | 165 - 170 |
| 120 - 125 | 145 - 150 | 170 - 175 |
| 125 - 130 | 150 - 155 | > 175 |
| 130 - 135 | 155 - 160 | Project Boundary |

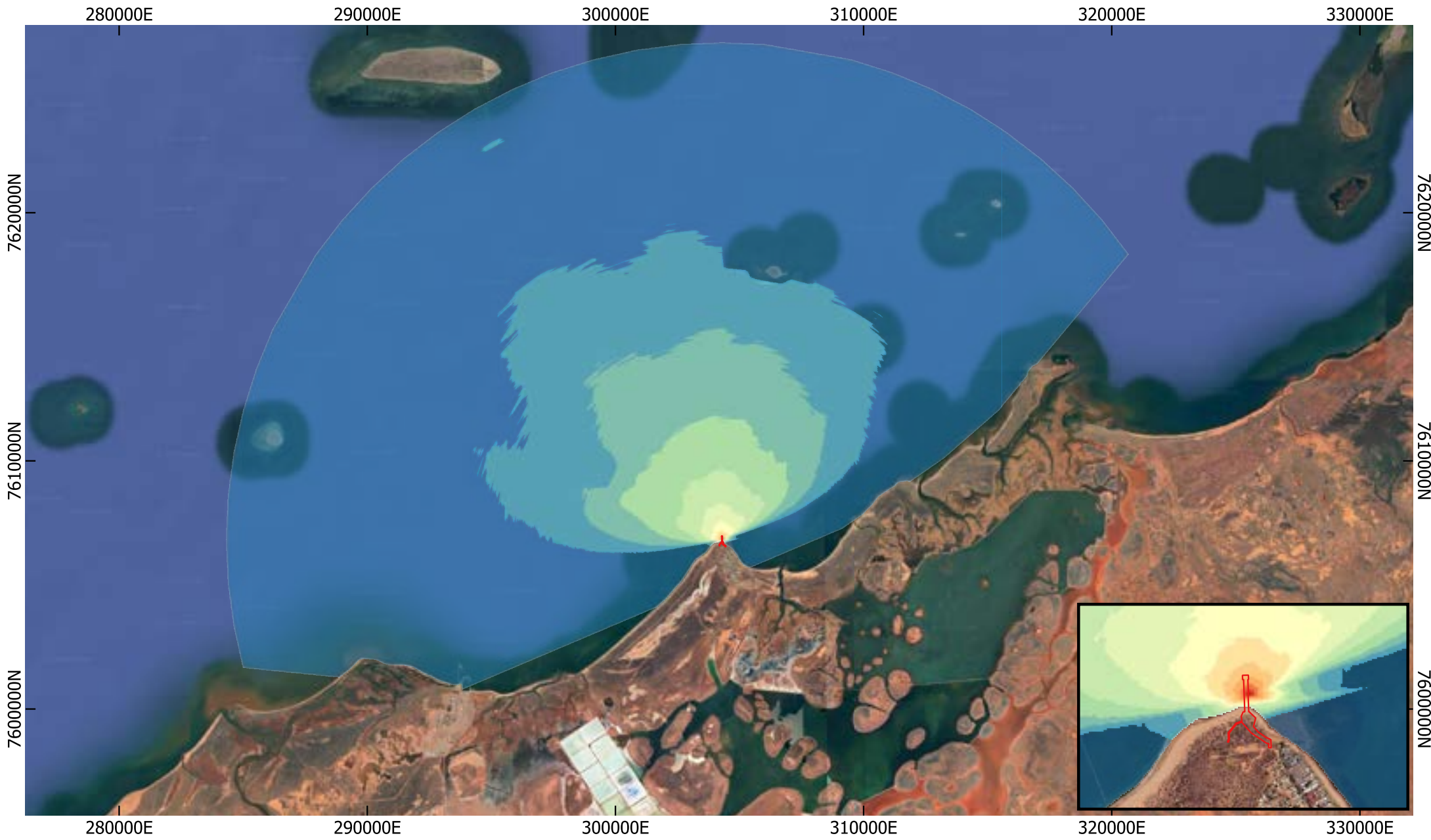


Onslow Recreational Jetty
Underwater Piling Noise Modelling

SEL Contour
Single Piling Strike
L2 - HAT

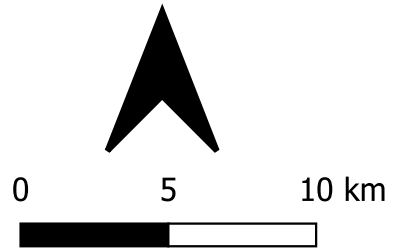
Project No. 755.23047
Revision No. 0
Date. 12/07/2024

FIGURE C.3



Legend

| | | |
|---------------------------------|-----------|------------------|
| SEL, dB re 1uPa ² .S | 135 - 140 | 160 - 165 |
| <= 120 | 140 - 145 | 165 - 170 |
| 120 - 125 | 145 - 150 | 170 - 175 |
| 125 - 130 | 150 - 155 | > 175 |
| 130 - 135 | 155 - 160 | Project Boundary |



Onslow Recreational Jetty
Underwater Piling Noise Modelling

SEL Contour
Single Piling Strike
L2 - MSL

Project No. 755.23047
Revision No. 0
Date. 12/07/2024

FIGURE C.4