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Gladstone Ports Corporation

Report for Western Basin Dredging and Disposal Project

Marine Megafauna Baseline and Impact Assessment

October 2009

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 Background

The Gladstone Port Corporation has contracted GHD Pty Ltd to conduct studies and prepare an Environmental Impact Statement (EIS) for the proposed Western Basin Dredging and Disposal Project. This Project is registered as a Significant Project under the auspices of the *State Development and Public Works Organisation Act 1971* and will be assessed under that Act.

The EIS comprises multiple elements, including sections on the description and assessment of potential impacts on the marine megafauna (cetaceans, dugong and marine turtles) ecological values of the Project. This document reports findings from the marine megafauna ecological surveys, examines potential impacts upon these species from the Project and provides subsequent recommendations that are to be incorporated into the EIS.

1.1.1 Survey and Project Location

The Project Area is located 10 km north of Gladstone City and is comprised of shallow subtidal and intertidal mud flats, a proportion of which will be reclaimed (Figure 1). The communities established within the Project Area and those in adjacent waters have been assessed and are discussed in detail in the Marine Ecology Assessment Report (GHD, 2009a) that complements this report. The landward edge of the bay in which the Western Basin Reclamation Area is located is bound by mangrove communities. These communities and the fauna they support have been assessed separately in the Terrestrial Ecology Report (GHD, 2009b).

The area surveyed for marine megafauna encompasses:

- The immediate Project Area of the Western Basin Reclamation Area;
- The areas to be targeted for capital and maintenance dredging;
- Any adjacent marine areas that have the potential to be impacted by the construction and operation of the proposed Project; and
- Areas extending north to Port Alma and down to the southern reaches of Rodds Bay (approximately 100 km in length).

These combined areas are hereafter referred to as the Survey Area, which is considered a minimum distance of ecological relevance (between habitat patches) for migratory marine fauna.

1.1.2 Purpose and Scope of this Report

This report has been collated from information sourced through a focussed desktop assessment of available information (including Government agencies databases) and from the results of a marine megafauna habitat utilisation survey. The survey was carried out to enhance and update existing knowledge of marine megafauna occurring within and adjacent to the Survey Area. The report is structured to initially provide a review of existing information on Indo-Pacific humpback and Australian snubfin dolphins, dugong, and marine turtles inhabiting or with the potential to inhabit the Project Area. The recent megafauna survey is then presented, to enhance the information available at a relatively project-specific level. Potential impacts to marine megafauna and relevant mitigation strategies for the

Project are discussed at length with respect to the information presented. The report provides sufficient information on key marine megafauna values to adequately assess potential impacts from the proposed Project. This information on these values will be considered in the EIS main documentation with information and recommendations on mitigations measures identified in this report used to support the findings of the EIS. Information from the complementary baseline marine ecology report has been used to support findings in this report and readers should be familiar with both documents.

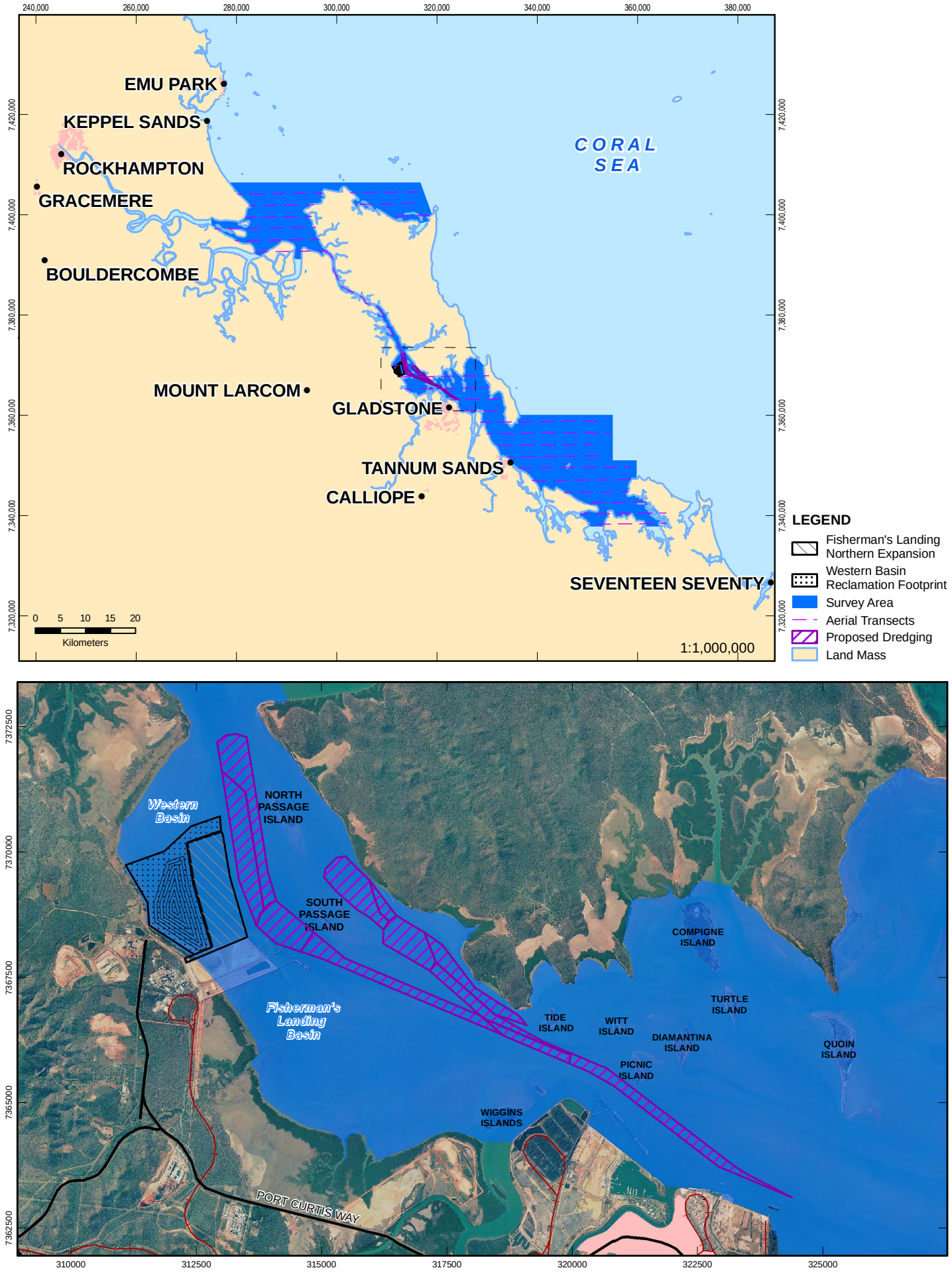
The marine megafauna survey was undertaken over a seven month period from November 2008 - July 2009, and included three days of aerial surveys (two surveys per day, high and low tide) and three monthly boat-based surveys (April, May and June). Seasonality of megafauna species distribution was difficult to detect given the limited survey period. Seasonal change is known to affect the abundance and distribution of critical habitats for megafauna species, such as seagrass, in the southern region of the Great Barrier Reef compared to northern tropical waters. While it is believed megafauna species dependent on these habitats are likely to respond to seasonal availability of critical habitats this is not well documented in research literature to date. Some response would be anticipated given the reduced standing crop and contracted distribution of seagrass in winter compared to summer.

Marine turtles are likely to show an increase in presence leading up to the nesting period (September/October) and during the nesting period (November – January), which has not been captured in these surveys. As such, recorded marine turtle presence and habitat use identified in this survey is temporally explicit.

1.2 Overview

The coastal environment of central Queensland supports numerous marine species that are vulnerable to anthropogenic impacts. Many key marine species in this area are of high conservation value and are afforded protection under State, National and International legislation. The main objective of the marine megafauna survey was to sample for the presence of key marine fauna species within the Project Area and adjacent waters to develop an understanding of their habitat utilisation in a local and regional context. This survey utilised the aerial survey experience and spatial modelling done by Alana Grech, a PhD student from James Cook University. The modelling aims to provide a greater interpretation of megafauna movements over time within the greater Survey Area and thus provide more definitive recommendations for species management.

The survey design involved two components (aerial and boat-based surveys) that consider the behaviours of inshore dolphins, dugongs and marine turtle species that require frequent surfacing intervals (Marsh and Sinclair 1989 a and b, Pollock *et al.* 2006, Lukoscheck and Chilvers, 2008, Chilvers *et al*. 2004, Groom *et al*. 2004; Parra *et al*. 2006). The surveys were conducted to enhance existing species distribution data at regional and finer spatial scales.



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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Port of Gladstone
Western Basin Dredging and Disposal Project

Job Number 42-15386
Revision A
Date 01 Sept 2009

Western Basin Project and Survey Area

Figure 1

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2. Policy and Legislative Context

2.1.1 International Conventions and Treaties

Migratory and threatened marine mammals, birds and reptiles are awarded protection within a variety of international agreements. These agreements are acknowledged within Australian legislation under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

2.1.2 Commonwealth Legislation and Policy

The EPBC Act incorporates legislation that provides for the protection of matters of National Environmental Significance (Protected Matters). A number of Protected Matters covered by the EPBC Act are relevant or potentially relevant to this marine in the Project Area these include:

- Listed threatened species;
- Listed cetaceans;
- Listed migratory species; and
- Listed marine species.

Listed Threatened Species and Cetaceans

The EPBC Act provides legislative protection for all nationally threatened fauna and flora species, and ecological communities. The Act seeks to provide a standard by which species and communities can be listed as threatened, it also seeks to develop recovery actions and plans for such threatened species and communities, identify areas of critical habitat for threatened species, provide a list of key threatening processes, and provide plans by which threatening process can be abated. All cetaceans are covered by the EPBC Act regardless of their conservation status.

Consideration of the risk to endangered species within a proposed impact area is required, including whether they are representative of a distinct or bioregional population, and in the case of vulnerable species, whether this population is considered particularly important relative to other populations.

Listed Migratory Species

The EPBC Act legislates protective status for all species that migrate to Australia (and/or its territories). Specifically, any species listed under international agreements and conventions pertaining to migratory species are protected under the Act. Migratory marine fauna are protected under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

A search of the Protected Matters Database showed that six migratory marine mammals, six migratory marine reptiles, and one migratory shark may potentially utilise habitats within and adjacent to the Project Area in Port Curtis.

Commonwealth Marine Area: Listed Marine Species and Listed Cetaceans

Commonwealth marine areas are marine areas within Australia's sovereign jurisdiction that are not governed by the States or Territories. This includes any waters within the Australian Exclusive Economic Zone, and extends from 3 to 200 nautical miles offshore. The legal protective status of Listed Marine species does not necessarily extend to State waters, unless there is a high likelihood that actions in State waters will significantly impact upon Listed Marine species of National Environmental

Significance. The waters within the Project Area are not within a Commonwealth Marine Area. Therefore, impacts on species within or adjacent to the Project Area listed as Marine Species or Cetaceans under the EPBC Act are relevant if the action is likely to have a significant impact on the environment of the Commonwealth Marine Area. In Queensland waters and under Queensland legislation, the Listed Marine under national legislation are protected. Other legislative mechanisms and policy support their conservation (below).

A significant impact is defined within the National Environmental Significance Guidelines as "a real chance or possibility that the action will have a substantial adverse effect on a population of a marine species or cetacean including its lifecycle and spatial distribution."

Recovery Plans

Recovery plans set out the research and management actions necessary to stop the decline, and support the recovery, of listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long term survival in the wild of a threatened species or ecological community. Commonwealth Recovery Plans have been developed for the following marine species identified as potentially occurring within the Project Area or adjacent waters:

- Marine turtles;
- Humpback and blue whales; and
- Whale shark.

Information on potential impacts to species relevant to the Project is discussed in Sections 6, 7 and 8.

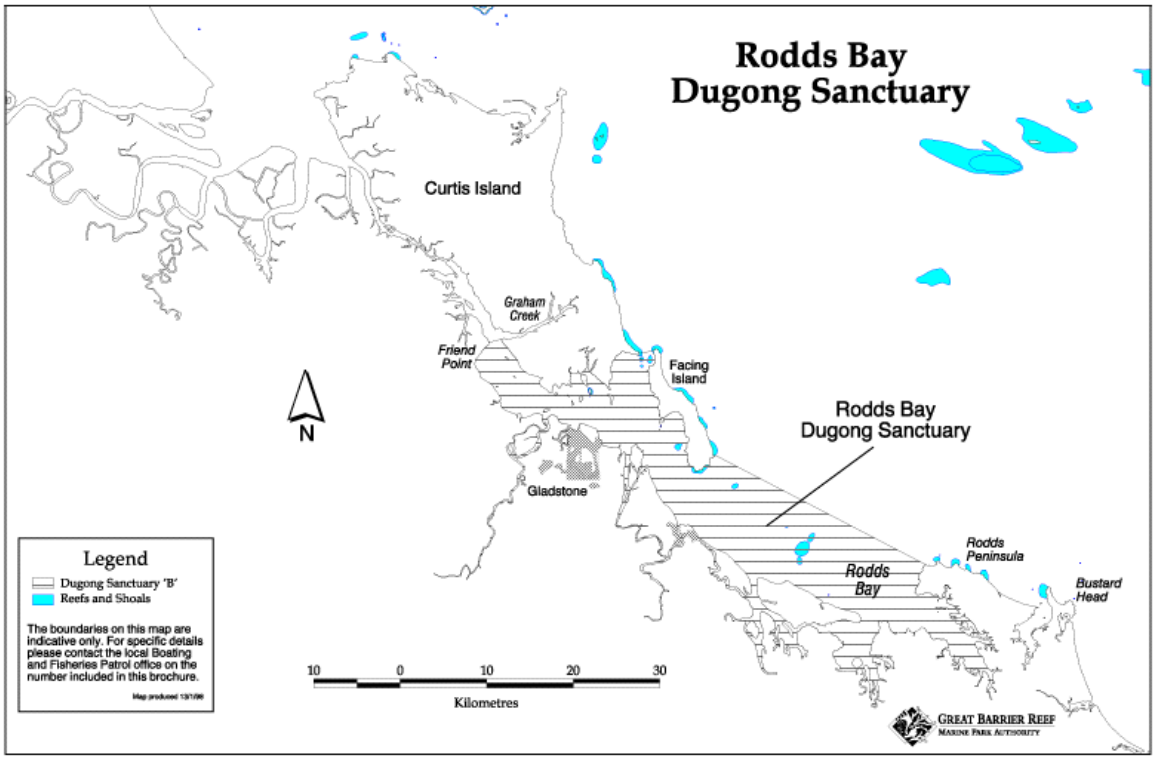
2.1.3 Queensland State Legislation and Policy

Nature Conservation (Wildlife) Regulation 2006

The Nature Conservation (Wildlife) Regulation 2006 (Qld) pursuant to the *Nature Conservation Act 1992* (Qld) categorises flora and fauna species occurring in Queensland as being presumed extinct, endangered, vulnerable, rare, common, international and prohibited. The management intent pertaining to each species is described within the Regulations, as are the principles relating to the use and taking of those listed species.

The *Nature Conservation (Dugong) Conservation Plan 1999* (Qld), under the *Nature Conservation Act 1992* (Qld) is a tool that allows for dugong recovery actions to be conducted in Commonwealth-nominated Dugong Protection Areas (DPAs). The restrictions were initially implemented under the *Queensland Fisheries Act* 1994, and then declared as legislation under the *Queensland Nature Conservation Act 1992,* and as Special Management Areas under the *Great Barrier Reef Marine Park Regulations 1983* and the *Great Barrier Reef Marine Park Zoning Plan 2003* (GBRMPA, 2009). The DPAs have the specific objective of protecting dugongs by limiting exposure to threatening fishing practices, no further provisions are provided in this legislation.

The Project Area is within a Species Conservation (Dugong Protection) Special Management Area ("Dugong Protection Area B"), Figure 2.



Source: GBRMPA website, 2009

Figure 2 Rodds Bay Dugong Protection Area

The following are listed as threatened species in the *Nature Conservation (Wildlife) Regulation 2006* (Qld), pursuant to the *Nature Conservation Act 1992* (Qld).

- Endangered: Loggerhead turtle (*Caretta caretta*), Olive ridley (*Lepidochelys olivacea*) and leatherback turtle (*Dermochelys coriacea*);
- Vulnerable: Dugong (*Dugong dugon*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*) and flatback turtle (*Natator depressus*);
- Rare: Australian snubfin dolphin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphin (*Sousa chinensis*).

Under section 72 of the *Nature Conservation Act 1992* (Qld), management of wildlife is to be undertaken in accordance with:

- The management principles prescribed for the class of the wildlife; and
- The declared management intent for the wildlife; and
- Any conservation plan for the wildlife.

Relevant conservation plans include:

- Nature Conservation (Whales and Dolphins) Conservation Plan 1997;
- Nature Conservation (Dugong) Conservation Plan 1999; and
- Recovery Plan for Marine Turtles in Australia 2003 (National/State).

Declared management intent also includes general measures described in the *Nature Conservation (Wildlife) Regulations* as “proposed” management intent. These include:

- As a priority, to put into effect recovery plans or conservation plans for the wildlife and its habitat; and
- To monitor and review the adequacy of environmental impact assessment procedures to ensure that they take into account the need to accurately assess the extent of the impact on endangered wildlife and develop effective mitigation measures.

3. Literature and Database Reviews

3.1 Overview

A desktop assessment of the known marine fauna values of the Project Area was conducted using Federal and State government online resources and Queensland Museum database requests. Searches undertaken included:

- The Commonwealth Department of the Environment, Water, Heritage and the Arts' (DEWHA) Protected Matters Search Tool for EPBC Act protected species for the area from: -23.7640, 151.1528, to -23.8891, 151.3730, with a 10 km buffer;
- The Queensland Department of Environment and Resource Management (DERM) Wildlife Online database for the area bounded by latitude 23.770077 South and longitude 151.142021 East with a 5 km buffer; and
- Queensland Museum vertebrate fauna database for records of marine species collected from the area bounded by latitude $25^0$10'00" to $23^0$30'00" South, and longitude $150^0$50'00" to $151^0$40'00" East.

In addition, published sources of information were reviewed to determine the known habitat requirements of rare and threatened species predicted to be in or adjacent to the Project Area.

A search of the Commonwealth EPBC Protected Matters online search tool revealed 75 listed marine fauna species (including ray-finned fishes) that occur or have the potential to occur in proximity to the Project Area (see Appendix A). Table 1 lists key threatened marine, migratory marine species and listed cetaceans and their current conservation status with respect to State (NCA) and National (EPBC) legislation and international status from the World Conservation Union (IUCN), and the likelihood of occurrence within the Project Area, as identified in the online search. These species are considered highly vulnerable to impacts as they are long-lived, slow-growing and have a low rate of fecundity. For each of these species, their ecology, distribution and population potentially affected by the Project is summarised in Appendix A. Key species are discussed in greater detail in this report. Table 1 does not suggest that species not identified to occur in this region by the online assessment do not occur within the immediate Project footprint or waters adjacent to the Project Area. Other key species not identified by the online searches have been observed whilst on survey and are discussed in this report.

Table 1 Listed Marine Fauna Potentially Found within the Project Area

Scientific Name	Common Name	EPBC	NCA	IUCN (World Conservation Union)[1]	Likely Occurrence within the Project Area
Threatened marine species					
Megaptera novaeangliae	Humpback whale	Vulnerable, Migratory (Bonn), Cetacean	Vulnerable	Least Concern	Possible
Balaenoptera musculus	Blue Whale	Endangered; Migratory (Bonn), Cetacean		Endangered	Unlikely

Scientific Name	Common Name	EPBC	NCA	IUCN (World Conservation Union)[1]	Likely Occurrence within the Project Area
Threatened marine reptiles					
Natator depressus	Flatback turtle	Vulnerable, Migratory (Bonn), Marine	Vulnerable	Data Deficient	Possible
Chelonia mydas	Green turtle	Vulnerable, Migratory (Bonn), Marine	Vulnerable	Endangered	Possible
Caretta caretta	Loggerhead turtle	Endangered, Migratory (Bonn), Marine	Endangered	Endangered	Possible
Lepidochelys olivacea	Olive ridley turtle	Endangered, Migratory (Bonn), Marine	Endangered	Vulnerable	Possible
Dermochelys coriacea	Leatherback turtle	Vulnerable, Migratory (Bonn), Marine	Endangered	Critically Endangered	Unlikely
Threatened sharks					
Pristis zijsron	Green sawfish	Vulnerable		Critically Endangered	Unlikely
Rhincodon typus	Whale shark	Vulnerable, Migratory (Bonn)		Vulnerable	Unlikely
Migratory marine mammals (not yet listed in this table)					
Balaenoptera edeni	Bryde's whale	Migratory (Bonn), Cetacean		Data Deficient	Unlikely
Orcaella heinsohni	Australian snubfin dolphin	Migratory (Bonn), Cetacean	Rare	Near Threatened	Likely
Orcinus orca	Killer whale	Migratory (Bonn), Cetacean		Data Deficient	Unlikely
Dugong dugon	Dugong	Migratory, Marine	Vulnerable	Vulnerable	Likely
Migratory Marine Reptiles					
Crocodylus porosus	Estuarine crocodile	Migratory (Bonn), Marine	Vulnerable	Lower Risk/least concern	Possible

Scientific Name	Common Name	EPBC	NCA	IUCN (World Conservation Union)[1]	Likely Occurrence within the Project Area
Listed Cetaceans					
Balaenoptera acutorostrata	Minke whale	Cetacean		Least Concern	Unlikely
Stenella attenuata	Spotted dolphin	Cetacean		Least Concern	Unlikely
Tursiops aduncus	Indian Ocean bottlenose dolphin	Cetacean		Data Deficient	Possible

[1] IUCN Red List categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Lower Risk, Data Deficient (Source: 2002 IUCN Red List of Threatened Animals).

As noted, the key species addressed in this report are marine turtles, dugong, and dolphins. These species have been both identified by the available government and museum databases and also observed to occur within the Project Area.

3.2 Coastal Environment of Western Basin, Gladstone

The Western Basin Dredging and Disposal Project is within the Great Barrier Reef World Heritage Area (GBRWHA) and is adjacent to the Great Barrier Reef Marine Park (GBRMP), Central Queensland. The Gladstone region has extensive industry spanning the coastline north and south of Port Curtis as well as within the area adjacent to the Project. More industry is proposed for development adjacent to the Project Area in coming years (refer cumulative impacts Section 8).

The marine environment within the Survey Area is characterised by a heterogenous habitat matrix of soft-sediment, rocky reef, coral, seagrass and algae with highly variably water depths partitioned by islands and channels. Given the significance of industry to the Gladstone region, the waters of Port Curtis are subject to high volumes of vessel traffic and coastal infrastructure. The Project Area of Western Basin is a relatively shallow embayment and is predominantly protected by Curtis and Facing Islands to the south east. To the north of the Project Area, the marine environment contracts to form a system of creeks, mud flats and mangrove habitats, and is known as The Narrows (Figure 1). The channels within the Survey Area, adjacent to the Project Area, are relatively deep (to approximately 20 m) but narrow, being buffered by steep channel edges and shallow soft sediment habitats. The diverse marine environment surrounding the Project Area is effectively the entrance to The Narrows, contributing to the dynamic ecology and distribution of species within Port Curtis.

Despite the high turbidity and sediment loads within the Project Area, seagrass occurs throughout most of Western Basin at densities which vary seasonally and between years (Rasheed *et al*. 2008, Chartrand *et al*. 2009). The extensive seagrass beds provide a direct and indirect foraging habitat for numerous key marine fauna species discussed further in the GHD Marine Ecology Report (this EIS). The waters within Port Curtis provide a habitat which has been frequently observed to support a resident marine turtle population and, dugong and dolphin species on a semi-permanent basis (I. Bell, pers. comm. 2009).

3.3 Cetaceans

3.3.1 Overview

The GBRWHA supports critical habitats for listed and threatened marine species as well as soft-sediment benthic communities, seagrass beds and coral reefs of global significance. Coastal dolphin species, Indo-Pacific humpback dolphins (*Sousa chinensis*) and Australian snubfin dolphins (*Orcaella heinsohni*) share a similar coastal niche and have been identified in Stranding Database records from Gladstone (Greenland and Limpus 2007). Aerial and boat-based surveys indicate that Australian snubfin dolphins occur mostly in protected shallow waters close to the coast, and close to river and creek mouths (Parra 2006; Parra & Corkeron 2001; Parra *et al.* 2002a.)

Coastal dolphins are among the most threatened species of cetaceans due to their close proximity to anthropogenic activities (Thompson *et al*. 2000; DeMaster *et al*. 2001). Dolphins have life history characteristics that render them vulnerable to threatening processes. These include long life spans, late maturity, low reproduction rates, low fecundity, and long parental care. These characteristics result in slow rates of population growth and vulnerability to rapid population declines (Taylor 2002). The shallow waters, seagrass beds, coral reefs and the creeks that characterise the Survey Area have previously been identified for other regions as important habitats for these species (Parra *et al*. 2006).The potential loss or reduction in quality of these environments may, therefore, have a negative impact on local populations of these species.

The Australian snubfin dolphin was only recently described as a new species, previously thought to be *Orcaella brevirostris*, and is the only cetacean endemic to northern Australian/Papua New Guinean waters (Beasley *et al*. 2005). Recent genetic studies on Indo-Pacific humpback dolphins indicate Australian populations may also represent a different species only found in Australia (Frère, 2008). As previously noted, snubfin and Indo-Pacific humpback dolphins are listed as Rare under the *Queensland Nature Conservation Act 1992* and are classified as Near Threatened by the IUCN (Reeves, 2008). Thus, Australian snubfin and humpback dolphins have extremely high biodiversity and conservation value at a national and international level.

The Gladstone region is a steadily growing coastal area in central Queensland with an average annual growth rate of 2.3% projected for the next 15 years (www.localgovernment.qld.gov.au). In this region, snubfin and humpback dolphins are already exposed to a heavily modified habitat due to expansive coastal industry. Any activity that has the potential to adversely impact local populations of these marine mammals should be evaluated carefully to ensure appropriate management.

Current threats include habitat degradation and loss due to coastal zone development, pollution, vessel traffic, overfishing of prey resources, and an increase in pathogen pollution (Marsh *et al*. 1999; Marsh *et al*. 2002; Parra *et al*. 2002; Marsh *et al*. 2003; Parra *et al*. 2004; Marsh *et al*. 2005; Parra *et al*. 2006).

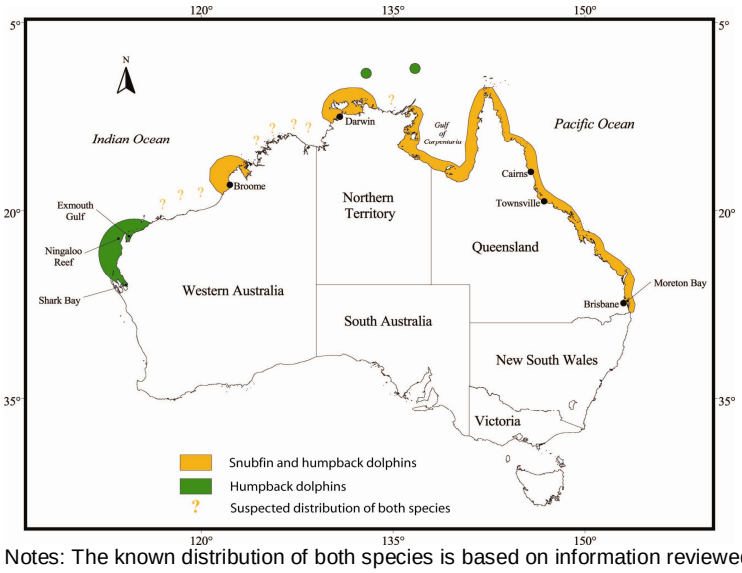
3.3.2 Distribution and abundance

Stranding (refer Figure 3)and observational data indicate snubfin and Indo-Pacific humpback dolphins are found throughout coastal waters of Queensland, Northern Territory and Western Australia (Figure 4). Snubfin dolphins have been recorded from Broome in Western Australia, along the northern coastline near Darwin and the Gulf of Carpentaria, and off the eastern coast as far south as the Brisbane River (Stacey and Arnold 1999). Recent surveys conducted in the far northern section of the Great Barrier Reef Marine Park showed that most sightings of Indo-Pacific humpback dolphins occurred

in waters less than 5 km from land, 20 km from the nearest river mouth, and in waters less than 15 m deep (Parra *et al.* 2006).

Indo-Pacific humpback dolphins have a similar range, extending from approximately the Queensland - New South Wales border in the east to Shark Bay in Western Australia (Preen 1995; Corkeron *et al*. 1997). Off the east and northern coast of Queensland the distribution of both species appears to be continuous, with the range of Indo-Pacific humpback dolphins extending further southeast into Moreton Bay. Snubfin dolphins have rarely been sighted further south than Gladstone.

Figure 3 Stranded Australian Snubfin Dolphin in Gladstone, 2007



Notes: The known distribution of both species is based on information reviewed in Parra *et al*. (2002; 2004). Question marks indicate areas of probable, but unconfirmed, distribution

Figure 4 Distribution of Snubfin and Humpback Dolphins in Australian Waters

The information available for Cleveland Bay, Townsville, indicates that Australian snubfin dolphins are not permanent residents in Cleveland Bay, but use the area regularly from year to year following a model of emigration and re-immigration. Individuals spend periods of days to a month or more in coastal waters of Cleveland Bay before leaving, and periods of over a month outside the study area before re-entering the Bay again. Due to a lack of data for the region, such movement patterns are not known for the Gladstone region at present though the dolphins are likely present in the bay periodically. Home

ranges and/or territories for this species appear to be large, as many of the identified individuals spent less than 30 days within the 310 km² Cleveland Bay study area (Parra 2006).

Migratory species are inherently difficult to survey and develop population estimates for. There are no current estimates of population sizes or trends for Australian snubfin and humpback dolphins at a national level. Estimates of population size are, however, available for Cleveland Bay, Moreton Bay, and have recently been developed for the Great Sandy Straits/Hervey Bay, Queensland.

Estimates of population size for both species in the Cleveland Bay and for Indo-Pacific humpback dolphins in The Sandy Straits are considerably small, numbering only 67 snubfin (95% CI = 51-88) dolphins and 54 humpback (95% CI = 38-77) dolphins in 2002 for Cleveland Bay (Parra *et al*. 2006). The Sandy Straits/Hervey Bay population has been suggested as the largest humpback dolphin population in Australia. Two communities have been identified in this region; a northern community numbering 72 (95% CI = 68- 81) and southern community numbering 55 (95% CI = 50-69) and they are believed to have little mixing (Cagnazzi *in review*), rendering them vulnerable to local impacts. Such small populations are more prone to local extinction than large stable populations due to a loss of genetic variability and environmental and demographic stochasticity (Caughley and Gunn 1996). Determination of the level of philopatry (fidelity to area of birth) in this species is important, as the impact of the loss of reproductive females from such groups is potentially greater than that for species with greater population interactions and migration (Ross 2006).

Population viability analysis of well known coastal dolphin species (i.e. bottlenose dolphin, *Tursiops truncatus*, and Hector's dolphin, *Cephalorhynchus hectori*) indicate that populations of less than a hundred animals face very high extinction probabilities (Thompson *et al*. 2000; Burkhart and Slooten 2003). Hence, given the existing very small populations, even small decreases in population size (e.g. 5% decline per year) have the potential to lead to local extinction of snubfin and Indo-Pacific humpback dolphins (Parra *et al*. 2006).

3.3.3 Habitat Use

Australian snubfin and humpback dolphins are typically associated with shallow, coastal and estuarine waters. Most schools of snubfin dolphins recorded during opportunistic aerial surveys of dugongs (*Dugong dugon*) along the Great Barrier Reef Region east coast of Queensland were seen within 10 km from the nearest point of land, in waters less than 10 m deep, and within 10 km from the nearest river mouth (Parra *et al*. 2002). Similarly, sightings of Indo-Pacific humpback dolphins in the same region occurred mainly in waters within 10 km from the nearest coast and shallow areas (i.e., areas less than 2 m deep at low tide, Corkeron *et al*. 1997). Indo-Pacific humpback dolphins display no apparent preference for clear or turbid waters, and have been reported in a variety of coastal habitats, from coastal lagoons and enclosed bays with mangrove forests and seagrass beds through to open coastal waters with rock and/or coral reefs. Although the choice of key habitats varies between different geographic regions, the choice of habitat is well defined and persistent at each location (Jefferson and Karczmarski 2001).

Snubfin and humpback dolphins studied extensively in other coastal areas, such as Townsville and the Great Sandy Straits, are present year round with no significant seasonal differences (Parra *et al* 2006, Cagnazzi *in review*). Calves and/or juveniles are also seen year round within Cleveland Bay, Townsville. Research to date suggests most individual dolphins do not reside permanently in these coastal locations but humpback dolphins undergo transient, short term and long term occupations with

these areas, using the coastal waters extensively from year to year following a model of emigration and reimmigration (Parra *et al*. 2006). A preference for creek and river mouths has been observed as well as association with dredged channels and breakwaters close (Parra 2006).

Indo-Pacific humpback dolphins are thought to be opportunist-generalist feeders, eating a wide variety of coastal and estuarine-associated fishes, although reef, littoral and demersal fish species are taken. Teleosts, some cephalopods and crustaceans have also been recorded as prey. These dolphins have been recorded feeding in association with prawn trawlers in Moreton Bay and Gladstone Harbour and presumably elsewhere throughout the species' range in Australia (Bannister *et al*. 1996; Ross *et al.* 1994, Groom pers. obs 2009). Australian snubfin dolphin prey includes fish of the families Engraulidae, Clupeidae, Chirocentridae, Anguillidae, Hemirhampidae, Leiognathidae, Apogonidae, Pomadasydae, Terapontidae and Sillaginidae (Heinsohn 1979; Marsh *et al.* 1989). These fishes are typically associated with shallow coastal waters and estuaries in tropical regions (Parra *et al.* 2002a). Feeding may occur in a variety of habitats, from mangroves to sandy bottom estuaries and embankments to rock and/or coral reefs. Feeding primarily occurs in shallow waters (<20 m depth) and may incorporate beaching behaviour on sandbanks.

3.4 Dugongs

Conservation Status

The range of the dugong extends from east Africa to Vanuatu between the latitudes of about 27^{o} north and south of the equator. Dugongs are classified as “vulnerable to extinction” at a global scale based on an inferred significant population reduction (www.IUCN.org 2009). Numbers have declined in most countries and territories where dugongs occur such that only relict populations remain separated by large distances (Marsh *et al*. 2002). As a result, the conservation of dugongs in Australian waters is particularly important because the region represents their last remaining stronghold. Their conservation is supported by the World Heritage listing of the GBR which specifically identifies the presence of significant populations of the dugongs as one of the GBRs values (Marsh *et al*. 2003). Under Australia’s *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*, dugongs are a listed migratory and marine species. Queensland’s *Nature Conservation (Wildlife) Regulation 1994* lists dugongs as “vulnerable”. The regulation notes that *the conservation of the habitat of vulnerable wildlife is critical to ensuring the survival of the wildlife* (*Queensland Nature Conservation (Wildlife) Regulation 1994*, p. 48).

Habitat

Dugongs are confined to shallow and protected areas where their primary food source, seagrass, is found (Heinsohn *et al*. 1977; Anderson 1981). Along the urban coast of Queensland dugongs mostly occur in large, northward facing bays (including the Gladstone region) that are sheltered from the prevailing southeast winds, as these bays support the most seagrass along this coastline (Marsh *et al*. 2002). GBRMPA reviewed habitats within the GBRMP for importance to dugong populations which noted the significance of the Gladstone Harbour/Rodds Bay DPA despite being majority within port limits (Dobbs, 2007). As a result of the shallow water environment where most of the seagrass foraging habitat is found, dugongs spend most of their time at water depths of less than 3 m (Chilvers *et al*. 2004; Hodgson 2004), but can occur in water depths up to 37 m (Marsh and Saalfeld 1989; Sheppard *et al*. 2006), and feeding trails have been recorded at depths up to 33 m (Lee Long and Coles 1997). Due to their low metabolic rates, dugongs are generally found in waters warmer than 19°C, although have been observed in temperatures as low as 16°C in Moreton Bay (Anderson 1986; Hodgson 2004). Their

need for warm waters affects their seasonal distribution at the southern limits of their range as outlined in the following section.

Seagrass Habitat in Gladstone

Extensive areas of seagrass communities were located in the 2002 baseline survey along the coastal areas from the Narrows to Rodds Bay in the intertidal to subtidal habitats (<5 m below mean sea level (MSL)). Seagrass occurred on the majority of shallow sand and mud banks in this area but rarely extended far into the subtidal areas off the edge of the banks. These meadows varied in area, biomass, community structure and species dominance (Rasheed *et al.* 2003). No deepwater seagrass meadows occurred in the study area in the baseline 2002 survey, that is, in the inner port areas west of Facing Island. Six large deepwater meadows occurred offshore from Facing Island and around Seal Rocks, West Banks and East Banks (Rasheed *et al.* 2003).

The 2002 surveys identified two meadows in the Western Basin region of the Survey Area. Other meadows were present across the Survey Area (Rasheed *et al.* 2003):

- In Fisherman's Landing Basin there was a large meadow similar in density and composition to the intertidal meadow in Western Basin and this was bounded by a small area of subtidal seagrass;
- Among the Passage Islands, opposite the Project Area;
- Although no seagrass was present within the channel area of The Narrows, the banks were generally lined with seagrass ranging from small subtidal meadows to larger intertidal meadows*;* and
- An extensive intertidal meadow of seagrass was observed on the eastern side of Curtis Island.

The channel, swing basins and berth pockets purported to be dredged for the Project did not contain any seagrass beds in 2002 (Rasheed *et al.* 2008). Of the 13 annually monitored meadows, the only meadows that occurred in the Survey Area included in the monitoring were those in Western Basin; to the south of Fisherman's Landing; and on the eastern side of Curtis Island.

Life History

The life history of dugongs makes them particularly vulnerable to human impacts. They are long-lived with the oldest individual age being estimated at 73 years. (Marsh 1980; Marsh 1995; Marsh 1999). They are also slow to reach sexual maturity; females have their first calf at 6 to 17 years of age, and have long calving intervals of 2.4 to 7 years (Marsh 1995; Kwan 2002). These two factors result in a slow rate of maximum population increase of less than 5% per year. Therefore, like coastal dolphin species, dugong populations are vulnerable to even incremental levels of human-caused mortality. This effect is multiplied when habitat quality (i.e., availability or access to forage) is reduced as dugongs respond by reducing fecundity (Marsh and Kwan 2008). This response was demonstrated in Torres Strait where, during periods of episodic seagrass dieback, female dugongs both delayed their age at first breeding, and significantly reduced their breeding rates (Marsh and Kwan 2008). These responses are typical of long-lived species to adverse environmental conditions (Gaillard *et al*. 2000). This effect emphasises the critical importance of habitat conservation.

Distribution and Abundance

Dugong abundance along the urban coast of Queensland, including the area between Cooktown and the Queensland-New South Wales border, is estimated to have declined significantly since the 1960s. This decline is evident in anecdotal information and records of dugong by-catch from a government shark control program (Marsh *et al*. 2005). By-catch of dugongs in shark control set nets at six locations

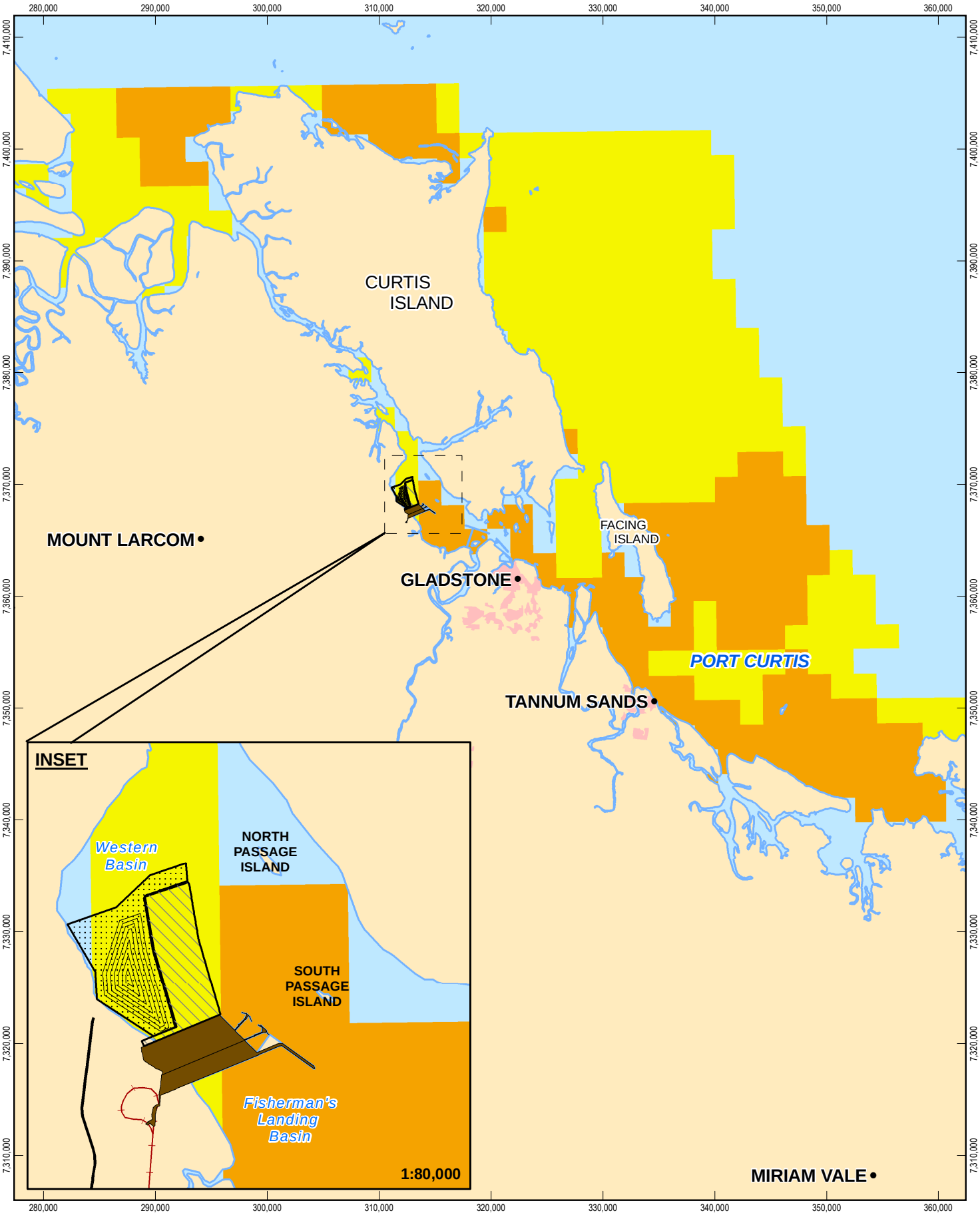
along the urban coastline were used to provide an index of the decline in dugong numbers from all causes in this area. Between 1962 and 1999, the catch rate of dugongs declined by 8.7% per year. If the catch rates are a reliable index of the dugong population, they suggest that by the 1990s the dugong population had declined to 3.1% of the 1960s urban coast population (Marsh *et al*. 2005). Most of this decline occurred in the 1960s and 1970s.

Aerial surveys for dugongs have been conducted regularly since the 1980s along the same urban coastline. Numbers within the Gladstone region have fluctuated between aerial surveys, having declined dramatically in the mid-1990s and then increased in more recent surveys. Movement between regions may at least partly explain these fluctuations, a conclusion that is supported by genetic evidence that dugong populations along the Australian coastline are not highly structured (McDonald 2006) and that individual dugongs have been tracked moving several hundred kilometres (Sheppard *et al*. 2006). The surveys suggest that numbers along this part of the coast have been stable over the last two decades but have not recovered to the levels projected for the mid 1960s. At a finer local scale such as Port Curtis/Rodds Bay, dugong populations fluctuate due to movements between individual bays (Marsh and Lawler 2006).

Dugong Spatial Modelling

Professor Helene Marsh and her research group from James Cook University have undertaken systematic aerial surveys of the GBRWHA approximately every five years between 1986 and 2005 by flying transects across the depth gradient (Marsh and Saalfeld, 1989, 1990; Marsh *et al*., 1993; Marsh *et al*., 1996; Marsh and Lawler, 2001, 2002). Grech and Marsh (2007) use the composite, spatial information on dugong distribution and relative abundance from these surveys to develop a spatially explicit dugong population model. By using the time series of data collected over 19 years, the model accounts for temporal changes in the use of various regions by dugongs including movements resulting from events such as seagrass dieback (Marsh and Kwan, *in press*). Grech and Marsh's (2007) model maps the relative density of dugongs across the GBRWHA at the scale of 4 km^2 dugong management units (cells), the spatial scale recommended for managers under Criterion B of the International Union for Conservation of Nature and Natural Resources Red List (www.IUCN.org 2009).

Grech and Marsh (2007) classified each dugong management unit as of low, medium, medium-high or high conservation value on the basis of the relative density of dugongs estimated from the model and a frequency analyses. This approach makes the assumption that the model of dugong density developed from the time series of aerial surveys is a robust index of a region's conservation value for dugongs. This assumption is justified because: (1) specialised areas of high conservation value such as calving or mating areas and migratory corridors have not been identified; and (2) density estimates are regarded as robust surrogates of habitat utilisation (Hooker and Gerber, 2004). Figure 5 shows the dugong population model for the Southern GBR. Areas around Gladstone have been identified as low to medium in dugong conservation value. To the north of Gladstone at Shoalwater Bay, the value of habitat increases substantially to an area of predominantly medium – high, with substantial patches of high conservation habitat. Both of these areas have also been recognised by GBRMPA as important dugong habitats as part of their representative areas program (Dobbs, 2007).



LEGEND

- Western Basin Reclamation Footprint
- Fisherman's Landing Northern Expansion
- FishermansLandingExistingReclamation
- Land Mass

Dugong Relative Density

- Low Dugong Conservation Value
- Medium Dugong Conservation Value
- Medium to High Dugong Conservation Value
- High Dugong Conservation Value

1:450,000 (at A4)

0 2.5 5 7.5 10 12.5

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Gladstone Ports Corporation
Western Basin Reclamation EIS

Job Number 42-15386
Revision A
Date 04 Aug 2009

Spatially Explicit Dugong Population Model for the Southern Great Barrier Reef

Figure 5

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Level 4 201 Charlotte Street Brisbane QLD 4000 Australia T +61 7 3316 4496 F +61 7 3316 333 E bnemail@ghd.com.au W www.ghd.com.au

Data source: Dugong Relative Density - GHD (2009); Reclamation Areas - ©The State of QLD (Gladstone Ports Corporation) 2009; DCDB (Feb 2009) - ©The State of Queensland (Department of Environment and Resource Management). Created by: KD

Movements

Dugongs exhibit movements between habitats at several spatial scales. Large scale movements likely occur as a result of episodic loss of seagrass from events such as cyclones, floods and sedimentation (Preen and Marsh 1995; Marsh *et al*. 2003; Gales *et al*. 2004; Marsh *et al*. 2004). At the scale of the individual, there is considerable variation in dugong movement patterns, with the home ranges of dugongs varying from 0.5 to 733 km^2 (Marsh and Rathbun 1990; Preen 1992; de Longh *et al*. 1998; Sheppard *et al*. 2006). Some satellite tracked dugongs moved no more than 15 km from where they were caught and tagged, while others exhibited "mesoscale" local movements between seagrass patches (15 – 100 km) or "macroscale" ranging movements (> 100 km) (Sheppard *et al*. 2006). Macroscale movements are between habitat areas and sometimes include "return trips" suggesting spatial memory of known habitat areas. The variation in the scale of movements observed among individual dugongs may be explained by variations and changes in seagrass quality, where animals respond to large scale seagrass loss by either remaining in the area or moving to find seagrass elsewhere (Preen and Marsh 1995; Marsh *et al*. 2004). Aerial surveys conducted over a series of years provide further evidence of large scale movements as numbers fluctuate throughout the Torres Strait, Queensland, Northern Territory and Western Australia (Marsh *et al*. 1996; Marsh *et al*. 1997; Marsh and Lawler 2001; Marsh *et al*. 2003; Gales *et al*. 2004; Marsh *et al*. 2004; Marsh and Lawler 2006; Marsh *et al*. 2007).

Mesoscale movements appear to often occur in response to water temperatures at the southern reaches of the dugongs' range. In Hervey Bay, satellite tagged dugongs made return trips across the Bay during winter to warm oceanic waters despite a lack of seagrass and the presence of large numbers of sharks in these waters (Sheppard *et al*. 2006). In Moreton Bay in winter, dugongs appear to move regularly between the preferred seagrass foraging habitat inside the bay, to deeper water 15 km outside the bay where water temperatures can be up to 5˚C higher than inside the bay (Preen 1992). Some local scale movements of dugongs also coincide with tidal movements in areas where dugongs are dependent on seagrass growing in intertidal and shallow sub-tidal areas (Heinsohn *et al*. 1977; Anderson and Birtles 1978; Marsh and Rathbun 1990; Sheppard *et al*. 2006). Given the extent of subtidal seagrass communities in Western Basin, it is likely that these are accessed on high tides. The movements in response to water temperatures and accessibility to seagrass are not known for dugongs in the Rodds Bay/Port Curtis region at present. It is likely that dugong movements respond to seasonal changes of contraction in winter and expansion in summer for subtidal seagrass standing crop in the Port Curtis area (Chartrand *et al* 2009).

Aerial surveys conducted to date do not provide data at a scale suitable for assessing dugongs' use of the proposed Project Area. However, the spatial model developed by interpolating the aerial survey data suggests that the development site contains low to medium dugong densities (Figure 5) and habitat of low rather than zero conservation value (Grech and Marsh 2007). Thus dugongs are predicted to use the development site and the potential impact of industry practice within this area on dugongs cannot be disregarded.

The loss or reduction in quality of any areas of conservation value to dugongs may potentially have a negative impact on the Rodds Bay/Gladstone population. The spatial model of dugong population density suggests all of Rodds Bay and adjacent waters is of some conservation importance to dugongs, this is affirmed by the delineation of the Dugong Protection Area within the region and importance of other regional habitats, such as Shoalwater Bay.

3.5 Marine Turtles

Of the world's seven species of marine turtles, six are found in the waters of the Queensland and potentially in the Port Curtis – Gladstone region. These species include green, flatback, hawksbill, olive ridley, loggerhead and leatherback turtles. Of these six species, the green, loggerhead, hawksbill and flatback have internationally significant populations in Queensland (Table 2). Marine turtles undertake extensive migrations up to 2600 km between nesting beaches and feeding areas, but repeatedly return to the same feeding and nesting areas throughout their lives (Limpus and Chatto, 2004). Such migrations and behaviours pose a complex arrangement for managers as various jurisdictional boundaries are crossed.

Kenchington (1990) articulated the complexities of managing turtle populations in the Great Barrier Reef Marine Park. They hatch from nests on land under Queensland jurisdiction, move to the sea across the intertidal areas under state jurisdiction, cross the low water mark to enter Commonwealth jurisdiction, and then move on to feed and grow for years in international waters. Eventually they return to the Great Barrier Reef to mate in areas under Commonwealth jurisdiction and for females to lay eggs on Queensland territory (www.gbrmpa.gov.au, 2009).

Table 2 Conservation Status of Marine Turtles Identified as Occurring or Potentially Occurring in the Project Area

Common Name	Scientific Name	Commonwealth *EPBC Act 1999*[2]	Queensland *NC (Wildlife) Regulation 1994*[3]	IUCN (World Conservation Union)[1]
Family: Chelonidae				
Loggerhead	*Caretta caretta*	Endangered, Migratory, Listed Marine	Endangered	Endangered
Green	*Chelonia mydas*	Vulnerable, Migratory, Listed Marine	Vulnerable	Endangered
Hawksbill	*Eretmochelys imbricata*	Vulnerable, Migratory, Listed Marine	Vulnerable	Critically Endangered
Flatback	*Natator depressus*	Vulnerable, Migratory, Listed Marine	Vulnerable	Data deficient
Olive ridley	*Lepidochelys olivacea*	Endangered, Migratory, Listed Marine	Endangered	Endangered

Common Name	Scientific Name	Commonwealth *EPBC Act 1999*[2]	Queensland *NC (Wildlife) Regulation 1994*[3]	IUCN (World Conservation Union)[1]
Family: Dermochelidae				
Leatherback	*Dermochelys coriacea*	Vulnerable, Migratory, Listed Marine	Endangered	Endangered

[1] IUCN Red List categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Lower Risk, Data Deficient (Source: www.iucn.org).

[2] Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Lower Risk, Data Deficient.[3] Queensland *Nature Conservation (Wildlife) Regulation 1994* schedules: Presumed Extinct, Endangered, Vulnerable, Rare, Common.

Different species of marine turtles share the same general life cycle in that they are all slow growing, taking decades to reach sexual maturity: 20 - 25 years for flatback and loggerhead turtles, 30 - 50 years for green turtles (Limpus and Chaloupka, 1997). Mature females do not breed every year and have non-breeding periods of between 5-8 years for green turtles and 2 - 3 years for flatback turtles (Parmenter and Limpus, 1995). These characteristics have implications where a high annual survivorship of adults and sub-adults is required for populations to remain viable. The long lifespan of marine turtles means that it is difficult to detect impacts over a few years given that most studies do not cover a single generation with impacts more likely to become evident over a period of decades (Limpus and Chatto, 2004).

In Queensland, marine turtles breed at a limited number of nesting sites with varying density. Individual females return at intervals to nest at beaches in the same area in which they were born. The Port Curtis/Gladstone region represents a medium density nesting site for flatback turtles and a low density nesting habitat for green turtles (Limpus *et al* 2006). Department of the Environment and Resource Management (2009) have identified south east Curtis Island, the seaward coastline of Facing Island and the coastal beaches of Tannum Sands as nesting habitat for marine turtles.

Critical nesting beaches monitored between far northern to southern Queensland, as they are considered as index beaches for turtle populations, include:

- Milman Island in the far northern GBR which is an internationally significant hawksbill turtle nesting beach;
- Raine and Heron Island which are both internationally significant green turtle nesting beaches;
- Peak and Crab Island which are major flatback turtle nesting site; and
- Wreck Island, a major loggerhead nesting site.

Inter-nesting and Foraging Habitat

Nesting female turtles generally do not feed during the breeding season (Limpus 1973; Tucker and Read 2001); however they use water depths up to 40 metres during the inter-nesting period (Bell 2005) and habitat up to tens of kilometres from the nesting beach (Tucker *et al.* 1996, Sperling 2007). Some species (for example, loggerhead turtles) appear to show quite strong fidelity to inter-nesting habitats

(Limpus and Reed 1985; Tucker *et al.* 1996), where as other species may be less tied to one specific location (for example, green turtles Carr *et al.* 1974; Meylan 1982).

As noted above, flatback turtles have been recorded to enter the Gladstone Harbour area during internesting periods. This area has been specifically identified as an area of high priority for green turtles within the GBRWHA by GBRMPA (Table 3). Adjacent habitat regions also of high priority in the Mackay/Capricorn region include Shoalwater Bay to Corio Bay and the Capricorn Bunker Islands.

Table 3 Marine Turtle Foraging Habitats identified as High Priority in the GBRWHA

Location	Area	per cent outside Marine Park*	Management Area	Species by genetic stock (where relevant)
Hedge Reef to Howick Group	2768.3	0	Far Northern	Hawksbill, Northern Great Barrier Reef green turtle
Hinchinbrook to Cape Bowling Green	2860.2	12.6	Townsville / Whitsunday	Southern Great Barrier Reef green turtle
Upstart Bay to Midge Point	765.9	7.1	Townsville / Whitsunday	Southern Great Barrier Reef green turtle
Shoalwater Bay to Corio Bay	1314.4	0	Mackay / Capricorn	Southern Great Barrier Reef green turtle
Gladstone Harbour**	239.2	100	Mackay / Capricorn	Southern Great Barrier Reef green turtle
Capricorn Bunker Group	1533.3	8.9	Mackay / Capricorn	Loggerhead, Southern Great Barrier Reef green, hawksbill turtle
Hydrographers Passage to Swains	33516.6	0	Townsville / Whitsunday and Mackay / Capricorn	Loggerhead, Southern Great Barrier Reef green turtle

*Includes waters such as those managed by Ports. The value does not include Hinchinbrook Channel and does not include State and Commonwealth Islands.
**Note, because this entire site is outside the Great Barrier Reef Marine Park it is not considered further in this analysis.

Source: Dobbs (2007)

3.6 Marine Turtles in the Gladstone Region

Curtis Island is recognised as a consistent medium density (Limpus *et al* 2006) nesting area for flatback turtles along the Queensland coast and low density nesting occurs by green turtles (Figure 6),. Gladstone Harbour and Rodds Bay are recognised as important foraging habitat for marine turtles (Dobbs 2007). In a regional context, the Capricorn Bunker Section of the Great Barrier Reef is an important feeding habitat where green turtles graze on the seagrass beds and flatback and loggerhead turtles forage for invertebrates (pers comm. I. Bell, Dobbs 2007). Green turtles primarily feed on seagrass and as such, they have a predicted high association with seagrass beds and prevalence in this region.

Given the urbanisation of the Gladstone coastline, marine turtles using the area are subject to numerous impacts such as habitat degradation and removal, vessel strike, marine pollution, among others. Theses are discussed in detail in Sections 6, 7, 8 and 9. Dredged channels also provide resting habitats for turtles (when they are not undergoing maintenance dredging). Of particular relevance to the Project is that medium density flatback turtle nesting occurs within the Gladstone region (Curtis, Wild

Duck and Peak Islands) (Limpus 1971; Limpus *et al.* 1981, 1983b, Limpus 2007). These islands are surveyed annually by the Queensland Turtle Conservation Project, with support from the Gladstone Port Corporation and data exists dating back to the 1970s. Scattered aperiodic nesting for flatback turtles occurs on mainland and inshore islands between Townsville and Torres Strait.

The Southern end of Curtis Island is considered as a nesting index beach for monitoring. In the 2005 - 2006 nesting survey, a moderate sized population was recorded with 51 nesting females noted during a two week nesting peak in late November – early December.

These flatback turtle nesting populations continue to indicate that the eastern Australian flatback turtle stock has had a stable breeding population over the past 36 years – spanning about one generation for this species. The Curtis Island flatback turtle nesting population has maintained an approximately constant size for the females over the 35 years since monitoring of the nesting females began in 1969. This constancy in size of the nesting females is consistent with the wider population not being subjected to excessive differential mortality that skews the population structure towards either reduced recruitment of new adults to the population or reduced survivorship of adults.

Recent research on Curtis Island nesting flatback turtles (Sperling 2007) suggests that inter-nesting females enter Gladstone harbour. These flatback turtles demonstrated dive periods up to 98 minutes with a mean dive time of 50 minutes. This mean dive time for flatback turtles is approximately twice as long as commonly seen in loggerheads and other large sea turtles, while comparable to the smaller olive ridley (*Lepidochelys olivacea)* and hawksbill turtle (*Eretmochelys imbricata*).

Foxes continue to be a significant predator of turtle eggs on Curtis Island. However, the fox baiting program along the Woongarra Coast has effectively reduced the loss of eggs to foxes to zero for this portion of the coast. The plastic mesh fox exclusion devices (FEDs) were effective in preventing predation of incubating turtle eggs in natural nests on Curtis Island. The flatback turtle has been well surveyed for its nesting distribution but not for its foraging distribution within the Gladstone region.

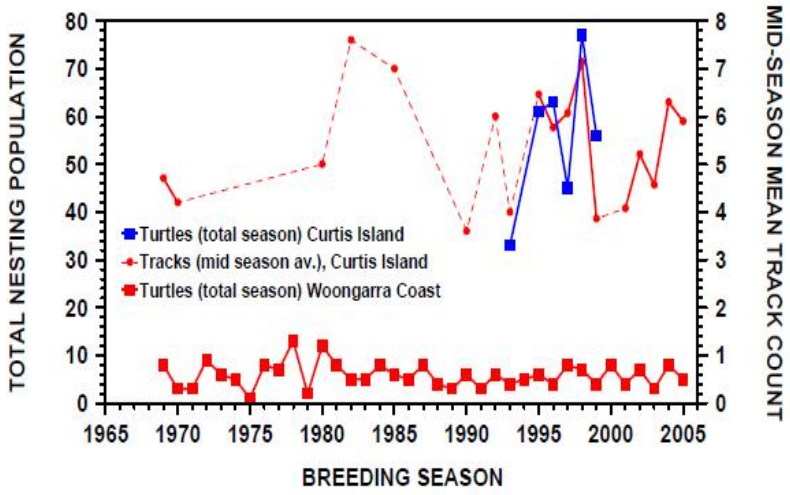


Figure 6 Marine Turtle Nesting Frequency for Curtis Island and Woongarra Coast, 1965 – 2005

3.6.1 Flatback Turtle (*Natator depressus*)

The flatback turtle is endemic to waters of northern Australia, Papua New Guinea and West Papua. Unlike all other marine turtles, the flatback turtle does not have a global distribution, and is largely restricted to Australian continental shelf waters (Limpus and Chatto, 2004) (Figure 9). In Queensland, the flatback turtle is relatively widespread, with major nesting sites occurring in Cape York, central and southern Queensland (Figure 7).

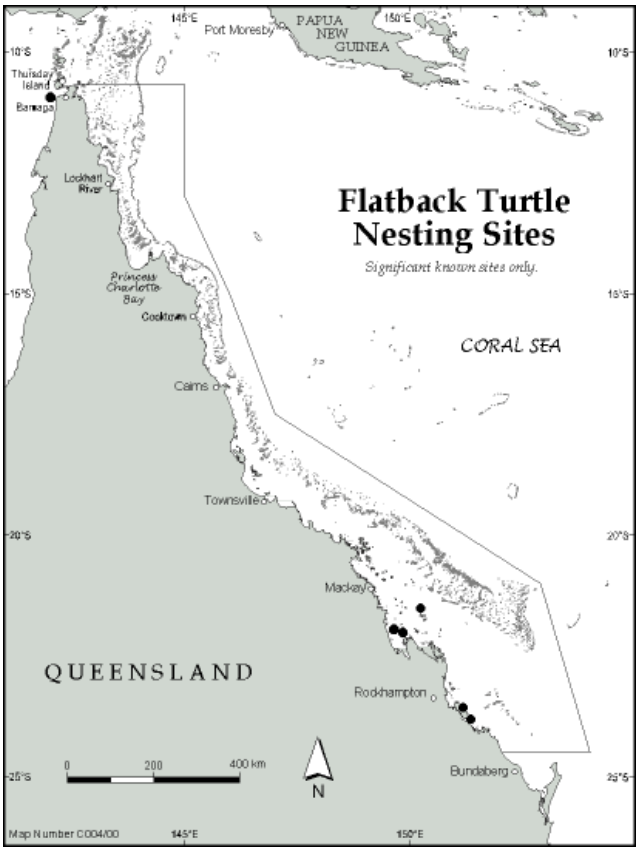
Eastern Australian nesting flatback turtles continue to display a high fidelity to specific nesting beaches with each turtle returning to lay successive clutches of eggs at the same beach, both within and between nesting seasons. Most females returned to nest on a two year remigration interval between breeding seasons and on a 12 - 14 day renesting interval within a breeding season. Little foraging information is available for flatback turtles with most data from fishery bycatch in the East Coast Trawl Fishery (Robins 1995).

In the Gulf of Carpentaria the species nesting distribution (not foraging distribution) has had some investigation though not to the extent of east coast Australian turtles (Chatto 1998; Hamann *et al.* 2006). QPWS, in cooperation with Traditional Owner groups, currently monitor the nesting beaches on the western Cape York. If continued, these surveys will provide valuable information on lesser known rookeries and populations. Overall, few data exist for the Gulf of Carpentaria population and population sizes and trends are thus unknown. Regardless, Limpus (2007) regards the Gulf of Carpentaria population to be in the early stages of decline (based on current and predicted level of threat).

In the Northern Territory (Cape Arnhem to the Bonepart Gulf (Western Australia)) the species has been well investigated, using both aerial and vehicle surveys, for its nesting distribution but not for its foraging distribution (Chatto 1998; Chatto and Baker 2008; Hamann *et al.* 2006; Schauble *et al*. 2006). Two index sites for the Northern Territory genetic stock have been surveyed to various degrees since the mid 1990s; Bare Sand (Guinea 1998) and Field Island (Schauble *et al.* 2006).

This species undertakes large reproductive migratory movements within continental shelf waters (Figure 9). Unlike other marine turtle species, hatchling and juvenile flatback turtles do not disperse in oceanic waters, but rather remain in pelagic coastal environments. At the southern extent of its Australian range, nesting peaks in November - December whilst in northern Australia nesting is more common between June and August. Nesting takes place on sandy beaches, with an average clutch size of 50 eggs (the least of all marine turtles). Flatback turtles forage in shallow continental shelf waters featuring soft-substrate benthos. A carnivorous species, the flatback turtle is known to consume jellyfish, sea cucumbers, soft corals, molluscs and squid, although more robust information on the dietary preferences of this species is lacking (DEWHA 2008b; EPA 2007a).

There are no estimates of population size for the flatback turtle. However, they are currently being calculated as part of the IUCN Red List Assessment process. This process was due to be completed mid 2008.

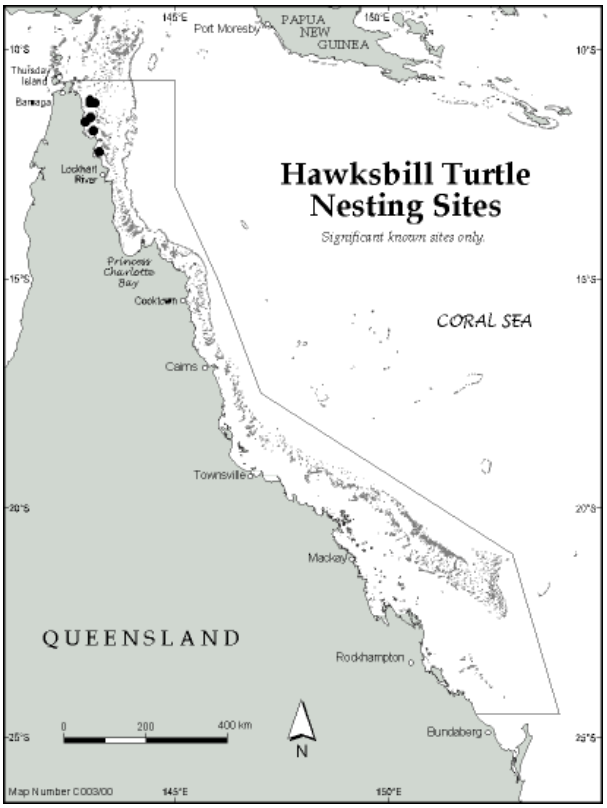


Source: GBRMPA website, 2009

Figure 7 Significant Flatback Turtle Nesting Sites in Queensland

3.6.2 Hawksbill Turtle (*Eretmochelys imbricata*)

The hawksbill turtle occurs throughout the world's oceans, from equatorial to temperate waters. Whilst foraging takes place over a wide latitudinal gradient, nesting is restricted to beaches in tropical areas. The hawksbill turtle is found in waters from southern Queensland to approximately the same latitude on the Western Australian coast. Two breeding populations occur in Australia, with nesting for the eastern population taking place in the northern Great Barrier Reef/Torres Strait and Arnhem Land (DEWHA 2008f). Within the Great Barrier Reef region, hawksbill turtle nesting areas are only found north of Princess Charlotte Bay and in the Torres Strait (Figure 8). The only nesting population for which there is sufficient information is at Milman Island, where data indicates a decline in the number of nesting females of about 3% per year.

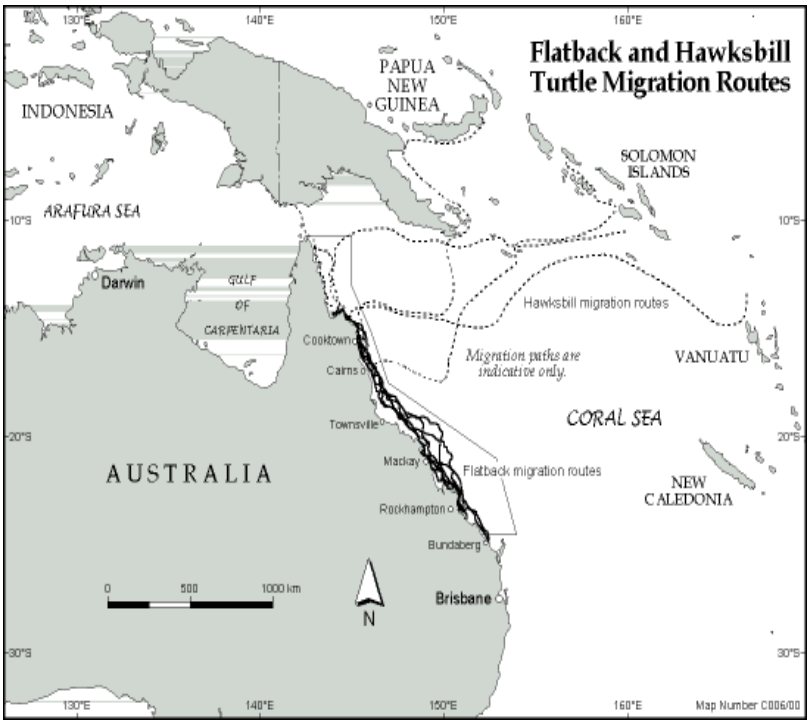


Source: GBRMPA website, 2009

Figure 8 Significant Hawksbill Turtle Nesting Sites within Queensland

The GBR supports one of the largest breeding populations of hawksbill turtles in the world, with an estimated 6000 - 8000 females nesting throughout the region each year (GBRMPA, 2009). Globally, the hawksbill turtle has suffered dramatic declines, with the current population representing only 20% of the population 100 years ago. Declines in the Australian population have been observed, as have decreases in the size of nesting females, and the proportion of hatchlings emerging from nests. Nesting in northern Queensland occurs between January and April, following long migrations from foraging grounds. Females may lay up to six clutches of approximately 122 eggs per season, although nesting only occurs every 2 to 4 years in this species (DEWHA 2008f; EPA 2007e).

This species is heavily reliant on reef and rocky habitats, where foraging for its major food source of sponges is concentrated. Other items consumed by this omnivorous species include seagrass, algae, cephalopods, gastropods and jellyfish. Following a passive stage of drifting on pelagic ocean currents, hawksbill turtles return to coastal environments at an age of between 5 and 10 years, although sexual maturity is not reached until approximately 30 years (Limpus and Chatto, 2004). It is unlikely that hawksbill turtles will be impacted by the development at the Project Area as breeding is restricted to the northern GBR, and reef and rocky habitats are favoured by this species are not present within the immediate Project Area (refer the Marine Ecology report).



Source: GBRMPA (2009)

Notes: Dashed lines (---) represent movements of hawksbill turtles.

Solid lines (-) represent movements of flatback turtles.

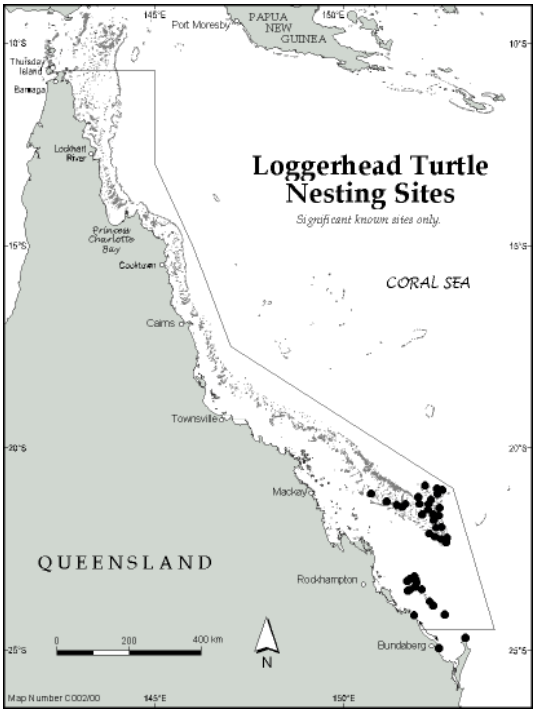
All migration paths are indicative only.

Figure 9 Flatback and Hawksbill Turtle Migration Routes

3.6.3 Loggerhead Turtle (*Caretta caretta*)

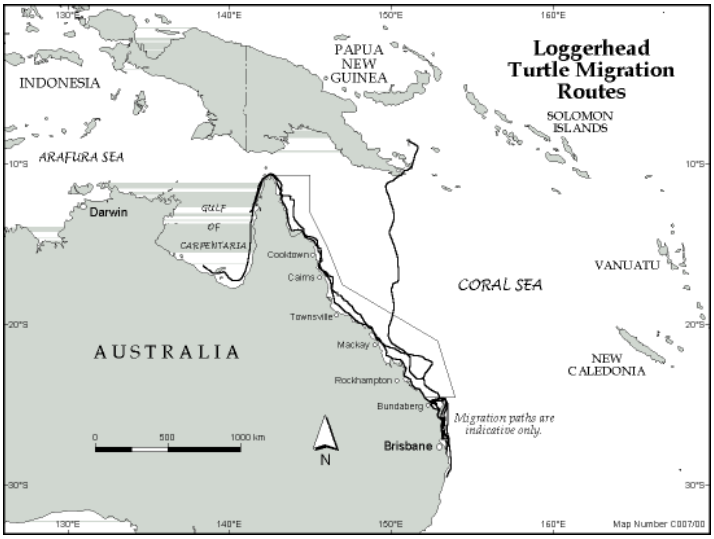
The loggerhead turtle is a wide-ranging species that undertakes large migrations between feeding and breeding grounds (Figure 10and Figure 11). Like most marine turtle species, the loggerhead turtle undergoes two distinct life stages. Juvenile loggerhead turtles are pelagic, feeding on plankton, algae, crustaceans and molluscs. Adult loggerhead turtles are benthic carnivores that take a variety of marine invertebrates (Limpus and Chatto, 2004). Foraging habitat for this species is confined to near shore shallow water environments, up to a depth of 55 m. Female loggerhead turtles lay up to three clutches each year. In Queensland waters mating commences in October, with nesting peaking in December. Sexual maturity is reached after approximately 30 years (DEWHA 2008d; EPA 2007c).

Since surveys began in the late 1970s the number of nesting females has steadily declined by 50-80% from about 1000 breeding females to a few hundred (www.gbrmpa.gov.au, 2009).The east Australian population of loggerhead turtles used to represent the bulk of the South Pacific stock (one of about eight loggerhead stocks globally). If this population disappears, it will mean the effective removal of the South Pacific stock. As female turtles return to nest in the area where they hatched, it is highly unlikely that a population that has become locally extinct would be recolonised by turtles from another population somewhere else in the world (www.gbrmpa.gov.au, 2009). Occasional loggerhead turtle nesting has been recorded on Curtis Island, though their significant nesting sites are islands further offshore (Wreck, Lady Musgrave and Heron Islands) (Figure 10).



Source: GBRMPA website, 2009

Figure 10 Significant Loggerhead Turtle Nesting Sites (indicative only)



Source: GBRMPA website, 2009

Figure 11 Loggerhead Migration Route (indicative only)

The loggerhead turtle has been recorded in coastal waters of all Australian states and territories. Globally, this species is found in tropical, sub-tropical and temperate waters, with a preference for shallow water habitats such as muddy bays, rocky and coral reefs and seagrass meadows. Beaches of central Queensland have been identified as one of the major global nesting aggregation localities for

this species. Although none of these nesting sites (Capricorn Bunker Islands, Mon Repos, Wreck Rock and Swains Reef) are directly adjacent to the Project Area, they are all located within the central Queensland region. It is estimated that the population of loggerhead turtles in eastern Australia has declined by as much as 80% in the last 15 years (DEWHA 2008d).

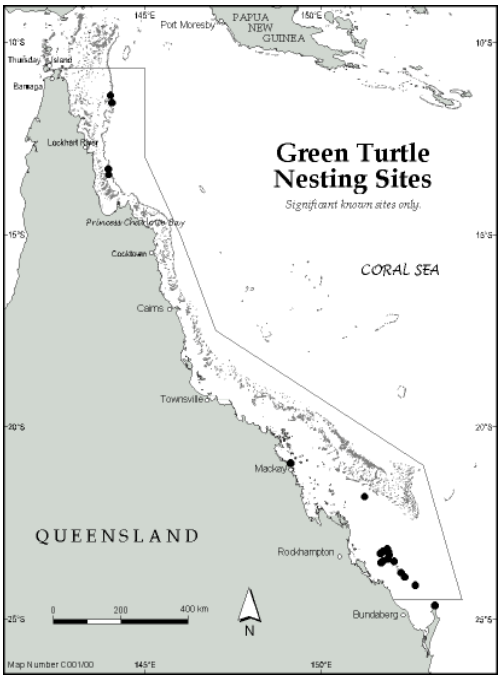
It is highly unlikely that any breeding behaviour including migrations to breeding sites, nesting, and hatchling survivorship will be affected by the Project. As Figure 11suggests, loggerhead turtles likely utilise the soft sediment habitats within and adjacent to the Project Area for foraging.

3.6.4 Green Turtle (*Chelonia mydas*)

The green turtle has a global distribution in tropical and sub-tropical waters. This species is usually associated with shallow marine habitats that support seagrass meadows, as seagrass constitutes the bulk of its diet. The green turtle nests along numerous beaches in Queensland with two genetically distinct breeding stocks of green turtles in the Great Barrier Reef utilising the coastline. Nesting sites for the southern stock are concentrated in the Capricorn/Bunker group of islands, with an average annual nesting population of 8,000 females. The northern green turtle stock predominantly nests around Raine Island and Moulter Cay, with an average annual nesting population of 30,000 females (Figure 12). Mating generally occurs in October, with nesting peaking in January, and taking place until the end of March (DEWHA 2008c). Green turtle nesting in the Gladstone region is of a low density with the area not being considered as a critical nesting habitat.

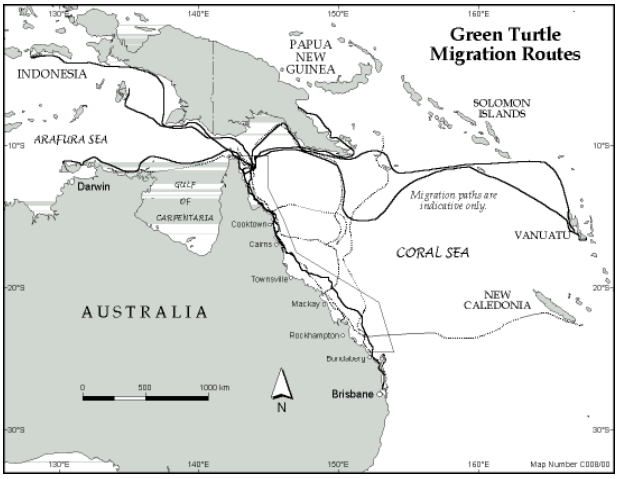
The green turtle undertakes large movements at various stages in its life cycle. Movements by green turtles between foraging grounds and reproductive migrations to nesting beaches often take place over long distances, in deep oceanic waters. Post-hatchling and juvenile green turtles spend up to 10 years in pelagic oceanic waters drifting in current lines. Following this phase, green turtles enter coastal environments where their movements and distribution are largely governed by the location of foraging grounds (particularly seagrass beds) (Figure 13). Seagrass and algae are the staples of this species' diet. Migrations to natal nesting sites may be up to 2600 km, although the average for green turtles in the Great Barrier Reef region is 400 km. Mating occurs in October for green turtles nesting in the southern Great Barrier Reef, with eggs being laid between October and March. Sexual maturity in this species is only reached after 30 to 40 years (DEWHA 2008c; EPA 2007b).

To date, there have been no detectable declines in the number of nesting green turtles at these sites. However, the 20-25 years of data for the key sites (Raine Island, Heron Island) do not cover a single generation for green turtles, and trends are difficult to determine with the large fluctuations in nesting numbers that can occur because of the El Niño Southern Oscillation (www.gbrmpa.gov.au, 2009). Additionally, population models using accumulated demographic data suggest that the northern and southern stocks may be exhibiting characteristics of a population under threat, including a decline in the size of nesting adults, increases in the non-breeding periods and a lack of expected increases of turtle numbers in dispersed feeding areas (Limpus and Chatto, 2004).



Source: GBRMPA website, 2009

Figure 12 Significant Green Turtle Nesting Sites in Queensland



Source: GBRMPA website, 2009

Notes: Dashed lines (---) represent movements of southern Great Barrier Reef green turtles.

Solid lines (-) represent movements of northern Great Barrier Reef green turtles.

All migration paths are indicative only

Figure 13 Green Turtle Migration Routes

3.6.5 Olive Ridley Turtle (*Lepidochelys olivacea*)

The olive ridley turtle is distributed throughout the world's tropical and subtropical waters. This species is generally associated with shallow coastal water environments, particularly where the substrate is soft. Its Australian distribution is from southern Queensland to the Northern Territory/Western Australia border. Large breeding aggregations occur in India, Mexico and Costa Rica, however this species has low density nesting in Australia. Nesting in Australia is confined to several localities in the Gulf of Carpentaria (DEWHA 2008e).

The olive ridley turtle is prevalent in a variety of pelagic and benthic habitats throughout its global range. It is usually restricted to coastal environments, and although it is known to forage at depths greater than 100 metres, in Australia it is most often encountered in waters less than 40 metres (Limpus and Chatto 2004). This species is predominantly carnivorous with molluscs, gastropods, crustaceans and jellyfish making up the bulk of its diet. Algae are also consumed by this species, although this has not been observed in Australian populations.

Little information pertaining to olive ridley turtle reproductive behaviour in Australia exists, as breeding is uncommon in the region. In other parts of its range, this species undertakes long migrations to breeding sites, where they form large aggregations (Limpus and Chatto, 2004). Nesting in the Gulf of Carpentaria is concentrated between April and November, where females lay an average of 109 eggs per clutch, in between 1 and 8 clutches per season (DEWHA 2008e; EPA 2007d).

This species is not known to nest regularly in the eastern Queensland region. Although it is known to transit the entire Queensland coast, it is more common in far northern Queensland (nesting on Western Cape York) and the Northern Territory. It is unlikely that the Project Area supports a large population of olive ridley turtles. Individuals may occasionally use the area for foraging. As this species rarely breeds in the region, and is likely to be present at low densities, negative impacts of this Project on the species are considered to be low.

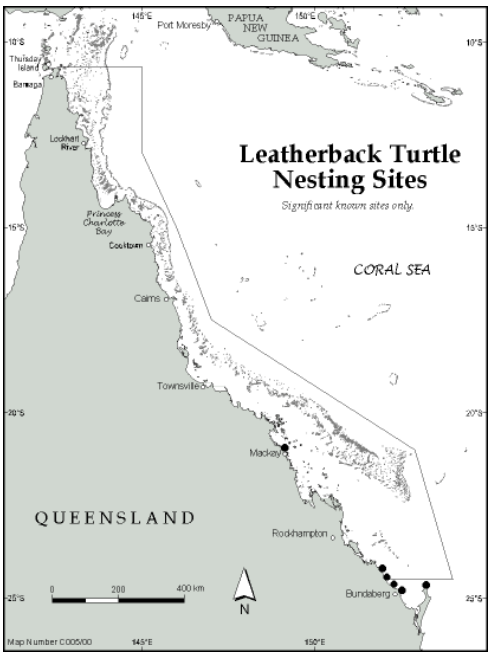
3.6.6 Leatherback Turtle (*Dermochelys coriacea*)

The leatherback turtle is the most widely distributed marine turtle, occurring in tropical, sub-tropical and temperate waters of all the world's oceans (ranging from Alaska in the north to Chile in the south). This pelagic species breeds on tropical beaches, and undertakes large migrations between foraging and breeding grounds. In Australia, the leatherback turtle has been recorded from all states, and although large concentrations feed off the southern coast of Queensland, this species is more generally found in southern Australia (New South Wales, Victoria, Tasmania and Western Australia). This species rarely breeds in Australia (DEWHA 2008g).

With a length of up to 3 metres the leatherback turtle is the largest marine turtle. Unlike all other marine turtle species, the leatherback turtle remains pelagic throughout its entire life, inhabiting offshore and oceanic waters. Soft invertebrate prey, dominated by jellyfish and cephalopods, are the major prey items of this carnivorous species. Leatherback turtles have recently been observed feeding on large jellyfish in the north of western Cape York. Foraging is not confined to the surface, and this species has been known to forage at depths of up to 200 metres (GBRMPA, 2009).

Leatherback turtles infrequently breed in Australia, with the majority of animals that forage in Australian waters migrating to Indonesia, Papua New Guinea and the Solomon Islands to nest. Nesting that has been recorded from scattered sites in northern Australia has been concentrated in December and January (Figure 14) (DEWHA 2008g; EPA 2006a). Leatherback turtles are unlikely to inhabit the

shallow coastal waters adjacent to the Project Area. This Project poses a minimal threat to populations of this species.



Source: GBRMPA website, 2009

Figure 14 Significant Leatherback Turtle Nesting Sites in Queensland

4. Marine Megafauna Survey

4.1 Overview

Marine megafauna surveys were undertaken to supplement existing information on marine fauna in the Port Curtis/ Rodds Bay region with a more detailed dataset to support decisions relating to the proposed Project. Two types of surveys were undertaken: aerial surveys to collect data at a larger spatial scale (all of Gladstone/Rodds Bay), and boat-based surveys at a finer spatial scale around the proposed Project Area. Nine survey days were undertaken from November 2008 – July 2009, comprising of three aerial survey days (3 events) and six boat-based days (3 events). Weather was a critical factor in determining the timing of surveys, and many surveys were postponed from the original schedule due to unfavourable sampling conditions particularly during the wet season (January – April) and at least some of the surveys undertaken had to be conducted in unfavourable weather conditions (July 2009 aerial survey).

Although no snubfin dolphins were sighted during the boat or aerial surveys, DERM stranding data records indicate they are present in the Gladstone area. The Gladstone region, as previously noted, is a highly modified marine environment supporting productive port and industry facilities, recreational activities and commercial fishing operations (Figure 15). These interactions are likely to impact on the existing environment directly and indirectly and developments should consider this.

Figure 15 Indo-Pacific Humpback Dolphins Observed on Survey Behind Fishing Trawler

4.2 Methodology

4.2.1 Boat-based Sampling

The boat-based surveys were carried out according to a stratified design across a variety of depths taking into consideration habitat information from existing epi-benthic habitat mapping (Rasheed *et al.* 2008). Each monthly sample event comprised 33 spot sampling sites, ten transects of approximately five km in length and a further five transects broken by the spot sampling sites. This mix of point and transect sampling was determined as the best method to capture the diversity of species predicted in the Project Area within a limited time frame, based on experience in other areas (Southern Moreton Bay, Abbot Point, Cleveland Bay). Transects were undertaken at a steady speed of approximately 10 – 12 km/hr. This design has the advantage of covering the heterogenous and patchy habitat in the Port Curtis environment over a period of time which is not viable for aerial surveys; this increases the theoretical detectability of species which must surface to breathe, and permits a targeted survey area of known marine fauna habitat.

The proposed development is within the Rodds Bay Dugong Protection Area (approximately 515 km^2 in area) supporting substantial seagrass meadows. Given the reliance of dugongs on seagrass habitats, a deliberate bias was developed to sample over known seagrass presence. Dugongs spend less than 2% of their time at the surface of the water and often surface cryptically (Anderson 1986; Churchward 2001). A 10 minute observation period for spot sampling was chosen because 90% of dugong dives are less than five minutes duration and dives greater than 10 minutes are very uncommon (Chilvers *et al.* 2004). Similarly, green turtles (*Chelonia mydas*) have recorded mean foraging dives of 4.5 mins (Rice *et al.* 2002). Cetaceans are also observed to surface regularly and have successfully been surveyed by undertaking boat-based transects (Lukoscheck and Chilvers 2008; Parra *et al.* 2006 and Skrovan *et al*., 1999).

Under good weather conditions (< 15 knots), boat-based spot sampling sites enable a sighting radius of approximately 200 m from the boat for surfacing megafauna with the exception of whales, which are clearly observed from distances over 500 m. Sighting distance is dependent upon sea state and weather conditions; as a result, an approximate distance of 200 m is given as the maximum distance of detection at any given survey time. This distance increases greatly with good weather conditions and declines consequently with increased swell or wind affected sea surfaces. Figure 16 depicts the survey sites undertaken each month where the red lines represent transects and open circles represent spot sampling sites.

During the 10 minute spot sampling, experienced observers are positioned facing the bow and stern of the vessel with each observer scanning 180^0; this provides a combined search area of approximately 0.125 km^2 (x 33 sites). The following information is recorded:

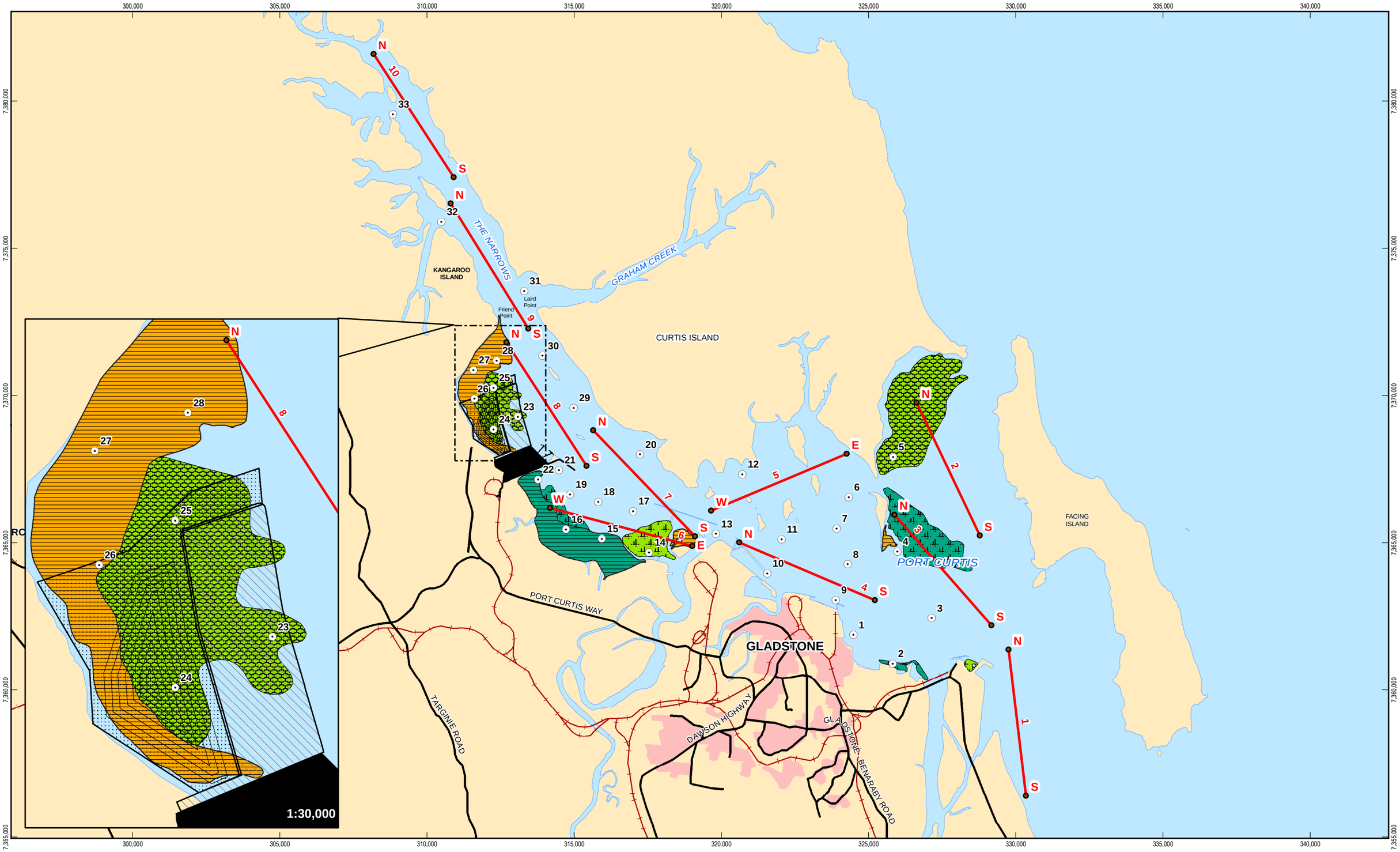
- G.P.S location;
- Time and date;
- Depth;
- Species and number of individuals;
- Identifiable behaviours; and
- Age class of species (where discernable). Species age class was defined as per Table 4.

For each boat-based survey event, approximately 50 km of transects were sampled, and 330 minutes of spot sampling carried out within the Project Area over two days each month. The sampling of sites was dependent upon tidal state where possible, so that shallower sites (< 3 m) were sampled at high tide to account for animals that may be accessing food resources that would otherwise be tidally restricted.

Table 4 Age Class Categories for Green Turtle, Dugong and Inshore Dolphins

Species	Age class	Size (curved carapace length for turtles)	Age range (years)
Green turtle (*Chelonia mydas*)	Adult	85 – 120 cm	32 +
	Subadult	65 – 90 cm	18 – 35
	Juvenile	40 - 65 cm	5 – 18
Dugong (*Dugong dugon*)	Adult	240 - 300 cm	6 - 70 +
	Calf	100 cm – 200 cm (closely associated with adult)	0.1 – 1.5
Indo-Pacific humpback dolphin *(Sousa chinensis)*	Adult	200 - 320 cm	
	Juvenile	150 – 200 cm	
	Calf	100 cm – 200 cm (closely associated with adult)	
Snubfin dolphin (*Orcaella heinsohni*)	Adult	200 - 275 cm	
	Juvenile	150 – 200 cm	
	Calf	<100 cm – 200 cm (closely associated with adult)	

Source: Adapted from - Chaloupka and Limpus, 2005, Marsh 2004, Jefferson *et al.* 1993.



1:120,000 (at A3)

0 1 2 3 4 5

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Sample Point
- Sample Transect
- Western Basin Reclamation Footprint
- Fisherman's Landing Northern Expansion
- FishermansLandingExistingReclamation

Gladstone Seagrass Meadows November 2008

- Continuous cover
- Aggregated patches
- Aggregated patches/ Continuous cover
- Isolated patches/ Aggregated patches
- Isolated patches
- Deep water meadow

Port of Gladstone
Western Basin Dredging and Disposal Project

Boat-based Marine Megafauna Survey Sites

Job Number	42-15386
Revision	A
Date	01 Sept 2009

Figure 16

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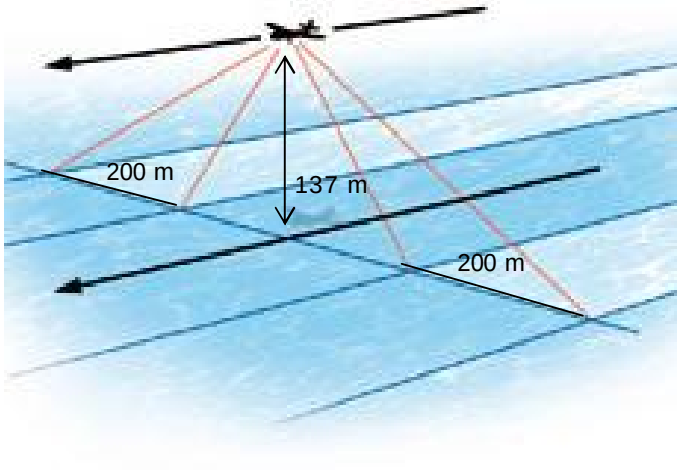
Level 4 201 Charlotte Street Brisbane QLD 4000 Australia **T** +61 7 3316 3000 **F** +61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

4.2.2 Aerial survey

The aerial survey was undertaken using a methodology adapted from Marsh and Sinclair (1989 a and b) and Pollock (*et al* 2006), which has been used to survey the entire Queensland coast for marine fauna over several years. Aerial surveys used a high-wing twin-engine Partenavia 68B with survey markers attached to struts which were fitted to the wings for this purpose.

Aerial transects flown were the same as those for the Queensland coast aerial surveys conducted by Marsh (*et al* 2005) with an additional transect flown up the middle of The Narrows (Figure 18). The aircraft flew along predetermined transects at a ground speed of 100 knots and at a height of approximately 450 ft or 137 m.

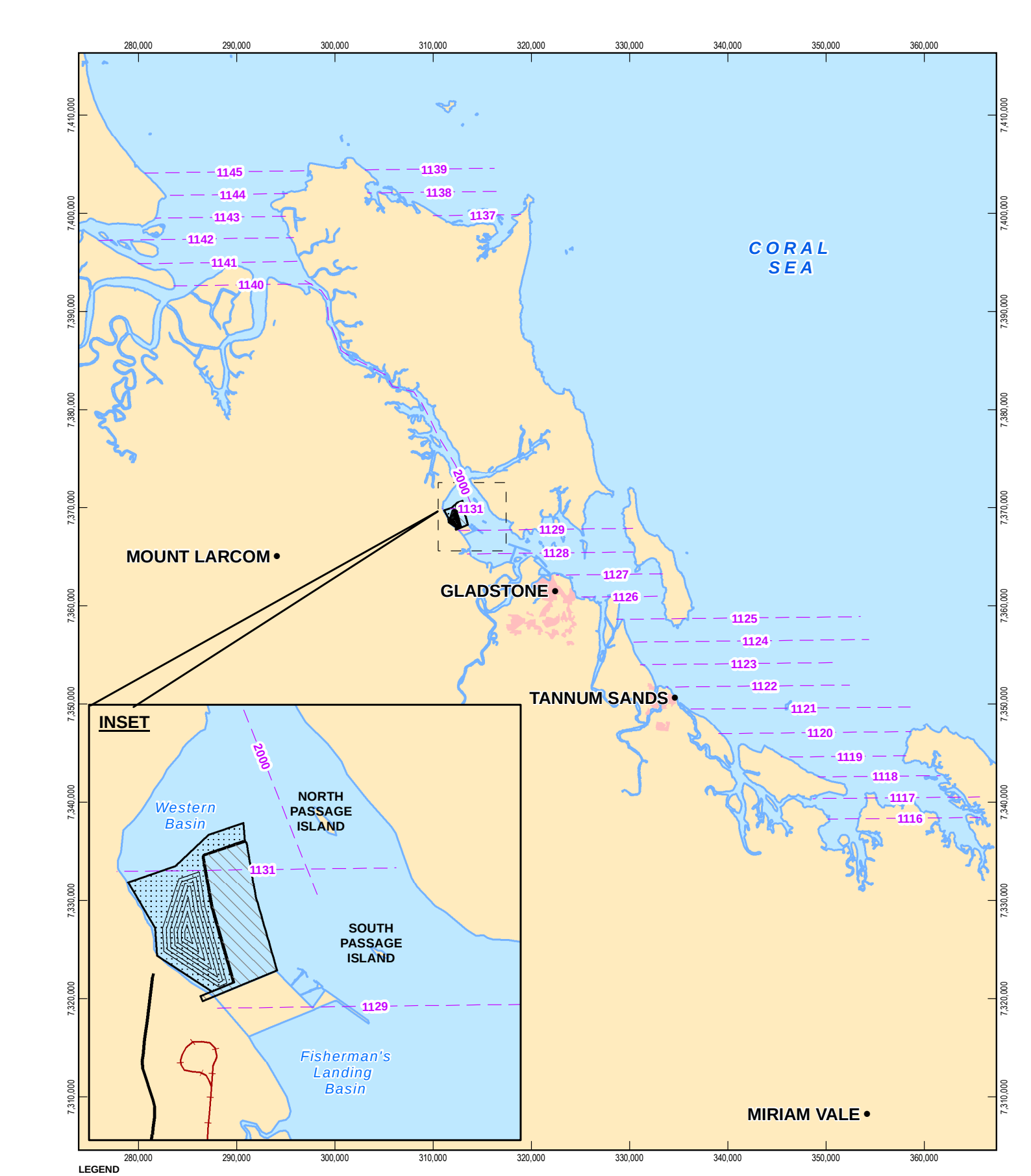
Two trained and experienced observers counted dugongs and other marine wildlife within a strip of sea defined by marker rods attached to 'pseudo wing struts'. The strip thus demarcated on either side of the aircraft is 200m wide when the aircraft is flying at the nominal height (137m) (Figure 17).



Source: Hodgson *et al* 2007

Figure 17 Aerial Survey Flight Parameters

Observers communicated with the survey leader at the front of the plane via an intercom system linked to a digital audio recorder. Information was recorded by the survey leader using a pocket computer programmed as a data logger and synchronised to a GPS. A micro-track digital voice recorder was also used for recording sightings and as back-up. The observer on each side scanned the transect on their side of the aircraft. The intercom tape recorder recorded all observations voiced by the survey team.



LEGEND

- Transect
- Fisherman's Landing Northern Expansion
- Western Basin Reclamation Footprint
- Land Mass

1:500,000 (at A4)

0 5 10 15 20

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

Marine Megafauna Survey
Aerial Transects over the Survey Area

Job Number	42-15386
Revision	A
Date	15 Sept 2009

Figure 18

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4.3 Results

4.3.1 Boat-based Surveys

Conditions

Three monthly boat-based surveys were undertaken during April, May and June 2009. Wind speed and weather conditions were highly variable during this period and where possible, surveys were undertaken where winds were less than 15 knots or 28 km/hr. Figure 19 outlines the wind conditions experienced during the survey period and on specific survey days. Due to cyclonic conditions and severe weather warnings, surveys were not undertaken in January - March. As indicated by Figure 19, the surveys were generally undertaken at wind speeds less than the monthly means with more favourable conditions being recorded in the morning. Boat-based survey conditions were excellent with maximum wind speeds not reaching over 10 knots (19 km/hr).

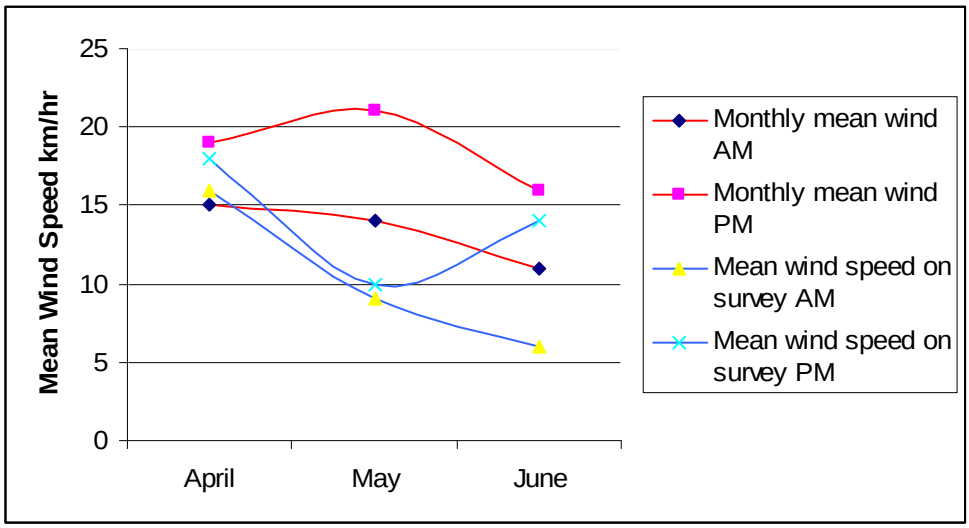


Figure 19 Mean Wind Speeds for Boat-based Surveys (km/hr)

Species Observed on Survey

Species observed on the boat-based surveys include Indo-Pacific humpback dolphins (Figure 20, Figure 21 and Figure 22), green, loggerhead, and hawksbill turtles, dugong, unidentified turtles (

Figure 23) and a seasnake. Sightings of species (turtle and seasnake) that have been recorded as unidentified were either brief encounters or observed at a distance too far to attain positive species identification. A summary table (Table 5) is provided to outline observations of marine species across the monthly survey periods.

Sightings of dugong and turtles were generally very brief and often no further opportunity was granted to observe again in the survey time. Dolphins however, re-surfaced frequently allowing for several observations and information to be recorded on group sizes, behaviours and age class. Green turtles and Indo-Pacific humpback dolphins were observed on every boat-based survey indicating a high level of habitat utilisation within the Survey Area suggesting its importance to these species. Marine fauna observed on survey was distributed from the southern limits of the boat-based survey in to the higher reaches of the Narrows.

Dugongs (N = 3) were briefly observed during the May survey in the Project Area and near the mouth of the Calliope River. The pair of dugong near the river mouth were a mother and a calf and appeared to be feeding. Both sites are shallow and have previously recorded seagrass presence (Chartrand *et al*, 2008).

Indo-Pacific humpback dolphins were recorded on numerous occasions during the survey period and showed a range of behaviours such as playing, feeding and travelling. Feeding was observed at the mouth of Graham Creek (in the Narrows), behind a trawler in Gladstone Harbour (Figure 15) two occasions and around the Passage Islands (north and south). For the majority of Indo-Pacific humpback sightings, calves were spotted amongst the groups suggesting the importance of this region as a calving area. The largest group size observed in the Survey Area was 12 individuals with at least eight of the dolphins being adults in the group and others being comprised of calves or juveniles. The maximum number of sightings across the Survey Area in one sampling event (two days) was 38. Over the three month period little variation in frequency of observations were recorded (April: N = 31, May: N = 38, June: N = 31). The study is not considered temporally extensive enough to detect seasonality in presence of species. The regularity of observations suggests that this area may support a resident population of numerous individuals of diverse ages.

Figure 20 Indo-Pacific Humpback Dolphins in the Project Area

Figure 21 Indo-Pacific Humpback Dolphins Observed in the Western Basin Project Area

Figure 22 Indo-Pacific Humpback Dolphins Observed Near Boat (and dredger operating in background) in the Survey Area

Marine turtles were observed throughout the Survey Area with a similar distribution to the Indo-Pacific humpback-dolphins. Observations were recorded at the northern and southern limits of the boat-based survey area of three turtle species; green, hawksbill and loggerhead. Highest frequency of turtle sightings was of the green turtle (N = 32). The majority of these were observed in June and most frequent individuals observed were within the immediate Project Area. Seagrass is known to occur within this area and as such this finding is not unusual. Juvenile hawksbill (N = 2) turtles were observed in association with rocky reef habitat at the southern end of Curtis Island. Loggerhead turtles (N = 3) were observed in deeper waters and channels where sand/rubble sediments were recorded (GHD Marine Ecology Report, 2009).

Table 5 Marine Fauna Observations on Boat-based Surveys

Date	Species and number	Age class	Depth (m)
April			
16/04/09	Unidentified turtle (1)	Adult (1)	3
16/04/09	Unidentified turtle (1)	Adult (1)	2.5
16/04/09	*Sousa chinensis* (3)	Adult (2), Calf (1)	10.4
16/04/09	*Eretmochelys imbricata* (2) Unidentified turtle (7)	Juvenile (2) Adult (5), Juvenile (2)	< 1
16/04/09	*Sousa chinensis* (9)	Adult (9)	3
16/04/09	Unidentified turtle (1)	Juvenile (1)	1.2
16/04/09	*Sousa chinensis* (8)	Adult (6), Juvenile (2)	10.5
16/04/09	*Caretta caretta* (1)	Adult (1)	11
17/04/09	*Caretta caretta* (1) Unidentified turtle (4)	Adult (1)	5
17/04/09	*Chelonia mydas* (1)	Juvenile (1)	2.3
17/04/09	Unidentified seasnake (1)	Adult (1)	2.3
17/04/09	*Sousa chinensis* (5)	Adult (3), Calf (2)	2
17/04/09	*Sousa chinensis* (3)	Adult (2), Juvenile (1)	2 – 8
17/04/09	*Sousa chinensis* (3)	Adult (1), Calf (2)	3.2
17/04/09	Unidentified turtle (1)	Adult (1)	1.5
Total	**Marine turtles: 20** **Dolphins: 31**		

Date	Species and number	Age class	Depth (m)
May			
14/05/09	Unidentified turtle (2)	Adult (1), Juvenile (1)	1.1
14/05/09	*Caretta caretta* (1)	Adult (1)	8.3
14/05/09	*Chelonia mydas* (1) Unidentified turtle (2)	Juvenile (1) Adult (2),	2.5
14/05/09	*Sousa chinensis* (7)	Adult (5), Calf (2)	10
14/05/09	*Dugong dugon* (2) Unidentified turtle (6)	Adult (1) Calf (1) Adult(5), Juvenile (1)	1.8
14/05/09	*Sousa chinensis* (4)	Adult (3), Juvenile (1)	6.2
15/05/09	*Dugong dugon* (1)	Adult (1)	2
15/05/09	Unidentified turtle (2)	Adult(1), Juvenile (1)	4.5
15/05/09	Unidentified turtle (3)	Juvenile (3)	7
15/05/09	Unidentified turtle (3)	Adult (2), Juvenile (1)	3
15/05/09	Unidentified turtle (1)	Adult (1)	1.8
15/05/09	*Sousa chinensis* (8)	Adult (6), Juvenile (1), Calf (1)	3 - 5.4
15/05/09	Unidentified turtle (1)	Adult (1)	2.2
15/05/09	*Sousa chinensis* (12)	Adult (8), Calf (4)	2 – 4.5
15/05/09	*Chelonia mydas* (3)	Juvenile (3)	1
Total	**Marine turtles: 25** **Dugong: 3** **Dolphins: 38**		
July			
22/06/09	*Sousa chinensis* (2)	Adult (2)	2.7
22/06/09	*Chelonia mydas* (2)	Juvenile (2)	1.2
22/06/09	*Chelonia mydas* (2)	Juvenile (2)	1.1
22/06/09	*Sousa chinensis* (5)	Adult (4), Calf (1)	3.7 – 10.4
22/06/09	*Sousa chinensis* (8)	Adult (7), Calf (1)	9
22/06/09	*Chelonia mydas* (3)	Adult (1), Juvenile (2)	3.6
23/06/09	*Chelonia mydas* (5)	Adult (3), Juvenile (2)	1.4
23/06/09	*Chelonia mydas* (2)	Adult (2)	1.3
23/06/09	*Chelonia mydas* (2) Unidentified seasnake (1)	Adult (2) Adult (1)	2.5
23/06/09	*Chelonia mydas* (3)	Adult (3)	1.4
23/06/09	*Chelonia mydas* (11)	Adult (11)	1.8

Date	Species and number	Age class	Depth (m)
23/06/09	*Sousa chinensis* (4)	Adult (3), Calf (1)	13
23/06/09	*Sousa chinensis* (12)	Adult (10), Calf (2)	8
23/06/09	Unidentified turtle (1)	Juvenile (1)	1.3
Total	**Marine turtles: 31** **Dolphins: 31**		

NB: Total values in RED identify highest values recorded during boat -based surveys

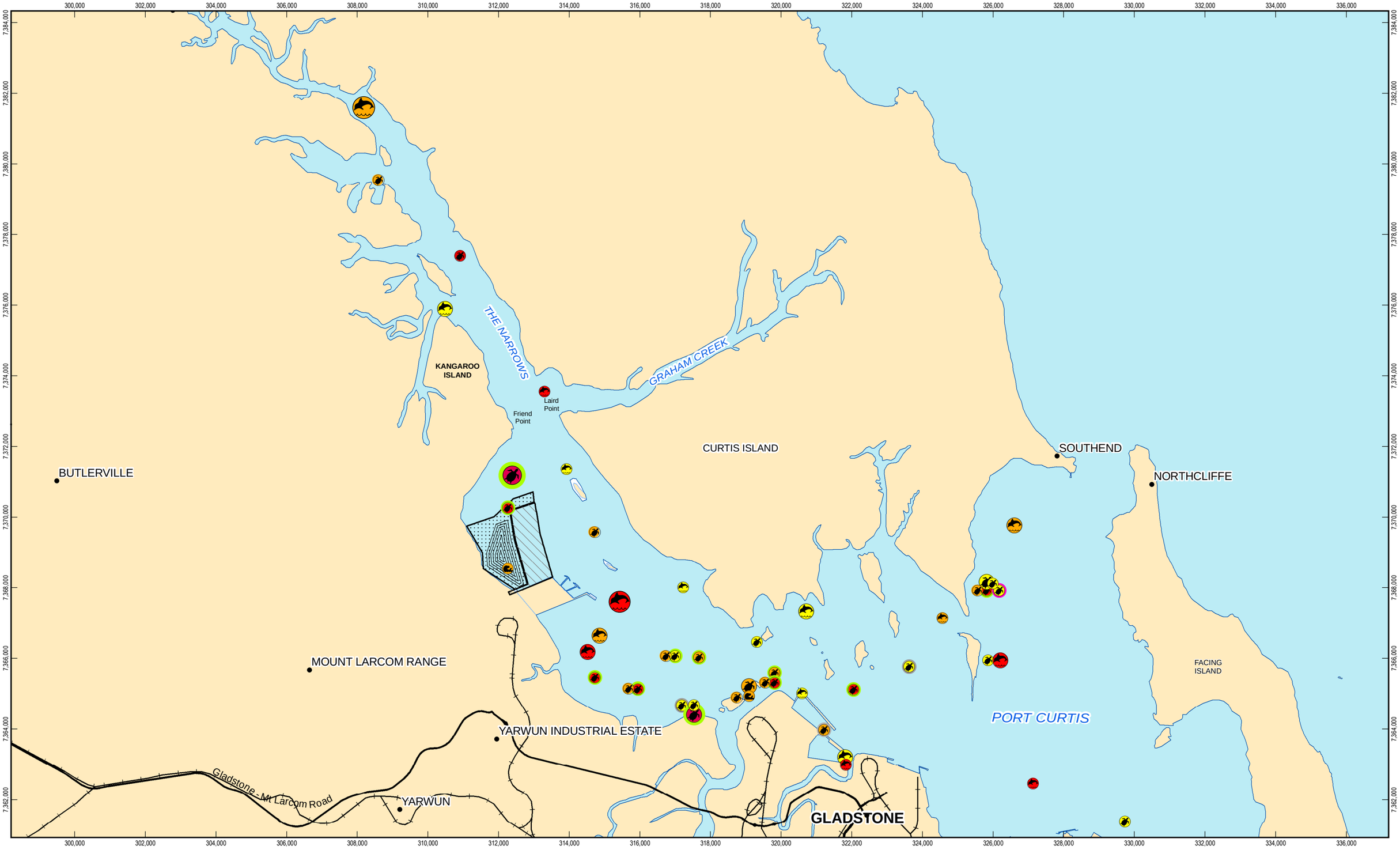
Recorded Depth and Habitat Utilisation for Observed Species

Table 6 outlines the range of depths where marine fauna species were observed on boat-based surveys. Marine turtles were found at depths ranging from <1 m to 11 m. Loggerhead turtles were recorded with a deeper range compared with green and hawksbill turtles. This is suggestive of their association with habitats that are not light dependent habitats, such as rocky reef or seagrass/algae meadows, which are preferential feeding habitats of hawksbill and green turtles respectively. The juvenile hawksbills were observed in rocky reef at <1 m and green turtles were not identified at depths greater than 3.6 m.

Indo-Pacific humpback dolphins showed the greatest variation in their depth profiles ranging from 2 – 10.5 m. Dolphins were observed within channels and in close association with sand/mud banks near creek mouths. Behaviours observed included playing, travelling and feeding (behind trawlers, at creek mouth and near Project Area). Dugongs were briefly observed in shallow areas near the Calliope River and Project Area; both of these areas have recorded seagrass beds.

Table 6 Observed Depth Range of Threatened Species Observed on Boat-based Survey

Species	Observed species frequency	Depth range
Green turtle *(Chelonia mydas)*	24	1m – 3.6 m
Loggerhead turtle (*Caretta caretta*)	3	5 m – 11 m
Hawksbill turtle (*Eretmochelys imbricata)*	2	<1 m
Unidentified turtle species	29	<1 m – 7 m
Indo-Pacific humpback dolphin (*Sousa chinensis)*	100	2 m – 10.5 m
Dugong (*Dugong dugon)*	3	1.8 m – 2 m



1:100,000 (at A3)

0 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Fisherman's Landing Northern Expansion
- Western Basin Reclamation Footprint

Fauna Sighted

- Unidentified Turtle
- HB Turtle
- LH Turtle
- Green Turtle
- Dolphin
- Dugong

Month Sighted

- April
- May
- June

Number of Individuals

- 1 - 4
- 4 - 9
- Greater than 10

Port of Gladstone
Western Basin Dredging and Disposal Project

Locations of Boat-based Observations of Marine Megafauna

Figure 23

Job Number	42-15386
Revision	A
Date	01 Sep 2009

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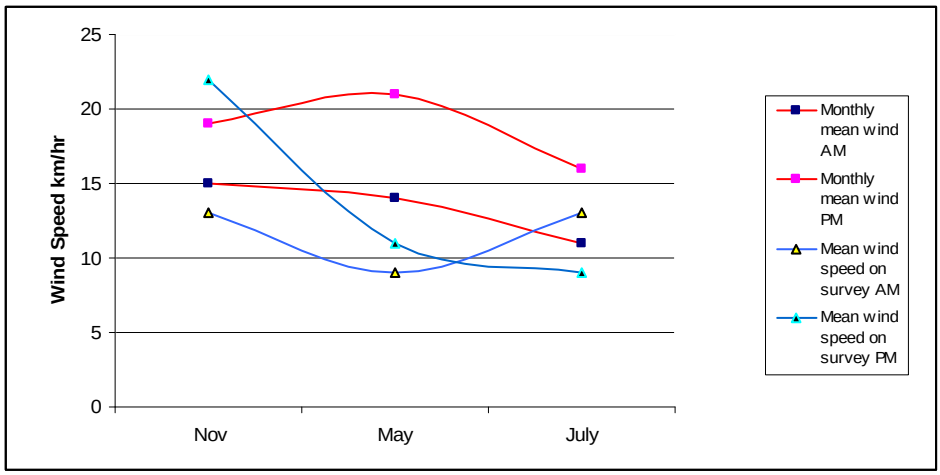
4.4 Aerial Surveys

Six aerial surveys were conducted, two per day on 25-11-08, 21-05-09 and 17-07-09. The aim of duplicating the surveys each day was to obtain information about tidal effects on the distribution of the animals. Each survey started as close as possible to the highest or lowest point of the tidal regime with each flight taking approximately three hours to complete from beginning to end (Table 7).

Table 7 Timing of Surveys in Relation to Tides in Gladstone

Date	High tide	Low tide	Start of surveys	
			a	b
25/11/2008	7:40	13:54	07:40	12:38
21/05/2009	6:24	12:43	06:59	12:27
17/07/2009	17:10	10:26	9:10	14:37

Weather conditions during aerial surveys were excellent during November and May. Sea state conditions offshore during the July survey were gusting up to approximately 12 knots (reaching a Beaufort scale of 4), this means the ability of observers to sight animals was likely compromised by the white caps on the water (Pollock *et al*. 2006). Inshore areas during this survey were affected by winds of approximately 8 knots and were acceptable for surveying (Figure 24). Fewer sightings were recorded during the July surveys than previous months, possibly attributable due to prevailing weather conditions; this highlights the importance of acknowledging other marine megafauna research activities and their knowledge contribution (i.e. previous aerial surveys).



Source: Bureau of Meteorology, Gladstone; NB: 1 knot = 1.852 km/hr

Figure 24 Monthly Mean and Survey Wind Speeds for Aerial Surveys (km/hr)

A summary table (Table 8) is provided below that outlines species observed on the aerial survey. The species numbers observed do not represent abundance estimates of species in the region as a correction factor is required to account for submerged animals unobserved due to turbidity and prevailing conditions. The presence of animals recorded provides a proxy measure for habitat utilisation in the Survey Area.

Table 8 Summary of Marine Megafauna Sightings on Survey

Survey Number and tidal state	Month	Number of Observed Species			
		Turtle	Dugong	Dolphin	Whale (Pilot)
1a (High)	Nov	99	14	32	
1b (Low)	Nov	56	12	0	
2a (High)	May	92	23	16	1
2b (Low)	May	94	10	0	
3a (Low)	July	53	10	10	
3b (High)	July	22	9	5	
	Total	416	78	63	1

NB Highest and lowest number of observations per survey are denoted in red (high) and blue (low)

Whale Sighting

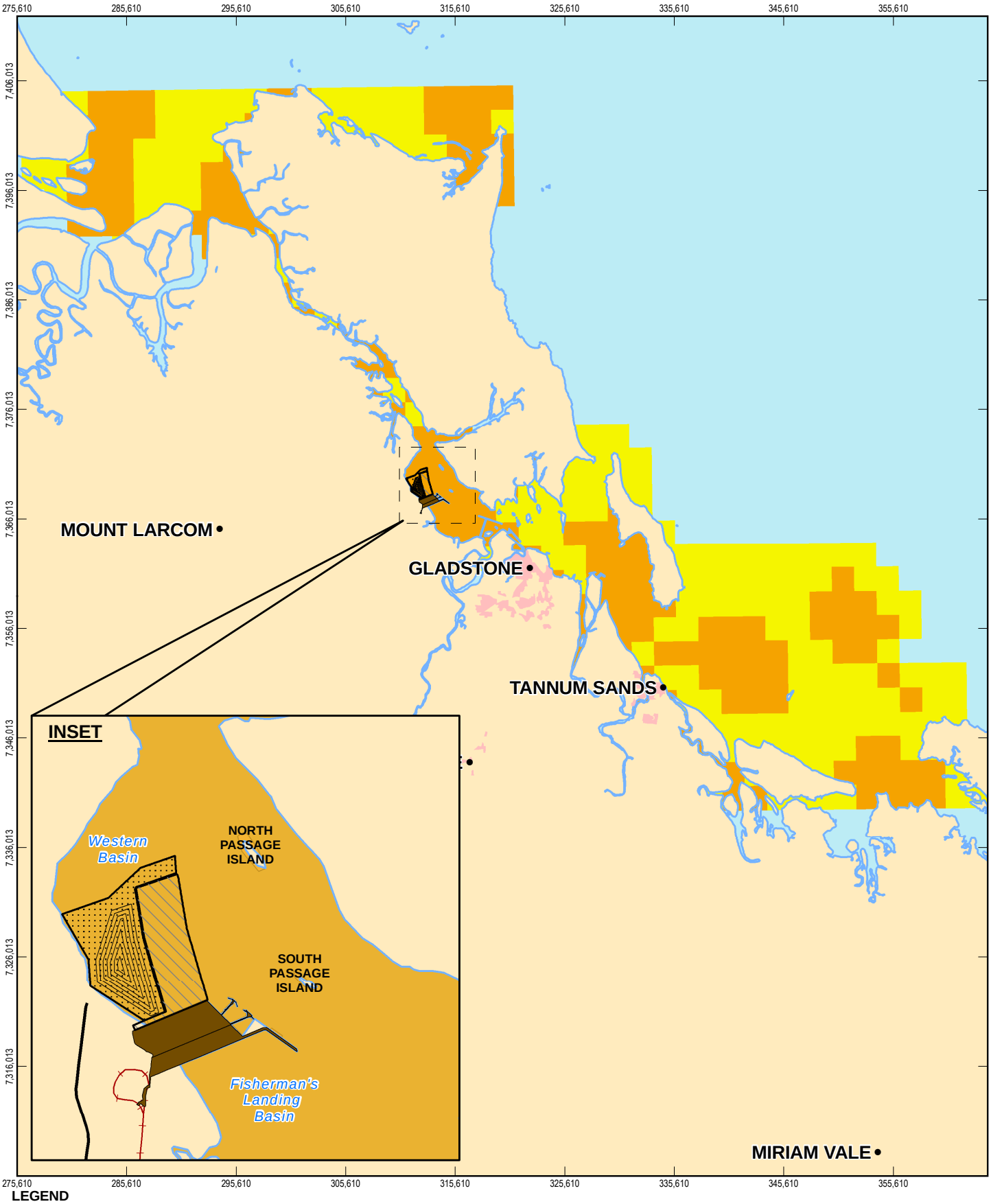
One whale was briefly observed around the northern tip of Curtis Island in relatively shallow coastal waters whilst undertaking the May high tide 2009 aerial survey. This species is most likely the melon-headed whale *(Peponocephala electra),* determined by its shape and colouration.

Dugong Sightings

Dugong sightings from the Project aerial surveys support a similar distribution identified in the dugong spatial model by Grech and Marsh (2007) (Figure 5). The majority of dugong sightings were distributed towards the southern section of the bay (within Rodds Bay) where known seagrass habitats exist. The highest number of dugongs recorded on an aerial survey was on a high tide in May (N = 23) with the lowest dugong numbers recorded in July, on a high tide (N = 9). No attempt was made to estimate dugong abundances for this region as dugong populations fluctuate between bays and in response to changing environments at often large scales < 100 km. Dugongs were observed within the Project Area and in adjacent waters, suggesting that the Survey Area is important for local dugong populations.

To enhance the application of the aerial survey data, the dugong spatial model by Grech and Marsh (2007) was applied to low tide versus high tide data. The models displayed differences in dugong distribution with regard to tidal regime. Dugong density for the low tide model and Grech and Marsh's model output for the Gladstone region scaled the conservation value of the Survey

Area as “Low – Medium” (Figure 5 and Figure 25). The aerial high tide model (Figure 26) identified a substantial shift in dugong distribution to an associated high conservation value in three key areas; the Survey Area, further south near Tannum Sands and Hummock Hill Island. The high tide would provide an opportunity for dugongs to access seagrass resources in shallow water areas that may otherwise be unavailable at a low tide. This model highlights the importance of the habitat that will be lost from the Project reclamation and dredging activity and from projected future developments in this area.



LEGEND

- Fisherman's Landing Northern Expansion
- Western Basin Reclamation Footprint
- FishermansLandingExistingReclamation

Dugong Relative Density

- Low Dugong Conservation Value
- Medium Dugong Conservation Value
- Medium to High Dugong Conservation Value
- High Dugong Conservation Value

1:474,710 (at A4)

0 2.5 5 7.5 10 12.5

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

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Date 01 Sept 2009

Low Tide Spatial Model of Dugong Distribution Figure 25

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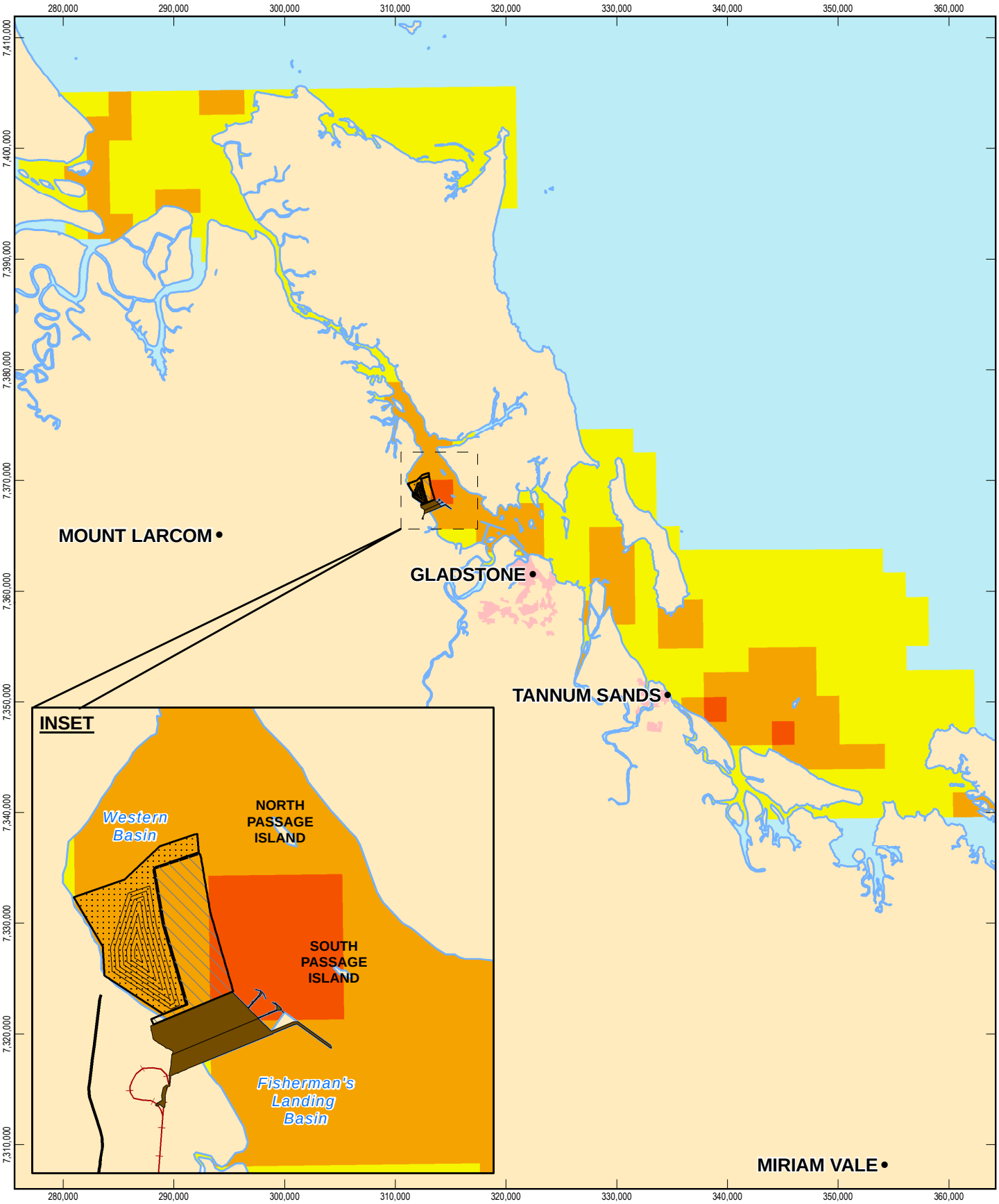

LEGEND

- Fisherman's Landing Northern Expansion
- Western Basin Reclamation Footprint
- FishermansLandingExistingReclamation

Dugong Relative Density

- Low Dugong Conservation Value
- Medium Dugong Conservation Value
- Medium to High Dugong Conservation Value
- High Dugong Conservation Value

1:473,712 (at A4)

0 2.5 5 7.5 10 12.5

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

Job Number 42-15386
Revision A
Date 01 Sept 2009

High Tide Spatial Model of Dugong Distribution Figure 26

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Turtle Sightings

Marine turtles were the most frequently observed animal during the aerial surveys with a maximum number of sightings recorded in November (N = 99). The majority of turtle observations were distributed throughout Rodds Bay, south of the Narrows with substantially fewer sightings recorded north of Curtis Island. Turtle observations appear generally associated with the same areas as dugongs, possibly in association with seagrass distribution. Turtles were not identified to species level from aerial surveys.

Dolphin Sightings

The highest number of dolphins were observed during the November high tide aerial survey (N = 32). Dolphin species were identified where possible and included Indo-Pacific humpback dolphins and common bottlenose dolphins. Dolphins were observed throughout the extent of the Survey Area with higher frequencies observed further offshore, this locality suggests the offshore observations may have been bottlenose dolphins. Dolphins are often difficult to detect on aerial surveys as they spend time at a range of depths, unlike feeding dugongs or green turtles that are often restricted to shallow waters or to the extent of seagrass depth, making them easier to observe from the air.

260,000 270,000 280,000 290,000 300,000 310,000 320,000 330,000 340,000 350,000 360,000

7,400,000 7,390,000 7,380,000 7,370,000 7,360,000 7,350,000 7,340,000

1145 1144 1143 1142 1141 1140 1139 1138 1137 2000 1131 1129 1128 1127 1126 1125 1124 1123 1122 1121 1120 1119 1118 1117 1116

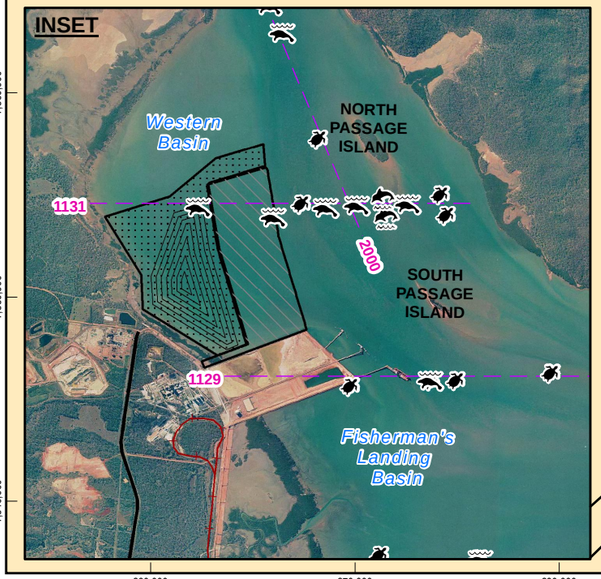
MOUNT LARCOM •

GLADSTONE •

TANNUM SANDS •

CALLIOPE •

INSET



1:300,000 (at A3)

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Fisherman's Landing Northern Expansion
- Western Basin Reclamation Footprint
- Transect

Sightings

- Dolphin
- Dugong
- Turtle
- Whale

Port of Gladstone
Western Basin Dredging and Disposal Project
All Dugong, Turtle and Dolphin Observations from Aerial Surveys November 2008 - July 2008

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Figure 27

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4.5 Results Summary

The aerial and boat-based survey results are consistent with current literature that acknowledges the importance of Rodds Bay as a key habitat area for significant marine fauna species. The surveys identified a range of age classes using Rodds the Survey Area, suggesting that it is not only an important foraging area but an area important for calving of marine mammals and foraging juvenile marine turtles.

Threatened marine fauna species identified on boat-based and aerial surveys include:

- Marine turtles on aerial (majority were green turtle, *Chelonia mydas*); N = 522;
- Dugong (*Dugong dugon*); N = 81 and;
- Dolphins (majority were Indo-Pacific humpback dolphins (*Sousa chinensis*) N = 163

N= Total number of individuals recorded across all surveys (aerial or boat-based)

The larger spatial scale survey identified areas within the Survey Area that are of high value to dugong and marine turtles, with numerous animals identified in the southern part of Port Curtis associated with known seagrass habitats. The dugong spatial model applied to the Project aerial survey data highlights the importance of three core regions in the Survey Area at high tide.

Of notable importance to this Project is the value of habitat detected in the immediate Project footprint. The Rodds Bay DPA is approximately 515 km^2 in area, of which a minimum of 3 km^2 of known seagrass habitat will be directly reclaimed and or removed by the proposed Fisherman's Landing and Western Basin reclamation Projects. Further indirect impacts are possible. Given the model output, this loss of habitat will impact species distribution within this core area.

The finer spatial scale survey identified use of habitat within the Project footprint by Indo-Pacific humpback dolphins, dugong and green turtles. It is expected that these key marine fauna species have a higher presence in areas of important habitat i.e. in close proximity to the port and channels, creek and river mouths and seagrass meadows, though the requirement to transit between habitat patches needs to also be acknowledged. As the whole bay is representative of important habitat, it is necessary to consider between habitat movements when assessing potential impacts on migratory species (Grech and Marsh, 2007). Expected impacts related to this Project are assessed below in 6, 7, and 8.

5. Conservation Threats to Marine Fauna

5.1 Overview

Marine megafauna are subject to numerous anthropogenic impacts given their association with coastal habitats. The following section outlines threats to marine fauna in the Gladstone area and other impacts affecting populations within a regional context. These threats and impacts are also discussed with respect to the proposed Project.

5.2 Vulnerability of Dugongs to Low Levels of Mortality

Limitations in our ability to detect population trends arise from (1) the large variability in population estimates resulting from large-scale movements (e.g., Marsh and Lawler 2001; Gales *et al*. 2004; Marsh *et al*. 2004), and (2) the slow rate of population increase for dugongs (Marsh 1995; Marsh 1999). An increase or decline in the population can only be detected if aerial surveys are conducted over many years and, therefore, a declining population may reach a critically low level before it is detected (Marsh 1995). The long-term aerial survey program along the Queensland urban coast has provided critical information about dugong distribution, abundance and trends. However, in the short-term, population estimates can be valuable when assessed in combination with known mortality rates from human impacts. Abundance estimates can be used to determine the Potential Biological Removal (PBR), which is the maximum level of human-caused mortality that can occur in a population from all causes (e.g. accidental entanglement in fishing nets or vessel strikes), while allowing the population to reach or maintain an optimal sustainable size (Wade 1998).

The PBR is the product of a minimum population estimate, half the maximum rate of increase, and a recovery factor that allows for population growth and compensates for uncertainties in population estimates or responses to human impacts (Wade 1998). Using this model, Marsh *et al*. (2005) estimate that if dugongs are to recover along the urban coast of Queensland including Rodds Bay - Gladstone then management should aim to reduce human related mortality to zero.

5.3 Habitat Degradation and Loss

Habitat destruction and degradation, including noise pollution and harassment, are threatening processes to key marine megafauna species. This threat is primarily a concern along the Queensland coast where high levels of construction, dredging, mining, land reclamation, resource extraction, agricultural development, tourism and recreational activities currently exist and are likely to continue, potentially with increasing impact as habitat degradation and loss increases with growing human population requirements. Coastal development can inhibit turtle access to nesting beaches, either through the presence of physical barriers or indirectly through reducing the amenity of nesting beaches or foraging areas. Camping and vehicle traffic on beaches can damage turtle nesting areas by compacting the sand, increasing dune erosion and creating wheel ruts that trap hatchlings (DEWHA in prep.). Port developments can also bring with them increased vessel activity, dredging of shipping channels and the potential for habitat degradation through accidental spillages of oils and chemicals (Limpus 2007). Increased pollution of foraging areas (such as seagrass meadows and coral reefs) from runoff of nutrients, sediments, pesticides can decrease water quality which in turn can degrade foraging resources. Coastal developments, including residential, industrial and tourism development, can directly destroy or degrade beach habitats used as nesting sites for flatback turtles as well as degrade foraging

habitat. Coastal development can also have indirect, but often cumulative, effects on nesting and foraging habitat.

5.3.1 Site Fidelity

Species with high levels of site fidelity such as those discussed in this report are vulnerable to population declines as a result of habitat degradation and loss, particularly when those species occupy relatively restricted habitats (Warkentin and Hernandez 1996). Dugong, marine turtles, snubfin and humpback dolphins migrate throughout coastal waters regularly from year to year (Parra *et al*. 2006, Marsh *et al* 2005, Preen 2000). Such site fidelity potentially conveys several ecological benefits including reduction in the costs and risks involved in relocating to new sites, and familiarity with resources and predators (Greenwood 1980).

5.3.2 Sedimentation and Increased Nutrient Loads

Elevated sediment and nutrient concentrations can negatively affect seagrass beds. Australian seagrass communities are generally characterised by low ambient nutrient loadings and increased nutrients and water turbidity can adversely affect seagrasses by lowering ambient light levels (Walker *et al.* 1999). Three major factors cause a reduction in light availability (Shepherd *et al.* 1989; Walker and McComb 1992; Abal and Dennison 1996):

- Chronic increases in dissolved nutrients leading to a proliferation of light absorbing algae including water column phytoplankton, benthic macroalgae or algal epiphytes on seagrass stems and leaves;
- Chronic increases in suspended sediments leading to increased water column turbidity; and
- Pulsed increases in suspended sediments and/or phytoplankton blooms that cause a dramatic reduction of water column light penetration for a limited time.
- All these will reduce the photosynthetic capability of affected seagrass.

Typically the areas that provide the ideal water conditions and shelter for the growth of seagrass, the primary food source for dugong and marine turtles, are also the ideal sites for port development and/or are downstream from heavily disturbed catchments (Marsh *et al*. 2002). In addition, seagrass is extremely sensitive to human impact (Marsh *et al*. 1999). Large-scale die-off of seagrass is commonly caused by smothering and lack of light as a result of high levels of suspended sediments. Although sedimentation can occur naturally, particularly as a result of cyclones and extreme rainfall events, it has been enhanced by clearing of inland and coastal vegetation, which has increased erosion and therefore the transport of sediments into rivers, estuaries and coastal waters (Green and Short 2003). This increase in sedimentation and nutrient loading has both chronic and acute impacts, causing the smothering of seagrass from regular rains as well as reducing the ability of the seagrass to recover from flooding events (Wachenfeld *et al*. 1998).

Other impacts on seagrass include direct removal and disturbance from dredging, land reclamation, mining or trawling, as well as the indirect effects of pollution from agriculture and sewage (Marsh *et al*. 1999; Marsh *et al*. 2002; Hodgson 2006).

The loss of seagrass habitats in the Project Area may have an impact on local green turtles, dugongs and dolphins (dolphins eat fish associated with seagrass meadows). The potential smothering of surrounding seagrass habitats (particularly to the north of the Project Area) from increased sediment loads during construction and maintenance dredging operations may potentially reduce the local

foraging habitat available for these species. This could result in potential displacement of animals from local areas as well as habitat fragmentation. As seagrass habitats are prevalent throughout the wider coastal area, and green turtles, dugongs and dolphins are highly mobile species, it is possible that the loss of foraging habitat will adversely affect the species at the local level and result in their movement to other areas.

5.3.3 Lighting Impacts on Turtles

There is no marine turtle nesting activity recorded within the Project footprint, however the closest nesting beach to Western Basin is on the south eastern beach of Curtis Island (not visible from the Western Basin development). As a public and highly used industrial marine area, Port Curtis is currently well lit.

The sea-finding process by turtles is directed by several cues; light brightness, shape and form of the beach environment and to a lesser extent beach slope (Lohmann *et al.* 1996). Light pollution on nesting beaches alters nocturnal behaviours in sea turtles, including; how sea turtles choose nesting sites; how they return to the sea after nesting; and how hatchlings find the sea after emerging from their nests (Witherington and Martin 1996, Salmon *et al*. 2000 cited in Limpus 2007). The most clearly demonstrated effect of artificial lighting on nesting is to deter turtles from emerging from the water (Witherington & Martin 1996). Hodge and colleagues (2007) documented disorientation of nesting flatback turtles at a low-density nesting beach at Hummock Hill Island (south of the Project Area). They determined that this disorientation was caused by the brightly illuminated salt-spray atmosphere above an alumina refinery sited some 18 km away from the nesting beach.

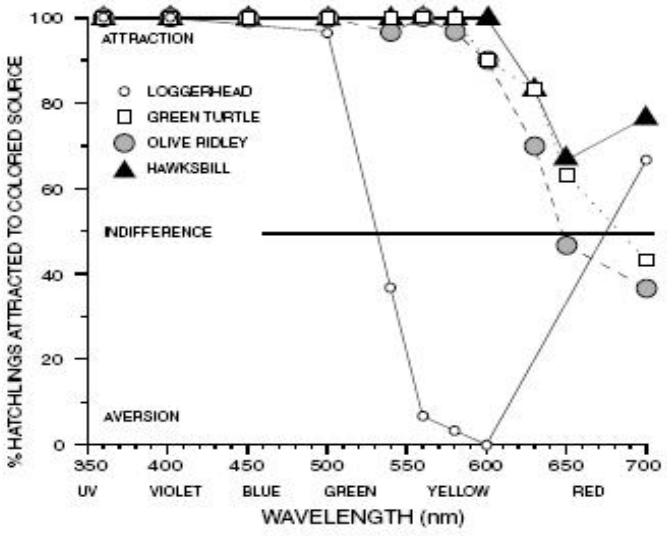
As such, Witherington and Martin (1996) regard artificial lighting of sea turtle nesting beaches as a form of 'habitat loss'. If sea turtles can't choose the most favourable nesting sites, the use of sub-optimal nesting beaches may compromise hatchling fitness, sex ratio and survivorship (Limpus 2007; Witherington and Martin 1996).

Pendoley (2005) showed conclusively that flatback hatchlings exposed to artificial light orient themselves significantly differently to hatchlings not exposed to artificial lights, though both light type and intensity, as a function of distance, are important variables. Pendoley (2005) concluded that sodium vapour lights had less potential to misorient flatback turtle hatchlings than fluoride or metal halide light sources, when all other factors (intensity and distance) are equal.

Lighting can be modified to reduce impacts to turtles by, for example;

- Restricting the height of available light or applying shrouds to control direction;
- Reducing the intensity of light glow;
- Using timers;
- Applying tint to windows; or
- Installing movement sensitive lights.

Low pressure sodium (LPS) lights are preferred based on studies that showed green turtles are less attracted to them than other lighting types and colours (Figure 28).



Source: Witherington and Martin, 1996

Figure 28 Hatchling Responses to Coloured Light Sources

5.3.4 Marine Debris

Marine debris consists of a variety of objects including litter and rubbish from boats and ships, items washed in from coastal waterways and lost fishing gear. As turtle hatchlings associate with converging zones of ocean currents, they come into close proximity to floating marine debris and consequently risk becoming entangled. Turtles may also mistake marine debris for food and ingest foreign objects, which may result in stomach and intestinal blockages. Entanglement in marine debris, such as discarded fishing line, may cause turtles to drown or become so encumbered that they cannot swim and feed properly. Debris washed up on nesting beaches may interfere with nesting turtles and prevent hatchlings from reaching the sea. During 1995–2003, there were three hatchling deaths attributed to entanglement or ingestion of plastic or other synthetic debris in Queensland (EPA Marine Wildlife Stranding and Mortality Database cited in Limpus 2007).

5.3.5 Pathogen Pollution

Recent studies have shown that pathogen pollution may have considerable negative effects on populations of coastal marine mammals (Kreuder *et al*. 2003). The carcasses of three humpback dolphins recovered along the Queensland coast between 2000 and 2001 were infected with *Toxoplasmosis gondii* (Bowater *et al*. 2003), a feline parasite that can be fatal or have deleterious effects to the health of marine mammals (e.g., infection with *T. gondii* is one of the leading causes of mortality of southern sea otters along the California coast, Kreuder *et al*. 2003). Given the small number of snubfin and humpback dolphins likely to be present in the Port Curtis/Gladstone region, the incidence of this pathogen is of serious concern.

The introduction of this parasite to the coastal ecosystem appears to be linked to runoff of contaminated water with cat faeces or litter carrying oocysts of *T. gondii* (Miller *et al*. 2002). Thus controls on the disposal of cat faeces, and improvements of the treatment of stormwater and sewage discharges will be

fundamental as a precautionary measure for the proposed development. Monitoring of the incidence of this pathogen in stranded animals and studies on its potential sources are also needed to determine areas of high risks associated with *T. gondii* infection.

Many marine turtles in southern Queensland and to a lesser extent in northern Queensland have contracted a potentially deadly virus called green turtle fibropapilloma disease. This disease has possible links with high nutrient loads in water, which may in part be attributed to coastal development and other land use practices. Monitoring of water quality within the Project Area should be undertaken to detect any possible increase in nutrient levels that may increase the opportunity for this disease to manifest.

5.3.6 Vessel Traffic

In Rodds Bay, areas used by dugongs, marine turtles and snubfin and humpback dolphins (i.e., Gladstone, creek mouths) overlap with areas of high vessel traffic. High vessel traffic in shallow coastal areas can cause serious injuries and mortalities to coastal dolphins dugong and turtles (Greenland and Limpus 2006, Groom *et al* 2004, Wells and Scott 1997,), reduce their access to particular areas within their home range (Allen and Read 2000), affect their acoustic communication (Van Parijs and Corkeron 2001), and alter their behaviour (Lusseau 2003; Constantine *et al*. 2004). All of these effects can be potentially detrimental to all marine fauna species in Port Curtis and particularly so for small populations of dolphins inhabiting Rodds Bay. In the past five years in Queensland, boat strike has been the leading cause of mortality in turtles and dugong (Table 9) (Greenland *et al.* 2004).

Boat traffic associated with the proposed Project development (including dredging activities) will create a temporary increase in vessel traffic during construction and provide potential for future permanent increases in vessel traffic to the reclaimed site. Vessel traffic is also likely to increase as a result of general population increase in Gladstone over time. The potential for boats to displace marine fauna and disrupt their behaviour is well documented (Van Parijs and Corkeron 2001; Bejder *et al*. 2006a; Bejder *et al*. 2006b; Lemon *et al*. 2006; Hodgson and Marsh 2007). The acoustic communication and group cohesion of humpback dolphins is affected by boat traffic and noise (Van Parijs and Corkeron 2001). Post mortem investigation on stranded humpback dolphins in Hong Kong suggests that some deaths may have been caused by boat strikes (Parsons and Jefferson, 2000).

Boat traffic has both direct lethal impacts as well as indirect habitat quality impacts on the surveyed marine fauna species. The incidence of marine fauna and harmful boating interactions is rapidly increasing relative to the increase in boat traffic along the urban coastline in Australia. In Queensland, the number of registered boats is currently increasing at 5% per year, and proportionally, vessel ownership and the level of on-water vessel boating is also increasing (Queensland Transport 2007). Boat strikes are a significant cause of dugong and turtle (particularly green turtles) mortality in Australia (Greenland and Limpus 2006), and their delayed response to boats makes them particularly vulnerable to large, high speed vessels (Groom *et al*. 2004; Hodgson 2004, Hazel and Gyuris, 2006). The risk of boat strikes to marine mammals and turtles increases as the density of boats increases. The relationship between boat density and the risk of boat strikes is particularly well illustrated in Florida where the number of vessel strikes on marine mammals has increased in conjunction with increasing vessel registrations (Ackerman *et al*. 1995).

The risk of boat strike is not only determined by the density of animals within an area, but also characteristics of boat traffic and the marine environment, including:

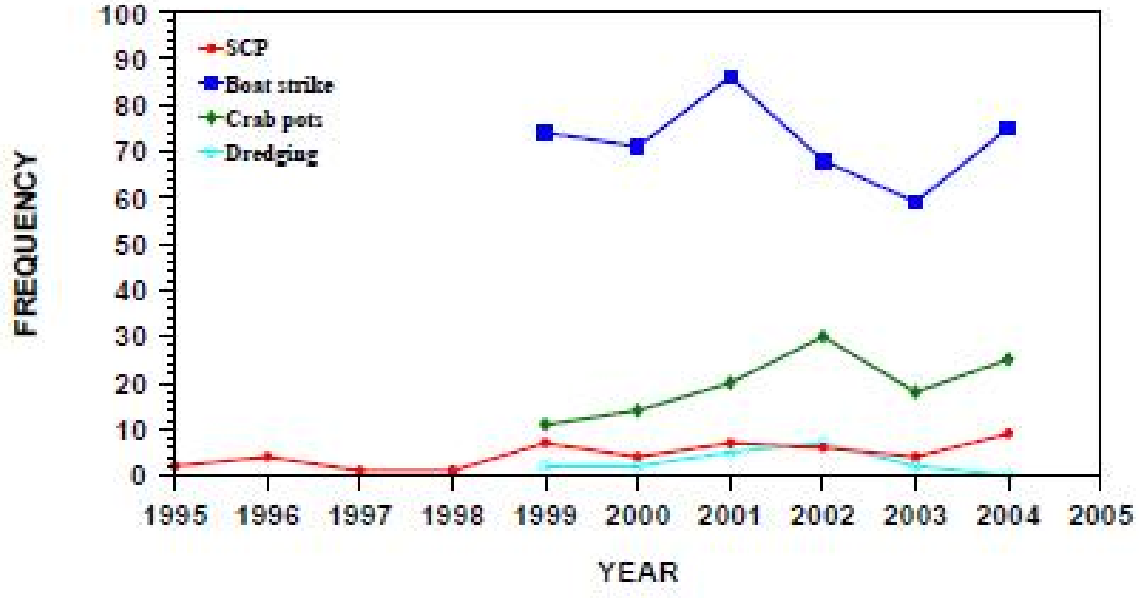
- Vessel size (draft and mass);
- Vessel speed;
- Average number of vessels transiting, and
- Depth profile of the area (Hodgson 2004).

In Moreton Bay for example, the highest number of boat strike mortalities occur within an area of low dugong densities but where large, high speed ferries are repeatedly transiting (Groom *et al*. 2004; Hodgson 2004; Greenland and Limpus 2006). Vessel speed is a key influence on the risk of vessel-strikes to marine turtles and marine mammals. The faster the vessel, the less time the animal has to take avoidance action and the greater the force of impact. Water depth affects the risk of boat strike as in shallow waters the animals cannot evade boats by diving and dugongs are known to have been crushed between boats and the water bottom (Yeates and Limpus 2003).

Disturbance from boat traffic may have indirect impacts on dugong populations through disruptions in feeding, which has been shown to occur even when boats are passing at distances greater than 500 m from the animals (Hodgson and Marsh 2007). Hazel and colleagues (2007) showed that green turtles were unable to avoid being struck by a 6 m aluminium boat travelling at speeds in excess of 4 kph (2 knots).

Where dugongs are feeding on large seagrass beds and are disrupted by a single boat passing, they tend to move in response to boats and resume feeding after approximately 2 min (Hodgson and Marsh 2007). However, dugongs and marine turtles that are feeding on small seagrass patches and are being continually disturbed by boats could either (a) have significantly reduced time available for feeding, which represents a reduction in habitat quality, or (b) could be displaced from an important feeding area, which effectively reduces the area of habitat available to a dugong population. As discussed in Section 3, dugongs and marine turtles respond to reductions in habitat quality or seagrass availability by reducing fecundity (Marsh and Kwan 2008), a response which could reduce the viability of a population.

Voluntary transit lanes and speed limits set in other areas along the Queensland coast for protection of dugongs and marine turtles have low levels of compliance (Groom 2003; Hodgson and Marsh 2007). Management of vessel speeds to protect marine megafauna species from vessel strike or disturbance should be considered as a precautionary measure in areas of high vessel traffic.



Source: Greenland and Limpus (2004)

Figure 29 Comparison of Annual Strandings and Mortality of Marine Turtles in Queensland from Anthropogenic Causes, 1995 - 2004

Table 9 Summary of Dugong Stranding and Mortality by Year and Identified Sources of Mortality in Queensland, 1996 - 2005

Cause of stranding and mortality	Year									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Natural causes										
Disease and ill health	2	3	1+2?	4	14	7	2	5	1	2
Shark	1?	1					1	1		
Stingray barb					1					
Cause undetermined		2	1	2	2	2	1			
Rescued or natural escape	1	1	2	2+2*	1+5*	1+1*	1[R]		1[R]	
Human related										
Boat strike	3	4	2		2+1*	4	7	3	4+1?	1+1[R] +2?
Entanglement in float lines and ropes					1		1	1[R]	1	
Netting	4	5	1+1?	9	3+1[R]	2			2	3+1[R]
QDPI shark control	3			2	2				2	1
Ingestion of fishing line/hooks								2		
Research			1[A]							
Hunting								1[Q]	3+1[PH]	1
Disease: *Toxoplasmosis*								1		
Undetermined		1	1?	5	3		1	6	2	1
Undetermined cause	19	12	18	41+2?	47+1?	31+6?	24+3?	19+7?	21+2?	25+2?
Total	35+1?	33+4?	27+4?	70+2?	83+1?	49+6?	40+3?	38+7?	38+3?	36+4?

Note: ? denotes non-validated dugong incident. * denotes natural escape. [A] denotes death during capture of a sick dugong. [Q] denotes a record from the Gulf of Carpentaria. [R] denotes rescued. [PH] denotes cause of death to be presumed hunting.

Source: Dugong Stranding Report (EPA, 2005)

5.3.7 Incidental Catch from Fishing Practices

Entanglements in gillnets and shark nets set for bather protection have long been recognised as a major threat for snubfin and humpback dolphins (Marsh *et al* 2005b, Cockcroft 1990; Paterson 1990; Hale 1997). Death or injury to turtles as a result of incidental capture (or bycatch) is also a significant threat; in particular, through trawling, gillnet fishing and set crab pots. In addition, entanglement in lost or discarded nets represents a very large threat.

Commercial gillnetting in Rodds Bay is permitted with safeguards and restrictions; however the coastal waters of the DPA do not include the full home range of snubfin and humpback dolphins using this area. The areas adjacent to Rodds Bay DPA offer different levels of protection. Shoalwater Bay to the north and the Great Sandy Strait to the south are both Dugong Protection Areas Type A. In these areas, the use of offshore set, foreshore set and drift nets are prohibited, except in Hervey Bay and Great Sandy Strait Protection Area where specialised fish netting practises are allowed to continue with modifications. The use of river set nets are allowed with modifications in Zone 'A' Dugong Protection Areas, except in two key areas where river set nets are prohibited (Hinchinbrook and Shoalwater Bay Dugong Protection Areas).

Although the threats from incidental drowning in gillnets have been reduced by the establishment of the Dugong Protection Areas in some of the region and the re-zoning of the Great Barrier Reef Marine Park

in 2003, the draft East Coast Finfish Management Plan proposes to allow increased gill netting in the area which increases the risk of mortality to dugongs, marine turtles and coastal dolphins. In 1991, 24 flatback Turtles were drowned in one shark net over a two-week period (Guinea & Chatto 1992) while Limpus (2007) reported that flatback turtles are regularly drowned in gill nets set along the coast of the south-eastern Gulf of Carpentaria.

Prior to the introduction of Turtle Excluder Devices (TEDs), a large number of marine turtles were drowned in trawl nets. Research suggests that some 5295 (± 1231) turtles were caught every year by trawlers operating in the waters off the East Coast of Queensland and the Great Barrier Reef, with between 1.1% and 7.8% of the turtles caught drowning (www.gbrmpa.gov.au, 2009). Nevertheless, these changes have not completely eliminated bycatch of turtles, with loggerhead turtles still being caught on drum lines in southern Queensland.

Turtles may be hooked on, or entangled in, fishing line. Williams and colleagues (1996) report that turtles can be hooked on the front and hind flippers, head, mouth, neck and carapace or get entangled in either the monofilament, mainline or balldrop/buoy line. In pot fisheries, turtles may become entangled in the float lines or enter pot traps and drown, given the Project Area supports numerous commercial crab fishers, this is a potential local impact.

Indigenous Hunting

The direct take of turtles and dugong in the Great Barrier Reef is legally restricted to traditional hunting by Aboriginal peoples and Torres Strait Islanders living adjacent to the Marine Park. Turtle meat and eggs are an important traditional element of the diet of Australia's Indigenous peoples, particularly for celebrations and family gatherings. Although dugongs have been officially protected since 1969 (Heinsohn *et al*. 1977), Indigenous Australians are allowed to hunt them as a Native Title Right. The take of turtles and dugong by Traditional Owners in the Gladstone region has not been quantified though is likely to be low as many Traditional Owner groups south of Cooktown have a voluntary moratorium on dugong hunting.

5.4 Climate Change

While there is little information about the specific effects of climate change on marine turtles, dugong or coastal dolphins, these impacts can be predicted by examining their biology and ecology. The changing temperatures and weather patterns associated with climate change are likely to have the greatest impact direct physiological impacts on marine turtles, as well as indirect effects through impacts on critical turtle habitats and feeding areas. Impacts could also be anticipated for seagrass and reef habitats associated with increased storm activity.

The sex of marine turtle hatchlings is determined by the incubation temperature of the eggs, with warmer incubation temperatures giving rise to higher numbers of female hatchlings. Climate change may alter beach sand temperatures and thus, cause changes in the male/female sex ratio in marine turtle populations. Once hatched, changing sea temperatures may affect the growth rate of hatchlings and juvenile turtles (pers comm. Ian Bell, 2009).

Climate change has the potential to affect critical marine fauna habitats. Rising sea levels and an increase in the frequency and intensity of severe storms may erode critical nesting beaches and reduce the availability of suitable nesting sites, degrade quality of available seagrass and the reduce the abundance of species that depend on these. The potential erosion of critical nesting habitats would

place a greater importance on medium to low density nesting areas such as Curtis Island which implies their integrity as a nesting beach is essential to support other beaches impacted by serious climatic events.

Climate change may also alter ocean circulation patterns and disrupt marine food webs, both of which would have significant impacts on marine fauna, particularly turtles during pelagic phases of their lifecycle.

5.4.1 Underwater Noise

The Project Area is a shallow water coastal environment. Ambient noise levels in shallow water vary widely in frequency and level distributions depending on time and location (Richardson *et al*. 1995). The primary sources of noise in most shallow water regions are distant shipping, industrial, or geophysical-survey noise; wind and wave noise; and biological noise. The Environmental Protection (Noise) Policy 2008 (Noise EPP) provides the regulatory detail under the EP Act but an underwater noise limit is not specifically detailed. The environmental values to be considered in the Noise EPP are the 'health and biodiversity of ecosystems' and the acoustic quality objective is achieved by preserving the 'amenity' of the area (Marine Park, for example). In the absence of a definitive noise policy relating to underwater noise, reference has been made to recent guidelines and other legislation to determine the likely impact of the Project.

Activities that may create underwater noise include dredging, piling driving, underwater surveying, and boats.

There is considerable national and international concern that the sounds introduced into the sea by humans could be having detrimental effects on marine mammals, by interfering with their ability to detect calls from individuals of the same species, echolocation pulses or other important natural sounds (Richardson *et al*. 1995).

Potential effects of the elevated background noise levels caused by this introduced man-made noise include:

- Limiting the detection by the mammals of natural sounds;
- Disturbing their normal behaviour resulting in possible displacement from areas; and
- Causing temporary or permanent reductions in hearing sensitivity.

These potential effects depend to a degree on the species of marine mammal involved. The potential area or zone of influence of a man-made sound is also influenced strongly by the levels and types of ambient noise (Richardson *et al.* 1995).

There is a large volume of literature concerned with the description of various impacts upon marine mammals (Richardson *et al.* 1995, McCauley 1994, Tasker & Weir 1998, Gisiner 1998, Davis *et al.* 1998, McCauley & Duncan 2001, and O'Brien 2002).

Generally, these impacts are measured through observations of behavioural responses to noises. As such, these responses are used as a surrogate measure for sensitivity or susceptibility. The number of extensive reviews available has drawn on the same limited experimental and observational data, indicating that much more of this work is required. Consequently, when considering the possible impacts of underwater noise on marine mammals, in general McCauley & Duncan (2001) suggest that it is necessary to recognise that:

- Each species in question has receptor systems for detecting the signal and that the noise frequency content must be such that it overlaps the hearing range of any species impacted;
- Different types of noises may have different effects;
- Different effects may be elicited from an approaching noise source as compared to a stationary or departing noise source; and
- The scale of the noise disturbance needs to be considered (i.e. is it frequent, infrequent or continual over short and long time scales).

Based on a review of anatomical and audiometric data Ketten (1998) supports the notion that marine mammals are acoustically diverse, with wide variations in ear anatomy, frequency range and amplitude sensitivity. The general trend is that larger species tend to have lower frequency ranges than smaller species.

All marine mammals have sensitive ears that are simultaneously adapted to sustain moderately rapid and extreme pressure changes, and which appear capable of accommodating acoustic power relationships several magnitudes greater than in air.

This is likely due to the fact that the aquatic environment propagates sound significantly more efficiently than air, and so aquatic auditory systems are adapted to these conditions. In addition, virtually all marine mammals are potentially impacted by sound sources with a frequency of 500 Hz or higher, but relatively few species are likely to be impacted by lower frequencies.

An animal's sensitivity to sounds varies with frequency, and its response to a sound is expected to depend strongly on the presence and levels of sound in the frequency band or range of frequencies to which it is sensitive (Richardson *et al.* 1995). Table 10 outlines the acoustic intensity and frequency of those sources of marine noise for which there is data, relative to the call and vocalisation ranges of marine mammals. While this information provides an indication of their known range of acoustic interactions, it does not necessarily relate to their acoustic or other physical tolerances to low frequency, high energy sound waves.

Table 10 Summary Table of Acoustic Intensity and Frequency of Noise Sources Relative to those for Marine Mammals (approximated from the literature)

Source	Acoustic Intensity (dB re 1µPa)	Frequency Range (Hz)
Great whales	130 – 188	16 – 8,000
Toothed whales (vocal)	125 – 180	1,600 – 120,000
Toothed whales (echolocation)	180 - 228	6,000 – 130,000
Dugongs	unknown	1,000 – 8,000
Earthquakes (≤4)	35 - 199	10 - 50
Ships	177	5 - 100
Seismic	215 – 230	10 - 300

Source	Acoustic Intensity (dB re 1µPa)	Frequency Range (Hz)
Extraction operations	182	unknown
Cutter-suction dredge (working)	~180	100 - 250
Clamshell dredge (working)	150-162	100 – 250
Boats	130 – 180	50 – 1000

The types of effects underwater noise may produce on marine mammals range from severe to no effect (McCauley 1994). There has been no documented evidence of any lethal effects for most whale species resulting from exposure to noise. Several studies (Malme *et al.* 1983; 1984; 1986; 1988, cited in McCauley 1994) have shown that some whales begin to avoid sounds at exposure levels of 110 dB received acoustic intensity, and more than 80% of the whales investigated including humpbacks, showed avoidance to sounds of 130 dB (re 1µPa). These sound events were continuous source (for example, ships) events. Therefore, it is likely that whales will avoid areas where the dredge is operating. However, as shipping occurs continuously within the port area, producing an acoustic intensity greater than 110 dB (re 1µPa) it is unlikely that dredging will result in a specific change to whale behaviour within the vicinity of the Port.

Recent experiments have been undertaken on bottlenose dolphins and white whales to test if any permanent changes in hearing thresholds occurred from exposure to intense signals (Schlundt *et al.* 2000). The tones in the range 40 – 7,500 Hz with levels up to 202 dB re 1 µPa (within the frequency and acoustic intensity ranges for seismic surveys and vocalisations of cetaceans, see Table 10) caused temporary threshold shifts in hearing, but returned to normal within a few days. This suggested that these whales had not suffered any sub-lethal effects from exposure.

In a long-term study over 25 years of whale responses to vessel approaches (Watkins 1986), the most vigorous response by whales came from the noise sources that changed suddenly, rapidly increased or were unexpected. Watkins (1986) also noted that whales that were preoccupied were less responsive than whales that were inactive. Other authors have found similar results where rapidly changing vessel noise often evokes a strong avoidance response, while a slow non-aggressive vessel approach results in little response from the whales (Richardson *et al.* 1995; McCauley *et al.* 1996). Vessel activity has also been implicated in long-term (Norris & Reeves 1978) and short-term (Jurasz & Palmer 1981; Baker & Herman 1989) changes in distribution of humpback whales.

There are many anecdotal reports of dugongs avoiding areas with high boat traffic, though very little research has been undertaken to investigate the sensitivity of dugongs to noise. Initial research results into the auditory physiology and hearing sensitivity have highlighted some significant anatomical differences between manatees and dugongs, as well as between sirenians and other marine mammals (URS 2003, cited in URS 2004). The sensitive parts of their auditory range appear to be restricted to the middle frequencies (1 – 18 kHz) (URS 2004). The sirenian inner ear has a mixture of marine and land mammal characteristics, and anatomically, they are relatively unspecialised. Their ears are closer to those of pinnipeds (seals and sea lions) than cetaceans, and there is no evidence that sirenians use echolocation (URS 2004).

The frequency of noise produced by dredgers (100 – 250 Hz) is outside the suspected high hearing sensitivity range of dugongs (1 – 18 kHz) and therefore it is of minimal risk to dugong.

Dredging

From the literature, the nature of dredging noise is that it occupies the mid- to low frequency range, is tonal and continuous. While there is little specific information relating to the sensitivity of cetaceans and dugongs to dredging noise, there is a trend in the information that indicates that dredging is not considered to pose a significant risk. No impacts have been observed during previous dredging campaigns at the Port.

The nature of sound from dredgers is described in the literature as being perceived as a stationary low to moderate frequency plus tonal noise. While the noise from dredgers is within the hearing frequencies of larger cetaceans, it is considered to increase ambient noise levels, but not cause undue interference or stress. It is thought that dugongs may have limited perception of dredger noises at such low frequencies (URS 2004).

In the recent revision documents for the DEH Cetacean Guidelines on the Application of the EPBC Act to Interactions between Off-shore Seismic Operations and Larger Cetaceans (URS 2004), a detailed risk assessment was undertaken for the impacts of various sources of noise on marine mammals occurring within Australian waters. The risk assessment was undertaken for those activities identified as having potentially significant impacts on marine mammals from an extensive literature review. No risk assessment was undertaken for dredging or similar sorts of activities, demonstrating that this activity is considered not to pose a significant threat to marine mammals.

Similarly, the authors of the DEH Guideline review did not consider it necessary to develop particular guidelines for management of impacts from dredging activities (URS 2004).

Underwater noise from dredging is likely to result in marine mammals avoiding the Project Area, however marine mammals may exhibit tolerance to such noise and may come into close proximity to construction activities. It is well documented for marine animals to avoid dredging activities and therefore impacts on marine life from dredging are expected to be minimal.

Pile Driving

19 channel markers may be installed as part of the Project. Installation of the channel markers will involve piling to a depth of 6-8 metres. It is expected than piling may take up to one day per marker.

An assessment of piling driving noise in the Western Basin was undertaken for the Wiggins Island Coal Terminal (Connell Hatch 2006). This assessment was based on piling activities using a 9t and 14t hammer, assuming piling noise levels ranging from 197 dB (re 1µPa) up to 226 dB (re 1µPa) at a distance of 1m from the source.

The underwater sound propagation used in the Western Basin for this assessment is consistent with the method commonly used in shallow water less than 40m deep (Urich 1983). The assessment determined an impact zone, which is an area where peak pressure levels from pile driving are predicted to be lower than the 218 dB (re 1µPa (peak)) threshold. The purpose of this impact zone is to prevent death or injury to marine mammals, fish and sea turtles. The assessment (Connell Hatch, 2006), found that using a 14t hammer for pile driving, the maximum range for the impact zone is predicted to be less than 5m.

Physiological impacts on marine mammals arising from underwater noise were assumed to be insignificant, as the noise would be detected well before the animals would reach the distance from the source established as the 'impact zone'.

Low-noise piling methods should be adopted where feasible, e.g. avoid use of impactive (or impulsive) piling methods. Should impactive piling methods be unavoidable, a soft-start procedure should be implemented between long breaks in activity, where the piling energy is gradually increased over a 5-10 minute time period. This is expected to alert animals to the presence of the piling activities and enable animals to move to a distance where the likelihood of injury is reduced. Where a marine mammal is observed within the 'impact zone' which is approximately 5m from the pile driving site, piling should be halted until the mammal has departed.

Other possible mitigation measures include:

- Bubble curtains which reduce the sources level of the piling noise;
- Acoustic deterrents which 'scare' marine species from the immediate vicinity of construction activity; and
- Acoustic and human observation techniques to ensure that species are not in the area during pile driving activities.

Animal Predation

The Queensland State government has been conducting large scale pig removal programs in northern and western Cape York Peninsula to improve hatchling survival. Fox baiting by QPWS staff continues along the mainland coast adjacent to flatback turtle rookeries. Limpus and Limpus (2003) indicate that as a result of fox control, fox predation of nests laid on mainland beaches is negligible. Foxes continue to be a significant predator of turtle eggs on Curtis Island. However, the fox baiting program along the Woongarra Coast has effectively reduced the loss of eggs to foxes to zero for this portion of the coast. The plastic mesh fox exclusion devices (FEDs) are found to be effective in preventing predation of incubating turtle eggs in natural nests on Curtis Island (Limpus *et al.* 2006).

6. Potential Impacts

The Western Basin Dredging and Disposal Project will have a number of permanent impacts on the marine ecological values of the area in which it is located. The majority of the impacts comprise the minimum removal of an area (approximately 3 km^2) of shallow and intertidal mud flat on the western basin in Port Curtis next to Fisherman's Landing (this does not include potential loss of seagrass from dredging activity in the Project Area). This area supports known seagrass habitats of demonstrated importance to dugong, marine turtles and of indirect importance to coastal dolphin species. Further, the loss of seabed associated with the reclamation works and dredging of channels (approximately 3 km^2 in total respectively) will also occur. In addition, a range of temporary impacts are expected as a result of construction activities, including dredge plume impacts and noise impacts.

A range of cumulative impacts may occur in regards to construction effects on marine megafauna species and removal of benthos.

With respect to key marine fauna species, the impacts expected to result from the Project, either during construction and dredging, include:

Direct impacts (both potential and probable);

- Removal of foraging and/or inter-nesting habitat for, marine turtle species (three species observed on survey), dugong and coastal dolphins;
- Damage/mortality to individual animals from direct contact related to construction activities;
- Impact to fauna by boat strike associated with the construction;
- Disturbance and displacement from increased noise and/or activity during construction and dredging on the local area;
- Increased rubbish that may be ingested or entangle marine fauna;
- Decline in water quality from altered hydrology (in some areas reduced flushing), dredging, construction, spills of fuel or other hydrocarbons, paint, animal waste (feline pathogens) - feral or domestic, solvents and cleaners.

Indirect impacts (both potential and probable);

- Decreased water quality from construction disturbance of sediments around the Western Basin site, mobilisation of contaminated sediment;
- An increase in sedimentation that may result in the smothering of adjacent benthic habitat communities;
- Degradation of habitats through continual human usage (including inappropriate waste management, boat fuel spills);
- Decreased water quality resulting from inappropriate waste management or an increase in sediments and pollutants as a result of construction waste or land use changes; and
- Noise and vibration impacts to marine fauna from in-water construction or ongoing operational activities.

- Reduced use of the area by mobile marine fauna may occur as a consequence of these potential impacts. This may have flow on effects for the value of the marine ecosystems within the Gladstone region.

To address this, an assessment of the risk of each impact and mitigation measures is provided below.

7. Risk Assessment

Overview

This risk assessment addresses the construction and operational aspects of the Western Basin Dredging and Disposal Project. It has been developed in order to assess the risk posed to the marine megafauna by activities undertaken as part of the proposed Project. The assessment identifies aspects of the works that pose an environmental risk, and classes these risked into one of four categories (High, Medium, Low and Very Low). The classification then allows priorities to be set for addressing and mitigating these risks.

7.1.1 The Risk Assessment Process

No international standard exists for risk management and as a result the risk assessment methodology employed here is based on the Australian Standard AS/NZS 4360: 1999 *Risk Management* (the Standard), HB 203: 2000 *Environmental Risk Management – Principles and Process* (the Guidelines), and the GPC Environment Procedure for Risk Assessment. The Standard and Guidelines set out a generic framework for establishing the context, identifying, analysing, evaluating, treating, monitoring and communicating risks. The Best Practice Environmental Management in Mining, Environmental Risk Assessment (EA, 1999) also adopts this standard though different definitions have been adopted by EA. The GPC Environment Procedure for Risk Assessment provides a whole of business risk matrix to assist in calculating the level of consequence and likelihood for identified risks.

Risk Assessment Methodology

The objective of a risk assessment is to filter the minor acceptable risks from the major non-acceptable risks. It involves consideration of the sources of risk, the consequences and the likelihood that those consequences may occur.

Risk analysis may be undertaken to various degrees of refinement depending upon the risk information and data available. Analysis techniques include:

- Qualitative assessment;
- Semi-Quantitative assessment; and
- Quantitative assessment.

In practice, a qualitative analysis is often used to first obtain a general indication of the level of risk and then a more quantitative analysis is applied to refine the risk.

A quantitative risk assessment can be undertaken based on statistical analysis for various consequences and probabilities. In the absence of statistical data, an estimate may be made of the degree of the consequence and frequency (refer to section 4.3 of the Standard).

The risk assessment methodology for this EIS uses a semi-quantitative process for determining risk. The semi-quantitative process estimates the degree of the consequence and probability and assigns a score to each. The assigned scores for consequence and probability are not linearly related to each other or to the level of environmental impact but are weighted descriptors (refer to section 4.3.4 of the Standard). The risk and impact assessment process used here to assess and weight potential Project

risks was undertaken using an Environmental Risk and Likely Impact ("ERLI") approach. For each possible impact aspect, two key areas were addressed:

Environmental Risk

This essentially considers the risk of irreversible change to natural ecological processes and community interaction. Assessment addresses:

- Conservation significance of environmental, social and cultural values and regional context of these values;
- Current level of integrity of natural ecosystem processes;
- Known sensitivity of ecosystem processes/natural values to human induced change;
- Natural change and resilience of relevant ecosystem processes/natural values;
- Potential for cumulative social and environmental impacts; and
- Level of scientific certainty of the above factors.

Likely Impact

This considered the likely impact of the Project, as modified and undertaken in accordance with mitigation strategies (including any environmental management plans or conditions from licensing/approval agencies) and includes:

- Geographic extent of the activities;
- Duration of the activities;
- Magnitude of potential environmental change;
- Confidence in prediction of impact;
- Confidence in mitigation strategies to minimise ecological and social risks; and
- Ability to monitor the impacts and detect change before irreversible change to system processes occurs.

The approach considered direct and indirect impacts, short and long term, cumulative, temporary and irreversible, and adverse and beneficial impacts.

The relative importance of each impact was examined to provide context and an ability to justifiably determine the impact's significance. In particular, the duration of the impact (temporary v permanent) and reversibility were considered. The ability of natural systems (including population, communities and ecosystems) to accept or assimilate impacts was also considered.

The above approach is used to provide the essential information that is used in the formal Risk Assessment as based on the Australian/New Zealand Standard 4360:2004. This methodology is outlined below.

Stage 1: Identification of Risk

This included identification of all relevant risks, addresses all known activities and related environmental aspects of the Project.

Stage 2: Risk Analysis

An important feature is recognition of the fact that an event's consequence extends beyond the immediate impact. This methodology ensures that the full consequences of events are visible to risk owners and managers and that the effects on the Project are all understood and treated. Each class of consequence is rated a score of 1 - 5, where "1" is minor consequence to "5" is critical.

An analysis of each risk is undertaken to determine an environmental event's likelihood of occurrence and its consequences. A five-level qualitative description of the likelihood and consequences for each risk enables a semi-quantitative method to be used to calculate a 'score' for each risk.

Definitions and scales for Consequences are shown in Table 11and definitions and scales for Likelihood are shown in Table 12.

Stage 3: Calculation of Risk Level

Two levels of risk are used:

The **Primary Risk Level (PRL)** is a conservative measure of risk, based on the most severe consequences across all the relevant criteria. PRL is calculated according to the equation:

Primary Risk Level (PRL) = Likelihood Rating X Maximum Consequence Rating

The **Secondary Risk Level (SRL)** is a less conservative measure of risk, which incorporates all relevant criteria, not just the most severe ones. SRL is calculated according to the equation:

Secondary Risk Level (SRL) = Likelihood Rating X Average Consequence Rating

In most circumstances PRL should be the preferred measure, as it is more conservative. Risk scores are banded into risk levels which provide a "plain English" view of the risk. Scores will always be visible to enable prioritisation within bands.

Table 13 and Table 14 show the bands, their threshold values and indicative management action.

Stage 4: Determination of Options for Treatment of Risks

Following the analysis of a risk it is necessary to investigate the options available for risk treatment and then determine the option or options that provide the greatest cost benefit.

Risks may be treated in one or a combination of ways[1]:

- Avoiding a risk by preventing the activity that leads to the risk eventuating;
- Reducing the likelihood of the risk eventuating;
- Reducing the consequences if the risk does eventuate;
- Transfer the risk; and
- Retaining the risk.

[1] After AS/NZS 4360:2004

Table 11 Threat Criteria and Consequence Scales

Category	Workplace Health & Safety	Environment	Financial Impact on Earnings before Interest and Tax	Community or Customer Reputation	Legal	Process Interruption
1 Minor	Near miss/no injury	On site release of pollutant contained without external assistance	Losses less than $100,000	Isolated complaint	Court action with small fine – less than $10,000	Less than 1 hour
2 Moderate	First Aid Treatment	On site release of pollutants contained with external assistance	Losses of $100,000 to $1 million	Multiple community or customer complaints	Court action with moderate fine - $10,000 to $75,000	1 hour to 1 shift
3 Significant	Medical treatment	Significant on or off site release and detrimental impacts	Losses of $1 million to $2.5 million	Community action with possible delays to Project	Court action with significant fine - $75,000 to $250,000	1 shift to 1 day
4 Major	Serious injury/lost time injury	Major offsite release and detrimental impacts	Losses of $2.5 million to $5 million	Community action severely delays Project	Court action with major fine - Greater than $250,000	1 day to 1 week
5 Critical	Major extensive injury (permanent disablement) or fatality	EPA ordered shutdown of major part of process	Losses of greater than $5 million	Community or customer outrage prevents projects or results in severe damage to Corporate image which limits future options	Court action with jail sentence	More than 1 week

Table 12 Likelihood Rating

Likelihood	Rating	Likelihood Calculator
Rare	1	The risk may occur only in exceptional circumstances (The risk is not likely to occur in the next 25 years)
Unlikely	2	The risk could occur at some time (The risk is likely to occur once in the next 5-25 years)
Possible	3	The risk might occur at some time (This risk is likely to occur in the next 2-5 years)
Likely	4	The risk will probably occur in most circumstances (The risk is likely to occur in 1-2 years)
Almost Certain	5	The risk is expected to occur in most circumstances (The risk is likely to occur within the next 12 months)

Table 13 Risk Assessment Matrix

	Consequence				
Likelihood	**Critical (5)**	**Major (4)**	**Significant (3)**	**Moderate (2)**	**Minor (1)**
Almost Certain (5)	High	High	High	Medium	Medium
Likely (4)	High	High	Medium	Medium	Low
Possible (3)	High	Medium	Medium	Low	Low
Unlikely (2)	Medium	Medium	Low	Low	Very Low
Rare (1)	Medium	Low	Low	Very Low	Very Low

Table 14 Risk Levels and Management Action (example)

Risk Level (PRL or SRL)	Descriptor	Indicative management action
1-4	Low	Manage by routine procedures, unlikely to need specific application of resources
5-10	Medium	Manage by specific monitoring or response procedures, develop more detailed actions as resources allow
10-16	High	Senior management attention needed and management responsibilities specified for further action
17-25	Extreme	Immediate action required, senior management will be involved

Limitations

As with any model, the relevance and applicability of the risk model revolves around a number of basic assumptions and limitations. The application of the risk model has been based on subjective ranges of consequences and probabilities.

Limitations of the application of the risk methodology for this assessment include:

- The assessment is based on the professional judgement of a limited number of experienced GHD staff and does not incorporate the collective experience of all parties involved with the Project. The full range of risks and the most appropriate consequence and likelihood rating would be best completed in a workshop involving key stakeholders;
- The assessment has been limited to a selected number of primary risks and the assessment of cumulative risk to the environment from multiple pollution sources or sources of environmental degradation has not been addressed. Cumulative risks are approached for this study in a qualitatively manner only.

Although a semi-quantitative methodology was used to conduct the risk assessment, the resultant risk estimation is purely relative. The risk estimations do not imply an absolute scale of risk that can be applied to any other situation or assessment.

7.1.2 Applying the Process to Expected Impacts

Table 15 adopts the process described above to provide an assessment of ecological risk for the Project with regard to marine megafauna.

Table 15 Marine Megafauna Risk Assessment

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
Construction Phase				
Building of Bund	Removal or damage to high conservation value megafauna habitat. Seagrass species, algae, and soft sediment invertebrates.	(4,5) High	No ability to control impact. Habitat is identified as high conservation value to dugong and recorded as important habitat for marine turtles and dolphins also. Offsets to be implemented for habitat losses. Consider implementation of 'like for like' offsets given importance as a foraging habitat.	(4, 5) High

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
	Water quality impacts (including from altered hydrology and siltation/sedimentation regimes) that may have potential flow on effects for trophic groups including seagrasses and fauna associated with this habitat i.e. marine turtles, dugong, dolphins.	(1, 5) Medium	No ability to control impact. Silt curtains to decrease impact inappropriate given high flow environment. Habitat and communities represented elsewhere in region except for seagrass complex. Implement offsets for habitat losses. Expected to be minimal impacts. Monitor adjacent sensitive ecosystem receptors according to Dredge Management Program and implement trigger levels for seagrass mortality on surrounding habitats. Consider bund construction approach under DMP water quality trigger levels exceeded.	(1, 5) Medium
	Alteration of intertidal benthic habitat from soft sediment to hard substrate	(3, 5) High	Will remove available seagrass foraging habitat and associated community structure at the local level potentially alienating dugong from future use in this area. Marine turtles and dolphins will likely be supported by algae, invertebrates and fish communities that will colonise the bund wall.	(3, 5) High
	Entrapment of megafauna when bund closed.	(4, 5) High	Manually remove marine fauna prior to reclamation works from closed bund. Relocate megafauna species to adjacent open marine system. Adopt a strategy to decrease potential trapping of fauna during bund construction such as use of coarse netting to deter entry into bunded area.	(4, 3) Medium
	Noise and vibration effects associated with construction works. Displacement of marine megafauna from immediate area.	(1, 4) Low	No ability to control impact. Megafauna known to occur in area presently co-exist with port and in-water operations. Impacts expected to be	(1, 4) Low

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
			temporary.	
Dredging of Material	Removal or damage to seagrass and, soft sediment habitats.	(3, 5) High	Where possible, avoid areas identified to be of high conservation value supporting critical / listed species. Dredge activities to be restricted to agreed footprint of channel works. Provide a dredging timescale to enable communities to be resilient and re-establish affected areas. Consider marine turtle nesting (Nov – Feb) and inter-nesting behaviours in dredge timing.	(2, 5) Medium
	Noise and vibration effects associated with dredging works.	(1, 5) Medium	Dredgers already operate in this environment so megafauna currently co-exist. Commence dredging operations when dredge head on sea bed to reduce turtle interactions. Impacts to be temporary and expected to be minimal.	(1, 4) Low
	Creation of habitat by changing bathymetry to a deeper habitat. Dredged channels are used by resting turtles.	Positive Benefit	Positive influence given that deeper water may provide opportunities for turtle refuge and provide alternative habitat sources, including sponge gardens. Seagrasses able to persist in deeper waters as well.	Positive Benefit
Dredging of Material - stationary dredger - clays / hard sediments		(4, 2) Medium	Fauna spotting to reduce likelihood of impact prior to deployment of dredge head.	(4, 2) Medium

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
Dredging of Material - mobile dredger - soft sediments	Direct impacts by dredge plant on marine megafauna leading to capture / reduction in diversity.	(4, 4) High	Use a tickler chain or turtle deflector head to avoid interaction with turtles resting on seabed. Maintain a fauna spotter and manage dredging operations to avoid interaction with megafauna.	(4, 2) Medium
Water Quality Impacts	Indirect impacts to surrounding foraging habitats leading to reduction in available food resources and displacement from local area	(4,5) High	Monitor water quality turbidity levels against site specific objectives within relevant sensitive ecosystem receptors and adjacent habitats, including seagrasses, and respond as required by DMP. Objectives and monitoring sites to be determined during development of DMP. Under DMP processes to respond to exceendence of trigger levels to be defined and should include potential options for alteration of dredging program to reduce/avoid cumulative plume creation. Dredge activity alteration under DMP may include reducing duration of dredging at particular locations during spring tide, relocating dredge to different areas in accordance with dredge program, planned increase in period between dredging activity at any one location to reduce seabed impacts at that site.	(4, 2) Medium
Reclamation of Land	Removal or damage to megafauna foraging habitat. Seagrass, algae, and soft sediment invertebrates.	(4,5) High	No ability to control impact. Habitat is identified as high conservation value to dugong and recorded as important habitat for marine turtles and dolphins also. Offsets to be implemented for habitat losses. Consider implementation of 'like for like' offsets given importance as a foraging habitat.	(4, 5) High

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
Pile Driving	Noise and vibration effects associated with pile driving works leading to avoidance of area by marine megafauna. Likely to be temporary impact. Small risk of direct injury to megafauna.	(4, 4) High	Use warning strikes or similar prior to commencement of pile driving (if found to be effective). Implement soft starts where possible to allow megafauna opportunity to leave area of impact. Consider use of a megafauna spotter on vessel to manage conduct of activity to avoid interaction with megafauna when animals within close proximity to vessel.	(4, 3) Medium
Other	Light spill from construction works leading to disorientation of marine fauna leading to inappropriate clustering of fauna at the site.	(1, 1) Very Low	Where possible implement lighting solutions to reduce potential attraction to site. Marine fauna currently co-exist with extensive lighting of construction and operational sites within Gladstone. Project Area not within sight of adjacent nesting habitats.	(1, 1) Very Low
	Increased vessel traffic - potential strike of marine fauna leading to death or injury.	(4, 3) Medium	Implement speed restriction areas and for construction works and Project Area. Educate construction workforce regarding risks to marine megafauna and requirement to avoid interaction with those species.	(4, 2) Medium
Operational Phase				
Water Quality Impacts	Impacts to marine water quality from alteration of stormwater input, including increased erosion or storm water run-off to adjacent marine environment during storm / flooding events. Potential to mobilise contaminants into the marine environment and reduce habitat and impact biodiversity.	(2, 3) Low	Implement appropriate topside waste and stormwater management. Design stormwater drainage systems to avoid increased scouring potential at release points in adjacent marine environment. Appropriate design of bund, including lining bund with geotextile fabric to reduce potential for fines to be moved back into marine environment through the bund wall.	(2, 2) Low

Activity Description	Potential Impacts and their Consequences	Preliminary Risk Assessment (C, L) Score	Additional Control Strategy	Residual Risk with Additional Control Strategies Adopted (C, L) Score
			Capping and revegetation of finished land surface to minimise erosion and sedimentation. Design of stormwater management system. Manage stormwater pond discharge to maintain water quality to stated objectives	
Light Spill from Western Basin Facilities	Light spill from channel markers and reclamation lighting leading to disorientation of marine fauna leading to inappropriate clustering of fauna at the site.	(1, 1) Very Low	Where possible implement lighting solutions to reduce potential attraction to site. Marine fauna currently co-exist with extensive lighting of construction and operational sites within Gladstone. Project Area not within sight of adjacent nesting habitats.	(1, 1) Very Low

8. Cumulative Impacts and Mitigation Strategies

8.1 Background

To have complete understanding of the full impact potential of a proposed development, it is necessary to assess the potential cumulative impacts that may result from the Project in combination with other projects.

An assessment of cumulative environmental impacts considers the potential impact of a proposed development in the context of:

- Previous developments to provide context to environmental resilience;
- Existing developments to understand direct potential confounding impacts; and
- Future developments to consider all potential and indirect environmental impacts.

The assessment enables all potential impacts of a project to be understood in relative context and not in isolation from other projects. Assessment of previous developments should be conducted in the context of the current baseline conditions of the environment. In this regard the existing environment has been characterised through studies conducted to complete the EIS and is reported in the main body of the EIS. Economic and social impacts from the Project are also presented in the body of the EIS, and, in accordance with the ToR, the cumulative impacts of relevance to these sections are noted here and detailed in the following sections.

A number of coastal developments are being undertaken at present or are proposed in the Gladstone within a similar time frame. The Western Basin Reclamation and Dredging EIS will facilitate further developments in this Project Area to include wharf construction and shipping. All anticipated Project dredging to facilitate these developments is assessed within this Western Basin Dredging and Disposal Project. Other associated projects and their potential impacts in this area include:

Dredging

- Wiggins Island Coal Terminal (approved project) included in our base case for modelling); and
- LNG Ltd (included in the Fisherman's Landing 153 ha EIS) - approximately 4 million m3 in Targinie Channel and Fisherman's Landing swing basin.

Marine Construction

Each LNG proponent and the potential future industries that establish on the reclamation will construct wharves and jetties – these are not assessed in this EIS. This Western Basin EIS facilitates their establishment, at present noise and access would be considered as main issues.

Shipping

This EIS assesses impacts relating to dredgers - not shipping vessels. However, an increase in shipping from the construction of wharves for LNG proponents and potential future industries that establish on the reclamation are expected.

Specific projects of relevance to this area include:

- Wiggins Island Coal Terminal – approved project;
- Gladstone Pacific Nickel - approved – dredging including in WICT approval;

- QCLNG - BG/QGC - on Curtis Island – EIS under preparation;
- LNG Ltd - on existing Fisherman's Reclamation - first stages of dredging to be undertaken separate to approvals for Western Basin - final stage of dredging is Stage 1B for Western Basin;
- GLNG - Santos/Petronas - on Curtis Island - EIS on complete and publicly available;
- Shell - on Curtis Island - no Initial Advice Statement at present; and
- APLNG - Origin/ConocoPhillips - on Curtis Island at Laird Point.

There is potential for cumulative environmental impacts to the region resulting from concurrent or successive developments particularly with regard to compounding impacts from multiple dredging and reclamation activities.

Impacts from future developments are not able to be quantified and, accordingly, it is appropriate to examine cumulative impacts across all developments from a qualitative perspective. In this regard the methodological approach to assessment of cumulative impacts for the proposed Western Basin Dredging and Disposal Project has been to:

- Describe the existing baseline conditions of relevance to the Project Area;
- Ascertain potential direct and indirect impacts from the Western Basin Dredging and Disposal Project;
- Identify mitigation and management measures for each identified impact;
- Ascertain which of the identified impacts may be compounded by concurrent or successive other developments within the local region;
- Qualitatively describe how identified impacts are compounded; and
- Identify mitigation and management measures against the compounded impact potential.

In accordance with the ToR the following describes identified cumulative impacts and mitigation measures for marine megafauna with consideration of the Western Basin Dredging and Disposal Project. This section focuses on the impacts identified in Section 7 that may be compounded by other projects occurring concurrently or in succession.

8.2 Cumulative Impacts

The Port of Gladstone has experienced ongoing development since the beginning of the twentieth century. Surveys in recent years have identified healthy seagrass habitats existing in close proximity to port facilities with high numbers of marine megafauna utilising these waters (documented for this Project). This demonstrates these communities persist under existing port operational conditions, though without prior quantified knowledge of marine megafauna populations and distribution in the local region, impacts that may have occurred from port operations are likely to remain unknown. The current baseline of marine megafauna habitat utilisation goes some way in which to base responsible decision – making with regard to future developments and potential impacts to marine megafauna.

Anticipated Project activities such as dredging and reclamation have both direct and indirect impacts on these megafauna habitats of demonstrated conservation value, it follows that the implementation of additional dredging and reclamation projects will have a cumulative impact on these communities and subsequently on marine megafauna species.

Section 5 of this report highlights existing conservation threats to megafauna species in Queensland which are currently unquantified for the Gladstone region. These impacts (unquantified) in concert with others as a result of proposed industrial developments in the Western Basin Dredging and Disposal Project Area will unquestionably impact marine megafauna identified to use the immediate Project Area.

Adjacent habitats will become increasingly important to support displaced megafauna species no longer able to continue feeding in the Western Basin Area. Safe passage between The Narrows and other habitat patches by marine megafauna will be compromised by increased vessel traffic from construction and operational activities and consequently increasing the risk of boatstrike to megafauna species, or the potential for habitat displacement as a result of underwater noise disturbance.

If the additional projects noted above all require lighting to manage their industry, lighting and response by nesting and hatchling turtles may develop into an issue of concern which will require further investigation and potential mitigation. The maintenance of acceptable water quality values, and flow regimes will also require monitoring from the relevant proponents.

Project timing and ongoing monitoring of the marine environment will be an important factor in determining potential cumulative impacts to the Project Area. Strategic assessment of these developments and resultant impacts is suggested to appropriately evaluate potential future impacts and provide guidance to monitoring and management.

9. Conclusion

Literature on previous studies within the region was reviewed prior to conduct of field work to provide information on seasonal habitat distribution and species presence to assist in designing the survey to meet local conditions and anticipated marine fauna. A survey program over nine months was implemented and included aerial and boat-based surveys for marine megafauna at a regional and finer spatial scale. Habitat utilisation of these areas by key marine fauna species (marine turtles, dugong and dolphins) was recorded and interpreted in the context of the proposed development.

Surveys recorded marine megafauna within the footprint of the development and throughout the Project Area. Megafauna identified on boat-based and aerial surveys include:

Threatened marine fauna species identified on boat-based and aerial surveys include:

- Marine turtles on aerial (majority were green turtle, *Chelonia mydas*); N = 522;
- Dugong (*Dugong dugon*); N = 81 and;
- Dolphins (majority were Indo-Pacific humpback dolphins (*Sousa chinensis*) N = 163

N= Total number of individuals recorded across all surveys (aerial or boat-based)

The larger spatial scale survey identified areas within the Survey Area that are of high value to dugong and marine turtles, with numerous animals identified in the southern part of Port Curtis (Tannum Sands) associated with known seagrass habitats. The dugong spatial model applied to the Project aerial survey data highlights the importance of three core regions in the Survey Area at high tide.

Of notable importance to this Project is the value of habitat detected in the immediate Project footprint. The Rodds Bay DPA is approximately 515 km^2 in area, of which a minimum of 3 km^2 of known seagrass habitat will be directly reclaimed and or removed by the proposed Fisherman's Landing and Western Basin reclamation Projects. Further indirect impacts to surrounding habitats are possible. Given the model output, this loss of habitat will impact and displace species within this core area.

The finer spatial scale survey identified use of habitat within the Project footprint by Indo-Pacific humpback dolphins, dugong and green turtles. It is expected that these key marine fauna species have a higher presence in areas of important habitat i.e. in close proximity to the port and channels, creek and river mouths and seagrass meadows, though the requirement to transit between habitat patches needs to also be acknowledged. The marine megafauna survey supported a number of key findings:

- Dugong distribution recorded on survey supports previous aerial survey observations by Marsh *et al.* 2005 and a close association with seagrass habitats. The habitat utilisation by dugongs was notably different at a high tide compared with low tide distributions, suggesting the importance of inter tidal seagrass habitats to dugongs in this area.
- Marine megafauna species are widely distributed throughout Port Curtis and the Gladstone region with observed high habitat utilisation, recognising the importance of Rodds Bay DPA habitat area for these coastal species, particularly on a high tide;
- The environment of Western Basin and adjacent waters represent important habitat for Indo-Pacific humpback dolphins of various age classes as numerous calves were observed on survey;

- Nesting habitats for marine turtles do not occur within the immediate footprint of the Project though inter-nesting habitat is identified within the Project Area; and
- Good quality foraging habitats exist for green turtles and habitat of high conservation value to dugongs is recognised throughout much of the Project Area and Port Curtis.

The Western Basin Dredging and Disposal Project involves the construction of a reclamation site over existing seagrass habitat within Western Basin, Port Curtis. Consequently the marine environment at this local scale will be markedly disturbed. In conjunction, within the Port Curtis region a number of other construction projects proposed to occur have the potential to result in confounding or cumulative impacts.

Each of these adjacent projects is likely to include adverse effects on the marine environment including removal of benthic seabed habitat, maintenance dredging operations and construction operations. In conjunction with the Western Basin development there is potential for greater, cumulative, impact upon water quality and vessel movements that may effect marine fauna utilisation of the area.

The main potential construction impacts, including potential cumulative impacts, that may result from the Western Basin Dredging and Disposal Project include:

- Removal of benthic habitat;
- Temporary acoustic disturbance;
- Degraded water quality associated with construction events and dredging; and
- Potential impacts to marine megafauna, from vessel operations.

The main potential operational impacts from the development include:

- Continuous disturbance of benthic marine systems;
- Impacts to water quality;
- Impacts to marine megafauna from vessel operations; and
- Increased potential of pollution to the marine environment from changed use.

Proposed mitigation strategies against each impact were identified. In brief, these include:

- Monitor benthic habitats and implement trigger levels for seagrass mortality on surrounding habitats;
- Comply with regulatory requirements for offsets with regard to habitat loss;
- Implement speed restriction areas and for construction works and Project Area. Educate construction workforce regarding risks to marine megafauna and requirement to avoid interaction with those species;
- Adopt a strategy to decrease potential trapping of fauna during bund construction such as use of coarse netting to deter entry into bunded area;
- Dredge activities to be restricted to agreed footprint of channel works. Provide a dredging timescale to enable communities to be resilient and re-establish affected;
- Implement appropriate topside waste and stormwater management;

- Whilst dredging, use a tickler chain or turtle deflector head to avoid interaction with turtles resting on seabed. Maintain a fauna spotter and manage dredging operations to avoid interaction with

megafauna. Consider marine turtle nesting (Nov – Feb) and inter-nesting behaviours in dredge schedule;

- Use warning strikes or similar prior to commencement of pile driving. Implement soft starts where possible to allow megafauna opportunity to leave area of impact. Avoid activity if breeding of megafauna noted in Project Area; and
- Where possible implement lighting solutions to reduce potential marine fauna attraction to site.

A construction and operational phase Environmental Management Plan (EMP) is recommended to address the potential impacts from this Project that explicitly addresses the aforementioned issues, e.g. water quality and vessel movements. This implemented with the knowledge of other regional Project impacts and communication with regulatory agencies will best address potential impacts to marine megafauna.

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Appendix A

Desktop Searches

Protected Matters Search Tool (EPBC)

Wildlife Online (NCA)

Queensland Museum

Qld Museum Database Search Results for Marine Reptiles and Mammals

Family	Species	Common Name	Locality	Latitude Longitude	Collection Date
Cheloniidae	Chelonia mydas	Green Turtle	Burnett River crossing, 8 km W Gayndah	25.12 151.53	4-Feb-95
Cheloniidae	Natator depressus	Flatback Turtle	Curtis Is, Sth Beach"	23.63 151.17	
Cheloniidae	Natator depressus	Flatback Turtle	Curtis Is, Sth Beach"	23.75 151.28	2-Jan-70
Cheloniidae	Natator depressus	Flatback Turtle	Gladstone, Curtis Is, S Ocean Beach	23.63 151.17	2-Jan-70
Cheloniidae	Natator depressus	Flatback Turtle	Gladstone, Curtis Is, S Ocean Beach	23.63 151.17	3-Jan-70
Hydrophiidae	Aipysurus eydouxii	Eydoux's Sea Snake	Rockhampton, Fitzroy R	23.5 150.83	
Hydrophiidae	Aipysurus eydouxii	Eydoux's Sea Snake	Rodds Bay, via Calliope	24 151.48	7-May-71
Hydrophiidae	Aipysurus laevis	Olive Sea Snake	Boyne Island, off Gladstone	23.93 151.35	
Hydrophiidae	Hydrophis sp	Sea Snake	Gladstone, Auckland Ck, Gladstone Power Stn	23.83 151.25	
Hydrophiidae	Hydrophis sp	Sea Snake	Targinie, via Gladstone	23.77 151.13	1-Jan-98
Hydrophiidae	Hydrophis elegans	Sea Snake	Boyne Island, off Gladstone	23.93 151.35	
Hydrophiidae	Hydrophis elegans	Sea Snake	Gladstone, Auckland Ck, Gladstone Power Stn	23.83 151.25	
Hydrophiidae	Hydrophis kingii	Spectacled Sea Snake	Curtis Is, S end, off Gladstone	23.75 151.3	2-Aug-70
Hydrophiidae	Hydrophis macdowelli		Gladstone, beach	23.85 151.28	
Hydrophiidae	Hydrophis major	Olive-headed Sea Snake	Boyne Island, off Gladstone	23.93 151.35	
Hydrophiidae	Hydrophis major	Olive-headed Sea Snake	Curtis Is, lighthouse	23.63 151.17	

Family	Species	Common Name	Locality	Latitude Longitude	Collection Date
Hydrophiidae	Hydrophis major	Olive-headed Sea Snake	Tannum Sands, E"	23.95 151.37	8-May-71
Hydrophiidae	Lapemis curtus	Spine-bellied Sea Snake	Off Tannum Sands	23.93 151.55	8-May-71
Cetacea			Curtis Is	23.63 151.17	
Balaenopteridae	Megaptera novaeangliae	Humpback whale	Gladstone	23.85 151.27	Aug-99
Dugongidae	Dugong cf dugong	Dugong	Gladstone Harbour, in cave	-23.85 151.27	

Qld Museum Database Search Results for Fish

Family	Species	Location	Lat/Long	Collection Date
Carcharhinidae	Rhizoprionodon taylori	Parsons Point, near Gladstone"|	23.52|151.18	06/11/1924
Rhinobatidae	Rhinobatos typus	Boyne Island, south of Gladstone	23.5623.52|151.18|151.21	12/04/1982/ 07/06/1982
Elopidae	Elops hawaiensis	Gladstone	23.51|151.17	20/10/1936
Megalopidae	Megalops cyprinoides	Gladstone	23.51|151.17	30/10/1936
Anguillidae	Anguilla reinhardtii	Baffle Ck, Colosseum, NC Line	24.21|151.37	30/09/1932
Anguillidae	Anguilla reinhardtii	Briffney Ck, Gladstone	23.53|151.14	08/12/1977|03/01/1978
Anguillidae	Anguilla reinhardtii	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Anguillidae	Anguilla reinhardtii	Gladstone, Ck at QAL access Rd	23.5|151.15	07/12/1977|10/01/1978
Anguillidae	Anguilla reinhardtii	Gladstone, Ck at Ufer Motors	23.5|151.15	08/12/1977|10/01/1978
Anguillidae	Anguilla reinhardtii	Miriamvale	24.2|151.34	24/08/1953
Anguillidae	Anguilla reinhardtii	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|04/01/1978
Muraenidae	Gymnothorax favagineus	Off Gladstone	23.51|151.17	07/05/1937
Clupeidae	Herklotsichthys castelnaui	Boyne River estuary	23.58|151.2	18/02/1999|27/10/1999
Clupeidae	Nematalosa erebi	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Clupeidae	Nematalosa erebi	Boyne River, above Awoonga Dam	24.06|151.17	11/10/1976
Clupeidae	Nematalosa erebi	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Clupeidae	Nematalosa erebi	Calliope River, downstream of	23.58|151.09	19/11/1985|28/02/1986

Family	Species	Location	Lat/Long	Collection Date
		Calliope		
Clupeidae	Nematalosa erebi	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/03/1986
Clupeidae	Nematalosa erebi	Calliope River, downstream of Calliope	23.58|151.09	
Clupeidae	Nematalosa erebi	Calliope River, downstream of Calliope	23.58|151.09	
Clupeidae	Sardinella gibbosa	Port Curtis, near Facing Island	23.55|151.23	05/02/1968
Synodontidae	Synodus sp	Off Gladstone	23.51|151.17	30/09/1936
Synodontidae	Trachinocephalus myops		23.34.5'S 151.20.1'E"|23.34|151.2	20/09/2004|23/05/2005
Harpodontidae	Harpadon translucens	Gladstone Harbour	23.51|151.17	23/04/1947
Ariidae	Arius graeffei	Boyne River below Awoonga Dam	24.04|151.19	18/10/1979
Ariidae	Arius graeffei	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|28/02/1986
Ariidae	Arius graeffei	Gladstone	23.51|151.17	30/09/1936
Plotosidae	Neosilurus hyrtlii	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Plotosidae	Neosilurus hyrtlii	Boyne River below Awoonga Dam	24.04|151.19	
Batrachoididae	Batrachomoeus dubius	Rundle Island, east of	23.33|151.29	01/10/2000|14/07/2003
Antennariidae	Tathicarpus butleri	Auckland Ck, Gladstone	23.51|151.14	29/07/1981|10/09/1981
Antennariidae	Tathicarpus butleri	Boyne Island, south of Gladstone	23.56|151.21	16/03/1959
Antennariidae	Tathicarpus butleri	Gladstone	23.51|151.17	18/05/1935
Antennariidae	Tathicarpus butleri	Port Curtis	23.55|151.23	29/10/1912
Antennariidae	Tathicarpus butleri	Port Curtis	23.55|151.23	02/02/1968
Hemiramphidae	Arrhamphus sclerolepis	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Hemiramphidae	Arrhamphus sclerolepis	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|18/06/1987
Hemiramphidae	Arrhamphus sclerolepis	Boyne River below Awoonga Dam	24.04|151.19	
Hemiramphidae	Arrhamphus sclerolepis	Boyne River, above Awoonga Dam	24.06|151.17	18/06/1987

Family	Species	Location	Lat/Long	Collection Date
Hemiramphidae	Hyporhamphus quoyi	Boyne River estuary	23.58|151.2	18/02/1999|27/10/1999
Hemiramphidae	Zenarchopterus buffonis	Calliope River, Gladstone	23.5|151.13	13/12/1993|28/09/1993
Hemiramphidae	Zenarchopterus buffonis	Flying Fox Creek, 2.5km N of Calliope River mouth	23.49|151.12	05/12/1989
Belonidae	Strongylura strongylura	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Poeciliidae	Poecilia reticulata	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Poeciliidae	Poecilia reticulata	Boyne Island, spillway channel	23.55|151.2	15/08/2004|01/02/2005
Poeciliidae	Poecilia reticulata	Briffney Ck, Gladstone	23.53|151.14	08/12/1977|03/01/1978
Poeciliidae	Poecilia reticulata	Gladstone, Ck at QAL access Rd	23.5|151.15	07/12/1977|10/01/1978
Poeciliidae	Poecilia reticulata	Gladstone, Ck at Ufer Motors	23.5|151.15	08/12/1977|10/01/1978
Poeciliidae	Poecilia reticulata	Gladstone, drain near railway line	23.51|151.16	08/12/1977|03/01/1978
Poeciliidae	Poecilia reticulata	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|04/01/1978
Poeciliidae	Xiphophorus helleri	Gladstone, Ck at Ufer Motors	23.5|151.15	08/12/1977|10/01/1978
Melanotaeniidae	Melanotaenia duboulayi	3 Moon Ck, Cania Dam, Burnett R system	24.31|151.01	05/11/1986|30/10/1987
Melanotaeniidae	Melanotaenia duboulayi	Monto, Burnett River system	24.52|151.08	27/06/1950
Melanotaeniidae	Melanotaenia duboulayi	Wuruma Dam, Nogo River, Burnett River system	25.1|150.59	28/03/1973|17/10/1978
Melanotaeniidae	Melanotaenia splendida	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Melanotaeniidae	Melanotaenia splendida	Farm Dam, east of Mt Larcom	23.46|151.08	01/08/1999|08/09/1999
Melanotaeniidae	Melanotaenia splendida	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Melanotaeniidae	Melanotaenia splendida	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1979
Melanotaeniidae	Melanotaenia splendida	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Melanotaeniidae	Melanotaenia splendida	Boyne River, above Awoonga Dam	24.06|151.17	11/10/1976
Melanotaeniidae	Melanotaenia splendida	Boyne River, above Awoonga Dam	24.06|151.17	01/06/1976|30/07/1990
Melanotaeniidae	Melanotaenia splendida	Briffney Ck, Gladstone	23.53|151.14	08/12/1977|06/01/1978
Melanotaeniidae	Melanotaenia splendida	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|06/01/1978

Family	Species	Location	Lat/Long	Collection Date
Melanotaeniidae	Melanotaenia splendida	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|06/01/1978
Melanotaeniidae	Melanotaenia splendida	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|06/01/1978
Melanotaeniidae	Pseudomugil signifer	Boyne River crossing, 4 ml SW of Bulburin	24.32|151.23	21/03/1975|24/05/1976
Melanotaeniidae	Pseudomugil signifer	Boyne River, above Awoonga Dam	24.06|151.17	
Melanotaeniidae	Pseudomugil signifer	Boyne River, Bulburin	24.31|151.29	08/12/1973|13/11/1985
Melanotaeniidae	Pseudomugil signifer	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Melanotaeniidae	Pseudomugil signifer	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/11/1986
Melanotaeniidae	Pseudomugil signifer	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Melanotaeniidae	Pseudomugil signifer	Futten Ck, Gladstone	23.51|151.16	02/08/1979|11/06/1979
Melanotaeniidae	Pseudomugil signifer	Three Mile Ck, trib Baffle Ck, S of Bororen	24.17|151.3	12/12/1977|10/01/1978
Atherinidae	Craterocephalus mugiloides	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Atherinidae	Craterocephalus stercusmuscarum	3 Moon Ck, Cania Dam, Burnett R system	24.31|151.01	05/11/1986|30/10/1987
Atherinidae	Craterocephalus stercusmuscarum	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Atherinidae	Craterocephalus stercusmuscarum	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1979
Atherinidae	Craterocephalus stercusmuscarum	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Atherinidae	Craterocephalus stercusmuscarum	Boat Ck, east of Yarwun	23.49|151.09	01/08/1999|08/09/1999
Atherinidae	Craterocephalus stercusmuscarum	Boyne River crossing, 4 ml SW of Bulburin	24.32|151.23	27/03/1975|19/11/1975
Atherinidae	Craterocephalus	Boyne River, above Awoonga Dam	24.06|151.17	

Family	Species	Location	Lat/Long	Collection Date
	stercusmuscarum			
Atherinidae	Craterocephalus stercusmuscarum	Calliope River, downstream of Calliope"|	23.58|151.09	03/09/1978|11/06/1979
Atherinidae	Craterocephalus stercusmuscarum	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Atherinidae	Craterocephalus stercusmuscarum	Futten Ck, Gladstone	23.51|151.16	02/08/1979|11/06/1979
Atherinidae	Craterocephalus stercusmuscarum	Larcom Ck, SW of Aldoga	23.5|151.03	01/08/1999|08/09/1999
Atherinidae	Craterocephalus stercusmuscarum	Monto, Burnett River system	24.52|151.08	27/06/1950
Atherinidae	Craterocephalus stercusmuscarum	Three Moon Creek, Burnett R system Mulgildie	25.06|151.08	18/06/1974
Atherinidae	Craterocephalus stercusmuscarum	Varris Ck, S of Mt Larcom	23.52|151.|	11/12/1977|03/01/1978
Atherinidae	Craterocephalus stercusmuscarum	Wuruma Dam, Nogo River, Burnett River system	25.1|150.59	28/03/1973|04/07/1973
Syngnathidae	Filicampus tigris	Gladstone	23.51|151.17	26/04/1982|17/09/1984
Syngnathidae	Hippocampus hendriki		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Syngnathidae	Hippocampus multispinus		23.43.5'S 151.39.9'E"|23.43|151.4	20/09/2004|09/05/2005
Scorpaenidae	Centropogon marmoratus	Auckland Inlet, near Gladstone Power Stn	23.51|151.14	04/10/1978|23/02/1984
Scorpaenidae	Centropogon marmoratus	Gladstone	23.51|151.17	03/03/1982|17/09/1984
Scorpaenidae	Notesthes robusta	Boyne River, south of Gladstone	24.01|151.2	14/02/1921
Scorpaenidae	Paracentropogon vespa	Calliope River mouth, Gladstone	23.55|151.1	28/03/1995|09/05/1995
Scorpaenidae	Parascorpaena mossambica		23.43.5'S	20/09/2004|04/06/2005

Family	Species	Location	Lat/Long	Collection Date
			151.39.9'E"|23.43|151.4	
Scorpaenidae	Scorpaena n.sp.1		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Scorpaenidae	Scorpaena sp M		23.45.3'S 151.33.3'E"|23.45|151.33	14/11/2005|09/06/2006
Scorpaenidae	Scorpaena sp M		23.50.1'S 151.35.1'E"|23.5|151.35	14/11/2005|09/06/2006
Aploactidae	Aploactis aspera	Curtis Island, east of	23.35|151.35	13/04/2002|10/09/2002
Aploactidae	Bathyaploactis ornatissimus	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Synanceiidae	Erosa erosa		23.45.3'S 151.33.3'E23.45|151.33	14/11/2005|09/06/2006
Synanceiidae	Inimicus caledonicus		23.38.1'S 151.27.9'E"|23.38|151.28	20/09/2004|04/06/2005
Synanceiidae	Inimicus caledonicus		23.45.3'S 151.33.3'E"|23.45|151.33	14/11/2005|09/06/2006
Synanceiidae	Synanceia horrida	Gladstone	23.51|151.17	08/06/1916
Synanceiidae	Synanceia horrida	Gladstone	23.51|151.17	17/11/1958
Platycephalidae	Ambiserrula jugosa		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Ambassidae	Ambassis agassizii	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Ambassidae	Ambassis agassizii	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1979
Ambassidae	Ambassis agassizii	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Ambassidae	Ambassis agassizii	Boat Ck, east of Yarwun	23.49|151.09	01/08/1999|08/09/1999
		Boyne River, above Awoonga Dam	24.06|151.17	
Ambassidae	Ambassis agassizii	Calliope R drainage, in dam, W of Mt Sugarloaf	23.52|151.06	01/08/1999|08/09/1999
Ambassidae	Ambassis agassizii	Farm Dam, east of Mt Larcom	23.46|151.08	01/08/1999|08/09/1999
Ambassidae	Ambassis agassizii	Farm Dam, NNE of Mt Larcom	23.46|151.06	01/08/1999|08/09/1999

Family	Species	Location	Lat/Long	Collection Date
Ambassidae	Ambassis agassizii	Futten Ck, Gladstone	23.51|151.16	02/08/1979|11/06/1979
Ambassidae	Ambassis agassizii	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|04/01/1978
Ambassidae	Ambassis agassizii	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|04/01/1978
Ambassidae	Ambassis marianus	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/11/1986
Serranidae	Anyperodon leucogrammicus	Off Gladstone	23.51|151.17	23/04/1938
Serranidae	Epinephelus coioides	Auckland Inlet, near Gladstone Power Stn	23.51|151.14	01/02/1978|23/02/1984
Serranidae	Epinephelus coioides	Calliope River mouth, Gladstone	23.55|151.1	07/05/1980|23/02/1984
Serranidae	Epinephelus coioides	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Serranidae	Epinephelus sp	Off Gladstone"|	23.51|151.17	28/12/1932
Serranidae	Triso dermopterus	Rundle Island, off	23.32|151.16	01/01/1994|14/06/1995
Serranidae	Triso dermopterus	Rundle Island, off	23.32|151.16	01/01/1994|13/09/1999
Plesiopidae	Fraudella carassiops		23.50.1'S 151.35.1'E"|23.5|151.35	14/11/2005|09/06/2006
Teraponidae	Amniataba percoides	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Teraponidae	Amniataba percoides	Boyne River below Awoonga Dam	24.04|151.19	18/06/1987
Teraponidae	Amniataba percoides	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Teraponidae	Leiopotherapon unicolor	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Teraponidae	Leiopotherapon unicolor	Farm Dam, east of Mt Larcom	23.46|151.08	01/08/1999|08/09/1999
Teraponidae	Leiopotherapon unicolor	Nogong Creek, Rundle Range	23.4|151	26/03/1975
Teraponidae	Leiopotherapon unicolor	Wuruma Dam, Nogo River, Burnett River system	25.1|150.59	28/03/1973|04/07/1973
Teraponidae	Terapon puta	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Priacanthidae	Priacanthus macracanthus	Off Gladstone	23.51|151.17	01/09/1924
Apogonidae	Apogon argyrogaster		23.39.9'S	20/05/2004|05/10/2004

Family	Species	Location	Lat/Long	Collection Date
			151.24.3'E"|23.4|151.24	
Apogonidae	Apogon argyrogaster	Curtis Island, east of	23.35|151.35	13/04/2002|10/09/2002
Apogonidae	Apogon argyrogaster	Gladstone, NE of	23.43|151.31	10/10/2000|27/07/2001
Apogonidae	Apogon limenus	Gladstone	23.51|151.17	02/02/1924
Apogonidae	Glossamia aprion	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1978
Apogonidae	Glossamia aprion	Awoonga Dam, Boyne River	24.05|151.18	02/07/1986
Apogonidae	Glossamia aprion	Boat Ck, east of Yarwun	23.49|151.09	01/08/1999|08/09/1999
Apogonidae	Glossamia aprion	Boyne River crossing, 4 ml SW of Bulburin	24.32|151.23	21/03/1975|19/11/1975
Apogonidae	Glossamia aprion	Boyne River, above Awoonga Dam	24.06|151.17	11/10/1976
Apogonidae	Glossamia aprion	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Apogonidae	Glossamia aprion	Futten Ck, Gladstone	23.51|151.16	02/08/1978|11/06/1979
Apogonidae	Glossamia aprion	Three Mile Ck, trib Baffle Ck, S of Bororen	24.17|151.3	12/12/1977|10/01/1978
Apogonidae	Glossamia aprion	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|03/01/1978
Apogonidae	Gymnapogon sp	Rundle Island, east of	23.33|151.29	01/01/2002|25/07/2002
Sillaginidae	Sillago analis	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Sillaginidae	Sillago ciliata	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Carangidae	Carangoides fulvoguttatus	Off Gladstone	23.51|151.17	
Carangidae	Caranx ignobilis	Gladstone	23.51|151.17	23/10/1936
Carangidae	Caranx melampygus	Off Gladstone"|	23.51|151.17	04/04/1974
Carangidae	Caranx sexfasciatus	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Carangidae	Gnathanodon speciosus	Off Gladstone	23.51|151.17	23/10/1936
Carangidae	Gnathanodon speciosus	Off Gladstone	23.51|151.17	27/02/1974
Carangidae	Scomberoides commersonianus	Gladstone	23.51|151.17	29/09/1936
Carangidae	Scomberoides lysan	Gladstone	23.51|151.17	08/11/1950|21/08/1974

Family	Species	Location	Lat/Long	Collection Date
Carangidae	Seriola lalandi	Off Gladstone	23.51|151.17	13/08/1936
Leiognathidae	Leiognathus equulus	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/11/1986
Lutjanidae	Lutjanus argentimaculatus	Rundles Beach, mouth of Fitzroy River	23.3|150.51	05/04/1972
Lutjanidae	Lutjanus gibbus	Off Gladstone	23.51|151.17	25/06/1974
Lutjanidae	Lutjanus russelli	Gladstone	23.51|151.17	24/07/1973
Nemipteridae	Scolopsis monogramma	Off Gladstone	23.51|151.17	12/04/1939
Gerridae	Gerres oyena	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Gerridae	Gerres subfasciatus	Boyne River estuary	23.58|151.2	18/02/1999|27/10/1999
Gerridae	Gerres subfasciatus	Gladstone"|	23.51|151.17	03/03/1983|17/09/1984
Gerridae	Gerres subfasciatus	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|28/09/1993
Haemulidae	Pomadasys kaakan	Gladstone	23.51|151.17	30/09/1936
Haemulidae	Pomadasys maculatus	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Lethrinidae	Lethrinus genivittatus	Off Gladstone	23.51|151.17	30/09/1936
Lethrinidae	Lethrinus genivittatus	Off Gladstone	23.51|151.17	30/09/1936
Lethrinidae	Lethrinus aticaudis	Off Gladstone	23.51|151.17	05/04/1972
Pentapodidae	Pentapodus aradiseus	Rock Cod Shoal	23.41|151.38	10/09/1913
Sparidae	Acanthopagrus australis	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|03/11/1986
Sparidae	Acanthopagrus australis	Curtis Island, south end	23.46|151.16	19/11/2002|22/07/2004
Sparidae	Acanthopagrus australis	Nogong Creek, Rundle Range	23.4|151	26/03/1975|24/05/1976
Sparidae	Acanthopagrus berda	Curtis Island, south end	23.46|151.16	19/11/2002|22/07/2004
Sparidae	Acanthopagrus berda	Gladstone	23.51|151.17	03/03/1982|17/09/1984
Sciaenidae	Johnius australis	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Sciaenidae	Johnius borneensis	Gladstone	23.51|151.17	06/07/1982|17/09/1984
Mullidae	Upeneus tragula	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Pempheridae	Leptobrama muelleri	Gladstone	23.51|151.17	09/10/1936
Pempheridae	Leptobrama muelleri	Gladstone	23.51|151.17	21/08/1974

Family	Species	Location	Lat/Long	Collection Date
Pempheridae	Parapriacanthus ransonneti	Polymaise Reef, south of	23.38|151.37	12/04/2002|11/07/2003
Kyphosidae	Kyphosus bigibbus	Off Gladstone	23.51|151.17	25/06/1974
Kyphosidae	Microcanthus strigatus	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Ephippidae	Drepane punctata	Gladstone	23.51|151.17	03/10/1936
Ephippidae	Drepane punctata	Gladstone	23.51|151.17	17/09/1984
Pomacanthidae	Pomacanthus semicirculatus	Off Gladstone	23.51|151.17	23/06/1974
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	02/12/1980|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	03/03/1982|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	03/04/1983|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	26/10/1977|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	03/04/1983|17/09/1984
Mugilidae	Liza subviridis	Gladstone	23.51|151.17	06/07/1982|17/09/1984
Mugilidae	Liza subviridis	Gladstone, Ck at QAL access Rd	23.5|151.15	07/12/1977|10/01/1978
Mugilidae	Liza subviridis	Nogong Creek, Rundle Range	23.4|151	02/03/1975|24/05/1976
Mugilidae	Liza tade	Gladstone	23.51|151.17	04/09/1913
Mugilidae	Liza vaigiensis	Gladstone	23.51|151.17	04/09/1913
Mugilidae	Liza vaigiensis	Gladstone	23.51|151.17	09/02/1924
Mugilidae	Liza vaigiensis	Gladstone	23.51|151.17	10/12/1924
Mugilidae	Liza vaigiensis	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Mugilidae	Mugil cephalus	Boyne River below Awoonga Dam	24.04|151.19	
Mugilidae	Mugil cephalus	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Mugilidae	Mugil cephalus	Calliope River, downstream of Calliope	23.58|151.09	19/11/1985|28/02/1986
Mugilidae	Mugil cephalus	Gladstone	23.51|151.17	04/09/1913
Mugilidae	Paramugil georgii	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Mugilidae	Paramugil georgii	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Mugilidae	Valamugil cunnesius	Gladstone	23.51|151.17	03/03/1983|03/09/1987

Family	Species	Location	Lat/Long	Collection Date
Sphyraenidae	Sphyraena jello	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Sphyraenidae	Sphyraena obtusata	Auckland Ck, Gladstone	23.51|151.14	30/09/1936
Sphyraenidae	Sphyraena sp	Gladstone	23.51|151.17	15/01/1924
Polynemidae	Eleutheronema tetradactylum	Gladstone	23.51|151.17	20/10/1936
Polynemidae	Eleutheronema tetradactylum	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Polynemidae	Polydactylus multiradiatus	Gladstone	23.51|151.17	03/03/1983|17/09/1984
Polynemidae	Polydactylus sp	Gladstone	23.51|151.17	20/10/1936
Labridae	Oxycheilinus bimaculatus	Masthead Island, west of	23.31|151.35	11/10/2002|11/07/2003
Labridae	Pteragogus flagellifer		23.45.3'S 151.33.3'E"|23.45|151.33	14/11/2005|09/06/2006
Scaridae	Scarus sp	Off Gladstone	23.51|151.17	04/08/1936
Opisthognathidae	Opistognathus eximius	Off Gladstone	23.51|151.17	18/06/1941
Blenniidae	Meiacanthus luteus		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Blenniidae	Omobranchus rotundiceps	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Blenniidae	Petroscirtes variabilis		23.36.3'S 151.35.1'E"|23.36|151.35|	20/09/2004|04/06/2005
Callionymidae	Orbonymus rameus	Cape Capricorn, 13 ml SE of	23.36|151.23	22/02/1924
Gobiidae	Bathygobius fuscus	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Gobiidae	Cabillus macrophthalmus		23.39.9'S 151.24.3'E"|23.4|151.24	20/05/2004|05/10/2004
Gobiidae	Favonigobius exquisitus	Turkey Beach, S of Gladstone	24.03|151.37	02/12/1985|12/12/1985
Gobiidae	Lubricogobius ornatus		23.34.5'S 151.20.1'E"|23.34|151.2	20/09/2004|23/05/2005
Gobiidae	Mugilogobius stigmaticus	Gladstone Marina	23.51|151.15	04/02/2001|10/02/2003
Gobiidae	Pseudogobius sp	Boyne River, south of Gladstone	24.01|151.2	21/12/1992|02/08/1995
Eleotrididae	Hypseleotris compressus	Auckland Ck, Gladstone	23.51|151.14	02/09/1978|11/06/1979
Eleotrididae	Hypseleotris compressus	Boat Ck, east of Yarwun	23.49|151.09	01/08/1999|08/09/1999

Family	Species	Location	Lat/Long	Collection Date
Eleotrididae	Hypseleotris compressus	Briffney Ck, Gladstone	23.53|151.14	08/12/1977|03/01/1978
Eleotrididae	Hypseleotris compressus	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Eleotrididae	Hypseleotris compressus	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Eleotrididae	Hypseleotris compressus	Farm Dam, east of Mt Larcom	23.46|151.08	01/08/1999|08/09/1999
Eleotrididae	Hypseleotris compressus	Four Mile Ck, S of Miriamvale	24.36|151.35	12/12/1977|03/01/1978
Eleotrididae	Hypseleotris compressus	Futten Ck, Gladstone	23.51|151.16	02/08/1979|11/06/1979
Eleotrididae	Hypseleotris compressus	Gladstone, Ck at QAL access Rd	23.5|151.15	07/12/1977|10/01/1978
Eleotrididae	Hypseleotris compressus	Gladstone, Ck at Ufer Motors	23.5|151.15	08/12/1977|10/01/1978
Eleotrididae	Hypseleotris compressus	Larcom Ck, SW of Aldoga	23.5|151.03	01/08/1999|08/09/1999
Eleotrididae	Hypseleotris compressus	Skeleton Ck, N of Miriamvale	24.2|151.3	12/12/1977|03/01/1978
Eleotrididae	Hypseleotris compressus	Sunvalley, Gladstone, at Ck	23.52|151.16	08/12/1977|04/01/1978
Eleotrididae	Hypseleotris compressus	Three Mile Ck, trib Baffle Ck, S of Bororen	24.17|151.3	12/12/1977|10/01/1978
Eleotrididae	Hypseleotris compressus	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|03/01/1978
Eleotrididae	Hypseleotris galii	Three Mile Ck, trib Baffle Ck, S of Bororen	24.17|151.3	12/12/1977|10/01/1978
Eleotrididae	Hypseleotris klunzingeri	3 Moon Ck, Cania Dam, Burnett R system	24.31|151.01	05/11/1986|30/10/1987
Eleotrididae	Hypseleotris klunzingeri	Awoonga Dam, Boyne River	24.05|151.18	20/12/1978|01/02/1979
Eleotrididae	Hypseleotris klunzingeri	Burnett R system, below Cania Dam, N of Monto	24.41|150.58	21/10/1987|30/10/1987
Eleotrididae	Hypseleotris klunzingeri	Three Moon Creek, Burnett R system, Mulgildie	25.06|151.08	08/06/1974
Eleotrididae	Hypseleotris sp	Boyne River, above Awoonga Dam	24.06|151.17	
Eleotrididae	Hypseleotris sp	Burnett R system, below Cania Dam, N of Monto	24.41|150.58	21/10/1987|30/10/1987
Eleotrididae	Hypseleotris sp	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|04/01/1978

Family	Species	Location	Lat/Long	Collection Date
Eleotrididae	Hypseleotris sp	Farm Dam, SW of Scrubby Mountain	23.45|151.04	01/08/1999|08/09/1999
Eleotrididae	Hypseleotris sp	Larcom Ck, SW of Aldoga	23.5|151.03	01/08/1999|08/09/1999
Eleotrididae	Hypseleotris sp	Varris Ck, S of Mt Larcom	23.52|151	11/12/1977|03/01/1978
Eleotrididae	Mogurnda adspersa	Calliope River, downstream of Calliope	23.58|151.09	03/09/1978|11/06/1979
Eleotrididae	Mogurnda adspersa	Clyde Ck, 15 km SW of Gladstone	23.56|151.13	09/12/1977|03/01/1978
Eleotrididae	Mogurnda adspersa	Granite Creek, Bulburin National Park	24.31|151.29	18/03/1975
Eleotrididae	Mogurnda adspersa	Larcom Ck drainage, in dam, Calliope R system	23.47|151.04	01/08/1999|08/09/1999
Eleotrididae	Mogurnda adspersa	Monto, Burnett River system	24.52|151.08	
Eleotrididae	Ophiocara porocephala	Auckland Ck, Gladstone	23.51|151.14	01/10/1991|15/04/1996
Periophthalmidae	Periophthalmodon freycineti	Port Alma	23.35|150.52	22/10/1913
Periophthalmidae	Periophthalmus novaeguiniaensis	Gladstone	23.51|151.17	23/09/1912
Amblyopidae	Caragobius sp	Boyne River estuary	23.58|151.2	18/02/1999|27/10/1999
Amblyopidae	Caragobius sp	Calliope River, Gladstone	23.5|151.13	11/05/1976
Acanthuridae	Acanthurus fuliginosus	Off Gladstone	23.51|151.17	21/02/1974
Acanthuridae	Naso unicornis	Off Gladstone	23.51|151.17	09/10/1941
Scombridae	Thunnus albacares	Off Gladstone	23.51|151.17	02/05/0039
Scombridae	Thunnus albacares	Off Gladstone	23.51|151.17	20/08/1938
Scombridae	Thunnus tonggo	Off Gladstone	23.51|151.17	23/04/1938
Bothidae	Grammatobothus	Port Curtis, near Facing Island	23.55|151.23	01/02/1968
Bothidae	Pseudorhombus arsius	Port Curtis, near Facing Island	23.55|151.23	05/02/1968
Soleidae	Paradicula setifer	Boyne River	23.56|151.18	24/03/2003|10/08/2004
Soleidae	Paradicula setifer	Calliope River	23.51|151.11	20/07/2003|10/08/2004
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	11/05/2003|12/08/2004
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	4/02/2003|12/08/2004
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	09/03/2003|12/08/2004

Family	Species	Location	Lat/Long	Collection Date
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	11/02/2003|12/08/2004
Soleidae	Pardachirus rautheri	Boyne River	23.55|151.17	19/04/2003|12/08/2004
Soleidae	Pardachirus rautheri	Calliope River	23.51|151.11|	17/04/2003|12/08/2004
Soleidae	Pardachirus rautheri	Calliope River	23.51|151.11|	21/03/2003|12/08/2004
Soleidae	Pardachirus rautheri	Fitzroy River	23.3|150.51	10/05/2003|12/08/2004
Soleidae	Phyllichthys sclerolepis	Calliope River, Gladstone	23.5|151.13	13/12/1993|28/09/1993
Monacanthidae	Anacanthus barbatus	Boyne River mouth	23.56|151.21	15/05/1959
Monacanthidae	Cantherhines sp		23.36.3'S 151.35.1'E"|23.36|151.35	20/09/2004|04/06/2005
Monacanthidae	Pseudomonacanthus elongatus	Cape Capricorn, SE of	23.38|151.25	18/10/2002|10/07/2003
Tetraodontidae	Anchiosomus multistriatus	Cape Capricorn, SE of	23.35|151.27	14/04/2002|11/07/2003
Tetraodontidae	Arothron hispidus	Gladstone	23.51|151.17	03/02/1982|17/09/1984

Queensland Government
Environmental Protection Agency
Queensland Parks and Wildlife Service

Wildlife Online Extract

Search Criteria: Species List for a Specified Point
Species: All
Type: All
Status: All
Records: All
Date: All
Latitude: 23.77007
Longitude: 151.142021
Distance: 5
Email: jeremy.simmonds@ghd.com.au
Date submitted: Thursday 14 May 2009 11:03:16
Date extracted: Thursday 14 May 2009 11:08:18

The number of records retrieved = 658

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	amphibians	Bufonidae	*Rhinella marina*	cane toad	Y			52
animals	amphibians	Hylidae	*Litoria fallax*	eastern sedgefrog		C		7
animals	amphibians	Hylidae	*Litoria nasuta*	striped rocketfrog		C		5
animals	amphibians	Hylidae	*Litoria rothii*	northern laughing treefrog		C		4
animals	amphibians	Hylidae	*Litoria dentata*	bleating treefrog		C		3
animals	amphibians	Hylidae	*Litoria wilcoxii*	eastern stony creek frog		C		2
animals	amphibians	Hylidae	*Litoria latopalmata*	broad palmed rocketfrog		C		5
animals	amphibians	Hylidae	*Cyclorana alboguttata*	greenstripe frog		C		2
animals	amphibians	Hylidae	*Litoria gracilenta*	graceful treefrog		C		3
animals	amphibians	Hylidae	*Litoria caerulea*	common green treefrog		C		12
animals	amphibians	Hylidae	*Litoria rubella*	ruddy treefrog		C		6
animals	amphibians	Hylidae	*Litoria inermis*	bumpy rocketfrog		C		4
animals	amphibians	Limnodynastidae	*Limnodynastes peronii*	striped marshfrog		C		6
animals	amphibians	Limnodynastidae	*Limnodynastes fletcheri*	barking frog		C		1
animals	amphibians	Limnodynastidae	*Limnodynastes terraereginae*	scarlet sided pobblebonk		C		12
animals	amphibians	Limnodynastidae	*Limnodynastes tasmaniensis*	spotted grassfrog		C		9
animals	amphibians	Limnodynastidae	*Platyplectrum ornatum*	ornate burrowing frog		C		10
animals	amphibians	Limnodynastidae	*Limnodynastes salmini*	salmon striped frog		C		1
animals	amphibians	Myobatrachidae	*Uperoleia rugosa*	chubby gungan		C		3
animals	amphibians	Myobatrachidae	*Pseudophryne major*	great brown broodfrog		C		6
animals	birds	Acanthizidae	*Acanthiza pusilla*	brown thornbill		C		1
animals	birds	Acanthizidae	*Smicrornis brevirostris*	weebill		C		8
animals	birds	Acanthizidae	*Gerygone levigaster*	mangrove gerygone		C		1
animals	birds	Acanthizidae	*Gerygone palpebrosa*	fairy gerygone		C		4
animals	birds	Accipitridae	*Aquila audax*	wedge-tailed eagle		C		4
animals	birds	Accipitridae	*Haliaeetus leucogaster*	white-bellied sea-eagle		C		1
animals	birds	Accipitridae	*Haliastur indus*	brahminy kite		C		5
animals	birds	Accipitridae	*Pandion cristatus*	eastern osprey		C		2
animals	birds	Accipitridae	*Lophoictinia isura*	square-tailed kite		R		1
animals	birds	Accipitridae	*Haliastur sphenurus*	whistling kite		C		6
animals	birds	Accipitridae	*Aviceda subcristata*	Pacific baza		C		4
animals	birds	Accipitridae	*Milvus migrans*	black kite		C		2
animals	birds	Aegothelidae	*Aegotheles cristatus*	Australian owlet-nightjar		C		12
animals	birds	Anatidae	*Aythya australis*	hardhead		C		2
animals	birds	Anatidae	*Chenonetta jubata*	Australian wood duck		C		1
animals	birds	Anatidae	*Dendrocygna arcuata*	wandering whistling-duck		C		4
animals	birds	Anatidae	*Anas superciliosa*	Pacific black duck		C		5
animals	birds	Anhingidae	*Anhinga novaehollandiae*	Australasian darter		C		2
animals	birds	Anseranatidae	*Anseranas semipalmata*	magpie goose		C		1
animals	birds	Ardeidae	*Ardea modesta*	eastern great egret		C		3
animals	birds	Ardeidae	*Egretta sacra*	eastern reef egret		C		1
animals	birds	Ardeidae	*Nycticorax caledonicus*	Nankeen night-heron		C		2
animals	birds	Ardeidae	*Egretta novaehollandiae*	white-faced heron		C		3
animals	birds	Ardeidae	*Butorides striata*	striated heron		C		1
animals	birds	Artamidae	*Artamus cinereus*	black-faced woodswallow		C		2
animals	birds	Artamidae	*Cracticus tibicen*	Australian magpie		C		27

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Artamidae	*Strepera graculina*	pied currawong		C		3
animals	birds	Artamidae	*Cracticus nigrogularis*	pied butcherbird		C		10
animals	birds	Artamidae	*Artamus leucorynchus*	white-breasted woodswallow		C		1
animals	birds	Artamidae	*Cracticus torquatus*	grey butcherbird		C		8
animals	birds	Burhinidae	*Burhinus grallarius*	bush stone-curlew		C		2
animals	birds	Cacatuidae	*Cacatua galerita*	sulphur-crested cockatoo		C		9
animals	birds	Cacatuidae	*Eolophus roseicapillus*	galah		C		1
animals	birds	Cacatuidae	*Calyptorhynchus banksii*	red-tailed black-cockatoo		C		5
animals	birds	Campephagidae	*Lalage leucomela*	varied triller		C		3
animals	birds	Campephagidae	*Coracina papuensis*	white-bellied cuckoo-shrike		C		7
animals	birds	Campephagidae	*Coracina tenuirostris*	cicadabird		C		12
animals	birds	Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike		C		14
animals	birds	Caprimulgidae	*Caprimulgus macrurus*	large-tailed nightjar		C		1
animals	birds	Charadriidae	*Vanellus miles*	masked lapwing		C		1
animals	birds	Charadriidae	*Vanellus miles novaehollandiae*	masked lapwing (southern subspecies)		C		2
animals	birds	Charadriidae	*Charadrius ruficapillus*	red-capped plover		C		2
animals	birds	Cisticolidae	*Cisticola exilis*	golden-headed cisticola		C		7
animals	birds	Climacteridae	*Cormobates leucophaea metastasis*	white-throated treecreeper (southern)		C		3
animals	birds	Columbidae	*Geopelia placida*					13
animals	birds	Columbidae	*Geopelia striata*	peaceful dove		C		6
animals	birds	Columbidae	*Ocyphaps lophotes*	crested pigeon		C		5
animals	birds	Columbidae	*Geopelia humeralis*	bar-shouldered dove		C		15
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	7
animals	birds	Columbidae	*Phaps chalcoptera*	common bronzewing		C		2
animals	birds	Coraciidae	*Eurystomus orientalis*	dollarbird		C		8
animals	birds	Corcoracidae	*Corcorax melanorhamphos*	white-winged chough		C		5
animals	birds	Corvidae	*Corvus orru*	Torresian crow		C		21
animals	birds	Cuculidae	*Cuculus optatus*	oriental cuckoo		C		1
animals	birds	Cuculidae	*Chalcites lucidus*	shining bronze-cuckoo		C		1
animals	birds	Cuculidae	*Eudynamys orientalis*	eastern koel		C		5
animals	birds	Cuculidae	*Cacomantis variolosus*	brush cuckoo		C		4
animals	birds	Cuculidae	*Cacomantis flabelliformis*	fan-tailed cuckoo		C		1
animals	birds	Cuculidae	*Scythrops novaehollandiae*	channel-billed cuckoo		C		9
animals	birds	Cuculidae	*Centropus phasianinus*	pheasant coucal		C		6
animals	birds	Dicruridae	*Dicrurus bracteatus*	spangled drongo		C		16
animals	birds	Estrildidae	*Taeniopygia bichenovii*	double-barred finch		C		7
animals	birds	Estrildidae	*Lonchura castaneothorax*	chestnut-breasted mannikin		C		1
animals	birds	Eurostopodidae	*Eurostopodus mystacalis*	white-throated nightjar		C		3
animals	birds	Falconidae	*Falco berigora*	brown falcon		C		2
animals	birds	Falconidae	*Falco cenchroides*	nankeen kestrel		C		1
animals	birds	Haematopodidae	*Haematopus longirostris*	Australian pied oystercatcher		C		1
animals	birds	Halcyonidae	*Dacelo leachii*	blue-winged kookaburra		C		4
animals	birds	Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra		C		24
animals	birds	Halcyonidae	*Todiramphus chloris*	collared kingfisher		C		1
animals	birds	Halcyonidae	*Todiramphus macleayii*	forest kingfisher		C		10
animals	birds	Halcyonidae	*Todiramphus sanctus*	sacred kingfisher		C		1

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animals	birds	Hirundinidae	*Hirundo neoxena*	welcome swallow		C		4
animals	birds	Jacanidae	*Irediparra gallinacea*	comb-crested jacana		C		4
animals	birds	Laridae	*Hydroprogne caspia*	Caspian tern		C		1
animals	birds	Laridae	*Gelochelidon nilotica*	gull-billed tern		C		2
animals	birds	Maluridae	*Malurus melanocephalus*	red-backed fairy-wren		C		15
animals	birds	Megaluridae	*Megalurus timoriensis*	tawny grassbird		C		1
animals	birds	Meliphagidae	*Myzomela obscura*	dusky honeyeater		C		1
animals	birds	Meliphagidae	*Lichenostomus fasciogularis*	mangrove honeyeater		C		3
animals	birds	Meliphagidae	*Melithreptus albogularis*	white-throated honeyeater		C		29
animals	birds	Meliphagidae	*Philemon citreogularis*	little friarbird		C		4
animals	birds	Meliphagidae	*Myzomela sanguinolenta*	scarlet honeyeater		C		2
animals	birds	Meliphagidae	*Manorina melanocephala*	noisy miner		C		15
animals	birds	Meliphagidae	*Philemon corniculatus*	noisy friarbird		C		23
animals	birds	Meliphagidae	*Melithreptus gularis*	black-chinned honeyeater		R		1
animals	birds	Meliphagidae	*Lichmera indistincta*	brown honeyeater		C		13
animals	birds	Meliphagidae	*Entomyzon cyanotis*	blue-faced honeyeater		C		16
animals	birds	Meliphagidae	*Meliphaga lewinii*	Lewin's honeyeater		C		1
animals	birds	Meropidae	*Merops ornatus*	rainbow bee-eater		C		20
animals	birds	Monarchidae	*Myiagra rubecula*	leaden flycatcher		C		9
animals	birds	Monarchidae	*Grallina cyanoleuca*	magpie-lark		C		4
animals	birds	Monarchidae	*Symposiarchus trivirgatus*	spectacled monarch		C		1
animals	birds	Motacillidae	*Anthus novaeseelandiae*	Australasian pipit		C		1
animals	birds	Nectariniidae	*Dicaeum hirundinaceum*	mistletoebird		C		11
animals	birds	Neosittidae	*Daphoenositta chrysoptera*	varied sittella		C		1
animals	birds	Oriolidae	*Oriolus sagittatus*	olive-backed oriole		C		5
animals	birds	Oriolidae	*Sphecotheres vieilloti*	Australasian figbird		C		8
animals	birds	Pachycephalidae	*Colluricincla harmonica*	grey shrike-thrush		C		10
animals	birds	Pachycephalidae	*Pachycephala rufiventris*	rufous whistler		C		6
animals	birds	Pachycephalidae	*Colluricincla megarhyncha*	little shrike-thrush		C		1
animals	birds	Pardalotidae	*Pardalotus striatus*	striated pardalote		C		16
animals	birds	Pelecanidae	*Pelecanus conspicillatus*	Australian pelican		C		1
animals	birds	Phalacrocoracidae	*Microcarbo melanoleucos*	little pied cormorant		C		2
animals	birds	Phasianidae	*Coturnix ypsilophora*	brown quail		C		3
animals	birds	Podargidae	*Podargus strigoides*	tawny frogmouth		C		14
animals	birds	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian grebe		C		2
animals	birds	Pomatostomidae	*Pomatostomus temporalis*	grey-crowned babbler		C		11
animals	birds	Psittacidae	*Alisterus scapularis*	Australian king-parrot		C		2
animals	birds	Psittacidae	*Trichoglossus haematodus moluccanus*	rainbow lorikeet		C		23
animals	birds	Psittacidae	*Platycercus adscitus palliceps*	pale-headed rosella (southern form)		C		1
animals	birds	Psittacidae	*Trichoglossus chlorolepidotus*	scaly-breasted lorikeet		C		17
animals	birds	Psittacidae	*Aprosmictus erythropterus*	red-winged parrot		C		5
animals	birds	Psittacidae	*Glossopsitta pusilla*	little lorikeet		C		7
animals	birds	Psittacidae	*Platycercus adscitus*	pale-headed rosella		C		21
animals	birds	Rallidae	*Gallinula tenebrosa*	dusky moorhen		C		2
animals	birds	Rhipiduridae	*Rhipidura albiscapa*	grey fantail		C		2
animals	birds	Rhipiduridae	*Rhipidura leucophrys*	willie wagtail		C		4

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animals	birds	Rhipiduridae	*Rhipidura rufifrons*	rufous fantail		C		2
animals	birds	Scolopacidae	*Numenius madagascariensis*	eastern curlew		R		3
animals	birds	Scolopacidae	*Tringa nebularia*	common greenshank		C		1
animals	birds	Scolopacidae	*Limosa lapponica*	bar-tailed godwit		C		2
animals	birds	Scolopacidae	*Numenius phaeopus*	whimbrel		C		2
animals	birds	Scolopacidae	*Calidris ruficollis*	red-necked stint		C		1
animals	birds	Scolopacidae	*Actitis hypoleucos*	common sandpiper		C		1
animals	birds	Strigidae	*Ninox boobook*	southern boobook		C		16
animals	birds	Threskiornithidae	*Platalea regia*	royal spoonbill		C		1
animals	birds	Threskiornithidae	*Threskiornis molucca*	Australian white ibis		C		1
animals	birds	Timaliidae	*Zosterops lateralis*	silvereye		C		2
animals	birds	Turnicidae	*Turnix varius*	painted button-quail		C		3
animals	bony fish	Ambassidae	*Ambassis agassizii*	Agassiz's glassfish				14
animals	bony fish	Anguillidae	*Anguilla reinhardtii*	longfin eel				1
animals	bony fish	Apogonidae	*Glossamia aprion*	mouth almighty				2
animals	bony fish	Atherinidae	*Craterocephalus stercusmuscarum*	flyspecked hardyhead				4
animals	bony fish	Centropomidae	*Lates calcarifer*	barramundi				1
animals	bony fish	Clupeidae	*Nematalosa erebi*	bony bream				3
animals	bony fish	Eleotridae	*Gobiomorphus australis*	striped gudgeon				2
animals	bony fish	Eleotridae	*Hypseleotris species 1*	Midgley's carp gudgeon				2
animals	bony fish	Eleotridae	*Hypseleotris compressa*	empire gudgeon				4
animals	bony fish	Eleotrididae	*Mogurnda adspersa*	southern purplespotted gudgeon				2
animals	bony fish	Hemiramphidae	*Arrhamphus sclerolepis*	snubnose garfish				2
animals	bony fish	Kuhliidae	*Kuhlia rupestris*	jungle perch				3
animals	bony fish	Melanotaeniidae	*Melanotaenia splendida splendida*	eastern rainbowfish				14
animals	bony fish	Monodactylidae	*Monodactylus argenteus*	diamondfish				1
animals	bony fish	Mugilidae	*Mugil cephalus*	sea mullet				4
animals	bony fish	Poeciliidae	*Gambusia holbrooki*	mosquitofish	Y			7
animals	bony fish	Poeciliidae	*Poecilia reticulata*	guppy	Y			1
animals	bony fish	Pseudomugilidae	*Pseudomugil signifer*	Pacific blue eye				2
animals	bony fish	Scatophagidae	*Selenotoca multifasciata*	striped scat				2
animals	bony fish	Terapontidae	*Terapon jarbua*	crescent grunter				1
animals	bony fish	Terapontidae	*Leiopotherapon unicolor*	spangled perch				2
animals	cartilaginous fishes	Dasyatidae	*Dasyatis fluviorum*	estuary stingray				1
animals	mammals	Bovidae	*Bos taurus*	European cattle	Y			1
animals	mammals	Canidae	*Vulpes vulpes*	red fox	Y			3
animals	mammals	Canidae	*Canis lupus dingo*	dingo				2
animals	mammals	Dasyuridae	*Planigale maculata*	common planigale		C		9
animals	mammals	Dasyuridae	*Sminthopsis murina*	common dunnart		C		2
animals	mammals	Delphinidae	*Tursiops truncatus*	bottlenose dolphin		C		1
animals	mammals	Dugongidae	*Dugong dugon*	dugong		V		1
animals	mammals	Emballonuridae	*Taphozous sp.*					3
animals	mammals	Emballonuridae	*Taphozous australis*	coastal sheathtail bat		V		4
animals	mammals	Emballonuridae	*Taphozous georgianus*	common sheathtail bat		C		4
animals	mammals	Emballonuridae	*Saccolaimus flaviventris*	yellow-bellied sheathtail bat		C		7
animals	mammals	Felidae	*Felis catus*	cat	Y			1

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animals	mammals	Leporidae	*Lepus capensis*	brown hare	Y			7
animals	mammals	Leporidae	*Oryctolagus cuniculus*	rabbit	Y			1
animals	mammals	Macropodidae	*Macropus parryi*	whiptail wallaby		C		11
animals	mammals	Macropodidae	*Macropus dorsalis*	black-striped wallaby		C		2
animals	mammals	Macropodidae	*Macropus robustus*	common wallaroo		C		1
animals	mammals	Macropodidae	*Macropus giganteus*	eastern grey kangaroo		C		21
animals	mammals	Macropodidae	*Wallabia bicolor*	swamp wallaby		C		9
animals	mammals	Molossidae	*Mormopterus sp.*					3
animals	mammals	Molossidae	*Mormopterus norfolkensis*	east coast freetail bat		C		1
animals	mammals	Molossidae	*Tadarida australis*	white-striped freetail bat		C		4
animals	mammals	Molossidae	*Mormopterus beccarii*	Beccari's freetail bat		C		2
animals	mammals	Muridae	*Mus musculus*	house mouse	Y			9
animals	mammals	Muridae	*Melomys cervinipes*	fawn-footed melomys		C		3
animals	mammals	Muridae	*Rattus rattus*	black rat	Y			1
animals	mammals	Peramelidae	*Isoodon macrourus*	northern brown bandicoot		C		10
animals	mammals	Petauridae	*Petaurus breviceps*	sugar glider		C		4
animals	mammals	Petauridae	*Petaurus norfolcensis*	squirrel glider		C		1
animals	mammals	Petauridae	*Petaurus australis australis*	yellow-bellied glider (southern subspecies)		C		4
animals	mammals	Phalangeridae	*Trichosurus vulpecula*	common brushtail possum		C		19
animals	mammals	Potoroidae	*Aepyprymnus rufescens*	rufous bettong		C		3
animals	mammals	Pseudocheiridae	*Petauroides volans*	greater glider		C		15
animals	mammals	Pteropodidae	*Pteropus alecto*	black flying-fox		C		1
animals	mammals	Suidae	*Sus scrofa*	pig	Y			1
animals	mammals	Tachyglossidae	*Tachyglossus aculeatus*	short-beaked echidna		C		3
animals	mammals	Vespertilionidae	*Nyctophilus sp.*					4
animals	mammals	Vespertilionidae	*Miniopterus schreibersii oceanensis*	eastern bent-wing bat		C		8
animals	mammals	Vespertilionidae	*Chalinolobus nigrogriseus*	hoary wattled bat		C		3
animals	mammals	Vespertilionidae	*Miniopterus australis*	little bent-wing bat		C		8
animals	mammals	Vespertilionidae	*Vespadelus vulturnus*	little forest bat		C		1
animals	mammals	Vespertilionidae	*Scotorepens greyii*	little broad-nosed bat		C		10
animals	mammals	Vespertilionidae	*Vespadelus pumilus*	eastern forest bat		C		1
animals	mammals	Vespertilionidae	*Chalinolobus gouldii*	Gould's wattled bat		C		7
animals	mammals	Vespertilionidae	*Scoteanax rueppellii*	greater broad-nosed bat		C		4
animals	mammals	Vespertilionidae	*Chalinolobus picatus*	little pied bat		R		2
animals	mammals	Vespertilionidae	*Chalinolobus morio*	chocolate wattled bat		C		1
animals	mammals	Vespertilionidae	*Scotorepens orion*	south-eastern broad-nosed bat		C		6
animals	reptiles	Agamidae	*Pogona barbata*	bearded dragon		C		2
animals	reptiles	Agamidae	*Diporiphora australis*			C		3
animals	reptiles	Agamidae	*Amphibolurus nobbi nobbi*	nobbi		C		1
animals	reptiles	Agamidae	*Chlamydosaurus kingii*	frilled lizard		C		5
animals	reptiles	Agamidae	*Amphibolurus nobbi*			C		4
animals	reptiles	Boidae	*Morelia spilota*	carpet python		C		2
animals	reptiles	Boidae	*Aspidites melanocephalus*	black-headed python		C		2
animals	reptiles	Chelidae	*Emydura sp.*					1
animals	reptiles	Colubridae	*Boiga irregularis*	brown tree snake		C		1

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animals	reptiles	Colubridae	*Tropidonophis mairii*	freshwater snake		C		2
animals	reptiles	Colubridae	*Dendrelaphis punctulata*	common tree snake		C		2
animals	reptiles	Elapidae	*Demansia vestigiata*	black whip snake		C		2
animals	reptiles	Elapidae	*Vermicella annulata*	bandy-bandy		C		6
animals	reptiles	Elapidae	*Hemiaspis signata*	black-bellied swamp snake		C		1
animals	reptiles	Elapidae	*Demansia psammophis*	yellow-faced whip snake		C		5
animals	reptiles	Elapidae	*Cacophis harriettae*	white-crowned snake		C		1
animals	reptiles	Elapidae	*Furina diadema*	red-naped snake		C		4
animals	reptiles	Elapidae	*Oxyuranus scutellatus*	coastal taipan		C		1
animals	reptiles	Elapidae	*Rhinoplocephalus nigrescens*	eastern small-eyed snake		C		2
animals	reptiles	Elapidae	*Rhinoplocephalus nigrostriatus*	black-striped snake		C		1
animals	reptiles	Gekkonidae	*Gehyra dubia*			C		11
animals	reptiles	Gekkonidae	*Oedura rhombifer*	zig-zag gecko		C		13
animals	reptiles	Gekkonidae	*Heteronotia binoei*	Bynoe's gecko		C		22
animals	reptiles	Gekkonidae	*Gehyra catenata*			C		1
animals	reptiles	Gekkonidae	*Diplodactylus vittatus*	wood gecko		C		7
animals	reptiles	Pygopodidae	*Lialis burtonis*	Burton's legless lizard		C		3
animals	reptiles	Scincidae	*Carlia munda*			C		12
animals	reptiles	Scincidae	*Carlia vivax*			C		39
animals	reptiles	Scincidae	*Menetia greyii*			C		3
animals	reptiles	Scincidae	*Carlia foliorum*			C		37
animals	reptiles	Scincidae	*Eulamprus tenuis*			C		3
animals	reptiles	Scincidae	*Lerista fragilis*			C		5
animals	reptiles	Scincidae	*Carlia pectoralis*			C		11
animals	reptiles	Scincidae	*Carlia schmeltzii*			C		19
animals	reptiles	Scincidae	*Ctenotus taeniolatus*	copper-tailed skink		C		8
animals	reptiles	Scincidae	*Eulamprus brachysoma*			C		4
animals	reptiles	Scincidae	*Anomalopus verreauxii*			C		3
animals	reptiles	Scincidae	*Lampropholis delicata*			C		5
animals	reptiles	Scincidae	*Morethia taeniopleura*	fire-tailed skink		C		2
animals	reptiles	Scincidae	*Calyptotis lepidorostrum*			C		2
animals	reptiles	Scincidae	*Glaphyromorphus punctulatus*			C		4
animals	reptiles	Scincidae	*Cryptoblepharus virgatus sensu lato*			C		34
animals	reptiles	Typhlopidae	*Ramphotyphlops wiedii*			C		6
animals	reptiles	Typhlopidae	*Ramphotyphlops unguirostris*			C		1
animals	reptiles	Varanidae	*Varanus varius*	lace monitor		C		1
animals	reptiles	Varanidae	*Varanus gouldii*	sand monitor		C		1
animals	reptiles	Varanidae	*Varanus tristis*	black-tailed monitor		C		5
animals	reptiles	Varanidae	*Varanus semiremex*	rusty monitor		R		1
plants	cycads	Zamiaceae	*Macrozamia miquelii*			C		2/1
plants	ferns	Adiantaceae	*Pellaea nana*			C		1/1
plants	ferns	Adiantaceae	*Cheilanthes sieberi*			C		3
plants	ferns	Adiantaceae	*Cheilanthes nudiuscula*			C		2
plants	ferns	Adiantaceae	*Adiantum hispidulum var. hispidulum*			C		2/2
plants	ferns	Adiantaceae	*Adiantum aethiopicum*			C		1
plants	ferns	Adiantaceae	*Adiantum hispidulum*			C		5

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plants	ferns	Adiantaceae	*Pellaea paradoxa*	heart fern		C		1
plants	ferns	Adiantaceae	*Pellaea falcata*			C		2
plants	ferns	Aspleniaceae	*Asplenium nidus*			C		1
plants	ferns	Aspleniaceae	*Asplenium australasicum*			C		3/1
plants	ferns	Davalliaceae	*Davallia pyxidata*			C		1
plants	ferns	Dennstaedtiaceae	*Pteridium esculentum*	common bracken		C		1
plants	ferns	Marsileaceae	*Marsilea mutica*	shiny nardoo		C		1
plants	ferns	Nephrolepidaceae	*Arthropteris tenella*	climbing fern		C		2/2
plants	ferns	Nephrolepidaceae	*Nephrolepis cordifolia*	fishbone fern		C		1
plants	ferns	Polypodiaceae	*Drynaria rigidula*			C		1
plants	ferns	Polypodiaceae	*Pyrrosia rupestris*	rock felt fern		C		1
plants	ferns	Polypodiaceae	*Microsorum punctatum*			C		2/1
plants	ferns	Polypodiaceae	*Platycerium bifurcatum*			C		1
plants	ferns	Polypodiaceae	*Pyrrosia confluens var. confluens*			C		2/2
plants	ferns	Polypodiaceae	*Drynaria sparsisora*			C		2/2
plants	ferns	Polypodiaceae	*Pyrrosia confluens*			C		1
plants	higher dicots	Acanthaceae	*Brunoniella*			C		1
plants	higher dicots	Acanthaceae	*Pseuderanthemum variabile*	pastel flower		C		4
plants	higher dicots	Acanthaceae	*Rostellularia adscendens*			C		2
plants	higher dicots	Acanthaceae	*Harnieria hygrophiloides*	white karambal		C		1
plants	higher dicots	Acanthaceae	*Brunoniella australis*	blue trumpet		C		2
plants	higher dicots	Aizoaceae	*Sesuvium portulacastrum*	sea purslane		C		1
plants	higher dicots	Amaranthaceae	*Achyranthes aspera*			C		1
plants	higher dicots	Amaranthaceae	*Alternanthera nana*	hairy joyweed		C		1
plants	higher dicots	Anacardiaceae	*Euroschinus falcatus*			C		5
plants	higher dicots	Anacardiaceae	*Pleiogynium timorense*	Burdekin plum		C		8
plants	higher dicots	Apocynaceae	*Carissa ovata*	currantbush		C		4
plants	higher dicots	Apocynaceae	*Hoya australis*			C		7
plants	higher dicots	Apocynaceae	*Alyxia magnifolia*			R		2
plants	higher dicots	Apocynaceae	*Marsdenia microlepis*			C		1
plants	higher dicots	Apocynaceae	*Parsonsia straminea*	monkey rope		C		2
plants	higher dicots	Apocynaceae	*Alstonia constricta*	bitterbark		C		4/1
plants	higher dicots	Apocynaceae	*Secamone elliptica*			C		4
plants	higher dicots	Apocynaceae	*Parsonsia velutina*	hairy silkpod		C		4
plants	higher dicots	Apocynaceae	*Marsdenia rostrata*			C		1/1
plants	higher dicots	Apocynaceae	*Cynanchum bowmanii*	bowman's milkvine		C		3
plants	higher dicots	Apocynaceae	*Marsdenia lloydii*			C		2/1
plants	higher dicots	Apocynaceae	*Alyxia ruscifolia*			C		5/1
plants	higher dicots	Apocynaceae	*Sarcostemma viminale subsp. brunonianum*			C		1
plants	higher dicots	Apocynaceae	*Sarcostemma viminale subsp. australe*			C		1
plants	higher dicots	Apocynaceae	*Parsonsia longipetiolata*			C		1
plants	higher dicots	Apocynaceae	*Gomphocarpus physocarpus*	balloon cottonbush	Y			3
plants	higher dicots	Apocynaceae	*Parsonsia paulforsteri*			C		1/1
plants	higher dicots	Apocynaceae	*Parsonsia leichhardtii*	black silkpod		C		1
plants	higher dicots	Apocynaceae	*Tylophora grandiflora*			C		1
plants	higher dicots	Apocynaceae	*Marsdenia viridiflora*			C		1

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plants	higher dicots	Apocynaceae	*Parsonsia rotata*	veinless silkpod		C		2
plants	higher dicots	Araliaceae	*Polyscias elegans*	celery wood		C		5
plants	higher dicots	Araliaceae	*Schefflera actinophylla*	umbrella tree		C		1
plants	higher dicots	Asclepiadaceae	*Sarcostemma viminale*			C		1
plants	higher dicots	Asteraceae	*Bidens pilosa*		Y			1
plants	higher dicots	Asteraceae	*Olearia canescens*			C		1
plants	higher dicots	Asteraceae	*Emilia sonchifolia*		Y			4
plants	higher dicots	Asteraceae	*Peripleura hispidula*			C		2
plants	higher dicots	Asteraceae	*Acmella grandiflora var. brachyglossa*			C		2/1
plants	higher dicots	Asteraceae	*Centratherum australianum*			C		1/1
plants	higher dicots	Asteraceae	*Pterocaulon sphacelatum*	applebush		C		4
plants	higher dicots	Asteraceae	*Ozothamnus cassinioides*			C		1/1
plants	higher dicots	Asteraceae	*Sigesbeckia orientalis*	Indian weed		C		1
plants	higher dicots	Asteraceae	*Wedelia spilanthoides*			C		1
plants	higher dicots	Asteraceae	*Cyanthillium cinereum*			C		2
plants	higher dicots	Asteraceae	*Glossocardia bidens*	native cobbler's pegs		C		2
plants	higher dicots	Asteraceae	*Conyza sumatrensis*	tall fleabane	Y			2
plants	higher dicots	Bignoniaceae	*Pandorea pandorana*	wonga vine		C		4/1
plants	higher dicots	Cactaceae	*Opuntia*			C		2
plants	higher dicots	Caesalpiniaceae	*Caesalpinia*			C		1
plants	higher dicots	Caesalpiniaceae	*Barklya syringifolia*	golden shower tree		C		6/1
plants	higher dicots	Caesalpiniaceae	*Chamaecrista absus var. absus*			C		4/1
plants	higher dicots	Caesalpiniaceae	*Chamaecrista nomame var. nomame*			C		2
plants	higher dicots	Caesalpiniaceae	*Caesalpinia scortechinii*	large prickle vine		C		1
plants	higher dicots	Capparaceae	*Capparis arborea*	brush caper berry		C		3
plants	higher dicots	Capparaceae	*Capparis sarmentosa*	scrambling caper		C		1
plants	higher dicots	Capparaceae	*Capparis loranthifolia*			C		2
plants	higher dicots	Capparaceae	*Capparis canescens*			C		6
plants	higher dicots	Casuarinaceae	*Allocasuarina torulosa*			C		3
plants	higher dicots	Celastraceae	*Denhamia pittosporoides*			C		2
plants	higher dicots	Celastraceae	*Elaeodendron melanocarpum*			C		2
plants	higher dicots	Chenopodiaceae	*Suaeda australis*			C		1
plants	higher dicots	Chenopodiaceae	*Halosarcia indica*			C		1
plants	higher dicots	Chenopodiaceae	*Halosarcia halocnemoides*			C		1
plants	higher dicots	Chenopodiaceae	*Sarcocornia quinqueflora*			C		1
plants	higher dicots	Combretaceae	*Lumnitzera racemosa*			C		1
plants	higher dicots	Combretaceae	*Terminalia porphyrocarpa*			C		8/2
plants	higher dicots	Convolvulaceae	*Evolvulus alsinoides*			C		2
plants	higher dicots	Convolvulaceae	*Jacquemontia paniculata*			C		2/1
plants	higher dicots	Cornaceae	*Alangium villosum subsp. tomentosum*			C		1
plants	higher dicots	Cucurbitaceae	*Diplocyclos palmatus*			C		1/1
plants	higher dicots	Cucurbitaceae	*Diplocyclos palmatus subsp. palmatus*			C		1/1
plants	higher dicots	Ebenaceae	*Diospyros geminata*	scaly ebony		C		8/2
plants	higher dicots	Ebenaceae	*Diospyros australis*	black plum		C		2
plants	higher dicots	Ebenaceae	*Diospyros fasciculosa*	grey ebony		C		1
plants	higher dicots	Elaeocarpaceae	*Elaeocarpus obovatus*	blueberry ash		C		1/1

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plants	higher dicots	Erythroxylaceae	*Erythroxylum australe*	cocaine tree		C		2
plants	higher dicots	Euphorbiaceae	*Ricinocarpos ledifolius*	scrub wedding bush		C		1
plants	higher dicots	Euphorbiaceae	*Excoecaria dallachyana*	scrub poison tree		C		1
plants	higher dicots	Euphorbiaceae	*Claoxylon tenerifolium*	Queensland brittlewood		C		1
plants	higher dicots	Euphorbiaceae	*Mallotus philippensis*	red kamala		C		6/1
plants	higher dicots	Euphorbiaceae	*Mallotus claoxyloides*	green kamala		C		4
plants	higher dicots	Euphorbiaceae	*Croton acronychioides*	thick-leaved croton		C		5/1
plants	higher dicots	Euphorbiaceae	*Alchornea ilicifolia*	native holly		C		5
plants	higher dicots	Euphorbiaceae	*Croton phebalioides*	narrow-leaved croton		C		3
plants	higher dicots	Euphorbiaceae	*Homalanthus nutans*			C		1/1
plants	higher dicots	Euphorbiaceae	*Croton stigmatosus*	white croton		C		1
plants	higher dicots	Euphorbiaceae	*Baloghia inophylla*	scrub bloodwood		C		3/1
plants	higher dicots	Euphorbiaceae	*Acalypha eremorum*	soft acalypha		C		5
plants	higher dicots	Euphorbiaceae	*Croton insularis*	Queensland cascarilla		C		2
plants	higher dicots	Euphorbiaceae	*Chamaesyce hirta*	asthma plant	Y			3
plants	higher dicots	Euphorbiaceae	*Tragia novae-hollandiae*	stinging-vine		C		2
plants	higher dicots	Fabaceae	*Glycine*			C		2
plants	higher dicots	Fabaceae	*Stylosanthes*			C		2
plants	higher dicots	Fabaceae	*Swainsona*			C		2
plants	higher dicots	Fabaceae	*Desmodium*			C		2
plants	higher dicots	Fabaceae	*Derris involuta*	native derris		C		1
plants	higher dicots	Fabaceae	*Zornia muriculata*			C		1
plants	higher dicots	Fabaceae	*Glycine tomentella*	woolly glycine		C		3
plants	higher dicots	Fabaceae	*Desmodium heterocarpon var. strigosum*			C		2/1
plants	higher dicots	Fabaceae	*Glycine clandestina var. clandestina*			C		2
plants	higher dicots	Fabaceae	*Austrosteenisia blackii var. blackii*			C		1/1
plants	higher dicots	Fabaceae	*Zornia muriculata subsp. muriculata*			C		2/1
plants	higher dicots	Fabaceae	*Tephrosia filipes subsp. filipes*			C		2
plants	higher dicots	Fabaceae	*Desmodium rhytidophyllum*			C		2
plants	higher dicots	Fabaceae	*Austrosteenisia blackii*	bloodvine		C		5
plants	higher dicots	Fabaceae	*Aeschynomene micranthos*			C		2/2
plants	higher dicots	Fabaceae	*Crotalaria medicaginea*	trefoil rattlepod		C		1
plants	higher dicots	Fabaceae	*Hardenbergia violacea*			C		1/1
plants	higher dicots	Fabaceae	*Erythrina vespertilio*			C		2
plants	higher dicots	Fabaceae	*Desmodium brachypodum*	large ticktrefoil		C		3
plants	higher dicots	Fabaceae	*Alysicarpus vaginalis*		Y			1
plants	higher dicots	Fabaceae	*Pycnospora lutescens*	pycnospora		C		2
plants	higher dicots	Fabaceae	*Indigofera linifolia*			C		1
plants	higher dicots	Fabaceae	*Galactia tenuiflora*			C		4
plants	higher dicots	Fabaceae	*Desmodium triflorum*		Y			1
plants	higher dicots	Fabaceae	*Zornia dyctiocarpa*			C		3
plants	higher dicots	Fabaceae	*Jacksonia scoparia*			C		1
plants	higher dicots	Fabaceae	*Indigofera linnaei*	Birdsville indigo		C		4/1
plants	higher dicots	Fabaceae	*Crotalaria montana*			C		4
plants	higher dicots	Fabaceae	*Rhynchosia minima*			C		1
plants	higher dicots	Flacourtiaceae	*Homalium alnifolium*	homalium		C		1

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plants	higher dicots	Goodeniaceae	*Brunonia australis*	blue pincushion		C		3
plants	higher dicots	Lamiaceae	*Callicarpa pedunculata*	velvet leaf		C		1/1
plants	higher dicots	Lamiaceae	*Clerodendrum floribundum*			C		2
plants	higher dicots	Lamiaceae	*Glossocarya hemiderma*			C		6
plants	higher dicots	Lamiaceae	*Anisomeles malabarica*			C		1
plants	higher dicots	Lamiaceae	*Plectranthus parviflorus*			C		2/1
plants	higher dicots	Lecythidaceae	*Planchonia careya*	cockatoo apple		C		10
plants	higher dicots	Loganiaceae	*Strychnos psilosperma*	strychnine tree		C		7/1
plants	higher dicots	Malvaceae	*Sida*			C		2/2
plants	higher dicots	Malvaceae	*Sida rohlenae*			C		2
plants	higher dicots	Malvaceae	*Sida subspicata*	spiked sida		C		6/1
plants	higher dicots	Malvaceae	*Abutilon auritum*	Chinese lantern		C		1
plants	higher dicots	Malvaceae	*Sida rhombifolia*		Y			1
plants	higher dicots	Malvaceae	*Abutilon oxycarpum*			C		1
plants	higher dicots	Malvaceae	*Hibiscus divaricatus*			C		1/1
plants	higher dicots	Malvaceae	*Hibiscus heterophyllus*			C		2/1
plants	higher dicots	Malvaceae	*Malvastrum americanum var. americanum*		Y			1
plants	higher dicots	Meliaceae	*Melia azedarach*	white cedar		C		1
plants	higher dicots	Meliaceae	*Turraea pubescens*	native honeysuckle		C		6/1
plants	higher dicots	Mimosaceae	*Acacia maidenii*	Maiden's wattle		C		5
plants	higher dicots	Mimosaceae	*Acacia leiocalyx*			C		7
plants	higher dicots	Mimosaceae	*Acacia fasciculifera*	scaly bark		C		1
plants	higher dicots	Mimosaceae	*Acacia crassa subsp. longicoma*			C		9/3
plants	higher dicots	Mimosaceae	*Acacia excelsa subsp. excelsa*			C		1/1
plants	higher dicots	Mimosaceae	*Archidendropsis thozetiana*			C		5/1
plants	higher dicots	Mimosaceae	*Acacia aulacocarpa*			C		14
plants	higher dicots	Moraceae	*Ficus fraseri*	white sandpaper fig		C		1
plants	higher dicots	Moraceae	*Trophis scandens subsp. scandens*			C		1
plants	higher dicots	Moraceae	*Streblus brunonianus*	whalebone tree		C		4
plants	higher dicots	Moraceae	*Trophis scandens*			C		4
plants	higher dicots	Moraceae	*Ficus platypoda*			C		1
plants	higher dicots	Moraceae	*Ficus opposita*			C		5
plants	higher dicots	Myrsinaceae	*Myrsine variabilis*			C		2/1
plants	higher dicots	Myrsinaceae	*Embelia australiana*	embelia		C		1
plants	higher dicots	Myrsinaceae	*Aegiceras corniculatum*	river mangrove		C		1
plants	higher dicots	Myrtaceae	*Gossia bidwillii*			C		6/2
plants	higher dicots	Myrtaceae	*Eucalyptus crebra*	narrow-leaved red ironbark		C		14
plants	higher dicots	Myrtaceae	*Melaleuca nervosa*			C		4
plants	higher dicots	Myrtaceae	*Eucalyptus exserta*	Queensland peppermint		C		5
plants	higher dicots	Myrtaceae	*Osbornia octodonta*	myrtle mangrove		C		1
plants	higher dicots	Myrtaceae	*Corymbia citriodora*	spotted gum		C		9
plants	higher dicots	Myrtaceae	*Corymbia intermedia*	pink bloodwood		C		7
plants	higher dicots	Myrtaceae	*Corymbia tessellaris*	Moreton Bay ash		C		5
plants	higher dicots	Myrtaceae	*Corymbia clarksoniana*			C		7/1
plants	higher dicots	Myrtaceae	*Eucalyptus acmenoides*			C		1
plants	higher dicots	Myrtaceae	*Eucalyptus melliodora*	yellow box		C		1

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plants	higher dicots	Myrtaceae	*Lophostemon confertus*	brush box		C		5/1
plants	higher dicots	Myrtaceae	*Corymbia erythrophloia*	variable-barked bloodwood		C		2/1
plants	higher dicots	Myrtaceae	*Lophostemon suaveolens*	swamp box		C		9
plants	higher dicots	Myrtaceae	*Eucalyptus tereticornis*			C		9
plants	higher dicots	Nyctaginaceae	*Boerhavia dominii*			C		1
plants	higher dicots	Oleaceae	*Olea paniculata*			C		1
plants	higher dicots	Oleaceae	*Notelaea microcarpa*			C		1
plants	higher dicots	Oleaceae	*Jasminum didymum subsp. racemosum*			C		4/1
plants	higher dicots	Oleaceae	*Jasminum didymum*			C		3
plants	higher dicots	Oleaceae	*Jasminum simplicifolium subsp. australiense*			C		1
plants	higher dicots	Oxalidaceae	*Oxalis corniculata*		Y			2
plants	higher dicots	Passifloraceae	*Passiflora aurantia*			C		2
plants	higher dicots	Passifloraceae	*Passiflora suberosa*	corky passion flower	Y			11
plants	higher dicots	Passifloraceae	*Passiflora subpeltata*	white passion flower	Y			3/2
plants	higher dicots	Pentapetaceae	*Melhania oblongifolia*			C		2
plants	higher dicots	Petiveriaceae	*Rivina humilis*		Y			2
plants	higher dicots	Phyllanthaceae	*Flueggea leucopyrus*			C		2
plants	higher dicots	Phyllanthaceae	*Breynia oblongifolia*			C		12
plants	higher dicots	Phyllanthaceae	*Phyllanthus virgatus*			C		6
plants	higher dicots	Phyllanthaceae	*Glochidion lobocarpum*			C		3
plants	higher dicots	Phyllanthaceae	*Phyllanthus microcladus*			C		2
plants	higher dicots	Phyllanthaceae	*Actephila sessilifolia*			R		1/1
plants	higher dicots	Phyllanthaceae	*Bridelia leichhardtii*			C		4
plants	higher dicots	Picrodendraceae	*Dissiliaria muelleri*	Mueller's redheart		C		8/4
plants	higher dicots	Picrodendraceae	*Petalostigma pubescens*	quinine tree		C		3
plants	higher dicots	Pittosporaceae	*Pittosporum revolutum*	yellow pittosporum		C		1
plants	higher dicots	Pittosporaceae	*Auranticarpa rhombifolia*			C		1
plants	higher dicots	Pittosporaceae	*Pittosporum spinescens*			C		5/2
plants	higher dicots	Plumbaginaceae	*Aegialitis annulata*	club mangrove		C		1
plants	higher dicots	Polygalaceae	*Polygala linariifolia*			C		1
plants	higher dicots	Putranjivaceae	*Drypetes deplanchei*	grey boxwood		C		8
plants	higher dicots	Rhamnaceae	*Pomaderris*			C		1/1
plants	higher dicots	Rhamnaceae	*Ventilago pubiflora*			C		1
plants	higher dicots	Rhamnaceae	*Alphitonia excelsa*	soap tree		C		13
plants	higher dicots	Rhizophoraceae	*Ceriops tagal*	yellow mangrove		C		1
plants	higher dicots	Rhizophoraceae	*Rhizophora stylosa*	spotted mangrove		C		1
plants	higher dicots	Rhizophoraceae	*Bruguiera gymnorhiza*	large-fruited orange mangrove		C		1
plants	higher dicots	Rubiaceae	*Psydrax*			C		1/1
plants	higher dicots	Rubiaceae	*Canthium*			C		2/1
plants	higher dicots	Rubiaceae	*Aidia racemosa*			C		7/5
plants	higher dicots	Rubiaceae	*Pomax umbellata*			C		1/1
plants	higher dicots	Rubiaceae	*Psydrax odorata*			C		7/2
plants	higher dicots	Rubiaceae	*Knoxia sumatrensis*			C		3/3
plants	higher dicots	Rubiaceae	*Morinda canthoides*			C		1
plants	higher dicots	Rubiaceae	*Pavetta australiensis*			C		2
plants	higher dicots	Rubiaceae	*Psychotria daphnoides*			C		4/1

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plants	higher dicots	Rubiaceae	*Spermacoce brachystema*			C		3
plants	higher dicots	Rubiaceae	*Spermacoce multicaulis*			C		1/1
plants	higher dicots	Rubiaceae	*Triflorensia ixoroides*			C		3
plants	higher dicots	Rubiaceae	*Pogonolobus reticulatus*			C		16/1
plants	higher dicots	Rubiaceae	*Psychotria loniceroides*	hairy psychotria		C		2
plants	higher dicots	Rubiaceae	*Cyclophyllum coprosmoides*			C		3
plants	higher dicots	Rubiaceae	*Psydrax odorata forma buxifolia*			C		1
plants	higher dicots	Rubiaceae	*Pavetta australiensis var. australiensis*			C		2/2
plants	higher dicots	Rutaceae	*Acronychia laevis*	glossy acronychia		C		1
plants	higher dicots	Rutaceae	*Micromelum minutum*	clusterberry		C		2/2
plants	higher dicots	Rutaceae	*Bosistoa transversa*	three-leaved bosistoa		C	V	11/10
plants	higher dicots	Rutaceae	*Acronychia pauciflora*	soft acronychia		C		6/3
plants	higher dicots	Rutaceae	*Bosistoa medicinalis*			C		9/7
plants	higher dicots	Rutaceae	*Geijera salicifolia*	brush wilga		C		3/1
plants	higher dicots	Rutaceae	*Murraya paniculata*			C		2
plants	higher dicots	Rutaceae	*Medicosma cunninghamii*	pinkheart		C		1
plants	higher dicots	Rutaceae	*Zanthoxylum brachyacanthum*			C		1
plants	higher dicots	Rutaceae	*Dinosperma melanophloia*			C		7/4
plants	higher dicots	Rutaceae	*Bouchardatia neurococca*	union nut		C		3/1
plants	higher dicots	Rutaceae	*Murraya ovatifoliolata*			C		4/1
plants	higher dicots	Santalaceae	*Exocarpos latifolius*			C		1
plants	higher dicots	Sapindaceae	*Dodonaea*			C		1
plants	higher dicots	Sapindaceae	*Atalaya multiflora*	broad-leaved whitewood		C		1
plants	higher dicots	Sapindaceae	*Dodonaea lanceolata*			C		7
plants	higher dicots	Sapindaceae	*Rhysotoechia bifoliolata subsp. bifoliolata*			C		1
plants	higher dicots	Sapindaceae	*Cupaniopsis anacardioides*	tuckeroo		C		4
plants	higher dicots	Sapindaceae	*Rhysotoechia bifoliolata*			C		1
plants	higher dicots	Sapindaceae	*Elattostachys xylocarpa*	white tamarind		C		5/1
plants	higher dicots	Sapindaceae	*Cupaniopsis wadsworthii*			C		3
plants	higher dicots	Sapindaceae	*Alectryon diversifolius*	scrub boonaree		C		1
plants	higher dicots	Sapindaceae	*Mischocarpus anodontus*	veiny pearfruit		C		1
plants	higher dicots	Sapindaceae	*Cupaniopsis shirleyana*			V	V	5/5
plants	higher dicots	Sapindaceae	*Atalaya salicifolia*			C		1
plants	higher dicots	Sapindaceae	*Arytera divaricata*	coogera		C		1
plants	higher dicots	Sapindaceae	*Atalaya rigida*			R		8/6
plants	higher dicots	Sapindaceae	*Harpullia hillii*			C		1
plants	higher dicots	Sapindaceae	*Alectryon connatus*	grey birds-eye		C		5
plants	higher dicots	Sapindaceae	*Jagera pseudorhus*			C		2
plants	higher dicots	Sapotaceae	*Planchonella*			C		1
plants	higher dicots	Sapotaceae	*Pouteria pohlmaniana*			C		2
plants	higher dicots	Sapotaceae	*Pouteria queenslandica*			C		2/1
plants	higher dicots	Sapotaceae	*Pouteria cotinifolia var. pubescens*			C		4
plants	higher dicots	Sapotaceae	*Planchonella pohlmaniana*			C		1/1
plants	higher dicots	Sapotaceae	*Pouteria sericea*			C		1
plants	higher dicots	Scrophulariaceae	*Scoparia dulcis*	Scoparia	Y			1
plants	higher dicots	Scrophulariaceae	*Mecardonia procumbens*		Y			1/1

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plants	higher dicots	Solanaceae	*Solanum nigrum*		Y			2
plants	higher dicots	Solanaceae	*Physalis peruviana*		Y			2/2
plants	higher dicots	Solanaceae	*Solanum stelligerum*	devil's needles		C		2/1
plants	higher dicots	Solanaceae	*Lycianthes shanesii*			C		2/2
plants	higher dicots	Sparrmanniaceae	*Corchorus*			C		3/3
plants	higher dicots	Sparrmanniaceae	*Corchorus trilocularis*			C		3/2
plants	higher dicots	Sparrmanniaceae	*Grewia latifolia*	dysentery plant		C		5
plants	higher dicots	Sterculiaceae	*Sterculia quadrifida*	peanut tree		C		6
plants	higher dicots	Sterculiaceae	*Brachychiton australis*	broad-leaved bottle tree		C		3
plants	higher dicots	Urticaceae	*Dendrocnide photinophylla*	shiny-leaved stinging tree		C		1
plants	higher dicots	Verbenaceae	*Lantana camara*		Y			7
plants	higher dicots	Verbenaceae	*Stachytarpheta jamaicensis*	Jamaica snakeweed	Y			1
plants	higher dicots	Violaceae	*Hybanthus stellarioides*			C		1
plants	higher dicots	Vitaceae	*Cissus opaca*			C		3
plants	higher dicots	Vitaceae	*Cissus oblonga*			C		7/2
plants	higher dicots	Vitaceae	*Cayratia acris*	hairy grape		C		4/1
plants	higher dicots	Vitaceae	*Cissus antarctica*			C		1
plants	higher dicots	Vitaceae	*Tetrastigma nitens*	shining grape		C		3/1
plants	lower dicots	Annonaceae	*Melodorum leichhardtii*			C		4
plants	lower dicots	Aristolochiaceae	*Aristolochia pubera*			C		2
plants	lower dicots	Avicenniaceae	*Avicennia marina subsp. australasica*			C		1
plants	lower dicots	Hernandiaceae	*Hernandia bivalvis*	cudgerie		R		5/3
plants	lower dicots	Hernandiaceae	*Gyrocarpus americanus*			C		2
plants	lower dicots	Lauraceae	*Litsea reticulata*			C		1
plants	lower dicots	Lauraceae	*Cryptocarya triplinervis var. pubens*			C		1/1
plants	lower dicots	Lauraceae	*Cryptocarya triplinervis*			C		3
plants	lower dicots	Lauraceae	*Cassytha pubescens*	downy devil's twine		C		2
plants	lower dicots	Menispermaceae	*Legnephora moorei*			C		1
plants	lower dicots	Menispermaceae	*Pleogyne australis*	wiry grape		C		4/1
plants	lower dicots	Menispermaceae	*Tinospora smilacina*	snakevine		C		2
plants	lower dicots	Menispermaceae	*Hypserpa decumbens*			C		1
plants	lower dicots	Monimiaceae	*Wilkiea macrophylla*	large-leaved wilkiea		C		1
plants	lower dicots	Nymphaeaceae	*Nymphaea caerulea*		Y			1
plants	lower dicots	Piperaceae	*Peperomia blanda var. floribunda*			C		1/1
plants	lower dicots	Ranunculaceae	*Clematis glycinoides*			C		1
plants	monocots	Agavaceae	*Furcraea foetida*		Y			1/1
plants	monocots	Amaryllidaceae	*Proiphys cunninghamii*	Moreton Bay lily		C		2/1
plants	monocots	Araceae	*Gymnostachys anceps*	settler's flax		C		2/1
plants	monocots	Arecaceae	*Livistona decora*			C		1
plants	monocots	Arecaceae	*Livistona australis*	cabbage tree palm		C		1
plants	monocots	Asparagaceae	*Asparagus africanus*		Y			1
plants	monocots	Commelinaceae	*Commelina diffusa*	wandering jew		C		3
plants	monocots	Commelinaceae	*Aneilema acuminatum*			C		3/2
plants	monocots	Cyperaceae	*Scleria*			C		2
plants	monocots	Cyperaceae	*Cyperus gracilis*			C		3
plants	monocots	Cyperaceae	*Fimbristylis dichotoma*	common fringe-rush		C		1

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plants	monocots	Cyperaceae	*Abildgaardia ovata*			C		1
plants	monocots	Cyperaceae	*Cyperus difformis*	rice sedge		C		1
plants	monocots	Cyperaceae	*Scleria brownii*			C		3
plants	monocots	Cyperaceae	*Gahnia aspera*			C		2
plants	monocots	Cyperaceae	*Cyperus fulvus*			C		4
plants	monocots	Dioscoreaceae	*Dioscorea transversa*	native yam		C		6
plants	monocots	Hemerocallidaceae	*Dianella longifolia*			C		2
plants	monocots	Hemerocallidaceae	*Dianella caerulea*			C		5
plants	monocots	Hemerocallidaceae	*Geitonoplesium cymosum*	scrambling lily		C		3
plants	monocots	Hemerocallidaceae	*Dianella*			C		2
plants	monocots	Hemerocallidaceae	*Dianella brevipedunculata*			C		2/1
plants	monocots	Juncaginaceae	*Triglochin procerum*			C		1
plants	monocots	Laxmanniaceae	*Lomandra filiformis*			C		1
plants	monocots	Laxmanniaceae	*Lomandra multiflora subsp. multiflora*			C		2/1
plants	monocots	Laxmanniaceae	*Eustrephus latifolius*	wombat berry		C		10
plants	monocots	Laxmanniaceae	*Lomandra confertifolia*			C		2
plants	monocots	Laxmanniaceae	*Lomandra confertifolia subsp. pallida*			C		3
plants	monocots	Laxmanniaceae	*Lomandra longifolia*			C		5
plants	monocots	Poaceae	*Aristida*			C		6
plants	monocots	Poaceae	*Eragrostis leptostachya*			C		1
plants	monocots	Poaceae	*Ancistrachne uncinulata*	hooky grass		C		3
plants	monocots	Poaceae	*Urochloa subquadripara*		Y			1
plants	monocots	Poaceae	*Enneapogon lindleyanus*			C		2
plants	monocots	Poaceae	*Chrysopogon sylvaticus*			C		2
plants	monocots	Poaceae	*Bothriochloa decipiens*			C		3
plants	monocots	Poaceae	*Arundinella nepalensis*	reedgrass		C		5
plants	monocots	Poaceae	*Sporobolus virginicus*	sand couch		C		3
plants	monocots	Poaceae	*Eragrostis sororia*			C		1
plants	monocots	Poaceae	*Aristida queenslandica var. dissimilis*			C		2
plants	monocots	Poaceae	*Dichanthium sericeum subsp. sericeum*			C		1/1
plants	monocots	Poaceae	*Capillipedium spicigerum*	spicytop		C		1
plants	monocots	Poaceae	*Eragrostis spartinoides*			C		3
plants	monocots	Poaceae	*Chrysopogon fallax*			C		2
plants	monocots	Poaceae	*Aristida personata*			C		3
plants	monocots	Poaceae	*Digitaria diffusa*			C		2
plants	monocots	Poaceae	*Dichanthium tenue*	small bluegrass		C		1
plants	monocots	Poaceae	*Themeda triandra*	kangaroo grass		C		9
plants	monocots	Poaceae	*Sarga leiocladum*			C		1
plants	monocots	Poaceae	*Ottochloa nodosa*			C		1
plants	monocots	Poaceae	*Digitaria minima*			C		1
plants	monocots	Poaceae	*Heteropogon contortus*	black speargrass		C		11
plants	monocots	Poaceae	*Leptochloa decipiens*			C		1
plants	monocots	Poaceae	*Digitaria parviflora*			C		4
plants	monocots	Poaceae	*Cymbopogon refractus*	barbed-wire grass		C		6
plants	monocots	Poaceae	*Paspalidium gracile*	slender panic		C		3
plants	monocots	Poaceae	*Paspalidium distans*	shotgrass		C		2

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	monocots	Poaceae	*Imperata cylindrica*	blady grass		C		1
plants	monocots	Poaceae	*Aristida gracilipes*			C		2
plants	monocots	Poaceae	*Oplismenus aemulus*	creeping shade grass		C		3
plants	monocots	Poaceae	*Eragrostis*			C		2
plants	monocots	Poaceae	*Melinis repens*	red natal grass	Y			3
plants	monocots	Poaceae	*Panicum simile*			C		2
plants	monocots	Poaceae	*Panicum effusum*			C		7
plants	monocots	Poaceae	*Aristida spuria*			C		1
plants	monocots	Ripogonaceae	*Ripogonum album*	white supplejack		C		1
plants	monocots	Smilacaceae	*Smilax australis*	barbed-wire vine		C		6
plants	monocots	Typhaceae	*Typha orientalis*	broad-leaved cumbungi		C		1
plants	monocots	Xanthorrhoeaceae	*Xanthorrhoea*			C		3
plants	monocots	Xanthorrhoeaceae	*Xanthorrhoea latifolia subsp. latifolia*			C		2
plants	monocots	Zingiberaceae	*Alpinia caerulea*	wild ginger		C		2
plants	monocots	Zosteraceae	*Zostera muelleri subsp. capricorni*			C		1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Presumed Extinct (PE), Endangered (E), Vulnerable (V), Rare (R), Common (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Australian Government
Department of the Environment, Water, Heritage and the Arts

Protected Matters Search Tool

You are here: Environment Home > EPBC Act > Search

29 July 2009 09:07

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Search Type: Line

Buffer: 10 km

Coordinates: -23.7640,151.1528, -23.8891,151.3730

Report Contents:

This map may contain data which are
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Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are

proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	3
Threatened Species:	24
Migratory Species:	32

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 and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

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. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Places on the RNE:	5
Listed Marine Species:	75
Whales and Other Cetaceans:	8
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

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

nominated.

State and Territory Reserves:	6
Other Commonwealth Reserves:	1
Regional Forest Agreements:	1

Details

Matters of National Environmental Significance

World Heritage Properties [Dataset Information]

Great Barrier Reef QLD

National Heritage Places [Dataset Information]

Great Barrier Reef QLD

Threatened Ecological Communities [Dataset Information]	Status	Type of Presence
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area
Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Geophaps scripta scripta Squatter Pigeon (southern)	Vulnerable	Species or species habitat likely to occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western)	Vulnerable	Species or species habitat may occur within area
Turnix melanogaster Black-breasted Button-quail	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Balaenoptera musculus Blue Whale	Endangered	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale	Vulnerable	Breeding known to occur within area
Xeromys myoides Water Mouse, False Water Rat	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea	Endangered	Species or species habitat may

Leatherback Turtle, Leathery Turtle, Luth		occur within area
Egernia rugosa Yakka Skink	Vulnerable	Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Endangered	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Vulnerable	Breeding likely to occur within area
Paradelma orientalis Brigalow Scaly-foot	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark	Vulnerable	Species or species habitat may occur within area
Plants		
Bosistoa selwynii Heart-leaved Bosistoa	Vulnerable	Species or species habitat likely to occur within area
Bosistoa transversa Three-leaved Bosistoa	Vulnerable	Species or species habitat likely to occur within area
Bulbophyllum globuliforme Miniature Moss-orchid	Vulnerable	Species or species habitat likely to occur within area
Cupaniopsis shirleyana Wedge-leaf Tuckeroo	Vulnerable	Species or species habitat likely to occur within area
Cycas megacarpa	Endangered	Species or species habitat known to occur within area
Parsonsia larcomensis	Vulnerable	Species or species habitat likely to occur within area
Quassia bidwillii Quassia	Vulnerable	Species or species habitat likely to occur within area
Taeniophyllum muelleri Minute Orchid, Ribbon-root Orchid	Vulnerable	Species or species habitat may occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Migratory	Breeding may occur within area
Myiagra cyanoleuca	Migratory	Species or species habitat likely to

Satin Flycatcher		occur within area
Rhipidura rufifrons Rufous Fantail	Migratory	Breeding may occur within area

Migratory Wetland Species

Birds

Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe	Migratory	Species or species habitat may occur within area
Limicola falcinellus Broad-billed Sandpiper	Migratory	Roosting likely to occur within area
Limosa limosa Black-tailed Godwit	Migratory	Roosting likely to occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Migratory	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank	Migratory	Roosting known to occur within area

Migratory Marine Birds

Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Sterna albifrons Little Tern	Migratory	Species or species habitat may occur within area

Migratory Marine Species

Mammals

Balaenoptera edeni Bryde's Whale	Migratory	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Migratory	Species or species habitat may occur within area
Dugong dugon Dugong	Migratory	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale	Migratory	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin	Migratory	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Migratory	Species or species habitat may occur within area

Reptiles

Caretta caretta	Migratory	Breeding known to occur within area

Loggerhead Turtle		
Chelonia mydas Green Turtle	Migratory	Species or species habitat may occur within area
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Migratory	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Migratory	Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Migratory	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Migratory	Breeding likely to occur within area
Sharks		
Rhincodon typus Whale Shark	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose	Listed - overfly marine area	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper	Listed - overfly marine area	Roosting likely to occur within area
Calidris subminuta Long-toed Stint	Listed - overfly marine area	Roosting likely to occur within area
Charadrius dubius Little Ringed Plover	Listed - overfly marine area	Roosting likely to occur within area
Charadrius ruficapillus Red-capped Plover	Listed - overfly marine area	Roosting known to occur within area

Gallinago hardwickii Latham's Snipe, Japanese Snipe	Listed - overfly marine area	Species or species habitat may occur within area
Gallinago stenura Pin-tailed Snipe	Listed - overfly marine area	Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area
Himantopus himantopus Black-winged Stilt	Listed - overfly marine area	Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail	Listed - overfly marine area	Species or species habitat may occur within area
Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Limicola falcinellus Broad-billed Sandpiper	Listed - overfly marine area	Roosting likely to occur within area
Limnodromus semipalmatus Asian Dowitcher	Listed - overfly marine area	Roosting likely to occur within area
Limosa limosa Black-tailed Godwit	Listed - overfly marine area	Roosting likely to occur within area
Merops ornatus Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Listed - overfly marine area	Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher	Listed - overfly marine area	Species or species habitat likely to occur within area
Nettapus coromandelianus albipennis Australian Cotton Pygmy-goose	Listed - overfly marine area	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Listed - overfly	Species or species habitat may occur within area

	marine area	
Phalaropus lobatus Red-necked Phalarope	Listed	Roosting likely to occur within area
Philomachus pugnax Ruff (Reeve)	Listed - overfly marine area	Roosting likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet	Listed - overfly marine area	Roosting likely to occur within area
Rhipidura rufifrons Rufous Fantail	Listed - overfly marine area	Breeding may occur within area
Sterna albifrons Little Tern	Listed	Species or species habitat may occur within area
Stiltia isabella Australian Pratincole	Listed - overfly marine area	Roosting likely to occur within area
Thinornis rubricollis Hooded Plover	Listed - overfly marine area	Roosting likely to occur within area
Tringa nebularia Common Greenshank, Greenshank	Listed - overfly marine area	Roosting known to occur within area
Tringa totanus Common Redshank, Redshank	Listed - overfly marine area	Roosting likely to occur within area
Mammals		
Dugong dugon Dugong	Listed	Species or species habitat likely to occur within area
Ray-finned fishes		
Acentronura tentaculata Hairy Pygmy Pipehorse	Listed	Species or species habitat may occur within area
Campichthys tryoni Tryon's Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys flavofasciatus Yellow-banded Pipefish, Network Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys intestinalis	Listed	Species or species habitat may occur

Australian Messmate Pipefish, Banded Pipefish		within area
Corythoichthys paxtoni Paxton's Pipefish	Listed	Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus excisus Indian Blue-stripe Pipefish, Blue-stripe Pipefish	Listed	Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish	Listed	Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish	Listed	Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish	Listed	Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish	Listed	Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish	Listed	Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish	Listed	Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse	Listed	Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish	Listed	Species or species habitat may occur within area
Micrognathus andersonii Anderson's Pipefish, Shortnose Pipefish	Listed	Species or species habitat may occur within area
Micrognathus brevirostris Thorn-tailed Pipefish	Listed	Species or species habitat may occur within area
Nannocampus pictus Painted Pipefish, Reef Pipefish	Listed	Species or species habitat may occur within area
Solegnathus hardwickii Pipehorse	Listed	Species or species habitat may occur within area
Solenostomus paradoxus Harlequin Ghost Pipefish, Ornate Ghost Pipefish	Listed	Species or species habitat may occur within area
Syngnathoides biaculeatus Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake	Listed	Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake	Listed	Species or species habitat may occur within area
Aipysurus eydouxii	Listed	Species or species habitat may occur

Spine-tailed Seasnake		within area
Aipysurus laevis Olive Seasnake	Listed	Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake	Listed	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle	Listed	Breeding known to occur within area
Chelonia mydas Green Turtle	Listed	Species or species habitat may occur within area
Crocodylus porosus Estuarine Crocodile, Salt-water Crocodile	Listed	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth	Listed	Species or species habitat may occur within area
Disteira major Olive-headed Seasnake	Listed	Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake	Listed	Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake	Listed	Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake	Listed	Species or species habitat may occur within area
Laticauda colubrina a sea krait	Listed	Species or species habitat may occur within area
Laticauda laticaudata a sea krait	Listed	Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle	Listed	Species or species habitat may occur within area
Natator depressus Flatback Turtle	Listed	Breeding likely to occur within area
Pelamis platurus Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans [Dataset Information]	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera musculus Blue Whale	Cetacean	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale	Cetacean	Breeding known to occur within area
Orcaella brevirostris Irrawaddy Dolphin	Cetacean	Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area

Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area

Commonwealth Lands [Dataset Information]

Defence

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Historic

St Lukes Anglican Church QLD

Natural

Balaclava Island and The Narrows QLD

Curtis Island (part) QLD

Garden Island Environmental Park QLD

Great Barrier Reef Region QLD

Extra Information

State and Territory Reserves [Dataset Information]

Boyne Island Conservation Park, QLD

Garden Island Conservation Park, QLD

Mackay/Capricorn Marine Park, QLD

Rodds Bay Dugong Protection Area, QLD

Wild Cattle Fish Habitat Area, QLD

Wild Cattle Island National Park, QLD

Other Commonwealth Reserves [Dataset Information]

Great Barrier Reef Marine Park, COM

Regional Forest Agreements [Dataset Information]
Note that all RFA areas including those still under consideration have been included.

South East Queensland RFA, Queensland

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the *Environment Protection and Biodiversity Conservation Act 1999*. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

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

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under "type of presence". For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

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

- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

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

Acknowledgments

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

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- 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, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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