GOVERNMENT OF
WESTERN AUSTRALIA

Browse LNG Precinct




Browse Liquefied Natural Gas Precinct
Strategic Assessment Report

(Draft for Public Review)
December 2010

Appendix C-10

Marine Megafauna Report Browse

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Rev 1

RPS

MARINE MEGAFAUNA REPORT

Browse MMFS 2009





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Browse MMFS 2009

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EXECUTIVE SUMMARY

Woodside Energy Ltd. (Woodside) plans to develop several gas condensate fields of the Browse Basin, with onshore processing facilities located at the Browse Liquefied Natural Gas (BLNG) Precinct near James Price Point on the Dampier Peninsula. This location has been determined by the Department of State Development (DSD) (via the Northern Development Taskforce (NDT)) and State (Western Australian) and Commonwealth Governments.

RPS was engaged by Woodside to undertake a series of marine megafauna baseline surveys from June to October 2009, to support the assessment and management of potential impacts to these fauna from the proposed LNG development. These surveys were:

- Nearshore Regional Survey (targeting dugongs).
- James Price Point (JPP) Migration Corridor Survey (targeting humpback whales).
- Reference Site Survey (targeting humpback whales at key locations over a regional area).
- Scott Reef Offshore Survey (targeting humpback whales).
- Vessel Transect Survey (to "ground truth" species recorded).

Although these surveys were designed to sample humpback whales (*Megaptera novaeangliae*) and dugongs (*Dugong dugon*), data were also obtained for other marine megafauna. Marine megafauna covered by this report include the toothed whales (dolphins, sperm whales and beaked whales), baleen whales, marine reptiles, and sharks and rays. Records of birds, fish and vessels were also collected but were a low priority and therefore records are incomplete. The results for humpback whales, dugongs and turtles are reported elsewhere.

The Nearshore Regional Survey employed the most suitable method for sampling small marine megafauna (e.g. low flight altitude, restricted weather conditions), and therefore provided the most comprehensive dataset for small marine megafauna out of the five survey types employed. The Nearshore Regional Survey was designed and first conducted by SKM in March (2009) to sample megafauna in the wet season (SKM 2009). RPS repeated the survey in July and September 2009 to obtain early and late dry season data. The survey extended from the mean high water level to approximately the 20 m isobath, and was conducted from Cape Bossut in the south to Cape Leveque in the north.

Results from the Nearshore Regional Survey have been supplemented with data from the other surveys, where applicable, to extend the spatial and temporal dataset. The other aerial and vessel based surveys were conducted by RPS from the beginning of July to mid-October 2009. The surveys provide the first systematic assessment of west Kimberley marine megafauna across dry and wet seasons.

Data from the surveys (including March 2009) were assessed to determine the species or faunal groups present, their distribution and abundance in inshore waters off the west coast of the Dampier Peninsula and out to Scott Reef.

In total, 20 hours were spent on-transect during each of the sampling periods of the Nearshore Regional Survey (July and September) which sampled data across a survey area of 9,353 km². Key findings from the Nearshore Regional Survey and other surveys are discussed and presented below.

The survey area contained a wide diversity of marine megafauna involving numerous species of sharks, fish, reptiles, birds and mammals. There were no diversity hot spots identified from the data whereby any single location supports relatively large numbers of animals from a range of species groups. Certain areas appeared to be important for one or two groups but not others.

Bottlenose and spinner dolphins were the most commonly recorded small cetacean during both aerial and vessel surveys, with the latter being more numerous due to larger group sizes. Both species were widespread along the west Kimberley coast. A larger number of spinner dolphins were recorded in the James Price Point area during vessel surveys compared with near Pender Bay. Other dolphin species identified in the waters off James Price Point were Indo-Pacific humpback dolphins and killer whales, both in very low numbers despite considerable survey effort from vessels. Snubfin dolphins were spotted from the vessels but only in Roebuck Bay on transit to and from the survey area. The survey did not differentiate between common or spotted bottlenose dolphins.

With the exception of humpback whales which are reported elsewhere, a very small number of other cetacean species was recorded from across the survey area, including probable minke and Bryde's whales sighting. Two sightings of unidentified beaked whales were recorded, but the confidence levels were low.

Several shark species were recorded off the west Kimberley coastline including tiger, hammerhead, lemon and whaler sharks. A single record of a great white was also recorded, which was considered a rarity for the survey area and outside its normal range. No whale sharks were spotted during any of the surveys. Lemon sharks appeared to favour deeper water whereas whaler sharks were found nearer to shore in relatively shallow water.

Rays were widely recorded across the survey area with the most common species being devilrays. These were found in all areas including at Scott Reef.

Sea snakes were the most commonly recorded megafauna group in the survey area and were widespread in shallow and deep water. They could not be identified to species, but existing knowledge of this group suggests that the community assemblage could be diverse and that a number of species are resident in the area. Sea snakes were most abundant in July and predominantly outside of the 10 m depth contour. The highest densities were recorded in July due west of Broome and between the 10 and 20 m isobaths.

No crocodiles were recorded during the 2009 aerial or vessel surveys. However, a single saltwater crocodile on the Lacepede Islands and tracks of another were recorded on the mainland during beach surveys for turtles.

Key Findings Obtained from the Survey Data

#	Key Findings	Document Reference
	Dolphins	
1	The spinner dolphin (DEC Priority 4) was the most numerous of the small cetacean species recorded offshore of James Price Point during the vessel surveys. Spinner dolphins were present in groups of between 6 and 25 individuals. They were widely dispersed from around the 10 m isobath and out to the limit of the survey where the water was around 50 m deep. Few sightings of this species were acquired off Pender Bay.	**4.1.1** **4.1.2.2** **4.1.2.6** **5.2** **5.3**
2	Bottlenose dolphins (*Tursiops* spp.) (DEC Priority 4) were the most commonly recorded small cetacean species offshore of James Price Point and Pender Bay, but were recorded mostly in small groups of up to five individuals, and occasionally up to ten individuals. They were widely dispersed from around the 10 m isobath and out the limit of the survey where the water was around 50 m deep. They were occasionally recorded from the air showing that they were widely distributed. It was not determined whether they were spotted or common bottlenose dolphins, but it is likely that both species were present.	**4.1.1** **4.1.2.1** **4.1.2.6** **5.1** **5.2** **5.3**
3	Indo-Pacific humpback dolphins (DEC Priority 4) were not recorded during the Nearshore Regional Survey. However, they were recorded during a vessel survey offshore of James Price Point on two occasions, and are likely to form a small part of the unidentified dolphin record. They are only likely to be present sporadically in very small numbers in shallow water along the coast.	**4.1.1** **4.1.2.3** **5.3**
4	Australian snubfin dolphins (Migratory MNES, DEC Priority 4) were only observed during off-survey periods and only within Roebuck Bay. With the known habits and movements of Australian snubfin dolphins, the marine environment off James Price Point is considered unlikely to provide habitat suitable for this species, but they may infrequently transit this area on rare occasions.	**4.1.1** **4.1.2.4** **5.3**
5	Dolphins (unidentified) were widely distributed in shallow waters of the west-coast Dampier Peninsula, including around Scott Reef and offshore around the potential pipeline corridor. The unidentified records are likely to be comprised of a number of dolphin species including those identified to genus or species including: spinner, bottlenose and, to a lesser extent, Indo-Pacific humpback dolphins. The distribution of these species will be determined by their habitat requirements and may be wide e.g. spinner dolphins or restricted to nearshore waters only e.g. Indo-Pacific humpback dolphins.	**4.1.1** **4.1.2.6** **5.1**
6	Killer whales were recorded during the James Price Point Migration Corridor Survey and vessel surveys in low numbers. Killer whales may be more numerous in the Kimberley during the winter when humpback whales are present. Their presence in nearshore waters, including the area around James Price Point, is likely to be infrequent.	**4.1.1** **4.1.2.5** **5.1**
7	Density maps indicate that the peak densities of dolphins changed location through the survey period, but there was a relatively higher density of dolphins offshore of the James Price Point area in comparison to surrounding waters at each survey period, particularly in September.	**4.1.1** **4.1.2.6** **5.1** **Figure 7**
	Baleen Whales	
8	No baleen whales (except humpbacks) were recorded during the Nearshore Regional Surveys. However, a minke whale and Brydes'' whale were recorded during other megafauna surveys off the Kimberley coast. Several species of baleen whales may occur in the region's deeper waters periodically but in low numbers.	**4.2** **5.1**
	Sharks and Rays	
9	Sharks were distributed across the entire megafauna survey area, with no obvious areas of particular preference. The dataset collected is too small to establish any temporal or species-specific trends.	**4.3.1** **5.1** **5.2** **5.4**

#	Key Findings	Document Reference
10	Tiger and hammerhead sharks were recorded over a wider area than other species and across the continental shelf from the surf zone to deepwater areas. Lemon and whaler sharks were recorded in the shallows out to waters as deep as 50 m.	4.3.1 4.3.2
11	A sighting of a great white shark was recorded during the Reference Site Survey approximately 67 km from James Price Point. This is considered to be outside their normal range.	4.3.2.3 5.3
12	No whale sharks (Vulnerable/ Migratory MNES) were sighted during any of the surveys.	4.3.1 5.3
13	Rays were widely distributed across the survey areas from the shallow nearshore out to deep water surrounding Scott Reef. Many were sighted in nearshore waters of Roebuck Bay, Gourdon Bay and around the Lacepede Islands.	4.4.1 4.4.2 5.1 5.3
14	Devilrays were frequently sighted and are likely to be present along the coast throughout the year.	4.4.1 4.4.2 5.1 5.2
	Marine Reptiles	
15	Sea snakes were the most commonly recorded megafauna group during the Nearshore Regional Survey. They were widely distributed along the coastline but less common around the James Price Point area.	4.6.1 4.6.2 4.6.2.2 5.1 5.2
16	The highest relative densities of sea snakes were recorded in July and September approximately 30 km west of Broome outside of the 10 m isobath.	4.6.2.1
17	No crocodiles were observed from aerial or vessel surveys. One saltwater crocodile was recorded during a separate turtle survey on the Lacepede Islands in December and fresh tracks of another were recorded on a beach approximately 10 km north of James Price Point.	4.6.2.3

ACRONYMS AND DEFINITIONS

Acronym	Definition
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals
CITES	Convention on International Trade in Endangered Species
CMST	Centre for Marine Science and Technology
CWR	Centre for Whale Research
DEC	Department of Environment and Conservation
DEH	Department of Environment and Heritage
DEWHA	Department of the Environment and Water, Heritage and the Arts
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Authority
EIS	Environmental Impact Statement
EPBC Act	The Environment Protection and Biodiversity Conservation Act 1999
ERMP	Environmental Review and Management Program
IMCRA	The Interim Marine and Coastal Regionalisation of Australia
IUCN	International Union for the Conservation of Nature and Natural Resources (aka World Conservation Union)
IWC	International Whaling Commission
JPP	James Price Point
LNG	Liquefied Natural Gas
MTPA	Million Tonnes Per Annum
MNES	Matters of National Environmental Significance
NDT	Northern Development Taskforce
NMB	National Marine Bioregionalisation
NT	Northern Territory
NW	North-west
SW	South-west
UNEP	United Nations Environment Program
WA	Western Australia

GLOSSARY

Baleen

Keratin plates located on the upper jaws of whales forming a filter-feeding apparatus used for trapping amphipods and other tiny foods, and as a common reference to the Mysticeti cetaceans.

Baseline survey

A baseline survey provides information on the condition and ecology of an area prior to undertaking any activities. A baseline survey may include the collection of data for one or a number of environmental parameters.

Bathymetry

Bathymetry is the measurement of water depths.

Benthic

Benthic refers to the geological, topographical and biological conditions of the bottom or seabed of an aquatic environment.

Cephalopods

A class of marine molluscs that have tentacles, a large beaked head, large well-developed eyes and nervous systems, in most species, an ink sac containing a dark fluid used for protection or defence and an internal shell in some species; includes octopuses, squids, and Nautilus.

Cetacea

Cetacea is a taxonomic order of marine and freshwater and includes the whales, dolphins and porpoises.

Continental Shelf

The continental shelf is an area of the seafloor averaging less than 200 m deep and includes the underwater, extended edge of a continent and associated coastal plain that was generally exposed during past times of lower sea level.

Cosmopolitan

Species with a global distribution, they are not confined to either hemisphere.

Double count

Double-counting refers to the same group or individuals of animals being surveyed that are counted (and thus recorded) twice by observers.

Dual platforms (refer also to platform)

Dual platforms refer to a method of survey that involves two locations of observers, for example; front seats versus rear seats of an aircraft (same deck, different seats).

Ecotype

A sub-group of a species that have evolved adaptations to a specific/different environment.

Exclusive Economic Zone

The EEZ is a seazone which extends 200 nautical miles from the coast, over which a state has special rights over the exploration and use of marine resources.

Gas condensate field

Is an area of land or seabed that is rich in an exploitable natural resource such as gas condensate.

Home range

An animal's home range is the size of the geographic area that is normally occupied and used by an individual or a species in which it gets its food, water and shelter.

Indonesian Throughflow

A warm oceanographic current that transports low salinity water between the Pacific Ocean and the Indian Ocean through the Indonesian Archipelago.

Marine megafauna

Megafauna are a group of marine fauna that are usually large and can normally be seen from the surface of the water. They can include animals such as whales, dolphins, dugong, sharks, rays and seabirds.

Matters of National Environmental Significance

MNES are matters of national environmental significance and are listed and protected under the EPBC Act.

Migratory species

Migratory species refers to a population which predictably travel from one place to another at regular times of year, often over long distances. It is also a conservation status listing under the EPBC Act.

Mysticeti

Mysticeti is a taxonomic suborder within the order Cetacea; the baleen whales, for example right whales; blue whales; humpbacks.

Neap tides

Neap tides have the smallest tidal range which occurs every two weeks during the first and third quarter moons. Compare with spring tides.

Nearshore

The nearshore region extends seaward from the shoreline.

Neritic

Neritic refers to shallow, nearshore waters.

Oceanography

Oceanography is the study of the ocean, its topography, with emphasis on the physical aspects of the oceans.

Odontoceti

Odontoceti is a taxonomic suborder that includes all toothed whales within the order Cetacea, for example dolphins, porpoises, sperm whales and beaked whales.

Offshore

The offshore region is located at a distance from the shore, extending outward to the edge of the continental shelf.

Oligotrophic

Oligotrophic refers to a body of water which is low in nutrients and in productivity.

Pelagic

Pelagic refers to species which inhabit the open sea, in surface waters or middle depths.
Pipeline Corridor

The potential area in which the pipeline from the offshore (upstream) facilities to the onshore (downstream) facilities will be constructed.

Platform

The platform refers to a location or position of an observer, for example the bridge deck of a vessel or the seats of an aircraft.

Provincial bioregion

A provincial bioregion (also referred to as bioregion) is an area of the ocean which has similar types of plants, animals and ocean conditions when compared to other areas of a similar size.

Ramsar wetland

A Ramsar wetland is an area designated under the Ramsar Convention 1971 as a wetland of international importance because of its importance for preserving biological diversity (particularly in the case of waterfowl), or because it is a representative, rare and unique wetland type.

Recapture

Recapture is to capture/count something for a second or subsequent time.

Semi-diurnal

Occurs twice a day, for example two tidal regimes per day (as opposed to diurnal which occurs once a day).

Spring tides

The highest tidal range, occurring every two weeks during a full or new moon. Compare with neap tides.

Strip Width Sampling

Strip width sampling is a type of line transect sampling in which sampling occurs only within a strip of predetermined width on either side of the aircraft or vessel. The assumption is made that all animals within the strip are detected with equal probability. The method requires a high density of target animals to reach a suitable number for robust estimation of numbers.

Temperate

Temperate areas have a distinct summer and winter seasons of moderate temperature and rainfall.

Threatened

Threatened refers to species which are endangered or vulnerable to decline.

Upwelling

The movement of dense, cold, and usually nutrient-rich water from the depths of the ocean towards the ocean surface, replacing the warmer, usually nutrient-depleted surface water and often resulting in highly productive ecosystems.

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APPENDICES

1.0 INTRODUCTION

1.1 Browse Project Details

Woodside Energy Ltd. (Woodside) plans to develop the Torosa, Brecknock and Calliance gas condensate fields located offshore in the Browse Basin. Natural gas and condensate hydrocarbons from offshore facilities will be transported to onshore processing facilities in the vicinity of James Price Point located on the Dampier Peninsula. The Browse Liquefied Natural Gas (BLNG) Precinct encompasses the construction and operation of Liquefied Natural Gas (LNG) processing facilities and associated infrastructure.

The development will include export tanker facilities to receive LNG (and potentially Liquid Petroleum Gas (LPG)) carriers and condensate tankers and an Integrated Marine Facility (IMF) to provide vessel all-weather harbouring facilities (for tugs and support vessels) and marine support and offloading facilities. Dredging will be required to establish a shipping channel route, turning basin and berth pockets for LNG (and potentially LPG) carriers and condensate tankers entering and departing the Marine Port Facilities. Dredging will also be required for establishment of the Marine Offloading Facility (MOF) and along designated sections of the pipeline route for protection of the gas pipelines. A single breakwater will also be constructed to provide a sheltered port for the export jetty and marine facilities.

The purpose of the BLNG Precinct is to provide a single onshore location for the various oil and gas operators in the Browse Basin. The central location is designed to eliminate the ad hoc development of LNG facilities on the Kimberley coast and islands. The location of the Precinct has been determined to be within the James Price Point coastal area development by the Department of State Development (DSD) (via the Northern Development Taskforce (NDT)) and State (Western Australian) and Commonwealth Governments.

A range of environmental investigations have been commissioned to characterise the environment in the region of the development, and inform the environmental impact assessment process. RPS Environment and Planning Pty Ltd (RPS) was engaged by Woodside to undertake a series of marine megafauna baseline surveys to support the assessment and management of potential impacts to these fauna from the proposed LNG development. Refer to Figure 1 for the regional location of the survey area.

For the purpose of this report, the James Price Point Coastal area is referring to the coastal waters from Quondong Point in the south to Coulomb Point in the north and offshore to approximately 3 Nm.

The James Price Point Marine Management Area describes an area intended to include the marine infrastructure and dredging footprint of the Browse LNG Precinct. This area was identified for the purposes of the Marine Megafauna surveys to examine fauna occurring within or near the development area and is in no way intended to delineate any future Management Zone (Figure 1).

The Kimberley region supports a number of threatened species listed under the Western Australian *Wildlife Conservation Act 1950* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), including marine reptiles, dugongs, large whales, dolphins, turtles and certain shark species. However, very few systematic surveys have occurred in the region to quantify the distribution and abundance of its megafauna, with no known long-term studies of population status, and few dedicated ecological studies of habitat usage.

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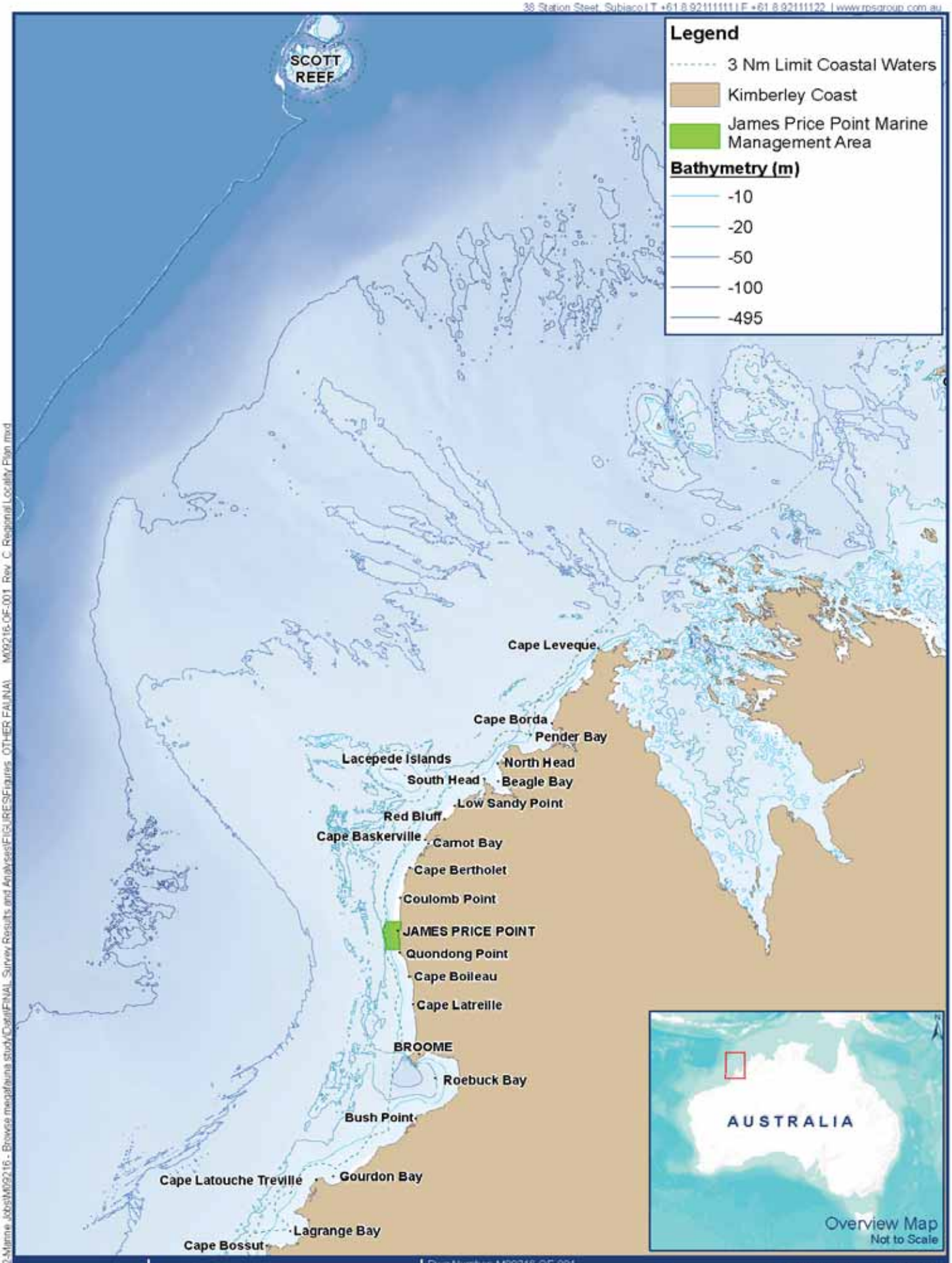

RPS woodside

Dwg Number: M09216-OF-001
Date: 02/03/2010
Revision: C
Scale: Not to Scale @ A4
Drafted by: M Angove
Source: RPS 2009

0 12.5 25 50 km

Regional Locality Plan

Figure 1

1.2 Study Objectives

The purpose of the study was to collect enough information to establish a baseline for megafauna at this location, and adequately inform an Environmental Impact Assessment for the proposed LNG development. A series of aerial and vessel based surveys conducted in 2008 (Jenner and Jenner 2009a) and 2009 (SKM 2009) were used to inform a survey design review. The following objectives were established as a result of the review:

- Quantify the distribution, relative density and abundance of marine megafauna in and adjacent to the proposed James Price Point Marine Management Area, and at suitable reference sites, through the period early July to mid October.

- Determine the distribution and relative abundance of marine megafauna in the potential offshore development footprint, particularly the offshore pipeline corridor and at Scott Reef from early July to mid October.

It was recognised at the survey design stage that achieving these objectives would be dependent on prevailing conditions in the field and suitable and robust survey method. The focus of the surveys was on dugongs (*Dugong dugon*) and humpback whales (*Megaptera novaeangliae*) as these two species were considered likely to be the most sensitive to the proposed development. Data for other marine megafauna (including, other large cetaceans, dolphins, marine reptiles, fish, sharks and rays) were also collected. The Nearshore Regional Survey was designed specifically for dugongs using Strip Width Sampling and provided the best means to sample other small marine megafauna. However, it is difficult to identify small megafauna species from the air so to help identify the smaller species found offshore of James Price Point, a Vessel Transect Survey was undertaken.

In the context of these objectives, megafauna include baleen whales, toothed whales, dugongs (the sole member of "sirenia" in Australian waters), marine reptiles, sharks and rays. Humpback whales, dugongs and turtles have been reported separately and are not included within this report. Fish (other than sharks and rays) and birds have been recorded for an indication of ecological activity with other megafauna species; they are not discussed to species level in this report.

Sightings of vessels were recorded during all surveys as incidental data for use in further environmental and social assessments.

2.0 BACKGROUND INFORMATION

2.1 Regional Geography

The Kimberley is situated at the top of the North West Marine Region (NWMR) which extends north from Kalbarri, to the Western Australian – Northern Territory border, covering an area of more than 1 million km² (DEWHA 2008).

Waters within the NWMR range in temperature between 22 °C and 26 °C, and cover a large area of shallow continental shelf and slope, with more than half the area having water depths of less than 500 m (Baker et al. 2008). The region experiences high tidal ranges and strong surface currents. Tides are semi-diurnal with daily tides ranging between 3 m during neap tides and 10 m during spring tides (DEWHA 2008). Prevailing currents of the region are the Leeuwin Current and the Indonesian Throughflow Current, which are seasonally variable (DEWHA 2008).

The Kimberley falls within two provincial bioregions: The North West Shelf Province and the Timor Province.

The North West Shelf Province extends from the North West Cape near Exmouth to Cape Bourgainville to the north of the Kimberley. It is almost wholly contained on the North West Shelf and covers an area of 238,759 km². Water depth in the province is relatively shallow compared with the Timor Province and ranges up to 200 m. The geomorphology is represented mainly by sediments with some sandy shoals, banks and valleys. The province extends from a dry tropical environment in the south west to a humid tropical environment in the north east.

The Timor Province occupies an area of 156,669 km² and extends from the edge of the shelf to the Argo Abyssal Plain. Water depths vary greatly in this province from 200 m on the shelf to almost 6,000 m on the abyssal plain. A wide range of geomorphic and oceanographic features lie within the Timor Province including shallow reefs such as Scott Reef, and deep muddy seabeds.

The west coast of the Kimberley from Gourdon Bay to Cape Leveque is characterised by warm shallow water with sandy substrates. Coastal processes are influenced by high tidal processes and strong alongshore currents (DEWHA 2008). Water layers are generally well mixed and highly turbid as a result of the strong currents, large tidal volumes and long interval swells arriving from the west. The bathymetry is therefore gently sloping, often for large distances offshore.

Coastal characteristics are dominated by low lying lands behind flat beaches. Occasional sedimentary outcrops and low-lying cliffs occur along much of the coastline. Embayments such as Roebuck Bay are typical of the shallow water and gentle bathymetric topography.

2.2 Habitat Characteristics

Several ecological habitats exist within the Northwest Shelf Province. Due to the diversity of the marine megafauna in the region, detailed information on preferred habitats for individual species is not discussed within the report. However, a number of key areas were identified within the northern extent of the province which form important marine megafauna habitats including Browse Island, Lacepede Islands, James Price Point, Quondong Point and Roebuck, Beagle and Pender bays (DEWHA 2008).

Large intertidal sand flats connect headlands and rocky shorelines between Quondong Point and James Price Point. The shoreline between each of the Points is often affected by storm surge associated with severe storms in the region, which influence shoreline development and stability. Unique bathymetry and oceanography surrounding Quondong Point result in enhanced biological productivity, attracting numerous bird species and baitfish, which in turn supports aggregations of large numbers marine megafauna species (DEWHA 2008).

Roebuck Bay is designated a Ramsar site as it supports large numbers of wading birds. It also qualifies as it has important mangrove habitat around its margins, which plays an important role in localised primary productivity. The higher productivity in these areas attracts aggregations of fish, and provides important habitat for several dolphin species, including Australian snubfin dolphins (*Orchaella heinsohnii*) (DEWHA 2008). It should be noted that Australian snubfin dolphins are not, however part of the criteria for Ramsar designation. Sheltered embayment's of Beagle and Pender bays also support extensive mangrove systems.

2.3 Marine Megafauna of the Area

The *Kimberley LNG Precinct – Scope of the Strategic Assessment* document (DSD 2008) recognised that the marine environment along the west coast of the Kimberley supports a diverse range of marine megafauna. Whilst many species of marine megafauna present in the area are listed under the EPBC Act, certain species are afforded a higher conservation value as "Matters of National Environmental Significance" (MNES). Based on a search of the EPBC Act protected Matters Database in November 2009 (DEWHA 2009a) and subsequent consultation with DEWHA, marine megafauna that are listed as MNES and that have either previously been recorded or may be expected to occur in the area are listed in Table 1 below. Refer to Table 1 of Appendix 2 for the full list of species that are listed under the EPBC Act and may be present within the area.

Table 1: Marine Megafauna Species Listed as Matters of National Environmental Significance (MNES) that May be Present within the Area

Scientific Name	Common Name	EPBC Status
Dolphins and other toothed whales		
Orcinus orca	Killer whale	Migratory
Orcaella heinsohni	Australian Snubfin dolphin (Irrawaddy (sic))*	Migratory
Physeter macrocephalus	Sperm whale	Migratory
Sousa chinensis	Indo-Pacific humpback dolphin	Migratory
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted bottlenose dolphin (Arafura/Timor Sea populations)	Migratory
Baleen whales		
Balaenoptera bonaerensis	Antarctic minke whale	Migratory
Balaenoptera musculus intermedia	Southern blue whale	Endangered, Migratory
Balaenoptera musculus brevicauda	Pygmy blue whale	Endangered, Migratory
Balaenoptera physalus	Fin whale	Migratory
Balaenoptera edeni	Bryde's whale	Migratory
Reptiles		
Crocodylus porosus	Saltwater crocodile	Migratory
Sharks		
Rhincodon typus	Whale shark	Vulnerable, Migratory
Glyphis spp.	River shark	Endangered
Rays		
Pristis microdon	Freshwater sawfish	Vulnerable
Pristis zijsron	Green sawfish	Vulnerable
Pristis clavata	Dwarf sawfish	Vulnerable

* sic: formerly known as the Irrawaddy dolphin
Note; Table omits humpback whales, dugongs and all turtle species

The Indo-Pacific humpback, spinner and Australian snubfin dolphins are DEC Priority Four species under the Western Australian *Wildlife Act 1950*. Priority Four species are those in need of further monitoring.

Recent surveys focusing on megafauna in the region conducted by Jenner and Jenner (2008, 2009a and b) and SKM (2009) have indicated, amongst other things, marine mammal species are a significant component of the nearshore marine ecosystem.

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3.0 METHODS

3.1 Overview

A combination of aerial and vessel surveys were undertaken between the beginning of July and mid-October 2009. Survey design and sampling intensity are summarised in Table 5 of Appendix 1. The most effective method to detect and count megafauna over regional spatial scales (1000's km^2) is by aerial survey. Undertaken in conjunction with aerials, vessel based surveys provide a confirmation of small species that are difficult to identify from the air.

Data for marine megafauna were collected during the following surveys:

- Nearshore Regional Survey – extensive series of parallel aerial transects covering the west coast of the Kimberley from Cape Bossut near LaGrange Bay in the south to Cape Leveque in the north. The survey covered an area from the coastline to the 20 m isobath (Figure 2). Two aerial surveys were conducted, one in July and the other in September. The survey used the same transect lines and sampling method as that conducted in March 2009 (SKM 2009).

- James Price Point Migration Corridor Survey – small series of parallel aerial transects adjacent to James Price Point

- Reference Site Survey – series of aerial transects based on aerial survey conducted by Jenner and Jenner in 2008

- Scott Reef Offshore Survey – series of aerial transects traversing to Scott Reef and back following similar transects of survey in 2008 (Jenner and Jenner 2009)

- Vessel Transect Survey – two series of parallel transects offshore of James Price Point and Pender Bay (as a reference site).

In contrast to the aerial surveys that targeted humpback whales, the Nearshore Regional Survey had the following design elements that enabled easier detection of dugong and smaller marine megafauna species as well as those that may inhabit turbid inshore waters:

- Survey personnel were focussed on the narrow sampling strip of 400 m on each side of the aircraft

- The survey personnel were focussed on dugong and smaller animals

- The survey altitude was 900 feet in comparison to 1000 feet for the surveys focussing on humpback whales

- Survey flights were undertaken at periods near neap tides when turbidity was likely to be lowest

- The Nearshore Regional Survey was given higher priority than others to sample during optimal environmental conditions e.g. sea state generally less than 3.

Therefore, the methods presented here are those employed for the Nearshore Regional Survey as this was the primary source of marine megafauna data for this report.

Where relevant, data collected from the other surveys have been discussed to provide a wider regional context and to identify continuing trends or divergences. Each of the humpback aerial survey areas are depicted in Figure 3 and the vessel transect survey area is depicted in Figure 4. Detail of methodology for those surveys is contained in the respective reports: Humpback Whale Survey Report and Marine Megafauna Report.

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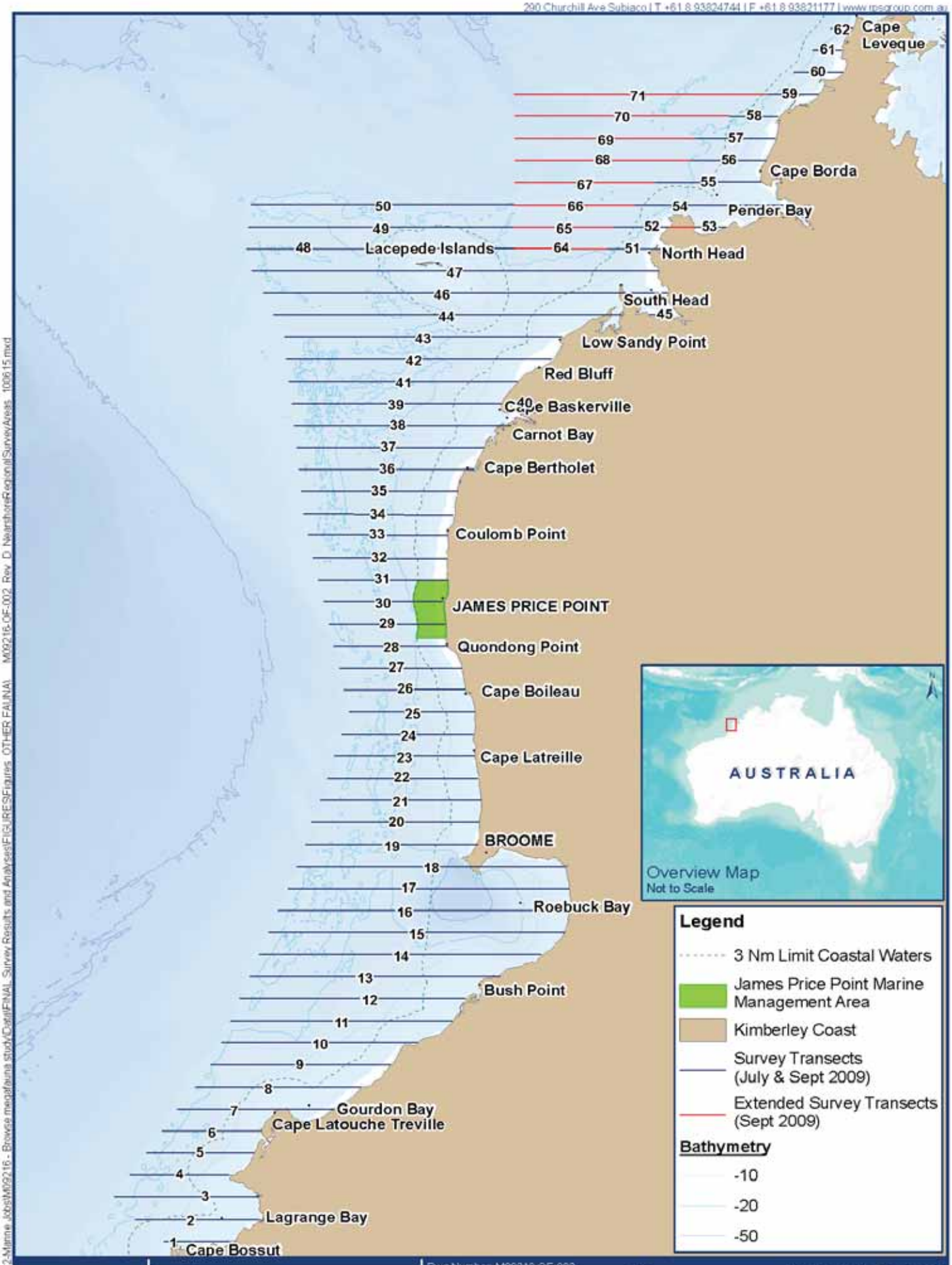

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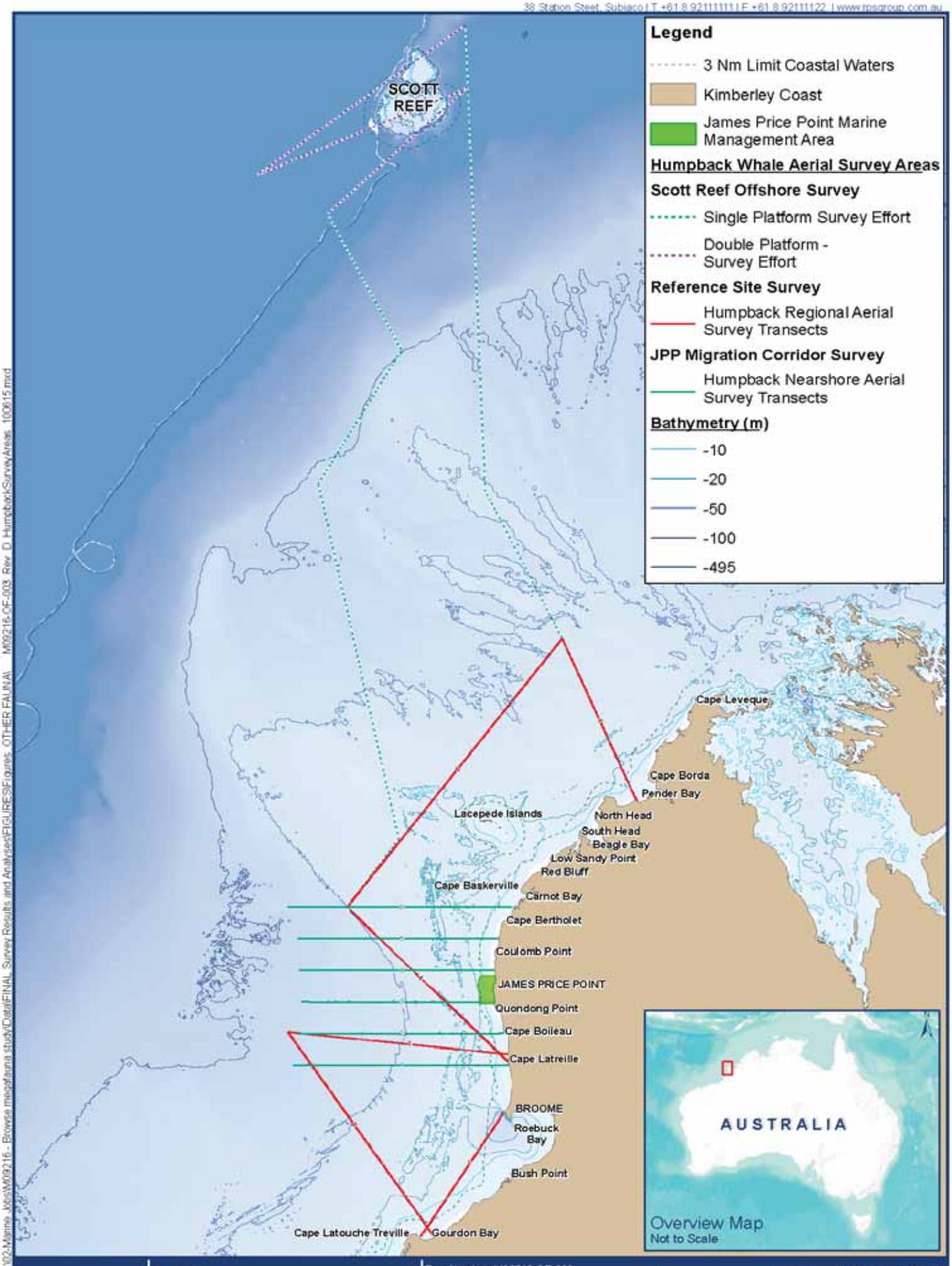

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Drafted by: M Angove
Source: RPS 2009

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Humpback Whale Aerial Survey Areas

Figure 3

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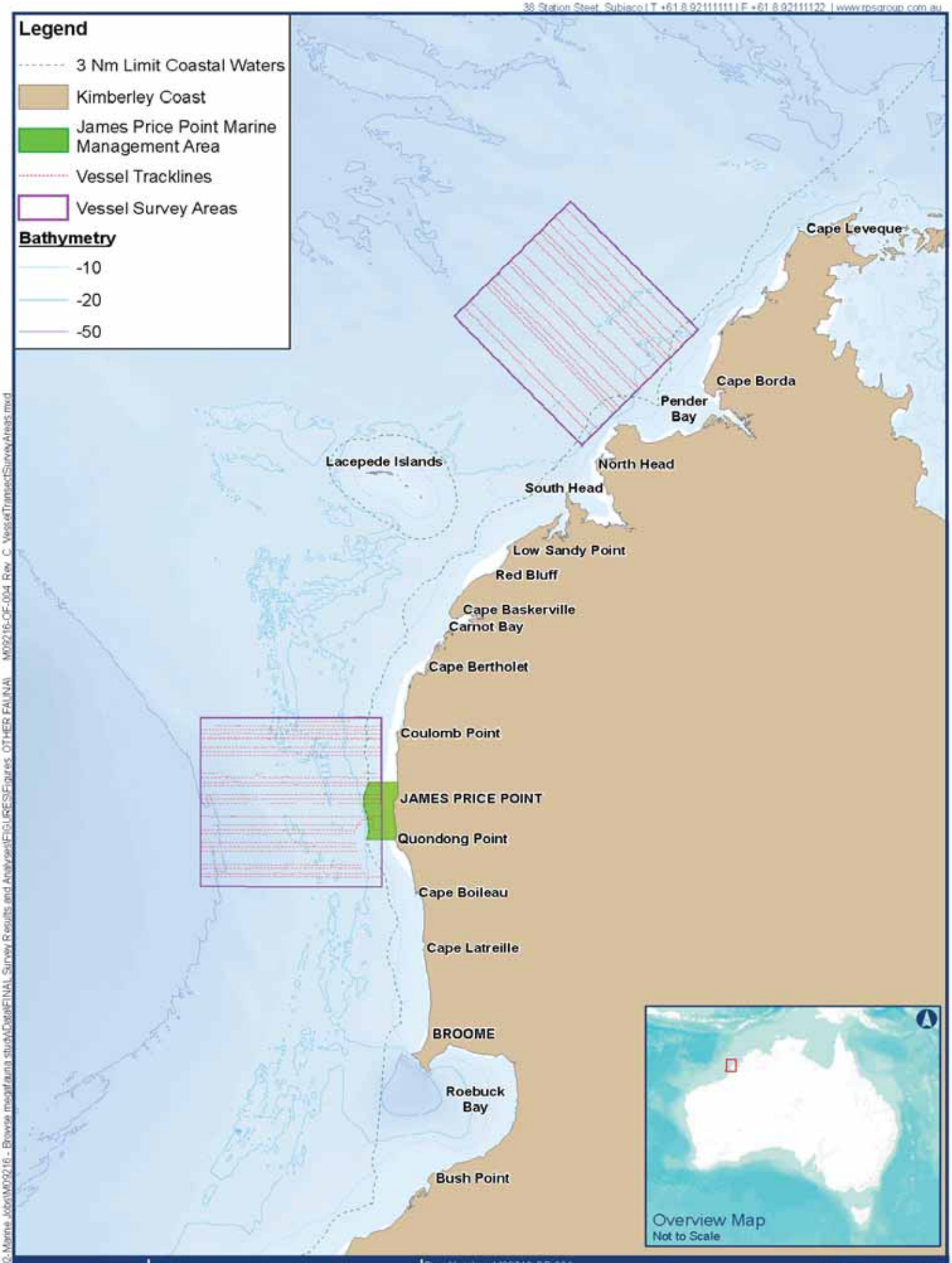

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Source: RPS 2009

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Vessel Transect Survey Areas

Figure 4

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3.2 Nearshore Regional Survey Schedule

The Nearshore Regional Survey was designed to extend the temporal dataset from March 2009 (late in the summer monsoonal season) over the drier winter months in order to account for seasonal variation. The July 2009 survey (NR1) was repeated in September 2009 (NR2) to account for changes within the dry season. The timing of these surveys is shown in Table 2 below.

Table 2: Timing of each Nearshore Regional Survey

Survey Name and Reference	Season	Survey Dates
March 2009 Megafauna Survey (SKM)	Late wet season	19/03/2009 20/03/2009 22/03/2009 24/03/2009 25/03/2009 26/03/2009
July 2009 Nearshore Regional Survey (NR1)	Early dry season	16/07/2009 17/07/2009 18/07/2009 19/07/2009
September 2009 Nearshore Regional Survey (NR2)	Late dry season	11/09/2009 12/09/2009 13/09/2009 17/09/2009

The whole survey area was sampled in the shortest time period that the weather and flight restrictions permitted (approx. four days). Survey transects were sampled in priority from number 18 to 63 (to maximise the quality of data from around James Price Point), and then number 17 to 1 to sample the southern extremity of the survey area. This pattern was used to minimise recounts between transects and minimise spatial autocorrelations. To maximise sightability of dugongs, and thus that of other marine megafauna, all surveys were conducted as close to the period of neap tides as possible when water turbidity was its lowest and in good weather (Beaufort Sea State (BSS) <4), and minimal glare (i.e. avoid early and midday high glare) (Marsh and Sinclair 1989; Lanyon 2003).

3.3 Nearshore Regional Survey Method

The sampling method used for dugongs and smaller marine megafauna was Strip Width Sampling, routinely used for dugongs in Australia as described by Marsh and Sinclair (1989) and refined by Pollock et al (2006). A dual platform arrangement was used which involved two observers on either side of the aircraft and a Team Leader. Observers recorded their sightings into digital audio files so that they could focus on spotting fauna. Data were transcribed to a database following the flights. The Nearshore Regional

Survey was conducted at an altitude of 900 feet (274 m) and at a constant speed of 110 kts (204 km/h). The aerial surveys designed to sample humpback whales were flown at an altitude of 1000 ft.

A double platform was adopted to sample humpbacks and dugongs so that a population estimate could be calculated using mark recapture analysis. Whilst both platforms on either side of the aircraft collected data for other marine megafauna, there was no intention to identify recaptures among these data. For all other megafauna groups, data from both platforms were used to provide a species list, but only data from the front platform were used in mapping and density analysis to avoid data duplication. This method was compatible with both Jenner and Jenner (2009a) and SKM (2009).

A trial flight was conducted on 30 June 2009 to test equipment in the aircraft and ensure observers were familiar with sampling protocol and target species identification.

Position fixes of the aircraft were obtained every second using a Garmin GPSMAP 60CSx and continuously downloaded to laptop. An external antenna was located in the cockpit of the aircraft to avoid interference. A backup GPS was also placed in the cockpit, and set to record fixes every second to internal memory.

An audio management system was used to capture the voice records from each observer. The audio management system, GPS and watches were synchronised prior to every flight so that records of sightings and environmental conditions could be allocated to positions after the flight from within the aerial database.

The Team Leader was responsible for monitoring survey progress, recording environmental conditions through the survey period, and informing the Observers when to start and stop surveying. The Team Leader monitored progress of the survey using a moving map facility on a laptop computer loaded with OziExplorer, and managed the GPS data stream of time, position and altitude for later downloading.

Environmental parameters collected by the Team Leader included wind speed (knots) and direction (degrees), cloud cover (oktas), Beaufort Sea State (BSS) (1–12), turbidity (1–4), visibility (1–9), other weather conditions (e.g. rain), transect start and finish time, and sighting data with associated viewing zone. For scales and descriptions of environmental categories, see Appendix 4.

A transect strip width of 400 m was surveyed on each side of the aircraft. This was demarcated into low, middle, high and very high zones, each of 100 m width. Any sightings obtained outside the sampling strip were also recorded but designated "outside" and not used in mapping. The viewing zones were marked on windows prior to each flight using geometry provided in Marsh and Sinclair (1989). The markings were based on individual observer seating position and survey flight height. Areas not surveyed included a 100 m strip under the aircraft, and 3,800 m between sampling strips.

Tandem Observers on each side of the aircraft independently recorded their observations in standard format. Observers reported glare at the start of each transect and changes occurred while on transect. Observers recorded megafauna according to a specific sequence defined on a laminated chart:

- Dugongs*
- Other cetaceans (that is, other than humpback whales)
- Whale sharks
- Crocodiles
- Other sharks, rays, sea snakes
- Vessels
- Bird and fish feeding aggregations
- Other biological and oceanographic features of interest.

* Sightings of dugongs and their calves took priority over all other species during the Nearshore Regional Survey.

3.4 Analytical and Mapping Methods

The marine fauna data were collated and analysed to generate species lists, summary statistics, distribution maps and density mapping. Inferences were made in the description for each species on behaviours observed and the potential importance of the survey areas for the species recorded.

3.4.1 Species List

From the sightings, marine megafauna species lists were compiled for both aerial and Vessel Transect Surveys. Sightings from both front and rear platforms were used to compile the species list. Where possible, fauna were identified to species but due to the survey altitude, this was not possible for many sightings. A larger proportion of animals were identifiable to species level from the Vessel Transect Surveys and named accordingly. In addition to fauna species, surface craft were also recorded.

3.4.2 Summary Statistics

Summary statistics of survey data have been compiled and presented in tabular format, including:

- Survey name
- Survey number
- Date or date range of the sighting(s)
- Number of sightings
- Number of animals
- Sea state
- Turbidity.

Summary statistics were compiled for all megafauna except for fish and birds.

3.4.3 Mapping

Maps of all sightings for each faunal group were produced using survey data from the front platform on either side of the aircraft. This method was used to avoid duplication and ensure comparability with data from Jenner and Jenner 2009. A series of figures (March, July and September 2009) were produced for each group. This enabled a direct comparison of similarities or differences between the survey periods. These data were not adjusted for environmental conditions.

3.4.4 Density Mapping

Density mapping was undertaken using the data for dolphins and sea snakes. Where high densities of two or more species overlap, the area may be identified as a hot spot. No other megafauna species were analysed by this model because of low numbers. A kernel density estimator was applied to the data using the Home Range Tools (HRT) extension for ArcGIS. Pre-processing to remove sampling bias was not required as the sampling effort was uniform across the survey area for the three surveys. A grid of 442 × 442 m was placed over the study area and several iterations using various search radii (smoothing values) were used. Results were inspected and the most logical and smoothest scale was selected for the final outputs (Section 3.0). Densities were grouped into Low, Medium, High and two intermediate levels.

4.0 RESULTS AND DISCUSSION

This section presents the results of the March, July and September 2009 surveys over the Nearshore Regional Survey area. Where applicable, megafauna data collected during the humpback surveys are presented in order to provide a wider regional context and to identify continuing trends or divergences.

4.1 Toothed Whales

4.1.1 Results

Dolphins were the only group of toothed whales (Odontoceti) recorded during the aerial Nearshore Regional Survey. A total of 80 groups of 369 dolphins including two calves were recorded in July 2009 and 69 groups of 294 dolphins including two calves were recorded in September 2009 (Table 3). By comparison fewer dolphins were recorded in March 2009 (36 groups of 180 dolphins) but of these 180 animals, nine were calves. Two sightings considered to be of beaked whales were recorded during the other aerial surveys.

Table 3: Dolphins (including Calves) Recorded During the Nearshore Regional Surveys

Dolphin Species	March 09 (SKM)		July 09 (NR1)		September 09 (NR2)	
	Animals	Groups	Animals	Groups	Animals	Groups
Bottlenose dolphin sp.	87 (6)	14	36	2	2	2
Spinner dolphin	0	0	100	1	9	1
Unidentified dolphin sp.	93 (3)	22	233 (2)	80	283 (2)	66
Total	**180 (9)**	**36**	**369 (2)**	**80**	**294 (2)**	**69**

(NR1= Nearshore Regional Survey one; NR2= Nearshore Regional Survey two)

The majority of the animals sighted in July and September 2009 were unable to be identified to species level. The two species recorded during the Nearshore Regional Survey were:

- Bottlenose dolphins (*Tursiops sp.*)
- Spinner dolphins (*Stenella longirostris*).

Bottlenose dolphins were the only dolphin taxa identified with high level of confidence during the March 2009 survey. Nine groups of these dolphins were detected during this survey period.

Two killer whales (*Orcinus orca*) were also recorded during the humpback surveys and five Indo-Pacific humpback dolphins (*Sousa chinensis*) were recorded during the vessel-based survey (see Table 4 of Appendix 1). Australian snubfin dolphins were a target species and were observed in Roebuck Bay when deploying to and from the vessel surveys. This species was not recorded offshore of James Price Point or Pender Bay.

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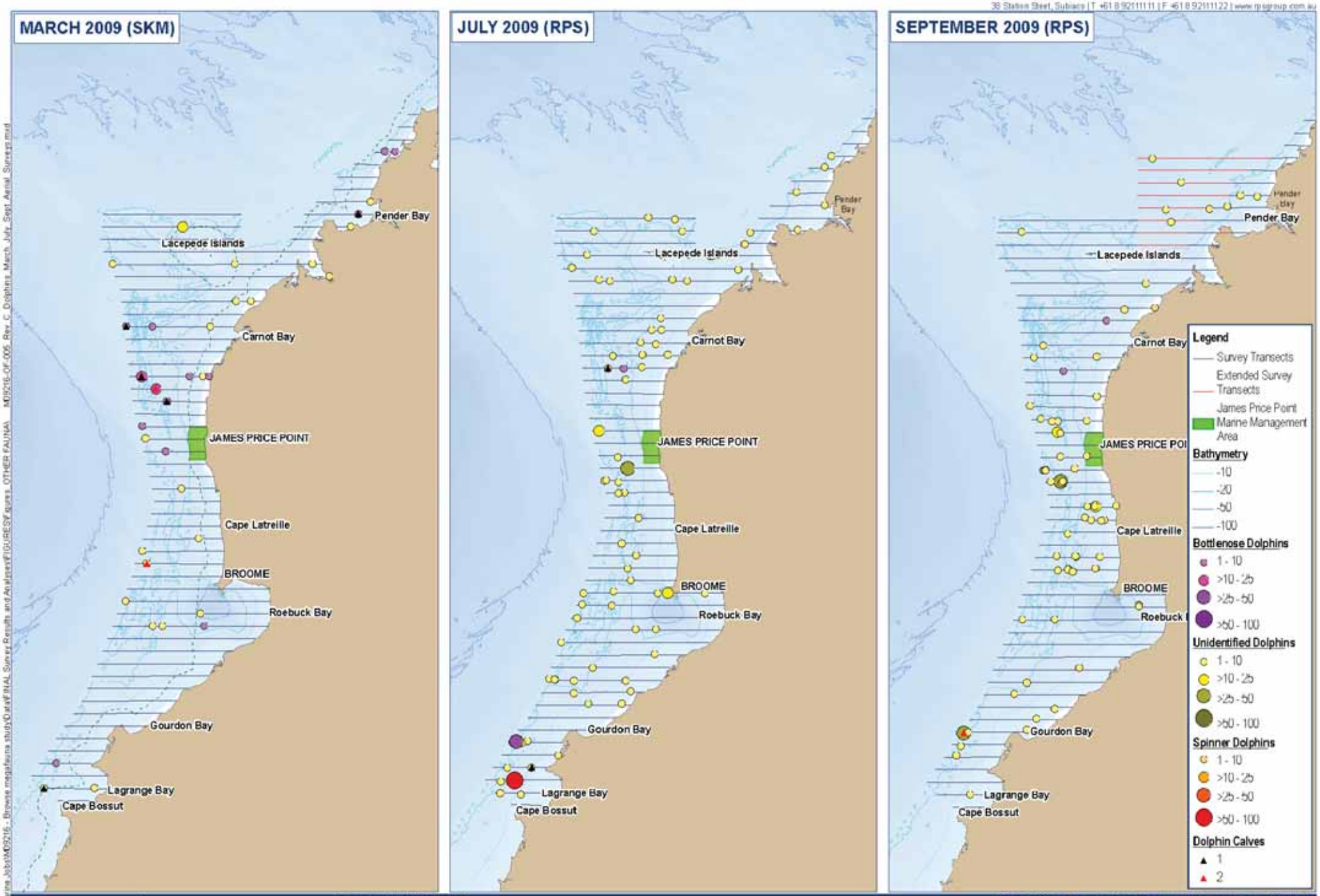

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Dolphins Recorded During the March (SKM), July and September Nearshore Regional Surveys

Figure 5

4.1.2 Discussion

4.1.2.1 Bottlenose Dolphins

Bottlenose dolphins were widely distributed across the survey area between Cape Latrielle and Pender Bay, and were generally found in waters less than 50 m but greater than 10 m. Occasional sightings were also recorded to the north of Pender Bay and just south of Scott Reef during the humpback surveys. The largest group of bottlenose dolphins, with an estimated 25 animals, was recorded approximately 15 km west of Gourdon Bay. The largest cluster of bottlenose dolphin groups was sighted south-west of James Price Point.

Although bottlenose dolphins were commonly (and confidently) recorded from aerial and Vessel Transect Surveys, the encounters did not permit confident differentiation between the two species expected in the area (common bottlenose dolphins (*Tursiops truncatus*) and spotted bottlenose dolphins (*T. aduncus*)). Common bottlenose dolphins recorded were likely to be the neritic ecotype rather than the offshore one as the water depth in which they were spotted was generally less than 50 m during the suite of megafauna surveys.

A total of 36 groups of bottlenose dolphin were recorded in the James Price Point Vessel Transect Survey area. This was the most commonly sighted dolphin species, but group size was generally low with a maximum of ten individuals. In all groups, there were 102 individuals recorded. Because of the low group size, bottlenose dolphins were the second most abundant dolphin in the area with spinner dolphin being more abundant. Sightings of this genus from the Vessel Transect Surveys were poor and could not establish groups to species.

These species are likely to be resident and widespread along the west coast of the Kimberley.

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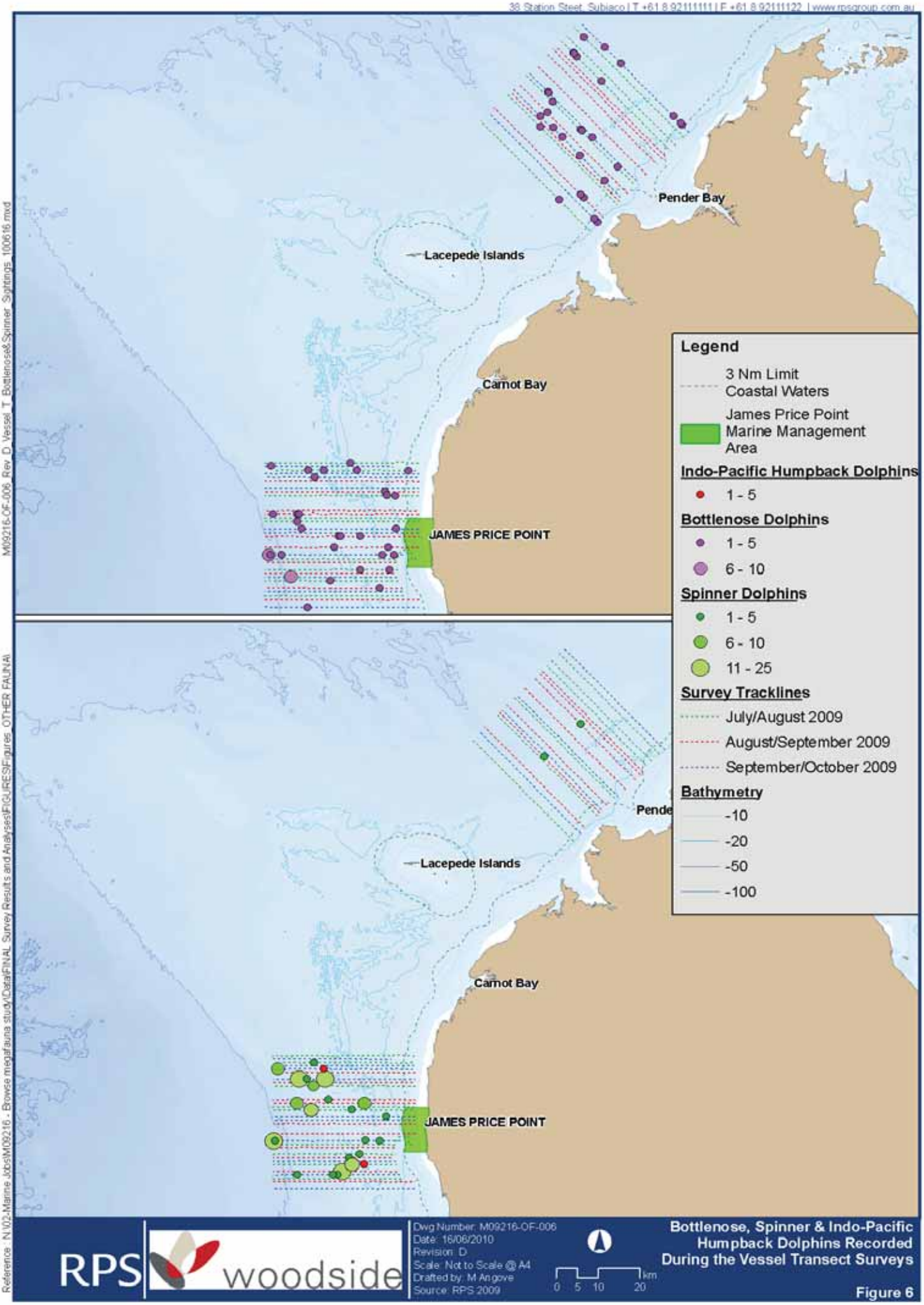

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Source: RPS 2009

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Bottlenose, Spinner & Indo-Pacific Humpback Dolphins Recorded During the Vessel Transect Surveys

Figure 6

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4.1.2.2 Spinner Dolphins

Spinner dolphins were the most numerous of dolphins in the area. In total, 109 spinner dolphins were recorded during the Nearshore Regional Survey. The largest group of spinner dolphins (50–100 animals) was recorded approximately 15 km west of Lagrange Bay in water 10–20 m deep.

Twenty-six groups of spinner dolphins were encountered during the three Vessel Transect Surveys in the survey area off James Price Point, involving an estimated 189 individuals. By comparison only two groups of spinner dolphins were recorded off Pender Bay. The Vessel Surveys were restricted to the survey boxes located off James Price Point and Pender Bay and therefore do not provide information for other areas of the coast.

Spinner dolphins were either sighted as groups ranging up to an estimated 100 individuals during the Nearshore Regional Survey or as pairs during the Vessel Transect Survey. Spinner dolphins were recorded more commonly in groups up to 30 individuals during the Vessel Survey. Fewer groups of spinner dolphins were recorded than bottlenose dolphins, but because they were often seen in large groups, they were the most numerous of the dolphin species recorded.

Spinner dolphins were mostly sighted in water of 25–50 m deep, and were seen on only one occasion closer than 5 km from the coast. Two sightings of large groups of spinner dolphins halfway between the mainland and Scott Reef occurred during the Scott Reef Offshore Surveys. The two groups comprised of approximately 10 and 25 animals.

This species is likely to be present throughout the year based on the records during the survey periods.

4.1.2.3 Indo-Pacific Humpback Dolphins

Two sightings of Indo-Pacific humpback dolphins, comprising a total of seven individuals, were recorded during the vessel-based survey in waters 20 m deep. One was of a group of five individuals sighted west of Quondong Point during the July–August 2009 Vessel Transect Survey. The other sighting involved a pair of dolphins west of Coulomb Point. There were too few sightings of this species to establish any trends over time from the data. No sightings were confirmed to species level during the aerial surveys, as expected. However, Indo-Pacific humpback dolphins are likely to be present in low numbers in nearshore waters and may have been part of the unidentified dolphin records.

This species normally inhabits shallow, nearshore and sheltered areas and is likely to travel along this coast between areas such as Roebuck Bay and Carnot Bay. They are probably transient along this coast in low numbers.

4.1.2.4 Australian Snubfin Dolphins

Australian snubfin dolphins *(Orcaella heinsohni)* were not recorded during any of the aerial surveys but they were observed in Roebuck Bay from the vessel whilst transiting to the survey areas off James Price Point and Pender Bay. This coastal species can be difficult to identify due to its inconspicuous appearance and habits. Based on the large survey effort and amenable survey conditions within the James Price Point area during survey, it is concluded that this species is seldom found outside of shallow and sheltered bays and inlets. However, it is thought that this species moves between sheltered areas (see Appendix 2), and therefore it is possible that this species may infrequently travel along the coast past James Price Point but in very low numbers.

4.1.2.5 Killer Whales

Killer whales were identified during the James Price Point Migration Corridor Survey and vessel surveys. Because of their size and coloration, it is unlikely they would be included within the unidentified dolphin data from the Nearshore Regional Surveys. There were two sightings of killer whales offshore of the Kimberley coast. One killer whale was recorded during the James Price Point Migration Corridor Survey in water between 25–50 m deep and approximately 35 km north-west of James Price Point (Table 1of Appendix 1). Killer whales were also observed during vessel surveys where one humpback cow/calf pair was repeatedly attacked by a group of eight to 10 killer whales.

Killer whales may be more abundant in the Kimberley during the winter when humpback whales are present. Killer whales are possibly the most active predator of humpback whales and are known to frequent calving grounds in particular (Corkeron and Connor 1999). However, because killer whales are an apex predator, and never highly abundant, it is unlikely they will be found in large numbers. They are likely to range widely in the region in very low densities.

4.1.2.6 Unidentified Dolphin Species

Unidentified dolphin species were widely distributed throughout the survey area, along the full stretch of the coast and from shallows to the deeper water (Figures 5). Dolphins were also recorded around Scott Reef and along the transects following the potential pipeline corridor. Calves were spotted on a number of occasions from the south near Cape Latouche Treville to Carnot Bay. Dolphins were also spotted along the full length of the transects sampled during the Reference Site Survey. This would indicate dolphins are not restricted to shallower coastal waters, nor concentrated towards the coast. However, individual species that make up the dolphin community are likely to be more restricted to particular marine habitats. They were less often recorded along transects out to Scott Reef but conditions were generally not as good between the mainland and Scott Reef and the data may include bias due to weather.

It is probable that bottlenose and spinner dolphins were part of the "unidentified dolphin" community in an approximately 60/40% split in groups as found during the Vessel Transect Surveys. It is more likely that most groups of over 15 animals were spinner dolphins as this species was more often recorded from the vessel in larger groups.

The following deepwater dolphin species have been previously recorded in the offshore area around Scott Reef and Browse Island (Jenner and Jenner 2009a and b) and may possibly have been included within the unidentified dolphin record of the Scott Reef Offshore Surveys in particular:

- Risso's dolphin (*Grampus griseus*)
- Fraser's dolphin (*Lagenodelphis hosei*)
- Short-beaked common dolphin (*Delphinus delphis*)
- Long-beaked common dolphin (*Delphinus capensis*)
- Pilot whale species (*Globicephala sp.*)
- Pantropical spotted dolphin *(Stenella attenuata)*
- Common dolphin *(Delphinus delphis).*

The false killer whale *(Pseudorca crassidens)* is another deepwater dolphin species identified during the 2008 surveys but, due to its conspicuous appearance, is unlikely to have been recorded as an unidentified dolphin.

Deepwater dolphins are highly mobile and known to prefer deepwater habitats and high productivity areas (Jenner 2009b). The spatial and temporal distribution of these dolphins is known to be highly variable, influenced by environmental, biotic and anthropogenic factors (Davis et al. 1998), therefore it is not likely that they are dependent on any one habitat within the survey area. They may be found at any time within the offshore areas of the potential footprint but were not recorded during the 2009 surveys.

4.1.2.7 Other Toothed Whales

Whilst no toothed whale (other than dolphin) species were identified during the Nearshore Regional Survey, three possible beaked whales (*Ziphidae*) were sighted during the Scott Reef Offshore Survey (Table 3 of Appendix 1). One beaked whale was sighted north-west of Pender Bay in waters deeper than 50 m and the other two near Scott Reef in deep water of around 495 m deep. The level of confidence in the sightings was relatively low. Many ziphid species are difficult to identify and differentiate from one another because the diagnostic morphological features are generally subtle (Hrvoje 2006). Beaked whales are known to feed in deep-water regions characterized by steep topography (Hain et al. 1985, Waring et al. 2001, in Auster & Watling 2008). Pender Bay is not a location in which beaked whales would be expected to frequent. None are expected to occur with any frequency near James Price Point, but they may be encountered occasionally near Scott Reef or along the northern pipeline route in low numbers.

The dwarf sperm whale *(Kogia sima)* was identified during the 2008 surveys (Jenner and Jenner 2009b) but not during the 2009 surveys. It is believed that the outer shelf areas and continental slope are important for *Kogia* species (DEWHA 2008). It is therefore unlikely that these species will be present in waters shallower than 500 m.

4.1.2.8 Density of Dolphins

Density maps from the Nearshore Regional Survey data indicate a changeable distribution of peak numbers of dolphins. In March, highest dolphin relative densities were located to the north-west of James Price Point, with lower relative densities north of Carnot Bay and the Lacepede Islands (Figure 7). However, substantially fewer dolphins were recorded during this survey than in July or September, and densities were relatively low across the survey area. Highest densities were recorded south-west of Cape Latouche Treville in July with a minor increase west of James Price Point. In September, the highest densities of dolphins were located between James Price Point and Cape Latreille. There was a relatively higher density of dolphins around (but outside of) the James Price Point area in comparison to surrounding waters during each survey period.

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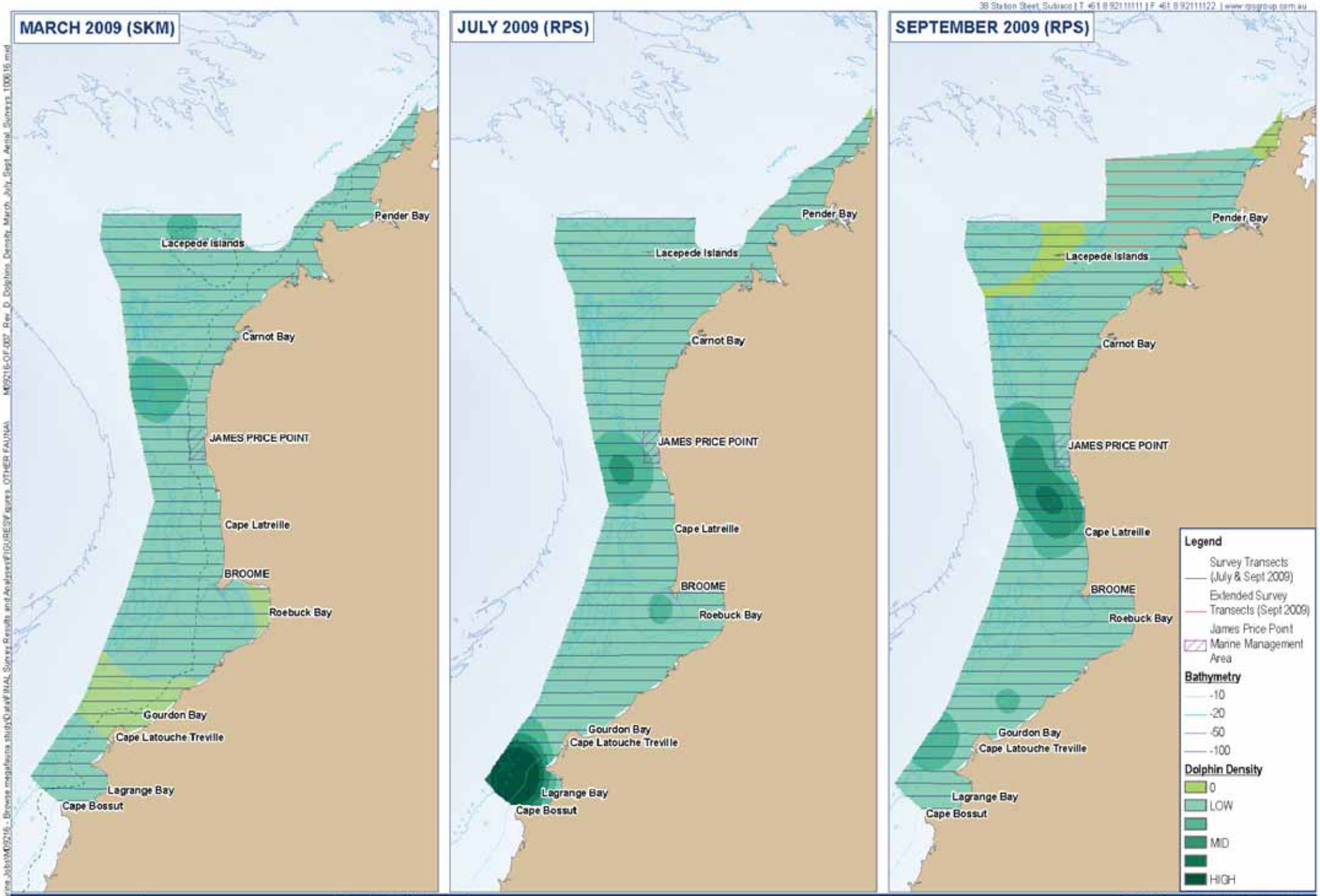

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Revision: D
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Drafted by: M Angove
Source: RPS 2009; SKM 2009

0 12.5 25 50 km

Dolphin Density Over Time (March 09; July 09; September 09)

Figure 7

4.2 Baleen Whales

Excluding humpback whales (and unidentified whales assumed to be humpback whales), no baleen whales were recorded during the Nearshore Regional Surveys. However, two baleen whales were recorded during other surveys.

One minke whale (*Balaenoptera acutorostrata*) was recorded in waters approximately 100 m deep, halfway between the coast (off Carnot Bay) and Scott Reef during the Humpback Offshore Survey (Table 3 of Appendix 1). One Bryde's whale (*Balaenoptera edeni*) was recorded in waters approximately 20 m deep, during the August/September Vessel Transect Survey about 10 km west of Coulomb Point (Table 4 of Appendix 1).

Other baleen whale species identified during the 2008 surveys (Jenner and Jenner 2009b) but not during 2009 surveys were:

- Blue whale *(Balaenoptera musculus)*
- Southern right whale *(Eubalaena australis)*.

These species are mainly oceanic (IUCN 2009) and are known to undertake seasonal migration from cold water feeding grounds to warm water breeding grounds (Bannister et al. 1996). The record of the southern right whale was not certain and it was acknowledged to be outside its usual range and considered to be vagrant at this location. Blue whales may visit the area on a seasonal basis but further information is required to confirm this (Refer to Appendix 2 for further information on these species).

4.3 Sharks

4.3.1 Results

A total of 28 sharks were recorded in July 2009 and 32 sharks were recorded in September 2009 (Table 4). By comparison, fewer sharks were recorded in March 2009 (Table 4), although this may be partly due to lower emphasis on recording this group than later in the year. Although the majority of the sharks sighted during all surveys were not identified to species level, several were and include:

- Hammerhead shark (*Sphyra sp*)
- Lemon shark (*Negaprion acutidens*)
- Tiger shark (*Galeocerdo cuvier*)
- Whaler shark (*Carcharhinus sp.*).

Table 4: Sharks Recorded During the Nearshore Regional Surveys

Shark Species	March 09 (SKM)		July 09 (NR1)		September 09 (NR2)	
	Animals	Groups	Animals	Groups	Animals	Groups
Hammerhead shark	0	0	0	0	2	2
Lemon shark	0	0	1	1	2	2
Other whaler sp.	0	0	0	0	6	5
Unidentified shark sp.	11	11	27	26	22	22
Total	**11**	**11**	**28**	**27**	**32**	**31**

(NR1= Nearshore Regional Survey one; NR2= Nearshore Regional Survey two)

Sharks were distributed across the entire megafauna survey area, from Lagrange Bay in the South to Scott Reef in the north but in low numbers. During the Nearshore Regional Survey, most sharks appeared to be somewhat closer to shore during September than in July (Figure 8). Based on all megafauna surveys, the majority of sightings were recorded in water shallower than 50 m. Generally, more sharks were distributed in the north of the survey during July and more in the southern part during September. Regular sightings were also obtained off Carnot Bay and James Price Point during other surveys.

Whale sharks have previously been recorded in the Kimberley region but were not on this occasion, despite extensive survey effort. This species is readily distinguishable from the air and potentially passing through this region between June and October. The presence of whale sharks in the area at other times cannot be excluded: however it is unlikely to occur in the area in high numbers.

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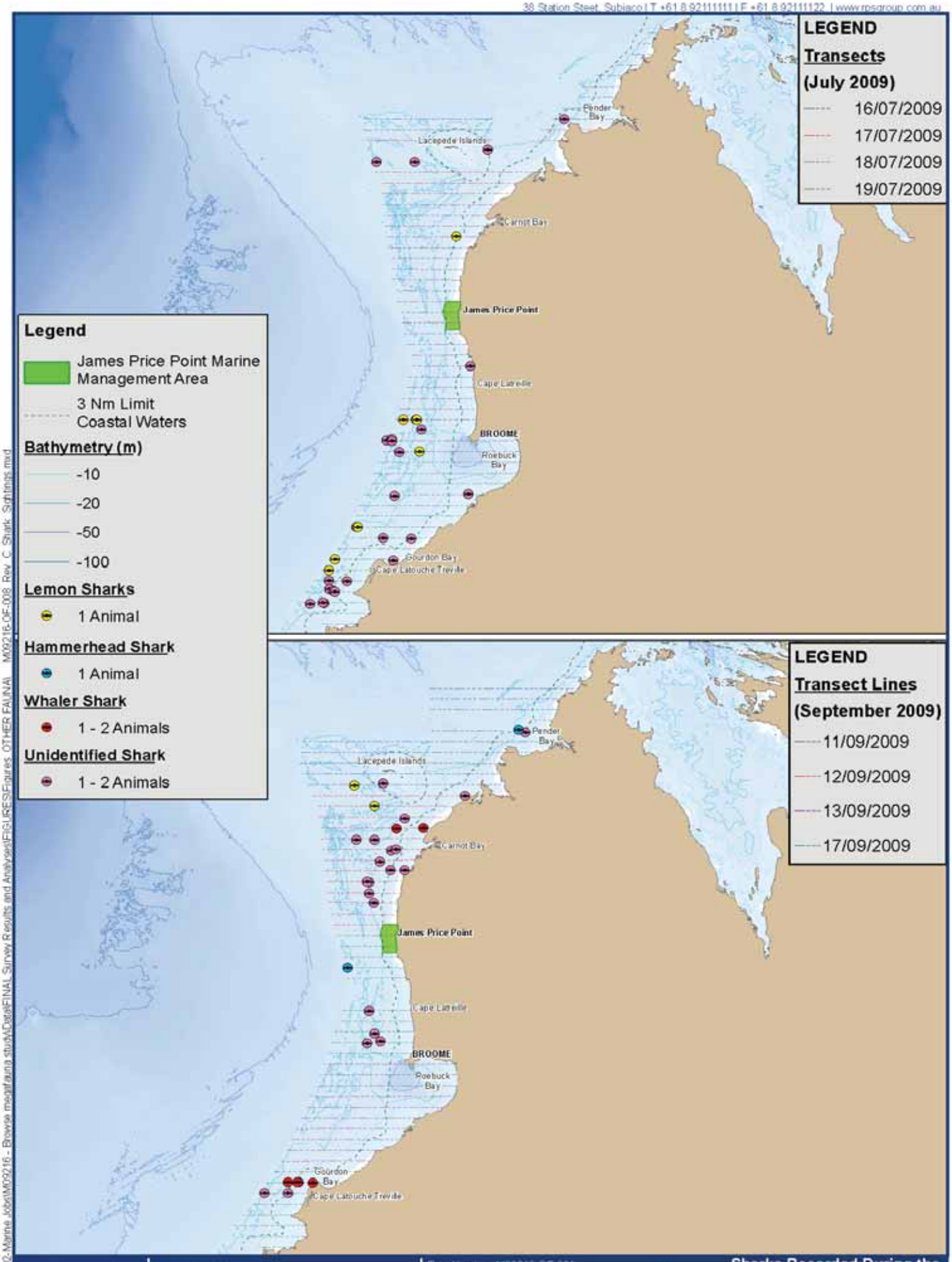

RPS woodside

Dwg Number: M09216-OF-008
Date: 04/03/2010
Revision: C
Scale: Not to Scale @ A4
Drafted by: M Angove
Source: RPS 2009

Sharks Recorded During the July and September 2009 Nearshore Regional Surveys

Figure 8

Reference: N:\02-Marine Jobs\M09216 - Browse mega\fauna study\Data\FINAL Survey Results and Analyses\FIGURES\Figures_OTHER FAUNA\ M09216-OF-008 Rev. C Shark Sightings.mxd

4.3.2 Discussion

4.3.2.1 Hammerhead Sharks

One hammerhead shark was recorded during the Nearshore Regional Survey, in 20 m deep waters approximately 30 km south-west of James Price Point. However, many more were recorded during other surveys. The largest groups of hammerhead sharks were recorded during the James Price Point Migration Corridor Survey, with a group of four sighted north-west of James Price Point in water of around 50 m deep. A single hammerhead shark was also recorded during the March survey (SKM 2009). There were too few sightings of this genus to establish any trends over time, but it is likely that it is present all year round.

4.3.2.2 Whaler Sharks (*Carcharhinus* sp.)

A number of whaler sharks were recorded during the Nearshore Regional Surveys although not to species level. According to Last and Stevens (2009), these sharks can be difficult to distinguish, as many species have very similar features. Species possibly present include:

- Dusky shark *(C. obscurus)*
- Bronze whaler *(C. brachyurus)*
- Sandbar shark (*C. plumbeus)*
- Bull shark *(C. leucas)*
- Grey reef shark (*C. amblyrhyncos)*
- Blacktip reef shark *(C. melanopterus)*
- Whitetip reef shark *(Triaenodon obesus)*
- Blacktip shark (*C. tilstoni*)
- Lemon shark (*Negaprion acutidens)*
- Tiger shark (*Galeocerdo cuvier*).

Lemon sharks were positively identified during the Nearshore Regional Surveys and tiger sharks were recorded during the James Price Point Migration Corridor Survey. Lemon sharks and unidentified whaler sharks were broadly distributed across the nearshore survey areas. However, in July more whaler sharks were recorded along the coast south of Broome to the end of the survey area. In September, more sharks were recorded in the north of the survey area, mainly between Carnot Bay and the Lacapede Islands. All sightings were of single animals. There were too few data for any trends to be identified. The lemon shark was not recorded during previous surveys in the area.

During the James Price Point Migration Corridor Survey, four tiger sharks were recorded in the nearshore region in water less than 20 m deep. All tiger shark sightings involved single animals. Being a tropical and sub-tropical species with broad habitat preferences, these whaler shark species are likely to be present year round and resident in the region.

4.3.2.3 Other Species

Shark species identified during other surveys or whilst off-transect were:

- Great white shark (*Carcharodon carcharias*)
- Leopard shark (*Triakis semifasciata*).

A great white (listed as Vulnerable on the EPBC Act) was recorded in the survey area during the Reference Site Survey. It was sighted west of Carnot Bay close to the 50 m isobath and around 67 km north-west of James Price Point. The single sighting of a great white shark is of interest as the Kimberley is considered to be outside of its known range. However, this shark follows migrating humpback whales and is known to undertake extensive migrations that can extend beyond its normal range. Whilst it may not be entirely vagrant at this location, it is likely to be a rare visitor.

One leopard shark was sighted off Coulomb Point, north of James Price Point in water of around 20 m deep during the Vessel Transect Survey (Table 4 of Appendix 1). This shark is not listed under the EPBC Act and is likely to reside in the region and be present throughout the year.

4.3.2.4 Distribution of Sharks

Based on the results from the suite of the megafauna surveys, tiger and hammerhead sharks were recorded over a wider area than other species, across the continental shelf from the surf zone to deep water areas. Lemon and whaler sharks were recorded in the shallows out to waters as deep as 50 m, again consistent with their known habits.

Based on knowledge of their biology, and the frequency of sightings in the surveys, all of these species are likely to be present throughout the year with the exclusion of the great white which may only be present through the winter. The lemon and whaler sharks are unlikely to be encountered beyond the 50 m bathymetric contour, while hammerhead and tiger sharks may be found widely between the coast and Scott Reef.

The bulk of shark sightings occurred to the north of James Price point and west of Carnot Bay where many fish were also recorded during the July and September Nearshore Regional Surveys.

4.4 Rays

4.4.1 Results

A total of 37 groups of 74 rays were recorded in July 2009 and 36 groups of 42 rays were recorded in September 2009 (Table 5). By comparison, fewer animals and groups of rays were recorded in March 2009 (34 and 24 respectively). The majority of the animals sighted were unable to be identified to species level. The species recorded were:

- Eagle ray (Myliobatidae sp.).
- Shovelnose ray (Rhynchobatidae sp.).
- Devilray (Mobulidae sp)*.

Table 5: Rays Recorded During the Nearshore Regional Surveys

Ray Species	March 09 (SKM)		July 09 (NR1)		September 09 (NR2)	
	Animals	Groups	Animals	Groups	Animals	Groups
Eagle	0	0	2	1	1	1
Shovelnose	0	0	0	0	1	1
Devilray	0	0	24	17	25	22
Unidentified ray sp.	34	24	48	19	15	12
Total	**34**	**24**	**74**	**37**	**42**	**36**

(NR1= Nearshore Regional Survey one; NR2= Nearshore Regional Survey two)

*The sightings of devilrays were actually recorded as manta rays during the survey but as there are two species that inhabit northern WA waters (*Manta birostris* and *Mobula eregoodootenkee*), both very similar, identification to species level is uncertain.

4.4.2 Discussion

Rays were widely distributed across the survey areas from the shallow nearshore out to deep water surrounding Scott Reef. Several groups of rays comprising up to 15 individuals were sighted during the Nearshore Regional Survey, the largest of which was recorded just west from Roebuck Bay (Figure 9). Rays were often sighted in nearshore waters off Roebuck Bay, Gourdon Bay and around the Lacepede Islands.

Devilrays and eagle rays are both readily identified from the air and the former was frequently sighted, typically in shallow nearshore waters. Only two sightings of eagle rays were recorded, in Roebuck Bay and at Scott Reef. A total of eighty-two unidentified ray species sightings could not be identified to species level.

The devilray was the most frequently recorded ray, often with greater frequency than unidentified rays. Most devilrays were sighted between the coast and the 50 m isobath. Several records were also obtained in water of around 100 m at Scott Reef. The largest cluster of devilrays was an estimated 18 individuals to the south-west and north-west of Carnot Bay. The species was recorded during all 2009 surveys and it is likely to be present in the study area throughout the year.

Neither devilrays nor eagle rays were observed in concentrations close to James Price Point or Scott Reef in July or September 2009, indicating that these locations are not of particular importance to either species at these times of the year.

Three species of sawfish are threatened and are therefore listed as MNES. However, sawfish were not recorded during any of the surveys, but it is acknowledged that these surveys were not intended or designed to sample this species.

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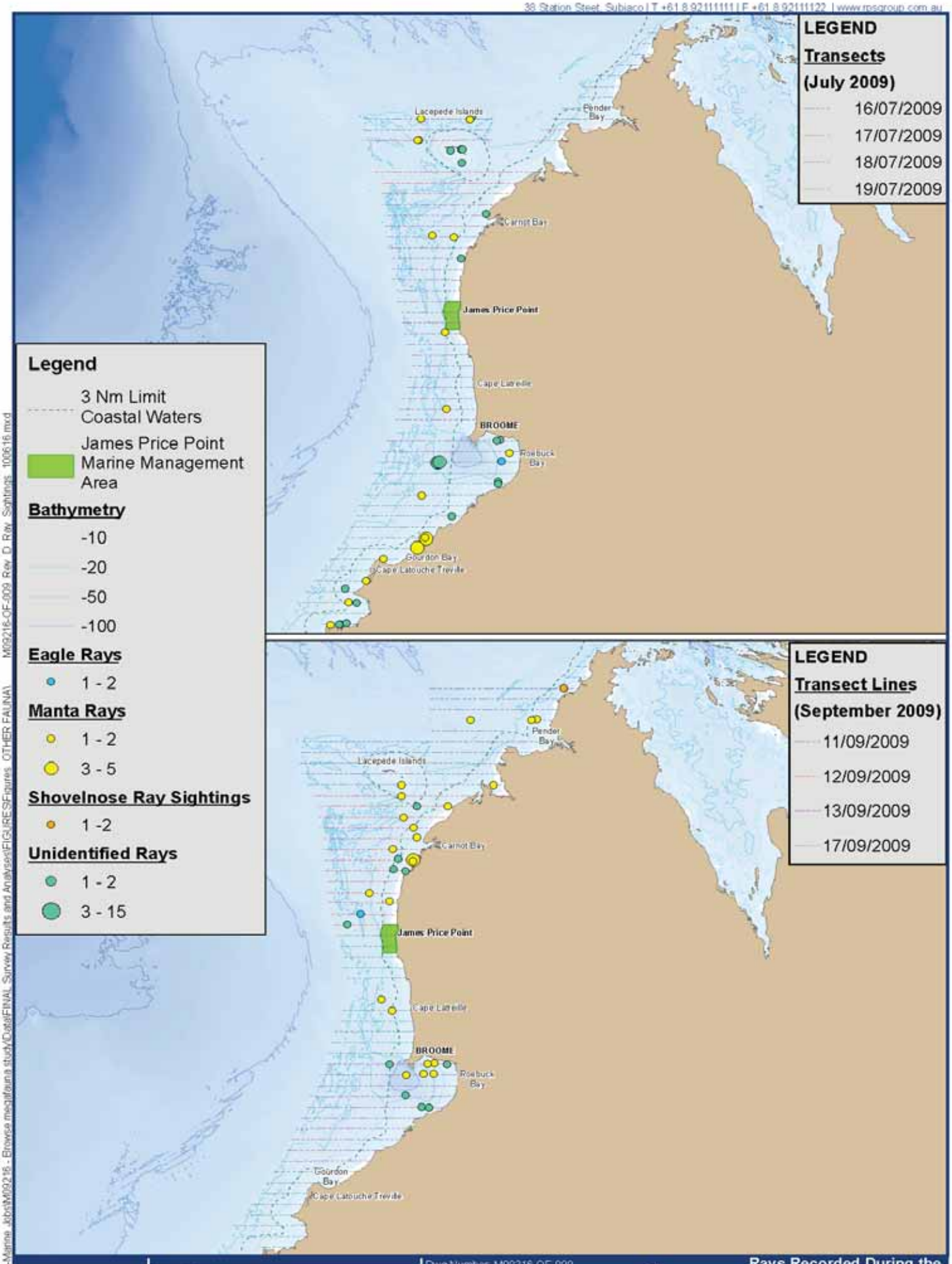

Reference: N:\02-Marine Jobs\M09216 - Browse megafauna study\Data\FINAL Survey Results and Analyses\FIGURES\Figures_OTHER FAUNA\ M09216-OF-009 Rev D Ray Sightings 100616.mxd

RPS woodside

Dwg Number: M09216-OF-009
Date: 16/06/2010
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Scale: Not to Scale @ A4
Drafted by: M Angove
Source: RPS 2009

0 12.5 25 50 km

Rays Recorded During the July and September 2009 Nearshore Regional Surveys

Figure 9

4.5 Bony Fish

4.5.1 Results

Fish and fish schools were recorded during the Nearshore Regional Survey as they provide potential indications of the productivity of the area and an indication of food sources for larger marine fauna such as dolphins. A total of 63 records of fish were recorded during the September survey and 89 during the July survey (Table 6). The total number of fish sightings recorded by SKM during the March survey was much lower (14), as this only relates to obvious bait balls. Recording fish sightings was a low priority and these records should therefore not be considered complete (Figure 10).

Table 6: Bony Fish (Osteichthyes) Recorded During the Nearshore Regional Surveys

Fish sightings recorded	March 09 (SKM)	July 09 (NR1)	Sept. 09 (NR2)
Unidentified fish species	14	89	63

(NR1= Nearshore Regional Survey one; NR2= Nearshore Regional Survey two)

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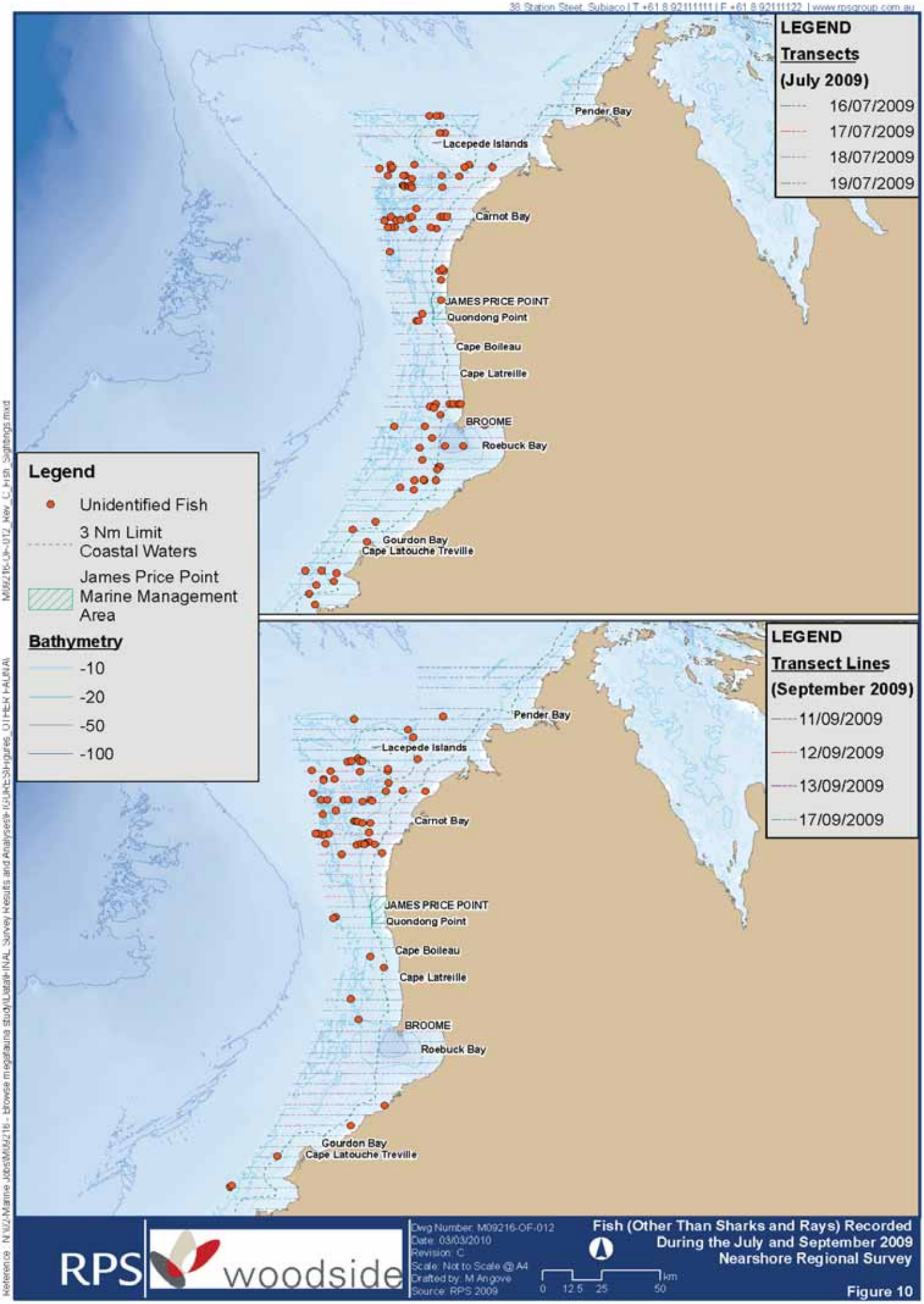

RPS woodside

Dwg Number: M09216-OF-012
Date: 03/03/2010
Revision: C
Scale: Not to Scale @ A4
Drafted by: M Angove
Source: RPS 2009

0 12.5 25 50 km

Fish (Other Than Sharks and Rays) Recorded During the July and September 2009 Nearshore Regional Survey

Figure 10

Reference: N:\MJ-Marine Jobs\M09216 - browse megafauna study\Data\final_Survey Results and Analyses\e-IGIS\MXD\Sightings_OTHER FAUNA\M09216-OF-012_Rev_C_Fish_Sightings.mxd

4.5.2 Discussion

Each of the three surveys (March, July and September) recorded fish throughout the area, most in waters just outside of the 3 Nm state limit. However, the marine conditions within 3 Nm of the coast generally make it hard to spot fish and their presence in nearshore waters should not be excluded. Many sightings of fish between Carnot Bay and north to the Lacepede Islands were recorded in both July and September. In September, there were also as many sightings recorded from Broome south to Cape Latouche Treville.

Most fish recorded during the Nearshore Regional Survey were either in shoals or were surface active. They were frequently observed forming bait balls, and often associated with birds, dolphins or both. These associations were occasionally recorded during the Vessel Transect Survey.

Species of fish identified during the humpback surveys were:

- Sunfish *(Elassoma* sp.*)*
- Tuna (*Thunnus* sp.).

4.6 Reptiles

4.6.1 Results

The only reptiles (apart from turtles) that were sighted during the Nearshore Regional Surveys were sea snakes (Table 7). They were not able to be identified to species level. The highest numbers of sea snakes were recorded in July (236 groups of 249 snakes), followed by the September count (171 groups of 183 snakes). Seventy six groups of 84 snakes were recorded in March (Table 7).

Table 7: Reptiles (Excluding Turtles) Recorded During the Nearshore Regional Surveys

Sea Snake Species	March 09 (SKM)		July 09 (NR1)		Sept. 09 (NR2)	
	Animals	Groups	Animals	Groups	Animals	Groups
Unidentified sea snake sp	84	76	249	236	183	171

(NR1= Nearshore Regional Survey one; NR2= Nearshore Regional Survey two)

4.6.2 Discussion

4.6.2.1 Distribution of Sea Snakes

Sea snakes are listed under the EPBC Act although not as Threatened or Migratory species and therefore are not recognised as MNES. Of all megafauna groups recorded throughout the Nearshore Regional Survey and the March survey, sea snakes were the most commonly sighted.

During the Nearshore Regional Survey sea snakes could not be identified to species level. Identifying sea snakes to species level during the vessel surveys was also not a high priority. There was a single sighting of a banded sea snake during the Vessel Transect Survey, approximately 26 km south-west of James Price Point, in between waters 20–50 m deep. Twenty species of sea snakes were listed through the EPBC Act Protected Matters Database Search as potentially occurring in the Kimberley region (Appendix 2). Therefore, the sea snake assemblage recorded may contain diverse species.

Sea snakes were distributed almost across the entire Nearshore Regional Survey area (Figure 11) and throughout the other survey areas, from Lagrange Bay in July and from Broome in September north to Pender Bay. They were also distributed along the length of the Scott Reef Offshore Survey, including at Scott Reef. The spatial distribution was less extensive during the March survey, with most sea snakes recorded between Cape Latreille and Low Sandy Point (SKM 2009). The majority of sightings were in waters between 10 to 50 m deep. As most species of sea snake occupy small home ranges (DEWHA 2008), these animals are likely to be resident in the region, in abundance, rather than being highly mobile and variable through the year.

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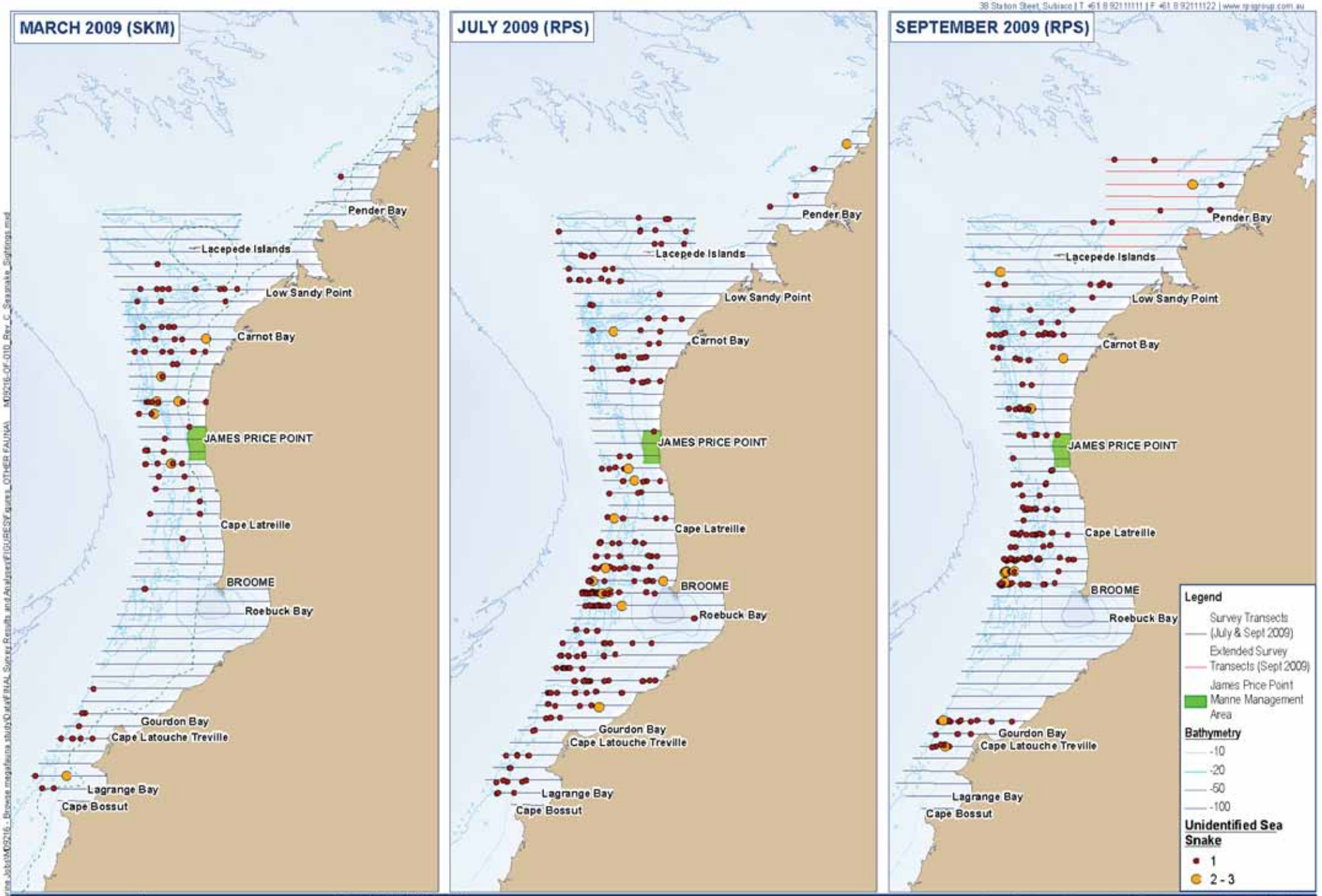

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Job Number: M09216-OF-010
Date: 04/03/2010
Revision: C
Scale: Not to Scale @ A4
Drafted by: M Angove
Source: RPS 2009, SKM 2009

0 12.5 25 50 km

Sea Snakes Recorded During the March (SKM), July and September 2009 Nearshore Regional Survey

Figure 11

4.6.2.2 Density of Sea Snakes

Sea snakes were represented through all three surveys but to a lesser extent in March. They were recorded along the entire length of the sampled coastline and found mostly in water deeper than 10 m. Most sea snakes were recorded as isolated individuals but many were also seen in pairs or threes. Areas where most regular sightings were recorded were north and west of Lagrange Bay, west of Carnot Bay (March, July and September) and west of Broome (July and September only) where the highest numbers were recorded. Sea snakes can only be spotted when conditions are very good and so changing environmental conditions may have partially masked their presence in other areas. Previously, sea snakes in the Kimberley have been reported to be in highest numbers in Pender Bay (Jenner and Jenner 2006), however, this study did not specifically target sea snakes.

The highest relative density of sea snakes recorded was approximately 30 km west of Broome in July and September in water depths of around 10 m to 20 m (Figure 12). Outside of this area, sea snake density was fairly even throughout the Nearshore Regional Survey area with the exception of nearshore waters. Reduction of sea snake abundance in the nearshore waters may be the result of sampling bias because of increased turbidity and wave action. Very few sea snakes were recorded in the area near James Price Point, and only one was recorded in Roebuck Bay.

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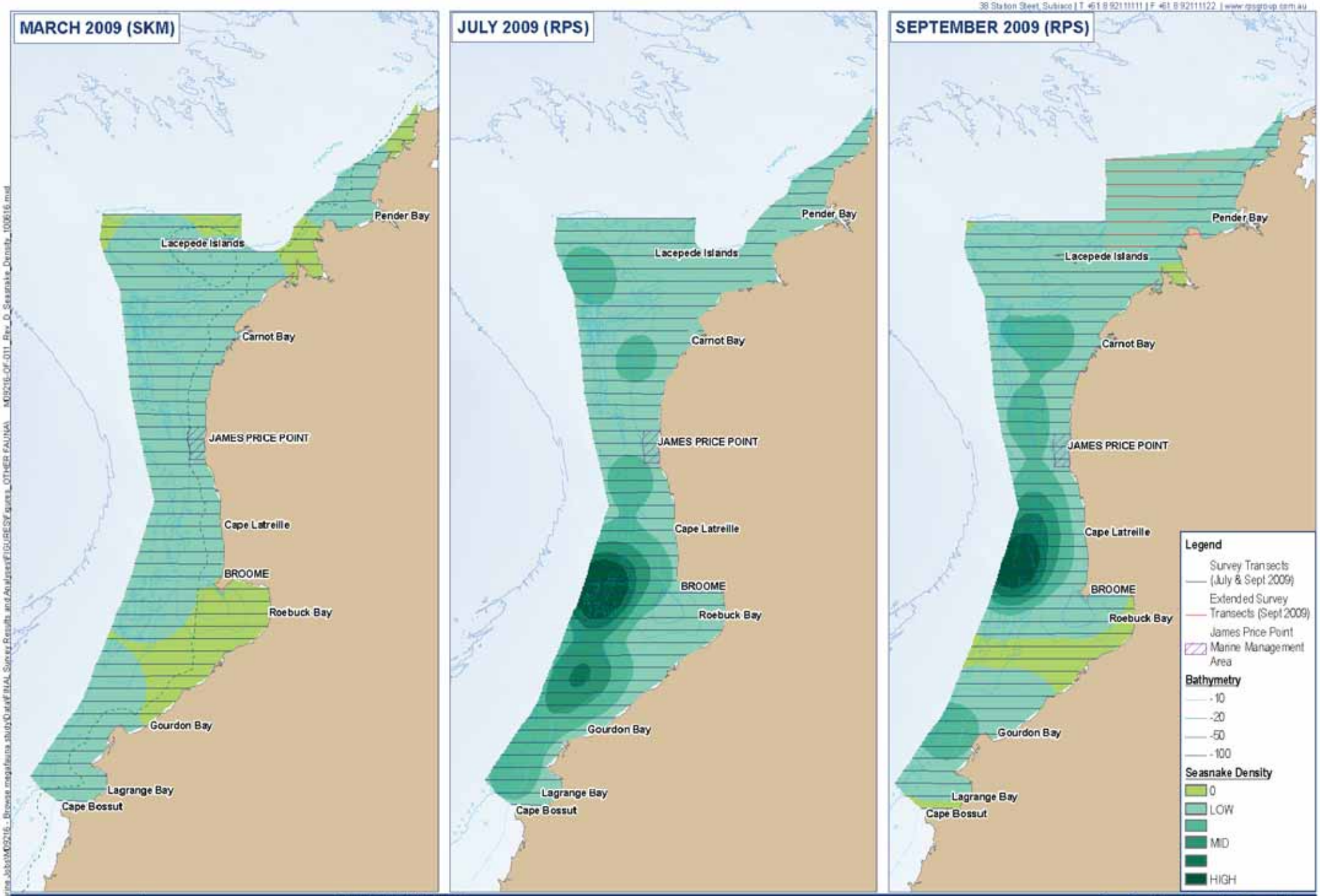

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Scale: Not to Scale @ A4
Drafted by: M Angove
Source: RPS 2009, SKM 2009

0 12.5 25 50 km

Sea Snakes Density Over Time (March, July & September 2009)

Figure 12

4.6.2.3 Crocodiles

Whilst crocodiles were not recorded during the Nearshore Regional Surveys, one individual and evidence of another were observed during a Turtle Survey on the Lacepede Islands. During a turtle survey that occurred in December 2009 and January 2010, one saltwater crocodile of almost 2 m in length was observed basking on the eastern beach of West Island of the Lacepedes on 05 December 2009. A fresh crocodile track was noted on Manari Beach, approximately 10 km north of James Price Point, on 20 January 2010.

The limited number of crocodile sightings throughout the surveys indicates that none of the areas surveyed, including onshore and offshore areas of potential footprint, provide important habitat or foraging areas for these animals.

4.7 Birds

4.7.1 Results

Birds could not be identified to species level during the Nearshore Regional Survey. In July, nine groups of birds were recognised as species of terns whilst the others were recorded as unidentified species. Birds were only recorded as feeding assemblages during the March survey (Table 8).

Table 8: Birds Recorded During the Nearshore Regional Surveys (from Front and Rear Platforms and outside Sampling Strip)

Species	March 09 (SKM)		July 09 (NR1)		Sept. 09 (NR2)	
	Animals	Groups	Animals	Groups	Animals	Groups
Tern sp.	N/A	N/A	625	9	0	0
Unidentified bird sp.	N/A	29	1145	26	300	2
Total	**N/A**	**29**	**1970**	**37**	**300**	**2**

(NR1= Nearshore Regional Survey one; NR2= Nearshore Regional Survey two)

4.7.2 Discussion

Collection of bird records was a lower priority than records of other marine megafauna (Section 3.3) and data should therefore not be considered complete. Bird sightings were recorded from both platforms and data from both, therefore they probably contain duplicate sightings.

Sightings of birds were often made in association with dolphins and fish (especially bait balls), or both. High levels of interaction between birds and other marine fauna can provide an indication of the area's productivity. However, based on the Nearshore Regional Survey data, the clusters of bird feeding assemblages did not correlate with clusters of fish or dolphin feeding assemblages. The greatest densities of schooling fish and bird feeding were recorded by the March survey north-west of Gourdon Bay and offshore of Cape Boileau to Quondong Point (SKM 2009).

The distribution of birds recorded by the Nearshore Regional Surveys is presented in Figure 13. More activity was recorded during the July Nearshore Regional Survey than the September survey. In July, numerous flocks of birds (including terns) were recorded over the steep 10–20 m gradient approximately 30 km offshore from Carnot Bay. Several flocks were also recorded over similar depths approximately 25 km offshore from Roebuck Bay. Unidentified bird species were recorded over the 20 m isobath around the Lacepede Islands during both Nearshore Regional Surveys as well as during the Humpback Offshore Survey. The Scott Reef Offshore Survey (repeated over a period of time from 3 July to 12 October) did not record birds at Scott Reef.

Other species of birds that were present in the area (as recorded by the humpback surveys; Tables 1, 2 and 3 of Appendix 1) were:

- Brown booby (*Sula leucogaster*).
- Wilson's storm petrel (*Oceanites oceanicus*).
- Shearwater (*Puffinus sp.*).

Of these, the brown booby was the most common. Other species likely to make up the unidentified records are of the bird groups sighted in 2008 (Jenner and Jenner 2009b):

- Frigate (*Fregata sp.*)
- Tropicbird
- Petrel (*Pterodroma sp.*)
- Gull (*Larus sp.*)
- Shearwater (*Puffinus sp.*)
- Noddy (*Anous sp.*).

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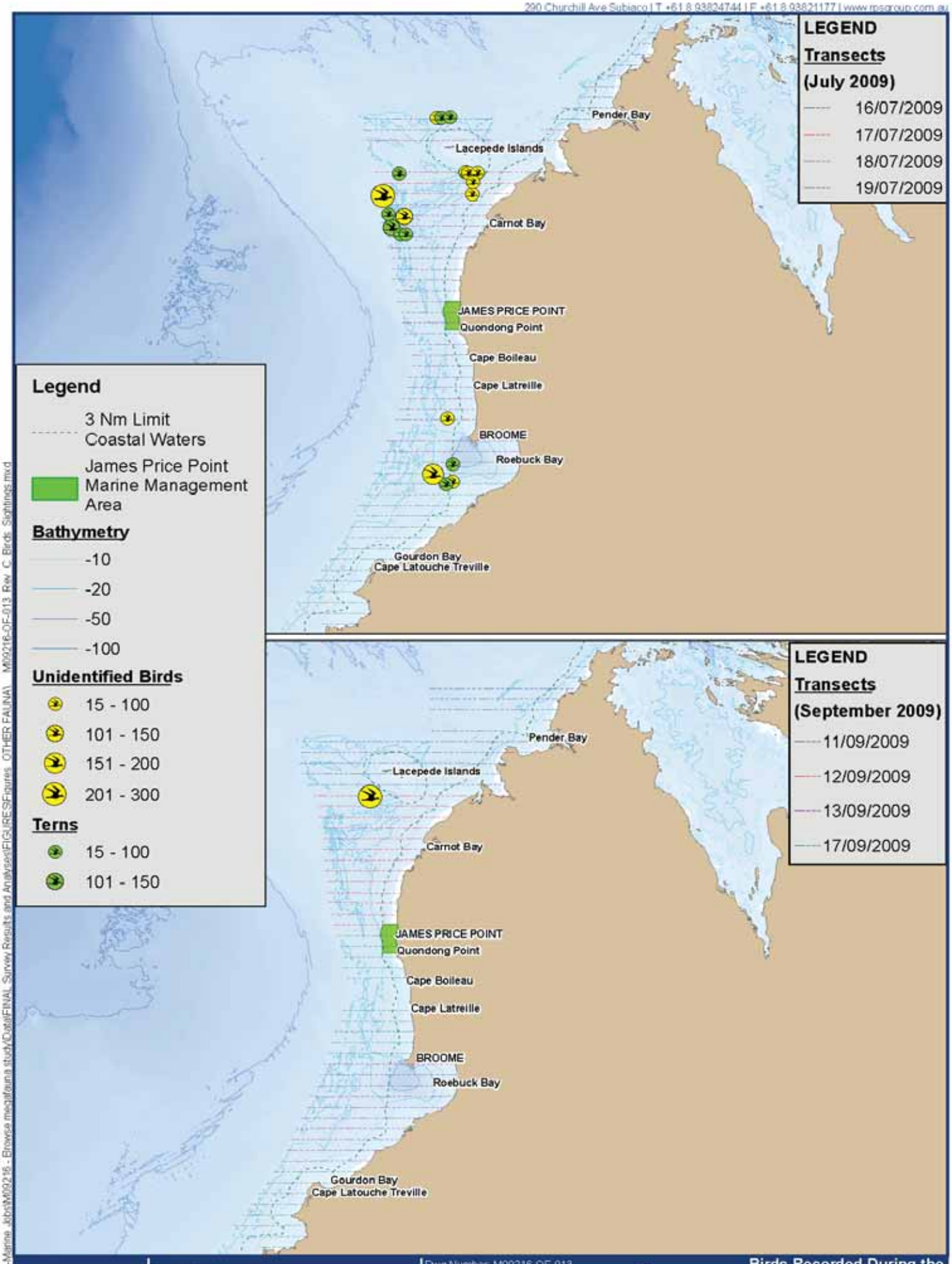

RPS woodside

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Date: 04/03/2010
Revision: C
Scale: Not to Scale @ A4
Drafted by: M Angove
Source: RPS 2009

0 12.5 25 50 km

Birds Recorded During the July & September 2009 Nearshore Regional Survey

Figure 13

Reference: N:\02-Marine Jobs\M09216 - Browse megafauna study\Data\FINAL Survey Results and Analyses\FIGURES\Figures_OTHER FAUNA\ M09216-OF-013 Rev C Birds Sightings.mxd

4.8 Vessels

4.8.1 Results

During the July 2009 Nearshore Regional Survey there were 91 sightings of 128 individual vessels and in September 2009 there were 56 sightings of 125 vessels (Table 9). The highest count was of recreational motor boats in July. Figure 14 presents the locations of all vessels recorded during all of the RPS marine megafauna surveys. It is probable that many of the same vessels were recorded more than once throughout the survey period. Survey effort in March was strictly limited to biological groups and did not record vessels.

Table 9: Vessels Recorded During the Nearshore Regional Surveys

Vessel Type	July 09 (NR1)		September 09 (NR2)	
	Individual vessels	Groups	Individual vessels	Groups
Recreational Charter	2	1	6	3
Recreational Motor	80	57	10	6
Recreational Sailing	4	4	0	0
Commercial Fishing	2	2	6	2
Commercial Pearling	7	3	15	5
Commercial Whale Watching	3	1	0	0
Commercial Cargo	0	0	1	1
Indonesian Type 1 & 2	0	0	4	1
Unidentified	30	23	83	38
Total	**128**	**91**	**125**	**56**

(NR1= Nearshore Regional Survey one; NR2= Nearshore Regional Survey two)

These vessel sightings were recorded for Woodside incidentally for their use in environmental and social assessments and have been provided in database and shapefile forms.

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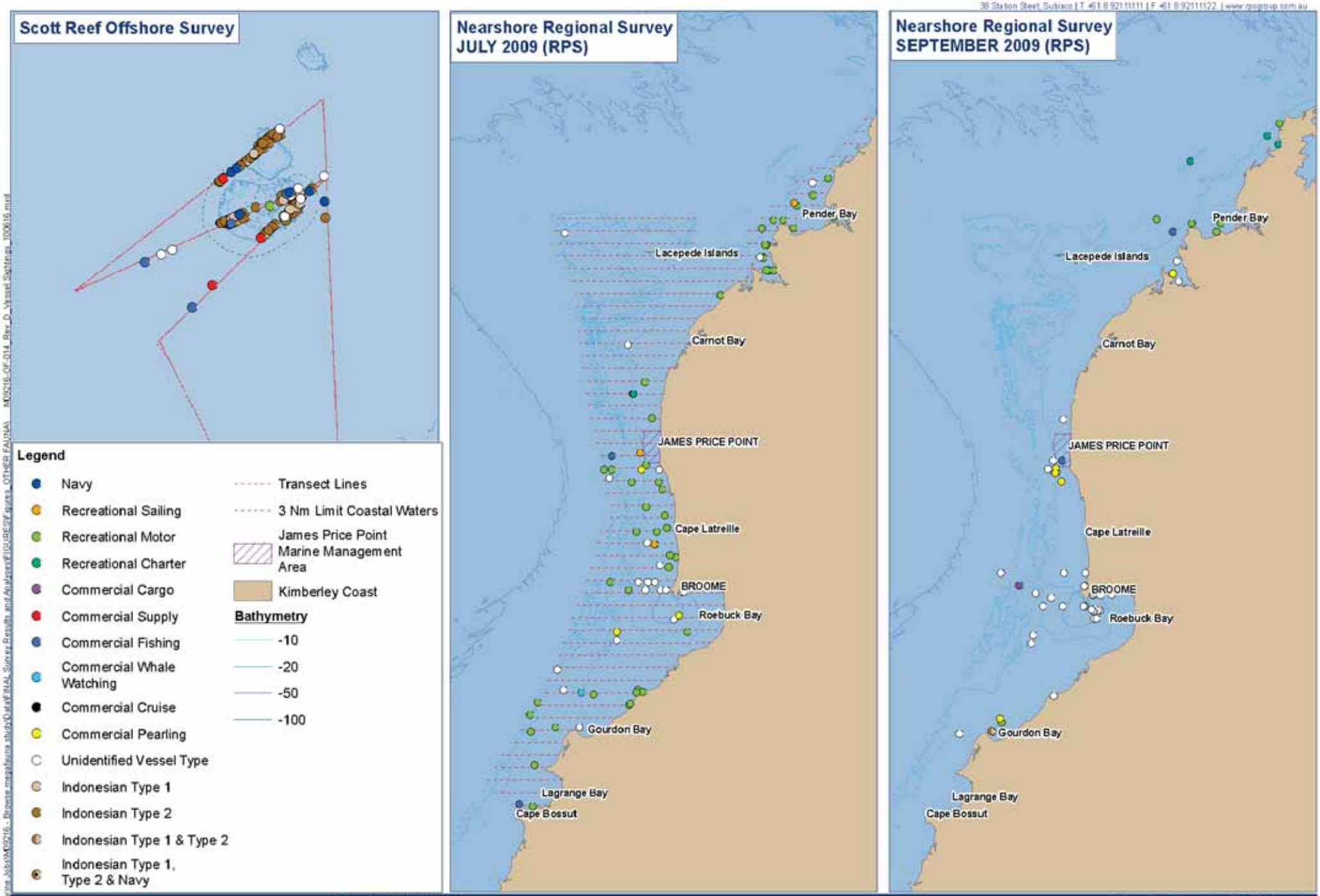

Job Number: M09216-OF-014
Date: 16/06/2010
Revision: 0
Scale: Not to Scale @ A4
Drafted by: M Angove
Source: RPS 2009, SKM 2009

Vessels Recorded During the Scott Reef Offshore & Nearshore Regional Surveys
Figure 14

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5.0 CONCLUSIONS

5.1 Survey Performance

Considerable effort was successfully conducted during the marine megafauna surveys. In total 20 hours were spent on-transect during each of the Nearshore Regional Survey, James Price Point Migration Corridor Survey and Scott Reef Offshore Survey campaigns, 25 hours on-transect during the Reference Site Survey and over 100 hours on the Vessel Transect Survey.

Weather and sea conditions during the surveys were generally conducive to sampling marine megafauna. The Nearshore Regional Survey was conducted with more exacting requirements of good environmental conditions (i.e. BSS <4 and during neap tides) than for the aerial surveys that focused on humpback whales, and were therefore more reliable for sampling small megafauna. Conversely, while data acquired during humpback surveys were not as consistent as during the Nearshore Regional Surveys, the surveys were more frequent and covered a wider geographic area.

Despite the surveys focussing mainly on humpback whales and dugongs, opportunities for sighting other marine megafauna were plentiful. Data on specific numbers and species identification were incomplete, however a good overview of the marine megafauna in the survey area was obtained.

The ease of confirming sightings to lower taxonomic levels varied with survey type and fauna. Larger whales, devilrays and some shark and dolphin species were the only fauna that could be reliably established from the aerial surveys. Some other dolphins, sharks and rays were occasionally established to species from the air with the aid of binoculars. This was not possible for fish, turtles or sea snakes.

Identification of sightings to the species level was generally achieved with a high level of confidence from the vessel. However, where sightings involved only short glimpses or conditions were not ideal, sightings could not be confidently identified to species level. Some species, such as killer whales, were more readily established than others. As a consequence, the results provide an indication of the presence or otherwise in the area of easily identified species such as killer whales, but are less reliable for more cryptic species such as bottlenose dolphins. Fauna groups that lent themselves to reliable sightings and thereby estimates of community composition from one survey platform (e.g. dolphins during Vessel Transect Survey), also provided an opportunity to infer likely community composition from sightings not identified to species (e.g. unidentified dolphins during aerial surveys).

While patterns in distribution and timing were identified for some fauna from the data acquired in the systematic surveys, they are from one season only and patterns may differ between years.

Habitat studies did not form part of this study. Therefore, no inference is made about the use of the habitats, with a few exceptions. Instead, discussion of the importance of a site for any group or species is generally based upon the abundance and frequency of records acquired from a given area.

The objectives of the survey to identify and map the marine megafauna across the survey area were achieved. The scheduled survey program for the winter of 2009 was intensive. Conditions were conducive to sampling megafauna for most of the survey period and only a small amount of survey effort had to be repeated or was conducted in sub-optimal conditions. Combined with data and information from previous surveys in 2008 and March 2009, the surveys have substantially added to the baseline information regarding marine megafauna of the region.

5.2 Dominant Species of the Nearshore Regional Survey Area

A number of small cetaceans were identified through the course of the surveys. The most common of these were bottlenose and spinner dolphins, which are relatively common and widespread. Spinner dolphins may be the most numerous of dolphins given their relatively large group sizes. Both species are likely to be resident and present throughout the year.

Of the sharks, whalers represented the largest fauna group and devilrays were the most recorded ray group. Sea snakes were the most commonly sighted fauna group but they were not identified to species level. Birds and fish were largely unidentifiable but terns represented the highest proportion of birds recorded in July.

For each of these groups, the unidentified species made up the greatest proportion of records.

5.3 Conservation Significant Species of the Nearshore Regional Survey Area

Of the dolphin species that are given specific conservation status under the EPBC Act and the Western Australian Wildlife Conservation Act 1950, spinner, Indo-Pacific humpback and Australian snubfin dolphins were all observed during the survey period, although the latter from within Roebuck Bay only. The spotted bottlenose dolphin is also considered likely to have been present, although not specifically confirmed by sighting.

The Indo-Pacific humpback dolphin was sighted only twice during the surveys, including once off James Price Point. Australian snubfin dolphins were regularly seen in Roebuck Bay, but not within the survey areas. Although both are coastal species and relatively cryptic in appearance and habit, the paucity of sightings relative to the level of effort conducted in suitable conditions off James Price Point suggests this area is unlikely to have particular importance for either of these species. The absence of Australian snubfin dolphins is not surprising given this species' association with shallow bays and inlets. Considering their observed presence in the region during the survey, it must be assumed that both species may passage the area, at least on occasion, when moving along the coast between habitats they are known to frequent.

Of the four shark species afforded specific protection as Threatened or Migratory under the EPBC Act and the Western Australian Wildlife Conservation Act 1950, only the great white shark (Vulnerable) was recorded in the survey area. The single sighting of a great white shark is of interest as the Kimberley is generally thought to be beyond its range. Whilst it may not be vagrant at this location it is likely to be a rare visitor.

Of the other two shark species of particular conservation significance, the whale shark (Vulnerable and Migratory) is clearly recognisable from the air as well as from vessel but was not recorded. Given the extent of survey effort, this species is considered to have been absent or at extremely low densities in the area during the survey period. The grey nurse shark (Vulnerable) is less readily identified and could have been present but was not recorded.

The three ray species identified as being of particular conservation significance, the freshwater, green and dwarf sawfish (Vulnerable), were not observed in any of the aerial or vessel surveys. However, the survey methods were not intended to sample these species.

5.4 Areas of Relative Importance

No habitat or behavioural studies were undertaken, but an indication of the relative importance of an area for megafauna was established by the frequency of occurrence and abundance of fauna in a given location.

Numbers of sightings of marine megafauna were high throughout the suite of megafauna surveys and comprised a large number of animals from a diverse range of fauna groups. This indicates that the area is productive during the winter. The diversity of fauna is concentrated in the nearshore area, particularly within 30 km of the coast and around the Lacepede Islands. Most species recorded in the coastal area were also recorded offshore, including Scott Reef, but in lower numbers.

The marine environment offshore of James Price Point is not excluded in supporting a diverse fauna community: records from all fauna groups (except other large whale species) were regularly recorded in the area adjacent to and offshore of James Price Point. However, none of those species reported in this document were considered to utilise the marine environments in proximity to James Price Point, the pipeline route or Scott Reef, to a greater degree than other areas. Conversely, the James Price Point Marine Management Area generally had fewer sightings than other locations, such as Carnot Bay, the Lacepede Islands or Roebuck Bay. Moderate densities of dolphins may occur periodically off James Price Point, but the data indicate use of the area through the periods of survey is sporadic. The sightings of sharks were widespread but with certain distinct concentrations along the coast. Overall, fewer sightings were obtained adjacent to James Price Point and this area does not appear to represent habitat of particular importance to sharks in the region. Sharks were recorded in and around Scott Reef, but also in relatively low numbers.

Data collected from the Nearshore Regional Survey for fish or birds did not provide evidence of any areas having significant biological activity. There were no obvious relationships between clusters of birds, fish or dolphins.

The key findings obtained from the survey data are presented in Table 10.

Table 10: Key Findings Obtained from the Survey Data

#	Key Findings	Document Reference
	Dolphins	
1	The spinner dolphin (DEC Priority 4) was the most numerous of the small cetacean species recorded offshore of James Price Point during the vessel surveys. Spinner dolphins were present in groups of between 6 and 25 individuals. They were widely dispersed from around the 10 m isobath and out to the limit of the survey where the water was around 50 m deep. Few sightings of this species were acquired off Pender Bay.	4.1.1 4.1.2.2 4.1.2.6 5.2 5.3
2	Bottlenose dolphins (*Tursiops* spp.) (DEC Priority 4) were the most commonly recorded small cetacean species offshore of James Price Point and Pender Bay, but were recorded mostly in small groups of up to five individuals, and occasionally up to ten individuals. They were widely dispersed from around the 10 m isobath and out the limit of the survey where the water was around 50 m deep. They were occasionally recorded from the air showing that they were widely distributed. It was not determined whether they were spotted or common bottlenose dolphins, but it is likely that both species were present.	4.1.1 4.1.2.1 4.1.2.6 5.1 5.2 5.3
3	Indo-Pacific humpback dolphins (DEC Priority 4) were not recorded during the Nearshore Regional Survey. However, they were recorded during a vessel survey offshore of James Price Point on two occasions, and are likely to form a small part of the unidentified dolphin record. They are only likely to be present sporadically in very small numbers in shallow water along the coast.	4.1.1 4.1.2.3 5.3

#	Key Findings	Document Reference
4	Australian snubfin dolphins (Migratory MNES, DEC Priority 4) were only observed during off-survey periods and only within Roebuck Bay. With the known habits and movements of Australian snubfin dolphins, the marine environment off James Price Point is considered unlikely to provide habitat suitable for this species, but they may infrequently transit this area on rare occasions.	4.1.1 4.1.2.4 5.3
5	Dolphins (unidentified) were widely distributed in shallow waters of the west-coast Dampier Peninsula, including around Scott Reef and offshore around the potential pipeline corridor. The unidentified records are likely to be comprised of a number of dolphin species including those identified to genus or species including: spinner, bottlenose and, to a lesser extent, Indo-Pacific humpback dolphins. The distribution of these species will be determined by their habitat requirements and may be wide e.g. spinner dolphins or restricted to nearshore waters only e.g. Indo-Pacific humpback dolphins.	4.1.1 4.1.2.6 5.1
6	Killer whales were recorded during the James Price Point Migration Corridor Survey and vessel surveys in low numbers. Killer whales may be more numerous in the Kimberley during the winter when humpback whales are present. Their presence in nearshore waters, including the area around James Price Point, is likely to be infrequent.	4.1.1 4.1.2.5 5.1
7	Density maps indicate that the peak densities of dolphins changed location through the survey period, but there was a relatively higher density of dolphins offshore of the James Price Point area in comparison to surrounding waters at each survey period, particularly in September.	4.1.1 4.1.2.6 5.1 Figure 7
	Baleen Whales	
8	No baleen whales (except humpbacks) were recorded during the Nearshore Regional Surveys. However, a minke whale and Brydes" whale were recorded during other megafauna surveys off the Kimberley coast. Several species of baleen whales may occur in the region's deeper waters periodically but in low numbers.	4.2 5.1
	Sharks and Rays	
9	Sharks were distributed across the entire megafauna survey area, with no obvious areas of particular preference. The dataset collected is too small to establish any temporal or species-specific trends.	4.3.1 5.1 5.2 5.4
10	Tiger and hammerhead sharks were recorded over a wider area than other species and across the continental shelf from the surf zone to deepwater areas. Lemon and whaler sharks were recorded in the shallows out to waters as deep as 50 m.	4.3.1 4.3.2
11	A sighting of a great white shark was recorded during the Reference Site Survey approximately 67 km from James Price Point. This is considered to be outside their normal range.	4.3.2.3 5.3
12	No whale sharks (Vulnerable/ Migratory MNES) were sighted during any of the surveys.	4.3.1 5.3
13	Rays were widely distributed across the survey areas from the shallow nearshore out to deep water surrounding Scott Reef. Many were sighted in nearshore waters of Roebuck Bay, Gourdon Bay and around the Lacepede Islands.	4.4.1 4.4.2 5.1 5.3

#	Key Findings	Document Reference
14	Devilrays were frequently sighted and are likely to be present along the coast throughout the year.	4.4.1 4.4.2 5.1 5.2
	Marine Reptiles	
15	Sea snakes were the most commonly recorded megafauna group during the Nearshore Regional Survey. They were widely distributed along the coastline but less common around the James Price Point area.	4.6.1 4.6.2 4.6.2.2 5.1 5.2
16	The highest relative densities of sea snakes were recorded in July and September approximately 30 km west of Broome outside of the 10 m isobath.	4.6.2.1
17	No crocodiles were observed from aerial or vessel surveys. One saltwater crocodile was recorded during a separate turtle survey on the Lacepede Islands in December and fresh tracks of another were recorded on a beach approximately 10 km north of James Price Point.	4.6.2.3

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APPENDIX I

Megafauna Data Recorded by RPS Humpback Aerial Surveys and Vessel Transect Survey

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APPENDIX 1: Megafauna data recorded by RPS Humpback Aerial Surveys and Vessel Transect Survey

Seven flights were conducted for the Aerial Humpback Whale Survey between the beginning of July and mid-October. Three separate flight plans were used for the humpback survey to acquire detailed data for the following:

- James Price Point (JPP) Migration Corridor Survey: The marine environment immediately offshore of James Price Point using a series of parallel random transects perpendicular to the coast.

- Reference Site Survey: The regional context by sampling several transects at key locations of Gourdon Bay, James Price Point and Pender Bay.

- Scott Reef Offshore Survey: Sampling along the approximate line of the pipeline corridor out to Scott Reef.

Table 1: Megafauna Data Recorded by JPP Migration Corridor Survey

	Flight 1		Flight 2		Flight 3		Flight 4		Flight 5		Flight 6		Flight 7		Flight 8	
	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups
Brown Booby			20	1												
Tern							50	1								
Unidentified Species		2	110	4												
Birds Total		**2**	**130**	**5**			**50**	**1**								
Bottlenose Dolphin			5	1	20	5	5 (1)	2							16	3
Killer Whale							1	1								
Spinner Dolphin					2	1							6	1		
Unidentified Species	170	10	95	22	496 (1)	53	204	22	107	14	57	6	83	8	176	44
Dolphin Total	**170**	**10**	**100**	**23**	**518**	**59**	**210**	**25**	**107**	**14**	**57**	**6**	**89**	**9**	**192**	**47**
Sail Fish															1	1
Sunfish					1	1										
Unidentified Species		4		21		36	1	8		5		6		22		35
Fish Total		**4**		**21**	**1**	**37**	**1**	**8**		**5**		**6**		**22**	**1**	**36**
Manta Ray			2	2	7	5			2	2	3	3	4	4	11	11
Rough Back															4	2
Unidentified Species	1	1			14	6	3	3	1	1	1	1	1	1	9	9
Ray total	**1**	**1**	**2**	**2**	**21**	**11**	**3**	**3**	**3**	**3**	**4**	**4**	**5**	**5**	**24**	**22**
Unidentified Species	25	23	108	104	303	289	94	89	3	3	6	6	11	10	145	139
Sea Snake Total	**25**	**23**	**108**	**104**	**303**	**289**	**94**	**89**	**3**	**3**	**6**	**6**	**11**	**10**	**145**	**139**
Hammerhead Shark			1	1	7	2	2	2								
Lemon Shark			1	1	4	4									2	2
Tiger Shark													1	1	1	1

	Flight 1		Flight 2		Flight 3		Flight 4		Flight 5		Flight 6		Flight 7		Flight 8	
	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups
Unidentified Species			7	7	15	10	2	2	2	2	1	1	5	5	16	16
Whaler Shark			1	1			1	1					1	1	2	2
Shark Total			**10**	**10**	**26**	**16**	**5**	**5**	**2**	**2**	**1**	**1**	**7**	**7**	**21**	**21**
Vessel	17	10	44	28	56	36	58	36	5	4	11	11	31	24	21	16

Flight 1 = 1 July 2009; Flight 2 = 31 July & 3 August 2009; Flight 3 = 18 August 2009; Flight 4 = 30 August 2009; Flight 5 = 10 September 2009;

Flight 6 = 22 September 2009; Flight 7 = 28 September 2009; Flight 8 = 10 October 2009.

Table 2: Megafauna Data Recorded by Reference Site Survey

	Flight 1		Flight 2		Flight 3		Flight 4		Flight 6		Flight 7		Flight 8	
	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups
Brown Booby	216	2	62	3	20	1	300	1						
Shearwater	40	1												
Tern	250	3			130	4	140	2						
Unidentified Species	1190	14	15	2	12	1								
Birds total	**1696**	**20**	**77**	**5**	**162**	**6**	**440**	**3**						
Bottlenose Dolphin	1	1	6	1	12	1	8	2			20	2	31 (2)	7
Spinner Dolphin							37	3			2	1	130	2
Unidentified Species	133	18	70	28	441 (2)	67	521	66	157 (1)	15	99	24	50 (1)	26
Dolphin total	**134**	**19**	**76**	**29**	**453**	**68**	**566**	**71**	**157**	**15**	**121**	**27**	**211**	**35**
Sunfish											1	1		
Unidentified Species	1	33	2	43	3	30		41	2	5	2	9		23
Fish total	**1**	**33**	**2**	**43**	**3**	**30**		**41**	**2**	**5**	**3**	**10**		**23**
Eagle Ray													5	5

	Flight 1		Flight 2		Flight 3		Flight 4		Flight 6		Flight 7		Flight 8	
	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups
Manta Ray	3	3	16	14			10	9			2	2	3	3
Unidentified Species					3	3	8	5			3	3	7	7
Ray total	**3**	**3**	**16**	**14**	**3**	**3**	**18**	**14**			**5**	**5**	**15**	**15**
Sea Snake Unidentified Species	**89**	**85**	**95**	**91**	**185**	**179**	**248**	**239**	**11**	**11**	**127**	**123**	**85**	**80**
Hammerhead Shark	2	2	1	1	1	1	1	1	1	1	2	2		
Lemon Shark			2	2	10	10	4	4	1	1	4	4	3	3
Tiger Shark							1	1						
Unidentified Species	3	3	9	9	13	13	13	13			15	15	15	15
Whaler Shark	1	1			1	1	1	1					3	3
White Pointer					1	1								
Shark total	**6**	**6**	**12**	**12**	**26**	**26**	**20**	**20**	**2**	**2**	**21**	**21**	**21**	**21**
Vessel	**35**	**29**	**69**	**51**	**41**	**29**	**53**	**42**	**54**	**28**	**26**	**20**	**32**	**30**

Flight 1 = 1 – 3 July 2009; Flight 2 = 1 – 4 August 2009; Flight 3 = 21 & 22 August 2009; Flight 4 = 30 August – 1 September;

Flight 6 = 18 – 22 September 2009; Flight 7 = 28 September 2009; Flight 8 = 11 & 12 October 2009.

Table 3: Megafauna Data Recorded by Scott Reef Offshore Survey

	Flight 1		Flight 2		Flight 3		Flight 4		Flight 6		Flight 8	
	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups
Brown Booby							60	1				
Tern					110	2	100	1				
Birds total					**110**	**2**	**160**	**2**				
Bottlenose Dolphin									1	1	1	1
Spinner Dolphin					10	1			30	1		
Unidentified Species	26 (1)	3	67	14	437 (4)	32	119 (1)	29	74	11		
Dolphin total	**26**	**3**	**67**	**14**	**447**	**33**	**119**	**29**	**105**	**13**	**1**	**1**
Sunfish			1	1			1	1	1	1		
Unidentified Species		3	2	14		41	2	39		13		3
Fish total		**3**	**3**	**15**		**41**	**3**	**40**	**1**	**14**		**3**
Beaked Whale					2	2						
Unidentified Species							1	1				
Eagle Ray							1	1				
Manta Ray			3	3	4	4	1	1	5	4		
Unidentified Species			4	4	14	11	2	2	5	4		
Ray total			**7**	**7**	**18**	**15**	**4**	**4**	**10**	**8**		
Sea Snake Unidentified Species	2	2	13	13	53	53	32	32	4	4	4	4
Hammerhead Shark					1	1						
Tiger Shark					3	3						
Unidentified Species	1	1			3	3	2	2			1	1

	Flight 1		Flight 2		Flight 3		Flight 4		Flight 6		Flight 8	
	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups
Shark total	**1**	**1**			**7**	**7**	**2**	**2**			**1**	**1**
Small Whale			3	2							1	1
Minke Whale											1	1
Unidentified Species			3	2								
Vessel	**15**	**13**	**23**	**12**	**132**	**53**	**125**	**46**	**137**	**29**		

Flight 1 = 3 July 2009; Flight 2 = 4 August 2009; Flight 3 = 22 August 2009; Flight 4 = 1 September 2009; Flight 6 = 19 September 2009;

Flight 8 = 12 October 2009

Table 4: Megafauna Data Recorded by Vessel Transect Survey

	James Price Point						Pender Bay					
	P1		P2		P3		P1		P2		P3	
	N	N/KM	N	N/KM	N	N/KM	N	N/KM	N	N/KM	N	N/KM
	104	0.3215	0	0.0000		0.0000		0.0000		0.0000		0.0000
Boobies		0.0000	30	0.0837		0.0000		0.0000		0.0000		0.0000
Brown Boobies		0.0000	30	0.0837		0.0000	6	0.0263		0.0000		0.0000
Brown Booby	50	0.1546	50	0.1394		0.0000		0.0000		0.0000		0.0000
Unidentified Species	0	0.0000		0.0000		0.0000		0.0000	30	0.1126		0.0000
Wilson's Storm Petrel	6	0.0186		0.0000		0.0000		0.0000		0.0000		0.0000
Birds Total	**160**	**0.4947**	**110**	**0.3067**		**0.0000**	**6**	**0.0263**	**30**	**0.1126**		**0.0000**
	2	0.0062		0.0000		0.0000		0.0000		0.0000		0.0000
Bottlenose Dolphin	21	0.0649	22	0.0613	30 (1)	0.0856	20	0.0876	3	0.0113	32	0.2103
Humpback Dolphin	5	0.0155		0.0000	2	0.0057		0.0000		0.0000		0.0000
Spinner Dolphin	56	0.1731	30	0.0837	62	0.1769		0.0000	5	0.0188		0.0000
Unidentified Species	25	0.0773	40	0.1115	13	0.0371	11	0.0482	6	0.0225		0.0000
Dolphin Total	**109**	**0.3370**	**92**	**0.2565**	**107**	**0.3053**	**31**	**0.1357**	**14**	**0.0525**	**32**	**0.2103**
Hammerhead Shark		0.0000	1	0.0028		0.0000		0.0000		0.0000		0.0000
Lemon shark		0.0000	1	0.0028		0.0000		0.0000		0.0000		0.0000
Leopard shark	1	0.0031		0.0000		0.0000		0.0000		0.0000		0.0000
Manta Ray		0.0000		0.0000		0.0000	1	0.0044		0.0000		0.0000
Tuna spp.		0.0000		0.0000		0.0000	0	0.0000		0.0000		0.0000
Unidentified species	0	0.0000	2	0.0056	0	0.0000	1	0.0044	0	0.0000	0	0.0000

	James Price Point						Pender Bay					
	P1		P2		P3		P1		P2		P3	
	N	N/KM	N	N/KM	N	N/KM	N	N/KM	N	N/KM	N	N/KM
Fish Total	**1**	**0.0031**	**4**	**0.0112**	**0**	**0.0000**	**2**	**0.0088**	**0**	**0.0000**	**0**	**0.0000**
Manta Ray	1	0.0031		0.0000	1	0.0029	1	0.0044		0.0000		0.0000
Unidentified species		0.0000		0.0000	1	0.0029		0.0000		0.0000		0.0000
Ray Total	**1**	**0.0031**		**0.0000**	**2**	**0.0057**	**1**	**0.0044**		**0.0000**		**0.0000**
banded		0.0000	1	0.0028		0.0000		0.0000		0.0000		0.0000
Unidentified species	56	0.1731	45	0.1255	61	0.1740	51	0.2233	31	0.1163	17	0.1117
Sea snake Total	**56**	**0.1731**	**46**	**0.1283**	**61**	**0.1740**	**51**	**0.2233**	**31**	**0.1163**	**17**	**0.1117**
Lemon shark		0.0000	3	0.0084	3 (1)	0.0086		0.0000		0.0000	1	0.0066
Leopard shark		0.0000	1	0.0028		0.0000		0.0000		0.0000		0.0000
Unidentified species		0.0000		0.0000	1	0.0029		0.0000		0.0000		0.0000
Whaler shark(Carcharinidae)		0.0000		0.0000		0.0000		0.0000	1	0.0038		0.0000
Shark Total		**0.0000**	**4**	**0.0112**	**4**	**0.0114**		**0.0000**	**1**	**0.0038**	**1**	**0.0066**
Vessel	**17**	**0.0526**	**11**	**0.0307**	**3**	**0.0086**	**7**	**0.0307**	**3**	**0.0113**		**0.0000**

P1 = 25 July – 9 August; P2 = 24 August – 7 September; P3 = 29 September – 9 October; P1 = 6 – 8 August; P2 = 4 – 6 September; P3 = 7 – 8 October

Table 5: Summary of Aerial Survey Effort Successfully Completed in the 2009 Campaign

Survey Name	Survey Number	Date	Transects Flown	Hours Spent on Transect	Distance Surveyed (km)	Sea State	Comments
JPP Migration Corridor	JPP1	1/07/2009	T6-T1	2:20:11	510.78	2–3	
	JPP2	31/07/2009	T5–T1	1:56:52	418.32	2–5	Poor conditions – repeated T6 on 3 Aug when conditions better.
		3/08/2009	T6	0:26:38	92.58	1–2	T6 from 31 Jul was repeated due to bad weather.
	JPP3	18/08/2009	T6–T1	2:19:45	509.36	1–3	
	JPP4	30/08/2009*	T6–T1	2:22:41	512.76	2–4	
	JPP5	10/09/2009	T6–T1	2:20:25	510.82	2–4	
	JPP6	22/09/2009	T1–T6	2:19:54	514.46	3–5	
	JPP7	28/09/2009	T1–T6	2:29:00	513.44	2–4	
	JPP8	10/10/2009	T1–T6	2:28:16	513.20	2	
Reference Site Survey [1]	R1	1/07/2009	T2	0:31:07	105.83	2	
		2/07/2009*	T1–T6	2:40:22	573.08	1–4	
		3/07/2009*	T4,T6	0:45:22	162.09	2–6	Flown as inshore segments of Offshore Survey
	R2	1/08/2009*	T6–T1	2:40:26	574.44	2	
		3/08/2009	T2,T4	0:56:34	199.88	1–4	
		4/08/2009	T6	0:20:51	76.899	2–4	Flown as inshore segment of Offshore Survey
	R3	21/08/2009	T6–T1	2:41:34	563.29	1–4	
		22/08/2009	T4,T6	0:47:21	170.343	1–3	T2 second replicate not obtained for R3 due to deteriorating conditions
	R4	30/08/2009*	T2	0:29:41	106.22	1–3	
		31/08/2009*	T6–T1	2:39:43	571.40	1–3	
		1/09/2009	T4,T6	0:45:34	170.47	1–3	Flown as inshore segments of Offshore Survey
	R6	18/09/2009	T1–T6	2:34:26	571.89	3	

Survey Name	Survey Number	Date	Transects Flown	Hours Spent on Transect	Distance Surveyed (km)	Sea State	Comments
		19/09/2009	T4,T6	0:45:46	169.71	2–5	Flown as inshore segments of Offshore Survey
		22/09/2009	T2	0:27:30	106.31	1–3	
	R7	28/09/2009	T2–T4,T6	2:15:08	473.06	2–4	T1, T5 and second replicates of T4 and T6 not obtained due to poor conditions
	R8	11/10/2009*	T1–T6	2:45:30	571.00	2–4	
		12/10/2009*	T4,T6	0:48:25	169.58	2–5	Flown as inshore segments of Offshore Survey. Second replicate of T2 not obtained due to deteriorating conditions
Scott Reef Offshore	O1	3/07/2009*	T3–T4,T7–T9	3:49:33	847.75	2–6	
	O2	4/08/2009*	T3–T4,T6–T11	3:58:32	869.74	2–4	
	O3	22/08/2009	T11–T3	4:05:17	871.71	1–3	
	O4	1/09/2009	T11–T3	4:02:41	870.89	1–3	
	O5	19/09/2009	T3–T11	3:52:48	869.04	2–5	
	O6	12/10/2009*	T3–T5,T11	1:33:47	328.47	2–5	
Nearshore Regional	NR1	16/07/2009	T62–T54,T50–T49	1:04:00	231.48	2–4	
		17/07/2009*	T53–T51,T4–T42	1:59:15	430.98	1–3	
		18/07/2009	T41–T17	3:41:10	792.82	1–3	Two flights undertaken
		19/07/2009	T16–T1	2:43:54	586.16	2–5	
	NR2	11/09/2009	T71–T46	3:22:34	740.27	2–5	Called off 62 after timing error
		12/09/2009	T45–T31	2:26:18	535.11	2–3	
		13/09/2009*	T18–T9	2:16:52	500.08	2–3	
		17/09/2009	T1–T8, T19–T30	2:25:37	526.83	1–2	Two flights undertaken

*Data that were acquired during poor conditions was not included in the dataset, if it was flown again.

Table 6: Effort and Schedule of the Completed Vessel Transect Survey

Survey No.	Survey Area	Date	Transects	Distance Surveyed (km)
1	JPP	25/07/09	1,27	120.99
		26/07/09	16	39.99
		29/07/09	37	57.41
		30/07/09	3	48.77
		5/08/09	39, 33, 17	140.56
	PB	6/08/09	3, 21	95.92
		7/08/09	6, 28, 8	233.01
		8/08/09	38	63.15
	JPP	9/08/09	10, 30	84.46
2	JPP	24/08/09	28, 9	37.10
		25/08/09	38	17.05
		27/08/09	15, 24, 35	80.85
		28/08/09	14, 21, 31	56.50
	PB	4/09/09	11, 33, 13	140.46
		5/09/09	24, 10	79.14
		6/09/09	27, 17	83.33
	JPP	7/09/09	6	24.71
3	JPP	29/09/09	26, 8	16.77
		2/09/09	2	1.09
		5/09/09	19, 32	11.47
		6/09/09	40, 20, 5	21.21
	PB	7/09/09	1, 26, 20	65.08
		8/09/09	35	19.71
	JPP	8/09/09	4	5.36
		9/09/09	36	14.81

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RPS

APPENDIX 2

Background Desktop of EPBC Listed Marine Megafauna and other Selected Species that may Exist in the Area

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APPENDIX 2: Background Desktop of EPBC Listed Marine Megafauna and other Selected Species that may Exist in the Area

1.0 INTRODUCTION

This desktop report serves to provide background information to the Browse Megafauna Report through describing megafauna species that have either previously been recorded within the area, or their habitat may exist within the area. In the context of this report, megafauna include baleen whales, toothed whales, marine reptiles, sharks and rays. As surveys were individually designed to target humpback whales, dugongs, turtles and sawfish, these species have been reported separately and are thus not included within this report.

This report places an emphasis on those species listed as Matters of National Environmental Significance (MNES) (Table 1) as well as those that are merely listed under the EPBC Act but are more likely to occur in the area than others. Those species which have not been described as they are deemed less likely to occur in the area are:

- Pygmy killer whale *Feresa attenuate*
- Pygmy sperm whale *Kogia breviceps*
- Dwarf sperm whale *Kogia sima*
- Fraser's dolphin *Lagenodelphis hosei*
- Blainville's beaked whale *Mesoplodon densirostris*
- Melon-headed whale *Peponocephala electra*
- Sperm whale *Physeter macrocephalus*
- Pantropical spotted dolphin *Stenella attenuata*
- Striped dolphin *Stenella coeruleoalba*
- Rough-toothed dolphin *Steno bredanensis*
- Cuvier's beaked whale *Ziphius cavirostris*

Species that are not listed under the EPBC Act but are listed under Schedule 1 of the *Wildlife Conservation Act (1950)* as potentially occurring in the area are also discussed here. These are:

- Grey nurse shark *Carcharias taurus*
- Great white shark *Carcharodon carcharias*
- Southern right whale *Eubalaena australis*

Several species that are neither listed under the EPBC Act nor the Wildlife Conservation Act are also described here. Those species that have been previously recorded in the area, are well known to the public and could be described as 'flagship' species are:

- Tiger shark *Galeocerdo cuvier*
- Hammerhead shark *Sphyra sp.*
- Leopard shark *Stegostoma fasciatum*
- Manta ray *Manta birostris*
- Spotted eagle ray *Aetobatus narinari*

Table 1: Listed, Threatened and Migratory Species under the EPBC Act (those in bold are recognised as MNES)*

Common Name	Scientific Name	Status
Mammals		
Antarctic minke whale	***Balaenoptera bonaerensis***	**Migratory**
Australian snubfin Dolphin	***Orcaella heinsohni***	**Migratory**
Blainville's beaked whale	*Mesoplodon densirostris*	Cetacean
Bryde's whale	***Balaenoptera edeni***	**Migratory**
Common bottlenose dolphin	*Tursiops truncatus*	Cetacean
Cuvier's beaked whale	*Ziphius cavirostris*	Cetacean
Dwarf sperm whale	*Kogia simus*	Cetacean
False killer whale	*Pseudorca crassidens*	Cetacean
Fraser's dolphin	*Lagenodelphis hosei*	Cetacean
Indo–Pacific humpback dolphin	***Sousa chinensis***	**Migratory**
Killer whale	***Orcinus orca***	**Migratory**
Melon-headed whale	*Peponocephala electra*	Cetacean
Minke whale	*Balaenoptera acutorostrata*	Cetacean
Pantropical spotted dolphin	*Stenella attenuata*	Cetacean
Pygmy blue whale	***Balaenoptera musculus brevicauda***	**Endangered, Migratory**
Pygmy killer whale	*Feresa attenuata*	Cetacean
Pygmy sperm whale	*Kogia breviceps*	Cetacean
Risso's dolphin	*Grampus griseus*	Cetacean
Rough-toothed dolphin	*Steno bredanensis*	Cetacean
Short beaked common dolphin	*Delphinus delphis*	Cetacean
Short-finned pilot whale	*Globicephala macrorhynchus*	Cetacean
Southern blue whale	***Balaenoptera musculus intermedia***	**Endangered, Migratory**
Sperm whale	*Physeter macrocephalus*	Cetacean
Spinner dolphin	*Stenella longirostris*	Cetacean

Spotted bottlenose dolphin / Indian Ocean bottlenose dolphin	***Tursiops aduncus***	**Migratory**
Striped dolphin	*Stenella coeruleoalba*	Cetacean
Reptiles		
Black-ringed mud/sea snake	*Hydrelaps darwiniensis*	Marine
Brown-lined sea snake	*Aipysurus tenuis*	Marine
Dubois' sea snake	*Aipysurus duboisii*	Marine
Dusky sea snake	*Aipysurus fuscus*	Marine
Elegant sea snake	*Hydrophis elegans*	Marine
Horned sea snake	*Acalyptophis peronii*	Marine
Leaf-scaled sea snake	*Aipysurus foliosquama*	Marine
North-western mangrove sea snake	*Ephalophis greyi*	Marine
Olive sea snake	*Aipysurus laevis*	Marine
Olive-headed sea snake	*Disteira major*	Marine
Short-nosed sea snake	*Aipysurus apraefrontalis*	Marine
Slender-necked sea snake	*Hydrophis coggeri*	Marine
Small-headed sea snake, McDowell's sea snake	*Hydrophis mcdowelli*	Marine
Spectacled sea snake	*Disteira kingii*	Marine
Spine-bellied sea snake	*Lapemis hardwickii*	Marine
Spine-tailed sea snake	*Aipysurus eydouxii*	Marine
Spotted sea snake	*Hydrophis ornatus*	Marine
Stokes' sea snake	*Astrotia stokesii*	Marine
Turtle-headed sea snake	*Emydocephalus annulatus*	Marine
Yellow-bellied sea snake	*Pelamis platurus*	Marine
Estuarine / Saltwater Crocodile	***Crocodylus porosus***	**Migratory**
Sharks		
Whale shark	***Rhincodon typus***	**Vulnerable, Migratory**

* Humpbacks, dugongs, marine turtles and sawfish are included in other reports, and thus omitted from this report.

2.0 DESCRIPTION OF CETACEAN SPECIES

The following sections describe those toothed whales (Odontocetes) and baleen whales (Mysticetes) that have been recorded from the region in previous surveys or expected to occur. All cetacean species are listed under the EPBC Act.

2.1 Toothed Whales (Odontocetes)

The Indo-Pacific humpback dolphin and snubfin dolphin are a DEC Priority Four species. Priority Four species are those in need of further monitoring.

Indo–Pacific Humpback Dolphin

The Indo–Pacific humpback dolphin (*Sousa chinensis*) is listed as Migratory under the EPBC Act and thus considered a Matter of NES. They are also a Priority Four species under the Western Australian *Wildlife Act 1950*, which means they are recognised as in need of further monitoring.

In Australia, the species is known to grow to at least 2.6 m in length with males being slightly larger than females (DEWHA 2009b). Indo-Pacific humpback dolphins prefer sheltered areas, and primarily inhabit coastal and estuarine waters less than 20 m deep, however records also indicate that they occur in river systems and shallow, protected offshore areas on occasion (Jefferson 2000; Corkeron et al. 1997; Bannister et al. 1996).

The global range of the Indo-Pacific humpback dolphin extends from the north coast of Australia, throughout South-east Aisa, to the east coast of Africa (IUCN 2009). In Australia, the Indo-Pacific humpback dolphin is found along the northern coastline, from Shark Bay, Western Australia, to the Queensland/NSW border on the east coast (Jenner and Jenner 2008).

In Western Australia, resident populations have been identified within the shallow waters of the inner Rowley Shelf, to the north of Exmouth Gulf. During a three year study of the humpback whale calving grounds in the Kimberley region, Indo-Pacific humpback dolphins were occasionally sighted in the nearshore region (CWR 2007).

Indo-Pacific humpback dolphins are likely to have been present within the unidentified dolphin sightings as they were recorded off-transect by observers as well as during the 2008 surveys (Jenner and Jenner 2009).

Male Indo-Pacific humpback dolphins reach sexual maturity at approximately thirteen years of age, whilst female dolphins reach sexual maturity at ten years of age (Ross 2002; Jefferson and Karczmarski 2001). Mating and calving areas have not been identified in Australia (Bannister et al 1996), however they are likely to occur in sheltered areas close to the coast. Reproductive activities take place year round, with a peak calving

season possibly occurring during the summer months (Bannister et al. 1996). Adults are generally found singly or in pairs, while immature individuals are found in groups (DEWHA 2009b).

Home ranges for Indo-Pacific humpback dolphins are extensive, with only certain individuals showing 'resident' behaviour (DEWHA 2009b). Large migrations reportedly occur, with evidence of movements between national boundaries, however no recognised migratory pathways have been identified in Australia (DEWHA 2009b). Stranding data also suggests that Indo-Pacific humpback dolphins undertake seasonal movements, with stranding densities peaking during the summer monsoon (Parsons 1998).

Indo-Pacific humpback dolphins are opportunist-generalist feeders, mainly feeding in shallow waters and targeting a variety of coastal and estuarine fish species and invertebrates (DEWHA 2009b). Foraging behind fishing trawlers is common and has been recorded in Moreton and Cleveland Bays in Queensland (Bannister et al. 1996; Ross et al. 1994). This behaviour may occur elsewhere in Australia (DEWHA 2009b).

Common Bottlenose Dolphin

Bottlenose dolphins (*Tursiops truncatus*) are distributed worldwide in temperate and tropical waters, in both coastal and offshore locations (DEWHA 2009b; IUCN 2009). These dolphins tend to be coastal, frequenting shallow coastal areas including estuaries, bays, lagoons and rivers (IUCN 2009). In Australia, however, bottlenose dolphins have generally been found in offshore waters deeper than 30 m, although distribution is largely unknown as they have also been recorded in some coastal areas (DEWHA 2009b).

An estimate of the minimum worldwide population size for the common bottlenose dolphin is 600,000 (IUCN 2009). The total population size for Australia is unknown (DEWHA 2009b) and, although several studies have provided minimum estimates for local populations such as Shark Bay, (Bannister et al. 1996), there are no population estimates for the Kimberley. In Australia, the bottlenose dolphin is found in all states and the Northern Territory, with the global population range extending between 65 ° North and 55 ° South (Bannister et al. 1996).

Group sizes of bottlenose dolphins are variable, and can range from groups with fewer than five individuals (usually males), to include over 1,000 individuals (Bannister et al. 1996). The species sometimes occur in mixed schools with spotted bottlenose dolphins (*Tursiops aduncus*), with recent data from Shark Bay reporting a hybridized population of bottlenose dolphins consisting of DNA from both T. *aduncus* and T. *truncates* (DEWHA 2009b). Large whales and other delphinid species are also known to associate with the species (IUCN 2009).

Little is known on the migratory patterns of the species, although it is believed that bottlenose dolphins in the extremes of the species range may exhibit seasonal migration (DEWHA 2009b, IUCN 2009), apparently in response to varying water temperature and prey availability (DEWHA 2009b).

Most of the information available on the feeding preferences of bottlenose dolphins is from inshore species which predominantly feed on various fish and invertebrates, however feeding may also occur in 'association with human activities' such as trawling (Bannister et al. 1996).

Female bottlenose dolphins reach sexual maturity between five and 11 years of age, whilst males mature betwen eight and 14.5 years of age (Bannister et al. 1996; DEWHA 2009b). The Australian mating season is diffused and occurs in summer with gestation lasting approximately twelve months, therefore the calving season peaks at the same time of year (Bannister et al. 1996; DEWHA 2009b). After becoming sexually mature, females give birth to calves every three to six years, with high calf mortality rate (Bannister et al. 1996; DEWHA 2009b). There are no known calving areas in Australia (Bannister et al. 1996).

Spotted Bottlenose Dolphin / Indian Ocean Bottlenose Dolphin

The spotted bottlenose dolphin (*Tursiops aduncus)* is listed as Migratory under the EPBC Act. In eastern Australia the species grows up to 2.3 m in length and generally range in group size from between five and 16 individuals (DEWHA 2009).

The total Australian population size of spotted bottlenose dolphins is unknown (DEWHA 2009b). Studies at Shark Bay estimate the size of the local population as 1,800–3,000 individuals (Preen et al. 1997; IUCN 2009).

Spotted bottlenose dolphins are known to occur in estuarine and coastal waters of Australia, and occur globally in shallow tropical and sub-tropical coastal and offshore waters (DEWHA 2009b). In Australia, this dolphin inhabits coastal and estuarine and nearshore areas, and shallow offshore areas around oceanic islands (DEWHA 2009b). This is the well-known species that inhabits the waters of Monkey Mia and the surrounding Shark Bay Marine Park (Bannister et al. 1996).

Varying movement patterns are displayed by the spotted bottlenose dolphin in Australia, including small areas of residency as well as long-range migrations (DEWHA 2009b). South-eastern Australia populations of the inshore spotted bottlenose dolphins exhibit a high degree of site fidelity to some local areas (DEWHA 2009b).

The spotted bottlenose dolphin mainly feed alone, preferring a variety of fish and cephalopods. They have also been known to feed in association with trawlers (DEWHA 2009b).

Little is known about the sexual maturity of the Australian spotted bottlenose dolphins, however studies elsewhere suggest males reach sexual maturity between 11 and 15 years, whilst females reach sexual maturity between 9-11 years (Cockcroft & Ross 1989). Gestation lasts around 12 months therefore calving peaks coincides with mating peaks, and generally occurs between spring and autumn (DEWHA 2009b Bannister et al. 1996). The period between pregnancies is approximately 3-6 years, with high calf mortality rates in the first three years of life (DEWHA 2009b).

Spinner Dolphin

The distribution of spinner dolphins (*Stenella longirostris*) spans across both northern and southern hemispheres, in tropical and subtropical zones, ranging from 40 °N to 40 °S (IUCN 2009). In Australia they are known to occur as far south as Bunbury in Western Australia and extending north around the top of Australia to the east coast near the NSW / Queensland border (DEWHA 2009b). Spinner dolphins are primarily pelagic however, in some regions, they are known to occur in shallow pelagic habitats over the continental shelf (Bannister et al. 1996). They are not known to be migratory, however seasonal movements in response to the presence of warm oceanographic currents such the Leeuwin Current in Western Australia.

The spinner dolphin size ranges from 1.29–2.35 m in length with males generally being larger than females (DEWHA 2009b). This species is usually seen in groups and are often observed bow-riding vessels or leaping and surfing waves (DEWHA 2009b). Generally, group size is less than 250 but occasionally spinner dolphins are known to congregate in the thousands (DEWHA 2009b). Spinners are often found in association with other dolphins and small whales and are known to form associations with tuna and seabirds, which is probably linked to feeding habits (Bannister et al. 1996). Their common name arises from their acrobatic displays in which they spin longitudinally along their axis as they leap through the air (DEWHA 2009b).

In response to food availability, certain populations of spinner dolphins have been observed to follow diurnal movement patterns, remaining inshore in protected areas during the day, and then moving offshore to feed on species that migrate towards the surface at night (DEWHA 2009b).

The reproductive cycle of Australian spinner dolphins is largely unknown, however, it is believed that males may reach sexual maturity after six years and females at around four years of age (DEWHA 2009b). Based on information from non-Australian species, spinner dolphins can give birth at any time of year and have a gestation period of approximately 10 months, with a calving interval of between two to three years (DEWHA 2009b). In Australian waters, Banister et al. (1996) suggests that no spinner dolphin calving areas are known.

Short-beaked Common Dolphin

The common dolphin (*Delphinus delphis*) is a relatively small and slender dolphin with females being slightly smaller (2.6 m) than the males (2.7 m) (Reeves et al. 2002).

Common dolphins are found throughout temperate and tropical waters of the world and can generally be associated with shallow waters nearshore, out to thousands of kilometres offshore (IUCN 2009). They are thought to be associated with various oceanographic features including ridges, escarpments and areas of seasonal upwelling (Bannister et al. 1996).

The common dolphin is found in offshore waters around Australia, although less in northern Australian waters (DEWHA 2009b). Their main clusters appear to be along the west coast of Australia and the Tasman Sea (DEWHA 2009b). They have been observed travelling in group sizes exceeding the thousands, and are very social, often seen bow riding or associating with other dolphin and whale species (Bannister et al. 1996).

It is believed that common dolphins worldwide follow seasonal migrations often associated with changes in sea temperature and prey abundance (DEWHA 2009b).

Common dolphins are opportunistic feeders and their prey varies according to season and availability (Bannister et al. 1996). Generally, they feed on small prey including pelagic fish from the middle and upper oceanic zones, and cephalopods, however this feeding behaviour also makes them vulnerable to incidental capture from commercial fishing (DEWHA 2009b).

Sexual maturity is generally reached earlier in female common dolphins than males, with calving occurring year round and peaking in spring and autumn (DEWHA 2009b). Calving intervals are varied, however usually occurring every one to three years, with gestation lasting approximately 10-11 months (Perrin 2002). Australia has no known calving areas for common dolphins (Bannister et al. 1996).

Risso's Dolphin

Risso's dolphin (*Grampus griseus)* is a fairly robust dolphin which grow from between 3 and 4 m in length (Reeves et al. 2002). They generally occur in groups of 25 but have also been seen in groups in excess of a hundred individuals, however they may also occur solitary (DEWHA 2009b).

Risso's dolphins inhabit tropical and temperate regions in waters both inshore and offshore, however they are more highly associated with offshore waters deeper than 1,000 m and are considered pelagic (DEWHA 2009b). In Australia, Risso's dolphins have been recorded in most states, with the only resident population being Fraser Island in Queensland (Bannister et al. 1996).

There are no estimates of population size in Australia, however based on surveys conducted elsewhere in the world it is believed Risso's dolphins to be fairly abundant throughout Australia waters (DEWHA 2009b). Clear migration patterns for Risso's dolphins have not been defined although seasonal shifts in density occur (Reeves et al. 2002).

Very little is known about the reproductive cycle of Risso's dolphins in Australia, although based on data from non Australian species it is believed that Risso's dolphins reach sexual maturity around 2.5 to 3 m in length and have a gestation period of approximately 1 year (Bannister et al. 1996).

Risso's dolphins feed mainly on pelagic squid, and will occasionally feed on other cephalopods and fish (Reeves et al. 2002). Most of their feeding activity occurs at night in response to prey availability (IUCN 2009). An effective hunting technique used by the species is the 'echelon formation' where they line up alongside each other at evenly spaced intervals (Bannister et al. 1996).

Australian Snubfin Dolphin

The Australian snubfin dolphin (*Orcaella heinsohni*), formerly known as the Irrawaddy dolphin (*O. brevirostris*), is listed as Migratory under the EPBC Act. Male dolphins are generally larger in size, often reaching 2.7 m in length whilst females reach 2.3 m (Beasley et al. 2005).

Australian snubfin dolphins are believed to be endemic to Australia and possibly New Guinea (DEWHA 2009b). In Australia, snubfin dolphins have been reported along the northern coastline between Broome in Western Australia, and the Brisbane River in Queensland (Parra et al. 2002). The species are primarily found in protected shallow coastal and estuarine waters, particularly near seagrass beds, thought to be associated with foraging habitats (Parra 2006).

The Australian snubfin dolphin has been observed in several locations along the Kimberley coast including Beagle and Pender Bays (DEWHA 2009b). Other Western Australian locations where Australian snubfin dolphins have been observed include Camden Sound, Prince Regent River, Buccaneer Archipelago, Deception Bay, Talbot Bay, King Sound and the Cambridge Gulf (Costin and Sandes 2009; Thiele 2008).

Reproductive behaviour of the Australian snubfin dolphin is poorly understood however, socialising has been observed year round in Cleveland Bay, Queensland, indicating that a specific breeding period may not occur (Parra 2006). Australian snubfin dolphins are generally observed in group sizes ranging from 5 to 15 individuals (Queensland Government Environment and Resource Management 2009). No research has been conducted on the reproductive behaviour of Kimberley populations.

Limited research has been conducted on the movement patterns of Australian snubfin dolphins, however studies within Cleveland Bay indicate they are not permanent residents and have large home ranges (Parra 2006). It is not known whether the snubfin dolphin undertakes migrations in the Kimberley.

Feeding preferences of Australian snubfin dolphins include a variety of coastal and estuarine associated fishes and invertebrates (DEWHA 2009b). They fish in pods, and have developed a hunting technique that involves spitting water to disorientate schools of fish back towards the hunting group (Marine Wildlife Australia 2009).

False Killer Whale

The false killer whale (*Pseudorca crassidens)* has a slender shaped body and can reach up to 5–6 m in length with males generally being larger than females (DEWHA 2009b). False killers generally occur in groups of 20–50 animals, which may form part of much larger schools consisting of hundreds of animals in response to food availability (Ross 2006).

These cetaceans have extensive oceanic ranges and occur in all tropical and warm temperate waters, and are usually found in water of over 1,000 m deep (Reeves et al. 2002). The indicative Australian distribution of false killer whales was based on recordings of strandings occurring in each state along the coasts (DEWHA 2009b). In Australia, mass strandings of false killer whales are frequent, occurring approximately every 2 ½ years, and can involve whole herds of up to 100 individuals (Ross 2006).

Little is known about migration patterns for false killer whales, but shifts in north-south and inshore-offshore abundance indicates possible seasonal migrations associated with warm water currents and availability of prey (Ross 2006).

False killer whales reach sexual maturity between 8–14 years of age, and have large calving intervals of approximately seven years which increase with age, resulting in low reproductive rates for the species (DEWHA 2009b). Gestation lasts approximately 15 months and weaning lasts between 1.5–2 years (Ross 2006). In Australia, no seasonal mating or calving patterns are known and no calving areas are known for the species (DEWHA 2009b).

False killer whales are versatile predators and are considered opportunistic feeders which are known to feed on a large variety of fish and cephalopods as well as other small cetaceans on occasion (DEWHA 2009b).

Killer Whale

The killer whale (*Orcinus orca*) is listed as Migratory under the EPBC Act. The killer whale is the largest of the Delphinidae (dolphins), growing up to 8–10 m in length (Ford et al. 2005; DEH 1999). This cetacean is highly social forming long life groups, although they can also be found singly or in small groups (DEH 1999).

Killer whales are distributed throughout marine waters of the world (Ford et al. 2005), and are distributed in Australia from polar to tropical waters during all seasons (DEWHA 2009b), where they form either transient or permanent populations (Ford et al. 2005). More substantial numbers are found in high latitudes than low latitudes (Corkeron and Conner 1999). Killer whales are generally oceanic and pelagic; preferring cold, deep waters, but have also been recorded in warmer shallower waters along the continental shelf in Australia (DEWHA 2009b). Killer whales have been sighted south of the Pilbara coastline in Exmouth Gulf (Jenner and Jenner 2005) and in the Barrow Island area (Butler 1975). There have also been strandings on this same island in 1970 (Butler 1975).

Soviet whaling data suggest that some killer whales undergo annual migrations to temperate climates while another portion remain in high latitudes over winter, moving in accordance with prey availability (Corkeron and Conner 1999).

Killer whales diet can vary seasonally within different regions however, as carnivorous mammals, they feed on a range of prey, including fish, pinnipeds (seals and sea lions) and small cetaceans (Corkeron and Conner 1999). Less commonly they feed on medium cetaceans such as minke whales (Ford et al. 2005), or the calves of larger whales such as grey and humpback whales. Killer whales seek out their prey and either herd them into coastal waters or attack them in deeper water (Ford et al. 2005).

Reproductive history is limited for killer whales in Australia, although as a global population females mature earlier than males, reaching sexual maturity at approximately 10 years compared with 16 years of age for males (Ross 2006). Calving occurs at three to eight year intervals, and gestation lasts approximately 12-17 months (Ross 2006). In Australia no calving areas exist, and there are no known mating or calving seasons, although it is thought calving occurs year round (DEWHA 2009b).

Short-finned Pilot Whale

Short-finned pilot whales (*Globicephala macrorhynchus*) have long but robust bodies and grow to approximately 4.1–7.2 m in length depending on sex and geographical location.

Schools of short-finned pilot whales normally comprise 15–30 individuals of mixed age and sex (Reeves et al. 2002). The species are also frequently seen in large groups of varying species such as other dolphin species (DEWHA 2009b).

These cetaceans are found throughout warmer temperate and tropical regions in deep waters over the edge of the continental shelf (Carwardine 1995). There are relatively few data available on short-finned pilot whales in WA however, it is believed that they are in relative high abundance, and are found in tropical to temperate oceanic waters, approaching coastal seas around Australia, including northern WA (DEWHA 2009b).

There are no known migration patterns for short-finned pilot whales and they appear to be generally nomadic (DEWHA 2009b). Seaonal short-term north–south, inshore–offshore movements occur, which are believed to be related to prey abundance (Olson

& Reilly 2002). Short-finned pilot whales feed mainly on vertically migrating prey, which includes squid, cuttlefish, octopus and fish, and are known to conduct deep dives in response to their prey (Ross 2006).

Males reach sexual maturity at 14–15 years of age, although larger males mature earlier, where as females mature at around nine years of age (DEWHA 2009b). Due to mating occurring year round, a diffused calving season occurs, however in the southern hemisphere, short-finned pilot whales calving peaks occur in during the winter months, and no known calving areas occur around Australia (Bannister et al. 1996). Gestation lasts approximately 15 months, followed by a two year weaning period and the calving interval is approximately five years (DEWHA 2009b). Most females will calve up to an age of 17-34, and only four to five times during their life (Ross 2006).

2.2 Baleen Whales (Mysticetes)

Mysticetes other than humpback whales that are found in the project area and their EPBC Act status are shown in Table 4.

Southern Right Whale

The southern right whale (*Eubalaena australis*) is listed as Endangered and Migratory under the EPBC Act. This is a stocky and large whale, and can grow up to 17.5 m, with females generally being larger than males (DEWHA 2009b). Southern right whales were hunted to near extinction in Australian waters at the end of the 19th century (Jackson et al. 2008) and, although recovering, the population is still very low, however increased populations sizes have been observed, with the species growth rate estimated to be around 7% per year (Bannister et al. 1996).

The southern right whale is distributed primarily along the southern coastline of Western Australia and has been recorded between Sydney and Perth, with occasional observations in Perth waters between May and October (Bridgewater 1990). Sightings in more northerly waters are relatively rare, but there have been recorded sightings as far north as Exmouth (DEWHA 2009b) including a southern right whale cow and calf pair in Exmouth Gulf in September 2005 (Jenner and Jenner 2005). This sighting coincides with its winter migration when they move into warmer waters (Thiele and Gill 1999).

Seasonal migrations occur between high and mid latitudes, moving from higher latitudes in summer, where feeding occurs to warmer mid latitudes in winter for breeding (Bannister et al. 1996).

Little is known on preferred habitats and foraging behaviour of southern right whales, with most knowledge gained from Soviet data on the stomach contents of the species (DEWHA 2009b). Habitat selection during calving has been implied through differences in habitat preference seen by calving and non-calving whales (DEWHA 2009b). It is

thought that calving whales prefer shallower habitats whilst foraging whales prefer deep offshore waters in areas of upwellings (DEWHA 2009b).

Southern right whales calve at 3 year intervals, extending to 5 during period of low prey availability, and have a gestation period of approximately one year (IUCN 2009). They appear to exhibit high site fidelity for breeding locations (DEWHA 2009b).

Feeding preferences for the species are not well known, although evidence gained from unreported Soviet data suggest southern right whales fed mostly on both euphausids and copepods (DEWHA 2009b). Recent observations by Bannister et al. (1996) on the feeding behavior of southern right whales in the South of Australia, as well as the baleen structure in the species suggest feeding also occurs on smaller sized plankton.

Dwarf Minke Whale

The dwarf minke whale (*Balaenoptera acutorostrata*) is a medium sized whale, growing up to 10.7 m in length with females generally growing larger than males (Bannister et al. 1996). In Australian waters, populations of the dwarf minke whales are considered to be stable/secure (DEWHA 2009b). The southern hemisphere population totals around 700,000 individuals (Bannister et al. 1996).

The dwarf minke whale is distributed worldwide in tropical and warm temperate oceanic waters (DEWHA 2009b). While this whale species can occur in both coastal and offshore waters (IUCN 2009), Bannister et al. (1996) suggests the species is mostly oceanic, with sightings recorded in coastal areas, and therefore is not restricted to deeper waters. However, in Australia it is believed the dwarf minke whale predominantly occur inshore, making them vulnerable to human exploitation (DEWHA 2009b). The dwarf minke whale is distributed in all states throughout Australia except in the Northern Territory, mostly occurring along the most northern coastline of Western Australia and Queensland (Bannister et al. 1996).

The precise migratory patterns of the dwarf minke whale is not known as they are less predictable than other rorquals, however it is believed they undertake seasonal migration from cold water feeding grounds to warm water breeding grounds (Bannister et al. 1996).

Male dwarf minke whales reach sexual maturity around 5–8 years, while females reach sexual maturity between nine and 6–8 years (Bannister et al. 1996). Limited data exist regarding the reproductive cycle for dwarf minke whales, however it is believed that the gestation period for the species lasts approximately ten months, with lactation continuing for an additional four to five months (DEWHA 2009b). Calving is thought to occur in warm temperate to tropical waters between May and July, although no specific dwarf minke whale calving grounds are known for Australia (Bannister et al. 1996).

Although no specific feeding grounds have been discovered in Australia, information suggests dwarf minke whales feed mainly on small planktonic crustacean species such as euphasiids.

Antarctic Minke Whale

The Antarctic minke whale (Balaenoptera bonaerensis) is listed by the EPBC Act as Migratory. This species is more full-bodied than the other large baleen whales, and can grow up to nearly 10 m in length (DEWHA 2009b). Antarctic mine whales are generally a solitary animal, swimming either alone or in pairs, and tend to prefer colder waters (DEWHA 2009b). The species has been recorded in all Australian states except the Northern Territory.

The Antarctic minke whale is a migratory whale often associated with deep, offshore waters along the shelf edge, often exceeding depths of 600 m (DEWHA 2009b). The species are regularly sighted in cold, Antarctic waters near the ice edge feeding during summer months, and migrate north during winter for breeding, however the species does not migrate as far north as other baleen whale species (DEWHA 2009b).

In Australia, limited information is available on the reproductive cycle of Antarctic minke whales, however information from the Antarctic suggests that mating peaks in August and September, and then, following a ten month gestation period, calving peaks in May and June (DEWHA 2009b).

Antarctic minke whales diet consists mostly of Antarctic krill found the edge of an ice pack, therefore, due to the lack of prey availability in lower latitudes, it is unlikely they feed whilst breeding in warmer waters (DEWHA 2009b).

Bryde's Whale

The Bryde's whale (*Balaenoptera edeni*) is listed as Migratory under the EPBC Act and is the second smallest baleen whale, growing up to approximately 15.5 m in length (DEWHA 2009b). They are generally not a social species and are normally sighted swimming solitary or in pairs.

Bryde's whales have been recorded in tropical and warm temperate waters, off all Australian states except the Northern Territory, in both oceanic and inshore regions (DEWHA 2009b). Key locations for Bryde's whales on the west coast of Australia are the Abrolhos Islands and north of Shark Bay in Western Australia (Bannister et al. 1996).

Some evidence suggests that bryde's whale have a nearshore and an offshore population, with the nearshore population limited to the 200 m depth isobar and remaining largely sedentary whilst the offshore population is found in water depths of between 500 to 1,000 m and displaying some seasonal movements (Bannister et al. 1996; DEWHA

2009b). The population types of bryde's whale may also be distinguished by the prey preferences, where whales in the nearshore populations prefer fish and whales from the offshore populations prefer small crustaceans (Bannister et al. 1996).

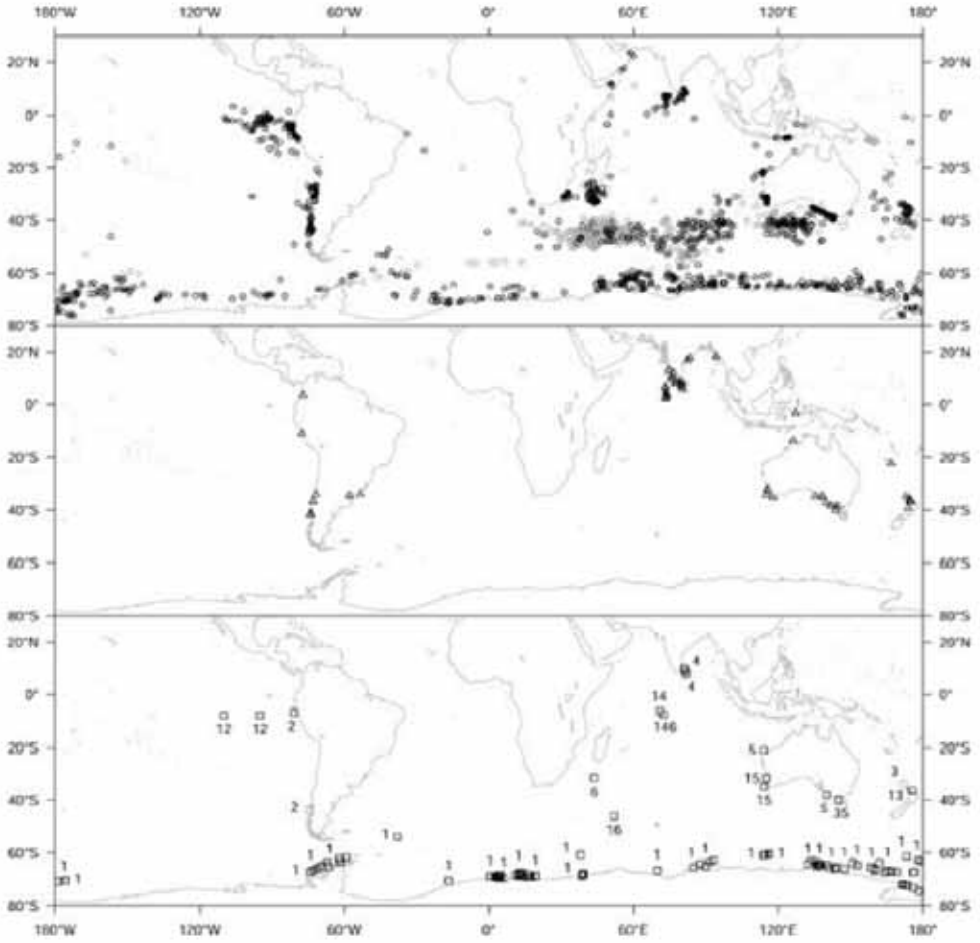
Breeding cycles in the nearshore and offshore populations of bryde's whales also differ, with nearshore whales calving year round, while the offshore whales have a distinct calving season during winter (DEWHA 2009b). Bryde's whales reproduce every two years, and have a gestation period of approximately one year (DEWHA 2009b).

Blue Whale

The blue whale (*Balaenoptera musculus*) is listed as Threatened and Migratory under the EPBC Act. There are two recognised subspecies of blue whale in Australian waters: the true blue whale of the southern hemisphere (*Balaenoptera musculus intermedia*), and the pygmy blue whale (*Balaenoptera musculus brevicauda*) (DEWHA 2009b). Blue whales are the largest of the whale species, growing to a length of 33 m and weighing up to 180 tonnes, whilst pygmy blue whales are slightly shorter, growing to approximately 25 m in length (DEWHA 2009b).

In 2000, Bannister and Burton estimated the population of southern hemisphere true blue whales to be between 1,000 and 2,000 animals. True blue whales were hunted heavily during the 1950s and 1960s, and were driven almost to extinction. Despite decades of protection, blue whales are yet to show signs of recovery (Jackson et al. 2008).

Both subspecies of blue whale may be found in all waters around Australia, and in the waters off Australia's Antarctic Territory (Bannister et al. 1996). Two key feeding/aggregation localities exist for blue whales in Australia, the Bonney Upwelling in South Australia where true blue whales aggregate, and the Perth Canyon near Perth in Western Australia where pygmy blue whales aggregate (DEWHA 2009b). Blue whales have been reported as recorded (visually and acoustically) as far north as the Barrow/Montebello area (Jenner and Jenner 2008; McCauley et al. 2004).



Source: Branch et al, (2007)

Figure 1: Blue Whale Distribution Recorded by Sightings, Strandings and Acoustic Recordings

Blue whale migration is oceanic and no specific migration routes have been identified in the Australasian region (DEWHA 2009b). During the summer months, blue whales feed in mid–high latitudes (south of Australia) when krill abundance, their preferred food source, is highest, and then move to temperate–tropical waters in the winter for mating and breeding (DEWHA 2009b). Feeding by blue whales is primarily, at the surface, however, in response to prey, they often undertake non-surface feeding by diving to prey at depth between 100–150 m (Fiedler et al. 1998).

Sexual maturity in blue whales is reached between seven and ten years, with a gestation period of 11 months (DEWHA 2009b). The main mating season for the blue whale extends over four to five months during the winter, from early April to late August, with peak conceptions occurring in late May and early June. The mean date for calving for the blue whale in the southern hemisphere is about mid April (Gampbell 1979).

3.0 DESCRIPTION OF REPTILE SPECIES

3.1 Sea Snakes

Australia has the highest species richness and endemism for sea snakes in the world (Cogger 1975). Storr et al. (1986) estimated that nine genera and twenty-two species of sea snakes occur in Western Australian waters. The north-west marine region is considered internationally significant for the diversity and abundance of sea snakes, particularly the reefs of the Sahul Shelf (DEWHA 2008). All but five of Australia's sea snake species are found in the Kimberley.

The species of sea snake that may occur in the development area are provided in Table 2. All species of sea snake are listed as marine species under the EPBC Act. The Western Australian *Wildlife Conservation Act 1950* does not list any of these sea snakes as either Threatened or Priority species.

Sea snakes occur only in the tropical and subtropical waters of the Indian and Pacific Oceans, usually on the continental shelves, and have been recorded at depths to approximately 55 m (Greer 2006). Studies of sea snakes in the Kimberley have recorded highest numbers in Pender Bay (Jenner and Jenner 2006).

Sea snake abundance in the region varies significantly, for example they are common around Scott and Ashmore Reefs yet are relatively absent from the Rowley Shoals (DEWHA 2008).

Sea snakes of most species reproduce annually, giving birth to live young (Greer 2006) in the ocean. It is not known when sea snakes reach sexual maturity; however, they are generally long lived and slow growing with small broods and high juvenile mortality (DEWHA 2008). Sea snake reproduction occurs all year round but may vary between species. Very little is known about the reproductive biology of sea snakes in Australia.

Most species of sea snake occupy small home ranges yet some have been recorded making seasonal alongshore and offshore movements (DEWHA 2008). For example, the spine-tailed sea snake (*Aipysurus eydouxii*) reportedly moves into estuaries during the dry season (DEWHA 2008).

Sea snakes occupy a diverse range of nearshore and offshore habitats. They are found in and around coral reefs, seagrass beds and sand flats (DEWHA 2008). Although sea snakes are found in deeper waters, diversity is generally highest in shallower habitats.

Sea snakes comprise both of specialist and generalist feeders. As a specialist feeder, the turtle-headed sea snake *(Emydocephalus annulatus)* feeds exclusively on the eggs of blennies, gobies and other coral reef fish (DEWHA 2008). Olive and dusky sea snakes

(*Aipysurus laevis* and *Aipysurus fuscus* respectively) are generalist feeders and forage on a variety of fish, eels and fish eggs (DEWHA 2008).

3.2 Estuarine Crocodiles

The estuarine, or saltwater, crocodile (*Crocodylus porosus*) is widely distributed throughout the Asia–Pacific region (Figure 9).

Estuarine crocodiles are listed in Schedule 4 (other specially protected fauna) under the Western Australian *Wildlife Conservation Act 1950* and are listed as Migratory under the EPBC Act. The IUCN has assigned the species 'Lower Risk/Least Concern' status.

Estuarine crocodiles are also listed under Appendix II (migratory species conserved through agreements) of the Convention for the Conservation of Migratory Species of Wild Animals (CMS/Bonn Convention) and Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Leech et al. 2009).

The largest population of estuarine crocodiles in Australia is in the Northern Territory, with smaller numbers in Queensland and Western Australia (Caldicott et al. 2005). In 2000, the number of crocodiles in Western Australia was estimated to be between 4,000 and 4,200 individuals (Kay 2004) with the highest density of estuarine crocodiles found in the east and north-west Kimberley.

Cambridge Gulf, the Prince Regent River and Roe River systems support the largest population of estuarine crocodiles (DEC 2009). Estuarine crocodiles occur in lower densities on the east coast of the Dampierland Peninsula in the rivers draining into King Sound. There are no major river systems on the west coast of the Dampierland Peninsula, however there have been occasional sightings of vagrant estuarine crocodiles in the Broome, Coulomb Point Nature Reserve and Willie Creek area (DEC 2009).

Information on mating habitats in the Kimberley region is limited; however, it is likely that estuarine crocodiles mate adjacent to nesting locations in river and creek systems.

Estuarine crocodiles typically nest in freshwater swamps, near tidal rivers and salt marshes. Female estuarine crocodiles construct a nest out of grasses and reeds before laying their eggs. They primarily nest in the wet season (October–May) when rainfall creates suitable nesting conditions. Female estuarine crocodiles lay a single clutch of approximately fifty eggs during the nesting season (DEC 2009).

In the Kimberley, significant nesting is limited to those river systems with extensive vegetation including the Ord, King and Roe River systems (DEC 2009). Low density nesting has been recorded in the Drysdale and Prince Regent Rivers and the Admiralty Gulf Creek (DEC 2009). It is unlikely that estuarine crocodiles nest on the west coast of the Dampierland Peninsula, including the James Price Point area.

Juvenile males that have been driven out of the mainland river systems by larger male crocodiles may inhabit offshore islands (Messel and Vorlicek 1986; Miller and Bell 1997; Ross 1998). These animals are likely to return to the mainland upon reaching sexual maturity, or perish in the sub-optimal environment (Messel and Vorlicek 1986; Miller and Bell 1997). The Lacepede Islands are within the migratory range of the species however, there are no records of estuarine crocodiles occurring on these islands.

The principal foraging habitat of estuarine crocodiles is coastal wetlands, which may extend up to 150 km inland, although they also frequent ocean beaches and offshore islands. Foraging in these areas is likely to occur on an opportunistic basis and vary with prey availability.

Juvenile estuarine crocodiles feed on small crustaceans, insects and small fish. Adult crocodiles feed on larger crustaceans, fish, turtles, birds and mammals (Webb et al. 1978; DEC 2009).

4.0 DESCRIPTION OF SHARK AND RAY SPECIES

Sharks and rays belong to the taxonomic class of Chondrichthyes (Last and Stevens 2009).

4.1 Sharks

Sharks are generally selective feeders, although they may exploit other food sources prey if the opportunity arises (Last and Stevens 2009). As carnivores, sharks typically feed on a range of prey including fish, squid, octopus, crustaceans, mammals, reptiles and other marine creatures (Department of Fisheries 2008).

Grey Nurse Shark

The grey nurse shark (*Carcharias taurus)* was listed in August 2000 as Vulnerable under the EPBC Act. This species is also protected under Schedule 1 of the Western Australian *Wildlife Conservation Act 1950*. It is listed by the IUCN as vulnerable.

Grey nurse sharks are generally distributed inshore in cool temperate to sub-tropical waters (DEWHA 2009b). The species can grow up to 3.5 m in length with females being slightly longer than males (DEWHA 2009b). In Australia, there are no known mating seasons, however it is known that the species reproduce biannually, typically producing two pups per litter due to oophagy, cannibalism within the uterus (Chidlow et al. 2005).

The grey nurse shark has a tendency to aggregate for feeding and mating purposes (DEWHA 2009b). Grey nurse sharks are distributed in WA continental shelf waters from Esperance to the North-west Shelf preferring inshore rocky reef habitats (Chidlow et al. 2005). The species feeds on a variety of fish and crustaceans (DEWHA 2009b).

Great White Shark

The great white shark (*Carcharodon carcharias*) is listed as Vulnerable under the EPBC Act and is protected under Schedule 1 of the Western Australian *Wildlife Conservation Act 1950*. The IUCN lists the species as Vulnerable (IUCN 2009). The estimated Australian population is fewer than 10,000 mature individuals (Commonwealth of Australia 2002).

Great white sharks have a broad global distribution and can be found throughout most seas and oceans of the world (IUCN 2009). Principally, they inhabit temperate pelagic waters (Compagno 2001) near continental shelves, with juveniles also found inshore (Commonwealth of Australia 2002). Their low numbers and wide distribution suggest that they will infrequently be present in high densities, but they are known to temporarily congregate at food sources, including concentrations of schooling fish

(IUCN 2009) and pinniped colonies of southern Australia (Commonwealth of Australia 2002).

Great white sharks are found off South Australia and southern Western Australia, and frequently reported from the Great Australian Bight (Last and Stevens 2009). They are thought to undertake regular long migrations offshore (Ferguson 1996) and studies have found that some South Australian sharks migrate seasonally up the east and west coasts of Australia (Last and Stevens 2009). Great white sharks are known to travel up WA's coast as far north as the North-west Cape (Department of Fisheries 2008). During such seasonal movements they may move outside of their normal range (Commonwealth of Australia 2002).

It is estimated that they reach sexual maturity at 12–17 years for females (4.5–5 m in length) and 7–10 years for males (3.5–4.1 m in length), respectively (IUCN 2009; Last and Stevens 2009; Environment Australia 2002). Great white sharks have a low reproductive rate. Litter sizes range from 2–17 pups (Bruce and Stevens 2001; IUCN 2009; Last and Stevens 2009). Gestation time is approximately 12–18 months (Bruce and Stevens 2001; IUCN 2009; Last and Stevens 2009). Females have a two to three year reproductive cycle (Bruce and Stevens 2001; IUCN 2009; Last and Stevens 2009).

Whale Shark

The whale shark (*Rhincodon typus*) is classified as Vulnerable and Migratory under the EPBC Act and is a totally protected fish under the *Fish Resources Management Act 1994*.

Whale sharks are the largest fish in the world (Wilson and Martin 2004). The species can grow up to 12 m in length and are frequently sighted feeding close to the surface (DEWHA 2009b).

Whale sharks occur worldwide in tropical and subtropical waters (Dewar et al. 2008). In Western Australia, whale sharks have been encountered from Shark Bay to the Dampier Archipelago, however a key location for whale shark aggregations is the Ningaloo Reef (DEWHA 2009b).

Whale sharks are highly migratory, with seasonal migrations to the Ningaloo Reef each year between May and June following coral spawning (DEWHA 2009b). The migration destinations of the whale sharks encountered on Ningaloo Reef are the subject of ongoing research, however studies by Wilson et al. (2006) suggest the species undertake northern migrations once leaving the reef, moving offshore in to the Indian Ocean (DEWHA 2009b).

Whale sharks are one of two shark species that are wholly omnivorous, filter feeding on plankton by travelling at the ocean's surface (Last and Stevens 2009).

No critical habitat for whale sharks has been identified in the Kimberley region.

Tiger Shark

Tiger sharks (*Galeocerdo cuvier*) are not listed on the EPBC Act or Western Australian legislation but are listed as Near Threatened by the IUCN (IUCN 2009).

This common variety of shark is found globally (Randall 1992). Tiger sharks are common in the waters off the Northern Territory and Queensland, and are found along the north coast of Western Australia (Last and Stevens 2009; Department of Fisheries 2008).

Tiger sharks are an easily identifiable large whaler shark due to their conspicuous dark barred markings along the length of their body (Last and Stevens, 2009). The tiger shark is a catholic feeder, largely omnivorous and commonly known as a scavenger, and consumes a range of marine prey including turtles, seasnakes, dugongs and dolphins, the tiger shark is an apex predator (Last and Stevens, 2009).

The species typically inhabits shallow inshore waters (1–150 m) in warm temperate and tropical areas (McAuley el al. 2002; Last and Stevens 2009). They can grow up to 5.5 m in length and are sexually mature between 2.5 and 3 m in length (IUCN 2009). Pupping is thought to occur during summer with a gestation period between 13 and 16 months, and mean litter sizes of approximately 30 pups (IUCN 2009).

Hammerhead Sharks

There are nine species of hammerhead sharks (Sphyrnidae) of which four have been recorded in Australian waters: winghead shark (*Eusphyra blochii*), scalloped hammerhead (*Sphyra lewini*), great hammerhead (*Sphyra mokarran*) and the smooth hammerhead (*Sphyra zygaena*) (Last and Stevens 2009).

In general, hammerhead sharks are common, with worldwide or localized distributions (Last and Stevens 2009). They are not listed under the EPBC Act or the Western Australian *Wildlife Conservation Act 1950*.

Hammerhead sharks that are known to occur in Australia are typically found at continental and insular shelves, ranging from shallow waters (<80 m) to waters of 275 m depth, although they are never truly oceanic (Last and Stevens 2009). They are found in the water column from surface to benthos (McAuley el al, 2002).

These sharks are distributed throughout the Kimberley, with both the winghead shark and smooth hammerhead occurring from northern Western Australia through to the Montebello Islands. The scalloped hammerhead and great hammerhead are also found in the Kimberley, with these sharks being distributed throughout northern Australia to as far south as Geographe Bay and Mandurah respectively. Little is known on the migratory patterns of the species in Australia (Cavanagh et al. 2003).

Most hammerhead species give birth to an average of 20 pups, after a gestation period of approximately 10 months, with pupping occurring during Summer (Cavanagh et al. 2003). The main food source for the species is fish and squid, therefore the head of these sharks is characteristic in shape and has adapted to enable them to catch squid species (Last and Stevens 2009).

Leopard shark

The leopard shark (*Stegostoma fasciatum)* is not listed under the EPBC Act and is likely to reside in the region and present throughout the year. The species occurs in shallow, tropical waters and has been recorded in the northern states of Australia including Western Australia, Northern Territory, Queensland and New South Wales (IUCN 2009).

Leopard sharks can grow between 2.5 and 3.5 m in length, is slow moving, and is often found on sandy bottoms around coral reefs (Australian Museum 2009). They feed mostly on benthic species including gastroposds and molluscs, and occasionally on craps, shrimps and small fish (Australian Museum 2009).

Little is known on the reproductive cycle of leopard sharks, however it is known that the species is oviparous, with egg cases often being as large as17cm in length (Australian Museum 2009). The species is thought to reach sexual maturity at approximately 1.5 m in length for males and 1.7 m in length for females (IUCN 2009).

4.2 Rays

Rays are thought to be long lived, taking a number of years to reach sexual maturity (Last and Stevens 2009). Rays fertilise eggs internally to produce large eggs and then bear live young (Last and Stevens 2009).

Rays inhabit a range of depths, although most are found in coastal environs, including coral reef, mangrove stands and estuaries (Last and Stevens 2009). Most rays have small crushing teeth and prey on invertebrates or small fish, but some scavenge for food, manta rays (*Manta birostris*) are the only ray species that feed on plankton (Last and Stevens 2009).

Manta Ray

Manta rays (*Manta birostris*) belong to the devilray family (Mobulidae). Devilrays are the largest of all rays, with manta rays being the biggest. These rays are cosmopolitan in tropical and sub-tropical waters and are mostly pelagic over the continental shelf and nearshore islands (Last and Stevens, 2009).

The manta ray is categorized as 'Near Threatened' by the International Union for Conservation of Nature (IUCN). It is not listed under Australian Commonwealth or State wildlife legislation.

Manta rays can reach up to 9 m between wing tips (Dewar et al. 2008), and weigh up to 1,350–1,400 kg (Martin 2003; Passarelli and Piercy 2009). They have dark brown, greyish blue, or black bodies on top, with an underbelly of white with pale edges (Passarelli and Piercy 2009). They also possess a distinct large triangle pectoral fin and protruding cephalic lobes, used to scoop water into its mouth (Passarelli and Piercy 2009). These rays sometimes swim in loose aggregations and spend considerable time near the surface, often breaching the upper water column (Passarelli and Piercy 2009).

Manta rays are a circumtropical and pelagic species, found in a variety of habitats in tropical to warm temperate seas (Martin 2003) of between 27–31 °C (Dewar et al. 2008; Sleeman et al. 2007) (Figure 6). These rays frequent a range of depths but are mainly sighted in shallow areas (<100 m) (Sleeman et al. 2007), including shallow waters associated with coral reefs (Martin 2003) and mangroves. They are also found in deeper oceanic waters (Preen et al. 1997) near shelf edges (Hodgson 2007), offshore islands, seamounts and areas of upwelling (Marshall et al. 2006). Juvenile rays remain inshore for a number of years prior to expanding their range offshore (Passarelli and Piercy 2009).

Western Australian populations have been recorded from the far north of Western Australia, to Rottnest Island in the south (Last and Stevens 2009). Surveys within the Ningaloo Marine Park indicate that manta rays occur year-round (Sleeman et al. 2007; Preen et al. 1997), however this population appears to be mostly transient, with only a small group of mature females residing in the area. Population numbers peak in the Park between late summer and autumn, concurrent with pulses in the abundance of food items such as zooplankton and krill. Significant numbers of manta rays have also been recorded in Shark Bay (Preen et al. 1997). No studies on Manta Rays have been conducted in the Kimberley.

Manta rays show a high degree of fidelity to specific feeding and cleaning locations (Last and Stevens 2009). Movements are thought to be associated with fluctuations in water temperature (Dewar et al. 2008; Sleeman et al. 2007) and prey densities (Preen et al. 1997). Studies indicate that manta rays move from deeper waters (<110 m) to coastal areas during pulses in fish/krill and zooplankton (Dewar et al. 2008; Sleeman et al. 2007; Preen et al. 1997). These pulses vary seasonally, but generally occur between late summer and autumn.

Manta rays are viviparous (give birth to live young), with an incubation period of at least nine months. Reproduction rates are low, with one litter per year often followed by a year of no breeding (Martin 2003), however detailed information on age at sexual maturity and reproductive rates is limited (Dewar et al. 2008). Because of this slow reproductive rate, the IUCN lists this species as near threatened (Martin 2003). Litters are small, generally consisting of only one to two pups born with a disk width of 1.22–

1.49 m and a mean weight of 35 kg (Last and Stevens 2009). Pups are generally birthed in shallow waters, where they will remain for several years prior to expanding their range offshore.

The age of sexual maturity is unknown, however male and female manta rays are believed to become sexually active once their disk widths reach 3.75 m and 3.80–4.10 m respectively (Last and Stevens 2009).

No breeding or birthing areas have been identified in Western Australia.

The manta ray is a filter feeder which sieves small planktonic animals and schooling bony fishes through adapted gill rakers and uses its characteristic cephalic lobes (modified extensions to the pectoral fins) to scoop water into its mouth (Dewar et al. 2008; Last and Stevens 2009). It is likely that they are omnivorous, consuming organic matter and debris whilst feeding on zooplankton and bony fishes. Seasonal movements of manta rays are likely to be linked to pulses in the abundance of these food sources.

Manta rays are usually solitary and do not feed in true schools, however aggregations do occur in areas of high food abundance.

Spotted Eagle Ray

The spotted eagle ray (*Aetobatus narinari*) is considered as 'Near Threatened' by the IUCN. In Australia, it is not listed on either Commonwealth or State wildlife legislation.

The spotted eagle ray has a long broad snout and a flattened body that is as broad as it is short (Bester 2009). The dorsal side of the body is dramatically patterned with white spots and the tail of this species is very long and whip-like (Bester 2009).

The spotted eagle ray is an excellent swimmer. While swimming these rays often breach the surface (Bester 2009).

Eagle rays are globally distributed (Luna 2007) in tropical to warm temperate waters (Bester 2009) (Figure 7). These rays are found in the waters off northern Australia with populations in Queensland, the Northern Territory and Western Australia, as far south as Exmouth Gulf.

Eagle rays are commonly found in shallow coastal areas (<60 m deep) inhabiting coral reefs and bays (Luna 2007; Bester 2009), where they feed on a range of molluscs, crustaceans and other marine invertebrates, including sea urchins. While they may be found inshore, they spend most of their time swimming in schools in open water (Bester 2009).

Eagle ray (Myliobatidae sp.)

Five species of eagle rays occur in Australian waters, inhabiting nearshore tropical waters (Last and Stevens, 2009). Of these, the whitespotted eagle ray and the banded eagle ray are known to occur in waters of north-west WA (Last and Stevens, 2009) and therefore possibly within the survey area.

Shovelnose ray (Rhinobatidae sp.)

There are four species of shovelnose rays found in Western Australia (McAuley el al, 2002). These rays have shark-like bodies and triangular heads. These rays are benthic animals, living at the bottom of continental shelf waters (McAuley el al, 2002). They feed on shellfish and other bottom-dwelling invertebrates (Last and Stevens, 2009). When camouflaged on the benthos they are very difficult to identify.

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APPENDIX 3

Types of Vessels Recorded during the Suite of Megafauna Surveys

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Vessel Types

1 pilot vessel
Average size (range): 10 – 22 metres
Speed (range): to 28 knots

2 cruise ship
Average size (range): to 213 metres
Speed (range): to 20 Knots

3 navy patrol boat
Average size (range): 34 -55 metres
Speed (range): to 24 Knots

4 cargo vessel
Average size (range): to 300 metres
Speed (range): to 17 Knots

5 livestock carrier vessel
Average size (range): 200 metres
Speed (range): 12 Knots

6 rig supply vessel
Average size (range): 20 – 100 metres
Speed (range): to 20 Knots

7 whale watching vessel
Average size (range): 8 – 35 Metres
Speed (range): to 25 Knots

8 dredging vessel
Average size (range): 10 – 30 metres
Speed (range): Towed up to 5knots

1 Indonesian fishing vessel
Average size (range): 15 – 30 Metres
Speed (range): to 15 Knots

2 recreational vessel (sail)
Average size (range): 10 – 25 Metres
Speed (range): to 15 Knots

3 recreational vessel (motor)
Average size (range): 8 – 35 Metres
Speed (range): to 25 Knots

4 pearling vessel
Average size (range): to 35 Metres
Speed (range): 20 Knots

Indonesian Fishing Vessel Types

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APPENDIX 4

Scales of Environmental Factors Affecting Survey Visibility

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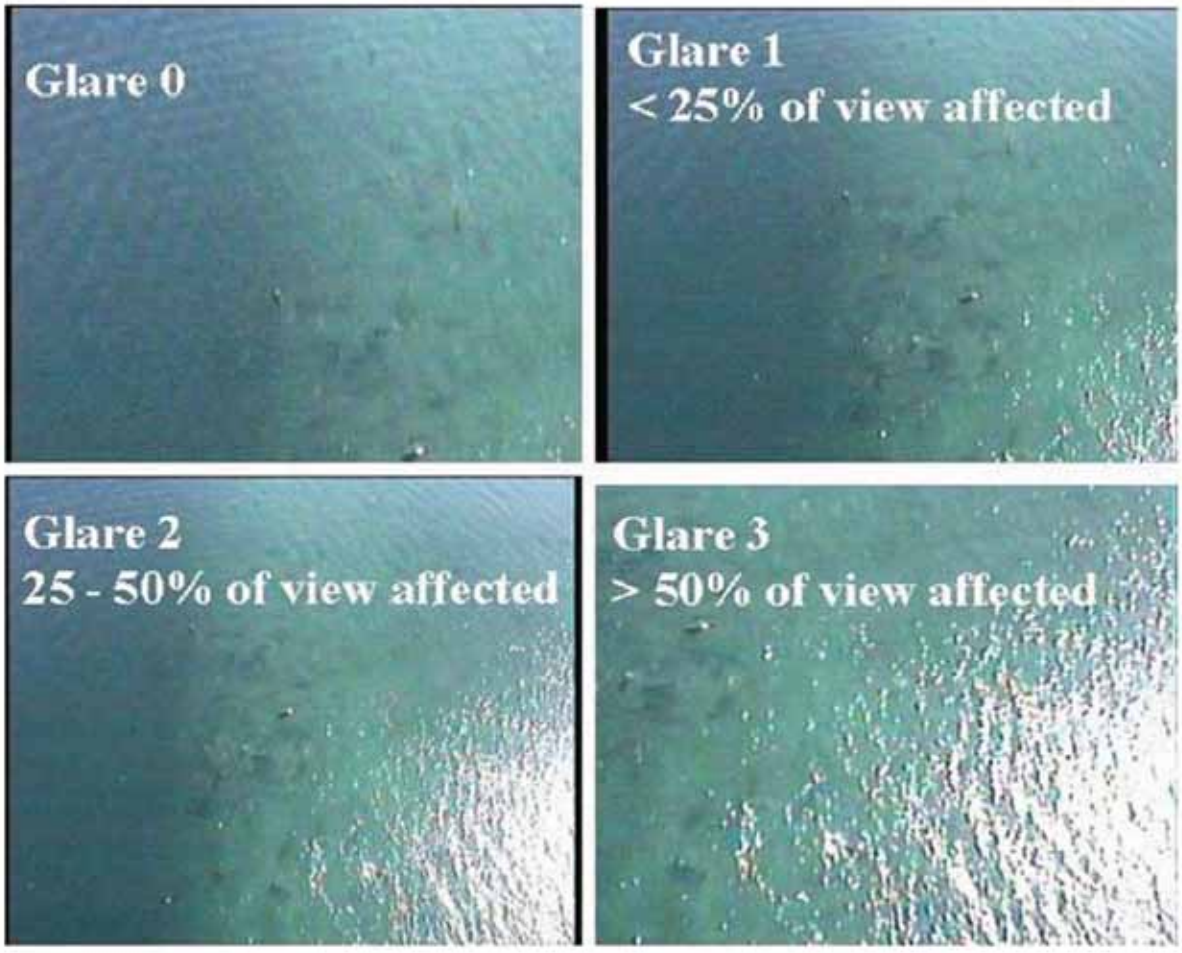
APPENDIX 4: Turbidity Scale

Turbidity	Water Quality	Depth Range	Visibility of Sea Floor
1	Clear	Shallow	Clearly visible
2	Variable	Variable	Visible but unclear
3	Clear	>5 m	Not visible
4	Turbid	Variable	Not visible

Force	Description	Sea Description	Speed Knots	Range	Forecast Description	Sea State	Waves in metres
0	Calm	Sea like a mirror	0	<1	Calm	Calm	0
1	Light air	Ripples with the appearance of scales are formed, but without foam crests.	2	1-3	Light	Smooth	0.1
2	Light breeze	Small wavelets, still short but more pronounced. Crests have a glassy appearance and do not break.	5	4-6	Light	Smooth	0.2
3	Gentle breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Scattered white horses.	9	7-10	Light	Slight	0.6
4	Moderate breeze	Small waves, becoming longer, fairly frequent white horses.	13	11-16	Moderate	Moderate	1
5	Fresh breeze	Moderate waves, taking a more Pronounced long form; many white horses are formed. Chance of some spray.	19	17-21	Fresh	Rough	2
6	Strong breeze	Large waves begin to form; white foam crests are more extensive everywhere. Probably some spray.	24	22-27	Strong	Very rough	3
7	Near gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	30	28-33	Strong	High	4
8	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind.	37	34-40	Gale	Very high	5.5
9	Strong gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.	44	41-47	Severe gale	Very high	7
10	Storm	Very high waves with long over-hanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of wind. On the whole the surface of the sea takes a white appearance. The 'tumbling' of the sea becomes heavy and shock-like. Visibility is affected.	52	48-55	Storm	Phenomenal	9
11	Violent storm	Exceptionally high waves (small & medium sized ships might be lost to view for a time behind the waves). The sea is completely coveered with long white patches of foam lying along the direction of the wind. Every-where the edges of the wave crests are blown into froth. Visibility is affected.	60	56-63	Violent storm	Phenomenal	11.5
12	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected	64+		Hurricane		14

Visibility Scales

Glare



Visibility Range

1	<50 m
2	50–200 m
3	>200–500 m
4	>500–1000 m
5	>1–2 km
6	>2–4 km
7	>4–10 km
8	>10 km
9	Not available