RPS

MARINE MEGAFAUNA SURVEY REPORT

Browse Marine Megafauna Study 2011





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Disclaimer

EXECUTIVE SUMMARY

RPS was engaged by Woodside Energy Limited (Woodside) to conduct an extensive series of marine megafauna baseline surveys in the waters adjacent to Dampier Peninsula in Western Australia. The surveys were designed to support the assessment and management of potential impacts to marine megafauna from the proposed Browse Liquefied Natural Gas (LNG) Precinct development near James Price Point. A series of aerial and vessel surveys were undertaken during the 2009 and 2010 humpback whale (*Megaptera novaeangliae*) migration period (June – October) to facilitate this assessment process.

Although these surveys were designed primarily to sample humpback whales and dugongs (*Dugong dugon*), data were also obtained for other marine megafauna (i.e. dolphins, marine reptiles, sharks, rays, fish and birds). The surveys showed similarities in marine megafauna distribution between years, with a relatively high abundance of dolphins, turtles and sea snakes compared to other megafauna groups. The sightings from all fauna groups recorded during the survey period in both years confirmed that the marine environment offshore of James Price Point contains a diverse assemblage of species, consistent with other locations along the Kimberley coast (DEC 2009).

In 2011, Woodside contracted RPS to collect a third year of marine megafauna baseline data for the Browse LNG Precinct. The Marine Megafauna Survey undertaken in 2011 was conducted along the west coast of the Dampier Peninsula between 20 and 85 km north of Broome. This survey was designed specifically for dugongs, but also acquired data for dolphins and vessels and it is the results of that survey that is presented in this report.

Survey Effort

The 2011 Marine Megafauna Survey included six flights that were conducted during neap tide periods between 29 June and 23 September 2011. The total sampling effort was 11 hours and 31 minutes and covered 2,533 km of linear transects and an overall survey area of approximately 1,917 km^2 per flight. The 400 m strip width sampling area on either side of the aircraft amounted to a sampling efficiency of 17% across the whole survey area.

Sightings of dugongs and dolphins were also collected during other studies conducted from aircraft and vessels in 2009 and 2010 and were drawn upon in this report to provide a wider appreciation of the activities and distribution of marine megafauna in this area.

Results and Conclusions

As with previous years, the survey area contained a number of megafauna species in 2011 including dugongs, snubfin dolphins, spinner dolphins and bottlenose dolphin species. Turtles were also common but reported elsewhere (RPS 2012a), whilst data for other marine reptiles were not analysed (but see RPS 2010b and 2011a). The megafauna dataset did not identify any "hot spots", in which a single location supports a relatively large number of animals.

Aerial surveys conducted in 2010 were not focussed on dugongs and hence data collected in 2010 were not used in comparing between years. Comparisons between the 2009 and 2011 aerial

surveys indicate high variability in dugong distribution throughout the sampling period with a limited distribution from the shore (median = 4.27–7.65 km). The 2011 survey recorded dugongs on average closer to shore than in 2009 and a greater abundance of observations were obtained between James Price Point and Cape Bertholet. These changes in observations may reflect variability in the abundance of seagrass, environmental parameters and/or individual behaviours (e.g. Campbell and Holley 2010). However, this was not demonstrated to be significant and may have been sampling chance.

Dolphins were common particularly in waters outside the 3 nautical miles (NM) (5.56 km) state boundary. Spinner dolphins were the most abundant of the 9% of dolphin observations that could be identified to species. Four potential Australian snubfin dolphins were also recorded approximately 10 km from the shore.

A range of vessel types were recorded during the flights including commercial (charters, fishing, pearling, supply boats and survey boats) and recreational vessels (motorboats and sailboats). Vessels were mostly observed in June and July and were distributed south of James Price Point. Pearling vessels were consistently found about 10 km from the shore adjacent to the permanent pearl farm located off Quondong Point Table 1 provides a summary of the key findings with reference to previous surveys.

Table 1: Key Findings from the 2011 Marine Megafauna Survey

Key Findings	Section
Dugongs	
Dugongs were recorded frequently on all flights during 2011 with a total of 150 adults and 37 calves recorded. The mean number of dugongs (adults and calves) per flight was 31 dugongs (SE = 6.88, range = 12–63, n = 6), which was similar to the number of dugongs reported on these transects during the July and September 2009 surveys (RPS 2010c).	3.3.1 3.3.2
Dugongs were mostly found in shallow (<20 m) nearshore waters, which is similar to the distribution observed in 2009 and 2010 (RPS 2010c). The highest frequency of individual dugongs (adults and calves) occurred 4 km from shore.	3.3.1 3.3.2
The median distance of individual adult dugongs from the shore in 2011 was 4.27 km (mean = 4.93 km, SE = 0.25, range = 0.13–19.08, n = 187) compared with 7.65 km (mean = 10.26, SE = 1.04, range = 0.69–33.27, n = 66) in 2009.	3.3.1 3.3.2
Eighty percent of individual dugongs were recorded between 2.6 km (95% CI: 1.1–4.2) and 8.3 km (95% CI: 6.6-10.0) from shore in 2011 and between 6.6 km (95% CI: 3.2-10.1) and 13.9 km (95% CI: 9.7-18.1) from shore in 2009.	3.3.1 3.3.2
Dolphins	
The majority of dolphin sightings (91%) were not established to species level, however three taxa were recorded: bottlenose species, spinner and Australian snubfin dolphins.	3.2.1
Dolphins were the most common fauna group observed within the survey area. A total of 907 adult dolphins and 13 calves were recorded. The majority of sightings (95%) were acquired west of the 3 NM state waters limit in water greater than 20 m deep.	3.2.1
Bottlenose dolphins were widely distributed in 20–50 m water depths in groups of <10 individuals. From other studies (RPS 2011a), it is suggested that most of the bottlenose dolphins recorded within 5 km of the coast were Indo-Pacific bottlenose dolphins. This species is likely to be present year round along the Dampier Peninsula.	3.2.1.1 3.2.2.1

Key Findings	Section
As with previous marine megafauna studies off James Price Point (RPS 2010b), spinner dolphins were found offshore in waters >20 m deep. Spinner dolphins are often recorded in large groups (50–100 dolphins per group). As they are not migratory, spinner dolphins are likely to be present within the entire survey area throughout the year.	3.2.13 3.2.2.2
Two potential observations of snubfin dolphins were reported approximately 10 km from the coast adjacent to Cape Bertholet and Quondong Point. The water depth was approximately 10 and 15 m deep respectively.	3.2.1.3 3.2.2.3

ACRONYMS

Acronym	Definition
BSS	Beaufort Sea State
CI	Confidence Interval
DSD	Department of State Development
EPBC Act	The *Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographic Information Systems
IMF	Integrated Marine Facility
IUCN	International Union for the Conservation of Nature and Natural Resources (aka World Conservation Union)
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
observer	Marine Fauna Observer
NM	Nautical mile
SE	Standard Error
TL	Team Leader

GLOSSARY

Baseline survey

A baseline survey provides information on the condition of an area. A baseline survey may include the collection of data for one or more environmental parameters.

Cetacean

A cetacean is a member of the order Cetacea (whales, dolphins and porpoises).

Double count

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

Dual platforms (refer also to "Platform")

Dual platforms refer to two locations of observers, i.e. front seats versus rear seats of an aircraft (same deck, different seats). A dual-platform survey arrangement is a standard method used in distance sampling to estimate observer bias and availability bias.

James Price Point coastal area

Refers to the coastal waters between Quondong Point in the south, Coulomb Point in the north and offshore to approximately 3 NM.

Marine megafauna

For the purpose of this study, marine megafauna refers to larger marine animals which includes; dolphins, dugongs, sharks, rays, turtles and sea snakes as they surface regularly and can be easily spotted from an aircraft or surface vessel.

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.

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.

Recapture

During a dual platform survey, a recapture occurs when a marked group or individual (already recorded by one observer/platform) is recorded by an observer on a separate platform. Generally, recaptured records are identified after the survey has been completed and during the data transcription phase.

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 sampling strip is defined for each observer by lines drawn on the aircraft windows. 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.

Threatened

Threatened refers to species that are listed as Endangered or Vulnerable under the EPBC Act.

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1.0 INTRODUCTION

1.1 Browse Project Details

Woodside plans to develop the Brecknock, Calliance and Torosa gas and condensate fields located offshore in the Browse Basin, Western Australia. Natural gas and condensate hydrocarbons from offshore facilities will be transported to onshore processing facilities at the Browse Liquefied Natural Gas (LNG) Precinct near James Price Point on the Dampier Peninsula (Figure 1).

The development will include export tanker facilities to accommodate LNG and liquefied petroleum gas (LPG) carriers and condensate tankers at an Integrated Marine Facility (IMF). The IMF will provide all-weather vessel harbouring facilities (for tugs and support vessels) and marine support and offloading facilities. Dredging will be required to establish a shipping channel, turning basin and berth pockets for LNG/LPG carriers that will enter into and depart from the IMF. Dredging will also be required to establish the Materials Offloading Facility (MOF) and designated sections of the pipeline corridor. Breakwaters may also be constructed to provide a sheltered port for the export jetty and marine facilities. A pipeline will also be laid between the upstream collecting infrastructure near Scott Reef and the Precinct development.

The purpose of the proposed Browse LNG Precinct is to provide a single onshore location for the various oil and gas operators developing the Browse Basin. The central location is designed to eliminate the ad-hoc development of LNG facilities on the Kimberley coast and islands. The Department of State Development (DSD) and Western Australian and Commonwealth governments determined that the Browse LNG Precinct should be located near James Price Point, approximately 60 km north of Broome.

The Kimberley region supports a number of species that are protected under the Western Australia *Wildlife Conservation Act 1950* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), including dugongs (*Dugong dugon*), dolphins, marine reptiles, large whales, and sharks. However, very few systematic surveys have been undertaken in the region to quantify the distribution and abundance of marine fauna, with no known long-term studies of population status.

To seek environmental approval of the Browse LNG Precinct at James Price Point, a Strategic Assessment Report (SAR) was prepared by the DSD (2010), which was supported by a suite of baseline surveys. These baseline surveys included a series of aerial and vessel surveys for humpback whales (*Megaptera novaeangliae*), dugongs (*Dugong dugon*) and other marine megafauna.

These baseline studies showed that the marine megafauna along the Dampier Peninsula are diverse and abundant, and for this reason RPS was commissioned in 2011 to acquire a third year of marine megafauna baseline data in support of the proposed Browse LNG Precinct development.

1.2 Project Objectives

The purpose of the 2011 Marine Megafauna Survey was to provide a third year of baseline data for marine megafauna along the west coast of the Dampier Peninsula. The survey targeted dugongs, dolphins and turtles as a priority but observations of vessels, sea snakes, sharks, rays and large aggregations of fish were also recorded as a second priority. This report provides results for dugongs, dolphins and vessels only. Turtles have been reported in the RPS Turtle Supplementary Report 2011 (RPS 2012a). Observations of sea snakes, sharks, rays and fish were not analysed in 2011 (but refer to RPS 2010b and 2011a).

The primary objectives of the 2011 Marine Megafauna Survey were to:

- Establish the distribution of targeted marine megafauna across the survey area.
- Determine the distances from shore for dugongs.
- Determine the relative abundance of megafauna in the survey area.
- Compare and contrast survey data between 2009, 2011 and, where possible, 2010 (noting that 2010 surveys focussed primarily on whales).

2.0 METHODS

2.1 Survey Design

The 2011 Marine Megafauna Survey was conducted using 15 transects from a more extensive aerial survey conducted in 2009 (SKM 2009 and RPS 2010c). The selected transects were located between Cape Latreille and Carnot Bay along the Dampier Peninsula (Figure 1). Transects varied in length from 23 to 38 km and extended west from the shoreline out approximately to the 30 m isobath. Transect lines were placed 4.6 km apart to avoid re-sightings. The sum length of all transects for each flight was approximately 416 km and each flight covered an area of approximately 1,917 km^2.

Flights were scheduled to occur fortnightly during neap tides between late June and late September 2011 for seven flights in total. All flights were conducted from a CASA 212-400 aircraft, flown at an altitude of 900 ft (274 m) and at a speed of 110 knots (204 km/h). Flights avoided poor weather conditions of Beaufort Sea State (BSS) ≥4, where possible. The Team Leader inspected weather forecasts in the few days leading up to the scheduled flight and selected the period with the most appropriate conditions for sampling small megafauna, and in particular dugongs.

Megafauna rarities recorded during the 2011 Humpback Whale Migration Corridor Survey conducted during the same survey campaign have also been included in this report. Refer to the Humpback Whale Survey Report 2011 for methods used during that survey (RPS 2012c).

2.2 Survey Platform Configuration

The survey team comprised one Team Leader and three platforms of tandem observers on either side of the aircraft (Figure 2). The two front observers (Platform 1) comprised the most experienced personnel while the two middle observers (Platform 2) were less experienced. The rear observers (Platform 3) comprised Traditional Owners (TOs) being trained in aerial surveys or observers new to RPS.

The platform configuration was adopted to acquire dual platform, double-count (mark-recapture) data, which were later used to confirm identification of species and determine recaptures for dugongs. The Team Leader and observers communicated via aviation noise-cancelling headsets that were connected to an eight-channel audio management system, which was also used to record audio entries of sighting details and environmental data for subsequent transcription to a database. The audio management system comprised a six-track TASCAM recorder and two, four-track ZOOM H4N recorders to record each observer and the Team Leader independently. Two Behringer HA4700 headphone amplifiers connected observers with the Team Leader. The pilots were also connected with the Team Leader through the aircraft's internal audio.

Flight track coordinates were acquired every second from a *Garmin GPSMAP 60CSx* with an external antenna located in the cockpit of the aircraft, and downloaded to a laptop. A back-up Global Positioning System (GPS) was also placed in the cockpit, which recorded the aircraft's location every second to the internal memory. Real-time output to the laptop enabled the Team Leader to monitor survey progress. These positions are reported to be accurate to within 10 to 15 m (GPSCO 2007) of the actual position in general use.

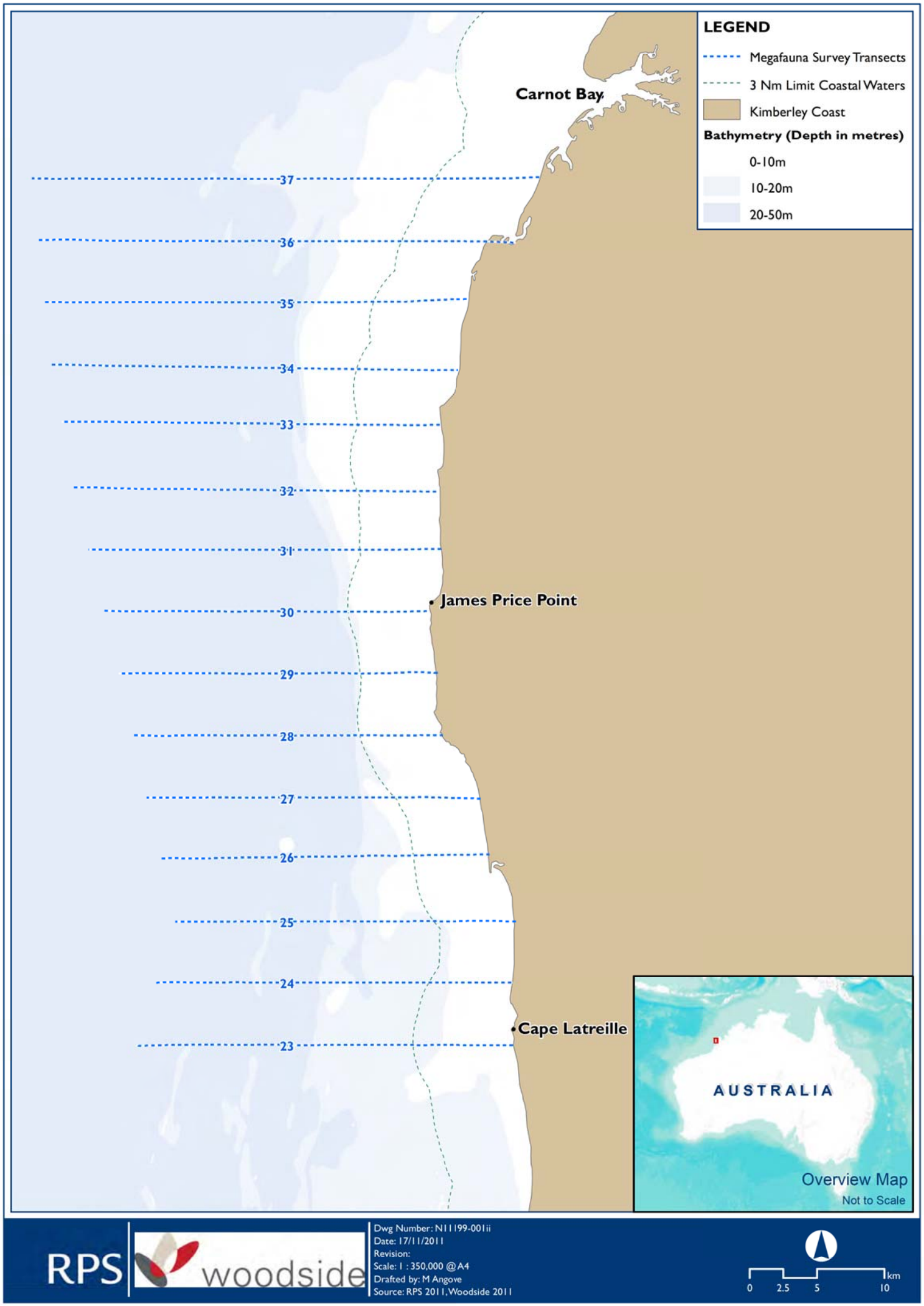

Figure 1: Geographic Extent of the Megafauna Survey

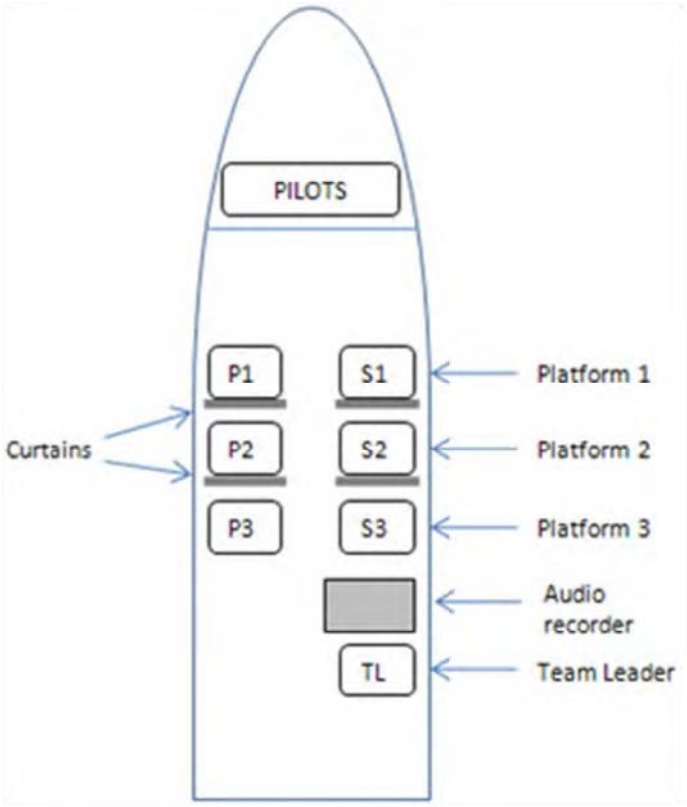

Figure 2: Configuration of Observers and Platforms in Aircraft

2.3 Sampling Protocol

The sampling protocol for the 2011 Marine Megafauna Survey followed the strip width method from Marsh and Sinclair (1989). The sampling zones were drawn on the aircraft windows according to the geometry instruction in Marsh and Sinclair (1989) and as shown in Figure 3. The observers focused all of their attention within the strip width and scanned the area to maximise chances of observing megafauna. Megafauna that were spotted just outside of the strip width zones were also recorded to encourage observers to make the distinction between the strip width zone and animals outside the zone. The records of megafauna that fell outside of the sampling strip were not included in the results or analyses.

Primary taxa recorded included dugongs, dolphins and turtles. Secondary recordings included vessels, sea snakes, sharks, rays, large aggregations of fish and any rare or unusual event. Where sightings were not confidently identified to species level, they were marked as Unidentified. On detection of a group, the observer continued searching for other groups, but checked on previously acquired groups to confirm the accuracy of the record and updated accordingly.

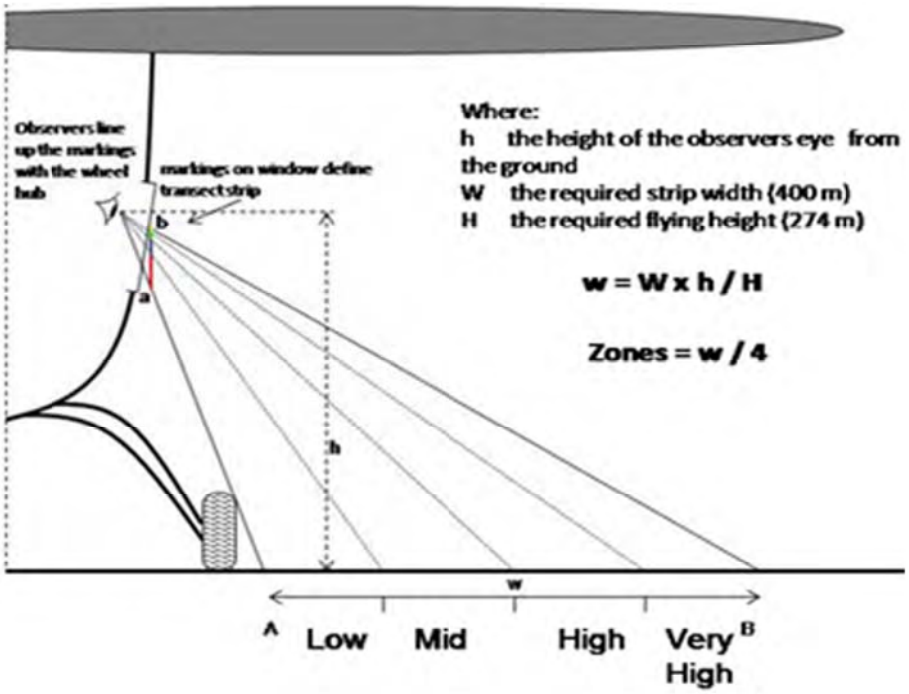

Figure 3: Strip Width Sampling Method Illustrating the Zones of Observation

Observers independently recorded a suite of variables for each megafauna sighting (using binoculars if required) in the following order:

- taxa (dugong, dolphin, turtle, vessel, sea snake, shark, ray or fish)
- horizontal zone (Low, Medium, High, Very High, Outside)
- vertical zone (front, behind)
- reliability index (certain, probable, guess)
- number in group
- number of calves
- direction of travel
- glare
- turbidity.

The environmental conditions including BSS, glare, turbidity, visibility, precipitation and wind speed and direction were recorded by the Team Leader at the beginning of the survey and updated during the survey as these variables changed.

The recording order of sighting parameters was compatible with the Microsoft Access database design to aid data transcription. Observers reported the glare level at the start of each transect, and any changes in glare intensity were recorded while on transect.

Only records of dugongs, dolphins, turtles, sharks and rays, vessels and rare or unusual events were transcribed into an Access database after each flight. Recordings of sea snakes or fish aggregations were not transcribed.

Recaptures for dugongs between platforms were identified through a combination of:

- proximity in time
- similarity in sighting details
- similarity in horizontal and vertical zone
- proximity in geographic position after sightings plotted in a Geographic Information System (GIS).

The time stamp for each record was established from the time that the strip width zone was recorded.

Recaptures were not identified for any other marine fauna group. Instead, only sightings from the front observers (port and starboard) were used in describing distributions for dolphins (and vessels). Conversely, sightings of rare species were reported regardless of whether they were obtained by the front or rear observers. This approach ensures that the most complete species list is obtained for the results and no important data are lost.

A comprehensive process of Quality Assurance and Quality Control was applied to all data acquired during the survey. This process began at the point of data acquisition and continued through data transcription and mapping. Only when data were verified and validated to a pre-determined level were they allowed to be analysed. Data collected by Platform 3 were helpful in checking data acquired on Platforms 1 and 2, but were not used in analysis or mapping.

2.4 Survey Schedule

Seven flights were scheduled to occur every two weeks during neap tides between late June and late September 2011 (Table 2). All transects were flown on a single day. The precise timing of each flight was selected according to weather conditions, with the aim to conduct flights when BSS was 3 or less. However, this was not always achievable. Flight six was cancelled due to poor weather conditions.

Survey test flights were conducted from 24–26 June 2011 to ensure that all equipment was functioning and configured correctly, and that observers were attuned to observing the target species prior to the commencement of the survey.

Table 2: 2011 Marine Megafauna Survey Schedule

Survey No.	Date
MS1	29 June
MS2	13 July
MS3	26 July
MS4	11 August
MS5	26 August
MS6	Flight cancelled
MS7	23 September

2.5 Data Analysis

Sea state above BSS 3-4 and high levels of glare strongly reduce the observer's ability to spot smaller fauna, as demonstrated by Pollock et al (2006). For this reason, BSS values for each transect have been plotted on all figures to aid with interpretation.

Maps of all sightings were produced for each marine megafauna group and vessels. To avoid duplication and ensure comparability with data from 2009 and 2010, the dolphin and vessel maps were based on survey data from the front platform only but the dugong mapping and analysis used data from both the front and rear platforms (minus recaptures). Data were plotted in GIS (ArcMap10) to provide overall distribution maps using estimated positions for megafauna.

The following analytical processes were applied to data collected during the 2009 Dugong Survey as reported in RPS (2010b and 2010c) and 2011 Megafauna Survey. Surveys conducted in 2010 were designed to sample humpback whales, and whilst dolphins and dugongs were recorded, the data are incompatible with those analysed here because of flight height and conditions.

The distance of each individual dugong from shore along each transect was analysed to produce histograms. The median and range of distance from shore were calculated by pooling all observations across all transects and flights within each year. The 10th and 90th percentiles were calculated to detect the range of distance from shore in which 80% of the dugongs were detected. Confidence Intervals (CIs) were derived around the 10th and 90th percentiles to describe an upper and lower range of dugong distribution.

It has been suggested that visually acquired dugong (or dolphin, whale etc) data should not be used in analyses to compare between flights or seasons without prior treatment

to remove the effects of environmental bias (Hodgson et al 2011). Environmental conditions that are less than ideal will mask fauna from observation and potentially result in a reduced sample size. Where conditions have been different between one survey and another, the resulting systematic bias may lead to error in concluding whether differences are present between samples. If conditions are uniformly different between surveys (or areas) or where samples are small and have primarily been collected during specific environmental conditions, the removal of bias is essential. Conversely, where sample size is large and samples have been obtained across a range of conditions, and those conditions have not been systematically distributed across the survey area or through time, there may be no systematic bias present in the data as a result of environmental conditions. RPS has investigated whether systematic negative bias is present in the raw data to the extent that it would prohibit comparative statistics. To do this the dugong data were adjusted using the "Availability Probability Estimates" from Pollock et al (2006) to remove the effects of environmental conditions. Raw data and adjusted data were then plotted against each other and fitted with a linear regression to illustrate the similarity between the two sets of data.

Analysis of variance (ANOVA) was used to test for temporal differences in the abundance of dugongs and their average distance offshore among years, among flights nested within years and for spatial differences, among sub-sample areas based on five groups of three adjacent transects. Because the abundance of dugongs along each transect was relatively low per flight, groups of three adjacent transects were pooled so that at least some dugongs were observed in each Area. Years (two levels, 2009 and 2011) and Areas (five levels, ranging from south = transects 23-25 to north = transects 35-37) were both treated as fixed, orthogonal factors. Flights nested within Years were treated as a nested random factor. The three transects flown within each area and each flight were each treated as replicate measures of the abundance or distance offshore in an Area, for each Flight within each Year. Before analysis, abundance (count) data were square root transformed (Sqrt(x +0.5)) and distance offshore (km) were transformed to natural logarithms in order to better meet distributional assumptions, but for both analyses the outcomes of tests were the same with untransformed data. Where appropriate, pooling of lower level and error terms was done in order to increase the power of tests of higher level factors, following the methods outlined by Underwood (1997).

3.0 RESULTS AND DISCUSSION

3.1 General Results

The 2011 Marine Megafauna Survey was designed to sample marine megafauna in the vicinity of the James Price Point area, with dugongs being the priority species. Data for dolphins were collected to the family level (Delphinidae) and, where possible, to the genus or species level. Dolphin data therefore presents a picture of the distribution and abundance of the dolphin community, but is an incomplete view for each of the dolphin species.

Caution must also be applied when comparing the data presented here with results from the 2009 and 2010 aerial surveys; in both previous years, all marine megafauna taxa were sampled together, but with more emphasis on either dugongs or humpback whales, depending on the survey. In 2011, the Marine Megafauna surveys focussed on dugongs, dolphins and turtles with the exclusion of humpback whales and may have resulted in a slight increase in sampling efficiency. Additionally, only two sampling events were undertaken in 2009.

Flights for the 2011 Marine Megafauna Survey were conducted over a total of six days, between 29 June and 23 September 2011 and amounted to 11 hours and 30 minutes on survey, with a mean of 1 hour 55 minutes. During this time, approximately 2,533 km of transect were sampled.

Survey condition pre-requisites for BSS were met during four of the seven scheduled flights, but three of the flights were affected to some degree by BSS ≥4, with flight six being cancelled. A short period of BSS 4 was encountered during the third flight and several transects were affected by BSS ≥ 4 during the fifth flight (i.e. transects 35–37). Glare hampered visibility on occasions and could not be avoided because of the time periods during the day when suitable sea state conditions were available.

BSS values for each transect have been plotted on all figures to aid with interpretation of the megafauna data. The final flight schedule and a summary of environmental conditions for each flight are provided in Table 3.

Table 3: Details of 2011 Marine Megafauna Survey Flights. Times Given Refer to Start of the First to the end of the Last Transect.

Survey No.	Date	Start Time	End Time	Sea State
MS1	29 June	13:37	16:08	2–3
MS2	13 July	9:02	11:36	2–3
MS3	26 July	13:32	16:10	2–4
MS4	11 August	13:44	16:21	2–3
MS5	26 August	14:13	16:58	3–5
MS6	Flight cancelled			
MS7	23 September	8:34	11:21	2

3.2 Dugongs

3.2.1 Results

Dugongs were recorded on every flight during the 2011 Marine Megafauna Survey with a total of 150 adults and 37 calves (Table 4) observed across 131 sightings. The mean number of dugongs (adults and calves) per flight was 31 dugongs (SE = 6.88, range = 12–63, n = 6). Group size ranged from one to four, with a median of one dugong and a mean of 1.4 dugongs. The greatest abundance of dugongs (63 individuals) was recorded on 23 September during optimal conditions, with fewest recorded (12 individuals) on 26 August, the latter possibly because of sub-optimal survey conditions.

Table 4: Number of Adult Dugongs and Dugong Calves Recorded during the 2011 Marine Megafauna Survey.

Trip No.	Date	Adult Dugongs	Dugong Calves	Total
MS1	29 June	24	9	33
MS2	13 July	24	7	31
MS3	26 July	20	4	24
MS4	11 August	21	3	24
MS5	26 August	12	0	12
MS6	Flight cancelled			
MS7	23 September	49	14	63
Total		**150**	**37**	**187**

In 2011, 97 of the 131(75%) dugong sightings were recorded within the 3 NM state boundary (Figure 5). Only 5 sightings of the remaining 33 sightings were located in water deeper than 20 m.

Raw dugong data (minus recaptures) from the 2009 Dugong Survey (RPS 2010c) and from the 2011 Marine Megafauna Survey were adjusted using the "Availability Probability Estimates" of Pollock et al (2006). The resultant plot of raw against adjusted values is shown in Figure 4. Assuming that the adjustment estimates of Pollock et al (2006) adequately addresses the effects of environmental conditions on dugong sightings, the resultant linear regression equation of y=1.876x + 0.067 (n=90) and regression coefficient of 0.97 shows that the raw data displays the same pattern as adjusted data and therefore is suited for use in statistical comparisons between flights or years without the need for further treatment.

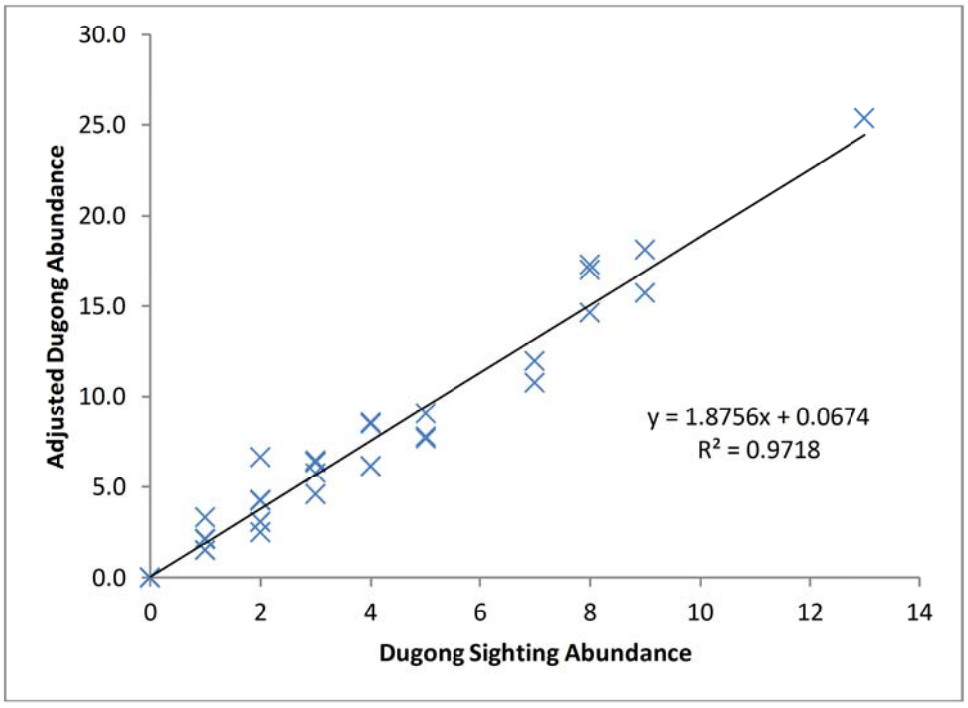

Figure 4: Raw Dugong Sampling Abundance Plotted against Abundance Estimates Calculated from Availability Probability Estimates of Pollock et al (2006). All data from 2009 Dugong Survey and 2011 Megafauna Survey have been used (n=90).

The most likely explanation for this is that the conditions in which surveys have been conducted have been consistent enough between flights and years and any differences have not been systematic e.g. poor conditions only to the north half of the survey area or western halves of each transect.

3.2.2 Comparisons between Years

Comparison in raw abundance data acquired from transects 23 to 37 in 2009 and 2011 using an ANOVA failed to detect any differences in dugong abundance: among the five groups of three transects (Area) which had been grouped spatially for analyses; between years; or among flights within each year (Table 5).

Table 5: Analysis of variance of abundance of dugong in 'Areas' (= groups of three adjacent transects) between 2009 and 2011, and among flights within each year.

Source	SS	DF	MS	F-ratio	P-value
Area	1.969	4	0.4923	0.517	0.726
Year	0.005	1	0.0050	0.010	0.920
Area * Year	2.67	4	0.6675	1.377	0.271
Flight(Year)	7.62	8	0.9525	1.965	0.096
Area * Flight(Year)	11.63	24	0.4847	1.097	0.367
Error	35.351	80	0.4420		

There was no evidence of an interaction between the Area and Flights within each year. Therefore, the interaction term of Area and Flights within Year could be pooled with the residuals to allow for more powerful tests (Underwood 1997). Pooling did not lead to a significant interaction between Area and Year ($p = 0.210$), but did lead to a significant difference between Flights within each Year ($F_{8,104} = 2.108$, $p = 0.041$, $MS_{pooled} = 0.452$), indicating that abundance varied from flight to flight, within years.

Pooling did not increase the power of the test of Area or Year. Therefore, despite an apparent greater abundance of dugongs to the north of James Price Point in both years (see RPS 2010c and Figure 5) and a greater abundance within the 3 NM state boundary, there was no statistical support for these observations.

Pooling all records across flights and transects, the highest frequency of individual dugongs (adults and calves) occurred 4 km from shore (Figure 6), with a median distance of individual dugongs from the shore in 2011 of 4.27 km (mean = 4.93 km). The median for the pooled data from July and September 2009 was 7.65 km (mean = 10.26 km). Overall in 2011, 80% of dugongs (from 10th to 90th percentiles) were recorded between 2.63 km (95% CI: 1.11-4.15) and 8.3 km (95% CI: 6.57-10.02) from shore, which appeared to be closer to shore than in 2009, where 80% of individual dugongs were recorded between 6.53 km (95% CI: 3.2–10.1) and 13.93 km (95% CI: 9.7–18.1) from shore.

The median distance from shore for records of calves in 2011 was 4.82 km (mean = 5.18 km, SE = 0.48, range = 0.88–15.52, n = 37). In 2009 the median distance from shore was 9.63 km, but this was based on only two records of calves.

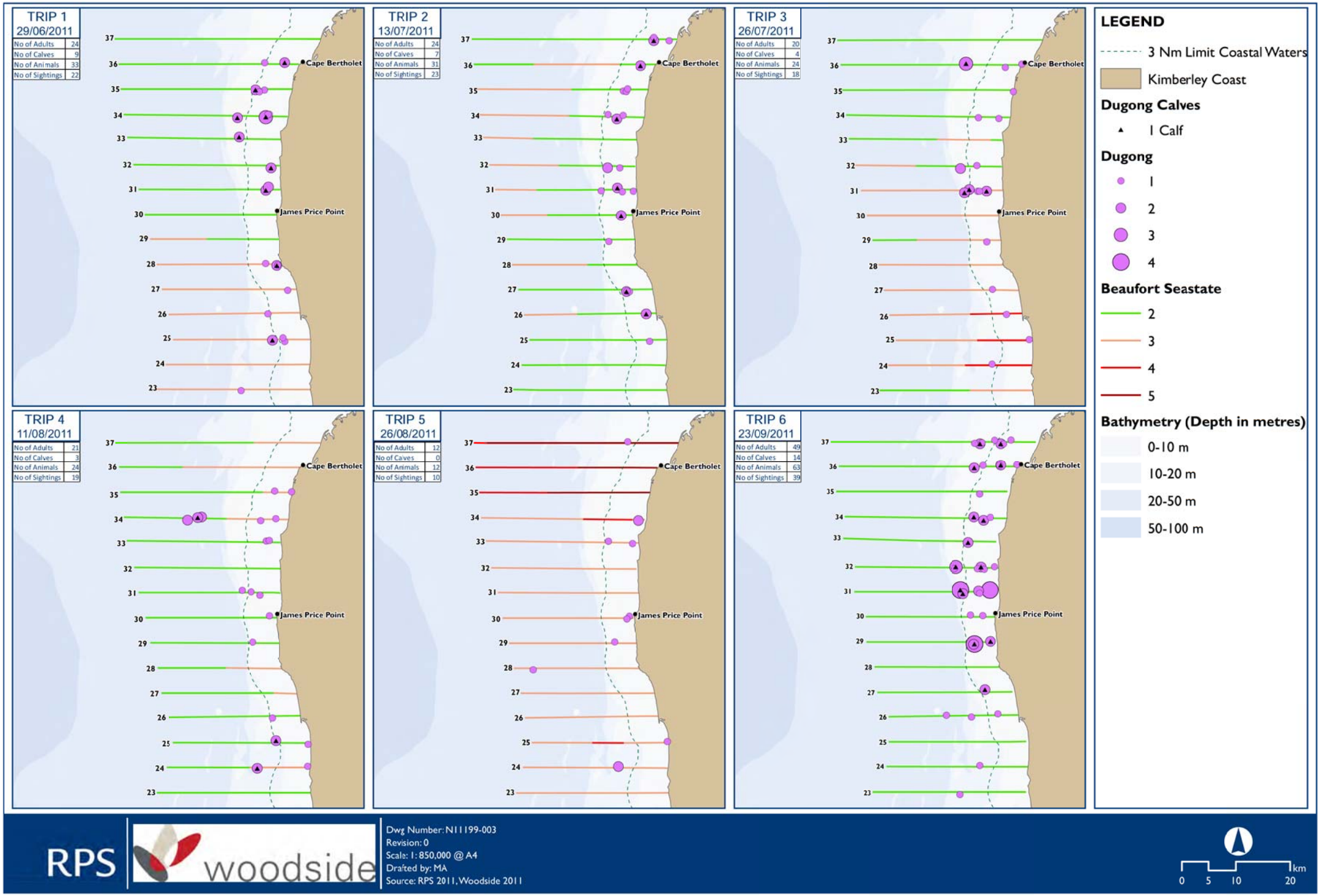

Figure 5: Distribution of Dugongs Recorded during the 2011 Marine Megafauna Survey

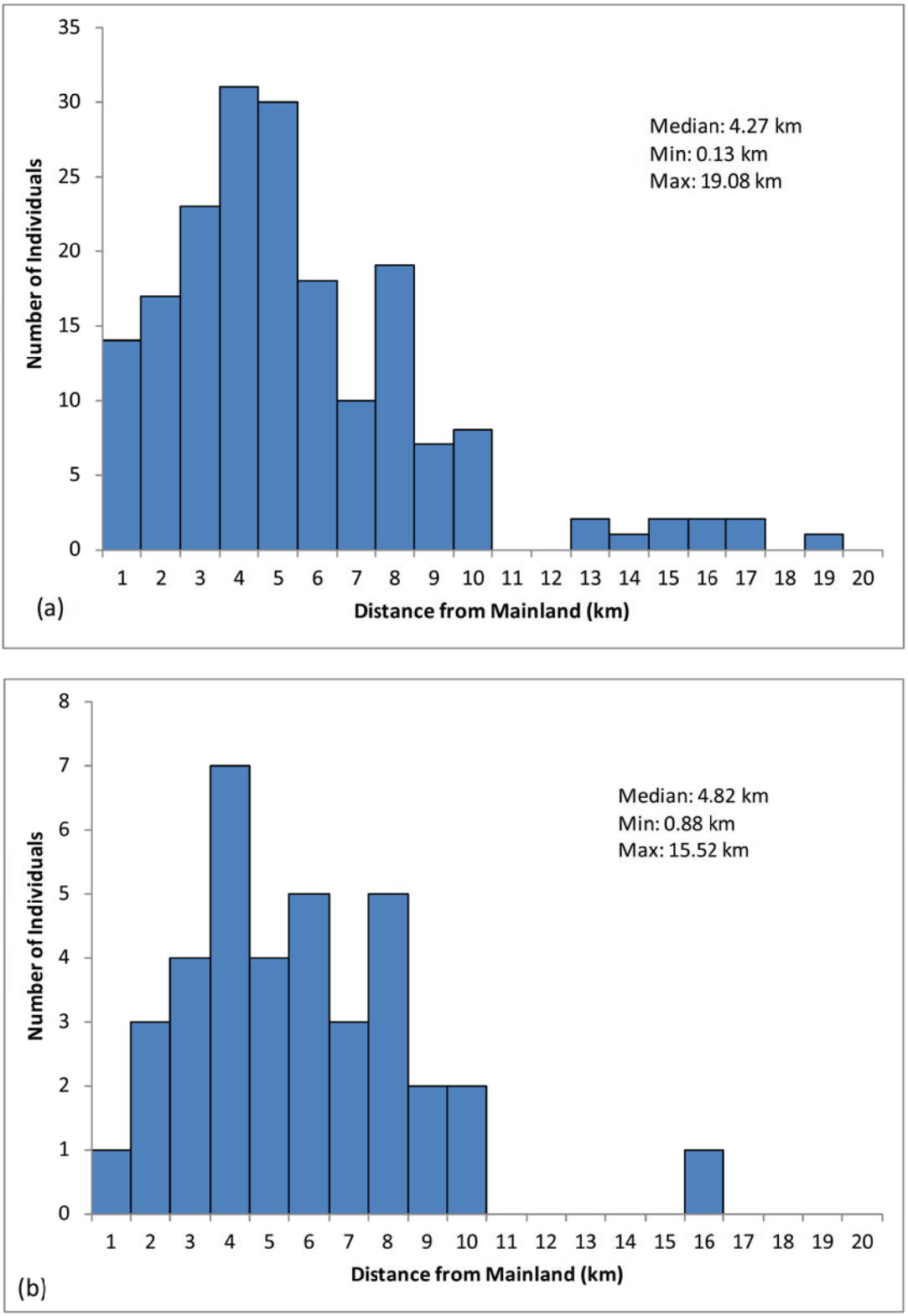

Figure 6: **Distances from the Shore that Dugong Adults (a) and Calves (b) were Recorded during the 2011 Marine Megafauna Survey.**

When the distances from shore for dugong records from 2009 and 2011 are plotted together as shown in Figure 7 a change in the pattern is apparent with the data in 2009 being more uniformly spread across the whole sampling area.

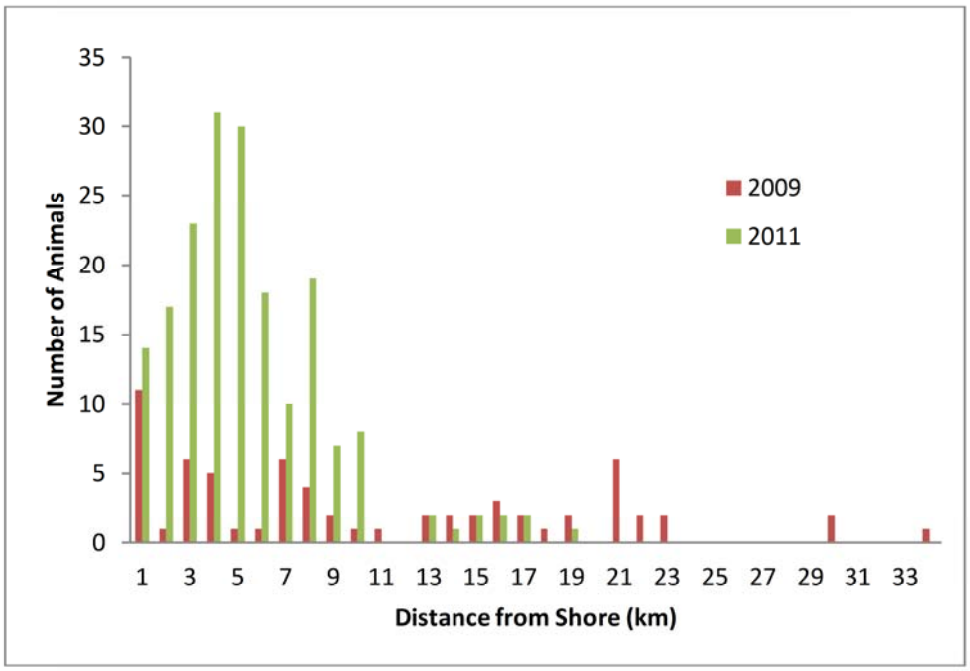

Figure 7: Distance from Shore for Dugongs for Data Collected on Transects 23–37 during the Megafauna Surveys in 2009 and 2011. The Disparity in Sighting Numbers is due to Two Surveys in 2009 Compared with Six in 2011.

ANOVA of the distance from shore across 2009 and 2011 found a difference between the two Years, but no detectable difference among the five sub-sample areas of three transects which had been grouped spatially for analyses (Table 6). However, a significant effect was also detected between the interaction of sub-sample Area and Flights within each Year, suggesting the pattern of distance offshore among Areas differed from flight to flight within years (Table 6).

Table 6: Analysis of Variance of Distance from Shore of Dugong in 'Areas' (= Groups of Three Adjacent Transects) between 2009 and 2011, and among Flights within each Year.

Source	SS	DF	MS	F-ratio	P-value
Area	4.263	4	1.0658	1.018	0.453
Year	8.184	1	8.1840	5.406	0.029
Area * Year	5.307	4	1.3268	0.876	0.493
Flight(Year)	8.374	8	1.0468	0.691	0.695
Area * Flight(Year)	36.33	24	1.5138	3.425	<0.001
Error	124.107	213	0.4420		

3.2.3 Dugong Discussion

Dugongs are listed as Vulnerable by the International Union for the Conservation of Nature and Natural Resources (IUCN) (IUCN 2010) and Migratory under the EPBC Act, though their migratory movements are associated more with the availability of seagrass beds and warmer water (DSEWPaC 2012) than specific locations and pathways as is the case with humpback whales. Dugongs occur throughout the coastal waters of northern Australia, from Shark Bay to northern New South Wales (NAILSMA 2006). However, they are known to aggregate at several locations, generally in sheltered embayments where their staple food crop of seagrass is abundant. Important dugong aggregation areas in Western Australia include Shark Bay and Exmouth Gulf (Marsh et al. 2002). Previous megafauna surveys indicate that the nearshore waters along the Dampier Peninsula are also important areas for dugongs (RPS 2010b and RPS 2011a).

Dugong distribution is dependent on seagrass production and suitable habitat (Sheppard 2010), and it is known that dugongs prefer some food patches and avoid others (Preen 1995; Anderson 1998). Because of the large spatial and temporal variability in seagrass beds, it is presumed that dugongs have adapted their foraging strategies accordingly. Tagging studies of dugong undertaken in Beagle Bay (north of James Price Point) have found stark variability in their movements – albeit based on just four animals, with three dugongs having a relatively short home-range but one travelling almost 500 km past James Price Point to Eighty Mile Beach (Campbell and Holley, 2010). Data collected by Campbell and Holley (2010) indicates that wider movements are interspersed with periods of localised foraging. Reasons for such large-scale movement is unknown but could possibly be attributed to dugongs searching for suitable foraging grounds (Marsh et al. 2002; Gales et al. 2004).

Although there was some variability in sampling abundance and small scale (within 40 km of James Price Point) distributions from flight to flight, the 2009 and 2011 aerial surveys showed that dugongs were present in both years within nearshore waters along the Dampier Peninsula. They were present during the isolated study conducted in March 2009 by SKM and then throughout the Marine Megafauna Survey campaigns from June/July to September/October in 2009–2011. Little is known about dugong abundance between October and March and March to June, but current information suggests that they are likely to be present throughout the year, dependent on the availability of seagrass and suitable water temperature.

Dugongs were also present offshore in very low numbers during the 2009 and 2010 Humpback Whale Migration Corridor aerial surveys where they were found up to 50 km from shore, although always within 25 m depth (RPS 2010a), indicating that dugongs are not restricted to just shallow inshore waters. However, given the likely absence of seagrass in deeper waters, they were probably just transiting rather than feeding. No dugongs were recorded at Scott Reef during the 2009 or 2010 aerial surveys.

Several dugongs were also observed during a marine mammal survey that took place in association with a geotechnical survey conducted in 2010 (RPS 2012b). The platform on which the observations took place was located only 1.5–2.5 km from shore and close to James Price Point. Interestingly, these sightings were acquired close to a relatively small drill rig and very large accommodation vessel used to conduct the geotechnical survey. This is considered to be unusual as dugongs are known to be difficult to sample from surface craft as they are cryptic and tend to avoid vessels, possibly out of fear of indigenous hunting activities.

No overall difference in abundance was found between the 2009 and 2011 aerial surveys but an overall difference in distance offshore was detected between the two years and from flight to flight within years (Figure 7 and Table 6). Distributions from shore during the March 2009 survey (SKM 2009) and the incidental sightings from the Humpback Whale Migration Corridor Survey in 2010 (RPS 2011b), more closely resemble the distribution found in 2011, than the broader distribution observed in July and September 2009. Therefore, it appears that dugong distribution from the shoreline can change markedly interannually and potentially at any time of year.

While the above observation also supports the model that the distribution of dugong offshore varies from year to year, the variability in data can potentially confound statistical testing. Given only two flights were flown in 2009 but six in 2011 (and numbers of dugongs vary from flight to flight), the consequent imbalance in the sampling program between years can potentially lead to further limitations of statistical testing.

There was also considerable variation and patchiness in distance offshore across years and this can also make any statistical testing difficult, but may also be a real factor (rather than chance) and biologically important. Apart from Roebuck Bay which is reported to support dugongs throughout the year (DCLM 2003), the numbers and patterns of dugong records sometimes varied considerably from flight to flight. For example, greater densities were recorded about 10 km off Quondong Point in July 2009, 10 km off Carnot Bay in September 2009 and within 5 km from the shore between Cape Bertholet and James Price Point in July and September 2011. At other times the abundances were not so great in these areas. In other places, the abundance and distribution appeared to stay relatively consistent across flights; for example, the number and distribution of dugongs between James Price Point and Cape Bertholet remained fairly consistent through the entire survey period in 2011. One explanation for this may be the relatively small area sampled compared with the overall survey area (17%). It is feasible that dugong numbers may be static in the area but move between the sampling strip of 400 m either side of the aircraft in which they can be seen, and the area outside the sampling strips of around 3,800 m in which they cannot be seen.

The higher densities of dugong records from James Price Point to Cape Bertholet corresponds with an abundance of seagrass identified in that area through baseline sampling in October 2011 (M. Mackie, Pers. Comm.). Much of the patchiness in dugong distributions observed here may be related to patchiness in seagrass productivity.

Three population estimates for dugongs were calculated for the nearshore waters (<20 m deep) between Cape Bossut and Cape Leveque in March, July and September of 2009. The March population estimate was 930 (SE = 301) (SKM, 2009), in July it was 1,774 (95% CI: 1,351–2,195) and in September 2009 it was 1,708 (95% CI: 1,188–2,205). This was for an overall survey area of 9,353 km^2 and reflects densities of between 0.1 and 0.19 animals per km^2. By comparison (though not tested statistically), the overall density in Shark Bay was estimated to be around 0.64 dugongs km^{-2} by Holley and Prince (2008), whilst Hodgson (2007) estimated between 0.24 and 0.49 dugongs km^{-2} in Exmouth Gulf.

It is considered likely that the sampling protocols adopted by SKM and RPS were different which would then have differentially influenced the population estimates. For this reason the data and population estimate from March 2009 have not been included in further analysis.

3.3 Dolphins

3.3.1 Results

Dolphins were commonly detected throughout the 2011 survey period, with a total of 907 adults and 13 calves recorded during the Megafauna Survey by the two primary observers. Two possible snubfin dolphins (*Orcaella heinsohni)* and a calf were recorded by a second observer and two further snubfin dolphins were recorded during the Humpback Whale Migration Corridor Survey (Table 7; Figure 8). Dolphins were seen on every flight, with 39% recorded as single individuals. Group size ranged from 1–50 dolphins (Figure 4). The majority of dolphins were observed west of the 3 NM coastal waters limit (Figure 8). Most of the dolphins confidently identified to species were recorded further than 10 km from shore; many unidentified dolphins were however, recorded closer to shore than this. Aggregations of ten or more dolphins were recorded on five of the six flights towards the western ends of the transects.

Although 91% of sightings were unable to be indentified to species level, at least three taxa were identified:

- bottlenose dolphin (*Tursiops* spp.)
- spinner dolphin (*Stenella longirostris*)
- Australian snubfin dolphin (*Orcaella heinsohni).*

Table 7: Number of Adult Dolphins (and Calves) Recorded during the 2011 Marine Megafauna Survey

Flight No.	Date	Unidentified Dolphin Species	Bottlenose Sp.	Spinner Dolphin	Snubfin Dolphin
MS1	29 June	111	5	34	0
MS2	13 July	178 (3)	0	0	2^
MS3	26 July	89 (5)	3	0	2 (1)
MS4	11 August	100 (2)	12 (1)	24	0
MS5	26 August	141	4	7	0
MS6	Flight cancelled				
MS7	23 September	160 (2)	0	37	0
Total		**779 (12)**	**24 (1)**	**102**	**4 (1)**

^ Observed during the Humpback Whale Migration Corridor Survey conducted on same day as the Marine Megafauna Survey (13 July 2011).

3.3.1.1 Bottlenose Dolphins

A low number of bottlenose dolphins groups (10 records) were reliably identified during the survey period. Group sizes were relatively small, ranging from single individuals up to 11 animals. The largest group contained a calf. All fauna identified as bottlenose dolphins were located >12 km from shore.

3.3.1.2 Spinner Dolphins

A combined total of 102 spinner dolphins (12 sightings) were recorded on four of the six flights, between transects 24 and 32. With the exception of unidentified dolphins, this was the most abundant dolphin taxa. Group size ranged from a single animal to groups of approximately 20 animals. No spinner dolphin calves were identified during the survey period, but this is not surprising due to their small size and elevation of the survey aircraft. All spinner dolphins were spotted >11 km from shore.

3.3.1.3 Australian Snubfin Dolphins

Four Australian snubfin dolphins were identified on two separate occasions, but with a low level of observer confidence. Two adults were detected on 13 July during the Humpback Whale Migration Corridor Survey approximately 10 km from shore in water approximately 10 m deep, west of Quondong Point (Figure 8). During the Marine Megafauna Survey two adults and one calf were recorded on 26 July. This group was observed in waters approximately 15 m deep and about 10 km off Cape Bertholet (Figure 8).

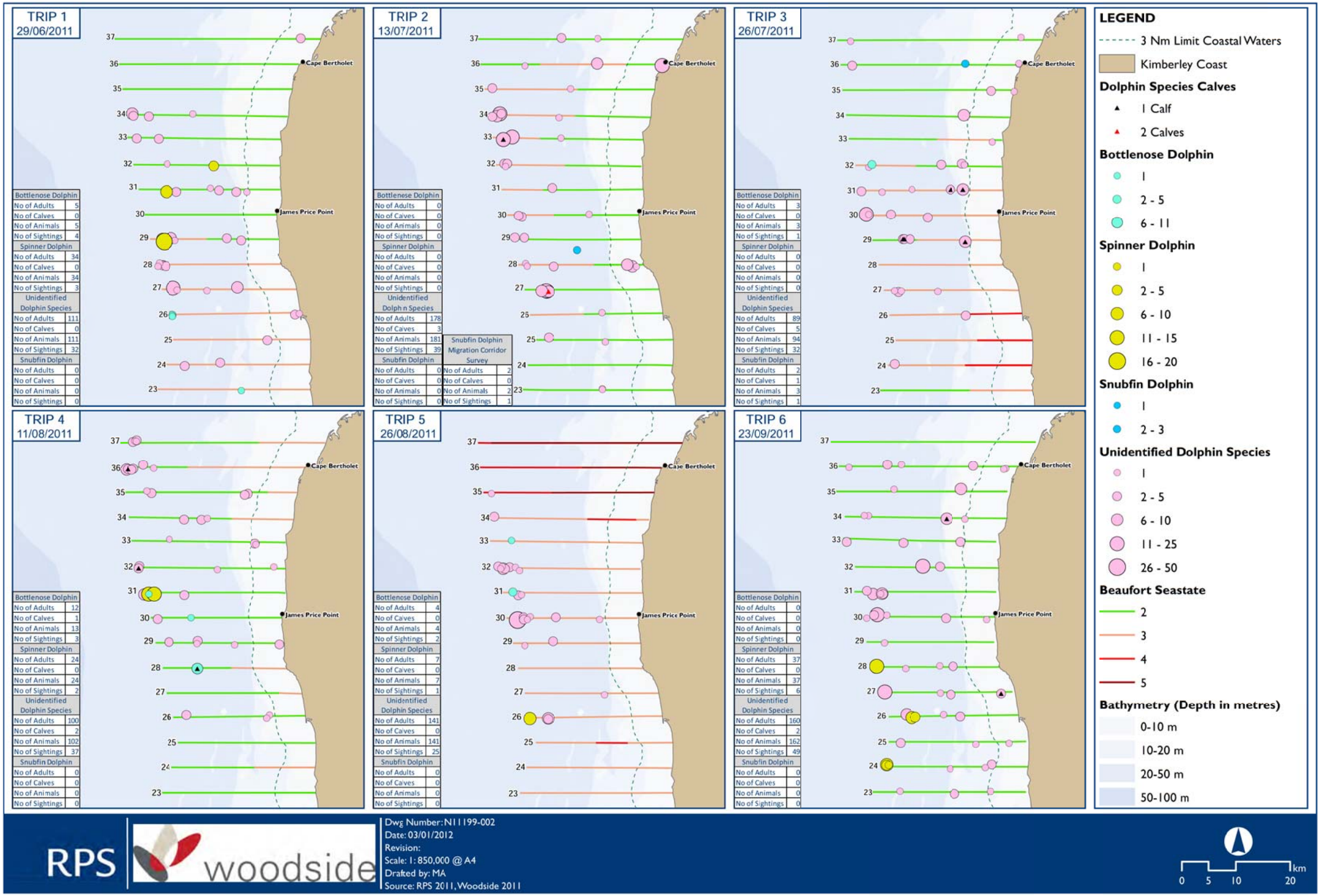

Figure 8: Distribution of Dolphins Recorded during the 2011 Marine Megafauna Survey

3.3.2 Dolphin Discussion

Five species of dolphin have been recorded during the entire Browse baseline survey program (2009–2011):

- Indo-Pacific bottlenose dolphins
- Indo-Pacific humpback dolphins (*Sousa chinensis*)
- Spinner dolphins
- Australian snubfin dolphins
- Killer whales (*Orcinus orca*).

It is also thought likely that common bottlenose dolphins also occur off the Dampier Peninsula. Only those that were recorded in 2011 are discussed in the following and draw upon results from the previous two years of baseline survey (but see RPS 2010b and 2011a).

3.3.2.1 Bottlenose Dolphins

Although the 2011 Marine Megafauna Survey flights were usually conducted in acceptable weather conditions, only a few bottlenose dolphins were confidently identified. These results were similar for the same transects sampled in 2009 during the Dugong Nearshore Surveys. None could be differentiated to either the common (*Tursiops truncatus*) or Indo-Pacific (*T. aduncus*) bottlenose dolphin.

In Australia, the known distribution of the common bottlenose dolphin is incomplete. They have been documented in offshore waters deeper than 30 m, but also in some coastal areas (Hale et al. 2000). In contrast, the Indo-Pacific bottlenose dolphin is known to be common throughout Western Australia (Bannister et al. 1996), often occurring in estuarine and coastal waters of northern Australia (Möller & Beheregaray 2001; Ross & Cockcroft 1990). Both species of bottlenose dolphins are known to occur in the Kimberley area (Ross 2006; RPS 2010b).

The 2009 aerial surveys (Humpback Whale Migration Corridor, Dugong and Reference Site surveys) identified that bottlenose dolphins were present throughout the survey areas between July and October, generally in water depths between 20 and 50 m (RPS 2010b). Additionally, bottlenose dolphins were the most commonly recorded small cetacean offshore of James Price Point and Pender Bay during the vessel surveys conducted between July and October, where there was more potential to establish species identification. In 2010 they were also frequently encountered across survey areas and once along the extended transects of the Humpback Whale Migration Corridor Survey approximately 120 km from shore (RPS 2011b). This taxon was also occasionally recorded in water depths between 200–500 m near Scott Reef in 2009 and 2010 (RPS 2011b).

In 2009, the group size ranged between one and 25 individuals and in 2010 between one and 23 individuals. Group size during the vessel surveys in 2009 for this species was between one and 10 individuals. Group size has therefore remained fairly constant and lies between one and 25 animals which is fairly typical for *Tursiops* species (Ross 2006).

A study conducted in association with a geotechnical survey in 2010 nearshore to James Price Point recorded Indo-Pacific bottlenose dolphins and their calves (n=50) but no common bottlenose dolphins (RPS 2011b). This may indicate that this species is more commonly found in the nearshore waters compared to the common bottlenose dolphin, and may account for most of the unidentified sightings close to shore during the aerial surveys. However, this study was conducted during August and September and may not reflect the dolphin assemblage throughout the year.

The data acquired across all baseline surveys, in particular broader scale 2009 and 2010 surveys, indicate that bottlenose dolphins are widely distributed along the west coast of the Dampier Peninsula. They are frequently recorded between the 3 NM state limit to the 50 m isobath, or around 60 km offshore. They can also occasionally be found further offshore (RPS 2010b). The presence of calves also suggests that they may be present in the survey area during all stages of their life cycle. The data acquired cannot provide any conclusive information on the differences between common or Indo-Pacific bottlenose dolphins. However, based on the sparse set of data acquired during the Geotechnical Survey and the known habits of these two species, there is likely to be a split between the distance from shore, with a greater likelihood of Indo-Pacific bottlenose dolphins being found closer to shore than common bottlenose dolphins.

Given the low number of records for this species, little can be summarised about changes in abundance or distribution through the survey period.

3.3.2.2 Spinner Dolphins

In Western Australia, spinner dolphins are known to occur as far south as Bunbury, with their range extending around the northern coasts of Australia to the east coast near the southern Queensland border (Bannister et al. 1996). Spinner dolphins are primarily pelagic and in some regions, they are known to occur over the continental shelf (Bannister et al. 1996). As with previous marine megafauna studies off James Price Point (RPS 2010b and 2011a), spinner dolphins were often found in waters >20 m deep during the 2011 survey. They are not known to be migratory (Secchi & Siciliano 1995) and are likely to be present within the survey area throughout the year.

Spinner dolphins were the most abundant of dolphin species recorded during the 2011 Marine Megafauna Survey. Sightings ranged from single individuals to groups of up to 20. It is also likely that some observations of unidentified dolphins may have been spinner dolphins, especially for those observations that included larger group sizes. It is also possible that spinner dolphins may be mistaken for certain fish species such as tuna, marlin and sailfish or vice versa from 900 feet given their size and slender build.

This species was the most commonly recorded dolphin off James Price Point during the 2009 vessel surveys, where the ability to identify dolphins to species would have been substantially improved over aerial survey from 900 ft. By comparison, few spinner dolphins were recorded during vessel surveys off Pender Bay in 2009, suggesting a limited distribution in the Kimberley, at least during the winter.

Spinner dolphins were also recorded regularly out to Scott Reef in both 2009 and 2010 where some of the largest groups were detected (RPS 2010b and 2011a). No spinner dolphins were recorded along the extended transects of the Humpback Whale Migration Corridor Survey in 2010, suggesting they may remain within a certain bathymetric range (<60–70 m) off the Dampier Peninsula and transit between the mainland and Scott Reef, rather than occur ubiquitously in the marine environment.

No spinner dolphins were recorded during the Marine Mammal Study associated with a geotechnical survey off James Price Point conducted in 2010 (RPS 2012b). The study was conducted within 1.5–2.5 km of the shore and therefore supports the conclusions that spinner dolphins are restricted to deeper water.

Spinner dolphin group sizes were low in 2011 compared to the 2009 and 2010 aerial surveys, where spinner dolphins were observed in groups of between 50 to 100 individual animals (RPS 2010b; RPS 2011a). Other studies have reported thousands of spinner dolphins in a single group (Perrin 2002).

Given the low number of records for this species, nothing can be summarised about changes in abundance or distribution throughout the winter.

3.3.2.3 Australian Snubfin Dolphins

The Australian snubfin dolphin is listed as Migratory under the EPBC Act and as Near Threatened by the IUCN (2010). The range of Australian snubfin dolphins extends from Papua New Guinea and along the north coast of Australia, where they have been reported between Broome in Western Australia and the Brisbane River in Queensland (Beasley et al. 2002; Parra et al. 2002).

Snubfin dolphins are found mostly within protected shallow water embayments and estuaries (Parra et al 2002), and have a preference for areas with seagrass beds in which they probably do most of their foraging (Parra 2006). Roebuck Bay is known as a key area for snubfin dolphins (Parra 2006) and this species was listed as Noteworthy Fauna in the Ramsar Wetland citation for the bay (as Irrawaddy dolphin [*O. brevirostris*]).

Snubfin dolphins were encountered near the vessel mooring area in Roebuck Bay near Broome when preparing for and transiting to the survey areas off James Price Point and Pender Bay in 2009. This gave the observers opportunity to identify this species but they were not subsequently detected in the survey area adjacent to James Price Point. The vessel survey was conducted in 20 X 20 NM boxes off James Price Point and Pender Bay and 1,033 km of transects were sampled over the course of 17 days in three blocks (end

July/early August, end August/early September and end September/early October). These findings were used to help determine the focus of the second year of baseline data collection. Given the absence of records for snubfin dolphin from the first year, the surveys in 2010 were not designed specifically for this species. However, the opportunity to acquire data for snubfin dolphins was taken by RPS (2012b) during a Marine Mammal Study conducted during a geotechnical survey within 1.5–2.5 km of the shore near James Price Point. Although the intensity of data collection was quite high during this study, the effort was limited in spatial scale. Whilst two other dolphin species and dugongs were recorded, no snubfin dolphins were detected. In the same year, Hodgson et al (2011) reported several records of snubfin off James Price Point during a vessel survey.

While it is known that snubfin dolphins forage in estuaries and embayments (Beasley et al. 2005), it is unclear if the snubfin dolphins recorded in 2010 and 2011 off the coast of the Dampier Peninsula were transiting the area or utilising these areas for foraging. Both observations of snubfin dolphins in this report were recorded in relatively shallow water (<15 m), but up to 10 km offshore, which is not considered to be typical foraging area for the species. However, one of the sightings was recorded off Cape Bertholet, which does comprise a protected area within an estuarine system. In 2009, snubfin dolphins were not recorded during either the aerial or vessel surveys but were observed occasionally within Roebuck Bay. In 2010, a group comprising six dolphins was spotted from the air approximately 1 km from Willie Creek in water approximately 5 m deep (RPS 2011a). The results from the extensive marine megafauna survey efforts from 2009 and 2010 suggest snubfin dolphins occur only infrequently in the survey area and within 15 km of the coast.

This finding was again supported in 2011 with only two sightings of snubfin dolphins comprising of five animals in total, both with low observer confidence in the identification to species level. It is concluded that snubfin dolphins occur in the waters off James Price Point on rare occasions during the winter. It is acknowledged that little is known about their presence in this area during the summer wet season.

Given the paucity of data for this species, little can be summarised about changes in abundance or distribution through the survey period.

3.4 Vessels

3.4.1 Results

A total of 101 vessels were recorded during the 2011 Marine Megafauna Survey (Table 8) with the majority of vessels spotted in June and July 2011. A range of vessels were recorded during the flights including commercial vessels (charters, fishing, pearling, supply boats and survey boats) and recreational vessels (motorboats and sailboats). Half of the vessels were motorboats. Recreational vessels were recorded during every flight.

Pearling vessels were also regularly spotted throughout the year adjacent to James Price Point and associated with the pearl farm at that location.

The distribution of vessels was mostly south of James Price Point with little activity recorded north of transect 30. Vessels were evenly distributed with the exception of pearling vessels that were recorded 4–8 km off Quondong Point (Figure 9). A high density of recreational vessels was also recorded 21 km from the shore on Transect 29 (Figure 9).

Comparisons in vessel data between years should be undertaken with caution as they were not given a high priority during the Megafauna Survey and are likely to be under-sampled because observers focussed within the sampling Strip Width. More vessels were recorded in 2011 with most of the vessels in both years comprising recreational boats, including motorboats and sailboats (Table 8; Table 9; Figure 10). Pearling vessels were also prominent in both years within the survey area. Apart from the pearling activities, which are stationary farms off Quondong Point, no obvious spatial patterns were detected.

Although vessels were not a priority target during the surveys, the data provides an indicative baseline measure of boating activity in the area. The majority of vessels recorded in 2009 and 2011 surveys were recreational motorboats, which were recorded south of James Price Point. This distribution was also reported in the previous Marine Megafauna and Humpback Whale Migration Corridor Surveys (RPS 2010b; RPS 2011a; RPS 2011b).

Table 8: Number of vessels recorded during the 2011 Marine Megafauna Survey

Trip date	Commercial Vessels					Recreational Vessels		Unidentified	Total
	Charters	Fishing	Pearling	Supply	Survey	Motorboat	Sailboat		
29/06/2011	1	2	3	1	0	15	3	1	26
13/07/2011	1	2	8	0	0	7	0	0	18
26/07/2011	0	0	6	0	0	17	0	2	25
11/08/2011	1	1	0	0	5	6	0	0	13
26/08/2011	0	0	5	1	3	1	0	2	12
23/09/2011	0	0	0	0	2	5	0	0	7
Grand Total	**3**	**5**	**22**	**2**	**10**	**51**	**3**	**5**	**101**

Table 9: Number of Vessels Recorded during the 2009 Marine Megafauna Survey

Trip date	Commercial Vessels					Recreational Vessels		Unidentified	Total
	Charters	Fishing	Pearling	Supply	Survey	Motorboat	Sailboat		
12/07/2009	0	0	0	0	0	1	0	1	2
18/07/2009	2	1	2	0	0	26	1	5	37
12/09/2009	0	0	0	0	0	0	0	5	5
17/09/2009	0	4	9	0	0	0	0	3	16
Grand Total	**2**	**5**	**11**	**0**	**0**	**27**	**1**	**14**	**56**

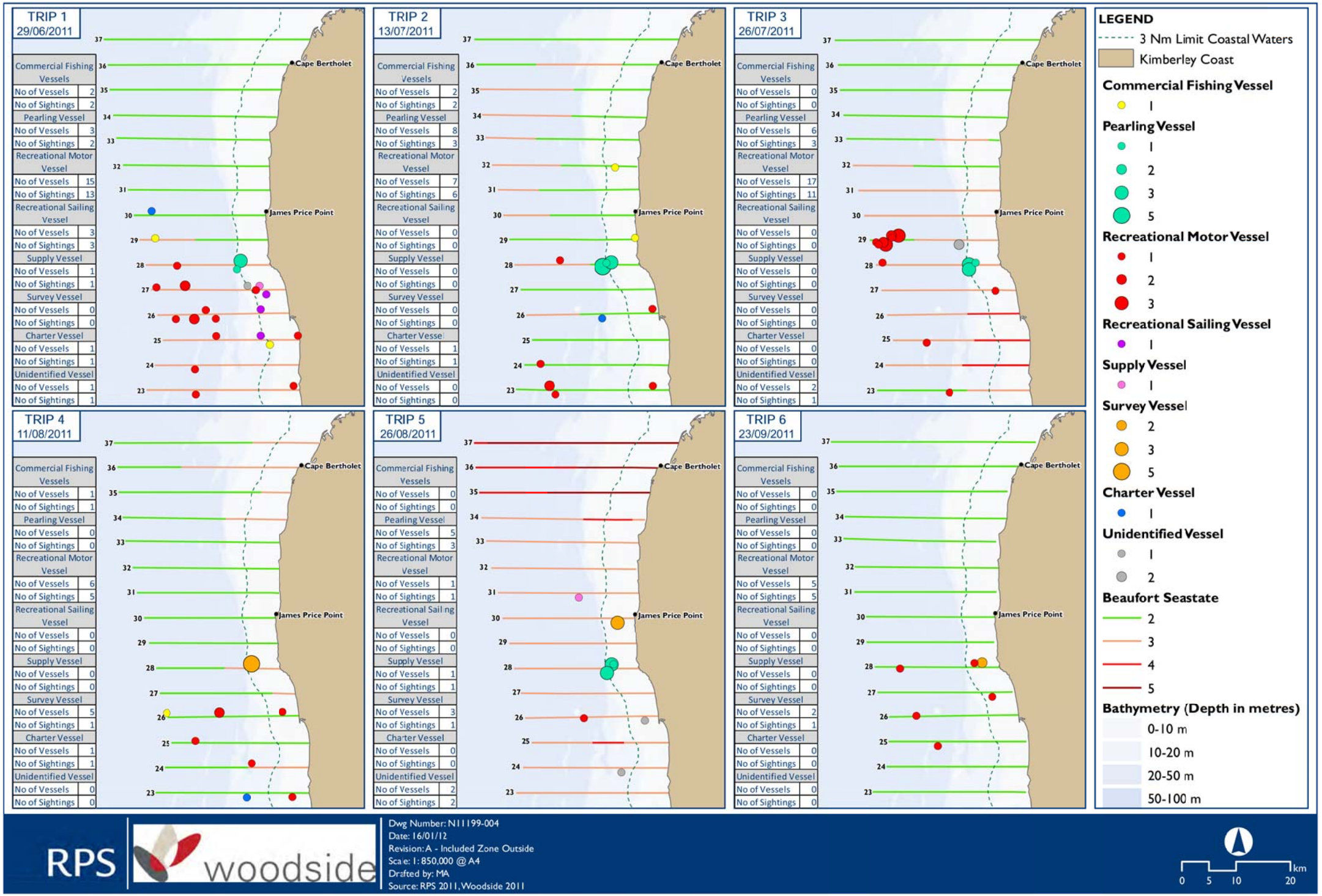

Figure 9: Distribution of Vessels Types Recorded during the 2011 Marine Megafauna Survey

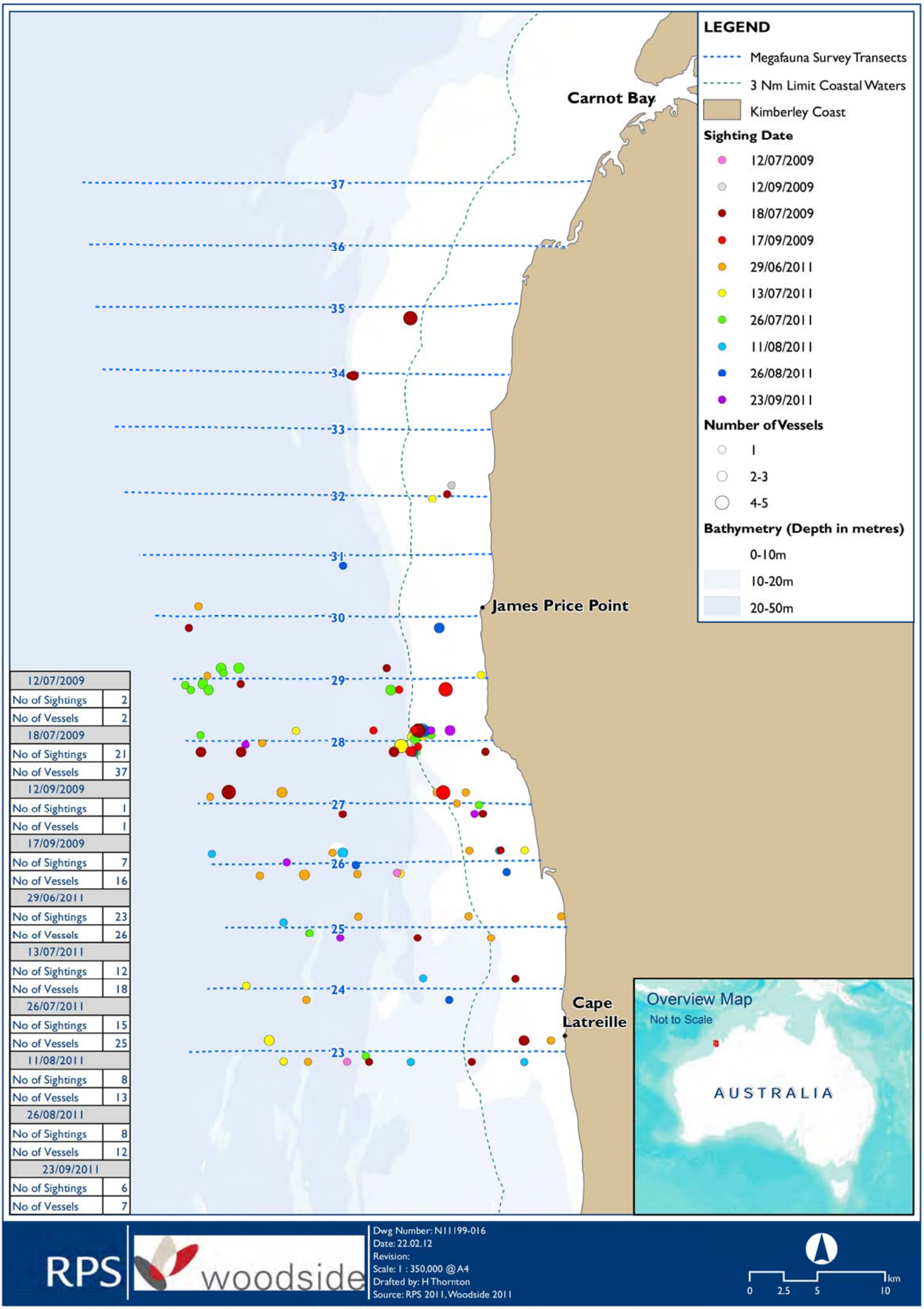

Figure 10: Distribution of Vessels in the 2009 and 2011 Marine Megafauna Surveys

4.0 CONCLUSIONS

This report presented the distribution of dugongs, dolphins and vessels between June and September 2011. It also compares these data with information gathered from the 2009 and 2010 Megafauna Surveys. As with previous years, the survey area contained all targeted megafauna groups including dugongs, snubfin dolphins, spinner dolphins and bottlenose species. Turtle data acquired at the same time have been reported in RPS (2012a) and a separate survey was conducted for humpback whales and reported in RPS (2012c). Data acquired on sea snakes and fish aggregations were collected but have not been reported in 2011. A summary of survey effort related to the 2009 and 2011 Marine Megafauna Surveys (Transects 23–37) is presented in Table 10.

Table 10: Summary Survey Effort Data for the 2009 and 2011 Marine Megafauna Surveys

	2009	2011
Survey Period	Mid-July and mid-September	28 June - 21 Sept
Number of Flights	2 (July and September)	6 (once per fortnight)
Total survey effort for transects 23-37	3.9h Mean: 1.9h	11.5h Mean: 1.9h
Total length of transects 23-37 (Mean length sampled per flight)	831 km Mean: 416 km	2,533 km Mean: 422 km

Survey conditions were generally good for most flights of the 2011 Marine Megafauna Survey and were generally consistent with conditions encountered during the surveys in 2009. In this report, data from other surveys conducted during the Browse MMFS were also drawn upon to provide a wider set of information for the three years of baseline study.

The megafauna dataset did not identify any "hot spots", in which a single location consistently supports a relatively large number of animals from a range of taxa.

The baseline survey results provide a robust and quantitative assessment for the spatial and temporal distribution of dugongs along the west coast of the Dampier Peninsula. Survey data for dolphins as a single taxonomic group are robust. Specific species that have been reliably identified along the Dampier Peninsula include the snubfin, Indo-Pacific bottlenose, Indo-Pacific humpback, killer whale and spinner dolphins. It is also likely that common bottlenose dolphins also occur in this area. However, the survey data does not enable detailed examination of distribution or abundance of individual species.

4.1 Dugong Conclusions

Dugongs were found to occur all along the west coast of the Dampier Peninsula in 2009 and 2011 and were also commonly recorded during surveys conducted primarily for humpback whales in 2009 and 2010. Information from other sources (Prince 2001, Marsh et al. 2002, Gales et al. 2004, Hodgson 2007), shows that dugong distribution and abundance in this area is affected by seagrass growth and biomass (stem and rhizomatous) across the region as well as water temperature in the wider region. The conditions in which dugong data are collected can affect sampling proficiency and may add error to the picture gained about dugong distribution and temporal patterns. Key findings for dugongs from the three years of baseline survey are provided in Table 11 and below:

- Dugongs are likely to be present off the west coast of the Dampier Peninsula throughout the year.
- Dugongs were most commonly recorded within the 3 NM state waters boundary in March 2009 and between July and September 2011 though this was not shown to be statistically significant.
- Their distribution from shore can vary and in July and September 2009 were more widely distributed out to the 20 m isobath.
- In 2011, 80% of dugongs were recorded between 2.63 (95% CI: 1.11– 4.15 km) and 8.3 km (95% CI: 6.57–10.02 km) from the shore.
- Occasionally, dugongs were recorded as much as 50 km from the mainland.
- Dugongs were not recorded around Scott Reef.

Table 11: Summary Data for Dugongs acquired during the 2009 and 2011 Marine Megafauna Surveys

	2009 (mid-July and mid-Sept)	2011 (28 June to 21 Sept)
Median and mean group size and range	Median: 1 (mean: 1.7, range: 1-10)	Median: 1 (mean: 1.4, range: 1-4)
Date of greatest number of adult dugong sightings	n/a^	23 September
Date of greatest number of dugong calf sightings	n/a^	23 September
Dugong adult median distance offshore (individuals) (km)	7.7	4.3
Dugong calf median distance offshore (km)	9.6*	4.8

	2009 (mid-July and mid-Sept)	2011 (28 June to 21 Sept)
Dugong range offshore of 80% individuals sampled (km)	6.6 (95% CI: 3.2-10.1) – 13.9 (95% CI: 9.7-18.1)	2.6 (95% CI: 1.1–4.2) - 8.3 (95% CI: 6.6-10.0)
Closest distance to shore - adult (km)	0.69	0.13
Closest distance to shore – calves (km)	7	0.88
Dugong population estimate for whole west coast of Dampier Peninsula	July 1,774 (95% CI: 1,351-2,195) and September, 1,708 (95% CI: 1,188 – 2,205)	n/a

* Only two calf sightings from 2009.

^ Many more transects were flown in 2009 and transects 23-37 were sampled over two days and thus cannot be compared with flights in 2011 when all transects were flown on the one day.

4.2 Dolphin Conclusions

Dolphins as a group were found ubiquitously throughout all survey areas along the Dampier Peninsula and out to Scott Reef. Five taxa were identified:

- spinner dolphin
- Indo-Pacific humpback dolphin
- snubfin dolphin
- bottlenose dolphins (*Tursiops* spp)
- killer whale.

It is likely that two species of bottlenose occurred in the area (*T. truncatus* and *T. aduncus*), of which *T. aduncus* is more likely to occur closer to shore than *T. truncatus*. Bottlenose dolphins were more frequently recorded than other species, but spinner dolphins were more numerous in the area by virtue of their larger group sizes. Indo-Pacific humpback dolphins were occasionally recorded whereas snubfin dolphins were only recorded twice in any one year. The Australian snubfin dolphin was recorded in shallower waters often <10 km adjacent to estuaries along the western Dampier Peninsula. Killer whales were only recorded three times during the three years of survey, once from each of the aerial surveys in 2009 and 2010, and once from the vessel focal follow studies undertaken in 2009. It is likely that this species travels widely in the region but in small isolated family groups.

Summary data for dolphins are provided in Table 12 details of which are drawn from this report and RPS (2010b and 2011a).

Table 12: Summary Data for Dolphins acquired during the 2009 and 2011 Aerial Marine Megafauna Surveys

	2009	2011
Unidentified Dolphins		
Greatest number of adults recorded	81	178
Date of greatest number of adults dolphin sightings	September	13 July
Greatest number of calves recorded	1	5
Date of greatest number of dolphin calf sightings	July	26 July
Median and mean group size and range	Median: 2.5 Mean: 4.1, Range: 1-20	Median: 2 Mean: 3.7, Range: 1-50
Closest distance to shore - adult (km)	0.08	0.004
Closest distance to shore – calves (km)	22.4 (n=1)	2.6
Bottlenose Dolphins (*T. truncatus and T. aduncus*)		
Greatest number of adults recorded	1	12
Date of greatest number of adults dolphin sightings	18 July & 12 Sept	11 August
Greatest number of calves recorded	n/a	1
Date of greatest number of dolphin calf sightings	n/a	11 August
Median and mean group size and range	1	Median: 1 Mean: 2.5, Range: 1-11
Closest distance to shore - adult (km)	15	12.6
Closest distance to shore – calves (km)	n/a	16
Spinner Dolphins^		
Greatest number of adults recorded	n/a	37
Date of greatest number of adults dolphin sightings	n/a	23 September
Greatest number of calves recorded	n/a	n/a
Date of greatest number of dolphin calf sightings	n/a	n/a
Median and mean group size and range	n/a	Median: 8.5 Mean: 8.5, Range: 1-20
Closest distance to shore - adult (km)	n/a	12.2
Closest distance to shore – calves (km)	n/a	n/a

^ No spinner dolphins were recorded along transects 23 – 37 in 2009 during the Aerial Nearshore Survey (from a much wide series of transects). As these were the only transects sampled in 2011, to report data from the other transects sampled in 2009 would be misleading.

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