A community survey of humpback whales, *Megaptera novaeangliae*, near the site of the proposed James Price Point Browse Liquefied Natural Gas precinct

Final Report - March 2013

Prepared for the Goolarabooloo and Broome Community No Gas Campaign

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Executive Summary

- The Western Australian Environmental Protection Authority (EPA) recently gave the Department of State Development (DSD) and Woodside Energy Ltd (WEL) environmental approval to develop an onshore gas processing facility, the **Browse Liquefied Natural Gas (BLNG) Precinct**, at James Price Point (JPP) on the Kimberley coast. **RPS Consultants** were engaged by the proponents to survey **humpback whales** (*Megaptera novaeangliae*) at the site, and their recommendations were used in the strategic assessment process.

- Due to community concerns over the rigour of the proponents' surveys, a **land-based survey** was initiated with Traditional Owners, the Goolarabooloo, and the Broome Community No Gas Campaign, to investigate humpback whale **numbers**, **behaviour** and **habitat use** of the JPP region for comparative purposes. The survey was carried out for a four hour period each day, from 1st July-30th September 2012.

- The land-based survey recorded **3343** individual humpback whales, including **214** cow-calf pairs. Taking a conservative approach and removing potential re-sightings of pods, **2669** individual whales, including **172** cow-calf pairs were recorded.

- Assuming that the **migration rate** observed during the four hour survey period was **constant** over a full 24 hour cycle, our results suggest that **12, 108 - 15, 876** individual whales passed within 8 km of the JPP shoreline over the entire 2012 migration season.

- Both the conservative number of 2669 whales and the extrapolated maximum of 15, 876 whales greatly exceeds the **1000 whales that RPS estimated** would pass within 8 km of the proposed development in 2012.

- This **disparity** is either due to **large inter-annual variation** in whale numbers using the nearshore area at JPP between our survey year (2012) and that of RPS (2010), or a **gross underestimation** of whale numbers by the RPS Consultants. Several possible methodological factors contributing to these different results are discussed.

- Timing of the **peak northern migration** for adult whales was consistent with previous studies, occurring in mid-late July and **coincided with a peak of cow-calf pairs**. This suggests that some **newborn whales** are born south of the observation platforms and **use the JPP** area.

- Whales engaged in resting, milling, playing and slow swimming **behaviours** close to shore, including critically important nursing interactions between cows and calves. Observations of **newborn calves** also suggest that some **calving** may occur in the JPP region and south of the JPP region. These observations are in contrast to the Strategic Assessment Report (SAR) and the WA EPA's assessment of the area being unattractive to whales as a resting place. **Vessels**, in particular large vessels, were also found to **influence** whale behaviour.

- The proposed BLNG precinct is likely to cause **significant habitat degradation** and **behavioural disturbance** to humpback whales, through acoustic pollution, possible ship strikes, changing water quality and turbidity from ongoing dredging and 2,700 annual shipping movements.

- This, in turn, may cause **exclusion of whales** from appropriate habitat, **reduced reproductive success** and even **mortality** events. There is, therefore potential for negative impacts at a **population level**.

- In light of this potential population risk, the science that has informed the impact assessment is not comprehensive, adequate or representative enough to demonstrate with **certainty** that this development will not lead to **population level impacts** on humpback whales.

Recommendations

1. The results of this study indicate that the nearshore waters around JPP are frequented by a significant number of humpback whales and represent a resting and nursing area for the population. These results are in contrast to the science informing the impact assessment so far. Due to this uncertainty, the **precautionary principle** should be applied and **more extensive and thorough research into the use of JPP by humpback whales needs to occur before the potential impacts of the BLNG development can be adequately assessed.**

2. This study demonstrates that the proponents have **not adequately assessed** the potential for **population impacts** of the BLNG development on humpback whales. In approving the development, the EPA has not adhered to its own legal mandates. We strongly urge the Commonwealth Government to meet their obligation under the *Environmental Protection and Biodiversity Conservation Act* (1999).

3. Should the proponents consider alternative locations in this **environmentally sensitive region** of the coast, further independent humpback whale surveys should be commissioned with an emphasis on the **rigour of the surveys**. These studies should **thoroughly assess** the potential **impacts of industrial activity** and provide **ecologically sustainable mitigation** strategies that strongly adhere to the **relevant legislation.**

Introduction

Project Background

The Western Australian Environmental Protection Authority (EPA) recently gave the Department of State Development (DSD) environmental approval to develop a Browse Liquefied Natural Gas (BLNG) precinct at Walmadan or James Price Point (JPP), which is located approximately 50 km north of Broome on the Dampier Peninsula, Western Australia (WA). The BLNG precinct will be primarily developed and operated by Woodside Energy Ltd (WEL) and joint venture partners Shell, Mitsui-Mitsubishi, BP and PetroChina. The purpose of the BLNG precinct is to provide a multi-user hub for processing oil and gas from the Browse Basin. The development will include three separate LNG refineries (DSD, 2010), an industrial port with a 7 km dredged shipping channel and a breakwater which extends several kilometres out to sea (DSD, 2010), 34 million m^3 of initial sea bed dredging (DSD, 2010) and up to 2,700 shipping movements per year. Ongoing dredging will be required for the life of the industrial port (DSD, 2010).

The JPP region has great social, cultural and ecological value. It contains numerous Indigenous heritage sites, dinosaur track-ways, endangered monsoon vine thicket and various threatened species. Consequently, as part of the strategic assessment process, the proponents were required to commission fauna studies which assessed the value of the area and the likely impact of the proposed development. RPS consultants were engaged by the proponents to carry out humpback whale surveys at the site. The consultants concluded that during the 2012 migration season, approximately 5% of the total Breeding Stock D population, or an estimated 1000 whales would pass within 8 km of the proposed development at JPP (RPS, 2010). The consultants also concluded that the JPP region was less important than other areas as a resting place for humpback whales (RPS, 2010). These findings were included in the strategic assessment report (SAR) compiled by the DSD and provided to the EPA. In July 2012, the EPA advised the WA Minister for the Environment that the development should proceed, partly based on the advice of the SAR (EPA, 2012). The EPA (2012) concluded that increased shipping movements and industrialisation of the WA coast in the last 50 years had not significantly affected the Breeding Stock D population, as it has coincided with an exponential increase in whale numbers at a rate of 10% per annum. The traditional custodians of the JPP region, the Goolarabooloo, and the Broome Community No Gas Campaign were concerned that the methods that informed the RPS study (2010) lacked scientific rigour and that proceeding with the development could have a detrimental impact on humpback whales at a population level. Consequently, a marine scientist-led community survey was initiated in collaboration with these communities to explore the numbers, behaviour and habitat use of the JPP area by the Breeding Stock D population, for comparative purposes. This 2012 survey built upon a preliminary study conducted in 2011 (Saulnier, 2012). The survey was largely unfunded, with all participants contributing their time voluntarily.

Humpback whales (Megaptera novaeangliae)

Humpback whales (*Megaptera novaeangliae*) are listed as both a vulnerable and migratory species under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) and as rare or likely to become extinct under the WA *Wildlife Conservation Act 1950* (*WC Act*). It has long been recognised that the Breeding Stock D population of humpback whales, migrate annually along the west coast of Australia, from their feeding grounds in the Antarctic to their tropical breeding grounds in the Kimberley (Jenner *et al.,* 2001). This migration is widely accepted to take place between June and November each year (Jenner *et al.,* 2001). However, it is only recently that scientists have begun to explore the potential size of the population and the areas which are used for calving and resting (Bannister and Hedley, 2001; Double *et al.,* 2012). While the Breeding Stock D population has been increasing at a rate of 10% per annum, it has not yet fully recovered from industrial whaling (Jenner and Jenner, 1994; Jenner and Jenner, 1996; Bannister and Hedley, 2001). Current abundance estimates show that the Breeding Stock D population lies between 26,000 – 34,000 (Hedley *et al.,* 2009; Kent *et al.*, 2012). Further, the Dampier Peninsula is considered to be significant for the Breeding Stock D population. The National Humpback Whale Recovery Plan 2005 – 2010 (NHWRP; DEH, 2005), lists the area from Broome north to Camden Sound as a calving area. Studies conducted in the region support this, suggesting that JPP and the broader Dampier Peninsula are used for calving, breeding and resting (Costin and Sandes, 2009; 2010; 2011; Blake *et al.,* 2011; Saulnier, 2012).

Aims

1) To collect data on the relative nearshore abundance of the humpback whale population, Breeding Stock D, in the JPP region, the site of WEL's proposed BLNG precinct.

2) To gather data on the different whale behaviours and habitat use of the JPP region for whale activities such as resting, nursing, breeding, calving, playing and feeding.

3) To characterise the impacts that the BLNG development will have on the Breeding Stock D population.

Methods

Survey Site

This land-based humpback whale survey was conducted from Murdudun or Mina's Block, which is located at 17° 33.607 S and 122° 8.822 E on the south-western side of the Dampier Peninsula, approximately 50 km north of Broome, WA, and approximately 8 km south of JPP, WA (Figure 1).

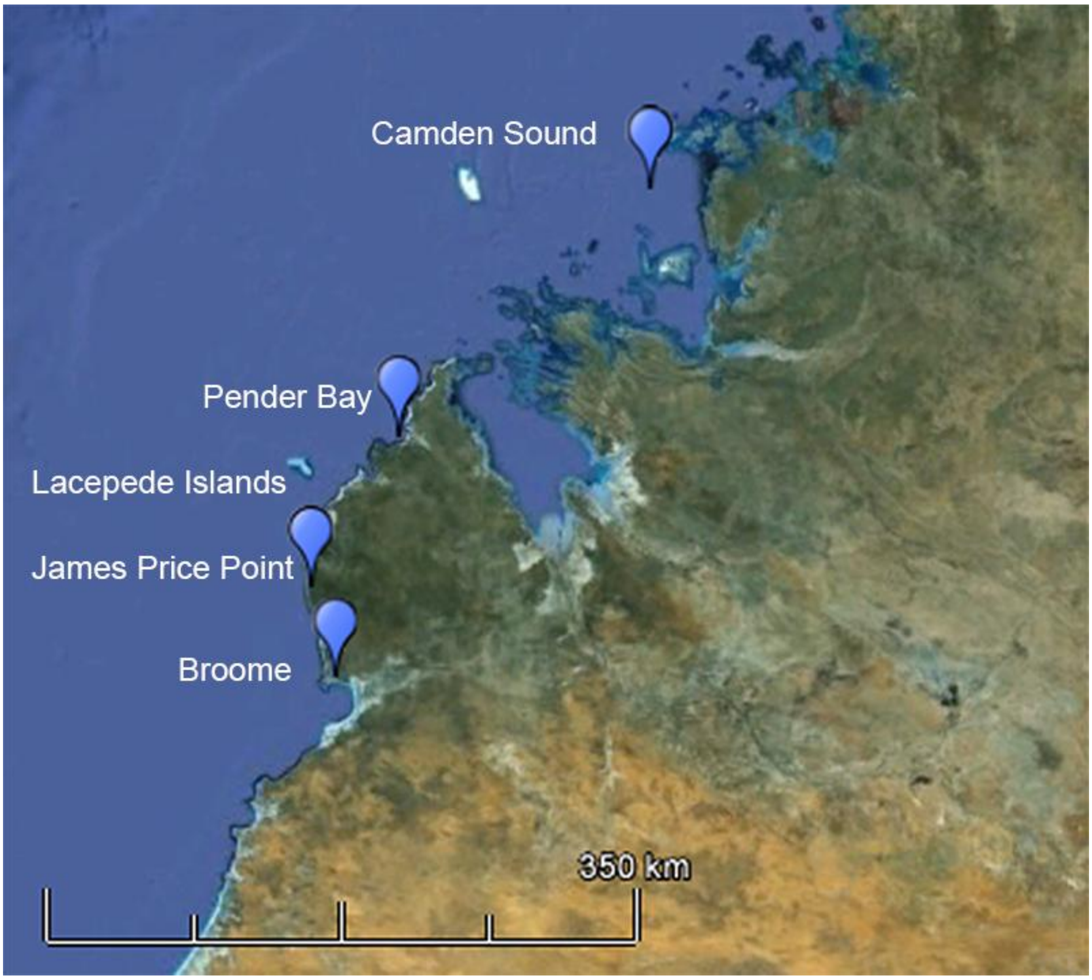

Figure 1: A map of the Kimberley coastline. Image source: Google Earth

The research site was selected as it is ideally situated to record the inshore migration of the Breeding Stock D population, and for its proximity to JPP (Figure 2), the site of WEL's proposed BLNG development.

The survey was conducted from two observation platforms located on a cliff top, approximately 10 m above sea level. Both platforms faced a west south westerly (WSW) direction and offered a 200˚ field of view from the observation point (from 150˚ south to 350˚ north). The survey area was divided into two quadrants, north and south, that corresponded with the observation platforms (Figure 2). The border of these two quadrants was delineated by a white buoy ('the due west marker'), which was located at 270˚ from the observation platforms and 4.2 km from the shoreline (Figure 3).

Given the height of the observation platforms (~ 10 m above sea level), the estimated maximum distance survey participants could see was approximately 11.3 km from shore (calculated using equation $d=3.57\sqrt{h}$). The outer limits of the survey area varied daily due to atmospheric refraction and other factors, such as fog and smoke that influenced visibility. A distance test, conducted by a boat travelling due west from the platform, established that the maximum distance survey participants could see from the shoreline extended to approximately 10.5 km with binoculars and 8 km with the naked-eye. The 6 m long boat was an appropriate proxy for testing the distance at which a whale could be detected if exhibiting subtle behaviours. However, surface active behaviours, such as breaching, which create large splashes of white water, may have been detected much further away and up to the estimated maximum distance of 11.3 km.

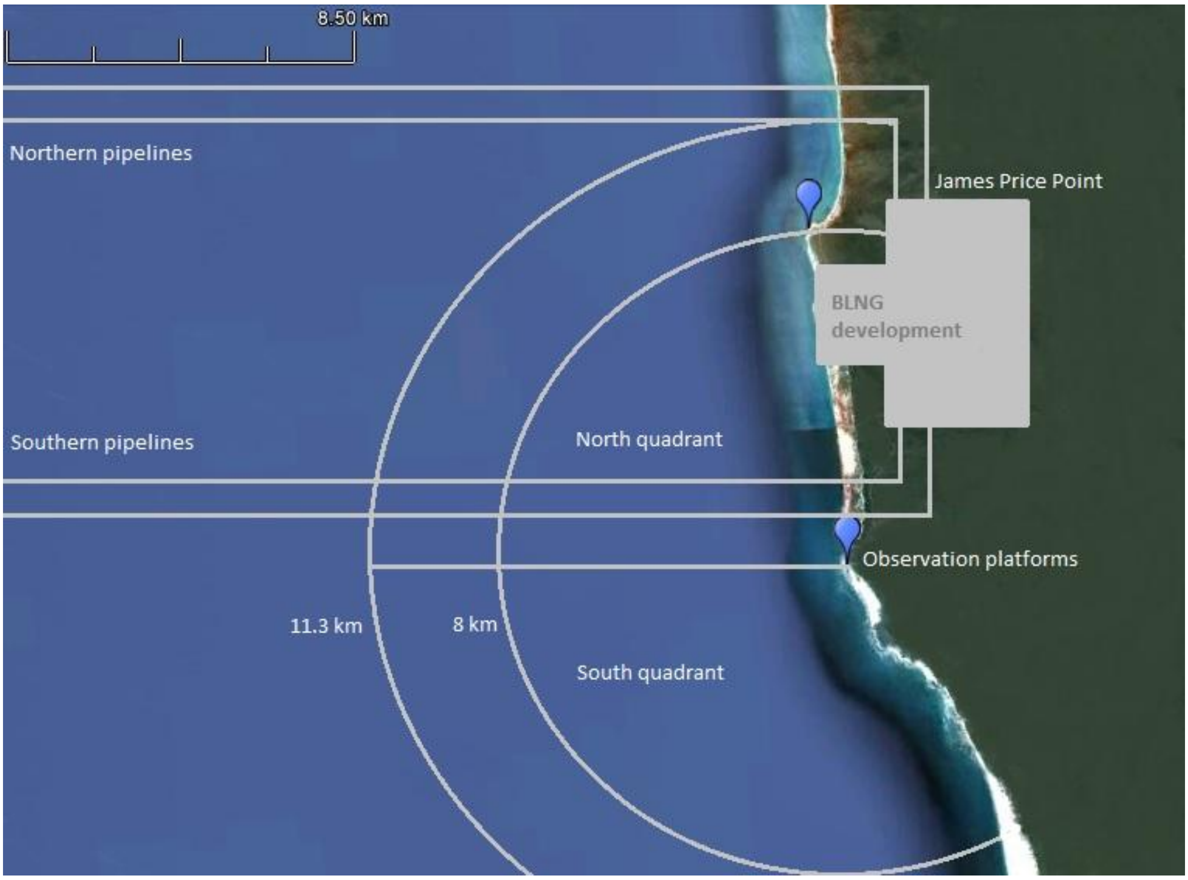

Figure 2: A map of the survey area and the observation platforms in relation to JPP and the BLNG development. The survey area covers 223 km^2 of the JPP region. Image source: Google Earth.

A pearl farm, run by Clipper Pearls, extended through the survey area. The eastern and western boundaries of the pearl farm ran parallel to shore at approximately 4.5 km and 6.5 - 7.5 km (Figure 3). There were a series of black and yellow radar markers located along these boundaries, at distances ranging from 4.2 - 9.7 km from the observation platforms (Figure 3). These markers were easily seen with binoculars and were used to assist with offshore distance estimations. The correct GPS location of these markers was obtained via radar and ground-truthed by boat. It could therefore be concluded that any whales sighted within the eastern boundary of the pearl farm were sighted within 5 km of the shoreline.

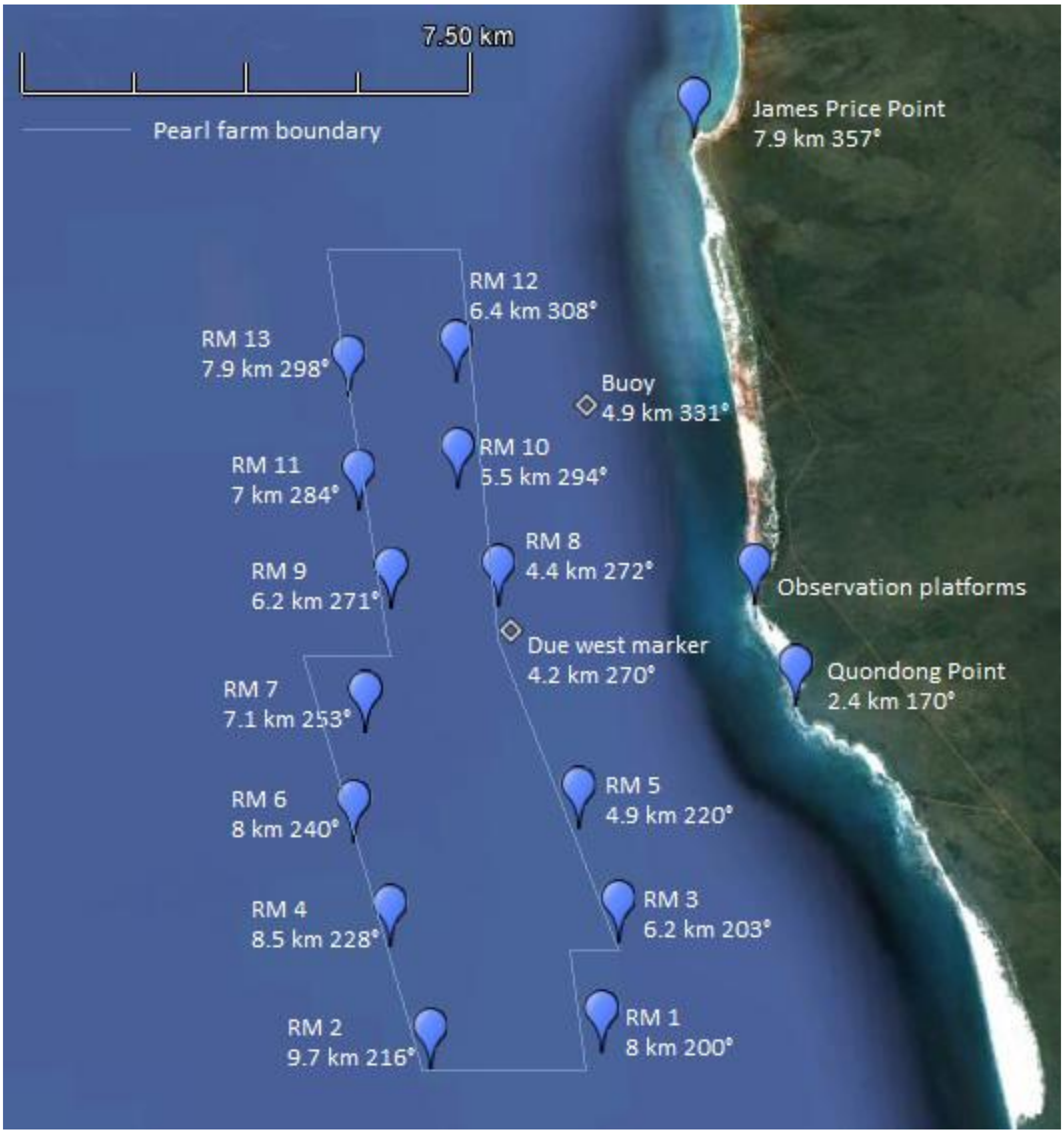

Figure 3: The reference points along the boundary of the pearl farm which were used by distance observers to make an estimate and to calibrate their distance estimates before each survey period. Listed for each reference point is the distance and compass bearing from the observation platforms. Note the 'due west marker' which delineated the boundary between the north and south quadrants. Image Source: Google Earth.

Survey Technique

The survey was conducted over a three month period, from 1st July – 30th September 2012. This period was chosen as it coincides with the population's peak northern migration along the coast of the Dampier Peninsula. To ensure consistency and precision in the recording of data, a lead marine scientist, who had experience in land-based humpback whale surveys, was present at all times during the survey period. All survey participants were trained in the survey methods by the lead marine scientist prior to participating in the survey, and were required to shadow a trained participant until they had a solid understanding of the survey methods.

Surveying was carried out continuously for a four hour period each day, from 0800 to 1200, given suitable weather conditions. The survey was not conducted if the sea conditions exceeded a 5 on the Beaufort scale or if other weather conditions, such as fog, inhibited visibility.

Figure 4: The observation platforms on the cliff top at Murdudun.

The survey area was divided into two quadrants corresponding with the observation platforms. South quadrant extended from 150˚ to 270˚, and north quadrant extended from 270˚ to 350˚ (Figure 2). At least six survey participants were positioned on each observation platform for the four hour survey period. Each survey participant had a delineated role as outlined in Table 1.

Table 1: The roles and methods of the six survey participants from each quadrant.

Participant	Role	Method
1. Primary observer	Sight whales and estimate distance from shore	Scanned the quadrant with a pair of binoculars (Bushnell Marine Series 7 x 50 mm) containing an inbuilt compass. Provided a compass bearing and estimated distance from shore of a sighted pod from a fixed home reference point.
2+3. Secondary observers	Focal follows	Carried out focal follows on specific pods. Recorded in detail location and behaviour using binoculars with an inbuilt compass.
4. Scanner	Continuously scan quadrant	Scanned quadrant with the naked-eye to guide other observers to pods sighted and to keep track of whales present in each quadrant.
5. Scribe	Record data	Recorded sightings and behaviour on data sheets.
6. 'Navionics' ™	Map whales sighted	Plotted the position of each sighting on an Apple Ipad ™ application, 'Navionics' ™, a charting program that produces a map of the area being surveyed.

When a pod or individual whale was sighted, the distance observer used the binoculars to obtain a compass bearing, and the pearl farm reference markers to make a distance estimate (Figure 3). To minimise inaccuracy, only six people made distance estimates over the three month survey period. Prior to the survey each morning, these observers familiarised themselves with the pearl farm reference markers (Figure 3) to calibrate their distance estimates. Each of the six distance observers also underwent a distance accuracy test.

Data sheets were used to record sightings. Each pod or individual was assigned a separate data sheet and distinctions were made between adults and cow-calf pairs. Adults were defined as bulls, cows without calves and juveniles. For each sighting, survey participants recorded the number of adults and cow-calf pairs, time, estimated distance, compass bearing, latitude, longitude, tide and behaviour. The lead marine scientist ensured that all survey participants were confident in identifying and recording whale behaviour, including, blowing, surface travelling, surface active behaviours (such as breaching and lobtailing), spy hopping, resting behaviour, play behaviour and potential breeding behaviours (such as bull running). To maximise consistency, the data collected was entered into excel spreadsheets by the lead marine scientist at the end of each survey period.

Each day, survey participants recorded the number of vessels present in the survey area (excluding pearl farm boats, which were recorded as either present or absent). Participants recorded the behavioural responses of whales to the presence of vessels. Sightings of other marine mammals, such as dugongs, were also recorded each day.

Focal follows

Focal follows were used to collect data about the habitat use of the JPP area and to limit the possibility of re-counting whales within the four hour survey period. A focal follow involved a single observer continuously tracking a pod or individual until it left the survey area. Focal follows were easily conducted when whales were visible on the surface, for example, when they were surface travelling, resting, or displaying surface active behaviours (such as breaching or lobtailing). Pods were also tracked by identifying the number and relative size of individuals within the group and their projected trajectory if they were to go under the surface. This allowed for identification and tracking of the same pod if they were to resurface. This was best achieved when whales moved through the survey area in a migratory fashion, or remained in one location. It was difficult to track whales when they displayed milling behaviour or stayed under the surface for an extended period of time. If a pod or individual were not re-sighted or reliably followed for a time period greater than 30 minutes, the focal follow was stopped.

Approximately every 15 minutes, observers re-recorded the time, compass bearing, distance to whale, latitude and longitude. The behaviour of each tracked pod was continuously recorded during each 15 minute interval. There was good communication between the observation platforms to ensure that whales passing between the two quadrants were correctly identified, recorded and followed.

If it was impossible to track all pods or individuals, priority was given to cow-calf pairs and whales within the eastern boundary of the pearl farm (approximately 4.5 km from the shoreline). Any pod believed to be a cow-calf pair was not marked as such until a positive identification was given by the lead marine scientist, or by a definite sighting, for example, a cow and calf simultaneously surfacing or breaching.

Potential Double Counting

Whales that could not be tracked due to distance or behaviour were still recorded on the data sheets. Without the vigilance of a focal follow, there was the potential for un-tracked whales to be recorded multiple times. If it was certain that a pod or individual whale had not been previously recorded (for example, at the start of the four hour survey period), it was counted as a new pod. However, if there was potential that a pod or individual had already been recorded, it was counted as a new pod that was possibly pre-recorded. For example, if a whale breached at 10 km 270° and 30 minutes later a whale surfaced at 9.5 km 280°, it was difficult to tell whether it was a new pod or the same pod. In this instance, the second observation would have been recorded as a new pod that was possibly pre-recorded.

In all cases, a conservative approach was taken to prevent double counting of whales by identifying on the data sheets those pods which had possibly already been sighted and recorded. These possibly pre-recorded pods were included in the overall total to create a maximum estimate of whales sighted, whereas they were excluded from the overall total to create a minimum estimate of whales sighted.

Distance Accuracy Tests

Distance accuracy tests were used to ascertain the error of distance estimate for each of the six distance observers. The tests utilised a 6 m long boat as a proxy for a whale. The boat stopped at 18 random locations within the survey area (ten within 4.5 km of the shoreline and eight beyond 4.5 km of the shoreline). The GPS point was taken at each of these locations on a Garmin Etrex 10. The distance observers, who were situated on the observation platforms, recorded the compass bearing and the distance of the boat at each location as they would for a whale. The average error and variability was then calculated for all distance estimates made.

Tides

Data relating to the tide was gathered from the tide station in Broome, as it most accurately reflected the tidal movements at the survey site (there may have been up to a 15 minute discrepancy between the tides at the two locations). The height of the tide was recorded each time a pod or individual was sighted.

Survey Limitations

The possible limitations of the survey methods include:

- Double counts of the same whales within each four hour survey period. This was minimised by the focal follows and by acknowledging and removing pods that had been potentially already sighted and recorded to provide a minimum estimate of the total number of whales recorded.

- Double counts of the same whales between days. There is a possibility that whales were milling or resting in the survey area for several days and were subsequently re-recorded each day. If this is the case, it is likely that this study over-estimated the number of whales using the JPP area. Carrying out photo identification on individual whales would help to negate this factor.

- Failure to capture fluctuations in whale activities throughout the day. As the survey was carried out during the same time each day, it did not reflect these variations. Longer survey periods or surveys carried out at different times of day would allow for these daily fluctuations to be measured.

- Non-observation of whales which were present. This occurred when distance observers were looking in another direction in the quadrant when a whale appeared. Non-observation mainly occurred during the peak migration period, when multiple whales were sighted at once. Non-observation was reduced by having additional observers present during the peak migration period.

- Inaccurate distance estimates. Several steps were taken to negate distance inaccuracies. Firstly, all distance observers were trained in distance estimation using the pearl farm reference markers. As a result, whales within 4.5 km of the shoreline were reliably estimated. Secondly, inaccuracy was reduced by limiting the number of survey participants who made distance estimates. Thirdly, distance accuracy tests were carried out to ensure consistency of distance estimates and to calculate the average error. Lastly, given the parameters of the survey area, all whales recorded were located within 11.3 km of the shoreline.

Results

Survey Effort

The total survey effort was 270 hours of observation over the three month period. This amounted to a total of ~ 3240 hours of volunteer effort.

On 16 days (out of 92), the survey was not conducted, as the sea conditions exceeded a 5 on the Beaufort scale. On 11 days, other weather conditions, such as fog and smoke, which affect visibility, led to a reduced survey effort (less than four hours). These reduced hours were included in the total number of survey hours, and whales counted during these reduced hours were included in the total number of whales recorded.

Numbers and Timing

From 1st July – 30th September 2012, land-based survey observers recorded 3343 individual humpback whales, including 214 cow-calf pairs. Taking a conservative approach and removing potential re-sightings of pods, 2669 individual whales, including 172 cow-calf pairs were recorded (Table 2).

Table 2: The total number of individual humpback whales recorded within 4.5 km, 8 km and 11.5 km of the shoreline, from 1st July - 30th September 2012. The minimum estimate has removed all potential re-sightings.

Total no. of individual whales (including cow-calf pairs)		
Distance from shore	**Minimum**	**Maximum**
4.5 km	985	1217
8 km	2018	2646
11.5 km	2669	3343

Within the ~ 223 km^2 survey area, a maximum density of 1.3 whales km^{-2} day^{-1} and a minimum density of 1.0 whales km^{-2} day^{-1} was estimated for the whole survey period. During the peak migration period (mid-July- late August), there was a maximum density of 1.88 whales km^{-2} day^{-1}.

The mean pod size was 1.6 whales (SEM =+/-0.03), including cow-calf pairs. The modal pod size was two whales, the minimum one and the maximum seven whales.

The number of whales sighted during each four hour period increased steadily during the first two weeks of July, with peak numbers of northbound whales being recorded during the third week of July (Figure 5). The number of whales fluctuated throughout the first three weeks of August, but ranged consistently between 60 and 100 individuals per four hour period. Despite some minor variation, the number of sightings steadily declined from the last week of August until the end of the survey period. Most whales sighted until mid-August were travelling north, while most whales sighted after the second week of September were travelling south. There was a period of cross-over in between in which it was not possible to determine a trend in direction. The greatest number of sightings occurred on the 19th of July, with a maximum of 116 individual whales, including 14 cow-calf pairs, being recorded.

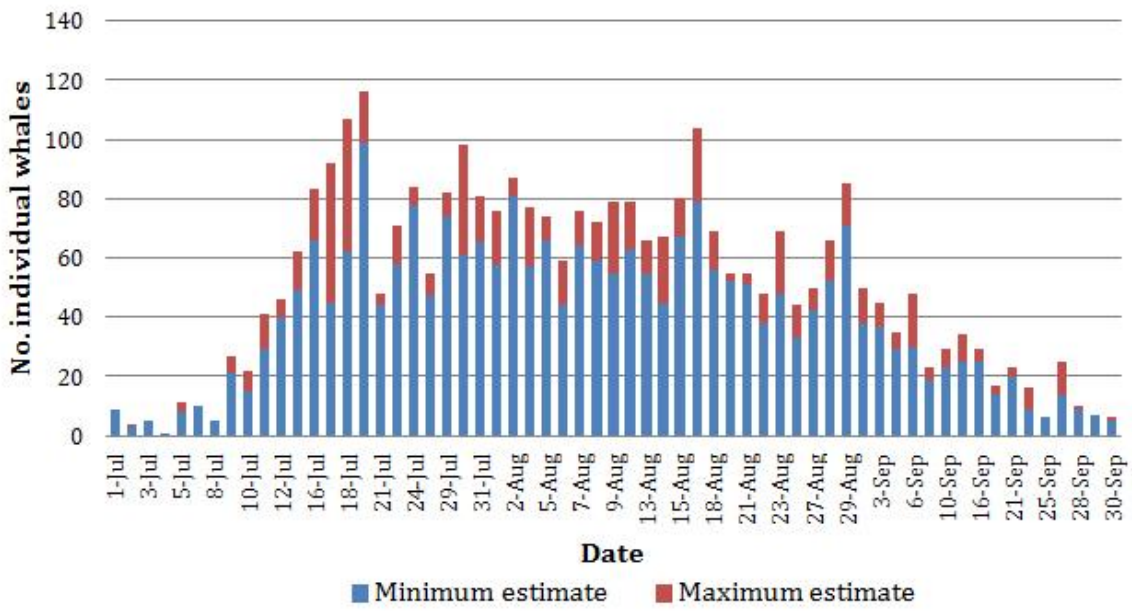

Figure 5: The total number of individual humpback whales recorded daily from 1st July – 30th September 2012. Days with no survey effort, or reduced survey effort (less than four hours) have been removed.

Land-based survey observers recorded a total of 214 cow-calf pairs. Taking a conservative approach and removing potential re-sightings of pods, 172 cow-calf pairs were recorded. Of these, 57% were sighted within 5 km of the shoreline. Smaller new born calves were observed travelling north through the survey area.

The number of cow-calf pairs recorded daily fluctuated throughout the survey period, but coincided with the peak number of total individual whales (Figure 6). The greatest number of cow-calf pairs was recorded on the 19th of July 2012, that being a maximum of 14 cow-calf pairs.

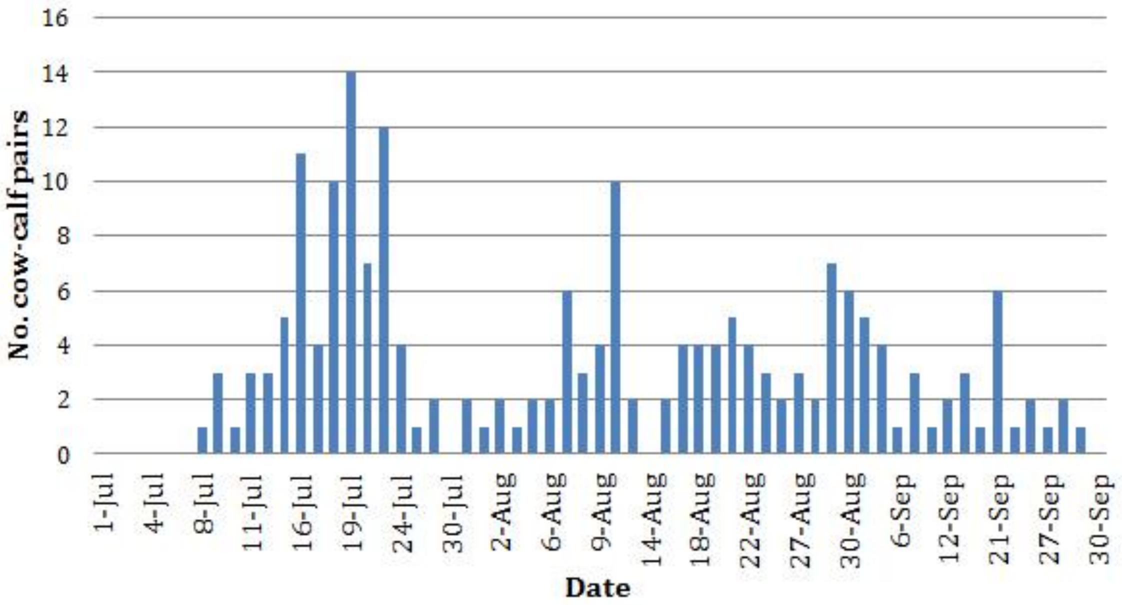

Figure 6: The total number of cow-calf pairs recorded daily from 1st July – 30th September 2012. Days with no survey effort, or reduced survey effort (less than four hours) have been removed.

Distance Accuracy Tests

The results of the distance accuracy tests show that there was an average error of 778 m (SEM+/- 74 m) for 98% of all distance estimates made. For the ten distance accuracy tests within 4.5 km of the shoreline, there was an average error of 630 m (SEM+/- 98 m). For the eight distance accuracy tests beyond 4.5 km of the shoreline, there was an average error of 980 m (SEM+/- 76 m).

Tides

This survey was conducted over an even spread of tidal heights (Figure 7, a). The total number of whales observed within 4.5 km of the shoreline was tightly related to tidal height, with far greater numbers of whales coming nearshore during high tides (Figure 7, b). There was no clear relationship between tidal height and the number of whales observed at distances greater than 4.5 km from shore (Figure 7, b). However, at all distances from shore, the lowest number of whales was observed during tides < 2 m in height (Figure 7, b). Only 29% of whale observations within 8 km of the shoreline occurred during tides < 5 m.

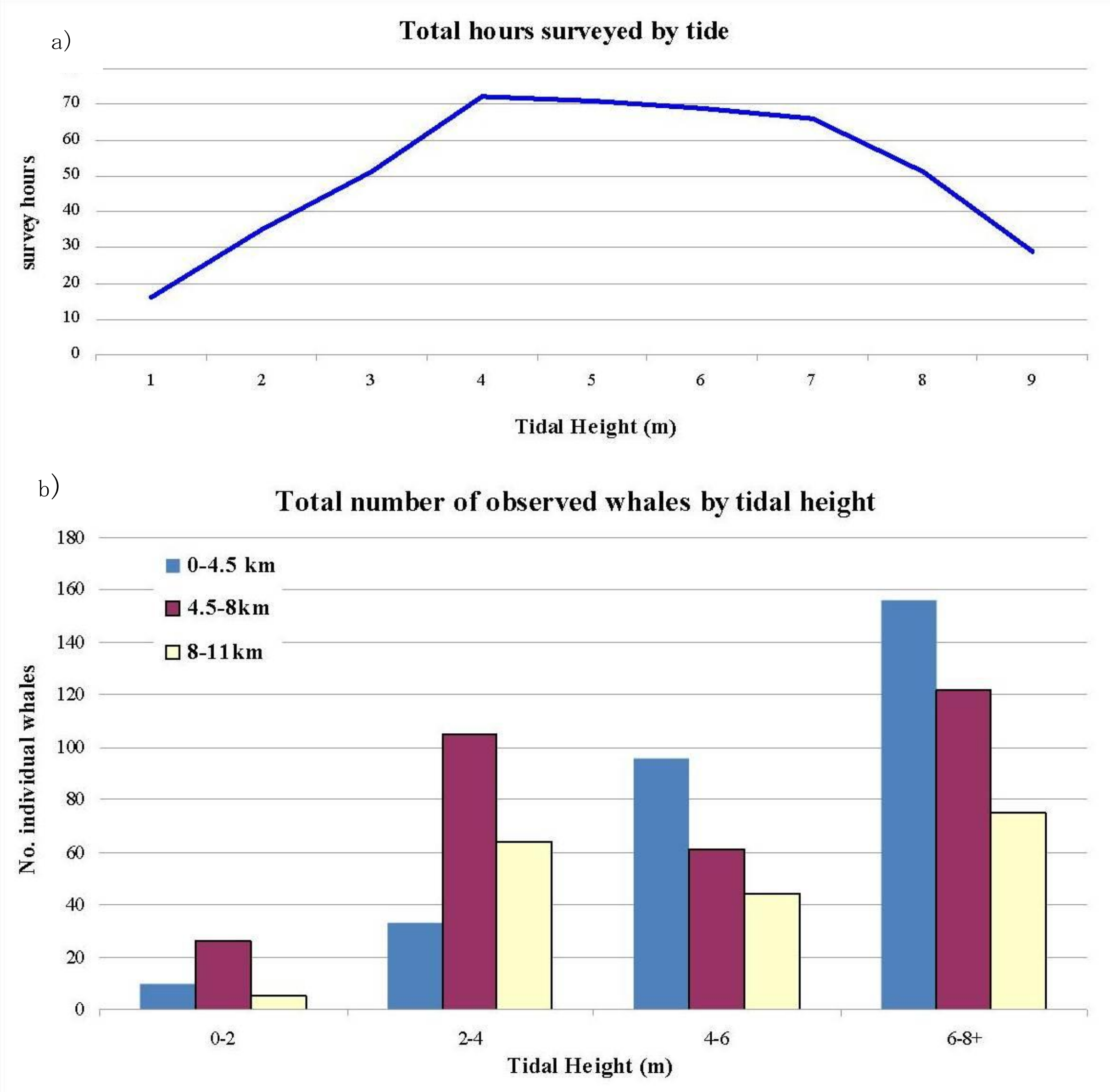

Figure 7, a: The total number of survey hours by tidal height. **Figure 7, b:** The total number of whales observed in three different distance from shore classes, separated into different tidal height brackets.

Behaviour

A total of 864 focal follows were conducted during the survey period. Focal follows lasted for periods that ranged between 30 minutes and four hours (the full length of the survey period). Travelling, resting, milling, playing and surface active behaviours, such as breaching and lobtailing, were commonly observed during these focal follows. Other behaviours such as spyhopping, bull-running and feeding were observed less frequently.

Of the 117 cow-calf pairs that were subject to focal follows within 8 km of the shoreline, 83% were travelling less than 4.6 km hr^{-1} (Figure 8), which has been reported as the average top speed of migration for individuals (Chittleborough, 1965).

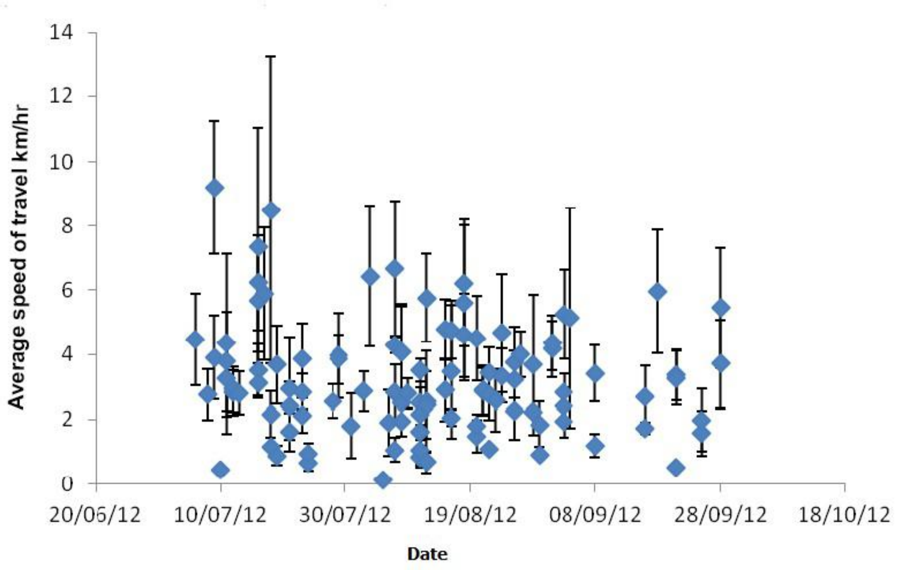

Figure 8: The average speed of travel for cow-calf pairs travelling within 8 km of the shoreline.

A total of 206 individual whales, including 33 cow-calf pairs, displayed passive resting and milling behaviours. Periods of resting and milling often lasted for the whole four hour survey period. Resting behaviours were commonly observed in two locations; the bay directly south of Quondong Point and approximately 2-3 km offshore from Kundandu (Figure 9). A total of 39 cow-calf pairs displayed play behaviour. This occurs when a cow and calf repeatedly exhibit surface active behaviours, such as breaching (Blake *et al*., 2010). Periods of playing were observed to last from 5 – 40 minutes.

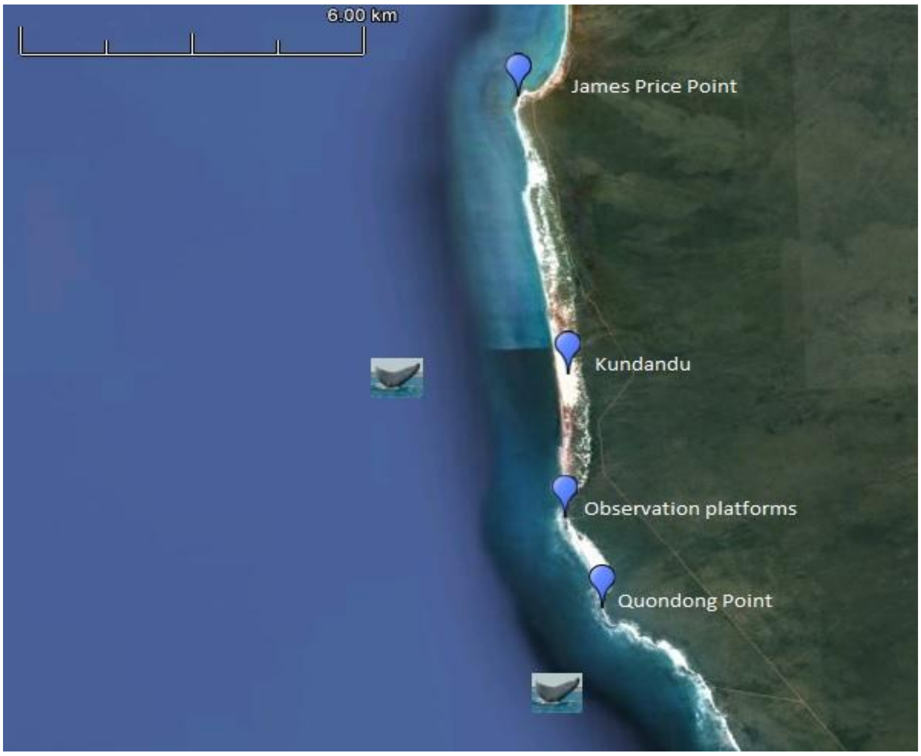

Figure 9: A map of the two locations where resting behaviours were commonly observed. Image source: Google Earth.

Vessels

Land-based observers recorded 324 sightings of vessels during the three month survey period. Common types of vessels included yachts and small fishing boats. On seven days, from 7th – 13th August, the *R/V Steve Irwin*, a large vessel that runs a 2100 BHP engine, was present in the survey area. Approximately 54 interactions between whales and vessels were recorded during the three month survey period. Eight of these interactions involved the *R/V Steve Irwin*. Common behavioural responses to vessels included increased surface activity (for example, breaching, lobtailing and pectoral slapping), changes in direction and increased time under water.

Other Large Marine Animals

Other large marine animals recorded during the survey period included, false killer whales, dugongs, spotted eagle rays, turtles, black tip reef sharks and various inshore dolphin species.

Discussion

This land-based survey involved 270 hours of observation, amounting to ~ 3240 hours of volunteer effort, which provided an extensive and thorough representation of humpback whale numbers, behaviour and habitat use in the JPP region.

Direction and Timing

Humpback whales were present in the survey area for the whole survey period, from 1st July - 30th September 2012. The timing of the peak northern migration was observed in the third week of July. This is consistent with commonly described patterns of migration in the area, which show that peak numbers of northbound whales approach Quondong Point (2.4 km south of the observation platforms) in mid-late July (Jenner *et al*., 2001; RPS, 2010). The majority of whales were north-bound until mid-August and south-bound after the second week of September. Between these two periods, it was not possible to determine a trend in direction. These observations are consistent with commonly described patterns of timing and direction of travel in the area (Jenner *et al.,* 2001; RPS, 2010; Blake *et al.*, 2011). Similarly, pod sizes observed in this study were consistent with previous studies on the pod composition of northbound humpback whales; pods generally contained one or two individuals (Brown and Corkeron, 2006).

The observed peak for cow-calf pairs coincided with the overall peak in individuals, occurring in the third week of July. This trend differs from other studies in the area, which recorded peak numbers of calves from late August – mid September (Jenner *et al.,* 2001; RPS, 2010). RPS (2010) used the results from these other studies to suggest that most calves are born north of the JPP area. However, this study observed smaller newborn calves travelling north through the survey area, as observed in other studies (Double *et al.,* 2012). This indicates that some calving occurs in the JPP area and south of the JPP area. It may also be the case that some larger yearling calves, which are still travelling with their mothers from the previous year (Valsecchi *et al*., 2002) were recorded by survey participants.

During the last two weeks of September, a significant decrease in whale numbers was recorded. These observations are consistent with previous studies in the area, which demonstrate that whales travel further offshore during the southern leg of their migration (Jenner *et al*., 2001; RPS, 2010; Blake *et al.,* 2011). However, this study continued to record substantial numbers of cow-calf pairs close to the shoreline until the end of the survey period. This indicates the importance of the nearshore coastal corridor at JPP for cow-calf pairs.

Whale Abundance and Proximity to Shore

The conclusions relating to whale abundance and proximity to shore that were reported in the RPS study (2010) differ to the results of this survey. The consultants concluded that an estimated 1000 whales or approximately 5% of the total Breeding Stock D population would pass within 8 km of the proposed development at JPP in 2012 (RPS, 2010). The EPA (2012) relied upon these estimates in reaching their conclusion that the BLNG development should proceed at JPP. In stark contrast to these results, land-based observers in this study recorded 2,018 – 2,646 whales within 8 km of the JPP shoreline (+/-0.7 km given distance estimation errors). This count was gathered from four hours of observation each day (except for 11 days where poor weather conditions led to a shorter survey period). Although humpback whales have been observed exhibiting different behaviour types depending on the time of day (e.g. Helweg and Herman, 1994), we could find no published evidence of variation in migration rates per time of day. This suggests that the migration rate observed during the four hour survey period could represent migration during the full 24 hour period, leading to a total count six times greater. Assuming this constant rate of migration, our results indicate that an estimated 12,108 - 15,876 whales could have passed within 8 km of the JPP shoreline during the entire 2012 migration season. These numbers greatly exceed the 1000 whales that RPS (2010) predicted would pass within 8 km of the proposed development in 2012. Given this disparity in numbers, it is concluded that the EPA did not have sufficient information to make an informed decision about the BLNG precinct and its impact on humpback whales.

Two main explanations may account for the large disparity between the two studies. Firstly, the number of whales using the nearshore habitat at JPP may be subject to inter-annual variation. If this assumption is correct, the population estimate contained in the SAR (DSD, 2010) was during a low use year and does not adequately capture this variability or the long term ecological significance of the JPP area to the Breeding Stock D population. The SAR (DSD, 2010) therefore underestimates the potential impact of the BLNG precinct on this population. Secondly, the estimates contained in the RPS study (i.e. 5% of the population within 8 km; 2010) may be vastly inaccurate and the Breeding Stock D population is either much larger than estimated, or that a larger proportion of the population is spending time within 8 km of the JPP shoreline. As the estimates of the size of the Breeding Stock D population have been researched and replicated by several authors (Bannister and Hedley, 2001; Hedley *et al*., 2009; Kent *et al*., 2012), it is more likely that the proportion of nearshore whales represented in the RPS study (2010) is an under-estimation. Assuming that the current Breeding Stock D population is 26,000 – 34,000 (Hedley *et al*., 2009), this study suggests that at a minimum, an estimated 36 - 47% of the population passes within 8 km of the JPP shoreline and will be impacted, to some degree, by the BLNG development and port facilities.

One further methodological factor that may have contributed to the disparity in nearshore whale numbers is the failure of the consultants to consider tidal movements at JPP. This study shows that tidal movements, which range up to 10 m in magnitude at JPP, affect whale proximity to shore. Tidal heights for the ten aerial surveys conducted by RPS were not listed in their report, or included in their analysis (RPS, 2010). However, from the dates and times of the aerial surveys, it was calculated that eight out of the ten surveys were conducted at tides < 5 m. Our results showed that only 29% of whale observations within 8 km of the shoreline occurred during tides < 5 m. Therefore, by sampling at low tidal heights, RPS (2010) greatly underestimated the number of whales that pass within 8 km of the JPP shoreline.

Behaviour and Habitat Use

The results of the focal follows show that humpback whales engage in a range of behaviours close to the JPP shoreline, including nursing and resting behaviours that are considered to be critically important interactions between cow-calf pairs (DEH, 2005). The results of this survey therefore suggest that JPP is used by humpback whales for a broad number of activities, including slow migratory travel, nursing, resting and breeding. Observations of new born calves also indicate that some calving may occur in the area.

The NHWRP (DEH, 2005) lists the area from Broome north to Camden Sound as a humpback whale calving area. In contrast, the RPS Consultants (2010) maintain that the 'main calving ground' for the Breeding Stock D population lies between Pender Bay and Camden Sound, cited from a study by Jenner *et al.* (2001). However, in their research, Jenner *et al.* (2001) did not define or delineate a main calving ground, nor use the term, 'main calving ground'. Instead, they focused on three areas, Pender Bay, Frost and Tasmanian Shoals and Camden Sound, which contained a high density of whales during the survey years (Jenner *et al.,* 2001). A recent study conducted by Double *et al.* (2012), which included contributing authors to Jenner *et al.* (2001), found that many whales calve and terminate their migration south of these recognised calving areas. This led the authors to conclude that there is a broad spatial distribution of calving events within the Breeding Stock D population and that the area from the Lacepede Islands to Camden Sound should not be seen as an exclusive calving area (Double *et al.*, 2012). The results of our survey support this research, as they suggest that some calving does occur in the JPP region and south of the JPP region. Land-based observers witnessed a number of new born calves travelling north through the survey area and engaging in other critical behaviours, such as nursing, resting, playing and milling. Further, during the peak migration period, false killer whales were regularly sighted by land-based observers. Research has shown that false killer whales are often present in areas where calving takes place, as they prey on newborn whales (Clapham, 1996).

The RPS consultants (2010) also concluded that the JPP region was less important than other areas as a resting place for humpback whales. The EPA (2012) relied on this hypothesis to conclude that humpback whales generally migrate steadily past JPP, relying on areas such as Pender Bay for resting. To the contrary, the results of this survey suggest that JPP is most likely used for resting. Survey participants observed 206 individual whales, including 33 cow-calf pairs displaying passive behaviours such as resting and milling, which are considered to be indicative factors of a resting area (Jenner and Jenner, 2009). While no data relating to exact times of residency or length of stay were gathered, it is likely that some of these whales remained in the JPP area for a number of days. Given this, it is possible that the number of whales recorded in this survey is an over-estimation, as whales using the area for resting may have been re-recorded over a number of days. However, this does not mean that the JPP area is of less significance to humpback whales, as resting areas are considered to be habitat which is important to the survival of humpback whales (DEH, 2005). Further studies involving photo identification would be useful to determine exactly how many whales remained in the JPP area for a number of days.

Vessels, in particular large vessels, such as the *R/V Steve Irwin*, were also shown to influence whale behaviour. It was observed that whales were more surface active (for example, breaching and lobtailing), on days that the Steve Irwin was present in the survey area. Other behaviours observed in response to large vessels, included changes in direction and increased time under water. Such behaviours have been described as common responses to vessels by cetaceans (Corkerton, 1995; Scheidat *et al.,* 2004), and are known to vary depending on the size of the boat and the way that the boats are manoeuvred around whales.

BLNG Impacts

The NHWRP (DEH, 2005) recognises that habitat degradation and behavioural disturbance through activities such as acoustic pollution, built structures, ship strike, changing water quality and dredging, pose a significant threat to humpback whales. The BLNG precinct has the potential to degrade humpback whale habitat through each of these listed activities.

As identified in the SAR (DSD, 2010), the BLNG development will include 34 million m^3 of initial sea bed dredging and will require ongoing dredging throughout the life of the industrial port. As a result, the EPA (2012) acknowledges that there will be 'a zone of moderate impact', extending approximately 12 km offshore from JPP. Given the boundaries of the survey area (Figure 2), all whales recorded in this survey will pass through the zone of impact. If the current population estimates of 26,000 – 34,000 (Hedley *et al,* 2009) are correct, the results of this study demonstrate that at a minimum, an estimated 47 - 62% of the population could be impacted by dredging associated with the BLNG development. These figures are much higher than those quoted in the SAR (DSD, 2010) and relied upon by the EPA (2012) in their assessment. The consultants predicted that only 30 – 40% of the population would pass within the zone of impact in 2012 (DSD, 2010).

Noise impacts from BLNG activities such as pile-driving, blasting, seismic testing and rock dumping also have the potential to impact whales using the JPP region (EPA, 2012). Sound from such activities may impede important communications between cow-calf pairs, and can lead to disturbance, injury or fatality if sound pressure occurs at extreme levels and in close proximity to whales (Southall *et al.,* 2007). Research has shown that calves are especially vulnerable to noise impacts (McCauley *et al.,* 2000). The EPA (2012) acknowledges that the zone where noise impacts could cause behavioural disturbance may extend as far as 7 km offshore from JPP and affect approximately 5% of migrating whales. Our survey results indicate that a minimum of 1870 individual whales, including 195 cow-calf pairs, were recorded within this zone. Given the current population estimates of 26,000 – 34,000 (Hedley *et al.*, 2009), the results of this survey demonstrate that at a minimum, an estimated 33 – 43% of the population may be subject to such types of behavioural disturbance. These numbers are an order of magnitude greater than those predicted by the consultants.

If the BLNG development proceeds, there will be an estimated 2,700 shipping movements to and from the precinct each year (DSD, 2010). The EPA (2012) concluded that this increase in shipping and associated activities at JPP is unlikely to disrupt whales at a population level. They reasoned that the Breeding Stock D population has increased exponentially over the last 50 years, despite the concurrent industrialisation of the Pilbara coastline (EPA, 2012). Given that the JPP area is used for critical interactions, such as nursing and resting, between cow-calf pairs, this comparison between the Pilbara and JPP is inappropriate. Injuries and fatalities resulting from ship strike have the potential to impact humpback whales and their calves using the JPP region for slow migration, nursing and resting (Jensen and Silber, 2004; DEH, 2005). Research has shown that the most lethal injuries are caused by ships at least 80 m in length, and by ships that are travelling at approximately 14 knots or faster (Laist *et al.,* 2001). A typical super-tanker, such as the Northwest Sanderling, operating in the Pilbara LNG precinct, is 270 m long and travels at an average speed of 12.7 knots (North West Shipping, 2012). Given the speed, size and quantity of super-tankers that will be moving in the JPP area, injuries and fatalities from ship strike are highly possible. The International Maritime Organization (IMO) has gone to the extent of modifying shipping routes to protect large whales from ship strike, which they have identified as a measurable threat to large whales (Silber *et al*., 2011). In 2007, five endangered blue whales were killed by ship strike in the Santa Barbara Channel. This event led to the re-routing of vessels in the area (Betz *et al.,* 2011). Given the lethal risk that ship strike poses to whales, the development of a port in an area that supports a high number of cow-calf pairs, could have potentially negative impacts on the humpback whale population.

Habitat degradation resulting from these BLNG activities has the potential to cause reduced occupancy or exclusion of whales from appropriate habitat and even mortality events (DEH, 2005; Lusseau and Bejder, 2007). In addition to habitat exclusion and the potential for ship strikes, the listed BLNG activities could affect calf-cow pair behavioural interactions and communications, leading to reduced reproductive success (DEH, 2005; Lusseau and Bejder, 2007). Given the number of whales that use the nearshore area at JPP, our results indicate that there is the potential for negative impacts at a population level (DEH, 2005; Lusseau and Bejder, 2007). In light of this potential population risk, the science that has informed the impact assessment is not comprehensive, adequate or representative enough to demonstrate with certainty that this development will not lead to population level impacts on humpback whales. Based on this uncertainty, we advise that until further and more extensive whale research occurs in the region, the BLNG development at JPP cannot be adequately assessed for its potential impacts to the humpback population under the *EPBC Act.*

Conclusion

The results of this land-based survey have shown that the nearshore coastal corridor at JPP is frequented by a significant number of humpback whales and their calves. In stark contrast to the science contained in the SAR (DSD, 2010), these results indicate that the JPP area had up to 36 – 47% of the total population passing within 8 km of the shoreline this season. Further, the area is used for a broad number of important whale activities, such as resting, nursing, milling, playing, and potentially, calving. Given this large disparity in results, it is concluded that the science informing the strategic assessment does not adequately or comprehensively represent the ecological importance of the area to humpback whales. Due to the high use of the area, the important whale activities and the large scale impacts associated with the project, there is the potential for population level impacts to the Breeding Stock D population. Until further and more extensive research occurs into whale use of the area, it cannot be demonstrated that the BLNG project will not cause population level impacts.

Recommendations

1. The results of this study indicate that the nearshore waters around JPP are frequented by a significant number of humpback whales and represent a resting and nursing area for the population. These results are in contrast to the science informing the impact assessment so far. Due to this uncertainty, the **precautionary principle** should be applied and **more extensive and thorough research into the use of JPP by humpback whales needs to occur before the potential impacts of the BLNG development can be adequately assessed.**

2. This study demonstrates that the proponents have **not adequately assessed** the potential for **population impacts** of the BLNG development on humpback whales. In approving the development, the Western Australian EPA has not adhered to its own legal mandates. We strongly urge the Commonwealth Government to meet their obligation under the *EPBC Act*.

3. Should the proponents consider alternative locations in this **environmentally sensitive region** of the coast, further independent humpback whale surveys should be commissioned with an emphasis on the **rigour of the surveys**. These studies should **thoroughly assess** the potential **impacts of industrial activity** and provide **ecologically sustainable mitigation** strategies that strongly adhere to the **relevant legislation.**

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Appendix

Commonly used abbreviations in this report

Abbreviation	Full Title
JPP	James Price Point
BLNG Precinct	Browse Liquefied Natural Gas Precinct
WEL	Woodside Energy Ltd
DSD	Western Australian Department of State Development
SAR	Strategic Assessment Report
EPA	Western Australian Environmental Protection Authority
DEH	Department of Environment and Heritage
NHWRP	National Humpback Whale Recovery Plan
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Cth)
WC Act	*Wildlife Conservation Act 1950* (WA)
IMO	International Maritime Organisation
WA	Western Australia
R/V	Research Vessel

Maps showing the weekly distribution of humpback whale sightings. Pods with cow-calf pairs are displayed in red. Pods without cow-calf pairs are displayed in yellow.

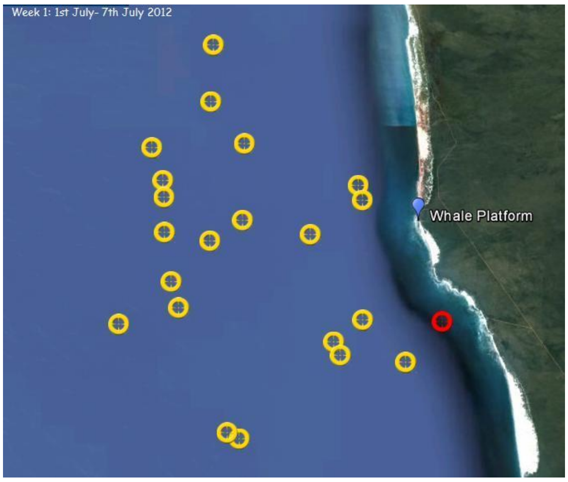

Figure A1: Week 1- 27 observation hours.

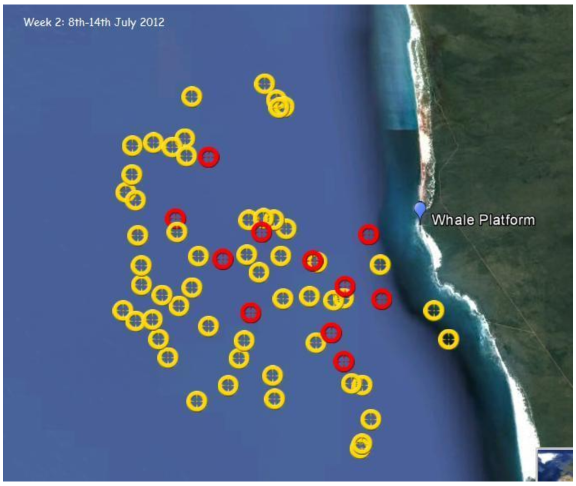

Figure A2: Week 2- 24 observation hours.

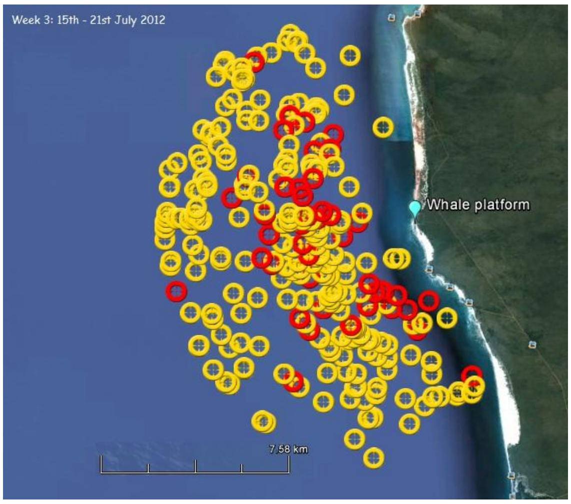

Figure A3: Week 3- 25 observation hours.

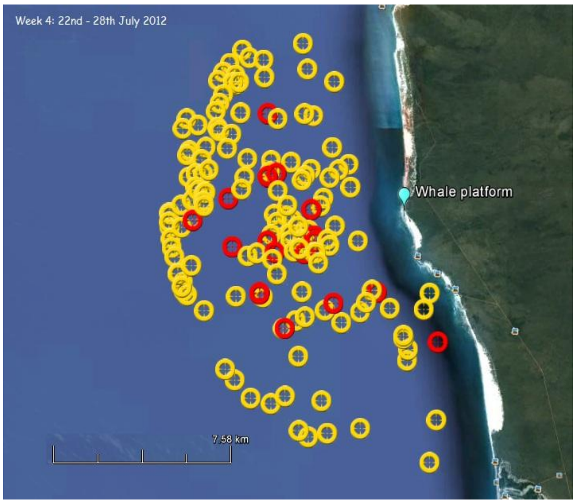

Figure A4: Week 4- 16 observation hours.

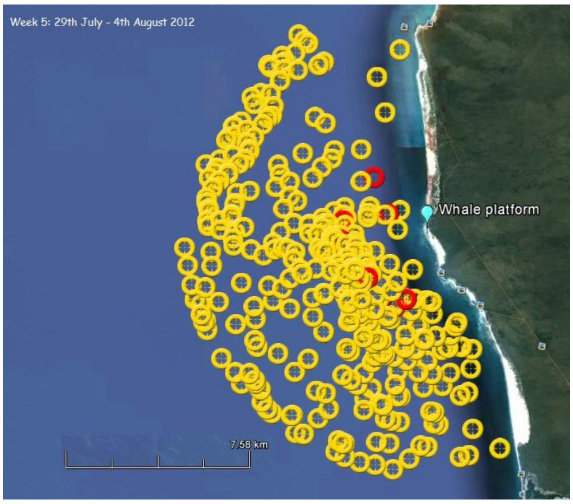

Figure A5: Week 5- 24 observation hours.

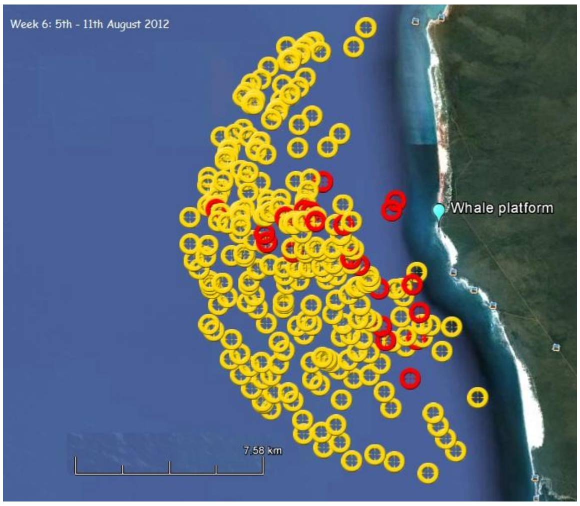

Figure A6: Week 6- 24 observation hours.

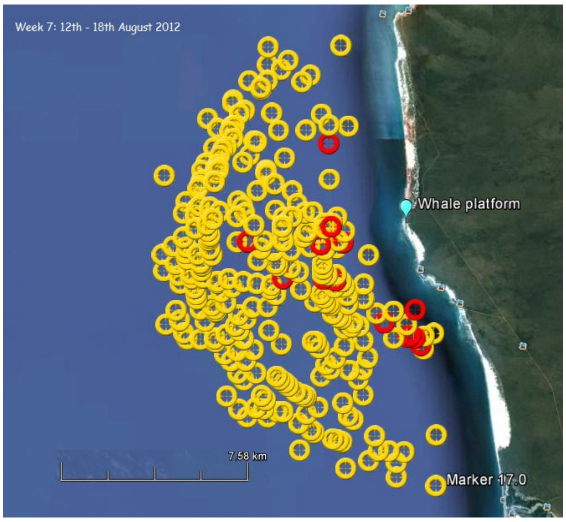

Figure A7: Week 7- 22 observation hours.

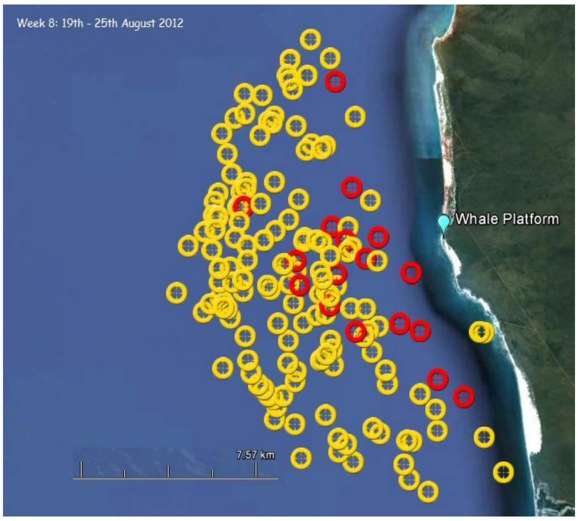

Figure A8: Week 8- 20 observation hours.

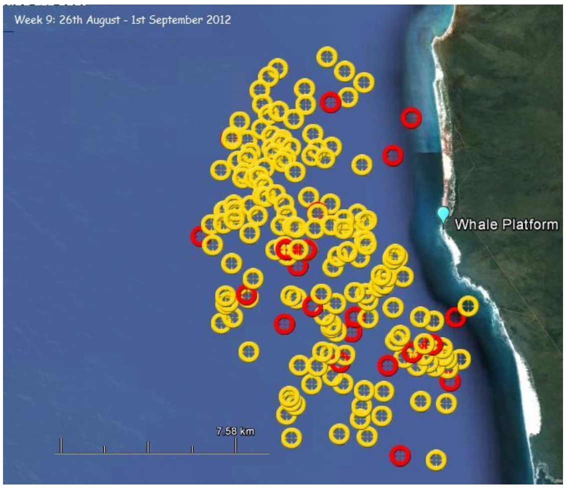

Figure A9: Week 9- 22 observation hours.

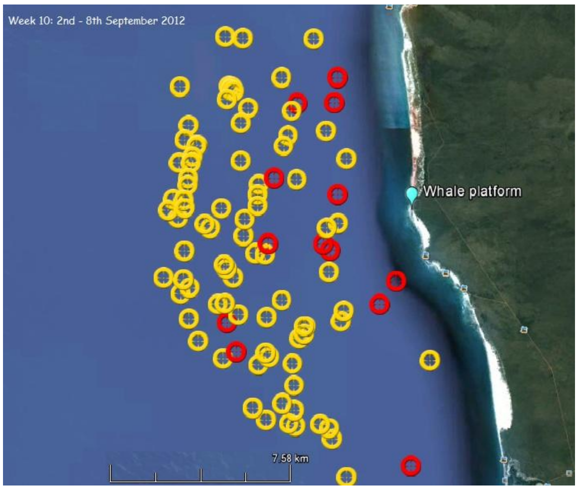

Figure A10: Week 10- 16 observation hours.

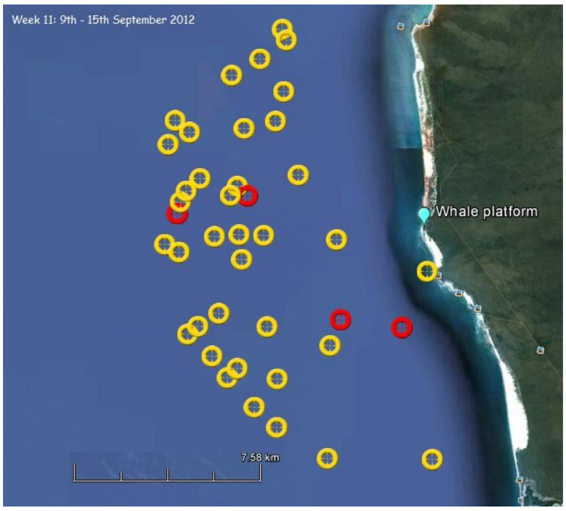

Figure A11: Week 11- 12.5 observation hours.

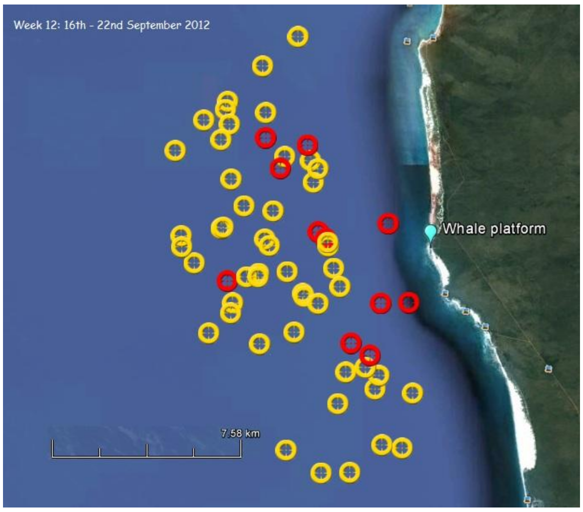

Figure A12: Week 12- 17 observation hours.

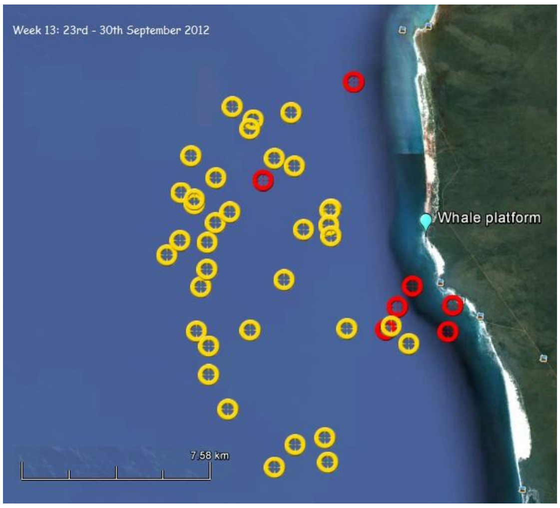

Figure A 13: Week 13- 24 observation hours.

Maps showing the trajectory of pods that were tracked on specific days during the survey period. A different colour is used to represent the trajectory of each pod.

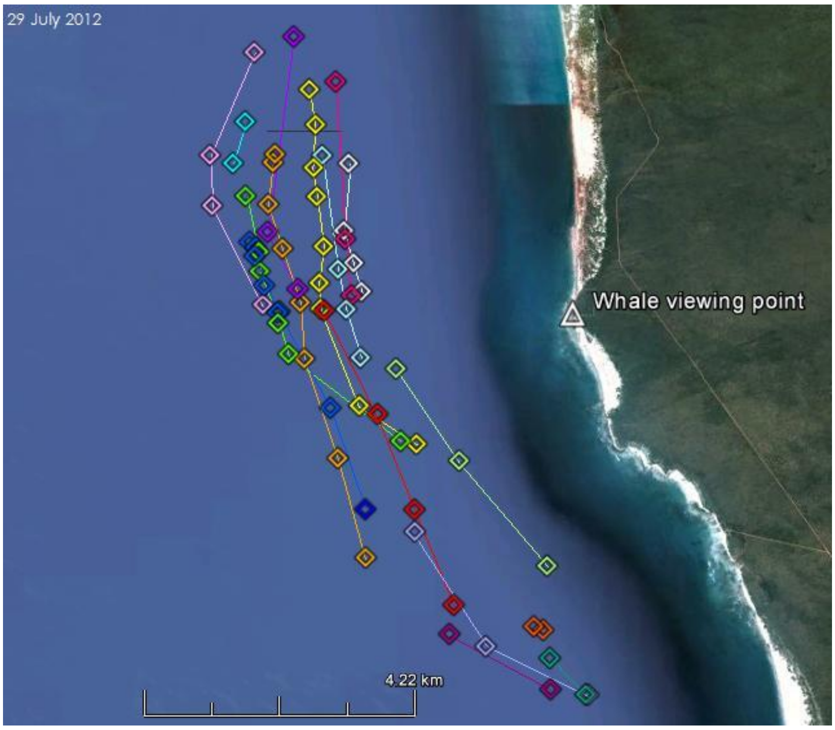

Figure A14: 29th July 2012 - 18 pods that were subject to focal follows within 5 km of the shoreline.

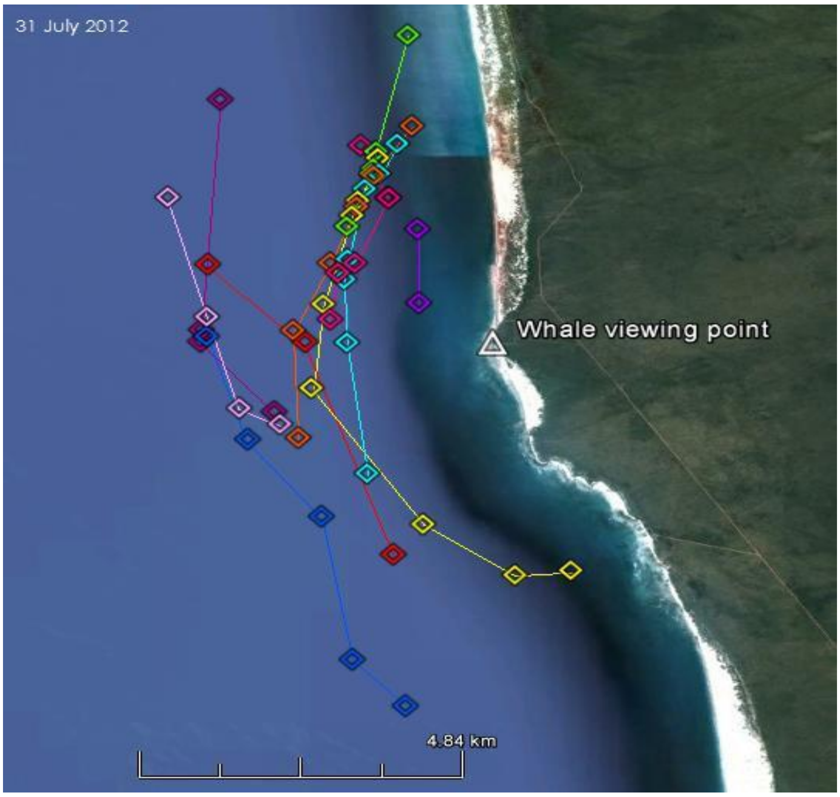

Figure A15: 31st July 2012 - 11 pods that were subject to focal follows within 5 km of the shoreline.

Selected images of humpback whales sighted during the survey

Figure A16: 16th July 2012 - Adult whale waving fluke and tail, approximately 4 km from the shoreline and 4 km north of the observation platforms. Photo by SteveCutts.

Figure A17: 16th July 2012 – Adult whale pectoral slapping, approximately 4 km from the shoreline and 4 km north of the observation platforms. Photo by Steve Cutts.

Figure A18: 6th August 2012 - A newborn calf breaching approximately 2 km from the shoreline and 50 m south of the observation platforms. Photo taken from the south observation platform, by Lauren Ausburn.

Figure A19: 10th August 2012 - Two adult whales blowing, approximately 6 km from the shoreline and approximately 3 km north of the observation platforms. Photo by Lauren Ausburn.

Figure A20: 10th August 2012 – A cow-calf pair migrating slowly north, approximately 5 km from the shoreline and 3 km north of the observation platforms. The black buoys indicate the eastern boundary of the pearl farm, approximately 4.5 km from shore. Photo by Charlotte Buckton.

Figure A21: 10th August 2012 – A whale breaching approximately 4.5 km from the shoreline and 3 km north of the observation platforms. Photo by Lauren Ausburn.

Figure A22: 10th August 2012 – Two adult whales simultaneously waving their tails, approximately 5 km from the shoreline and 3 km north of the observation platforms. Photo by Charlotte Buckton.

Figure A23: 20th August 2012 - Whale raising pectoral fin, approximately 5 km from the shoreline and 3 km south of the observation platforms. Photo by Jamie Lamb.