Rio Tinto Alcan

South of Embley Inshore Dolphin Project
December 2014 Baseline Survey

March 2015

Executive summary

Background

The Rio Tinto Alcan (RTA) South of Embley Project (SoE Project) Inshore Dolphin Strategy (RTA 2014) documents the survey program to be conducted on the Australian snubfin dolphin (*Orcaella heinsohni*) and the Australian humpback dolphin (*Sousa sahulensis*) within the vicinity of the South of Embley Project area.

As a result of limited information available on the status of inshore dolphins along Western Cape York, this project will contribute important information towards understanding Australia's inshore dolphins.

Inshore Dolphin Strategy Objectives

The inshore dolphin surveys conducted as part of the RTA SoE Project have two principal objectives:

- provide a better understanding of the distribution, habitat use and abundance of Australian snubfin and Australian humpback dolphins within the study area;
- contribute information towards the 'co-ordinated research framework to assess the national conservation status of Australian snubfin dolphins (*Orcaella heinsohni*) and other tropical inshore dolphins' (hereafter referred to as the National Inshore Dolphin Strategy) (refer Department of Environment 2013).

Study Area and Capture-Recapture Design

The survey design for the Strategy systematically covered the study area between latitudes 12.60°S and 13.35°S. Vessel-based surveys were conducted out to 15km from the coast, covering water depths of at least 1-25m, and at least 15km upstream major rivers in both the Weipa and Aurukun Estuary systems.

Following recommendations for selecting sites for sampling (Brooks et al. 2014), the study area (1,014km^2) was separated into three sites:

- **Site 1 (410km^2)**

  Port of Weipa/Embley Estuary south to the tip of the RTA mining lease, including the Embley Estuary (existing anthropogenic impact);
- **Site 2 (287km^2)**

  From the tip of the RTA mining lease south to Thud Point (SoE construction site);
- **Site 3 (317km^2)**

  South of Thud Point to five kilometres south of the Ward River mouth, including the Archer, Ward and Watson River systems within the Aurukun Estuary (un-impacted site).

Each site was surveyed four times (i.e. four secondary samples) during the primary sample.

Boat-based surveys were conducted along pre-determined transects within the three sites. Data collection was based on capture-recapture using photo-identification of individual dolphins. The capture-recapture data was analysed using closed capture-recapture models within the program MARK.

Specific methods to address the project objectives are described in detail in the Strategy (RTA 2014), and are based on survey recommendations in: 'Methods for assessment of the conservation status of Australian inshore dolphins' (hereafter referred to as the Methods Document: Brooks et al. 2014).

Results

Survey Schedule

Two days of training were conducted with all survey personnel, including Traditional Owners on 6 and 7 December (in-class and boat-based training days respectively). Boat-based surveys were conducted throughout the study site from 7-19 December 2014.

Survey Effort

Survey effort was conducted in the three sites (Figure E1), as well as while transiting between sites during daylight hours. During 11 days of surveys, a total of 3182 km were travelled over 288 hrs, consisting of:

- 3,031km over 276hrs within sites (1,662km over 167hrs spent 'on-transect' surveying for dolphins);
- 161km over 12hrs while transiting between sites.

Beaufort Conditions

Overall, survey conditions were very good, with 59.5% of survey effort completed in Beaufort 2 or less conditions.

Dolphin Sightings Within Sites

During surveys within sites, a total of 110 dolphin groups were observed (total group size = 476).

Australian humpback dolphins (*Sousa sahulensis*) were the most frequently observed species (all sites), followed by Indo-Pacific bottlenose dolphins (*Tursiops aduncus*). Small numbers of Australian snubfin dolphins (*Orcaella heinsohni*) were observed (primarily Site 3), as well as one group of Gray's spinner dolphins (*Stenella longirostris longirostris*) and one group of offshore bottlenose dolphins (*Tursiops truncatus*) (both Site 2) (Figure E1).

Two mixed groups of Australian humpback dolphins and bottlenose dolphins were observed during surveys (all Site 1), and one mixed group of Australian humpback and Australian snubfin dolphins (Site 1).

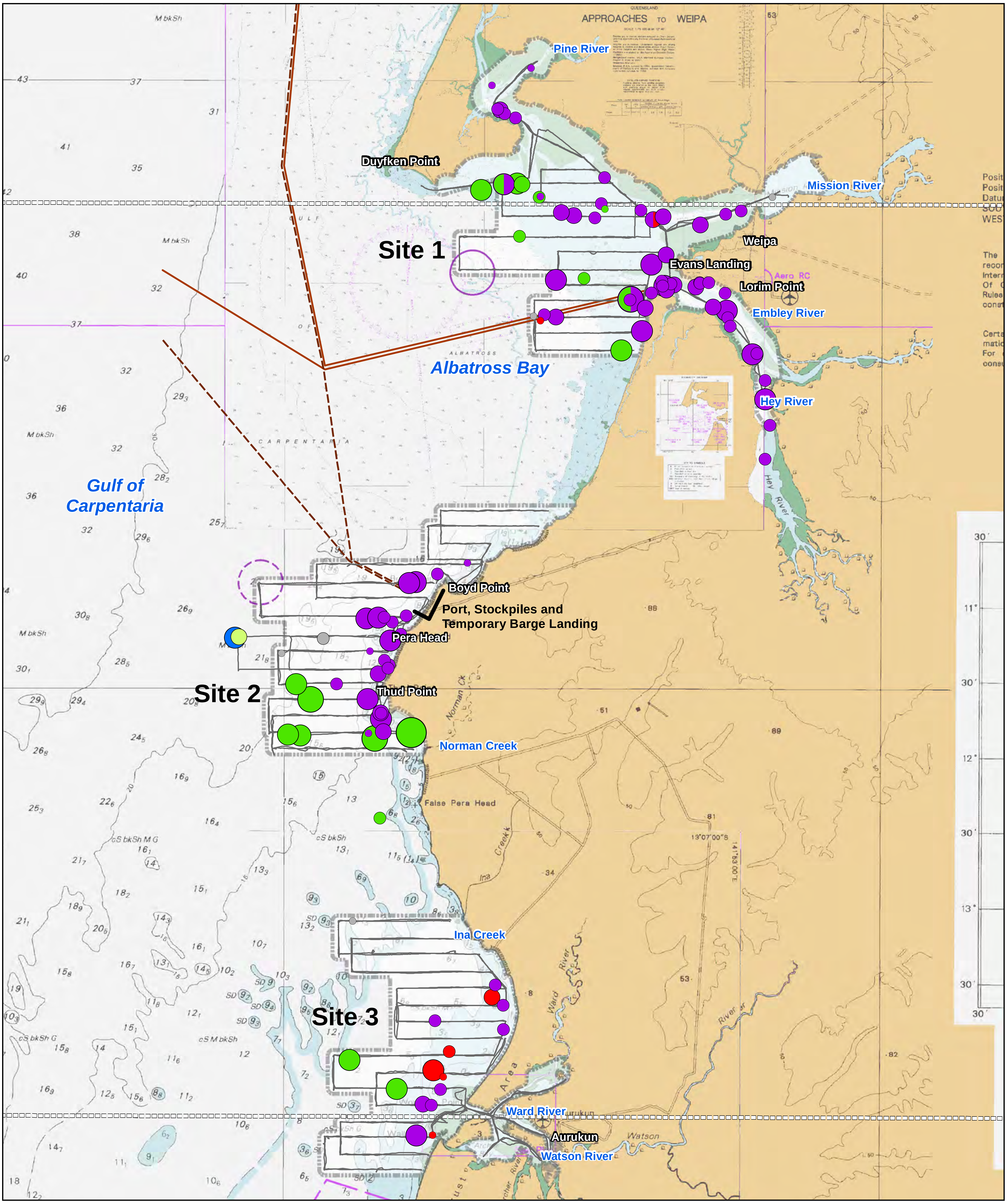
Dolphin Sightings While Transiting

Only one bottlenose dolphin group (2 individuals) was observed while transiting between Sites 3 and 2.

Dolphin Encounter Rates

Encounter rates were calculated for each site and sample. For all sites combined, Australian humpback dolphins were by far the most frequently encountered species (0.17 dolphins per km of transect), followed by bottlenose dolphins (0.09 dolphins per km of transect) and then Australian snubfin dolphins (0.01 dolphins per km of transect).

Interestingly, no dolphins were observed within the Aurukun Estuary at any time during surveys.



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Species

- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Snubfin
- Offshore bottlenose
- Spinner
- Unknown

Group Size

- 1
- 2-3
- 4-5
- 6-10
- 11-20
- 32

- Transects completed
- Site boundary
- North/South Project Boundaries

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Revision 0
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Dolphin sightings - all samples combined

Figure E1

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66 Smith Street Darwin NT 0810 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drw@ghd.com.au W www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

Identifications

Of the 114 groups encountered during surveys, 94 groups (82% of sightings) were successfully photo-identified. A total of 42hrs and 31mins were spent photographing dolphin groups, with 15,625 images taken.

A total of 193 individual dolphins were identified, consisting of:

- 124 Australian humpback dolphins;
- 59 bottlenose dolphins
- 7 Australian snubfin dolphins
- 2 Gray's spinner dolphins
- 1 offshore bottlenose dolphin.

Abundance Estimates

Closed capture-recapture analyses were run on the resulting capture histories within MARK using the program CAPTURE.

A total of 220 (183-281) Australian humpback dolphins were estimated to use the entire study area, with 101 (85-129) estimated for Site 1 and 138 (83-277) in Site 2. No estimates were possible in Site 3 because of the low number of individuals identified (n=11).

A total of 116 (87-175) bottlenose dolphins were estimated for the entire study area, with 24 (21-36) estimated for Site 1. No estimates were possible for Sites 2 and 3 because of the low number of individuals identified and/or lack of recaptures (n=27 with few recaptures and n=12 respectively).

No estimates of Australian snubfin dolphins were possible because of the very low number of sightings and photo-identified individuals.

More sophisticated capture-recapture analysis using both open and closed models will be used for future analysis, once more data is available.

Dolphin Habitat Preferences

Survey findings indicate that a number of sites within the study area are important for inshore dolphins:

- Australian humpback dolphins were observed in all three sites, with the majority of individuals observed in Sites 1 and 2. The region with the highest encounter rate (17 dolphins per km^2) was at the mouth of the Mission River (Site 1). Other regions with high encounter rates (3-7 dolphins per km^2) were around the Embley River mouth (Site 1) and along the coastline from Pera Head south to Thud Point (Site 2).
- Bottlenose dolphins were observed in all three Sites, with the majority of individuals observed in Sites 1 and 2. The regions with the highest encounter rates (10-12 dolphins per km^2) were southeast of Duyfken Point (Site 1) and in the small bay south of Thud Point (Site 2).
- Australian snubfin dolphins were observed in Sites 1 and 3, with the majority of individuals observed in Site 3. The region with the highest encounter rate (1-3 dolphins per km^2) was north west of the Aurukun Estuary mouth (Site 3).

When comparing average environmental parameters for inshore dolphin species between all sites, the main differences were:

- Australian humpback dolphins and bottlenose dolphins were observed at similar depths (average depths of 9.1m and 9.8m respectively), whereas Australian snubfin dolphins were observed in consistently shallower waters (average depth of 5.1m);
- Australian snubfin dolphins were observed in the most turbid waters (average turbidity of 14.1NTU), with bottlenose dolphins observed in the clearest (average turbidity of 3.2NTU) and Australian humpback dolphins ranging throughout clear to turbid waters (average turbidity of 6.7NTU).

Discussion

The pre-construction survey completed in December 2014 was the first of five annual primary samples to be undertaken as part of the RTA SoE Project. The required study design is described in detail in the associated Strategy (RTA Weipa 2014). As a result of favourable weather and other logistical considerations, these pre-construction surveys were successful and achieved all required objectives:

- All pre-determined transect lines were completed four times (i.e. four secondary samples);
- Photo-identification was successful, with 193 individuals identified, consisting of 124 Australian humpback dolphins, 59 bottlenose dolphins, 7 Australian snubfin dolphins, 2 Gray's spinner dolphins and 1 offshore bottlenose dolphin;
- Encounter rates were calculated for all inshore dolphin species;
- Reliable abundance estimates were obtained for Australian humpback and bottlenose dolphins. Due to a low number of sightings, abundance estimates could not be calculated for Australian snubfin dolphins;
- Data was collected which has contributed towards understanding habitat preferences for all three inshore dolphin species;
- Significant data was collected on additional marine megafauna sighted during surveys, particularly dugongs, turtles and sea snakes;
- Data collected as reported here will contribute significantly towards supporting the National Inshore Dolphin Research Strategy;
- Wik Waya and Thanikwithi Traditional Owners were trained in survey methods and involved in surveys;
- These surveys achieved the objectives of the Strategy for the baseline data (pre-construction) survey event.

This study found that the Weipa and Boyd Bay/Thud Point sites should be considered regional hotspots for both Australian humpback and Indo-Pacific bottlenose dolphins, where encounter rates in both sites were five to forty times higher than that highest encounter rates from other regions studied in Northern Australia.

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1. Project Background

Rio Tinto Alcan is completing works to construct and operate a new mine and port facility at a location to the south of the Embley River in northern Queensland (Figure 1). Referred to as the South of Embley (SoE) Project, works will involve the construction and operation of a bauxite mine and associated processing and port facilities for shipping of bauxite to Gladstone and international markets. The SoE Project involves a staged increase in production up to 50 million dry product tonnes per annum (Mdptpa) of bauxite. The initial production is likely to be approximately 22.5Mdptpa. Actual production rates and the timing and size of capacity expansions will depend on market conditions. The anticipated mine life is approximately 40 years, depending on production rates.

The SoE Project is located near Boyd Point on the western side of Cape York Peninsula (Figure 1). Detailed information on the SoE Project is presented in the *South of Embley Project Environmental Impact Statement* (RTA Weipa 2013).

The South of Embley (SoE) Project (EPBC 2010/5642) was approved, with conditions, on 14 May 2013 by the Minister for Sustainability, Environment, Water, Population and Communities (now Minister for the Environment). The approval (varied 3 June 2014) required an Inshore Dolphin Offset Strategy to be prepared and submitted to the Minister for approval at least six months prior to the commencement of construction works (such work excludes preliminary works) (Condition 55). The Strategy is to be approved by the Minister prior to the commencement of construction works (i.e. before commencement of the “action”).

The main components of the SoE Project associated with the Inshore Dolphin Offset Strategy are illustrated in Figure 2 and summarised below:

- **Barge, ferry and tug facilities**

  The construction and operation of a new ferry and tug terminal at Hornibrook Point, a roll on/roll off barge facility at Humbug Wharf, and a new barge and ferry terminal on the western bank of the Hey River. The initial construction phase also requires construction of temporary barge and ferry access near the Boyd Port and temporary berthing facilities at the Humbug and Hey River sites. Approximately 8 to 10 months following the commencement of construction, the Humbug and Hey River terminals will be completed and regular passenger ferry services will commence as well as the transport of Project equipment and materials;

- **Port and ship-loading facilities**

  The construction and operation of Boyd Port, ship-loading and tug mooring facilities between Boyd Point and Pera Head. Works will include a jetty, bulk carrier vessel wharf and berthing structures, tug and line boat moorings, ship-loader and dredging of berth pockets and departure areas;

- **Shipping activities**

  The transport of bauxite in bulk carriers from Boyd Port to international locations as well as continuing bauxite shipping to the Port of Gladstone, and the transport of cargo and fuel for the Project from international and domestic locations to the existing Port of Weipa.

The initial construction phase of the SoE Project is expected to take approximately 30 to 36 months. This is likely to vary as weather conditions or construction progress may accelerate, or delay, various stages.

The Port of Weipa will continue to receive deliveries of fuel, cargo, and equipment for the SoE Project at the Humbug, Evans Landing, and Lorim Point wharves from domestic (mostly the Port of Cairns) and international ports. Materials will then be transferred either to vehicles or smaller barges as required for transport to the SoE Project area. Some construction phase deliveries, such as construction materials and equipment modules, may be made directly to the Boyd Port site or the barge/ferry terminal sites. As such, while direct construction works may occur within the Project area, indirect impacts may occur across a broader geography.

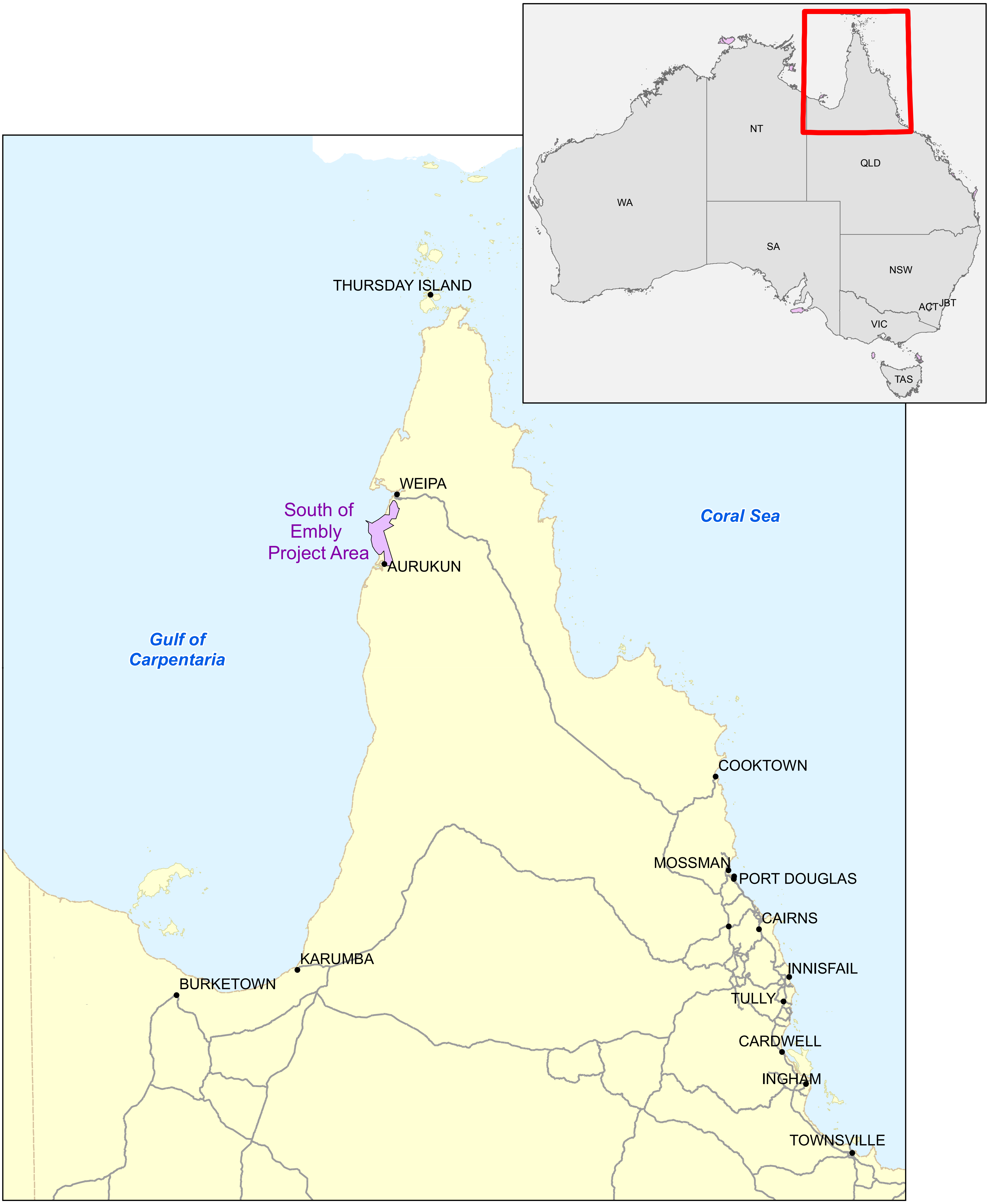
The SoE Inshore Dolphin Offset Strategy aims to collect information required to identify and manage potential impacts to dolphin species that are known to occur in the vicinity of the SoE Project. RTA has committed to implementing the SoE Project Inshore Dolphin Strategy (RTA 2014) (herein referred to as the Strategy). The Strategy documents the survey program to be conducted on the Australian snubfin dolphin (*Orcaella heinsohni*) and the Australian humpback dolphin (*Sousa sahulensis*) within the vicinity of the SoE Project area (Figure 1).

The Strategy has been prepared in consultation with the Department of Environment to address Conditions 49 to 55 of the SoE Project approval (EPBC 2010/5642) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Strategy has been designed to achieve the following:

- obtain knowledge about the distribution and abundance of local and regional populations of Australian snubfin and Australian humpback dolphins in the Western Cape York area (Condition 49);
- identify habitat utilised by these species (Condition 49);
- describe surveys to be undertaken in the marine environment between the latitudes 12.60°S and 13.35°S (Condition 50);
- provide scheduling in support of surveys being undertaken prior to construction, during construction and after construction of the Boyd Port and river facilities (Condition 50);
- contribute to the independent research on Australian snubfin and Australian humpback dolphins (Condition 51);
- specify targeted outcomes, benchmarks and readily measureable performance indicators and goals, and timeframes for reporting and implementation (Condition 51);
- identify the persons responsible for implementing the Strategy (Condition 51);
- provide information on Traditional Owner employment opportunities associated with the implementation of the Strategy (Condition 51);
- identify the mechanisms that will be used to report the number of local indigenous persons actually employed in the implementation of this SoE Strategy (Condition 51).

Survey findings that result from implementation of this Strategy will be used to inform the Marine and Shipping Management Plan for the operational phase of the SoE Project on an on-going basis (Condition 54).

Based on Strategy requirements, this report documents findings from the pre-construction surveys conducted in December 2014.



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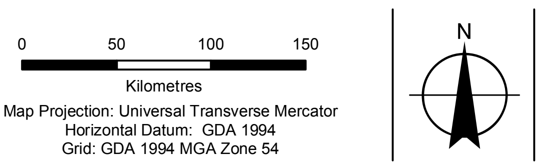
South of Embly Project Area

Roads



Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Location map

Figure 1

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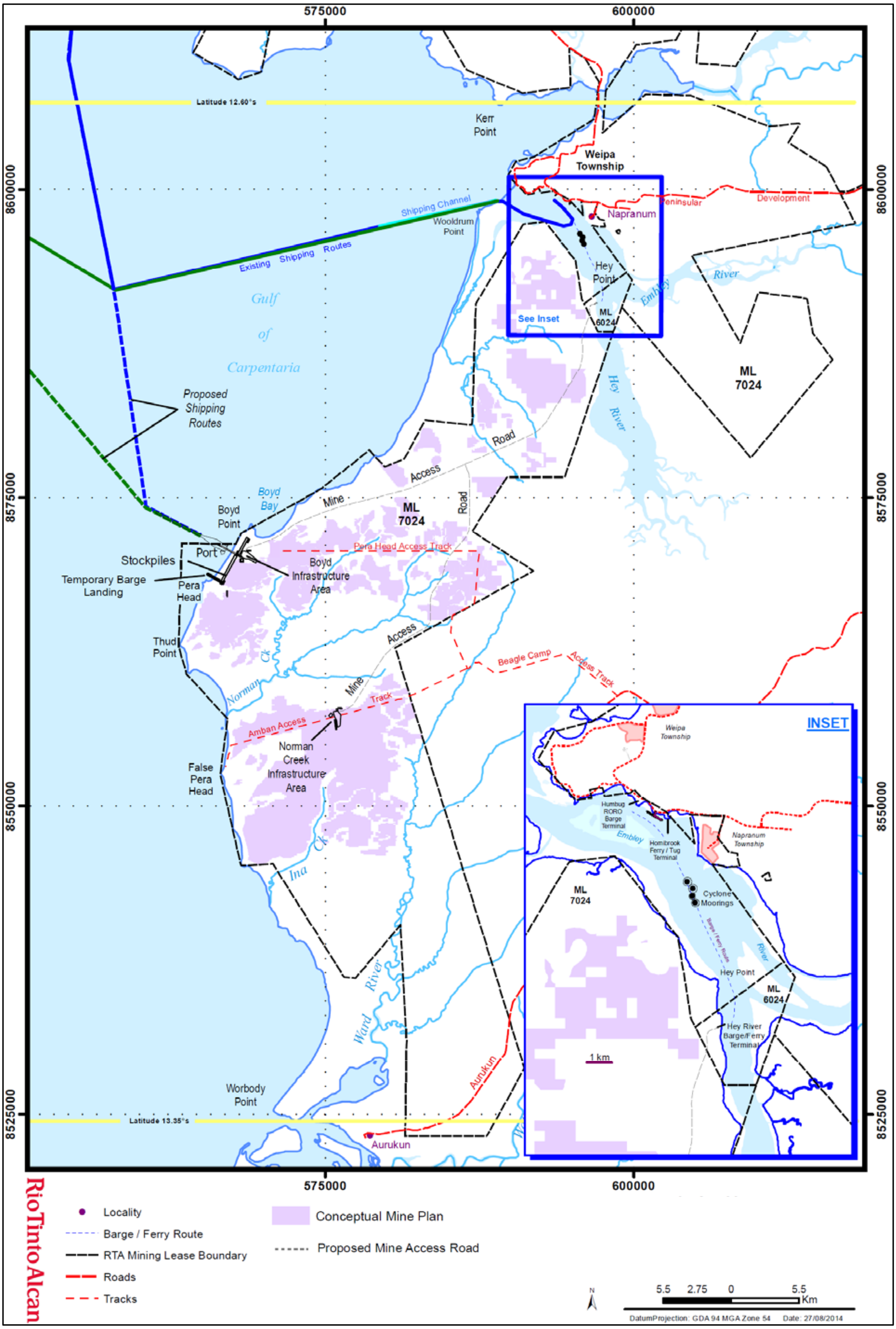


Figure 2 South of Embley Project Site

2. Survey Background, Objectives and Methods

2.1 Inshore Dolphins Status along Western Cape York

The Australian snubfin dolphin and Australian humpback dolphin are tropical inshore dolphins of northern Australia. Both are newly described species (2005 and 2014 respectively), thought to be endemic to northern Australia, and possibly Papua New Guinea (Beasley et al. 2005, Jefferson and Rosenbaum 2014). These little-known dolphin species occur in small, localised populations in often-remote regions of northern Australia, from the Fitzroy River on the east coast of Australia across to the Dampier Peninsula on the west coast. Indo-Pacific bottlenose dolphins (*Tursiops aduncus*: hereafter bottlenose dolphin) are also a dolphin species found throughout Northern Australian coastal waters. All three species are listed as migratory and Matters of National Environmental Significance in Australian legislation (Beasley et al. 2012, Allen et al. 2012, Bejder et al. 2012, Cagnazzi et al. 2013).

To date, there has been limited information available on inshore dolphins utilising Western Cape York. Dolphins were initially recorded in aerial surveys conducted by Marsh et al. (1998) along Western Cape York and the southern Gulf in 1997. During these surveys, 18 of the 64 dolphin groups (28%) sighted were confirmed to species:

- fourteen groups (78%) were bottlenose dolphins, in groups of up to 23 animals;
- two single Australian humpback dolphins were sighted (one near Albatross Bay and one north of Karumba);
- a group of seven Australian snubfin dolphins were sighted near the Wellesly Islands, and another two groups in Port Musgrave.

In May and July 2013, Beasley and Golding (2014) conducted nine days of transect surveys in the Karumba region, covering 832 km. Eleven dolphin groups were sighted consisting of nine Australian humpback dolphin groups (total group size = 37), one bottlenose dolphin group (total group size = 3) and one group of unknown species; probably humpback dolphins based on body features and colour (total group size = 3).

In 2009, the Port of Weipa Environmental Management Plan stated that “dolphins have been sighted and it is likely that inshore species such as Irrawaddy River dolphins [now known as Australian snubfin dolphins], Indo-Pacific humpback dolphins [now known as Australian humpback dolphins] and bottlenose dolphins inhabit coastal and estuarine areas, including port waters around Weipa. There is no indication that the region has any special significance for dolphins or whales” (NQBP 2009, pg 11). However, this statement was made with no megafauna-specific baseline studies having been conducted in the area. Incidental marine mammal observations were undertaken during habitat mapping at the proposed SoE port site between 2007 and 2010, which confirmed the presence of Australian snubfin dolphins and Australian humpback dolphins in the area (RTA Weipa, 2013, Figure 9-6). A nine-day cetacean survey in August 2012 over approximately 220km^2 confirmed the presence of Australian humpback dolphins within the Embley River Estuary (14 individuals) and at Boyd Point (four individuals) (RTA Weipa, March 2013, Section 9.5.2.3). The Australian snubfin dolphin was not observed in the August 2012 survey.

These observations confirm that inshore dolphin species use habitats associated with the Port of Weipa and other coastal locations to the north and south of the Port. However, these observations were limited as survey effort, and the number of sightings, were inadequate to provide robust population estimates or habitat use data. As the SoE Project construction and operational activities have potential to affect these species it is appropriate to collect relevant data, as provided through the Strategy.

2.2 Inshore Dolphin Strategy Objectives

The inshore dolphin surveys conducted as part of the Rio Tinto Alcan (RTA) South of Embley Project have two principal objectives:

- provide a better understanding of the distribution, habitat use and abundance of Australian snubfin and Australian humpback dolphins within the study area;
- contribute information towards the ‘co-ordinated research framework to assess the national conservation status of Australian snubfin dolphins (*Orcaella heinsohni*) and other tropical inshore dolphins’ (hereafter referred to as the National Inshore Dolphin Strategy) (refer Department of Environment 2013).

2.3 Study Design and Methods

2.3.1 Study Area

The survey design for the Strategy systematically covers the study area between latitudes 12.60°S and 13.35°S, which cover the Weipa/Aurukun region of Western Cape York, Queensland (Figure 3).

The Weipa/Aurukun region has a tropical monsoonal climate with distinct wet and dry seasons. The wet season occurs between October and April and tropical cyclones regularly cross the Gulf of Carpentaria during this period. Average annual rainfall in Weipa is ~1884 mm, 95% of which is received during the wet season (Larcombe and Taylor 1997; URS 2002). Temperatures range between 13°C and 35 °C in winter and 18°C and 38 °C in summer (NQBP 2009). South-easterly winds dominate in the dry season and lighter, northerly and westerly winds are predominant in the wet season. The monsoonal climate gives hot, wet summers and mild, dry winters (NQBP 2009).

Detailed descriptions of the marine habitat that spans the coastal waters from Weipa south to Thud Point can be found in the RTA SoE EIS (RTA Weipa 2013; Section 6 - Marine). There is minimal literature available on the marine environment south of Thud Point to the Aurukun Estuary system (i.e. Ward and Watson Rivers). The continental shelf bathymetry surrounding the Aurukun region extends up to 5km from the coast, with considerable freshwater/brackish discharge primarily south of the estuary mouth from the Ward and Watson Rivers. The Aurukun region is therefore more similar to Albatross Bay than the Pera Head/Thud Point region, where deep water (i.e. up to 25m in water depth) can be found 15km from the coast. ,

2.3.2 Survey Design

Vessel-based surveys were conducted out to 15km from the coast, covering water depths of at least 1-25m, and at least 15km upstream major rivers in both the Weipa and Aurukun Estuary systems. The survey design was developed using principles outlined in Dawson et al. (2008), and following accepted methods used for other inshore dolphin surveys (Balmer et al. 2008; Rosel et al. 2011; Beasley et al. 2013; Smith et al. 2013; Brown et al. 2014), with consideration of survey design principles based on Brooks et al. (2014) and Brooks and Pollock (2014).

Following recommendations for selecting sites for sampling (Brooks et al. 2014), the study area (1,014km^2) was separated into three sites (refer Figure 3):

- **Site 1 (410km^2)**

  Port of Weipa/Embley Estuary south to the tip of the RTA mining lease, including the Embley Estuary (existing anthropogenic impact: Appendix 1);

- **Site 2 (287km^2)**

  From the tip of the RTA mining lease south to Thud Point (SoE construction site: Appendix 2);

- **Site 3 (317km^2)**

  South of Thud Point to five kilometres south of the Ward River mouth, including the Archer, Ward and Watson River systems within the Aurukun Estuary (un-impacted site: Appendix 3).

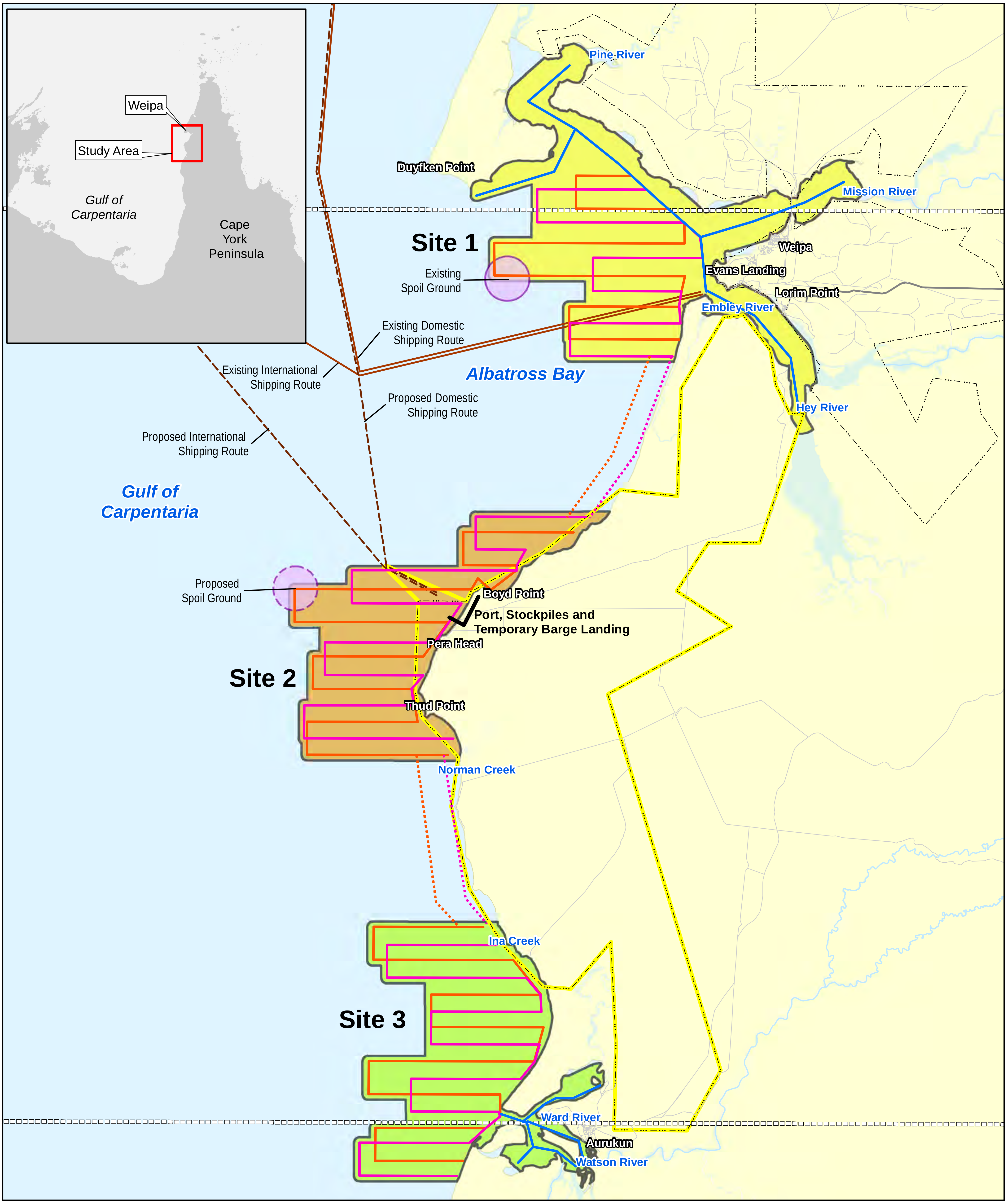
Transit lines that ran parallel to the coast, spaced 2km apart, were placed between these sites. These transit lines were designed to provide less intensive coverage of areas between sites, providing information on habitat use and movements between sites (Figure 3).

Each site was surveyed four times (i.e. four secondary samples) during the primary sample. The transect lines for each of the three sites were completed before the next secondary sample begins. Pre-determined transect length within each site are shown in Table 1.

Table 1 Survey Design Calculations for Each Site

Site area	Site Area (km2)	Transect Length (transect A + River) (km)	Transect Length (transect B + River) (km)	Proportion of area covered by transects (Transect A Length/Site Area)	Proportion of area covered by transects (Transect B Length/Site Area)
Site 1	410.4	154.5	147.4	0.4	0.4
Site 2	287.0	112.4	103.4	0.4	0.4
Site 3	316.9	137.5	129.2	0.4	0.4
All sites		404.4	380.0		

Data collection was based on photo-identification of individual dolphins within a capture-recapture model for estimating abundance. Using this method, individual dolphins are identified from photographs based on patterns of nicks and notches on the leading and trailing edges of the dorsal fin which are visible from both sides of individuals, which results in a database of individuals (Würsig and Jefferson 1990; Urian et al. 1999; Brown et al. 2014, Brooks and Pollock 2014).



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Transect A	Transit A	Site 1	North/South Project Boundaries	Existing Shipping Route	RTA Mining Lease 7024	Existing Dredge Spoil Grounds
Transect B	Transit B	Site 2		Proposed Shipping Route	South of Embly Project Area	Proposed Dredge Spoil Grounds
Transect River		Site 3				

0 5 10 15

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Study area showing sites and indicative survey lines

Figure 3

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66 Smith Street Darwin NT 0810 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drw@ghd.com.au **W** www.ghd.com.au

Data source: DNRM - Roads, Placenames (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CM

2.3.3 Vessels and Observers

Three vessels were used for surveys, one 16m live-aboard catamaran and two 5.5m aluminium plate vessels (Figure 4). One 5.5m vessel was based in Weipa and conducted Site 1 transects, while the other two vessels worked together to complete Sites 2 and 3; each site normally taking one day to complete using both vessels.

On all vessels two observers kept watch throughout the day, while a third observer rested. Observer positions were rotated every 30 minutes. Detailed survey protocol and data collection methods are described in detail in the Strategy (RTA 2014).

Figure 4 Live Aboard Vessel Eclipse and 5.5m Survey Tender

2.3.4 Encounter Rates

Encounter rates provide a standardised method to measure relative abundance within a pre-determined study area. Encounter rates were calculated using two methods, the Linear Encounter Rate (LER: i.e. total number of dolphins, including dependent calves, divided by the total kilometres travelled ‘on-effort’ during each sample), and the Survey Area Encounter Rate (SAER: i.e. total number of dolphins, including dependent calves, divided by the total survey area of the corresponding sample). The SAER assumes a 500m wide strip around the transect line (250m on each side of the transect line), as described in Brown et al. (2014).

2.3.5 Environmental Parameters

Environmental parameters (depth, temperature, turbidity, salinity and pH) were recorded with Horiba water quality meters at the location of each dolphin sighting, and at pre-determined locations along the transect lines within each site.

2.3.6 Abundance Estimates

Capture-Recapture Assumptions

Throughout the study, bias was minimised through relevant photo-identification techniques, in order to address all model assumptions. The assessment of the robustness of the various capture-recapture assumptions in the context of this study is based on Table 1 in Beasley et al. (2013).

Photo Grading

During analyses, all photo-identification images were examined and graded according to: 1) image quality (poor, good, and excellent); and 2) presence/absence of identifiable features (unrecognisable, subtle markings, and recognisable). Unusable images were graded as 'poor'; and usable images (good lighting; dorsal fin in-focus, completely visible and perpendicular to the image) were graded as 'good' or 'excellent'. Only individuals with unambiguous, permanent marks (see Slooten et al. 1992) were categorized as 'recognizable' in subsequent re-examination of the good or excellent images.

Estimating the Number of Recognisable Individuals

To estimate the number of recognisable individuals in the population during pre-construction surveys, a selection of closed models were fitted to capture histories of distinctive individuals to produce abundance estimates for each site, and for all sites combined. Closed models were run using the program CAPTURE within MARK (White 2004)

The closed capture-recapture models were run using Full Likelihood models of Otis et al (1978), which are based on the full likelihood parametrization with three types of parameters; p_i, c_i and f_o (the number of individuals in the population, but not encountered).

The advantages of using closed models are that they provide estimates with higher precision than open models and can allow for heterogeneity of capture probabilities between individuals (Brown et al. 2014). However, a major constraint is that closed models assume that the study site is closed to gains (i.e. births and immigration) or losses (i.e. deaths or emigration) of individuals for the duration of the sampling period. Violation of this assumption, which is likely during most photo-identification studies of inshore dolphins, is likely to result in biased estimates of abundance. For each sampling period, the closed model M*t* was fitted, which allows for capture probability to vary with time and between individuals.

Open models allow for demographic changes in the population over the sampling period, and provide estimates for gains and losses, although not allowing for non-random temporary emigration (Brown et al. 2014). POPAN open models consider the animals encountered during the sampling events representative of a component of a larger super-population, and estimate a probability of entry of animals from the super-population into the sampled population (Carroll et al. 2013, Tyne et al. 2014). These models allow correction for animals that may enter and exit the study area rapidly between sampling events, therefore being unavailable for capture. The super-population estimate is useful for studies such as this one, where the absolute size of a population is of more interest than the abundance or density of animals within a specific area at any given time (e.g. Constantine et al. 2012, Carroll et al. 2013).

Brooks and Pollock (2014) recommended that a Multistate Robust Design (MRD) model is used for analysis of capture-recapture data collected across impacted and non-impacted sites (Nichols and Coffman. 1999, Kendall and Nichols 2002, Kendall 2013). The MRD is an extension of the Closed Robust Design model (Pollock 1982, Pollock et al. 1990, Kendall et al. 1995, Kendall and Nichols 1995, Kendall et al. 1997) and the multistate model for recapture data (Arnason 1972; 1973, Brownie et al. 1993, Schwarz et al. 1993). After the next primary survey session (2015), robust capture-recapture models will be analysed using the program MARK 5.1 (White 2004). The robust design is considered most appropriate for this study as it uses a combination of closed and open models. In addition to estimating abundance, a robust design allows estimation of survival, temporary emigration, and recruitment (Kendall et al. 1997, Kendall 2010). Survival estimation using the robust design is relatively insensitive to heterogeneity (Pollock 1982, Pollock et al. 1990, Kendall 2010). The MRD will be used for analysis once two primary samples have been completed.

Estimating Mark Rate

Abundance estimates obtained through the capture–recapture analyses are only relevant to the recognisable individuals within the population and must be scaled by 'mark-rate' ($\hat{Q}$) in order to obtain an estimate of the total population size (Williams et al. 1993, Wilson et al. 1999, Chilvers and Corkeron 2003, Gormley et al. 2005, Parra et al. 2006). Assuming that recognisability was independent of the likelihood of dolphin's being within photographic range, and that photographic effort was uniform across individual animals during each encounter, the proportion of identifiable individuals in the total population was estimated by analysing all excellent quality photographs throughout the primary sample. The total number of photos with identifiable individuals was then divided by the total number of photographs in the sample, to provide an unbiased estimate of the proportion of identifiable individuals in the population (Gormley et al. 2005, Parra et al. 2006, Beasley et al. 2013).

The estimate of mark-rate and variance is produced by:

$$\hat{Q} = I/T \quad (1)$$

$$\mathrm{var}(\hat{Q}) = \frac{\hat{Q}(1-\hat{Q})}{T} \quad (2)$$

where I is the number of photographs of individuals with recognisable marks, and T is the total number of photographs taken during the study period.

Estimating The Total Population Size

To include the unmarked portion of the population in the estimates, the population estimate obtained by MARK was scaled by the mark-rate to provide an estimate of total abundance ($\hat{N}$) and its variance as follows:

$$\hat{N}_j^{\,*} = \frac{\hat{N}_j}{\hat{Q}} \quad (3)$$

$$\mathrm{var}\left(\hat{N}_j^{\,*}\right) = \left(\frac{\hat{N}_j}{\hat{Q}}\right)^2 \left(\frac{\mathrm{var}(\hat{N}_j)}{\hat{N}_j^{\,2}} + \frac{\mathrm{var}(\hat{Q})}{\hat{Q}^2}\right) \quad (4)$$

where j represents the sampling periods, $\hat{N}$ is the mark-recapture estimate, and $\hat{N}^*$ is the estimate of total abundance.

As recommended by Burnham and Anderson (1998), log-normal confidence intervals were constructed for abundance estimates, as standard confidence intervals often result in a lower limit below zero which is not realistic. Log-normal confidence intervals gave a lower limit of $\hat{N}_L^{\,*} = \hat{N}^*/r$, and an upper limit of $\hat{N}_U^{\,*} = \hat{N}^* \times r$.

For 95% confidence intervals, r is given by:

$$r = \exp\left[1.96\sqrt{In(1+CV(\hat{N}^*)^2)}\right] \quad (5)$$

2.4 Ethics and Survey Approvals

Field data collection took place under a Scientific Purposes Permit from the Queensland Department of Environment and Heritage Protection (WISP11956112), with approval from James Cook University (Approval A1750) and GHD Animal Ethics Committees. The surveys were conducted as part of the Western Cape Communities Co-Existence Agreement (WCCCA), with the permission and active participation of Wik Waya and Thanikwithi Traditional Owners (Figure 5).

2.4.1 Traditional Owner Involvement

In 2001, the Western Cape Communities Coexistence Agreement (WCCCA) was signed by 11 Traditional Owner Groups, four Aboriginal Shire Councils, Comalco, the Queensland Government and the Cape York Land Council, and was registered as an Indigenous Land Use Agreement (ILUA) with the Native Title Tribunal under the Native Title Act 1993 on 24 August 2001. The Agreement covers RTA's mining lease areas ML7024 and ML6024, and it formally acknowledges the rights and responsibilities of RTA and Traditional Owners over this area including, but not limited to environmental and cultural heritage management (RTA Weipa 2012).

Of relevance to the Strategy, Section 4.3.8 of the SoE Communities, Heritage and Environment Management Plan (RTA Weipa 2012) states that "*Traditional Owners expressed interest in understanding any impacts and management requirements for turtles, dugong, dolphins and other sea animals. RTA Weipa is required to undertake considerable survey work to understand the number of marine turtles and other marine animals, and where they live and nest in the area*". Sites of cultural importance (i.e. the Mouth of Norman Creek) were identified prior to survey in consultation with Traditional Owners to determine where survey vessels can, and cannot transit. The Strategy and all surveys will work within this Agreement, and in close consultation with the WCCCA, with regards to indigenous engagement throughout the project.

The importance of engaging with Traditional Owners and Indigenous ranger programs to obtain inshore dolphin occurrence and distribution information (particularly in remote regions of northern Australia), is acknowledged by both the Strategy and the National Inshore Dolphin Strategy. A key aim of the National Inshore Dolphin Strategy is to develop an indigenous engagement strategy (Department of the Environment 2013), and involve indigenous ranger groups in monitoring inshore dolphin populations. This study is in a unique position to contribute significantly towards this objective, through existing RTA policies regarding indigenous involvement in project activities, such as those described within the SoE Communities, Heritage and Environment Management Plan (RTA Weipa 2012), and established relationships with Traditional Owners in the region.

GHD would like to acknowledge and thank the Wik Waya and Thanikwithi Traditional Owners, who participated in these surveys and greatly assisted with data collection and sighting dolphin and marine megafauna groups (Wik Waya: Leon Hall, Natasha Wales and Simeon John; Thanikwithi: Henry Hart, Garrett Kerindum, Richard Ornyengaia, Helen Karyuka, Marion Kerindum, Mildred Karyuka: Figure 5), and the RTA Community Relations Advisors and Wolf Leschinok, who facilitated Traditional Owner involvement.

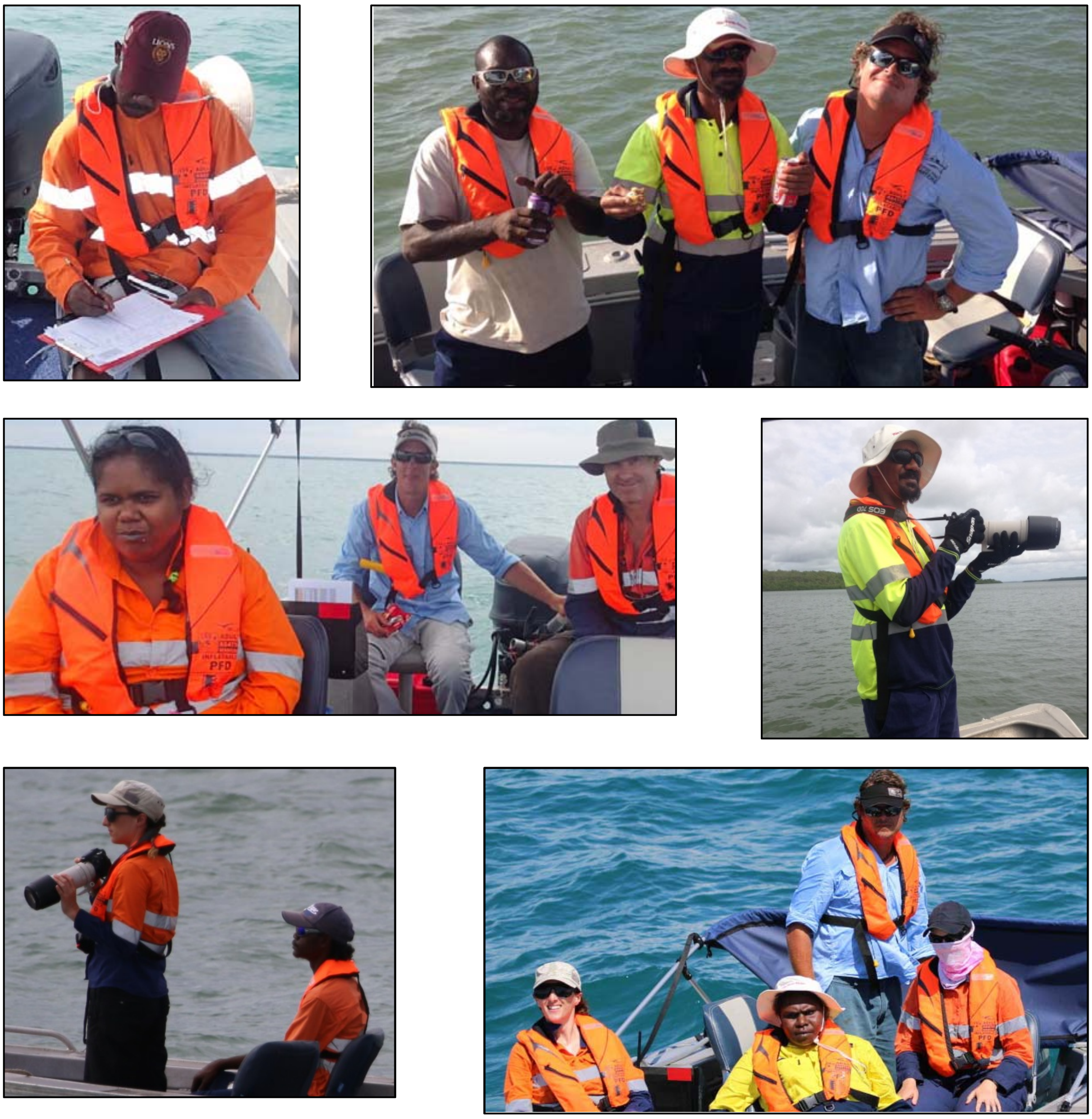


Figure 5 Traditional Owners Involved in Preconstruction Surveys

3. Results

3.1 Training and Survey Schedule

Two days of training were conducted with all survey personnel, including seven Wik Waya and Thanikwithi Traditional Owners, on 6 and 7 December 2014 (in-class and boat-based training days respectively). Boat-based surveys were conducted throughout the study site from 7-19 December 2014, no surveys conducted on 12-13 December 2014 due to poor weather (Table 2).

Table 2 Training and Survey Schedule

Date	Activity	Secondary Sample	Tidal Cycle
05 December 2014	Personnel arrive to Weipa		
06 December 2014	Training – In-class		
07 December 2014	Training – Boat-based – Site 1	1	Spring
08 December 2014	Surveys – Site 1 and 3	1	Spring
09 December 2014	Surveys – Site 1 and 2	1	Spring
10 December 2014	Surveys – Site 1 and 2	2	Spring
11 December 2014	Surveys – Site 1 and 3	2	Spring
12 December 2014	No surveys (poor weather)		
13 December 2014	No surveys (poor weather)		
14 December 2014	Surveys – Site 1	2	Neap
15 December 2014	Surveys – Site 1 and 2	3	Neap
16 December 2014	Surveys – Site 1 and 3	3	Neap
17 December 2014	Surveys – Site 1 and 3	4	Neap
18 December 2014	Surveys – Site 1 and 2	4	Neap
19 December 2014	Surveys – Site 1 Demob in evening	4	Neap

3.1.1 Training Days

The in-class training included discussion on:

- Aims and objectives of the project;
- Job Safety Analysis and risk assessment;
- Marine mammal identification (with a focus on inshore dolphins and dugongs);
- Turtle identification (with a focus on species that can be found within the study area);
- Mapping of areas dolphins have previously been sighted within, and outside, the study area, and discussion of culturally important sites that survey vessels should not traverse;
- An introduction to survey and observer protocols;
- Data collection protocols;
- Introduction to survey equipment;
- Information regarding vessels that will be used for surveys, including safe-operating procedures when working on-board vessels.

In addition to the in-class training, half a day of at-sea training was conducted to confirm all vessels were appropriately equipped for the surveys, and to familiarise all survey personnel with the vessels and data collection protocols.

All GHD personnel were already experienced with inshore dolphin surveys, so the two 5.5m vessels began Sample 1 surveys in Site 1 during the training day, while two experienced GHD observers and all Traditional Owners conducted the training day on-board the live-aboard.

3.2 Survey Effort

Survey effort was conducted throughout Sites 1-3, as well as while transiting between sites during daylight hours (Figure 3).

During 11 days of surveys, a total of 3,182km were travelled over 288hrs, consisting of:

- 3031km over 276hrs within sites;
- 161km over 12hrs while transiting between sites.

3.2.1 Survey Effort within Sites

A total of 3031km (276hrs) were travelled within sites. Of this total, 1,662km (167hrs) were spent 'on-transect' surveying for dolphins. The effort (kilometres travelled and time) within each site is shown in Table 3.

Table 3 Total Distance and Time Spent Surveying at Each Site

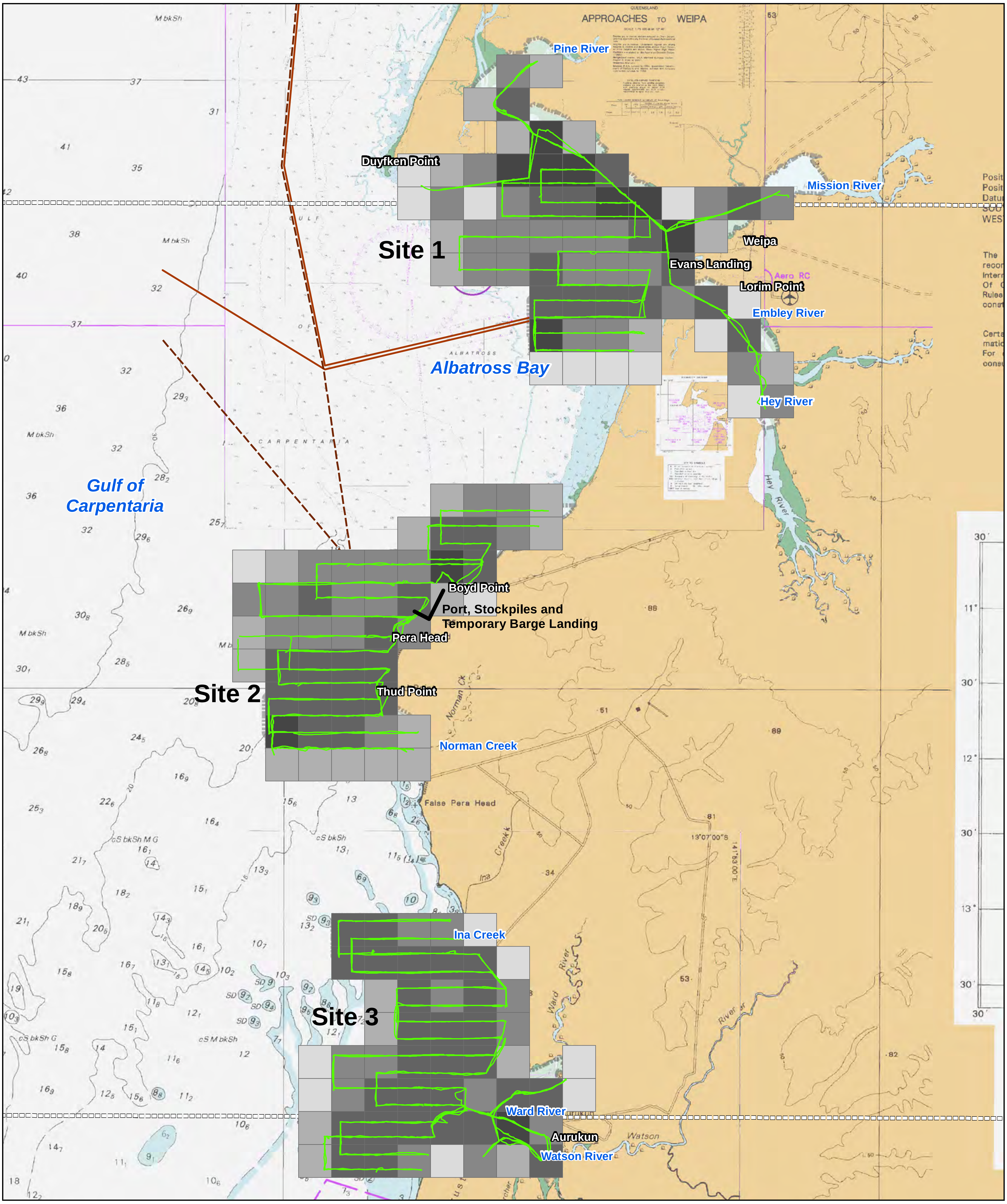
Sample Number	Total Kilometres Travelled	Total Time On Water (hh:mm)	Total Transect Kilometres Travelled	Total Transect Time (hh:mm)	Total Number of Sightings
1	794.4	75:57	430.4	42:29	34
2	665.8	58:57	394	38:31	19
3	799.6	70:42	435.9	44:18	30
4	760.9	70:44	401.4	41:31	27
Total - Sites	3020.7	276:20	1661.7	166:49	110
Total - Transit	160.9	11:33	150	10:29	1
Combined Total	3181.6	287:53	1811.7	177:18	111

Note: The total kilometres travelled and total time on water included transit to, and from, the survey lines and back to the vessel/boat ramp at the end of the day. The total transect kilometres and total transect time is the time spent on transect lines searching for dolphins. The totals are provided for all sites combined (Total – Sites), for transit surveys between sites (Total – Transit), and the combined total from all surveys (Combined Total).

With one 5.5m vessel, Site 1 took approx. 2-3 days to complete. At the start and end of the primary sample, all three vessels were able to assist surveying Site 1, which enabled the four secondary samples to be completed on-time.

With two vessels surveying Site 2 and 3, each site took one day to survey, given good weather conditions and approx. 7 – 10 hours surveying time/day per vessel (i.e. calm in the mornings, with weather conditions deteriorating as the day progressed). Some survey effort was conducted in Beaufort 4, in the event that winds were unusually strong in the morning (i.e. morning sea breeze), or under the circumstance that only a small amount of transect remained at the end of the day to finish the site, and a transit was required to the next site that afternoon..

Extrapolating from a 500m survey strip around the transect lines (i.e. 250m on each side), each sample surveyed approximately 40% of the total study area. Survey effort was relatively even across the study area, with some expected peaks where survey lines overlapped and near the coast. Within a 3km x 3km grid overlay, survey effort ranged from <2 – 25 km^2 (Figure 6).



LEGEND

Survey effort (km^2)

- < 1
- 1 - 3
- 3 - 6
- 6 - 9
- 9 - 13.5
- Transects completed
- North/South Project Boundaries
- Site boundary

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Job Number	43-22205
Revision	0
Date	23 Jan 2015

Effort map showing transects and total survey effort for all secondary samples combined

Figure 6

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66 Smith Street Darwin NT 0810 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drw@ghd.com.au **W** www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

3.2.2 Survey Effort While Transiting

A total of 161km (12hrs) were travelled while transiting between sites. Of this total, 150km (10hrs) were spent surveying for dolphins on six transits (Table 4).

Table 4 Total Distance and Time Spent Surveying while Transiting Between Sites

Date	Location	Total Kilometres Travelled	Total Time On Water (hh:mm)	Total Transect Kilometres Travelled	Total Transect Time (hh:mm)	Total Number of Sightings
07-Dec-14	Transit - Site 1 to 2	30.7	2:33	30.7	2:33	0
10-Dec-14	Transit - Site 2 to 3	33.6	1:15	33.6	1:15	0
10-Dec-14	Transit - Site 2 to 3	40.4	3:10	29.9	2:19	0
12-Dec-14	Transit - Site 3 to 2	20.7	1:52	20.7	1:52	0
16-Dec-14	Transit - Site 2 to 3	16.6	1:19	16.2	1:06	1
18-Dec-14	Transit - Site 2 to 1	18.9	1:24	18.9	1:24	0
	TOTAL	**160.9**	**11:33**	**150.0**	**10:29**	**1**

Note: The total kilometres travelled and total time on water included transit between sites, and some transit within sites. The total transect kilometres and total transect time is the time spent on transit with observers searching for dolphins.

3.3 Weather Conditions

3.3.1 Beaufort Conditions during Site Surveys

Overall, survey conditions were very good during site surveys, with 59.5% of survey effort spent in Beaufort 2 or less conditions (Table 5, Figure 7 and Figure 8):

Table 5 Beaufort Conditions during Site Surveys

Beaufort	Wind Speed (knots)	Total Kilometres Travelled	Proportion (%) of Transect Kilometres
0	0	19.1	1.0
1	1-3	108.3	6.5
2	4-6	868.7	52.0
3	7-10	572.2	34.0
4	11-15	93.4	6.5

Note: Table 5 provides information on the Beaufort state, wind speed characteristic of each Beaufort state, the total kilometres travels on transect in each Beaufort state (i.e. transits to and from transect lines are excluded from this total), and the subsequent proportion of transect kilometres conducted in each Beaufort state.

Figure 7 Example of Beaufort 0 Conditions

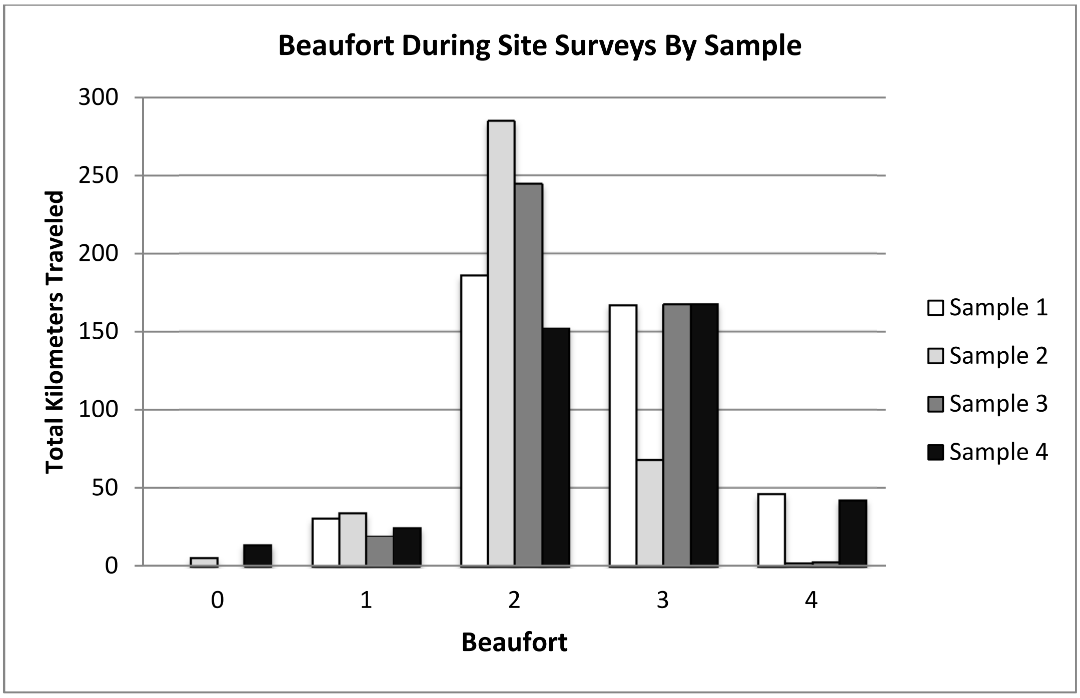


Figure 8 Summary of the Total Kilometres Surveys within Sites and Beaufort Condition

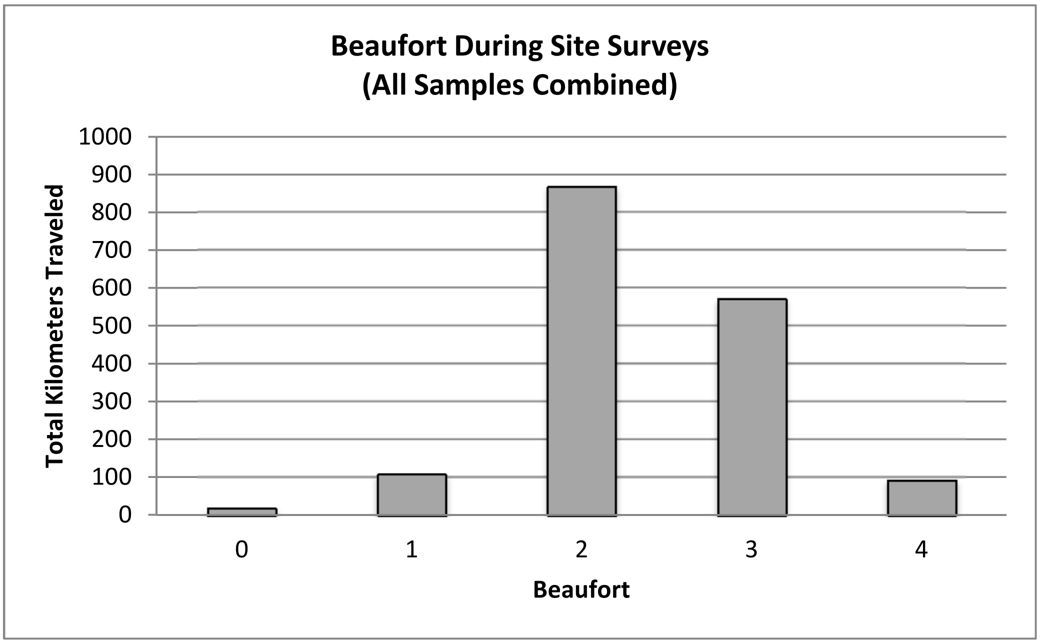
3.3.2 Beaufort Conditions during Transit Surveys

Transits between sites were normally conducted in the late afternoon/early evening once a site had been completed. As a result of being conducted in the late afternoon, weather conditions were often unfavourable, with 52% of effort conducted in Beaufort 3 conditions and 48% in Beaufort 4 conditions (Table 6, Figure 9). Transit surveys were not conducted during the morning when the weather was calmest because this provided the optimal conditions to complete the transect site surveys (which were always the highest priority), before the weather deteriorated in the early afternoon.

Table 6 Summary of Beaufort Conditions during Transit Surveys

Beaufort	Wind Speed (knots)	Total Kilometres Travelled	Proportion (%) of Transect Kilometres
0	0	0.0	0
1	1-3	0.0	0
2	4-6	0.0	0
3	7-10	78.2	52
4	11-15	71.8	48

Note: Table 5 provides information on the Beaufort state, wind speed characteristic of each Beaufort state, the total kilometres travels on transect in each Beaufort state (i.e. transits to and from transect lines are excluded from this total), and the subsequent proportion of transect kilometres conducted in each Beaufort state.



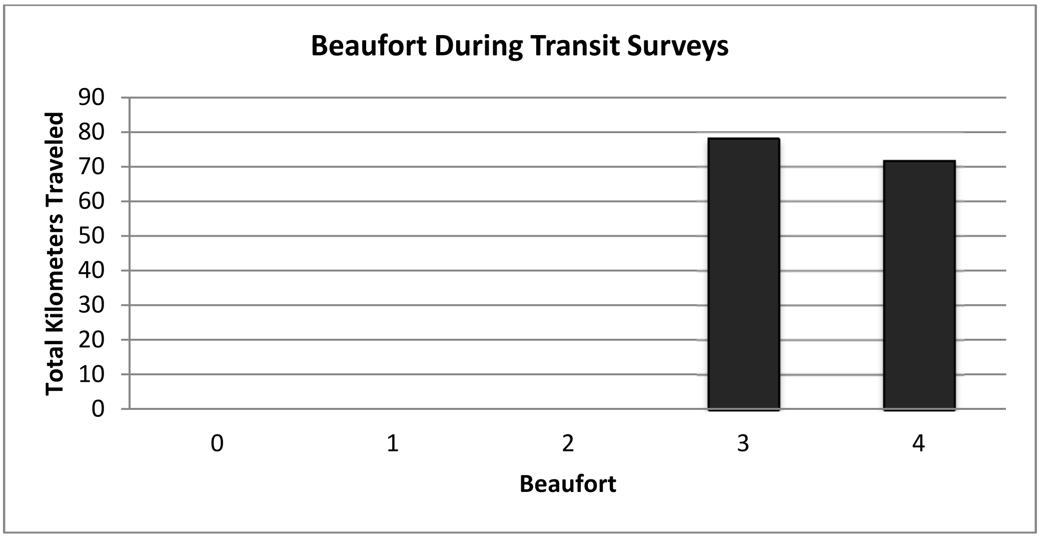


Figure 9 Summary of Beaufort Conditions during Transect Surveys Within Sites (Top) and Transit Surveys (Bottom)

3.4 Dolphin Sightings

3.4.1 Dolphin Observations within Sites

During surveys within sites, a total of 110 dolphin groups were observed (total group size = 476) (Table 7; Figure 10), with the following observations:

- Australian humpback dolphins = 283 (all sites);
- Bottlenose dolphins = 156 (all sites);
- Australian snubfin dolphins = 17 (primarily Site 3, with one dolphin in Site 1);
- Spinner dolphins = 9 (Site 2);
- Offshore bottlenose dolphins = 4 (Site 2);
- Unknown dolphins = 7 (all sites).

Table 7 Summary of Dolphin Groups Observed

Species	Number of Groups	Total Group Size	Number of calves	Calf Species in Mixed Groups
Humpback	78	277	1	
Bottlenose	16	138	10	
Snubfin	6	16	0	
Humpback/ Bottlenose	2	20 (2 humpback / 18 bottlenose)	1	Bottlenose (1)
Humpback/ Snubfin	1	5 (4 humpback / 1 snubfin)	2	Humpback (2)
Offshore Bottlenose	1	4	0	
Spinner	1	9	0	
Unknown	5	7	0	
TOTAL	**110**	**476**	**14**	

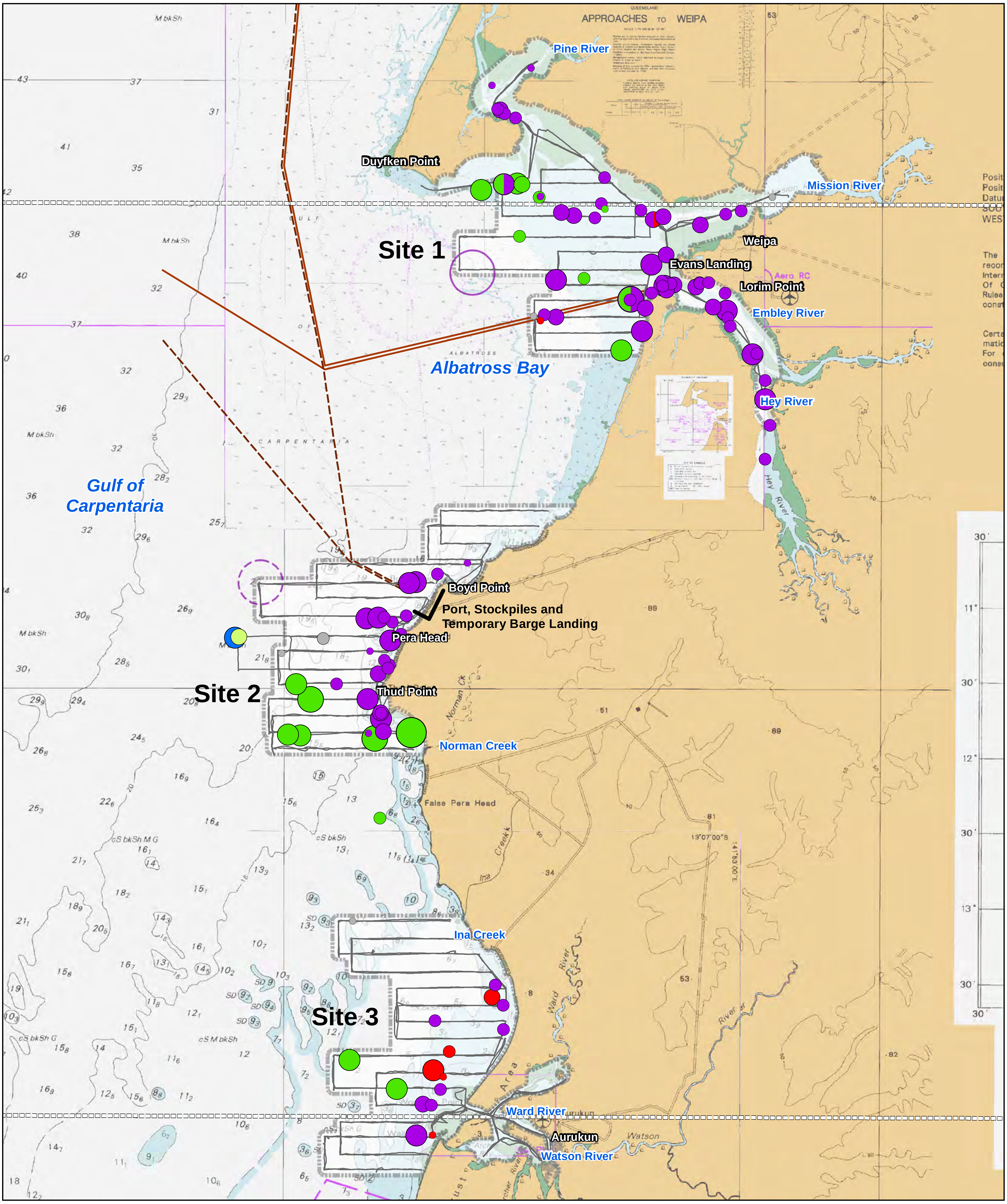
Note: The sighting summary includes the species, the number of groups sighted, the total group size, the number of calves observed within groups, and what species of calf were observed within the mixed species groups.

The number of groups observed in each sample ranged from 19 – 34 (Sample 2 and Sample 1 respectively), with total group size ranging from 115 – 159 (Sample 2 and Sample 4 respectively: Table 8). Two mixed species groups of humpback and bottlenose dolphins were observed during surveys (all Site 1), and one mixed species group of humpback and snubfin dolphins (Site 1) (Table 7).

Table 8 Summary of Dolphin Species / Mixed Species Groups Observed

Species	Sample 1		Sample 2		Sample 3		Sample 4	
	Group	Size	Group	Size	Group	Size	Group	Size
Humpback	24	81	12	40	25	95	17	61
Bottlenose	6	30	3	20	2	9	5	79
Snubfin	--	--	2	7	1	3	3	6
Humpback/Bottlenose	1	11	--	--	1	9	--	--
Humpback/Snubfin	--	--	1	5	--	--	--	--
Offshore Bottlenose	--	--	--	--	--	--	1	4
Spinner	--	--	--	--	--	--	1	9
Unknown	3	3	1	3	1	1	--	--
TOTAL	**34**	**125**	**19**	**115**	**30**	**117**	**27**	**159**

Note: Each sample is separated into the total number of groups observed (i.e. Group) and total group size (i.e. Size).



LEGEND

Species

- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Snubfin
- Offshore bottlenose
- Spinner
- Unknown

Group Size

- 1
- 2-3
- 4-5
- 6-10
- 11-20
- 32

- Transects completed
- Site boundary
- North/South Project Boundaries

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Job Number 43-22205
Revision 0
Date 23 Jan 2015

Dolphin sightings
- all samples combined

Figure 10

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66 Smith Street Darwin NT 0810 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drw@ghd.com.au W www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

3.4.2 Dolphin Sightings While Transiting

Only one bottlenose dolphin group (2 individuals) was observed while conducting transit surveys (between Sites 3 and 2).

3.4.3 Dolphin Group Size and Composition (Within Sites)

Bottlenose dolphins had the largest average group sizes (9 individuals) of all species, with Australian snubfin dolphins having the smallest (3 individuals). Australian humpback dolphin average group size was 4 individuals (Table 9).

The largest group sizes encountered for all three species were:

- bottlenose dolphin = 32 individuals (south of Thud Point);
- humpback dolphin = 9 individuals (Hey River);
- snubfin dolphin = 6 individuals (northwest of Aurukun Estuary mouth).

Table 9 Dolphin Group Size and Composition

	Humpback	Bottlenose	Snubfin	Spinner	Offshore Bottlenose
Average group size (Stdev)	3.6 (1.93)	8.6 (7.61)	2.7 (2.07)	9.0	4.0
Range	1 - 9	1 - 32	1 - 6	--	--
Total number of sightings	78	16	6	1	1
Total group size	277	138	16	9	4
Total adults (%)	227 (82%)	112 (81%)	14 (88%)	9	4
Total juveniles (%)	40 (14%)	25 (18%)	2 (12%)	--	--
Total calves (%)1	10 (4%)	1 (1%)	0	--	--

Note: The values are for all sites and all samples combined. For each species sighted during pre-construction surveys, the summary table presents the average group size (including standard deviation), group size range, total number of sightings, total group size and the proportion of adults, juveniles and calves in each group.

All species had similar average group sizes between samples. The only exception was bottlenose dolphin groups during Sample 4, which had much larger average group sizes (all groups observed in Site 2).

Australian Humpback Dolphins

Australian humpback dolphins were observed in all sites. Average group size was similar throughout all samples, with the most individuals (n=95) observed during Sample 3(Table 20). Groups were generally quite approachable which enabled good photo-identification (Figure 11.)

[1] No neonate dolphins were sighted during pre-construction surveys

Table 10 Humpback Dolphin Group Size and Composition

	Sample 1	Sample 2	Sample 3	Sample 4
Average group size (Stdev)	3.4 (2.00)	3.3 (1.44)	3.8 (2.20)	3.6 (1.84)
Range	1 - 9	1 - 5	1 - 8	1 - 7
Total number of sightings	24	12	25	17
Total group size	81	40	95	61
Total adults (%)	68 (84%)	27 (68%)	83 (87%)	49 (80%)
Total juveniles (%)	9 (11%)	10 (25%)	10 (11%)	11 (18%)
Total calves (%)	4 (5%)	3 (7%)	2 (2%)	1 (2%)

Figure 11 Adult Australian Humpback Dolphin Observed during Surveys

Bottlenose Dolphins

Bottlenose dolphins were observed in all sites. Average group size was similar for most samples, apart from Sample 4 when a group of 32 individuals were observed south of Thud Point in Site 2 in the early morning. Large bottlenose groups were subsequently observed throughout the day in Site 2 (Table 11). Most bottlenose dolphin groups were quite approachable, which enabled good photo-identification (Figure 12).

Table 11 Bottlenose Dolphin Group Size and Composition

Total - All Sites	Sample 1	Sample 2	Sample 3	Sample 4 *
Average group size (Stdev)	5.0 (2.28)	6.7 (2.52)	4.5 (4.95)	15.8 (10.31)
Range	3 - 8	4 - 9	1 - 8	6 - 32
Total number of sightings	6	3	2	5
Total group size	30	20	9	79
Total adults (%)	26 (87%)	17 (85%)	7 (78%)	62 (78%)
Total juveniles (%)	4 (13%)	2 (10%)	2 (22%)	17 (22%)
Total calves (%)	0	1 (5%)	0	0

Note: * Very high numbers of bottlenose dolphins sighted in Site 2 during Sample .

Figure 12 Juvenile Bottlenose Dolphin Observed during Surveys

Australian Snubfin Dolphins

Australian snubfin dolphins were observed in Sites 1 and 3, although the majority of groups were observed in Site 3 (Table 12). Of the six groups observed, average group size was small (2-4 individuals per sample). Australian snubfin dolphin groups were very difficult to approach and photograph, which resulted in a small number of photo-identifications. Most groups were observed in good conditions (i.e. Beaufort <2) and often traveling away from the vessel (Figure 13). These sighting restrictions would indicate that there were probably more Australian snubfin groups in the area but their evasive behaviour may have resulted in an unknown proportion of groups being missed.

Table 12 Australian Snubfin Dolphin Group Size and Composition

	Sample 1	Sample 2	Sample 3	Sample 4
Average group size (Stdev)	--	3.5 (3.54)	3	2.0 (1.73)
Range	--	1 - 6	--	1 - 4
Total number of sightings	--	2	1	3
Total group size	--	7	1	6
Total adults (%)	--	5 (71%)	3 (100%)	6 (100%)
Total juveniles (%)	--	2 (29%)	0	0
Total calves (%)	--	0	0	0

Figure 13 Adult Australian Snubfin Dolphins Observed during Surveys

A single Australian snubfin dolphin was sighted near the Aurukun Estuary mouth. This animal was observed to have a pox-like infection over its body, which was not observed in any other Australian snubfin dolphins encountered (Figure 14).

Figure 14 Australian Snubfin Dolphin With a Pox-like Infection Over Most of Its Upper Body

Mixed Species Groups

Three mixed species dolphin groups (i.e. two humpback and bottlenose dolphin groups and one humpback and snubfin dolphin group) were observed during surveys. All mixed groups were sighted in Site 1 (Table 13).

Table 13 Mixed Species Dolphin Group Size and Composition

	Humpback/Bottlenose	Snubfin/Humpback
Average group size (Stdev)	10.0 (1.41)	5
Range	9 - 11	--
Total number of sightings	2	1
Total group size	20 (humpback = 2 / bottlenose = 18)	5 (humpback = 4 / snubfin = 1)
Total adults (%)	16 (humpback = 2 / bottlenose = 14	3 (humpback = 2 / snubfin = 1)
Total juveniles (%)	3 (bottlenose)	0
Total calves (%)	1 (bottlenose)	2 (humpback)

Gray's Spinner Dolphins

A group of nine Gray's spinner dolphins (*Stenella longirostris longistris*) were observed in Site 2 approximately 15km west of Pera Head, in 25m water depth (Figure 15).

Figure 15 Gray's Spinner Dolphin Observed during Surveys

Offshore Bottlenose Dolphins

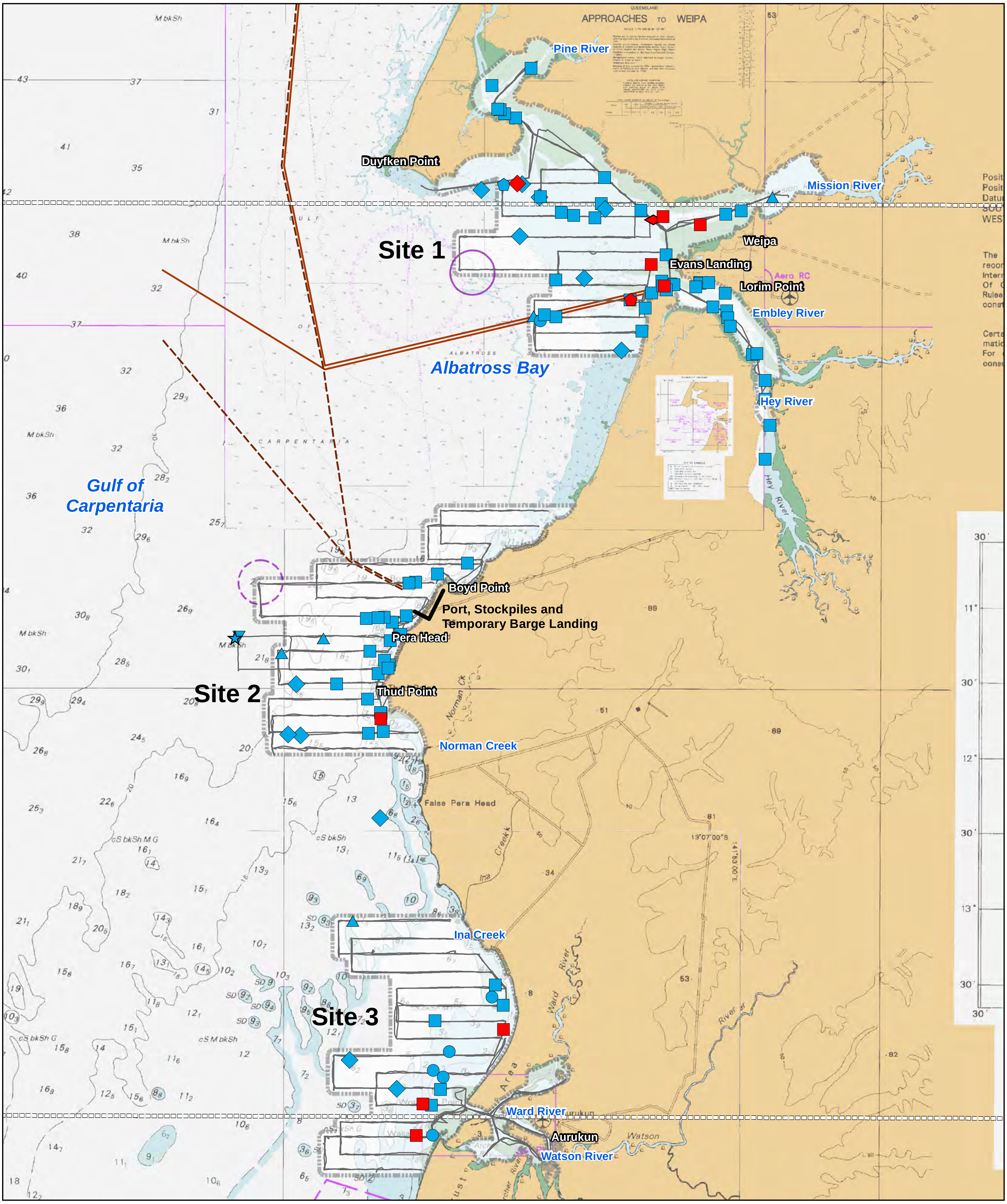
A small group of four offshore bottlenose dolphins were observed within 500m of the group of the Gray's spinner dolphins (Figure 16).

Figure 16 Offshore Bottlenose Dolphin Observed during Surveys

Calves Sighted During Surveys

Fourteen calves were observed during surveys (Figure 17), consisting of 12 humpback dolphin calves and 2 bottlenose dolphin calves (Table 7and Table 8). The majority of calves were observed in Site 1, with three calves observed in Site 3 and one calf observed in Site 2 (Figure 18).

Figure 17 Example of an Australian Humpback Dolphin Calf Sighted during Surveys (Site 3)



LEGEND

Dolphin Calves
- Calf present in group
- Calf absent in group

Species
- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Offshore bottlenose
- Snubfin
- Spinner
- Unknown
- Transects completed
- Site boundary
- North/South Project Boundaries

0 2 4 6 8 10
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Dolphin calf sightings

Figure 18

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3.5 Dolphin Encounter Rates

Encounter rates provide a measure of relative abundance, so enable studies at different regions to be compared, as long as the same methodology is used in each study.

3.5.1 Linear Encounter Rate

The Linear Encounter Rate (LER) was calculated as the total number of dolphins (including dependent calves), divided by the total kilometres travelled 'on-effort' during each sample.

LERs were calculated for each site for each sample, where for all sites combined, Australian humpback dolphins were by far the most frequently encountered species (0.17 dolphins per km of transect), followed by bottlenose dolphins (0.09 dolphins per km of transect) and then Australian snubfin dolphins (0.01 dolphins per km of transect) (Figure 19).

LERs for each sample are shown in Table 14 and Appendix 7-10.

- Australian humpback dolphin encounter rates were highest in Sample 3 (0.22 dolphins per km of transect), and lowest in Sample 2 (0.10 dolphins per km of transect).
- Bottlenose dolphin encounter rates were highest in Sample 4 (0.20 dolphins per km of transect), and lowest in Sample 3 (0.02 dolphins per km of transect).
- Australian snubfin dolphin encounter rates were highest in Sample 2 (0.02 dolphins per km of transect); Australian snubfin dolphins were not sighted in Sample 1 or 3.

Table 14 Linear Encounter Rates for each Inshore Dolphin Species

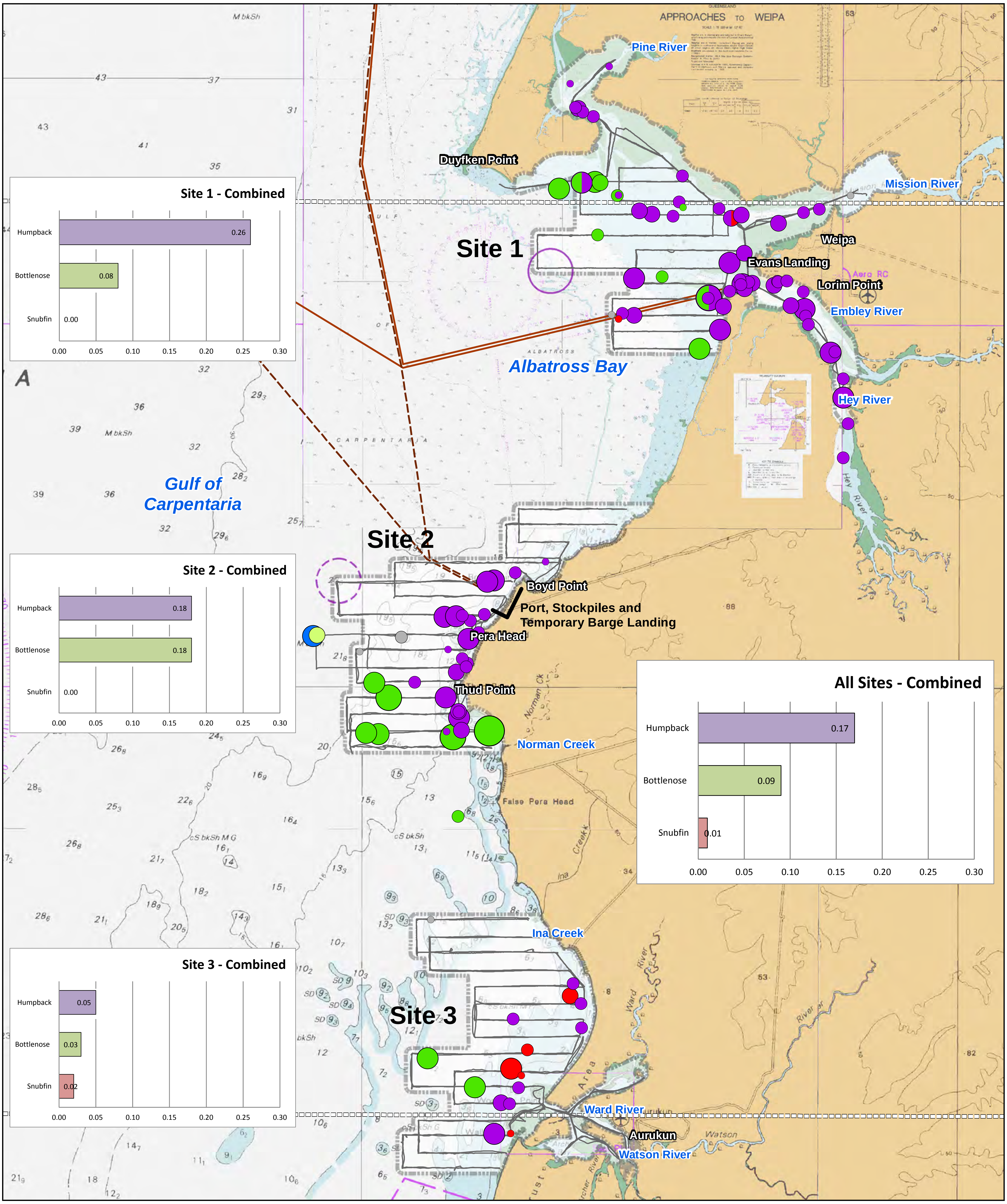
Sample	Total survey length (km)	Encounter rate (per km travelled)		
		Humpback	Bottlenose	Snubfin
Sample 1	430.4	0.19	0.09	0.00
Sample 2	394.0	0.10	0.05	0.02
Sample 3	435.9	0.22	0.02	0.00
Sample 4	401.4	0.15	0.20	0.01
Overall Total	1661.7	0.17	0.09	0.01

LERs for each site are shown in Table 15 and Appendix 7-10.

- Australian humpback dolphin encounter rates were highest in Site 1 (0.26 dolphins per km of transect) and lowest in Site 3 (0.05 dolphins per km of transect);
- Bottlenose dolphin encounter rates were highest in Site 2 (0.18 dolphins per km of transect) and lowest in Site 3 (0.02 dolphins per km of transect);
- Australian snubfin dolphin encounter rates were highest in Site 3 (0.02 dolphins per km of transect) and lowest in Site 1 (<0.001 dolphins per km of transect); no Australian snubfin dolphins were sighted in Site 2.

Table 15 Linear Encounter Rates of Inshore Dolphins

Site	Total survey length (km)	Encounter rate (per km travelled)		
		Humpback	Bottlenose	Snubfin
Site 1	638.2	0.26	0.08	0.00
Site 2	472.3	0.18	0.18	0.00
Site 3	551.2	0.05	0.03	0.02
Overall Total	**1661.7**	**0.17**	**0.09**	**0.01**



LEGEND

Species

- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Snubfin
- Offshore bottlenose
- Spinner
- Unknown

Group Size

1, 2-3, 4-5, 6-10, 11-20, 32

- Transects completed
- Site boundary
- North/South Project Boundaries

0 2 4 6 8 10
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Dolphin sightings with encounter rates - all sightings combined

Figure 19

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3.5.2 Survey Area Encounter Rate

The Survey Area Encounter Rate (SAER) was calculated as the total number of dolphins (including dependent calves), divided by the total survey area of the corresponding sample (assuming a 500m wide strip around the transect line).

The survey effort (length and area) and encounter rates per sample are shown in Table 16. The results are obviously the same if using LERs or SAERs because the transect length contributes to both calculations, however presenting both methods enables comparisons with studies that use either method to calculate encounter rates. SAER encounter rates for Australian humpback dolphins were highest in Sample 3 (0.47 individuals per km^2), for bottlenose dolphins highest in Sample 4 (0.41 individuals over km^2), and for Australian snubfin dolphins highest in Sample 2 (Table 16).

Table 16 Survey Area Encounter Rates for Each Inshore Dolphin Species

Sample	Total survey length (km)	Survey Area (Km^2)	Encounter rate (per km^2)		
			Humpback	Bottlenose	Snubfin
Sample 1	430.4	204.1	0.40	0.20	0.00
Sample 2	394.0	191.2	0.21	0.10	0.04
Sample 3	435.9	203.8	0.47	0.04	0.00
Sample 4	401.4	194.5	0.31	0.41	0.03
Overall Total	**1661.7**	**793.6**	**0.35**	**0.19**	**0.02**

SAERs for each site are shown in Table 17. Australian humpback dolphin encounter rates were highest in Site 1, bottlenose dolphin encounter rates were highest in Site 2 and Australian snubfin dolphin encounter rates were highest in Site 3.

Table 17 Survey Area Encounter Rates Per Site

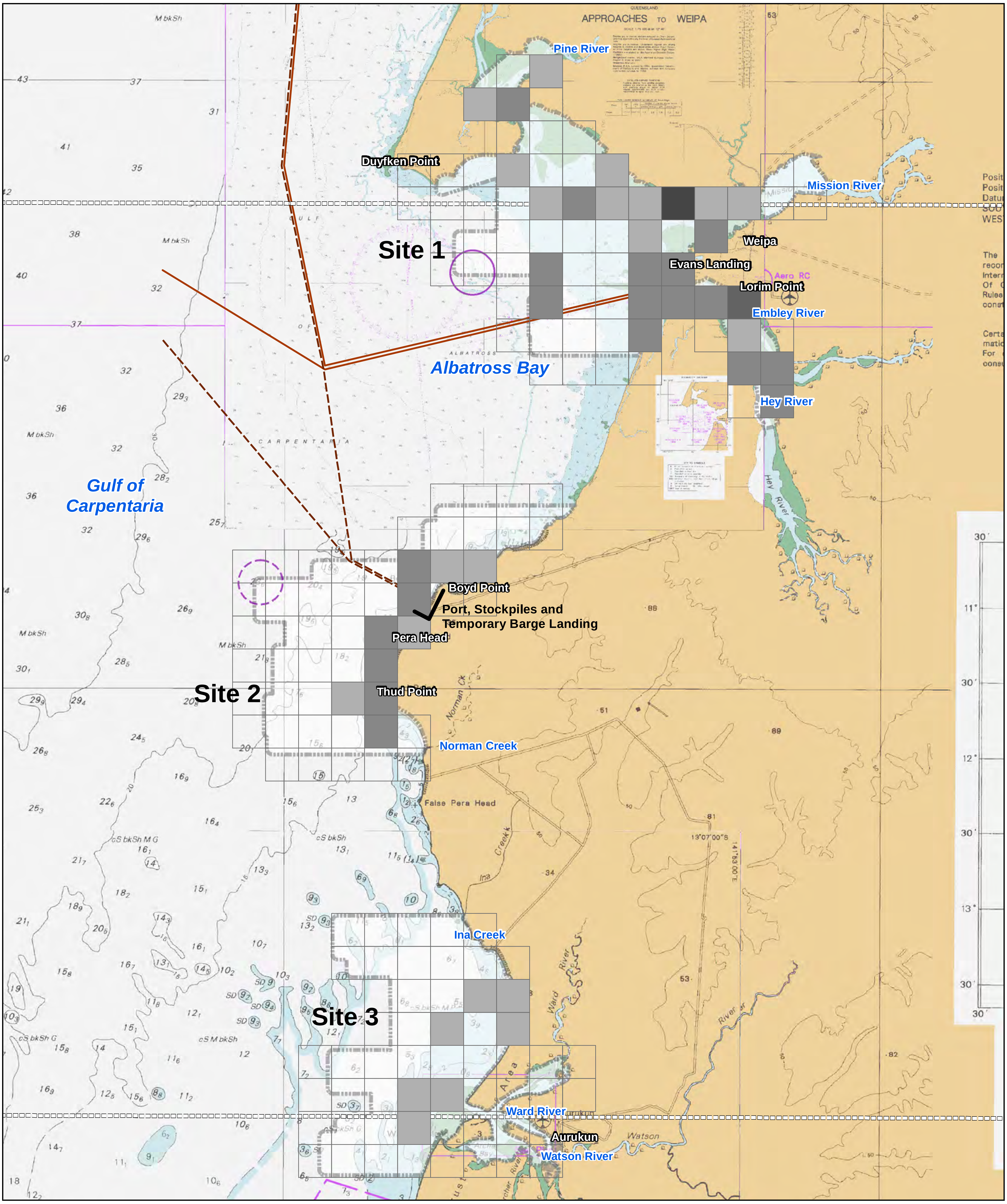
Sample	Total survey length (km)	Survey Area (Km^2)	Encounter rate (per km^2)		
			Humpback	**Bottlenose**	**Snubfin**
Site 1	638.2	301.1	0.55	0.16	0.04
Site 2	472.3	223.4	0.38	0.38	0.00
Site 3	551.2	269.1	0.10	0.05	0.05
Overall Total	**1661.7**	**793.6**	**0.35**	**0.19**	**0.02**

The mapped encounter rates using a 3km x 3km grid are shown in Figure 20 to Figure 22. These maps assist with informing the identification of areas where dolphin groups were commonly sighted, with sightings standardised by effort.

Australian humpback dolphins were observed in all three sites, with the majority of individuals observed in Site 1. The region with the highest encounter rate (17 dolphins per km^2) was at the mouth of the Mission River (Site 1). Other regions with high encounter rates (3-7 dolphins per km^2) were around the Embley River mouth (Site 1) and Pera Head south to Thud Point (Site 2) (Figure 20).

Bottlenose dolphins were observed in all three Sites, with the majority of individuals observed in Sites 1 and 2. The regions with the highest encounter rates (10-12 dolphins per km^2) were southeast of Duyfken Point (Site 1) and south of Thud Point (Site 2) (Figure 21).

Australian snubfin dolphins were observed in Sites 1 and 3, with the majority of individuals observed in Sites 3. The region with the highest encounter rate (1-3 dolphins per km^2) was north west of the Aurukun Estuary mouth (Site 3) (Figure 22).



LEGEND

Humpback dolphins per km² effort

- 0
- < 1
- 1 - 5
- 5 - 10
- 10 - 16.7

North/South Project Boundaries

Site boundary

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Humback dolphin encounter rates

Figure 20

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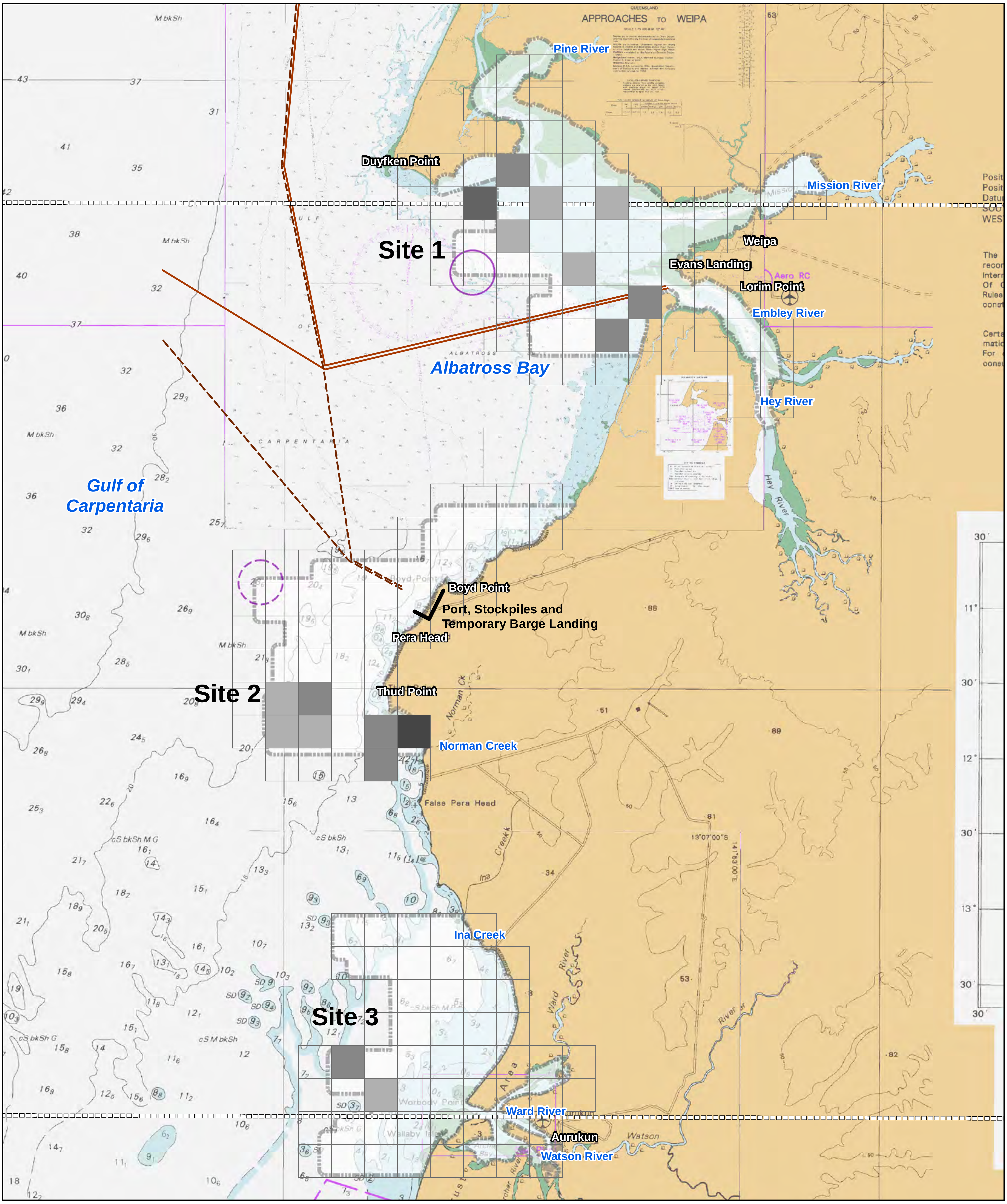

LEGEND

Bottlenose dolphins per km² effort

- 0
- < 1
- 1 - 5
- 5 - 10
- 10 - 12.2
- North/South Project Boundaries
- Site boundary

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

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Bottlenose dolphin encounter rates

Figure 21

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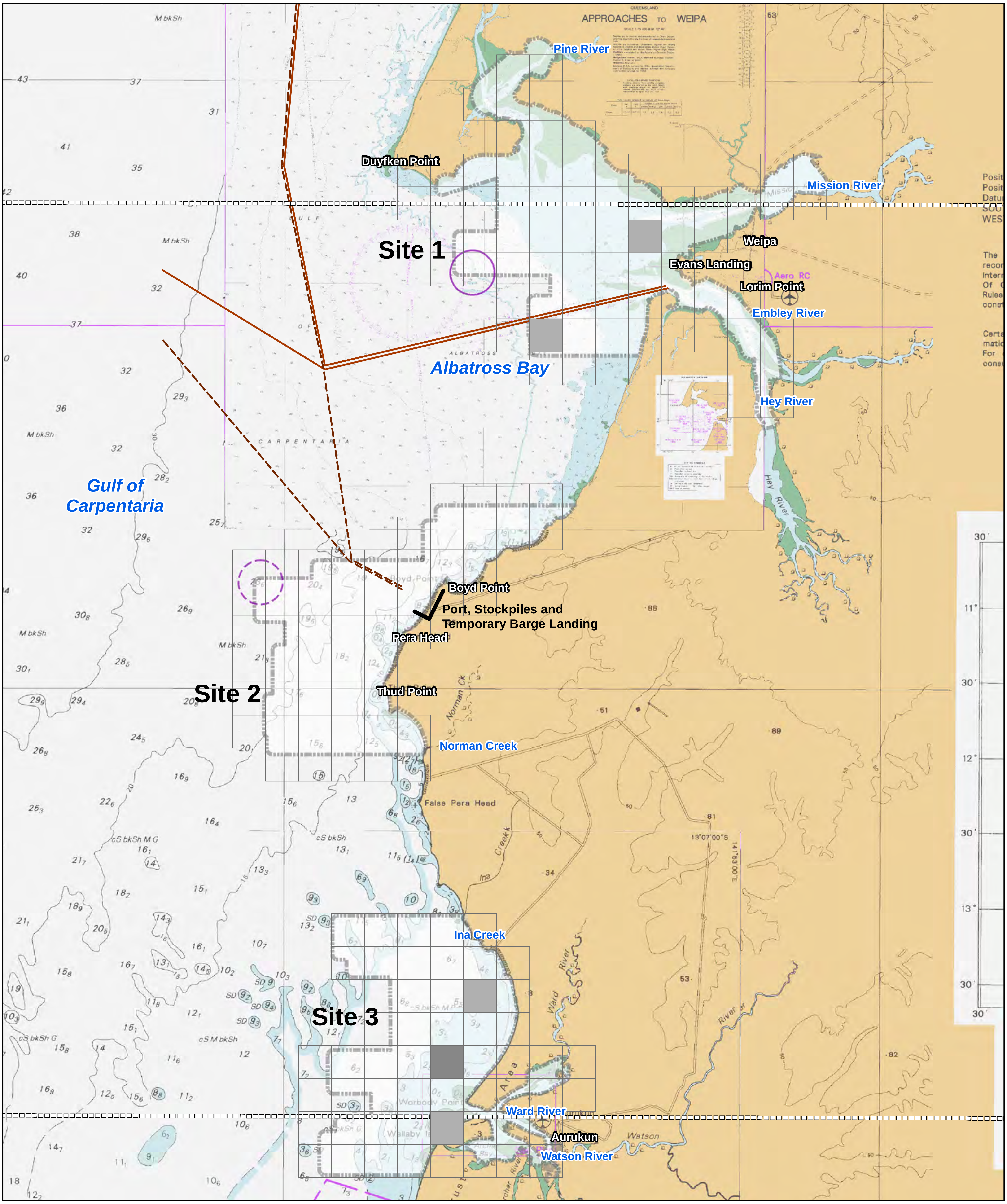

LEGEND

Snubfin dolphins per km² effort

- 0
- < 1
- 1 - 5
- 5 - 10
- > 10
- North/South Project Boundaries
- Site boundary

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Snubfin dolphin encounter rates

Figure 22

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Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

3.6 Environmental Parameters Associated with Sightings

Dolphins were sighted throughout the study area, however, there were apparent differences in encounter rates and habitat preferences between species and sites.

3.6.1 Tidal Cycle

The tidal cycle in the Weipa/Aurukun region can vary from semi-diurnal (2 tides per day) neap tides, to diurnal (1 tide per day) spring tides. Surveys began on 7 December on spring tides (new moon) and transitioned into neap tides on Friday 12 December (waxing crescent). During spring tides maximum tide height was 2.89m and minimum tide height was 0.68m. During neap tides maximum tide height was 2.61m and minimum tide height was 1.08m.

Of the 11 survey days, five were conducted on a neap tide and six on a spring tide. Of the 111 sightings, 50 (45%) were sighted on a neap tide and 61 (55%) on a spring tide (Figure 23). Although these proportions appear largely similar, when looking at sightings in each tidal cycle by site there are apparent differences. In Site 1, more sightings were observed in spring tides (62.5%), in Site 2 more sightings were observed in neap tides (61%) and in Site 3 more sightings were observed in spring tides (62.5%: Table 18).

Table 18 Number of Dolphin Sightings in Each Tidal Cycle

Site	Spring	Neap
1	40 (62.5%)	24 (37.5%)
2	13 (39.0%)	20 (61.0%)
3	10 (62.5%)	6 (37.5%)

Despite these apparent differences, within Site 1, dolphins appeared to use the Pine, Embley and Mission Rivers equally in each tidal cycle (Figure 24), and overall encounter rates show no obvious differences between samples that could be obviously attributed to the tidal cycle (Appendix 7-10).

3.6.2 Tide State

There are four options for tide state recorded when dolphin groups are sighted; high, ebb, low and flood. Of the 111 sightings, 87% of sightings were observed in a flooding tide (Figure 25):

- Flood = 97 (87%);
- High = 7 (6%);
- Ebb = 4 (4%);
- Low = 3 (3%).

Although a high proportion of sightings were observed in a flood tide, during the December 2014 surveys, the majority of survey effort was conducted in a flood tide which would have biased any potential for comparisons of sightings compared to tide state (Figure 25).

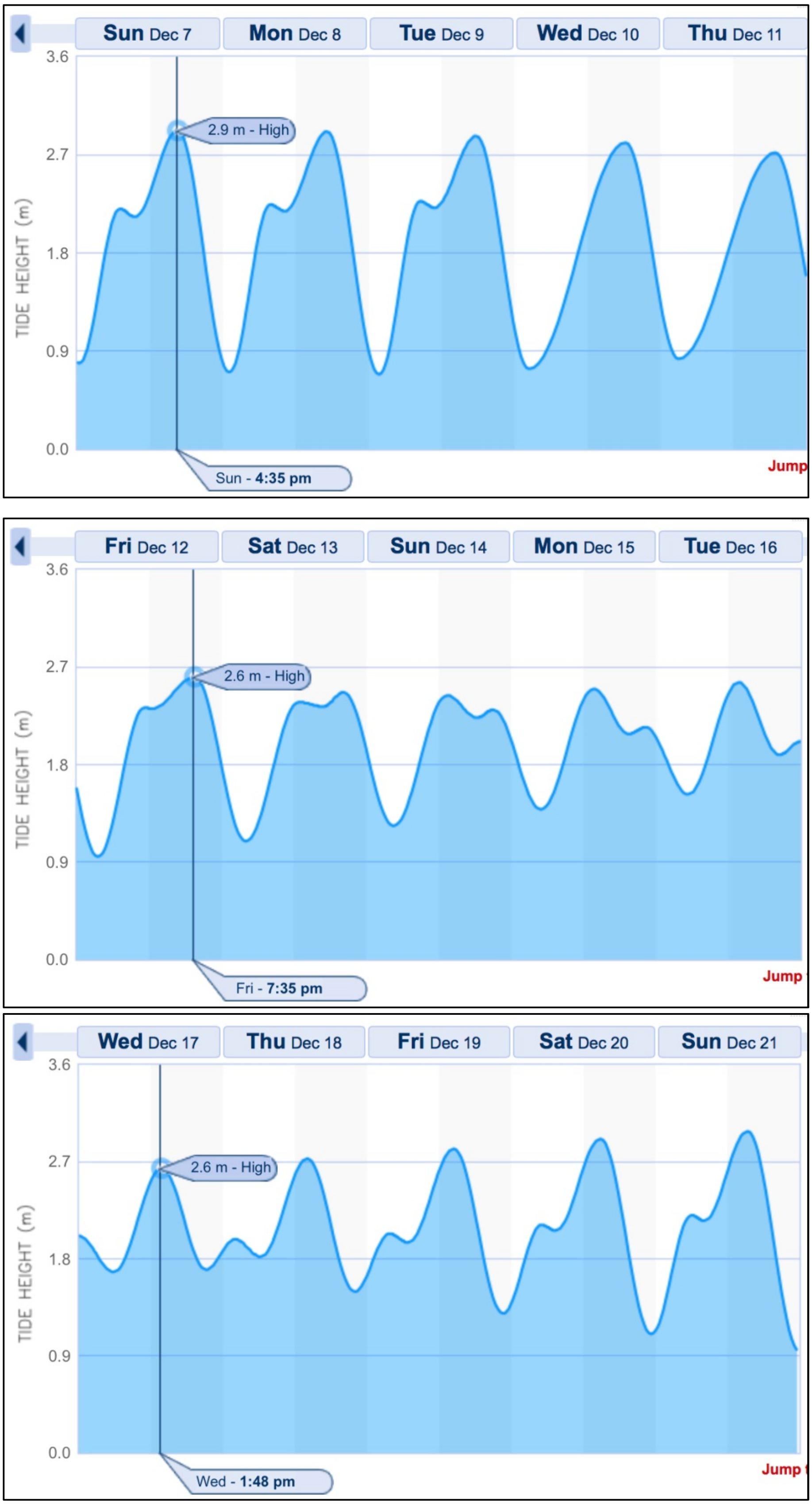
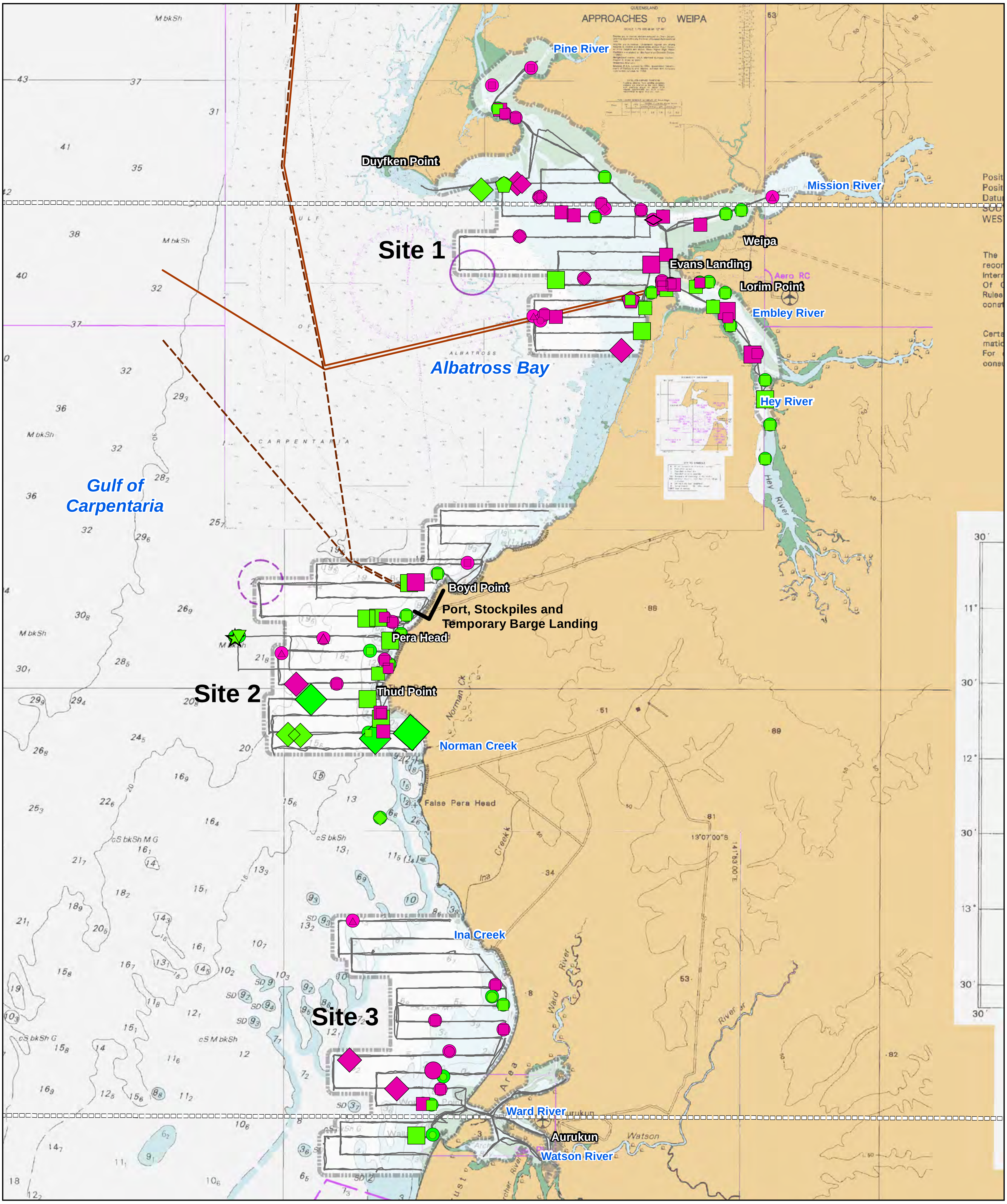


Figure 23 Tide State While Undertaking Surveys

Note: Tides obtained from the Bureau of Meteorology and images below obtained from WillyWeather



LEGEND

Tide Cycle	Species		Group Size			
Spring	Bottlenose	Offshore bottlenose	1	6-10	32	Transects completed
Neap	Bottlenose/Humpback	Snubfin	2-3	11-20		Site boundary
	Humpback	Spinner	4-5			North/South Project Boundaries
	Humpback/Snubfin	Unknown				

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Tide cycle

Figure 24

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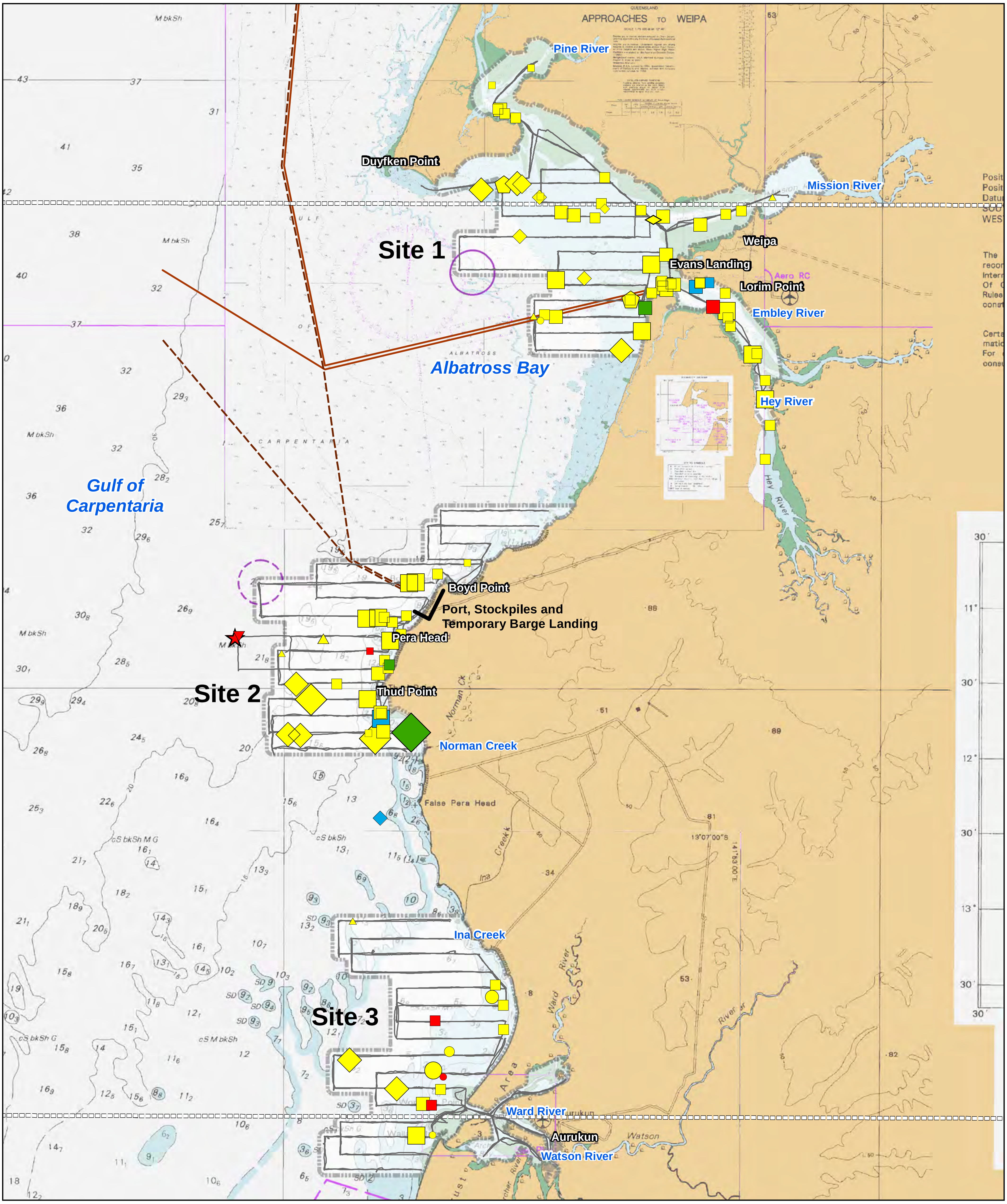

LEGEND

Tide State
- Low
- Flood
- High
- Ebb

Species
- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Offshore bottlenose
- Snubfin
- Spinner
- Unknown

Group Size
- 1
- 2-3
- 4-5
- 6-10
- 11-20
- 32

- Transects completed
- Site boundary
- North/South Project Boundaries

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

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Tide state

Figure 25

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3.6.3 Environmental Parameters Associated with Sightings

Environmental parameters (depth, temperature, turbidity, salinity and pH) were recorded at the location of each dolphin sighting (Table 19).

Table 19 Environmental Parameters at the Location of the First Observation for Each Group

	Humpback	Bottlenose	Snubfin	Spinner/Offshore Bottlenose
Total groups	78	16	6	2
Depth (Stdev)	9.1 (5.4) (range = 0.8 – 20.9)	9.8 (6.2) range = 3.2 – 20.0	5.1 (2.9) range = 2.5 – 10.4	25.0
Salinity	34.7 (0.6) range = 33.1 – 36.8	34.6 (0.5) range = 33.7 – 35.4	34.2 (0.5) range = 33.3 – 34.8	34.5
Turbidity	6.7 (9.8) range = 0.0 – 49.0	3.2 (4.3) range = 0.0 – 13.9	14.1 (13.0) range = 2.8 – 30.1	0.0
Temperature	31. 9 (1.1) range = 29.0 – 33.7	31.8 (1.0) range = 28.9 – 33.4	32.0 (1.0) range = 30.9 – 33.1	32.4
pH	8.0 (0.2) range = 7.8 – 8.3	8.0 (0.2) range = 7.9 – 8.3	8.0 (0.2) range = 7.8 – 8.3	7.9

When comparing average environmental parameters for inshore dolphin species between all sites, the main differences were:

- Australian humpback and bottlenose dolphins were sighted at similar depths (average depths of 9.1m and 9.8m respectively), whereas Australian snubfin dolphins were sighted in shallower waters (average depth of 5.1m) (Figure 26);
- Australian snubfin dolphins were sighted in the most turbid waters (average turbidity of 14.1NTU), with bottlenose dolphins sighted in the clearest (average turbidity of 3.2NTU) and Australian humpback dolphins between the two (average turbidity of 6.7NTU) (Figure 27).

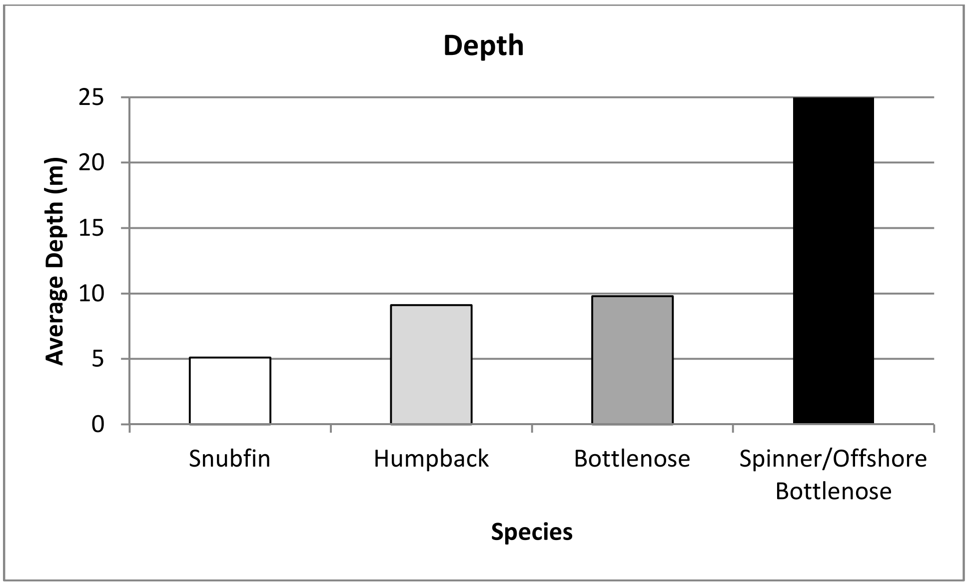


Figure 26 Depth Comparisons for Dolphin Species Sighted During Surveys

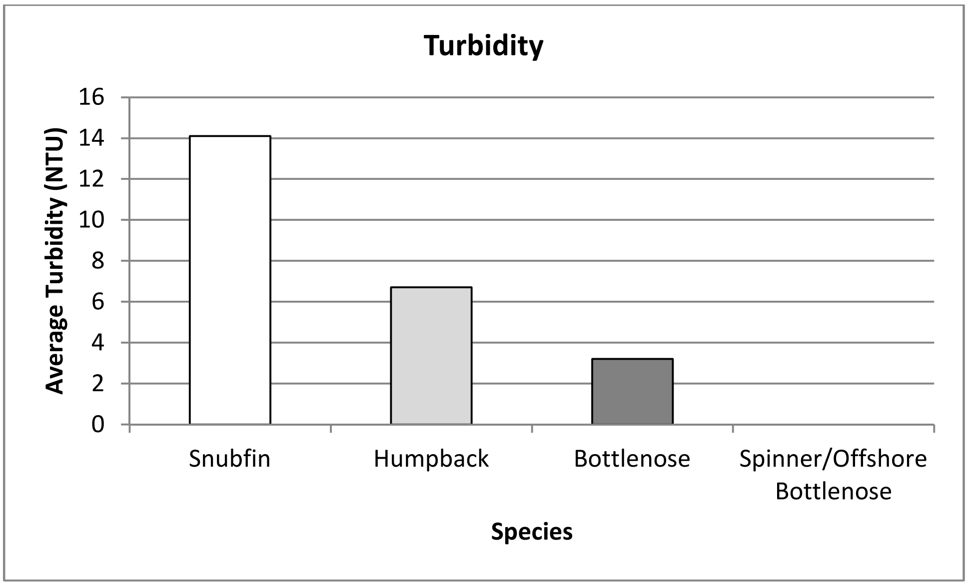


Figure 27 Turbidity Comparisons for Dolphin Species Sighted During Surveys

3.6.4 Identification and Resight Rates

Of the 114 groups encountered during surveys, 94 groups (82% of sightings) were successfully photo-identified. A total of 42 hours and 31 minutes were spent photographing dolphin groups, with 15,625 images taken.

The total number of individual dolphins photo-identified in each site, and the combined total number of photo-identifications are shown in Table 20, where identifications consisted of:

- 124 Australian humpback dolphins;
- 59 bottlenose dolphins;
- 7 Australian snubfin dolphins;
- 2 Gray's spinner dolphins;
- 1 offshore bottlenose dolphin.

Table 20 Total Number of Photo-identifications For Each Dolphin Species Encountered During Surveys

Species	Total identified – All Sites	Total identified – Site 1	Total identified – Site 2	Total identified – Site 3
Australian Humpback dolphins	124	70	43	11
Bottlenose dolphins	59	20	27	12
Australian snubfin dolphins	7	1	0	6
Gray's spinner dolphin	2	0	2	0
Offshore bottlenose dolphin	1	0	1	0

Note: The total number of photo-identifications for each dolphin species, as well as the number of photo-identifications identifications separated by site

When comparing the number of identifications by secondary sample, the most Australian humpback dolphins were sighted in Sample 3 (n=65), the most bottlenose dolphins were identified in Samples 1 and 4 (n=27 in each sample) and the most Australian snubfins were identified in Sample 2 (n=6).

Table 21 Total Number of Photo-identifications For Each Dolphin Species Separated By Secondary Sample

Species	Sample 1	Sample 2	Sample 3	Sample 4
Australian Humpback dolphins	58	31	65	34
Bottlenose dolphins	27	14	19	27
Australian snubfin dolphins	0	6	0	1

Australian Humpback Dolphins

Of the 124 Australian humpback dolphins identified:

- 81 (65%) were sighted once;
- 26 (21%) were sighted twice;
- 15 (12%) were sighted three times;
- 2 (2%) were sighted four times (Figure 28 and Figure 29).

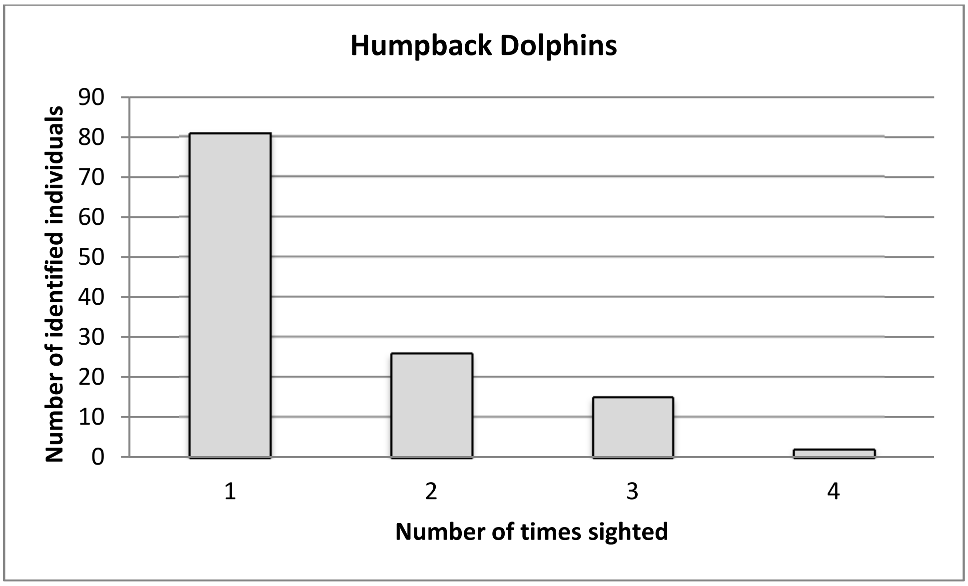


Figure 28 Summary of the Total Number of Times Each Australian Humpback Dolphin Individual Was Sighted

Figure 29 Example of a Photo-identified Australian Humpback Dolphin (SSAH23 From Site 1)

Comparisons of the number of individuals identified between sites and samples are shown in Table 22, where the most Australian humpback dolphin individuals were identified in Site 1 (n=70) and the least in Site 3 (n=11).

Table 22 Total Number of Australian Humpback Dolphin Photo-identifications Separated By Secondary Sample and Site

Sample	Site 1	Site 2	Site 3
1	43	12	3
2	25	6	0
3	25	37	3
4	19	10	5
Total Identified	70	43	11

Bottlenose Dolphins

Of the 59 bottlenose dolphins identified:

- 44 (75%) were sighted once;
- 6 (10%) were sighted twice;
- 6 (10%) were sighted three times;
- 3 (5%) were sighted three times (Figure 30 and Figure 31).

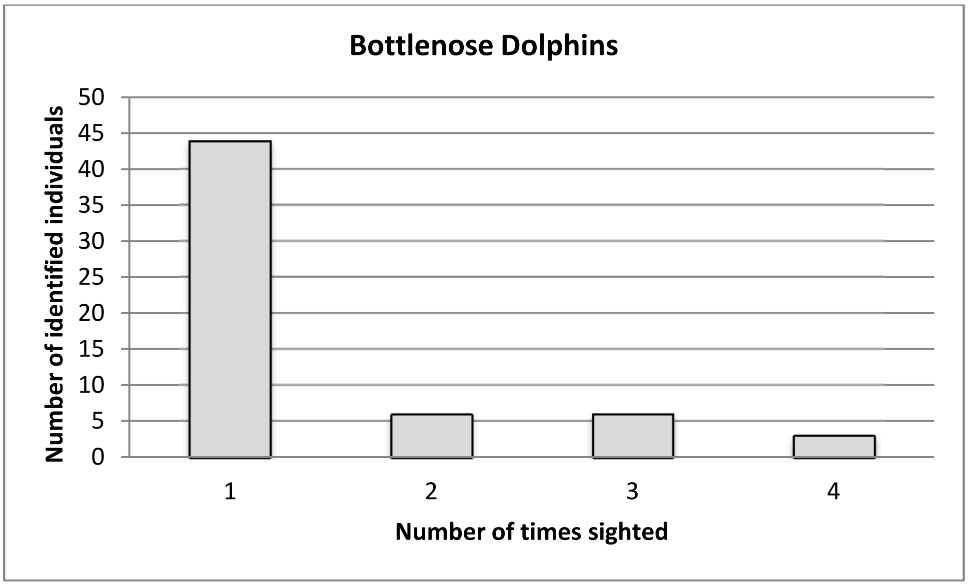


Figure 30 Summary of the Total Number of Times Each Bottlenose Dolphin Individual Was Sighted

Figure 31 Example of a Photo-identified Bottlenose Dolphin (TADU28 From Site 2)

Comparisons of the number of individuals identified between sites and samples are shown in Table 23, where the most individuals were identified in Site 2 (n=27) and the least in Site 3 (n=12).

Table 23 Total Number of Bottlenose Dolphin Photo-identifications Separated By Secondary Sample and Site

Sample Number	Site 1	Site 2	Site 3
1	14	1	12
2	14	0	0
3	19	0	0
4	0	26	0
Total Identified	20	27	12

Australian Snubfin Dolphins

Of the seven individuals identified, all were only sighted once (Figure 32). Most photo-identification images were unsuitable for capture-recapture analysis because of poor quality.

Figure 32 Example of a Photo-identified Australian Snubfin Dolphin (OHEI01 From Site 1)

Discovery Curve

A cumulative discovery curve after 11 survey days (Figure 33) suggests no plateau in the number of identifications of any species. The apparent plateau’s for bottlenose and Australian snubfin dolphins (i.e. days 5-8 for bottlenose dolphins and days 6-8 and 10-11 for Australian snubfin dolphins) are a result of a lack of sightings, rather than a plateau of sightings (as indicated by the red marker borders).

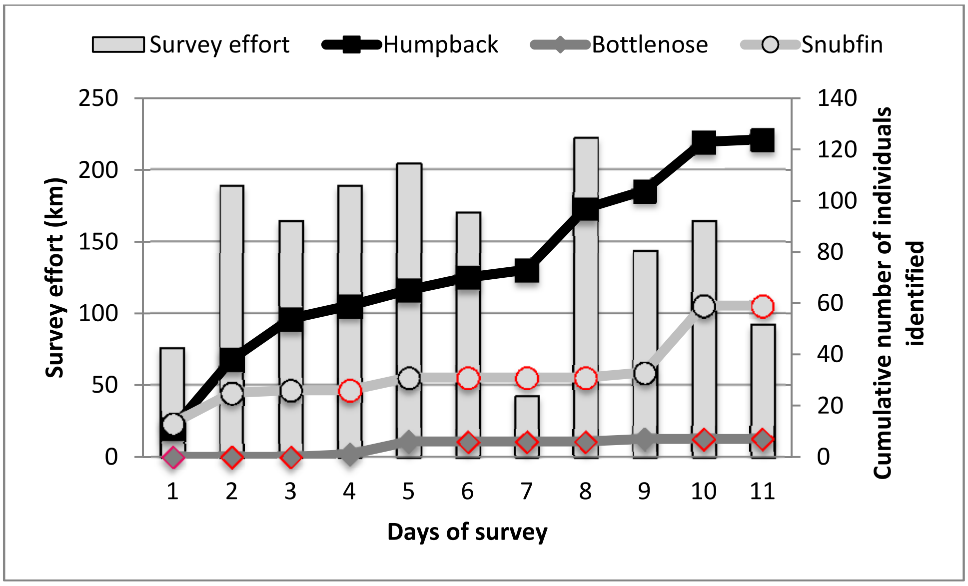


Figure 33 Cumulative Discovery Curve of Photo-identifications Identified For Each Day of Effort

Note: The graph shows the cumulative number of Australian humpback, bottlenose and snubfin dolphin individuals identified for each day of effort during the 11 days of pre-construction surveys. Grey bars indicate daily survey effort (km), with the lines representing the number of individuals identified for each species. The days with no sightings of each species are highlighted with a red marker border, as no re-identifications were possible on these days because of no sightings. Australian humpback dolphins were the only species sighted on every survey day.

3.6.5 Abundance Estimates

Closed capture-recapture analyses were run on the resulting capture histories within MARK using the program CAPTURE. The proportion of distinctive Australian humpback dolphins was estimated to be 0.81, while the proportion of distinctive bottlenose dolphins was estimated to be 0.84. No proportion is available for Australian snubfin dolphins as a result of small sample size and lack of good quality images.

Australian Humpback Dolphins

Using a closed capture-recapture model a total of 220 distinctive Australian humpback dolphins were estimated for the entire study area, with 101 estimated for Site 1 and 138 in Site 2 (Table 24). No estimates were possible in Site 3 because of the low number of individuals identified (n=11).

Accounting for the unmarked proportion of the population, a total of 272 Australian humpback dolphins were estimated to utilize the entire study area, with 125 individuals utilising Site 1 and 170 utilising Site 2 (no estimates available for Site 3) (Table 24).

Table 24 Closed Capture-Recapture Estimates for Australian Humpback Dolphins

	Distinctive Population				Total Population			
Site	n	Nd	SE	95% CI	θ	N	SE	95%CI
1	70	101	10.79	85-129	0.81	125	4.85	116 - 134
2	43	138	45.95	83-277	0.81	170	9.13	154 - 189
3	11	--	--	--	--	--	--	--
All Sites Combined	124	220	24.54	183-281	0.81	272	8.43	256 - 288

Note: Australian humpback dolphin abundance estimates, where n=the total number of individuals identified, Nd=estimated size of the distinctive population, SE=standard error, 95%CI=95% confidence intervals, θ = estimated distinctive proportion, N = estimated size of total population with associated SE and 95%CI,

Bottlenose Dolphins

A total of 116 distinctive bottlenose dolphins were estimated for the entire study area, with 24 estimated for Site 1 (Table 25). No estimates were possible for Sites 2 and 3 because of the low number of individuals identified and/or lack of recaptures (n=27 with few recaptures and n=12 respectively).

Accounting for the unmarked proportion of the population, a total of 138 bottlenose dolphins were estimated to utilize the entire study area, with 29 individuals utilising Site 1 (no estimates available for Sites 2 or 3) (Table 25).

Table 25 Closed Capture-Recapture Estimates for Bottlenose Dolphins

	Distinctive Population				Total Population			
Site	n	Nd	SE	95% CI	θ	N	SE	95%CI
1	20	24	3.33	21 - 36	0.84	29	2.25	25 - 33
2	27	--	--	--	--	--	--	--
3	12	--	--	--	--	--	--	--
All Sites Combined	59	116	21.46	87 - 175	0.84	138	6.21	127 - 151

Note: Bottlenose dolphin abundance estimates, where n=the total number of individuals identified, Nd=estimated size of the distinctive population, SE=standard error, 95%CI=95% confidence intervals, θ = estimated distinctive proportion, N = estimated size of total population with associated SE and 95%CI,

3.6.6 Movements between Sites

Based on photo-identification of individual dolphins, there were no movement of individuals between sites over the 15-day survey period. From a total of 124 Australian humpback dolphin identifications, 15 individuals were sighted on three occasions and 2 individuals (SSAH04 and SSAH23; both from Site 1) were sighted on four occasions.

SSAH23 was only sighted within the Embley River near Evans Landing, whereas SSAH4 was sighted at the mouth of the Embley and Mission Rivers (Figure 35).

From a total of 59 bottlenose dolphins, 6 were sighted 3 times and 3 (TADU02, TADU07 and TADU10; all from Site 1) were sighted four times (Figure 34).

3.7 Megafauna Sightings

During surveys, sighting data was collected on all marine megafauna encountered. Surveys would commonly not deviate from the transect line for megafauna, only on some instances when a good photograph was possible, or there was potential for a dugong to be confused with an Australian snubfin dolphin.

A total of 262 marine megafauna aggregations were encountered (i.e. more than one individual within 50m of each other considered an aggregation), consisting of 303 individuals (Figure 35).

Table 26 Marine Megafauna Observed during Surveys

Species	Adults	Juveniles	Newborns
Crocodile	2	1	0
Dugong	9	0	0
Ray - Eagle	19	0	0
Ray – Flat-tailed	1	0	0
Ray - Stingray	8	0	0
Ray - Unknown	3	0	0
Sea snake (3 dead)	90	0	0
Marine file snake (1 potentially dead?)	1	0	0
Shark – Hammerhead	0	2	0
Shark - Leopard	1	1	0
Shark - Spinning	2	0	0
Shark – Tawny nurse	1	0	0
Shark - Unknown	2	2	0
Turtle - Flatback	10	0	0
Turtle - Green	8	3	0
Turtle - Hawksbill	11	2	0
Turtle - Unknown	117	7	0
Total	285	18	0

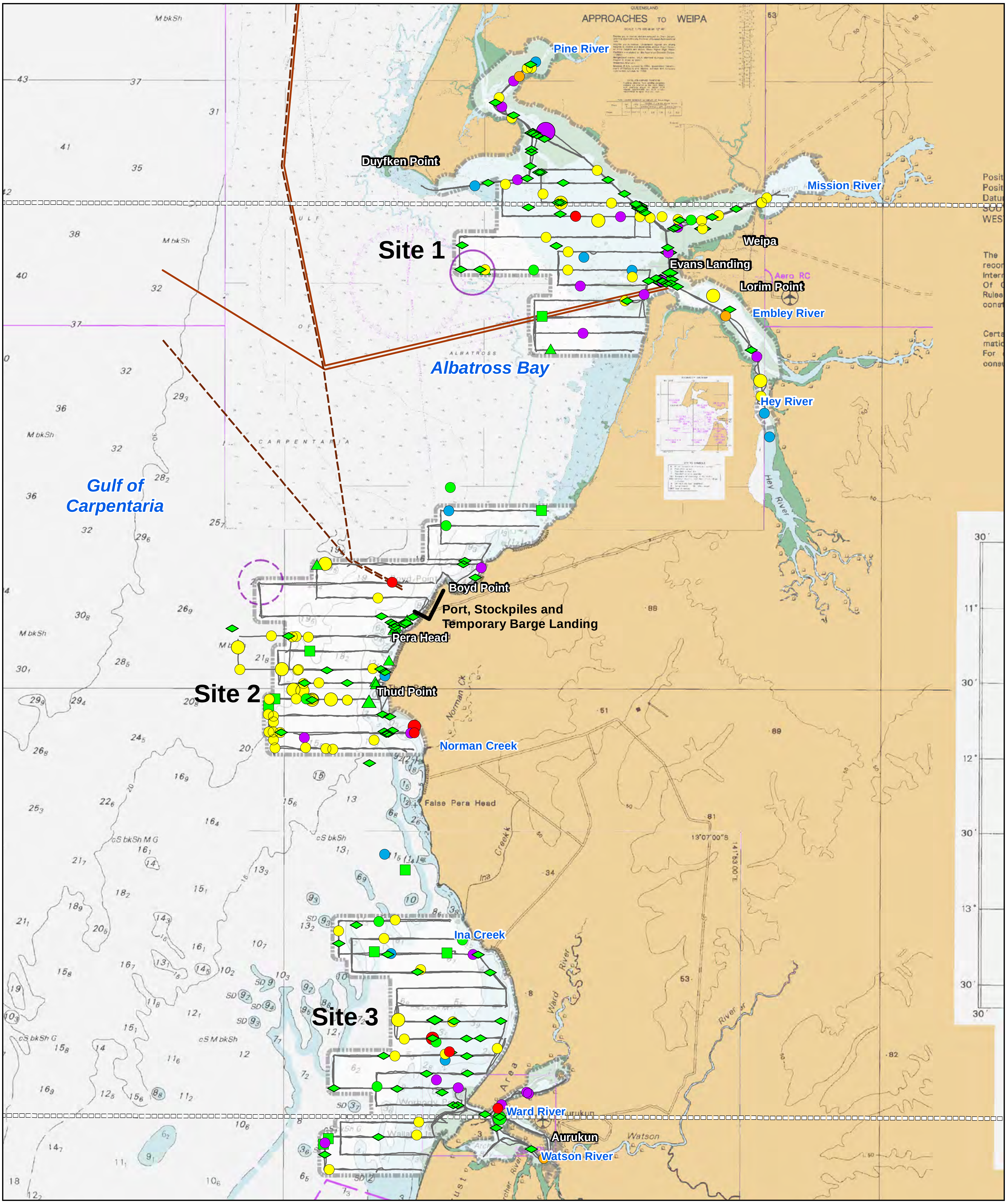
3.7.1 Dugongs

A total of 9 dugongs were sighted during surveys (all adults, Table 26). Dugongs were sighted in all sites, with:

- 1 sighted in Site 1
- 4 sighted in Site 2
- 4 sighted in Site 3.

At least 2 dugongs were sighted in the small bay south of Thud Point, swimming amongst 32 bottlenose dolphins sighted on 18 December (Figure 34). At least one dugong (however it is possible there were 2-3 individuals) was sighted in the Ward River in the evening when the live-aboard was at anchor. Due to light conditions it was not possible to discern with confidence if there was more than one animal present. No dugong were sighted in the Aurukun Estuary during day-light hours, and no dolphins were sighted in the Estuary at any time during surveys.

Figure 34 Dugong Swimming with Bottlenose Dolphins South of Thud Point



LEGEND

Megafauna

- Crocodile
- Dugong
- Ray
- Seasnake
- Shark
- Turtle - Flatback
- Turtle - Green
- Turtle - Hawksbill
- Turtle - Unknown

Group Size

- 1
- 2 - 3
- 4 - 10

- Transects completed
- Site boundary
- North/South Project Boundaries

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Job Number 43-22205
Revision 0
Date 02 Mar 2015

Marine megafauna sightings

Figure 35

G:\43\22205\GIS\Maps\4322205_03.mxd

66 Smith Street Darwin NT 0810 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drw@ghd.com.au W www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

3.7.2 Sea Snakes

A total of 91 sea snakes were observed during surveys (all adults), with:

- 32 observed in Site 1 (including 2 dead sea snakes)
- 44 observed in Site 2 (including 2 dead sea snakes)
- 13 observed in Site 3
- 1 observed during transit

The main species observed were spine-bellied sea snake (*Hydrophis curtus*, previously *Lapemis curtus*) (Figure 36) and elegant sea snake (*Hydrophis elegans*) (Figure 38), although at least one other species of Hydrophis was confirmed through photographs (Figure 37). One species was originally confused with a sea snake, but was later confirmed as a marine file snake (*Acrochordus granulatus*)[2] (Figure 39).

Figure 36 Spine-bellied sea snake

Figure 37 *Hydrophis sp.*

[2] All sea snakes and the marine filesnake photographs confirmed to species by Vinay Udyawer (James Cook University sea snake specialist)

Figure 38 Elegant sea snake

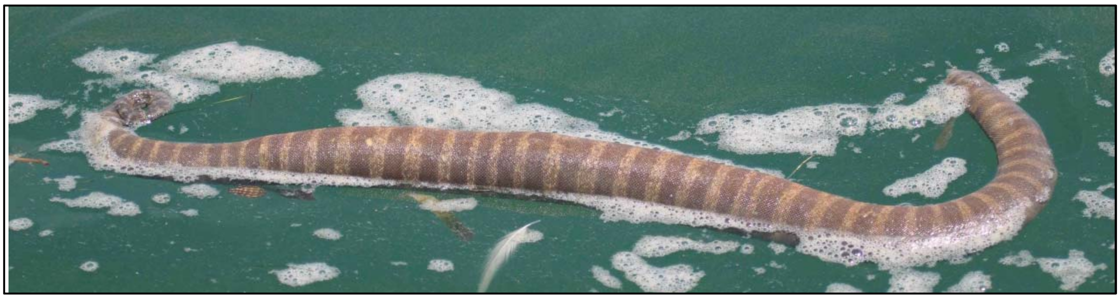


Figure 39 Marine file snake

3.7.3 Turtles

A total of 158 turtles were observed during surveys (all adults) in all sites, with:

- 10 flatback turtles (Figure 35, Figure 40Figure 40 and Figure 41Figure 41):
  - 1 sighted in Site 1
  - 4 sighted in Site 2
  - 4 sighted in Site 3
  - 1 sighted during transit
- 11 green turtles (Figure 35):
  - 2 sighted in Site 1
  - 2 sighted in Site 2
  - 6 sighted in Site 3
  - 1 sighted during transit
- 13 hawksbill turtles (Figure 42 and Figure 42):
  - 2 sighted in Site 1
  - 11 sighted in Site 2
  - 0 sighted in Site 3
- 124 unknown turtles (Figure 42):
  - 67 sighted in Site 1
  - 27 sighted in Site 2
  - 29 sighted in Site 3
  - 1 sighted during transit

Turtles were identified to species level based on a good photograph, or a close observation confirming the identification. Observers were required to be 100% certain of a turtle identification before it was confirmed. Flatbacks were occasionally identified with terns were standing on their backs; the turtle was easily visible and readily able to be photographed from the survey vessel.

Figure 40 Flatback Turtle with Tern

Figure 41 Flatback Turtle

Figure 42 Hawksbill Turtle

4. Discussion

The pre-construction survey completed in December 2014 was the first of five annual primary samples to be undertaken as part of the RTA SoE Project. The required study design is described in detail in the associated Strategy (RTA Weipa 2014). As a result of favourable weather and other logistical considerations, these pre-construction surveys were successful and achieved all required objectives:

- All pre-determined transect lines were completed four times (i.e. four secondary samples);
- Photo-identification was successful, with 193 individuals identified, consisting of 124 Australian humpback dolphins, 59 bottlenose dolphins, 7 Australian snubfin dolphins, 2 Gray's spinner dolphins and 1 offshore bottlenose dolphin;
- Encounter rates were calculated for all inshore dolphin species;
- Reliable abundance estimates were obtained for Australian humpback and bottlenose dolphins. Due to a low number of sightings, abundance estimates could not be calculated for Australian snubfin dolphins;
- Data was collected which has contributed towards understanding habitat preferences for all three inshore dolphin species;
- Significant data was collected on additional marine megafauna sighted during surveys, particularly dugongs, turtles and sea snakes;
- Data collected as reported here will contribute significantly towards supporting the National Inshore Dolphin Research Strategy;
- Wik Waya and Thanikwithi Traditional Owners were trained in survey methods and involved in surveys;
- These surveys achieved the objectives of the Strategy for the baseline data (pre-construction) survey event.

4.1 Survey Design

As a result of uncertainties in dolphin encounter rates and behavioural suitability for photo-identification, prior to these surveys it was uncertain whether the survey design and transect length was too ambitious for the time and budget available. Although only one extra survey day was required to complete pre-construction surveys (i.e. in addition to the re-planned survey days), the timely completion of future surveys will be very dependent on favourable weather conditions. Successful completion of pre-construction surveys was assisted by careful planning of vessel movements during the survey and adapting to on-site conditions, and a period of favourable weather for surveys, with only two stand-down-days due to inclement weather during the survey period. Accordingly, the use of three vessels (one being a live-aboard vessel) and the number of personnel applied to this survey would be considered to be the minimum logistical requirements for collection of required data for future surveys. On average, survey days consisted of approximately 10 hours per vessel. This amount of vessel time should be the maximum amount of time planned per day for each vessel, to enable surveys to be conducted in good weather conditions and to manage observer fatigue.

Based on review of observations made during this survey it is recommended that minor modifications to the transect design be made prior to future surveys, where at least two transect lines will need to be slightly altered because water depth is consistently too shallow for vessels to transverse areas even at high tides (i.e. Sites 1 and 3). It is also recommended that consideration be given to extending transect lines an additional 5km out from the coastline to 26m water depth in Site 2 west of Pera Head. This is where the spinner and offshore bottlenose dolphins were sighted. This is also the area where large baleen whales are likely to be sighted, species of interest for informing the Marine and Shipping Management Plan. Including this area of deeper water into the survey area would improve chance of collecting data regarding these species. If overall transect length is increased through these modifications consideration would need to be given to adjusting the survey plan to take account of any added time on the water needed to achieve these observations.

4.2 Dolphin Observations

In this study, Australian humpback dolphins were by far the most frequently encountered species, although bottlenose dolphin encounter rates were very high in particular areas (i.e. south of Thud Point). Australian snubfin dolphins were rarely encountered.

Australian humpback dolphins have recently been described as a separate humpback dolphins species, endemic to Australia and potentially Papua New Guinea (Jefferson and Rosenbaum 2014). Results from this study indicate that the Weipa/Aurukun region is particularly important for Australian humpback dolphins. Accordingly, because of the large size of the study area, monitoring planned to be completed under the Strategy will contribute significantly towards understanding distribution, habitat preferences and movements of this species.

The bottlenose dolphin groups observed appeared to consist primarily of Indo-Pacific bottlenose dolphins, based on their proportionally long rostrum, small size and subtle spinal blaze (although the spinal blaze was not obvious on many individuals). One group of offshore bottlenose dolphins was confirmed 15km west of Pera Head (water depth = 25m), based on their large body size (i.e. 3.5-4.0m) and very short rostrum.

Australian snubfin dolphins were rarely sighted, and very evasive. The pox-like fungus infection observed on a single Australian snubfin dolphin was noteworthy, as such infections were previously thought to be associated with poor water quality (Palmer and Peterson 2014), which is contrary to the relatively un-impacted site conditions where the dolphin was sighted (i.e. near the Aurukun Estuary where there is no major development, and no known waste discharge from Aurukun township). Similar pox-like infections have been sighted on Australian snubfin dolphins in Darwin Harbour, where extensive photo-identification and biopsy study has been conducted since 2006. The following excerpt is a pers. comm. from Carol Palmer, Senior Scientist with the Department of Land and Resource Management, Northern Territory Government regarding recent analysis of a biopsy sample from an Australian snubfin dolphin with pox-like lesions from Darwin Harbour:

> "*A biopsy was obtained from a free-ranging Australian snubfin dolphin with skin lesions in March 2014 from Darwin Harbour. The subsequent fungus analysis was identified by panfungal PCR testing (which amplifies the ITS1 region of the rDNA cluster) and subsequent sequencing of the PCR product. The identification was confirmed by amplifying the entire ITS and D1/D2 region of the 28S gene, which are best for molecular ID of fungi. Paracoccidioides brasiliensis is the sister taxon to Loboa loboi, and since the advent of molecular testing on suspected dolphin lobomycosis cases, many are turning out to be P. brasiliensis rather than L. loboi, which may be the human counterpart. Molecular testing was performed at Pathology West, Mycology Laboratory at Westmead Hospital, NSW – testing supervised by Catriona Halliday* (Carol Palmer pers. comm.)"

This is the first known sighting of a snubfin dolphin with pox-like virus outside of the Darwin region, and was an important sighting to have during the pre-construction surveys. As with the Darwin Harbour Australian snubfin dolphin population and the INPEX project, potential stress and habitat displacement associated with construction of the proposed port at Boyd Point could not be an attributed source of the pox-like fungus, since this individual was sighted during pre-construction surveys. It is therefore likely that some other environmental stressor is causing this fungus.

One group of Gray's spinner dolphins was sighted in the same location as the offshore bottlenose dolphin group. The taxonomic status of spinner dolphins in Australian waters is still under extensive review, with continuing studies along the Great Barrier Reef (Southern Cross University) and Western Australia (Murdoch University). There is known significant geographic variation in spinner dolphins, both in size and in colour pattern between regions throughout the world (Rice 1998). Three subspecies have been described (Perrin 1990); the Eastern spinner dolphin (*Stenella longirostris orientalis*), the Central American spinner dolphin (*S. l. centroamericana*) and Gray's or Hawaiian spinner dolphin *S. l. longirostris*, with *S. l. longirostris* also occurring in the Australian region (Bannister et al. 1993). A fourth, very small subspecies, the dwarf spinner dolphin, *S. l. roseiventris* (Wagner 1846), inhabits shallow water in the Gulf of Thailand, the Timor Sea and the Arafura Sea (Perrin et al. 1999), where specimens from the Great Barrier Reef area appear to be intermediate between *S. l. longirostris* and *S. l. roseiventris* in terms of body length and skull size (Perrin et al. 1999).

There are few records of spinner dolphins for the Gulf of Carpentaria, although a dwarf form of spinner dolphin has been confirmed to inhabit oceanic waters surrounding Nhulunbuy, East Arnhem Land (Beasley et al. 2012). The spinner dolphins sighted in this study were the larger Gray's spinner dolphins, which are not known to have been formally recorded for the western Cape, or likely the Gulf of Carpentaria. These records of this species are significant in terms of informing the Marine and Shipping Management Plan, as it is a species of interest in oceanic waters. However, since it is often boat-attracted and commonly bow-rides, it is considered that there would be negligible impact (i.e. in terms of noise disturbance) on this species realised from increased boat traffic associated with the proposed SoE port and shipping channel. Any pollution or spillage that occurs in this area of deeper water would, however, be a significant concern to this unknown sub-population.

4.3 Encounter Rates

Encounter rates differed significantly for each species, where for all sites and samples combined, Australian humpback dolphins were by far the most frequently encountered species (0.17 dolphins per km of transect), followed by bottlenose dolphins (0.09 dolphins per km of transect) and then Australian snubfin dolphins (0.01 dolphins per km of transect)

The overall relative abundance of inshore dolphin species in the study (i.e. Australian humpback dolphins the most commonly encountered, followed by bottlenose and Australian snubfin dolphins) was consistent with other similar studies along the Queensland coast (compared using LERs). This includes comparison with studies conducted around the Hinchinbrook Region near Townsville, QLD (i.e. Cardwell), Princess Charlotte Bay north of Cooktown, and Karumba situated at the southern end of Western Cape York (Beasley et al. 2013a,b,c; Beasley et al. 2014: Table 27). However, the LERs for the Weipa/Aurukun region were much higher than in any other region. There were also a small number of Australian snubfin dolphins encountered in the Weipa/Aurukun region, compared to none sighted in any regions surveyed in north Queensland (Table 27).

Table 27 Encounter Rate Comparisons with Other Regions Along the North Queensland Coast

Site	Transect Length (km)	Encounter rates		
		Humpback	Bottlenose	Snubfin
Cardwell, QLD 2013	804.2	0.03	0.04	0.00
Cardwell, QLD 2014	432.7	0.08	0.00	0.00
Princess Charlotte Bay, QLD	55.7	0.14	0.00	0.00
Karumba	459.6	0.08	0.01	0.00
Albatross Bay (Site 1)	638.2	0.55	0.16	0.00
Pera Head/Thud Point (Site 2)	472.3	0.38	0.38	0.00
Aurukun Estuary and coast (Site 3)	551.2	0.10	0.05	0.05
Weipa/Aurukun Region (All Sites combined)	1661.7	0.35	0.19	0.02

The overall encounter rates in this study contrasted significantly with similar boat-based surveys in Roebuck Bay, Western Australia (study area = 100km^2), where Australian snubfin dolphins were the most frequently encountered species, with 1.3 dolphins per km^2 of survey effort across two sampling periods in 2013 and 2014 (compared using SAERs: Table 28). Bottlenose dolphins were the next most frequently encountered (0.09 dolphins per km^2), followed by humpback dolphins (0.05 dolphins per km^2: Brown et al. 2014). The contrast in species encounter rates between studies was probably exacerbated by the Roebuck bay region being much smaller than this study area, with more effort closer to shore. However, there is a real difference in habitat preferences between sites, where Roebuck Bay appears to be a particularly important region for Australian snubfin dolphins, whereas the Weipa/Aurukun region appears to be particularly important for Australian humpback dolphins.

Table 28 Encounter Rate Comparisons with Roebuck Bay, Western Australia (Brown et al. 2014)

Study Area	Total survey length (km)	Total survey area (km^2)	Encounter rates		
			Humpback	Bottlenose	Snubfin
Roebuck Bay (Brown et al. 2014)	807.8	397.6	0.05	0.09	1.32
Albatross Bay (Site 1)	638.2	301.1	0.55	0.16	0.00
Pera Head/Thud Point (Site 2)	472.3	223.4	0.38	0.38	0.00
Aurukun Estuary and coast (Site 3)	551.2	269.1	0.10	0.05	0.05
Weipa/Aurukun Region (All Sites combined)	1661.7	793.6	0.35	0.19	0.02

4.4 Habitat Preferences

Although a high proportion of sightings were observed in a flood tide during these surveys, the results are confounded because the majority of survey effort was conducted in a flood tide. This contrasts to most other regions of Northern Australia, where there is commonly flood and ebb within a 12-hour time-period. Given that changes in the timing of flood and ebb tides during the morning only occur every few months in the Weipa/Aurukun region, any assessment of habitat preferences related to tide state will require comparisons between primary periods, rather than within primary periods. However, as described in the Strategy, because each primary sample will be conducted once a year, it will be more important to schedule future primary samples for similar tides states (i.e. flooding tides during the morning), so that samples can be adequately compared.

As a result of the unusual tide states along the western Cape and limited survey timing, it will not be possible to definitively investigate habitat preferences associated with tide state as part of this study; which is one of the environmental factors proposed as determining inshore dolphin distribution in some areas (i.e. Darwin Harbour: Brooks and Pollock 2014). It would therefore be useful for any independent additional study conducted in the region to investigate potential differences to contribute towards understanding inshore dolphin habitat preferences along Western Cape York.

Based on SAERs Australian humpback dolphins were primarily observed around the Mission and Embley river mouths (Site 1) and Pera Head south to Thud Point (Site 2). Australian humpback dolphin calves were primarily observed in Site 3, with one calf observed south of Thud Point. Bottlenose dolphins were primarily observed at the mouth of the Pine River and south east of Duyfken Point (Site 1) and south to southwest of Thud Point (Site 2), with the largest group being observed in the small bay south of Thud Point (which may be an important area for resting, calving or foraging). Bottlenose dolphin calves were primarily observed throughout Site 1. Australian snubfin dolphins were primarily observed north west of the Aurukun Estuary mouth (Site 3), with no calves being sighted.

In relation to the proposed SoE port development, one of the most important findings from these results is that Australian humpback dolphins are most commonly encountered in the coastal region along the coast from Boyd Point south to Thud Point, and within the Embley/Hey River. As a result of these findings, any coastal development within these two areas will need to be conducted with consideration of mitigation measures to reduce any potential impact on dolphins using these regions. It was encouraging that at least during these pre-construction surveys (December), no calves were sighted around the Boyd Point/Pera Head or within the Embley/Hey Rivers. In the event that a large number of calves were sighted in these areas, there would have been increased concern on the effect of SoE Project construction activities on important calving/nursery areas. However, inshore dolphin calving often has seasonal peaks, so the presence of calves, and any inshore dolphins, observed in the Boyd Point/Pera Head area, would ideally be recorded whenever SoE project boats, or SoE research teams, are working in the area.

The total lack of dolphin sightings within the Aurukun Estuary, including at the mouth of the estuary was surprising, and inconsistent with known habitat preferences of inshore dolphins (Parra et al. 2006). At least one dugong was observed at night while the vessel was at anchor, however, apart from this individual, no dugong were observed during daylight hours within the estuary. There is no data available on dolphin and dugong observations within the Aurukun Estuary, although anecdotal reports from fishers indicate that dolphins and dugongs have commonly been previously observed in the estuary. During this study, there were anecdotal reports of Aurukun Traditional Owners recently using firearms to kill dugongs within the Aurukun Estuary, rather than drowning them, and this may be one explanation for the lack of sightings, where dolphins and dugongs have been displaced out of the area because of the loud blasts from firearms.

4.5 Abundance of Dolphins in the Weipa/Aurukun Region

This study found that the Weipa and Boyd Bay/Thud Point sites should be considered regional hotspots for both Australian humpback and Indo-Pacific bottlenose dolphins, where abundance estimates were much higher than other areas that have been surveyed in Northern Australia (Table 29).

Table 29 Summary of Inshore Dolphin Abundance Estimates From Northern Australia

Species	Study Site	Population Estimate	Source
Australian humpback dolphin	Port Essington, NT (325km2)	48-207	Palmer et al. 2014
	Cleveland Bay, Qld (310km2)	34-54	Parra et al. 2006
	Capricorn Coast, Qld (~1,000km2)	104-115	Cagnazzi 2013
	Curtis Coast, Qld (510km2)	45-84	Cagnazzi 2013
	Great Sandy Strait (760km2)	150	Cagnazzi et al. 2011
	Darwin Region (Darwin and Bynoe Harbours and Shoal Bay), NT (~1,000km2)	84-97	Brooks and Pollock 2014
	Weipa/Aurukun Region, QLD (~1,000km2)	256 - 288	This study
Bottlenose dolphin	Port Essington, NT (325km2)	34-75	Palmer et al. 2014
	Darwin Region (Darwin and Bynoe Harbours and Shoal Bay), NT (~1,000km2)	21-37	Brooks and Pollock 2014
	Weipa/Aurukun Region, QLD (~1,000km2)	127 - 151	This study
Australian snubfin dolphin	Port Essington, NT (325km2)	136-222	Palmer et al. 2014
	Cleveland Bay, Qld (310km2)	64-76	Parra et al. 2006
	Keppel Bay, Qld (980km2)	65-84	Cagnazzi et al. 2013
	Darwin Region (Darwin and Bynoe Harbours and Shoal Bay), NT (~1,000km2)	50-68	Brooks and Pollock 2014
	Weipa/Aurukun Region, QLD (~1,000km2)	No estimate possible	This study

Note: Table adapted from Palmer et al. (2014)

During pre-construction surveys few Australian snubfin dolphins were sighted, with most groups being elusive and difficult to photograph. Sightings of Australian snubfin dolphins require extremely good sea conditions, ideally Beaufort 0-2, particularly if groups of evasive and avoid the survey vessels. These pre-construction surveys were conducted in good sea conditions (i.e. 59.5% of survey effort spent in Beaufort 2 or less), however, if weather conditions are more favourable during future surveys it is anticipated a higher number of Australian snubfin dolphin groups may be observed.

The estimates presented in this report are closed population estimates based on one primary sampling occasion (i.e. pre-construction surveys). Robust design analysis will be possible for future surveys, where in addition to estimating abundance, a robust design allows estimation of survival, temporary emigration, and recruitment (Kendall *et al*. 1997, Kendall 2010). Survival estimation using the robust design is also relatively insensitive to heterogeneity (Pollock 1982, Pollock *et al*. 1990, Kendall 2010).

4.6 Movements between Sites

No dolphins were observed to move between sites, which is not surprising given the relatively short survey duration. There are some preliminary indications of individual habitat preferences within sites, such as the Australian humpback dolphin SSAH23, which was only sighted within the Embley River system. Future surveys will provide valuable information on movements within, and between, sites, and environmental parameters that may be driving these movements.

Australian humpback and bottlenose dolphins are known to move hundreds of kilometres in the Darwin Region, Northern Territory. As of March 2014, 32% of Australian humpback dolphins had moved between Darwin Harbour and Bynoe Harbour (a distance of approximately 320km), and 41% of bottlenose dolphins had moved from Bynoe Harbour and Shoal Bay into Darwin Harbour (distances of approximately 320km and 50km respectively).

Continued photo-identification studies in the Weipa/Aurukun region will provide new insights into movements and connectivity of all inshore dolphin species.

4.7 Considerations for the Proposed Port Development and Informing the Marine and Shipping Management Plan

The main considerations from this study of relevance to the proposed SoE Project and Marine and Shipping Management Plan are as follows:

- Any development in the Embley/Hey Rivers and coastal area from Boyd Point south to Pera Head will need to mitigate the potential impact of construction activities on inshore dolphins in the region, particularly Australian humpback dolphins.
- The small bay south of Thud Point appears to be a particularly important habitat for bottlenose dolphins and dugong. No use of this area is planned as part of the SoE Project, so no mitigation measures are required for consideration.
- It was encouraging that at least during these pre-construction surveys (December 2014), no calves were sighted around the Boyd Point/Pera Head or within the Embley/Hey Rivers. Inshore dolphin calving is however commonly seasonal, so the presence of calves in these areas, and any inshore dolphins observed, would ideally be recorded, whenever SoE project boats, or SoE research teams, are working in the area.
- Pre-construction surveys did not observe any large baleen whales in any of the sites, and importantly none near the proposed SoE Project shipping channels. Spinner dolphins and offshore bottlenose dolphins were observed in offshore waters, however, these are fast-moving, boat-attracted species that will not require mitigation measures in terms of potential disturbance caused by increased boat activity.

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6. Glossary

Aurukun Estuary – estuarine area of the Ward, Watson and Archer Rivers

Commencement of the action - any works that are required to be undertaken for construction (except exploration, site investigation and preliminary works).

Construction – any works that are required to be undertaken for the project including the beneficiation plant (including tailings storage facility); Boyd Port facility, and Hey and Embley River facilitates; dam construction; clearing of vegetation; and infrastructure facilities (including power station, roads, and fuels storage). Excludes preliminary works.

DoE – Commonwealth Department of the Environment

Listed dolphin species – listed migratory species under the EPBC Act, specifically Australian Snubfin Dolphin (*Orcaella heinsohni*); and Australian Humpback Dolphin (*Sousa sahulensis*) – previously the Indo-Pacific Humpback Dolphin (*Sousa chinensis*)

Local inshore dolphin population – those dolphin population/s that utilise the Boyd Point SoE Project area

Operation/s – commencement of activities associated with bauxite mining and production, including shipping activities from the Boyd Port and facilitates in the Hey and Embley Rivers. This does not include activities associated with construction or preliminary works.

Preliminary works – includes activities associated with the upgrade of Beagle Camp and Pera Head Access Roads; establishment of exploration drill and seismic lines; vegetation clearing and construction of the mine access road (between Hey River terminal and Boyd mine infrastructure area); terrestrial vegetation clearing associated with temporary barge landing area near Pera Head; construction and operation of barge landing area located on Hey River; preparation of laydown areas at Humbug and Hornibrook terminals (existing disturbed areas); construction (including vegetation clearing of up to 30 hectares) and operation of a temporary accommodation camp (up to 200 persons) in the project area; installation and operation of ancillary infrastructure (including diesel fuelled power generation, laydown areas, package sewage treatment plants, waste storage and disposal facilities, fuel storage, offices and cribs, and access roads); construction and operation of an artesian bore including associated storage and treatment facilities and pipelines; and, installation of communications infrastructure.

Project Area – the construction and operational area associated with the South of Embley Project works at Boyd Point on the western side of Cape York Peninsula

Regional inshore dolphin population - those dolphin population/s which utilise some part of the study area

RTA – Rio Tinto Alcan

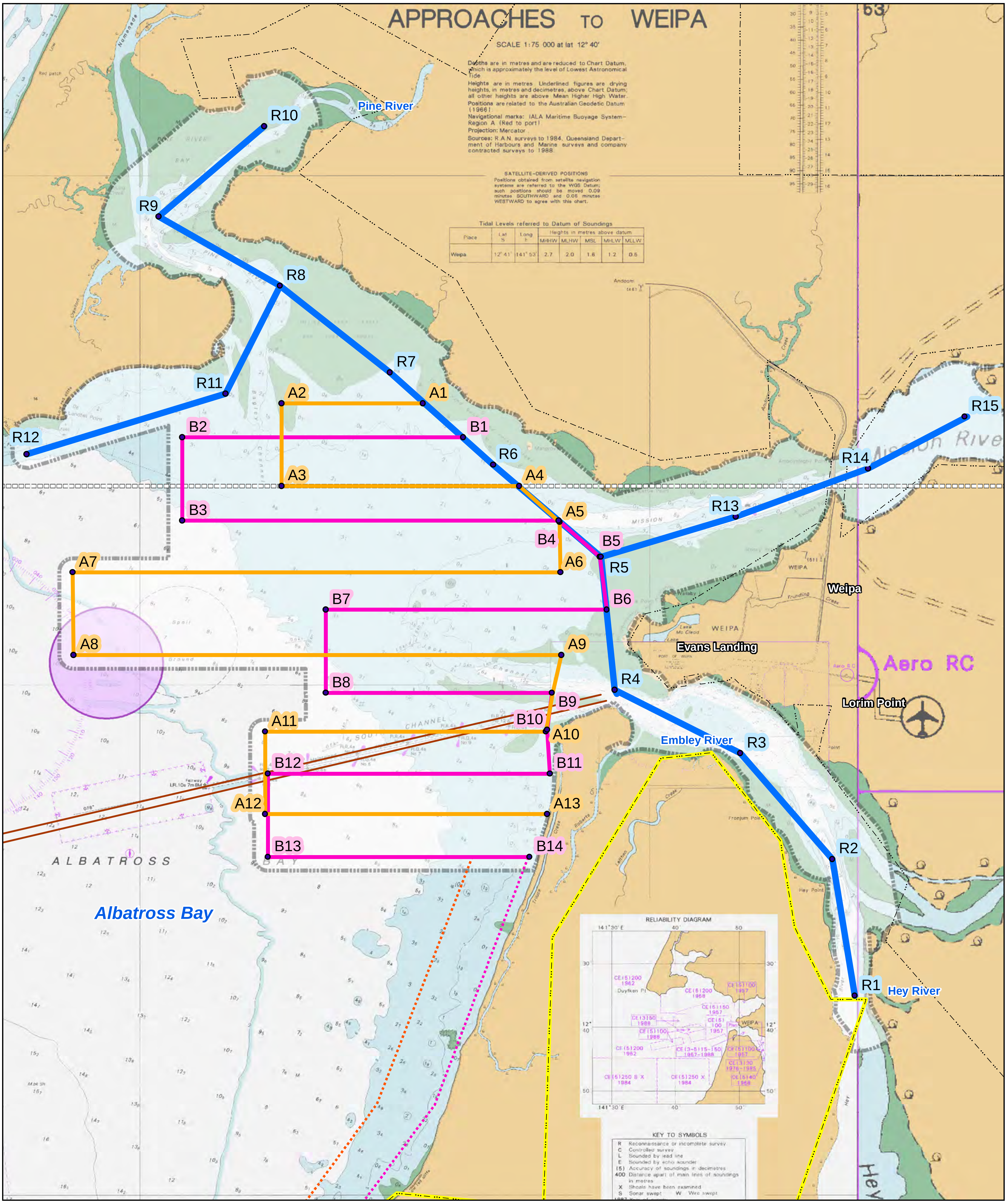
SoE Project – South of Embley Project

Strategy – Inshore Dolphin Offset Strategy

Study Area – an area bounded between latitudes 12.60°S and 13.35°S, out to 15 km from the coast and at least 15km upstream major rivers in both the Weipa and Aurukun Estuary systems.

Appendices

Appendix A – Survey Lines Site 1



LEGEND

- Transect A
- Transect B
- Transect River
- Transit A
- Transit B
- Norman Creek Exclusion Zone
- Site Boundary
- Existing Shipping Route
- North/South Project Boundaries

0 1 2 3 4 5
Kilometres

Horizontal Datum: WGS 1984
Grid: GCS WGS 1984

N

GHD

Rio Tinto Alcan
South of Embley Inshore Dolphin Project

Job Number 43-22205
Revision 0
Date 22 Jan 2015

Site 1 transect lines

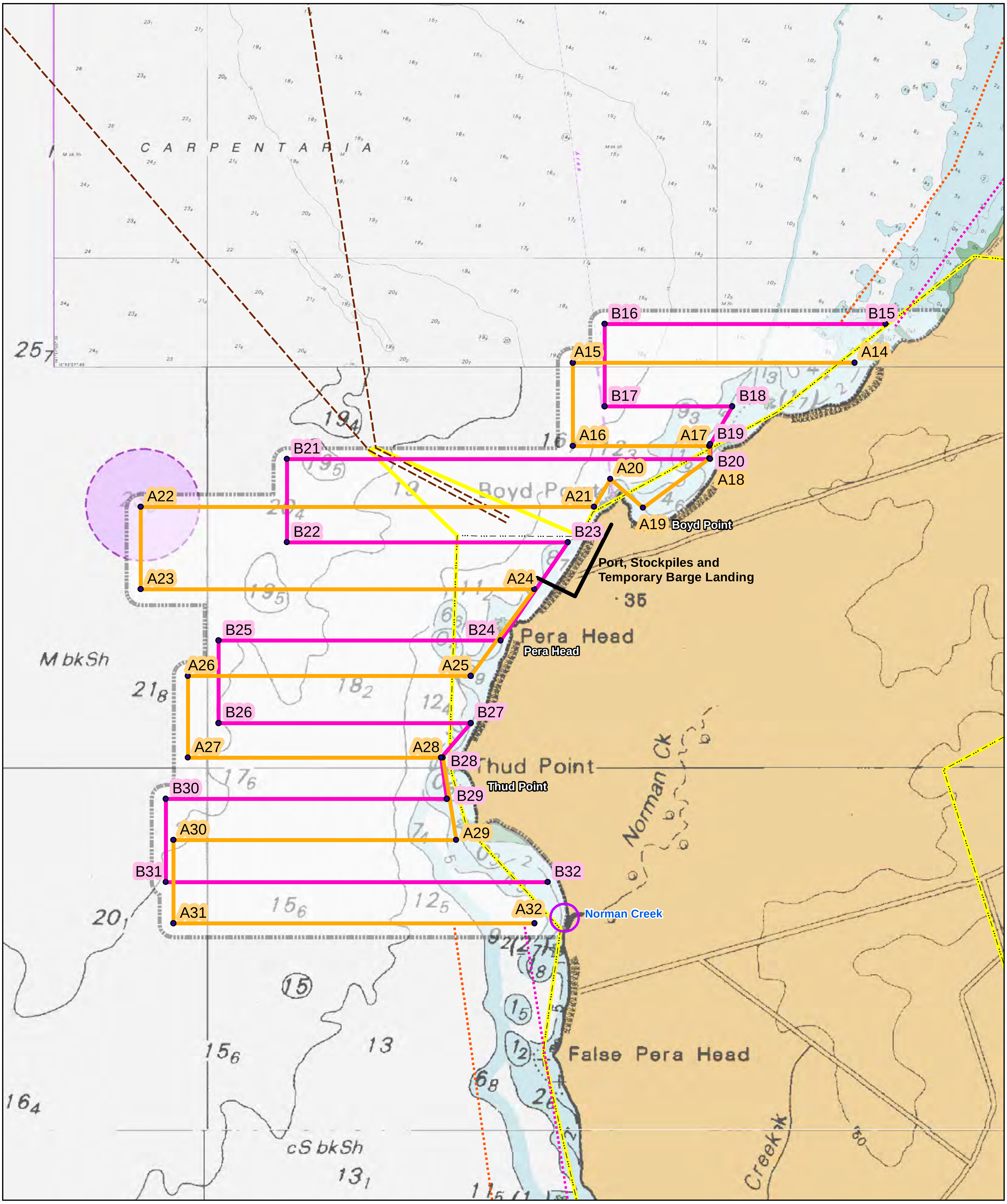
Appendix A

G:\43\22205\GIS\Maps\4322205_03.mxd

66 Smith Street Darwin NT 0810 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drw@ghd.com.au W www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CM

Appendix B – Survey Lines Site 2



LEGEND

Transect A	Transit A	Norman Creek Exclusion Zone
Transect B	Transit B	Site Boundary
Proposed Shipping Route	Proposed Port Infrastructure	North/South Project Boundaries

0 1 2 3 4 5
Kilometres

Horizontal Datum: WGS 1984
Grid: GCS WGS 1984

N

Rio Tinto Alcan
South of Embley Inshore Dolphin Project

Job Number 43-22205
Revision 0
Date 22 Jan 2015

Site 2 transect lines

Appendix B

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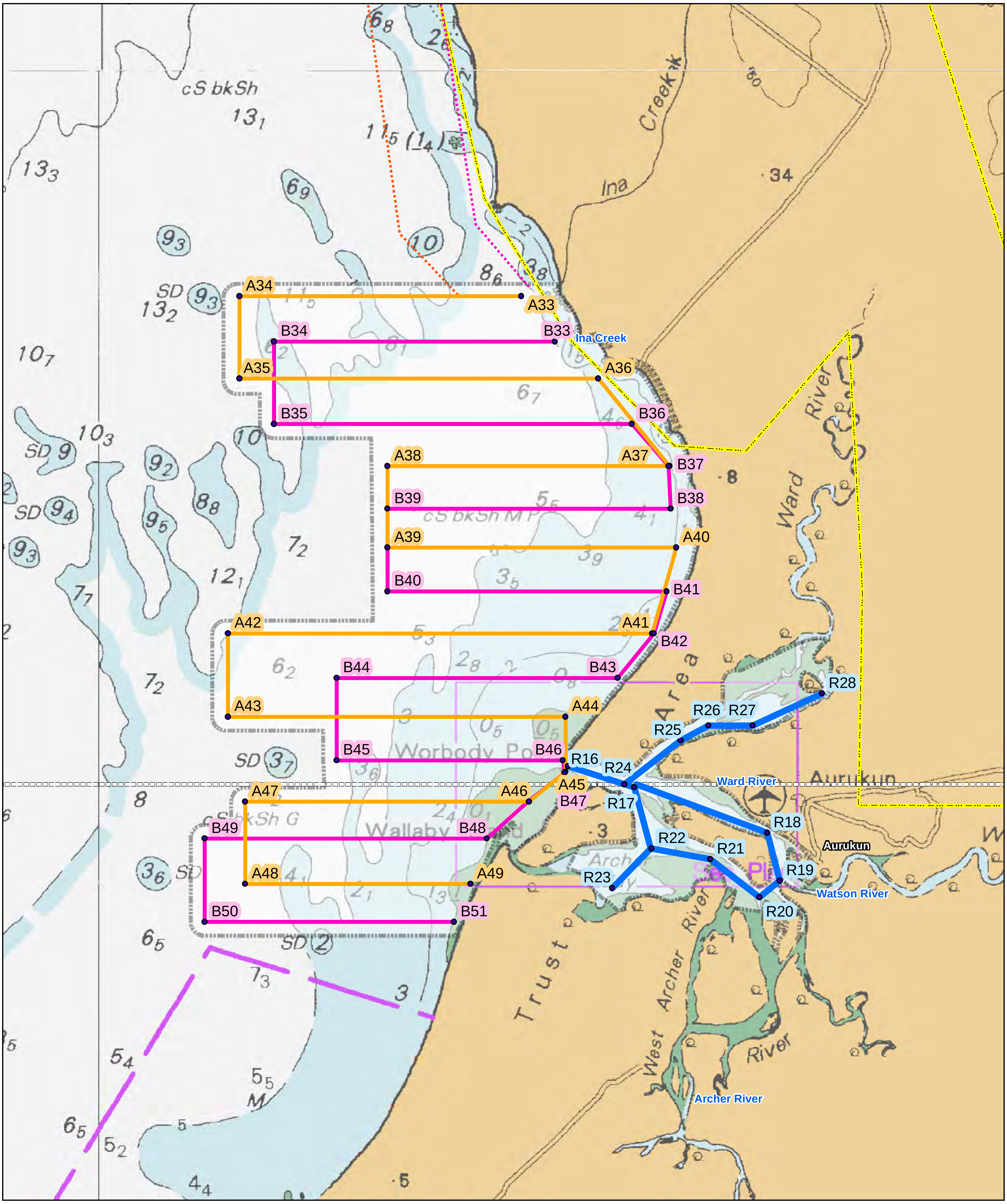
66 Smith Street Darwin NT 0810 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drw@ghd.com.au W www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CM

Appendix C – Survey Lines Site 3



LEGEND

- Transect A
- Transect River
- Transit B
- Norman Creek Exclusion Zone
- North/South Project Boundaries
- Transect B
- Transit A
- Site Boundary

0 1 2 3 4 5
Kilometres

Horizontal Datum: WGS 1984
Grid: GCS WGS 1984

N

Rio Tinto Alcan
South of Embley Inshore Dolphin Project

Job Number	43-22205
Revision	0
Date	22 Jan 2015

Site 3 transect lines

Appendix C

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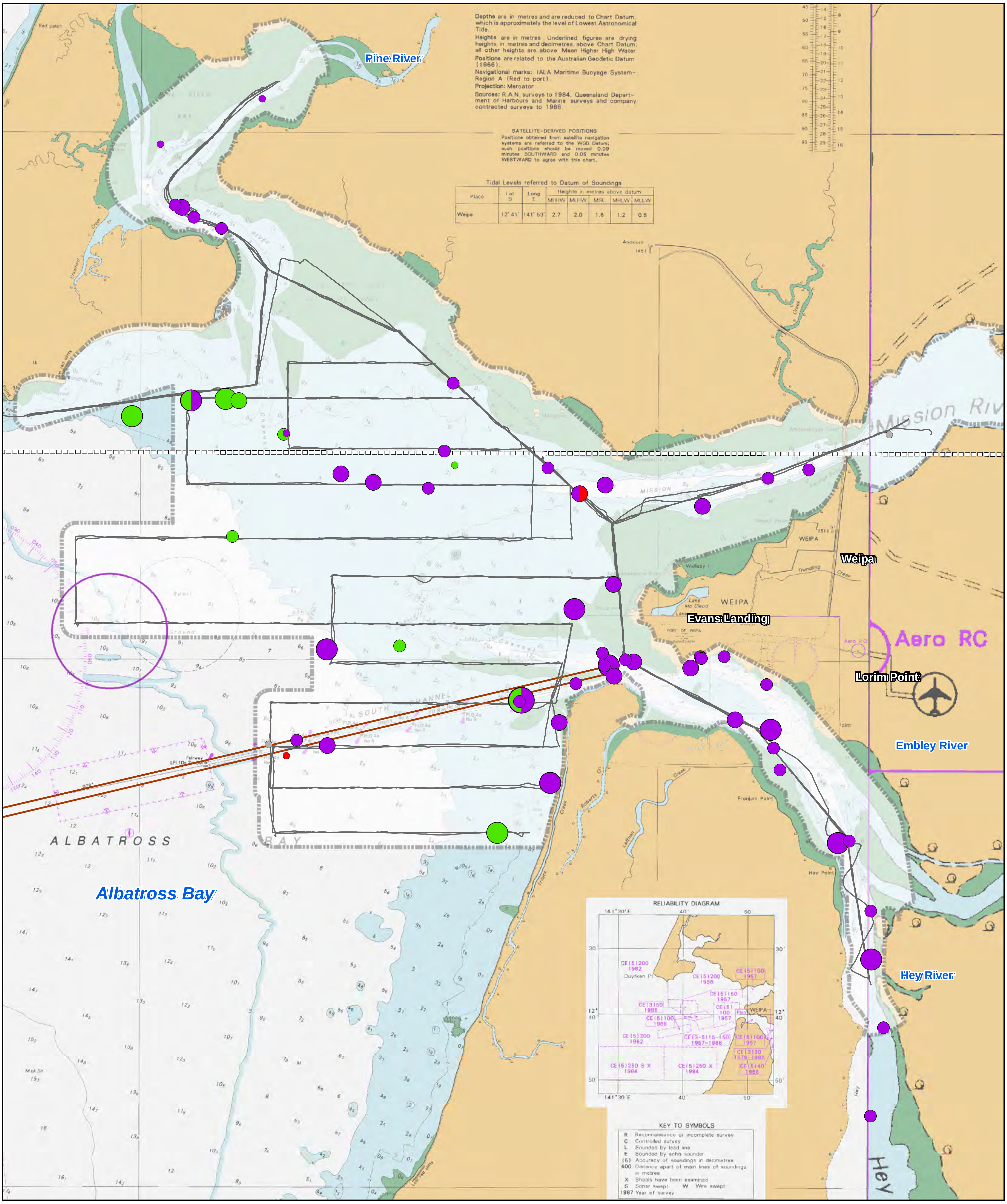
66 Smith Street Darwin NT 0810 Australia **T** 61 8 8982 0100 **F** 61 8 8981 1075 **E** drw@ghd.com.au **W** www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CM

Appendix D – Dolphin Sightings Site 1 Combined



LEGEND

Species

- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Snubfin
- Unknown

Group Size

- 1
- 2-3
- 4-5
- 6-10
- 11-20

- Transects completed
- Site boundary
- North/South Project Boundaries

0 1 2 3 4 5
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Job Number	43-22205
Revision	0
Date	23 Jan 2015

Site 1 Dolphin sightings

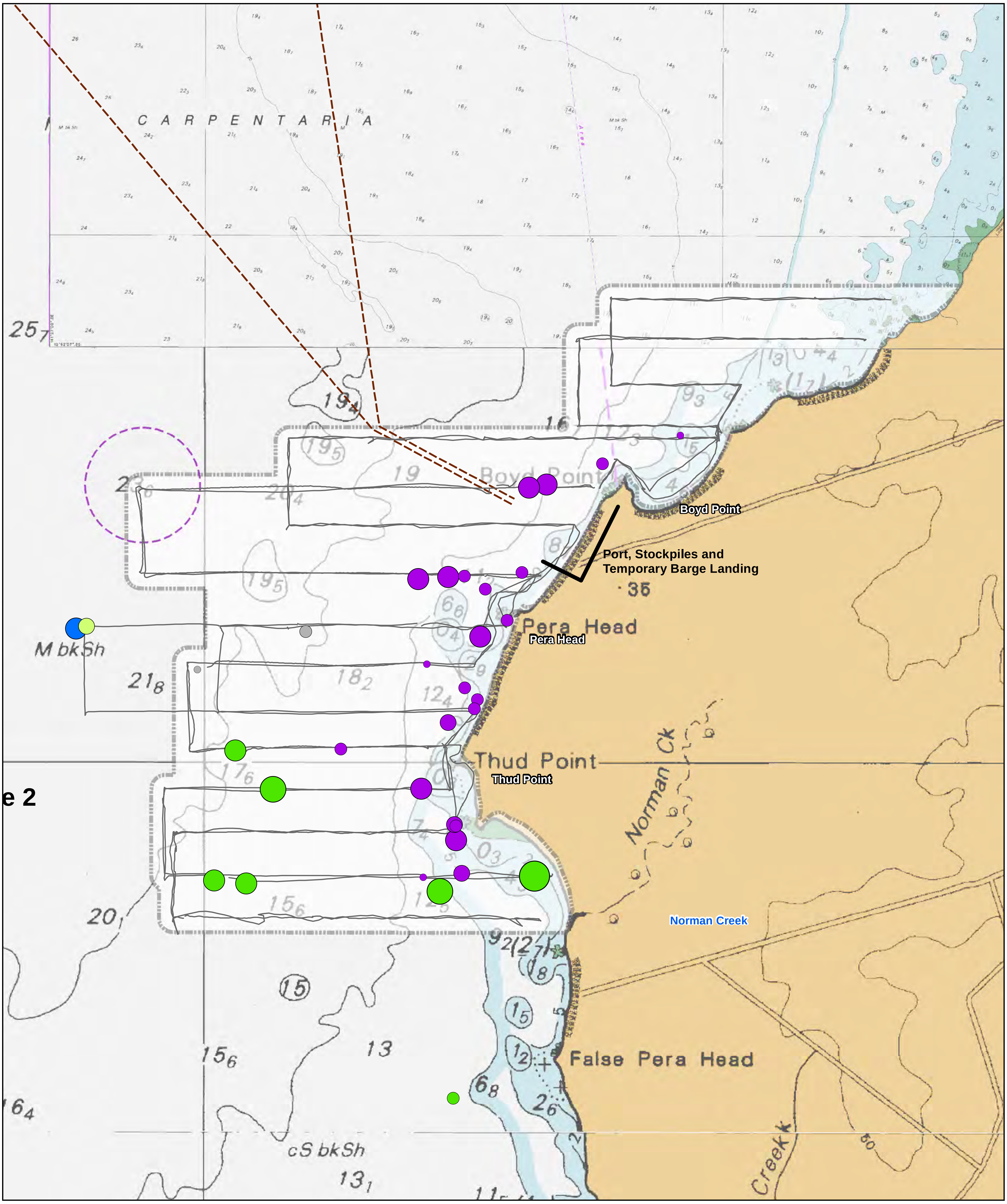
Appendix D

G:\43\22205\GIS\Maps\4322205_03.mxd

66 Smith Street Darwin NT 0810 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drw@ghd.com.au W www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

Appendix E – Dolphin Sightings Site 2 Combined



LEGEND

Species

- Bottlenose
- Humpback
- Offshore bottlenose
- Spinner
- Unknown

Group Size

- 1
- 2-3
- 4-5
- 6-10
- 11-20
- 32

- Transects completed
- Site boundary
- North/South Project Boundaries

0 1 2 3 4 5
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Job Number 43-22205
Revision 0
Date 23 Jan 2015

Site 2 Dolphin sightings

Appendix E

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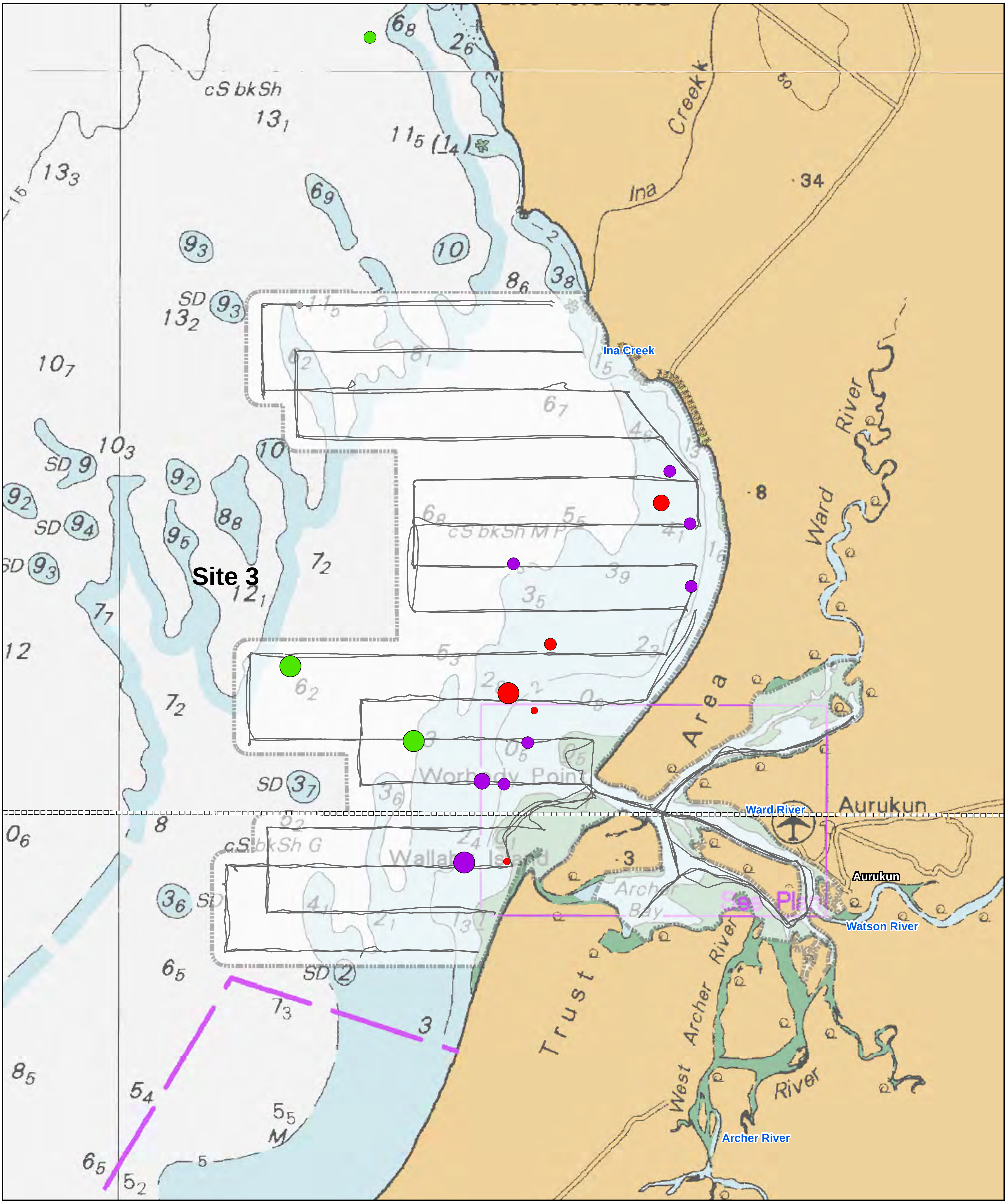
Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

Appendix F – Dolphin Sightings Site 3 Combined



LEGEND

Species

Bottlenose, Humpback, Snubfin, Unknown

Group Size

1, 2-3, 4-5, 6-10, 11-20

Transects completed

Site boundary

North/South Project Boundaries

0 1 2 3 4 5 Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Job Number	43-22205
Revision	0
Date	23 Jan 2015

Site 3 Dolphin sightings

Appendix F

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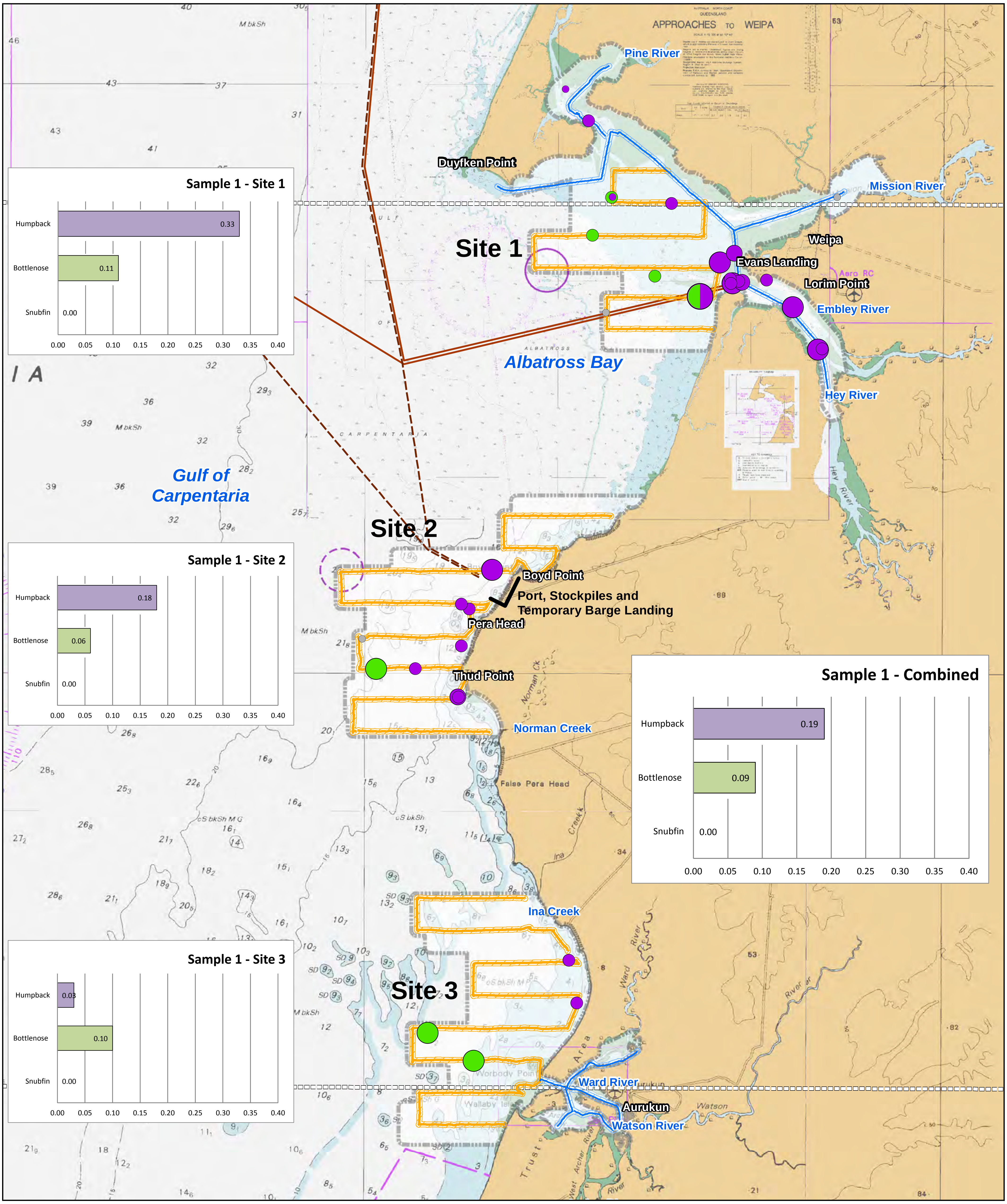
Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

Appendix G - Linear Encounter Rates of Inshore Dolphins (Sample 1)



LEGEND

Species

- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Snubfin
- Offshore bottlenose
- Spinner
- Unknown

Group Size

- 1
- 2-3
- 4-5
- 6-10
- 11-20
- 32

- Transect A
- Transect River
- Transect A 500m Swath
- Transect River 500m Swath
- Transects completed
- North/South Project Boundaries
- Site boundary

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Sample 1 Dolphin sightings with encounter rates

Job Number	43-22205
Revision	1
Date	28 Jan 2015

Appendix G

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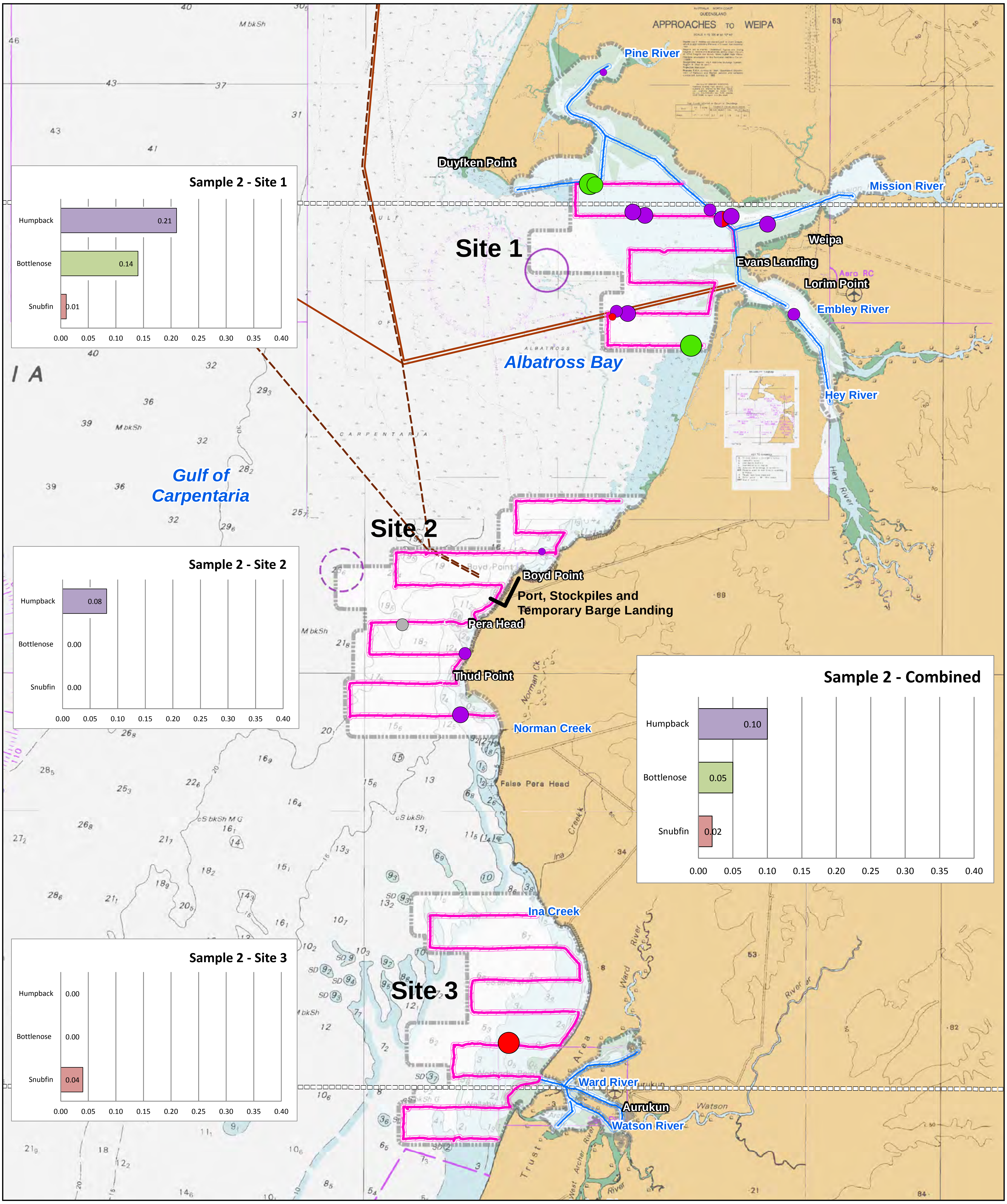
66 Smith Street Darwin NT 0810 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drw@ghd.com.au W www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

Appendix H - Linear Encounter Rates of Inshore Dolphins (Sample 2)



LEGEND

Species

- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Snubfin
- Offshore bottlenose
- Spinner
- Unknown

Group Size

- 1
- 2-3
- 4-5
- 6-10
- 11-20
- 32

- Transect B
- Transect River
- Transect B 500m Swath
- Transect River 500m Swath
- Transects completed
- North/South Project Boundaries
- Site boundary

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Job Number	43-22205
Revision	1
Date	28 Jan 2015

Sample 2 Dolphin sightings with encounter rates

Appendix H

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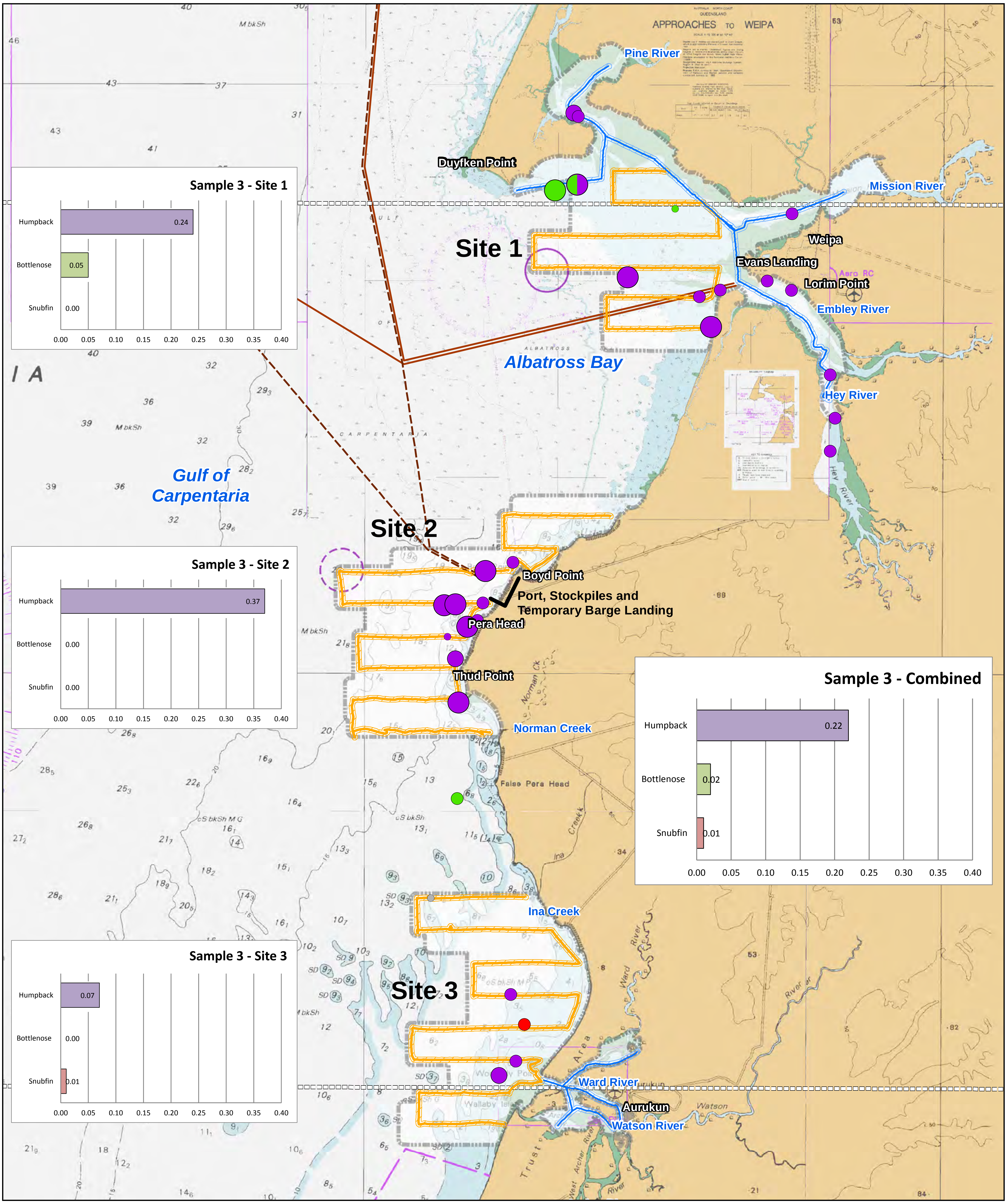
Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

Appendix I - Linear Encounter Rates of Inshore Dolphins (Sample 3)



LEGEND

Species
- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Snubfin
- Offshore bottlenose
- Spinner
- Unknown

Group Size
- 1
- 2-3
- 4-5
- 6-10
- 11-20
- 32

- Transect A
- Transect River
- Transect A 500m Swath
- Transect River 500m Swath
- Transects completed
- North/South Project Boundaries
- Site boundary

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Job Number	43-22205
Revision	1
Date	28 Jan 2015

Sample 3 Dolphin sightings with encounter rates

Appendix I

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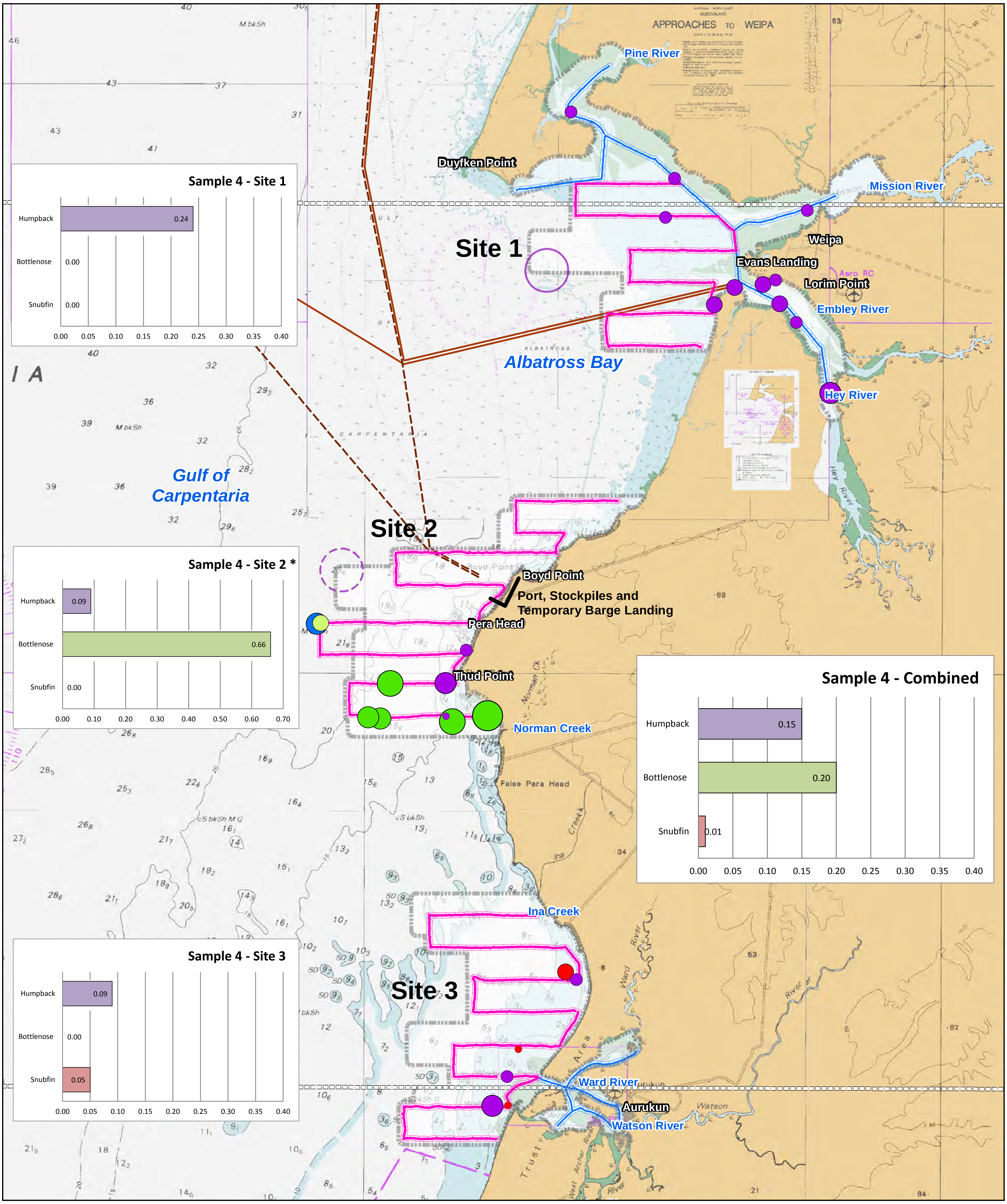
Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

Appendix J - Linear Encounter Rates of Inshore Dolphins (Sample 4)



LEGEND

Species

- Bottlenose
- Bottlenose/Humpback
- Humpback
- Humpback/Snubfin
- Snubfin
- Offshore bottlenose
- Spinner
- Unknown

Group Size

- 1
- 2-3
- 4-5
- 6-10
- 11-20
- 32

- Transect B
- Transect River
- Transect B 500m Swath
- Transect River 500m Swath
- Transects completed
- Site boundary
- North/South Project Boundaries

0 2 4 6 8 10
Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 54

N

GHD

Rio Tinto Alcan
Dolphin Offset Strategy - South of Embley Project

Job Number 43-22205
Revision 1
Date 28 Jan 2015

Sample 4 Dolphin sightings with encounter rates

Appendix J

G:\43\22205\GIS\Maps\4322205_03.mxd

66 Smith Street Darwin NT 0810 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drw@ghd.com.au W www.ghd.com.au

Data source: DNRM - Mineral Leases (2014). GHD - Transects, Sites, Project Boundaries (2014). Created by: CW

Appendix K – Australian humpback dolphin capture histories

Individual	1	2	3	4
SSAH01	o			
SSAH02	o			
SSAH03	o	o		
SSAH04	o	o		o
SSAH05	o			
SSAH06	o			
SSAH07	o			
SSAH08	o			
SSAH09	o			
SSAH10	o			o
SSAH11	o			
SSAH12	o			
SSAH13	o			
SSAH14	o			
SSAH15	o			
SSAH16	o			
SSAH17	o			
SSAH18	o		o	
SSAH19	o		o	
SSAH20	o			
SSAH21	o		o	
SSAH22	o	o		
SSAH23	o		o	o
SSAH24	o			
SSAH25	o		o	o
SSAH26	o	o		o
SSAH27	o	o		
SSAH28	o			
SSAH29	o	o		
SSAH30	o			o
SSAH31	o			o
SSAH32	o		o	
SSAH33	o			
SSAH34	o			o
SSAH35	o			o
SSAH36	o			
SSAH37			o	
SSAH38	o			
SSAH39	o			
SSAH40	o			
SSAH41	o		o	o
SSAH42	o			o
SSAH43	o			

Individual	1	2	3	4
SSAH63		o		
SSAH64		o		
SSAH65		o		
SSAH66		o		
SSAH67		o		o
SSAH68		o		
SSAH69		o		o
SSAH70			o	
SSAH71			o	
SSAH72		o		
SSAH73		o		
SSAH74		o	o	
SSAH75		o		
SSAH76			o	
SSAH77		o		
SSAH78			o	
SSAH79			o	
SSAH80			o	
SSAH81			o	o
SSAH82			o	o
SSAH83			o	
SSAH84			o	
SSAH85			o	
SSAH86			o	
SSAH87			o	
SSAH88			o	
SSAH89			o	
SSAH90			o	
SSAH91			o	
SSAH92			o	
SSAH93			o	
SSAH94			o	
SSAH95			o	
SSAH96			o	
SSAH97			o	
SSAH98			o	
SSAH99			o	
SSAH100			o	
SSAH101			o	
SSAH102			o	
SSAH103			o	
SSAH104			o	
SSAH105			o	

SSAH44	o			
SSAH45	o		o	
SSAH46	o		o	
SSAH47	o			
SSAH48	o			
SSAH49	o			
SSAH50	o			o
SSAH51	o			o
SSAH52	o	o	o	
SSAH53	o			
SSAH54		o		
SSAH55			o	
SSAH56		o		
SSAH57		o	o	
SSAH58		o	o	
SSAH59		o		
SSAH60		o	o	
SSAH61		o	o	
SSAH62		o		
SSAH106			o	
SSAH107				o
SSAH108				o
SSAH109				o
SSAH110				o
SSAH111			o	
SSAH112				o
SSAH113				o
SSAH114				o
SSAH115				o
SSAH116				o
SSAH117				o
SSAH118				o
SSAH119				o
SSAH120				o
SSAH121				o
SSAH122				o
SSAH123				o
SSAH124				o
Grand Total	**58**	**31**	**65**	**34**

Appendix L – Bottlenose dolphin capture histories

	Sample			
Individual	**1**	**2**	**3**	**4**
TADU01	o		o	
TADU02	o	o	o	
TADU03	o	o		
TADU04	o			
TADU05	o		o	
TADU06	o	o		
TADU07	o	o	o	
TADU08	o	o		
TADU09	o			
TADU10	o	o	o	
TADU11	o			
TADU12	o			
TADU13	o			
TADU14	o			
TADU15	o			
TADU16	o			
TADU17	o			
TADU18	o			
TADU19	o			
TADU20	o			
TADU21	o			
TADU22	o			
TADU23	o			
TADU24	o			
TADU25	o			
TADU26	o			
TADU27		o		
TADU28		o	o	
TADU29		o	o	
TADU30		o	o	

	Sample			
Individual	**1**	**2**	**3**	**4**
TADU31		o	o	
TADU32			o	
TADU33			o	
TADU34				o
TADU35				o
TADU36				o
TADU37				o
TADU38				o
TADU39				o
TADU40				o
TADU41				o
TADU42				o
TADU43				o
TADU44				o
TADU45				o
TADU46				o
TADU47				o
TADU48				o
TADU49				o
TADU50				o
TADU51				o
TADU52				o
TADU53				o
TADU54				o
TADU55				o
TADU56				o
TADU57				o
TADU58				o
TADU59				o
Grand Total	**27**	**14**	**19**	**27**

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