Amrun Project 2016 Inshore Dolphin Survey Summary – Blue Planet Marine

As part of the Commonwealth EPBC Approval for the Amrun Project, Rio Tinto was required to develop and implement an *Inshore Dolphin Offset Strategy*[1] ("Strategy"). The Strategy was designed primarily to obtain knowledge about the distribution, abundance and habitat utilised by populations of Australian snubfin dolphin and Australian humpback dolphins in the region from Weipa to Aurukun, including surveys undertaken prior to construction, during construction and after construction of the Amrun Port and river facilities.

Following a baseline survey completed in December 2014 by GHD Pty Ltd, Blue Planet Marine (BPM) was contracted by Rio Tinto Alcan (RTA) to conduct the first annual survey during the initial construction period of the project. Following survey training days conducted from 4-6 November, the survey was completed between 7-19 November 2016.

The methods used for the 2016 survey followed those of the 2014 survey, described in detail in the *Inshore Dolphin Offset Strategy*[1] and the *2014 Inshore Dolphin Baseline Survey*[2] report by GHD. Three vessels undertook simultaneous, predetermined line-transect surveys to collect sighting, photo-identification and habitat data on inshore dolphins pods encountered at three sites ranging from Pine River in the north to Aurukun in the south (Figure 1).

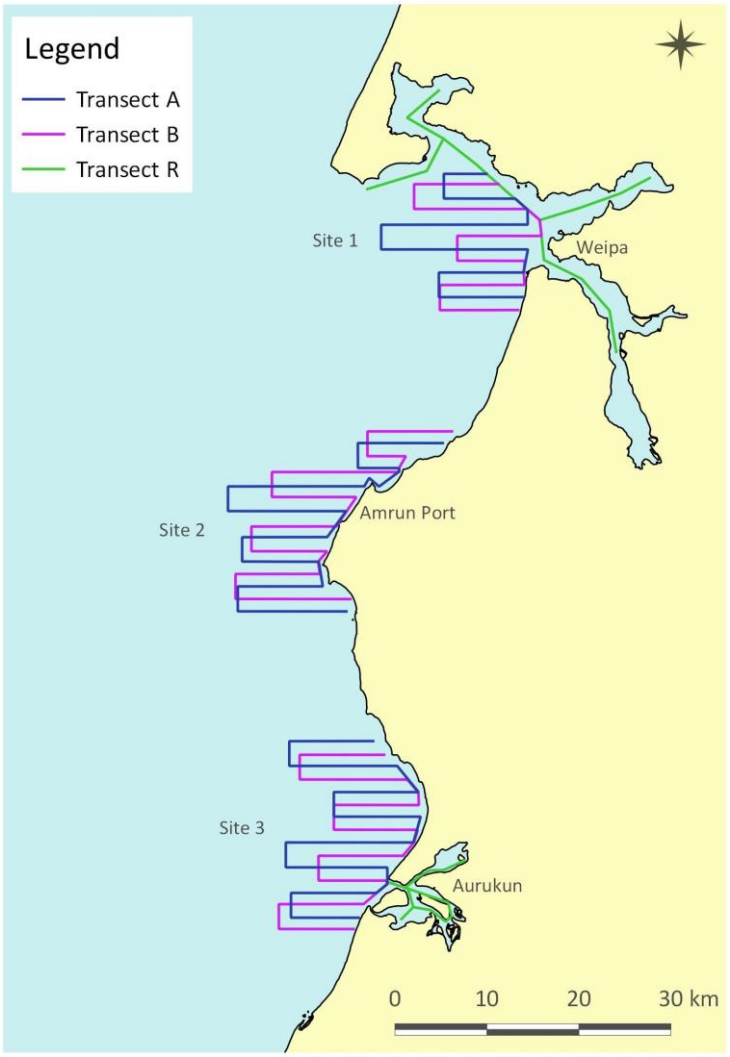

Figure 1. Overview of transects for the Inshore Dolphin Survey undertaken in November 2016.

1. Rio Tinto Alcan (2015) Inshore Dolphin Offset Strategy - South of Embley Project
2. GHD (2015) Rio Tinto Alcan, South of Embley Inshore Dolphin Project, December 2014 Baseline Survey

These surveys were designed using Robust Design capture-recapture methods, such that each primary sample (i.e. each year's total survey) was made up of a number of smaller secondary samples. For the 2014 and 2016 surveys, the primary sample included four secondary samples, made up of either "A" or "B" transects at each site, plus river transects ("R" transects) for sites 1 and 3 (Table 1).

Sample	Site 1 transects	Site 2 transects	Site 3 transects
Secondary sample 1	A1 to A13, R1-R15	A14 to A32	A33 to A49, R16-R28
Secondary sample 2	B1 to B14, R1-R15	B15 to B32	B33 to B51, R16-R28
Secondary sample 3	A1 to A13, R1-R15	A14 to A32	A33 to A49, R16-R28
Secondary sample 4	B1 to B14, R1-R15	B15 to B32	B33 to B51, R16-R28

A team of eleven researchers undertook the surveys in 2016, including Traditional Owners Tianna Chevathen and Jessie Motto, members of RTA's Environment team Linda Wells and Glenn Woodrow, and BPM's Dave Paton, Rob Slade, Anthony Muyt, Corey Lardner, Mitch Burrows, Andrew Nichols and Dan Burns. BPM's 6m RHIB, *Beluga*, was used to survey site 1, while the 17m live-aboard vessel, *Phantom IV*, was used in conjunction with the 6.4m RHIB, *Coda*, to complete the surveys at Sites 2 and 3 and to assist with site 1 as needed.

A total of 304 hours and 54 minutes were spent on the water for the 2016 survey, with all vessels at all sites totalling 3968 kilometres travelled. Beaufort conditions ranged from 0 to 4 throughout the survey, during which time the research team sighted a total of 63 dolphin pods consisting of 244 individuals (Figures 2-5), including:

- 47 Australian humpback dolphin pods consisting of 148 individuals (Group size (GS) ranged from 1-9),
- 12 inshore bottlenose dolphin pods consisting of 72 individuals (GS: 1-18),
- 1 offshore bottlenose dolphin pod consisting of 2 individuals (GS: 2),
- 2 Australian snubfin dolphin pods consisting of 14 individuals (GS: 3-11),
- 4 unidentified dolphin pods consisting of 7 individuals (GS: 1-4), and
- one unconfirmed sighting, recorded as one "possible juvenile dolphin".

Of the 63 sighted pods, two included mixed species groups of Australian humpback dolphins with inshore bottlenose dolphins.

At least one useable identification photograph was obtained from 41 (65%) of the 63 dolphin pods sighted, with a total of 107 individual dolphins photo-identified. Identified individuals included:

- 61 humpback dolphins,
- 35 bottlenose dolphins, and
- 11 snubfin dolphins.

No dolphins of any species were identified in more than two secondary samples or at more than one site. Of the 61 identified humpback dolphins, 57 were identified in one secondary sample and 4 were identified in two secondary samples. Of the 35 identified bottlenose dolphins, 34 were identified in one secondary sample and 1 was identified in two secondary samples. All 11 identified snubfin dolphins were photographed on the same day and not sighted otherwise.

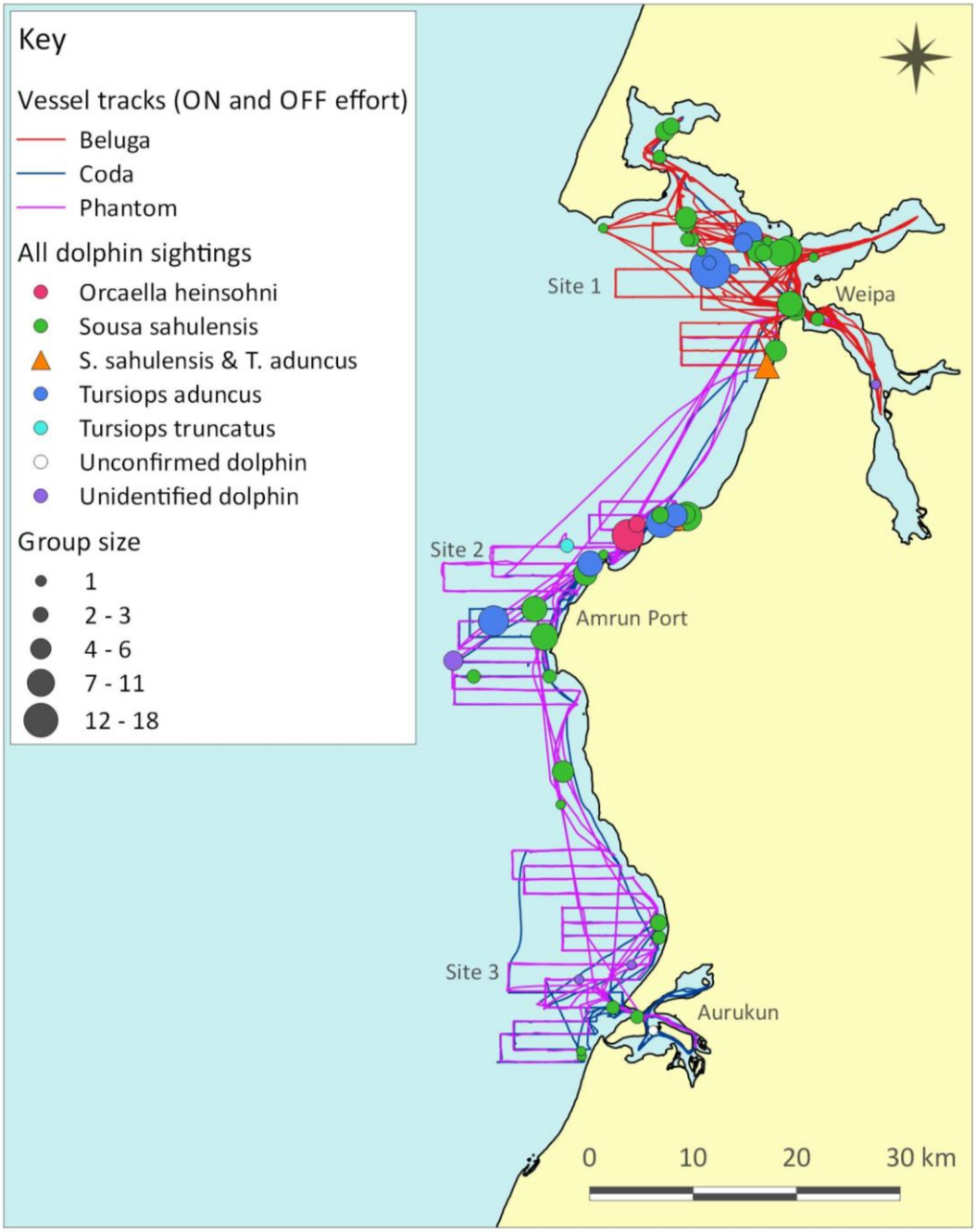

Figure 2. Overview of dolphin sightings and survey effort for the 2016 Inshore Dolphin Survey.

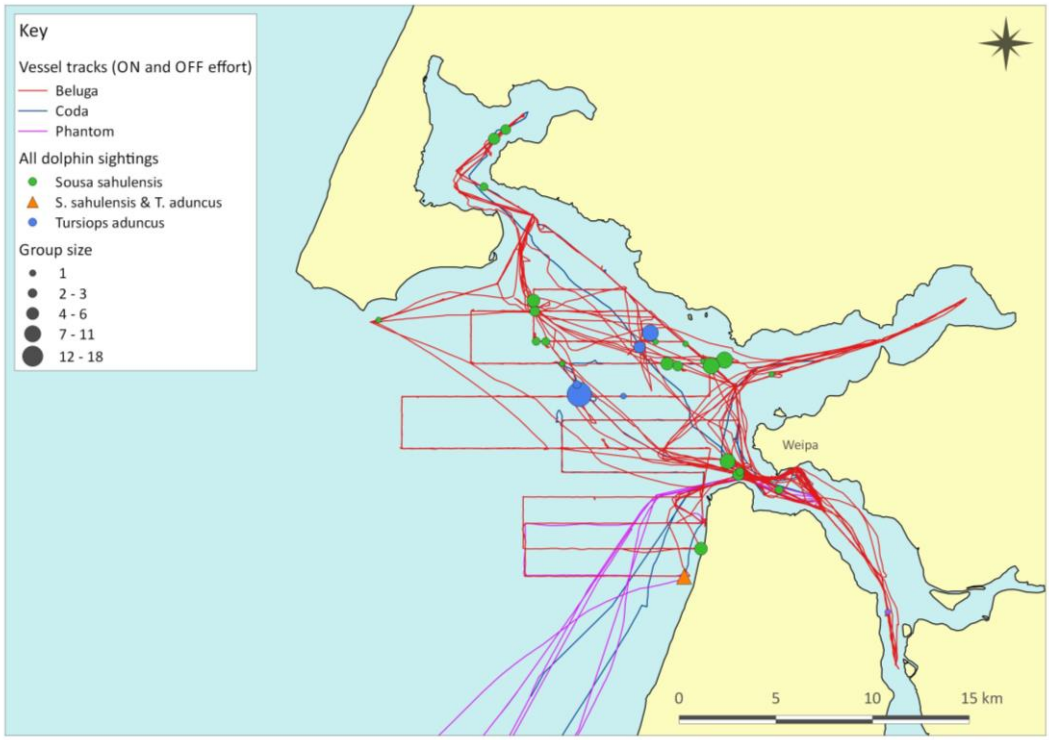

Figure 3. Dolphin sightings and survey effort at Site 1 for the 2016 Inshore Dolphin Survey.

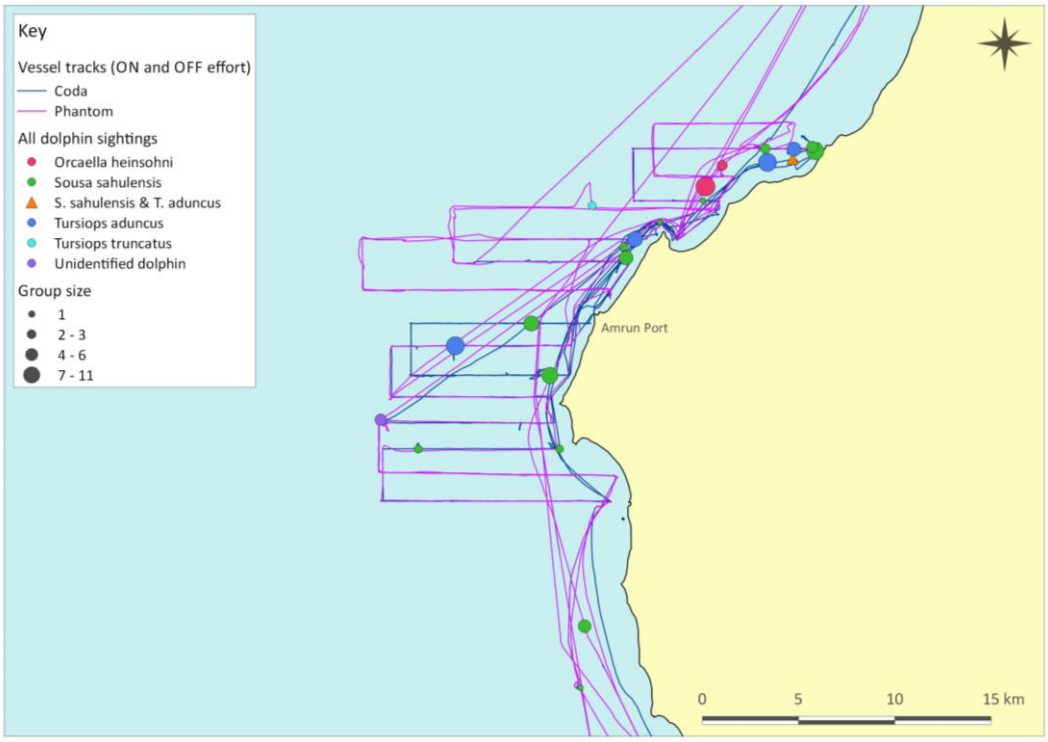

Figure 4. Dolphin sightings and survey effort at Site 2 for the 2016 Inshore Dolphin Survey.

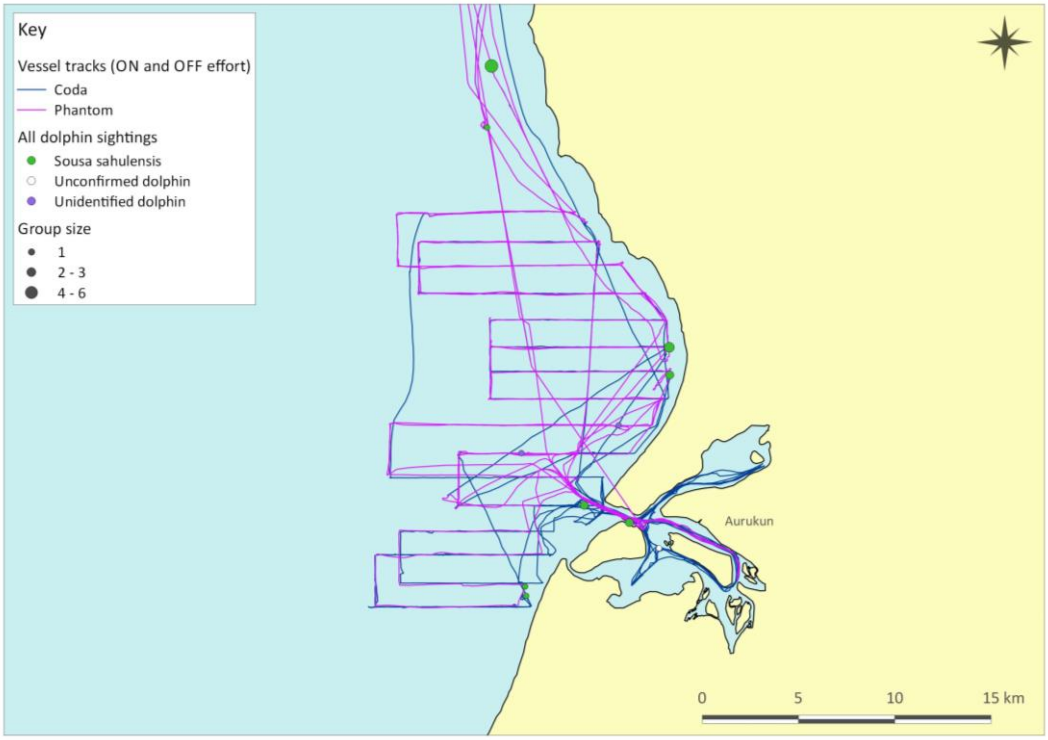

Figure 5. Dolphin sightings and survey effort at Site 3 for the 2016 Inshore Dolphin Survey.

In addition, a small number of humpback, bottlenose and snubfin dolphins were photo-identified using less distinctive or "ephemeral" characteristics (e.g. scratches) but were deemed to be "unrecognisable" for the purposes of multi-year capture-recapture analyses. The latter analyses will be included in the full 2016 report once the 2014 data become available for comparison, along with further details about encounter and resight rates, abundance estimates, habitat preferences and further graphical representations of effort and sightings.

During the 2016 dolphin surveys, the observer team also made 219 incidental sightings of other marine megafauna species, including turtles, sharks, rays, crocodiles, dugongs and sea snakes. Of these, the most common were marine turtles (n=119, =54%) and sea snakes (n=58, =27%).

1. Addendum – Results Summary

1.1 Survey effort and schedule

Survey training and induction days were conducted from 4-6 November 2016 and the survey was completed between 7-19 November 2016. A summary of key dates are as follows:

- 4 November – Inshore Dolphin Survey training day conducted with all personnel;
- 5-6 November – On-water training and testing of equipment, including conducting 'practice' transects;
- 7-11 November – Secondary sample 1 of the inshore dolphin survey completed;
- 8-12 November – Secondary sample 2 completed;
- 13-16 November – Secondary sample 3 completed;
- 16-19 November – Secondary sample 4 completed;
- 20 November – Demobilisation.

A total of 336 hours and 07 minutes were spent on the water for the 2016 survey, with all vessels across all sites totalling 3,857 kilometres travelled. Of this, the total "on effort" survey work (i.e. observing for dolphins while on transect – the terms "on effort" and "on transect" are used interchangeably hereafter) totalled 125 hours and 56 minutes and 1589 kilometres. Survey effort per sample is shown in Table 1 and per site in Table 2. Transects that were later resurveyed due to survey design and sampling protocols or poor weather conditions were excluded from analyses.

Secondary sample	Total time on water (h:mm)	Total distance travelled (km)	Total time on transect (h:mm)	Total distance travelled on transect (km)
1	72:35	710.7	33:15	401.6
2	86:22	1056.5	30:35	393.0
3	92:34	1084.7	30:47	396.6
4	84:34	1005.5	31:18	398.5
Total	**336:07**	**3857.3**	**125:56**	**1589.7**

Table 1. Survey effort per secondary sample during the 2016 dolphin survey[1].

Site	Total time on water (h:mm)	Total distance travelled (km)	Total time on transect (h:mm)	Total distance travelled on transect (km)
1	146:01	1683.0	53:26	637.8
2	71:54	927.3	31:43	424.9
3	118:11	1247.1	40:46	527.0
Total	**336:07**	**3857.3**	**125:56**	**1589.7**

Table 2. Survey effort per site during the 2016 dolphin survey.

1. Times and distances for *Phantom IV* for 07 November have been estimated due to a technical problem with the GPS track recording from that day.

Using a 3 x 3 km grid overlaid on the study area and assuming a 500 m strip width (i.e. 250 m either side of the transect line), survey effort while on transect for all four sampling occasions combined is represented in Figure 1.

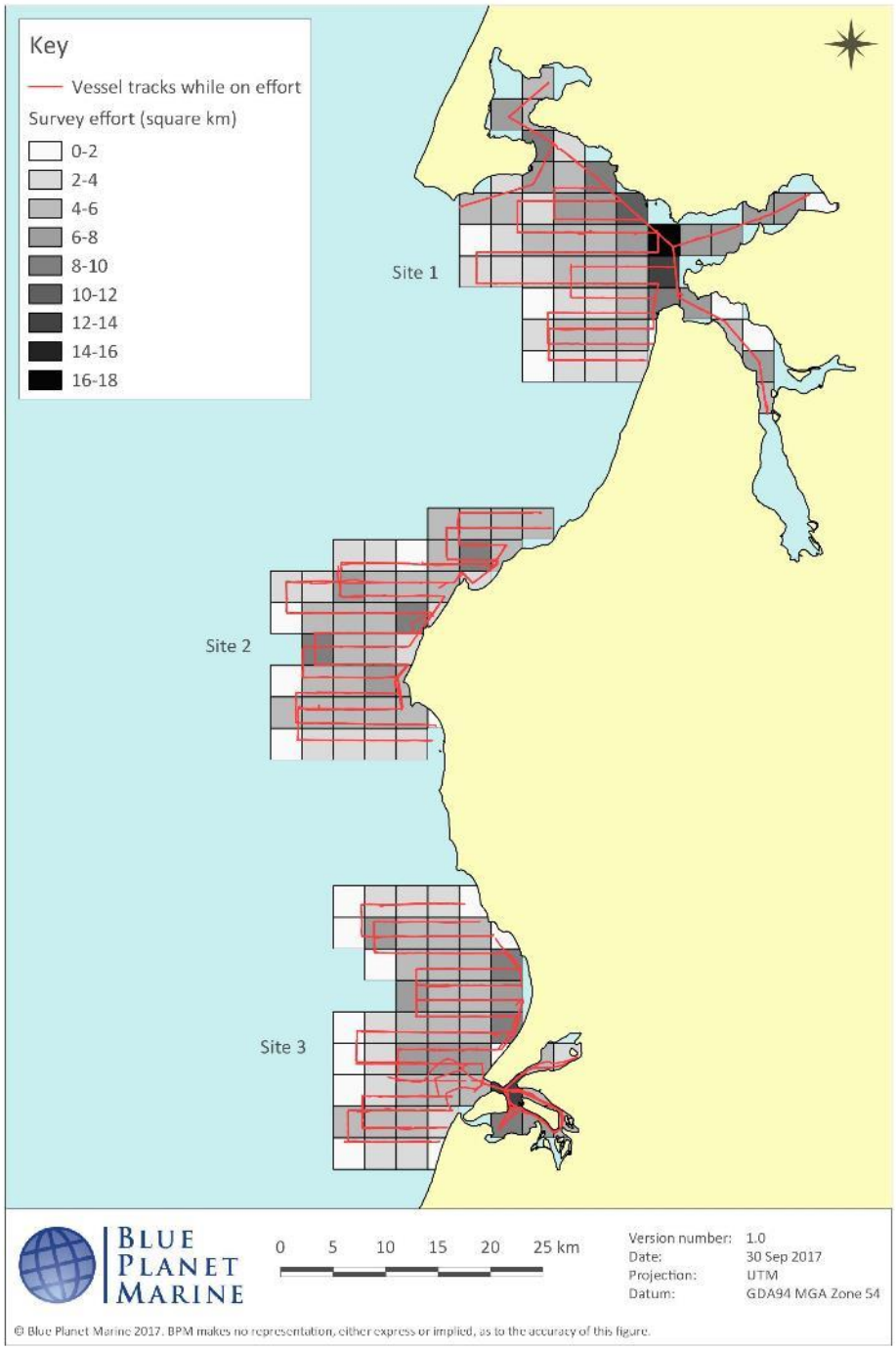

Figure 1. Survey effort for the 2016 survey with 3x3km grid overlay showing effort in km^2 per grid cell.

1.2 Survey conditions present

Weather conditions during the 2016 survey were good overall, with no full days lost due to poor weather and over 75% of the survey completed in Beaufort sea state of 2 or 3. Total kilometres travelled at each Beaufort sea state during the survey are shown in Table 3. No transects were commenced in sea states above Beaufort 3, however some transects were commenced in lower sea states and completed in Beaufort 4 as the weather worsened. These transects were later resurveyed if time allowed before completing a sample. Transects completed in Beaufort 4 which were later

resurveyed were excluded from “on effort” analyses, while those not resurveyed later were included in analyses.

Beaufort sea state	Total distance travelled on transect (km)	Proportion of distance travelled on transect (%)
0	11.3	0.7
1	270.4	17.0
2	621.7	39.1
3	603.5	38.0
4	82.8	5.2
Total	**1589.7**	**100.0**

Table 3. Survey conditions while on effort for the 2016 dolphin survey, excluding transects that were resurveyed.

Survey conditions per secondary sample are shown in Figure 2.

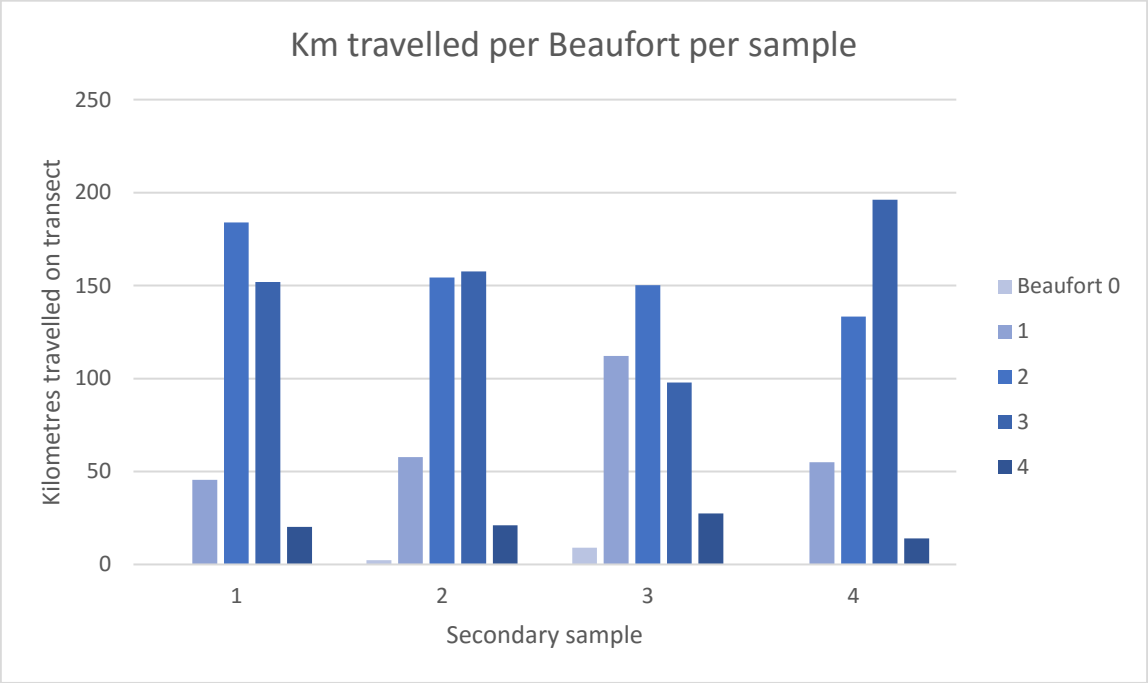

Figure 2. Weather conditions and distance travelled on transect per secondary sample.

1.3 Dolphin sightings

A total of 64 dolphin pods of 243 individuals were observed during the 2016 survey, including both ‘on’ and ‘off effort’ sightings:

- 47 Australian humpback dolphin pods (148 individuals);
- 12 inshore bottlenose dolphin pods (72 individuals);
- 1 offshore bottlenose dolphin pods (2 individuals);

- 2 Australian snubfin dolphin pods (14 individuals); and
- 4 unidentified dolphin pods (7 individuals).

One unconfirmed dolphin sighting, recorded as “possible juvenile dolphin” was excluded from the analyses. Of the 64 sightings, two included mixed species groups of Australian humpback dolphins with inshore bottlenose dolphins. An overview of dolphin sightings for all sites is shown in Table 4 - Table 8 and Figure 3 - Figure 6.

Dolphin species	Number of pods	Number of individuals	Mean pod size	Min. pod size	Max. pod size
Snubfin	2	14	7	3	11
Humpback	45	144	3.2	1	9
Inshore bottlenose	10	68	6.8	1	18
Offshore bottlenose	1	2	2	2	2
Humpback and inshore bottlenose (mixed group)	2	8	4	3	5
Unidentified dolphin	4	7	1.8	1	4
Total	**64**	**243**	**3.8**	**1**	**18**

Table 4. Dolphin sightings for all sites during the 2016 survey.

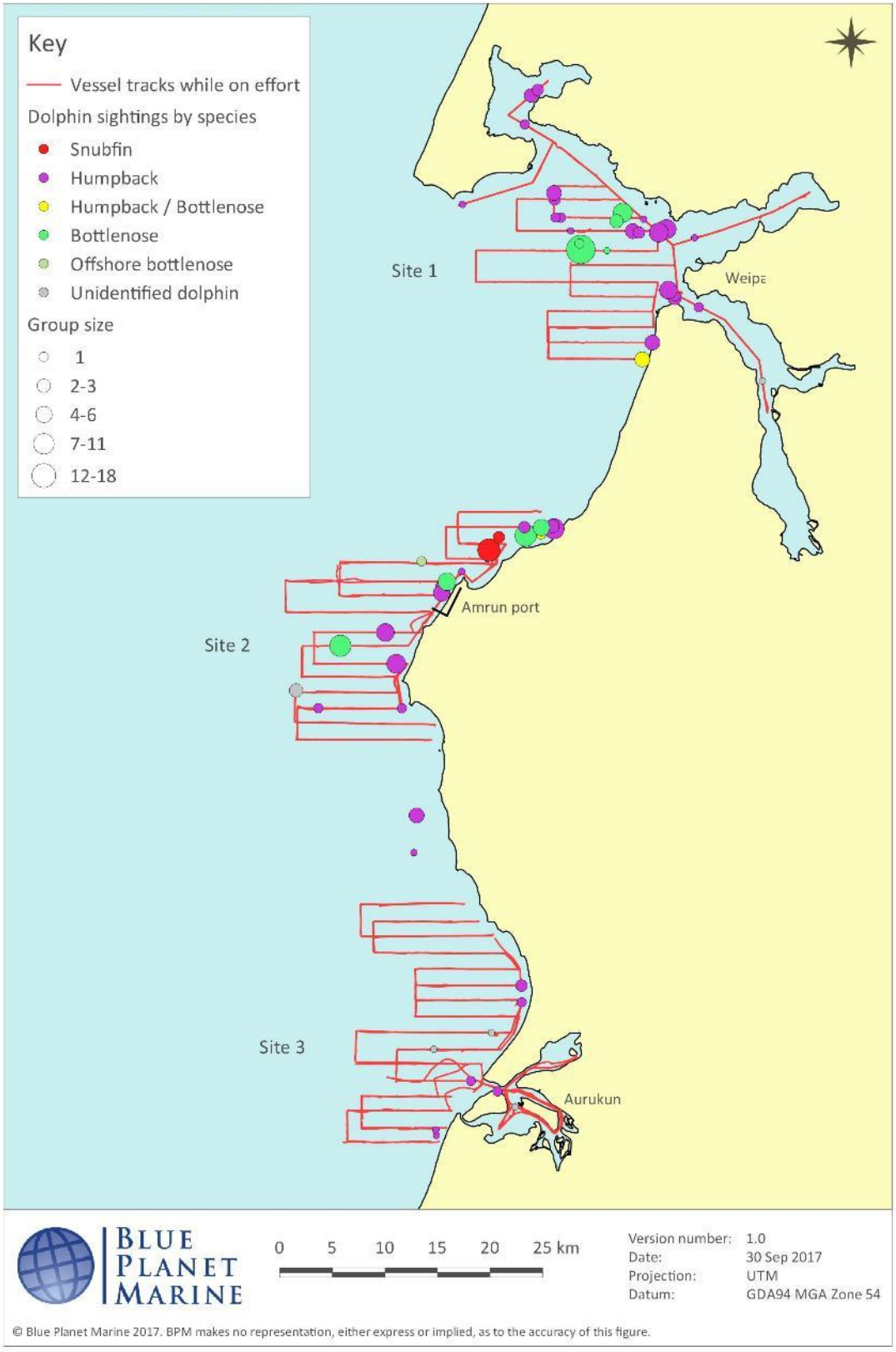

Figure 3. All dolphin sightings (on and off effort) and on effort vessel tracks from the 2016 survey.

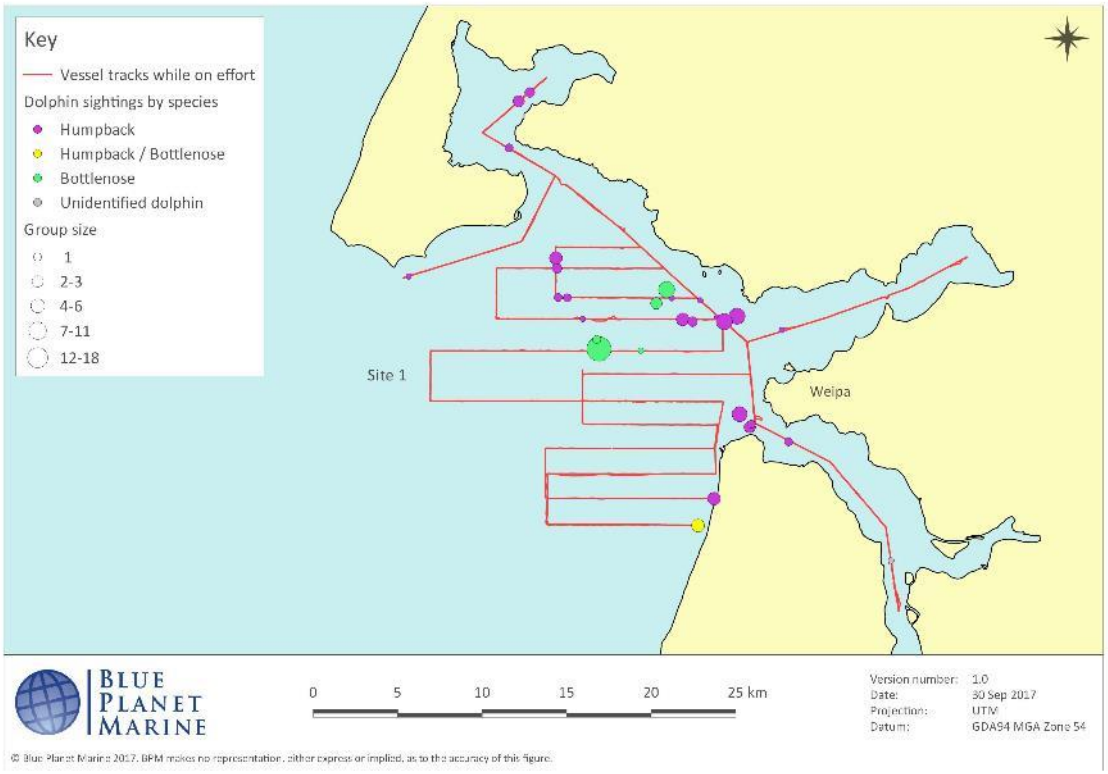

Figure 4. Dolphin sightings at Site 1.

Dolphin species	Number of pods	Number of individuals	Mean pod size	Min. pod size	Max. pod size
Humpback	23	73	3.2	1	8
Inshore bottlenose	6	35	5.8	1	18
Humpback / bottlenose	1	5 (3HB, 2BN)	5	5	5
Unidentified dolphin	1	1	1.0	1	1
Total	**31**	**114**	**3.7**	**1**	**18**

Table 5. Dolphin sightings at Site 1.

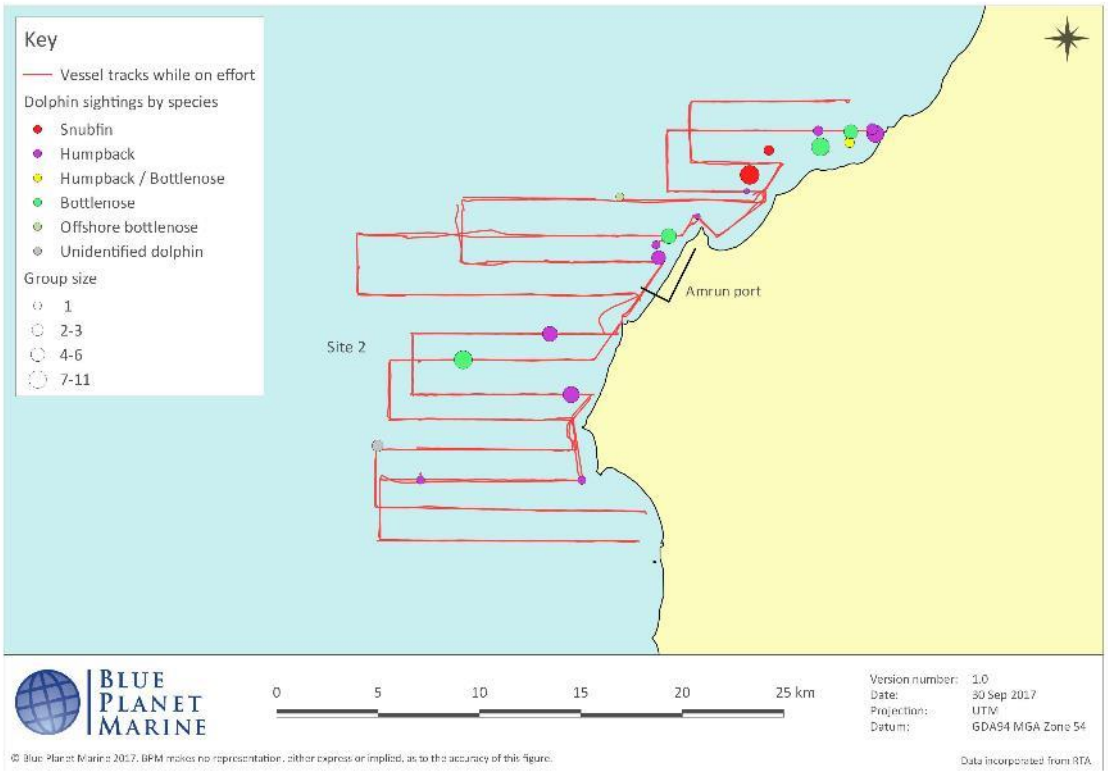

Figure 5. Dolphin sightings at Site 2.

Dolphin species	Number of pods	Number of individuals	Mean pod size	Min. pod size	Max. pod size
Humpback	15	58	3.9	1	9
Humpback & bottlenose	1	3 (1HB, 2 BN)	3	3	3
Inshore bottlenose	4	33	8.3	6	10
Offshore bottlenose	1	2	2	2	2
Snubfin	2	14	7	3	11
Unidentified dolphin	1	4	4	4	4
Total	**24**	**114**	**4.8**	**1**	**11**

Table 6. Dolphin sightings at Site 2.

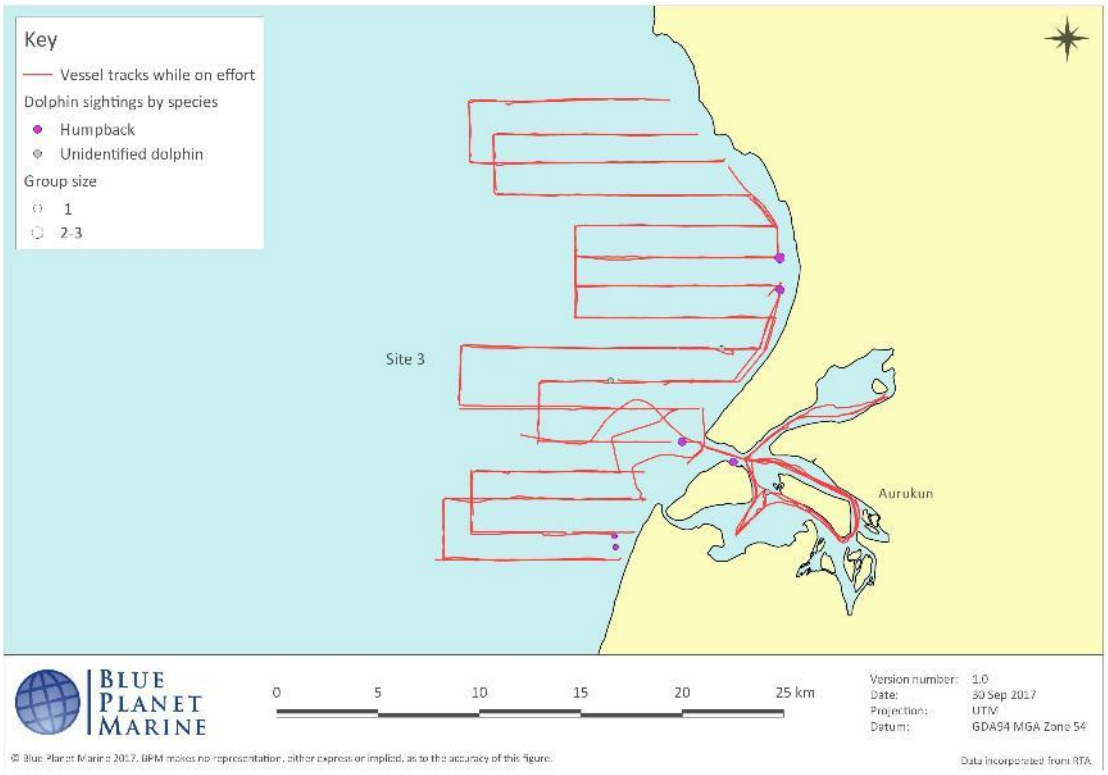

Figure 6. Dolphin sightings at Site 3.

Dolphin species	Number of pods	Number of individuals	Mean pod size	Min. pod size	Max. pod size
Humpback	7	13	1.9	1	3
Unidentified dolphin	2	2	1	1	1
Total	**9**	**15**	**1.7**	**1**	**3**

Table 7. Dolphin sightings at Site 3.

Dolphin sightings per secondary sample are shown in Table 8.

Secondary Sample #	SS 1		SS 2		SS 3		SS 4	
Dolphin species	**# pods**	**# individuals**	**# pods**	**# individuals**	**# pods**	**# individuals**	**# pods**	**# individuals**
Snubfin	0	0	0	0	0	0	2	14
Humpback	8	14	5	11	16	57	16	62
Inshore bottlenose	4	31	0	0	4	31	2	6
Offshore bottlenose	0	0	0	0	0	0	1	2
Humpback and inshore bottlenose (mixed group)	0	0	0	0	1	3 (1 HB, 2 BN)	1	5 (3 HB, 2 BN)
Unidentified dolphin	2	2	2	5	0	0	0	0
Total	**14**	**47**	**7**	**16**	**21**	**91**	**22**	**89**

Table 8. Dolphin sightings per secondary sample.

1.4 Group composition

Of all dolphins sighted during the 2016 survey, over 80% were adults (n=191), with 18.1% juveniles (=43) and 1.7% calves (n=4). No neonates were sighted during the survey. In a small number of instances (n=3) sightings were brief and group composition could not be confirmed. A breakdown of group composition by species is shown in Table 9.

Dolphin species	Adults (%)	Juveniles (%)	Calves (%)	Total
Snubfin	13 (92.9)	0	1 (7.1)	14
Humpback	111 (75.5)	35 (23.8)	1 (0.7)	147
Inshore bottlenose	60 (85.7)	8 (11.4)	2 (2.9)	70
Offshore bottlenose	2 (100)	0	0	2
Unidentified dolphin	5 (100)	0	0	5
Total	**191 (80.3)**	**43 (18.1)**	**4 (1.7)**	**238**

Table 9. Group composition by species of dolphins encountered during the 2016 survey.

1.5 Encounter rates

Linear Encounter Rates (LER) were calculated using the total number of dolphins sighted 'on effort' divided by the total kilometres travelled 'on effort' during each sample (Table 10) and site (Table 11). Overall, on effort LERs for the 2016 survey were highest for humpback dolphins (0.044 per km of transect), followed by inshore bottlenose dolphins (0.016 per km). The two snubfin dolphin pods sighted were both 'off effort', and thus the LER was 0.000.

Secondary sample	Distance travelled on effort (km)	No individual dolphins sighted on effort			Mean Linear Encounter Rate on effort (per km of transect)		
		Snubfin	Humpback	Bottlenose	Snubfin	Humpback	Bottlenose
SS1	401.6	0	11	11	0.000	0.027	0.027
SS2	393.0	0	4	0	0.000	0.010	0.000
SS3	396.5	0	18	7	0.000	0.045	0.018
SS4	398.5	0	37	7	0.000	0.093	0.018
Total	**1589.7**	**0**	**70**	**25**	**0.000**	**0.044**	**0.016**

Table 10. Linear on effort encounter rates of snubfin, humpback and inshore bottlenose dolphins per secondary sample of the 2016 survey

Site	Distance travelled on effort (km)	No individual dolphins sighted on effort			Mean Linear Encounter Rate on effort (per km on transect)		
		Snubfin	Humpback	Bottlenose	Snubfin	Humpback	Bottlenose
1	637.8	0	42	8	0.000	0.066	0.013
2	424.9	0	24	17	0.000	0.056	0.040
3	527.0	0	4	0	0.000	0.008	0.000
Total	**1589.7**	**0**	**70**	**25**	**0.000**	**0.044**	**0.016**

Table 11. Linear on effort encounter rates of snubfin, humpback and inshore bottlenose dolphins per site of the 2016 survey

Survey Area Encounter Rates (SAER) were also calculated assuming a 500 m strip width around the transect (i.e. 250 m either side, estimated to be the average distance to which dolphins could be reliably observed under a variety of sea conditions (Brown et al. 2014)). Overall SAERs for the 2016 survey were 0.088 humpback dolphins sighted per km^2 on effort and 0.031 for bottlenose dolphins. SAERs per sample are shown in Table 12 and per site in Table 13.

Secondary sample	Surveyed area on effort (km^2)	No individual dolphins sighted on transect			Mean Survey Area Encounter Rate (per km^2 on effort)		
		Snubfin	Humpback	Bottlenose	Snubfin	Humpback	Bottlenose
SS1	200.8	0	11	11	0.000	0.055	0.055
SS2	196.5	0	4	0	0.000	0.020	0.000
SS3	198.3	0	18	7	0.000	0.091	0.035
SS4	199.3	0	37	7	0.000	0.186	0.035
Total	**794.8**	**0**	**70**	**25**	**0.000**	**0.088**	**0.031**

Table 12. Survey Area on effort encounter rates of snubfin, humpback and inshore bottlenose dolphins per secondary sample of the 2016 survey

Site	Surveyed area on effort (km^2)	No individual dolphins sighted on effort			Mean Survey Area Encounter Rate on effort (per km^2)		
		Snubfin	Humpback	Bottlenose	Snubfin	Humpback	Bottlenose
1	318.9	0	42	8	0.000	0.132	0.025
2	212.5	0	24	17	0.000	0.113	0.080
3	263.5	0	4	0	0.000	0.015	0.000
Total	**794.8**	**0**	**70**	**25**	**0.000**	**0.088**	**0.031**

Table 13. Survey Area on effort encounter rates of snubfin, humpback and inshore bottlenose dolphins per site of the 2016 survey

Survey Area Encounter Rates for all dolphin species sighted while on effort with a 3 x 3 km grid overlay of the study area are shown in Figure 7. Humpback dolphin SAERs per grid cell are shown in Figure 8 and those for bottlenose dolphins in Figure 9.

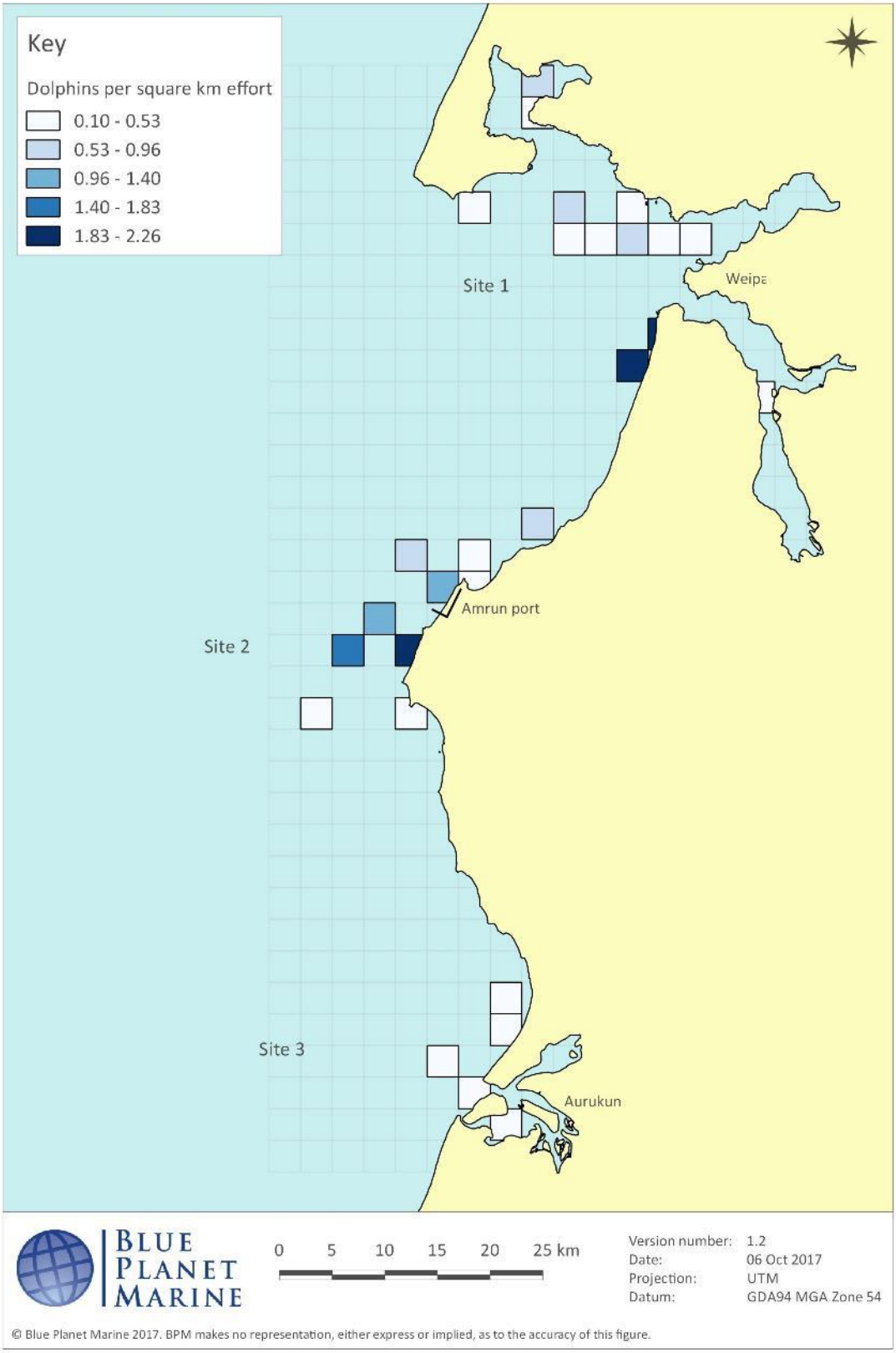

Figure 7. Survey Area Encounter Rates on effort for all dolphin species combined from the 2016 survey.

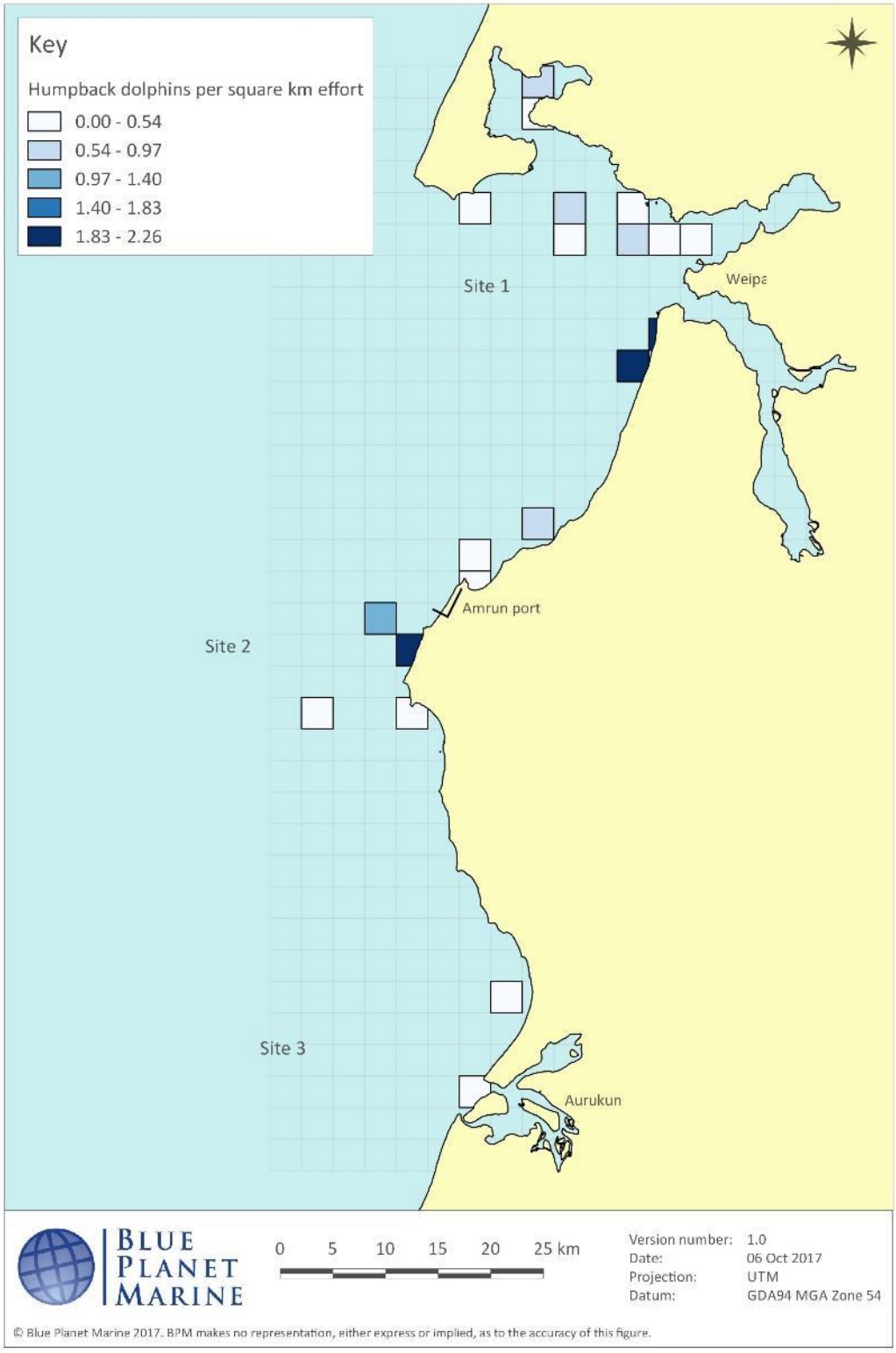

Figure 8. Survey Area Encounter Rates for humpback dolphins from the 2016 survey.

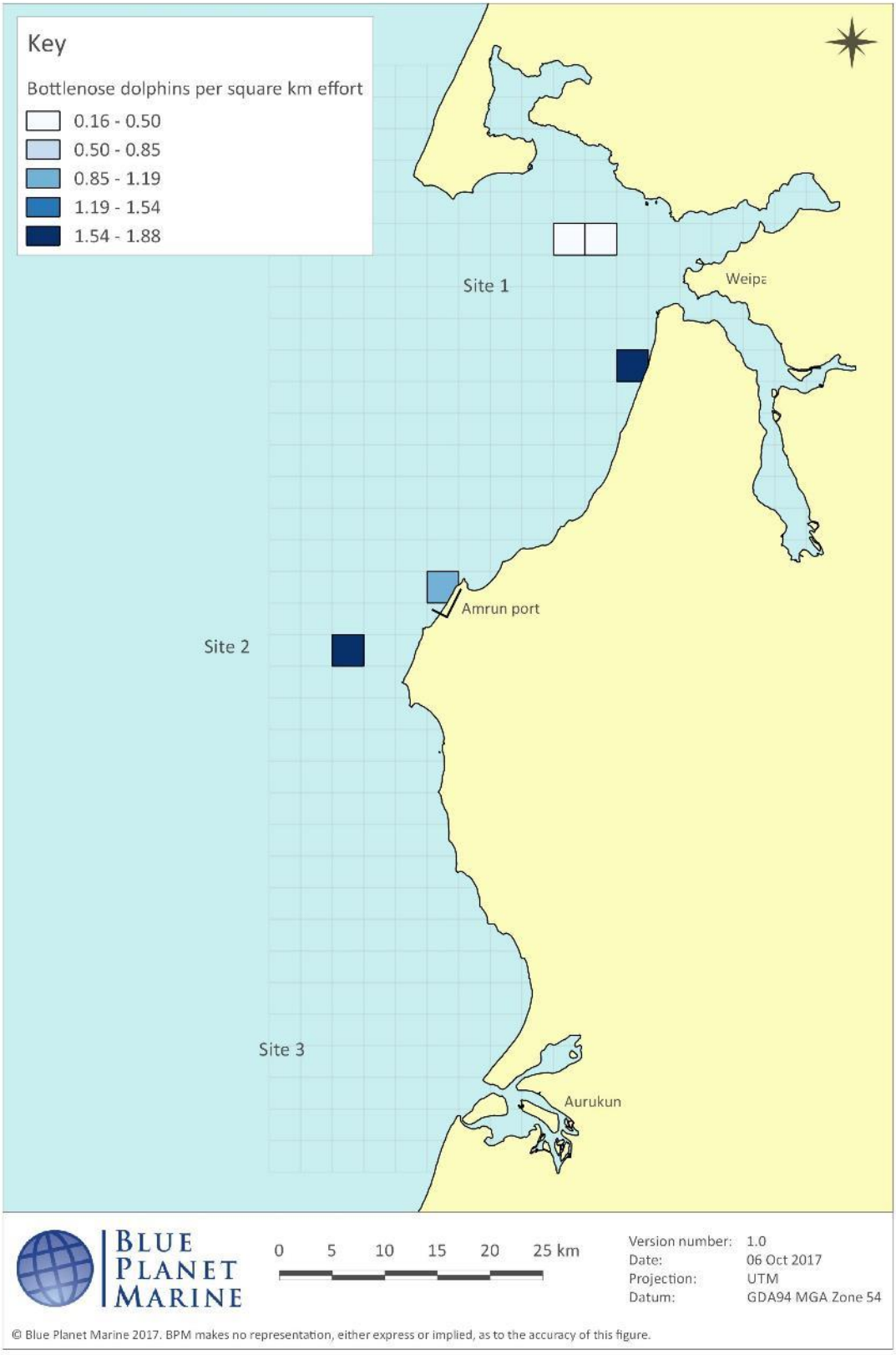

Figure 9. Survey Area Encounter Rates for bottlenose dolphins from the 2016 survey.

1.6 Identification and resight rates

Identification photographs were obtained from 41 (64%) of the 64 dolphin pods sighted during the 2016 survey. A total of 112 individual dolphins were photo-identified, including 65 humpback, 36 bottlenose and 11 snubfin dolphins. Examples of photo-identification images of each species are shown in Figure 10 - Figure 12.

Figure 10. Example of an identification image of humpback dolphin (SSA20161109-BEL-002-3L-0234).

Figure 11. Example of an identification image of bottlenose dolphin (TADU20161116-COD-001-4_IMG_3482-474).

Figure 12. Example of an identification image of snubfin dolphin (OHE20161118-PHA-001-3R_IMG_1444).

Photo-identifications by species and sample are shown in Table 14 and by species and site in Table 15. No dolphins of any species were identified in more than two secondary samples. One bottlenose dolphin was identified in Sample 1 and then again in Sample 4. Of the 61 identified humpback dolphins, 57 were identified in one secondary sample only and 4 were identified in two secondary samples. No individual of any species was identified at more than one site during the 2016 survey.

Secondary sample	Number of photo-identified individuals			Total number of new individuals
	Snubfin	Humpback	Bottlenose	
SS1	0	3	13	16
SS2	0	4	3	7
SS3	0	27	17	44
SS4	11	31	3	45
Total	**11**	**65**	**36**	**112**

Table 14. Photo-identifications by species and secondary sample. N.B. Total identifications are higher than the total number of new individuals as some dolphins were identified in more than one sample.

Site	Number of photo-identified individuals			Total number of new individuals
	Snubfin	Humpback	Bottlenose	
1	0	32	16	48
2	11	24	20	55
3	0	9	0	9
Total	**11**	**65**	**36**	**112**

Table 15. Photo-identifications by species and site.

1.7 Abundance estimates

With only 11 identification images of snubfin dolphins, capture-recapture analyses were not possible for this species. Of the 65 individual humpback dolphins that were photo-identified, four were deemed to be "unrecognisable" for the purposes of capture-recapture analyses. (Figure 13) One bottlenose dolphin was also assessed as being unrecognisable and rejected from capture-recapture analyses (Figure 14). After removing the rejected individuals, capture histories for 61 humpback dolphins and 35 bottlenose dolphins were investigated for alternative structures using program CAPTURE before fitting maximum likelihood models in MARK.

Figure 13. Example of a rejected image of a humpback dolphin. Although this individual has distinctive marks on the right side dorsal, it was not assessed as being distinctive enough to be able to reliably identify it from a good quality photograph of either side of the dorsal fin in future.

Figure 14. Example of a rejected image of a bottlenose dolphin whereby the individual was not assessed as being distinctive enough to be able to reliably identify it from a good quality photograph of either side of the dorsal fin in future.

1.7.1 Distinctiveness

Using only good or excellent quality images to assess the distinctiveness or "recognisability" of individuals, the proportion of the population assessed as being recognisable for humpback dolphins was 0.80 and for bottlenose dolphins was 0.81.

1.7.2 Humpback dolphins

With only sixty one humpback dolphins captured (i.e. photo-identified) across the whole site (Weipa + Boyd Point + Aurukun) during four sampling occasions, the capture history data did not support models that provided reliable estimates. Only three humpback dolphins were captured on the first sampling occasion and four on the second, although 27 were captured on the third and 31 on the fourth.

Preliminary diagnostic tests in program CAPTURE were hampered by the low rates at which the dolphins were captured. They did suggest various forms of heterogeneity (unequal probabilities of capture among animals and differences between probabilities of first and subsequent captures) however, but models could not be built to accommodate or assess these affects because of limited numbers of captures, especially on the first two occasions.

The best model that could be fitted, estimated probabilities of capture varying by occasion, and total abundance. The estimated number of distinctive humpback dolphins that used the sample area during the four sampling occasions was 301 (with SE = 135, and 95% confidence interval between 146 and 734). This is far more humpback dolphins than were expected and would be atypical of humpback dolphin populations in other areas.

The underlying problem was the low capture probabilities over the four sampling occasions (0.01, 0.01, 0.09 and 0.10. This issue will be considered in detail in the **Error! Reference source not found.** of this report.

Due to the very low capture probabilities, unreliable estimates and wide confidence intervals produced by the capture-recapture analyses, total abundance was not estimated using the proportion of marked individuals.

1.7.3 Bottlenose dolphins

With only thirty-five bottlenose dolphins photo-identified across the whole site (Weipa + Boyd Point + Aurukun) during four sampling occasions, the capture history data did not support models that provided reliable estimates. Thirteen bottlenose dolphins were captured on the first sampling occasion, only three on the second, seventeen on the third and three on the fourth.

Preliminary diagnostic tests in program CAPTURE were hampered by the low rates at which the dolphins were captured. They did not however suggest that models with more complex structure than time-varying capture probabilities would be required.

The best model that could be fitted estimated probabilities of capture varying by occasion, and total abundance. The estimated number of distinctive bottlenose dolphins that used the sample area during the four sampling occasions was 388 (with SE = 372, and 95% confidence interval between 100 and 1958). This is far more bottlenose dolphins than were expected, but the estimate cannot be considered to be reliable. As for humpback dolphins, the underlying problem was the low capture probabilities over the four sampling occasions (0.03, 0.01, 0.04 and 0.01).

Due to the very low capture probabilities, unreliable estimates and wide confidence intervals produced by the capture-recapture analyses, total abundance was not estimated using the proportion of marked individuals.

1.8 Habitat preferences

The 2016 survey commenced on 7 November with neap tides as the moon neared first quarter (8 Nov). The full moon occurred on 14 November. For the purposes of this analysis, tides from 12-17 November were considered spring tides, with neap tides returning for the final two days of survey (18-19 November). Dolphin sightings during these phases are shown in Table 16.

Site	Spring tide number of sightings (%)	Neap tide number of sightings (%)
1	19 (61.3)	12 (38.7)
2	14 (66.7)	7 (33.3)
3	3 (23.1)	10 (76.9)
All sites	**36 (55.4)**	**29 (44.6)**

Table 16. Dolphin sightings during spring and neap tides

More than half of all sightings occurred on a rising tide (n=37, 57%), with 35% on a falling tide (n=23), 6% at high tide (n=4) and 2% at low tide (n=1). It should be noted that the majority of the 2016 survey was conducted during rising tides, with more than half of the daily survey time conducted on a rising tide for 10 of the 13 days. Furthermore, some areas of the study area were unable to be surveyed at low tide, for example the upstream Mission River transect R14-R15. Sightings by tide state are shown in Table 17.

Site	Falling (%)	Low (%)	Rising (%)	High (%)
1	10 (32.3)	0	20 (64.5)	1 (3.2)
2	9 (42.9)	0	11 (52.4)	1 (4.8)
3	4 (30.8)	1 (7.7)	6 (46.2)	2 (15.4)
All sites	**23 (35.4)**	**1 (1.5)**	**37 (56.9)**	**4 (6.2)**

Table 17. Dolphin sightings and tide states

Although sample sizes were small, the two sightings of snubfin dolphins occurred at the shallowest mean depth of any species, with humpback dolphins sighted at a mean depth of 7.8 m and inshore bottlenose dolphins at 9.6 m. Summary statistics for depths at which dolphin sightings occurred are shown in Table 18.

Species	Number of pods sighted	Depth at sighting location (m)			
		Mean	Std Dev	Minimum	Maximum
Humpback	47	7.8	5.3	1.3	21.5
Bottlenose	12	9.6	6.3	3.4	22.0
Offshore bottlenose	1	22.3	N/A	22.3	22.3
Snubfin	2	7.4	0	7.4	7.4

Table 18. Depth at sighting location of dolphin pods.

Summary statistics for other environmental parameters recorded at dolphin sighting locations are shown in Table 19.

Species	Number of pods sighted	Temperature (°C)		Conductivity (mS)		Turbidity (NTU)		pH	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Humpback	47	29.7	2.2	56.7	1.9	2.8	2.5	7.9	0.4
Bottlenose	12	29.9	2.4	56.2	1.0	1.4	1.8	7.9	0.2
Offshore bottlenose	1	N/A	N/A	54.3	N/A	0.4	N/A	N/A	N/A
Snubfin	2	28.5	0	56.4	0	2.5	0	7.9	0

Table 19. Environmental parameters recorded at dolphin sighting locations

1.9 Individual movements

No dolphin was sighted at more than one site during the 2016 survey. Eight humpback dolphins and one bottlenose dolphin were photographed on more than one day of the survey (Figure 15), including two individual humpback dolphins (16Hump009 and 010) that were photographed together near A13 on 13 November and then again near the mouth of the Embley River on 18 November. Another group of three humpback dolphins (16Hump058, 059 and 060) were photographed near A5 on the afternoon of 18 November and approximately 2 km further offshore nearly 24 hours later. The only resighted bottlenose dolphin (16Bott009) was photographed near transect A6-A7 at Site 1 on 8 November and approximately 3 km north of that location on 19 November. The largest distance travelled between sightings of the same individual was 7.64 km (16Hump018).

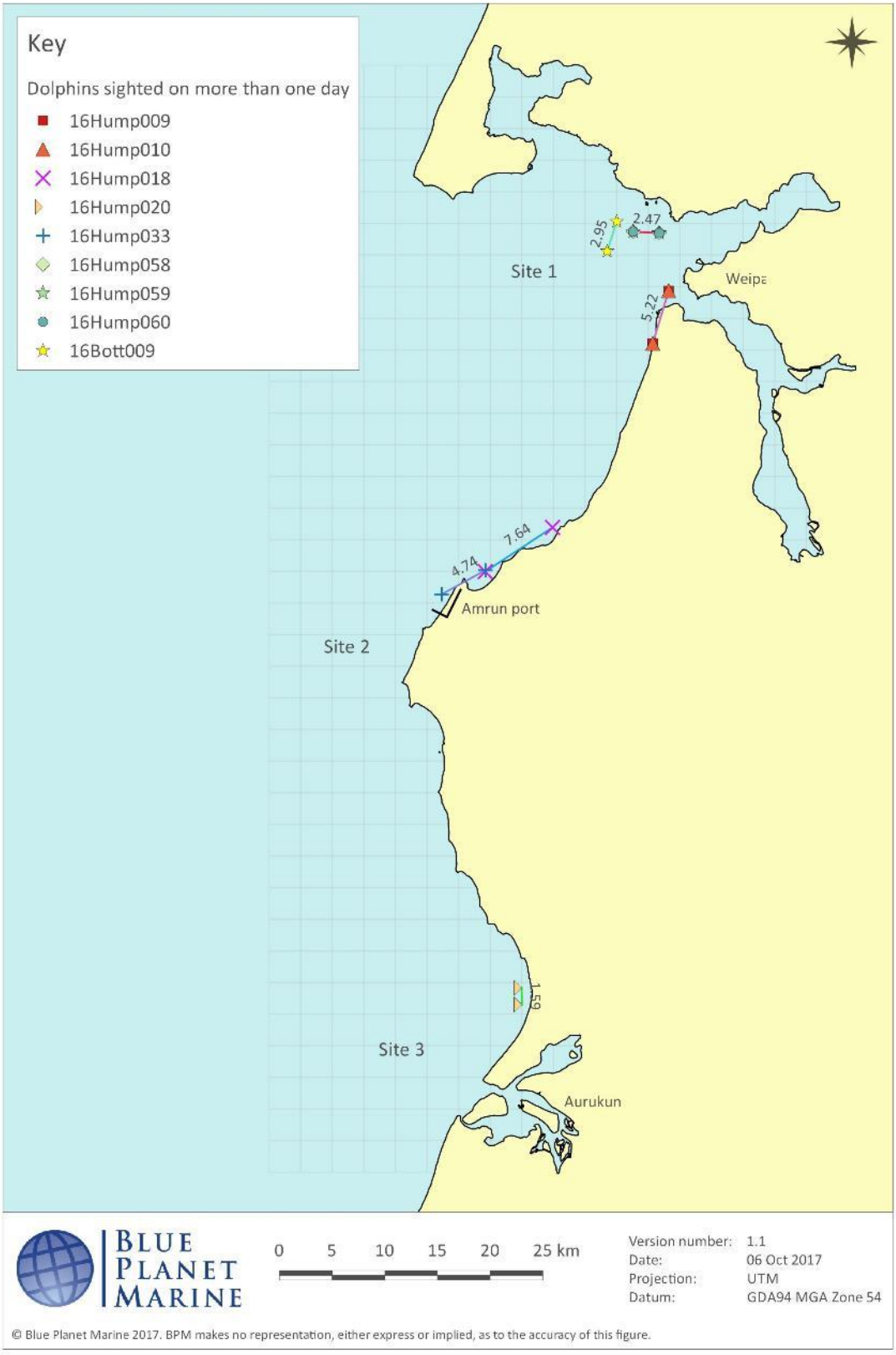

Figure 15. Locations of dolphins photographed on more than one day of the survey. Distances (km) between sightings are shown on the line in between the points.

1.10 Other marine megafauna sightings

During the 2016 inshore dolphin surveys, the observer team made 219 incidental sightings of other marine megafauna species. Of the non-dolphin species sighted, the most common were marine turtles (n=119, 54%) and sea snakes (n=58, 27%). Other marine megafauna sightings are summarised in Table 20. Example images of megafauna sighted are shown in Figure 16 - Figure 18 and locations of sightings in Figure 19.

Species	Number sighted
Crocodile	2
Dugong	1
Ray - cowtail	1
Ray - eagle	1
Ray - estuarine	2
Ray - manta	3
Ray - unidentified	13
Sea snake	58
Shark - black tipped reef	5
Shark - copper	1
Shark - leopard	2
Shark - unidentified	10
Shark - whaler	1
Turtle - flatback	17
Turtle - green	10
Turtle - hawksbill	17
Turtle - loggerhead	4
Turtle - unidentified	71
Total	**219**

Table 20. Other marine megafauna sighted during the 2016 dolphin survey.

Figure 16. Spine bellied sea snake

Figure 17. Flatback turtle

Figure 18. Leopard shark

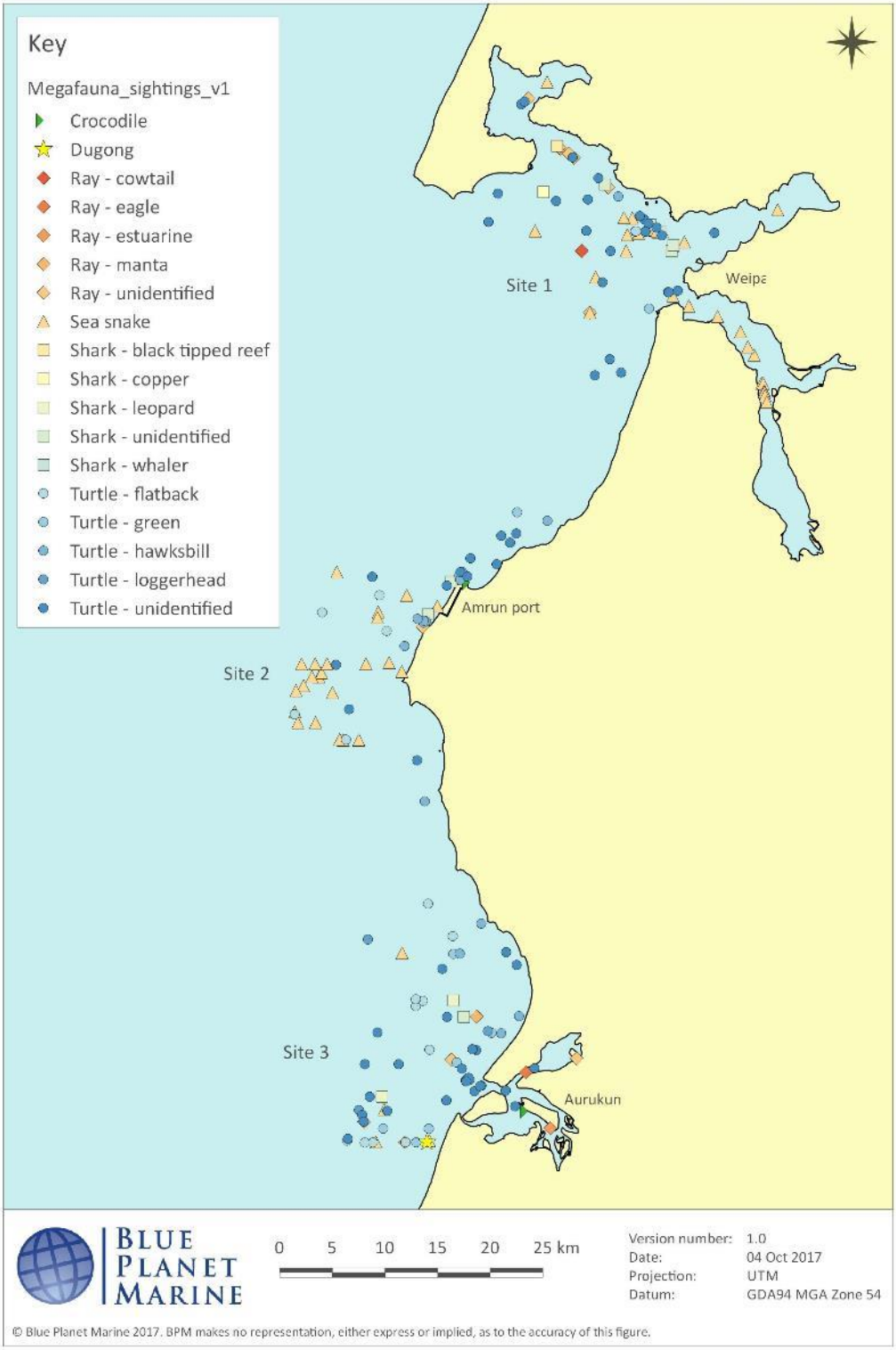

Figure 19. Locations of marine megafauna sightings during the 2016 dolphin survey.