

Contract No. HY/2011/03
Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road –
Section between Scenic Hill and Hong Kong Boundary
Crossing Facilities Dolphin Monitoring

17th Quarterly Progress Report (September-November 2016)
submitted to China State Construction Engineering (HK) Ltd.

Submitted by

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24 December 2016

1. Introduction

- 1.1. The Hong Kong Link Road (HKLR) serves to connect the Hong Kong-Zhuhai-Macao Bridge (HZMB) Main Bridge at the Hong Kong Special Administrative Region (HKSAR) Boundary and the HZMB Hong Kong Boundary Crossing Facilities (HKBCF) located at the northeastern waters of the Hong Kong International Airport. The construction of HKLR is separated into two sections, with the construction for the section between Scenic Hill and Hong Kong Boundary Crossing Facilities being commenced in October 2012.
- 1.2. According to the updated Environmental Monitoring and Audit (EM&A) Manual (for HKLR), monthly line-transect vessel surveys for Chinese White Dolphin should be conducted to cover the Northwest and Northeast Lantau survey areas as in AFCD annual marine mammal monitoring programme.
- 1.3. In October 2012, Hong Kong Cetacean Research Project (HKCRP) has been commissioned to conduct this 54-month dolphin monitoring study in order to collect data on Chinese White Dolphins during the construction phase (i.e. impact period) of the HKLR03 project in Northwest Lantau (NWL) and Northeast Lantau (NEL) survey areas, and to analyze the collected survey data to monitor distribution, encounter rate, activities and occurrence of dolphin calves. Photo-identification will also be collected from individual Chinese White Dolphins to examine their individual range patterns.

- 1.4. From the monitoring results, any changes in dolphin occurrence within the study area will be examined for possible causes, and appropriate actions and additional mitigation measures will be recommended as necessary.
- 1.5. This report is the 17th quarterly progress report under the HKLR03 construction phase dolphin monitoring programme submitted to the China State Construction Engineering (HK) Limited, summarizing the results of the surveys findings during the period of September to November 2016.

2. Monitoring Methodology

2.1. Vessel-based Line-transect Survey

- 2.1.1. According to the requirement of the updated EM&A manual, dolphin monitoring programme should cover all transect lines in NEL and NWL survey areas (see Figure 1) twice per month throughout the entire construction period. The co-ordinates of all transect lines are shown in Table 1.

Table 1. Co-ordinates of transect lines

Line No.		Easting	Northing		Line No.		Easting	Northing
1	Start Point	804671	815456		13	Start Point	816506	819480
1	End Point	804671	831404		13	End Point	816506	824859
2	Start Point	805475	815913		14	Start Point	817537	820220
2	End Point	805477	826654		14	End Point	817537	824613
3	Start Point	806464	819435		15	Start Point	818568	820735
3	End Point	806464	822911		15	End Point	818568	824433
4	Start Point	807518	819771		16	Start Point	819532	821420
4	End Point	807518	829230		16	End Point	819532	824209
5	Start Point	808504	820220		17	Start Point	820451	822125
5	End Point	808504	828602		17	End Point	820451	823671
6	Start Point	809490	820466		18	Start Point	821504	822371
6	End Point	809490	825352		18	End Point	821504	823761

7	Start Point	810499	820880		19	Start Point	822513	823268
7	End Point	810499	824613		19	End Point	822513	824321
8	Start Point	811508	821123		20	Start Point	823477	823402
8	End Point	811508	824254		20	End Point	823477	824613
9	Start Point	812516	821303		21	Start Point	805476	827081
9	End Point	812516	824254		21	End Point	805476	830562
10	Start Point	813525	820872		22	Start Point	806464	824033
10	End Point	813525	824657		22	End Point	806464	829598
11	Start Point	814556	818853		23	Start Point	814559	821739
11	End Point	814556	820992		23	End Point	814559	824768
12	Start Point	815542	818807					
12	End Point	815542	824882					

2.1.2. The survey team used standard line-transect methods (Buckland et al. 2001) to conduct the systematic vessel surveys, and followed the same technique of data collection that has been adopted over the last 19 years of marine mammal monitoring surveys in Hong Kong developed by HKCRP (see Hung 2015, 2016). For each monitoring vessel survey, a 15-m inboard vessel with an open upper deck (about 4.5 m above water surface) was used to make observations from the flying bridge area.

2.1.3. Two experienced observers (a data recorder and a primary observer) made up the on-effort survey team, and the survey vessel transited different transect lines at a constant speed of 13-15 km per hour. The data recorder searched with unaided eyes and filled out the datasheets, while the primary observer searched for dolphins and porpoises continuously through 7 x 50 *Fujinon* marine binoculars. Both observers searched the sea ahead of the vessel, between 270° and 90° (in relation to the bow, which is defined as 0°). One to two additional experienced observers were available on the boat to work in shift (i.e. rotate every 30 minutes) in order to minimize fatigue of the survey team members. All observers were experienced in small cetacean survey techniques and identifying local cetacean species.

2.1.4. During on-effort survey periods, the survey team recorded effort data including

time, position (latitude and longitude), weather conditions (Beaufort sea state and visibility), and distance traveled in each series (a continuous period of search effort) with the assistance of a handheld GPS (*Garmin eTrex Legend*).

- 2.1.5. Data including time, position and vessel speed were also automatically and continuously logged by handheld GPS throughout the entire survey for subsequent review.
- 2.1.6. When dolphins were sighted, the survey team would end the survey effort, and immediately record the initial sighting distance and angle of the dolphin group from the survey vessel, as well as the sighting time and position. Then the research vessel was diverted from its course to approach the animals for species identification, group size estimation, assessment of group composition, and behavioural observations. The perpendicular distance (PSD) of the dolphin group to the transect line was later calculated from the initial sighting distance and angle.
- 2.1.7. Survey effort being conducted along the parallel transect lines that were perpendicular to the coastlines (as indicated in Figure 1) was labeled as “primary” survey effort, while the survey effort conducted along the connecting lines between parallel lines was labeled as “secondary” survey effort. According to HKCRP long-term dolphin monitoring data, encounter rates of Chinese white dolphins deduced from effort and sighting data collected along primary and secondary lines were similar in NEL and NWL survey areas (Hung 2013). Therefore, both primary and secondary survey effort were presented as on-effort survey effort in this report.

2.2. *Photo-identification Work*

- 2.2.1. When a group of Chinese White Dolphins were sighted during the line-transect survey, the survey team would end effort and approach the group slowly from the side and behind to take photographs of them. Every attempt was made to photograph every dolphin in the group, and even photograph both sides of the dolphins, since the colouration and markings on both sides may not be symmetrical.
- 2.2.2. One to two professional digital cameras (*Canon EOS 7D and/or 60D models*), each equipped with long telephoto lenses (100-400 mm zoom), were available on board for researchers to take sharp, close-up photographs of dolphins as they

surfaced. The images were shot at the highest available resolution and stored on Compact Flash memory cards for downloading onto a computer.

- 2.2.3. All digital images taken in the field were first examined, and those containing potentially identifiable individuals were sorted out. These photographs would then be examined in greater detail, and were carefully compared to the existing Chinese White Dolphin photo-identification catalogue maintained by HKCRP since 1995.
- 2.2.4. Chinese White Dolphins can be identified by their natural markings, such as nicks, cuts, scars and deformities on their dorsal fin and body, and their unique spotting patterns were also used as secondary identifying features (Jefferson 2000).
- 2.2.5. All photographs of each individual were then compiled and arranged in chronological order, with data including the date and location first identified (initial sighting), re-sightings, associated dolphins, distinctive features, and age classes entered into a computer database.

2.3. *Data analysis*

- 2.3.1. Distribution Analysis – The line-transect survey data was integrated with the Geographic Information System (GIS) in order to visualize and interpret different spatial and temporal patterns of dolphin distribution using sighting positions. Location data of dolphin groups were plotted on map layers of Hong Kong using a desktop GIS (ArcView[®] 3.1) to examine their distribution patterns in details. The dataset was also stratified into different subsets to examine distribution patterns of dolphin groups with different categories of group sizes, young calves and activities.
- 2.3.2. Encounter rate analysis – Encounter rates of Chinese white dolphins (number of on-effort sightings per 100 km of survey effort, and total number of dolphins sighted on-effort per 100 km of survey effort) were calculated in NEL and NWL survey areas in relation to the amount of survey effort conducted during each month of monitoring survey. Dolphin encounter rates were calculated in two ways for comparisons with the HZMB baseline monitoring results as well as to AFCD long-term marine mammal monitoring results.

Firstly, for the comparison with the HZMB baseline monitoring results, the encounter rates were calculated using primary survey effort alone, and only

data collected under Beaufort 3 or below condition would be used for encounter rate analysis. The average encounter rate of sightings (STG) and average encounter rate of dolphins (ANI) were deduced based on the encounter rates from six events during the present quarter (i.e. six sets of line-transect surveys in North Lantau), which was also compared with the one deduced from the six events during the baseline period (i.e. six sets of line-transect surveys in North Lantau).

Secondly, the encounter rates were calculated using both primary and secondary survey effort collected under Beaufort 3 or below condition as in AFCD long-term monitoring study. The encounter rate of sightings and dolphins were deduced by dividing the total number of on-effort sightings (STG) and total number of dolphins (ANI) by the amount of survey effort for the present quarterly period.

- 2.3.3. Quantitative grid analysis on habitat use – To conduct quantitative grid analysis of habitat use, positions of on-effort sightings of Chinese White Dolphins collected during the quarterly impact phase monitoring period were plotted onto 1-km² grids among NWL and NEL survey areas on GIS. Sighting densities (number of on-effort sightings per km²) and dolphin densities (total number of dolphins from on-effort sightings per km²) were then calculated for each 1 km by 1 km grid with the aid of GIS. Sighting density grids and dolphin density grids were then further normalized with the amount of survey effort conducted within each grid. The total amount of survey effort spent on each grid was calculated by examining the survey coverage on each line-transect survey to determine how many times the grid was surveyed during the study period. For example, when the survey boat traversed through a specific grid 50 times, 50 units of survey effort were counted for that grid. With the amount of survey effort calculated for each grid, the sighting density and dolphin density of each grid were then normalized (i.e. divided by the unit of survey effort).

The newly-derived unit for sighting density was termed SPSE, representing the number of on-effort sightings per 100 units of survey effort. In addition, the derived unit for actual dolphin density was termed DPSE, representing the number of dolphins per 100 units of survey effort. Among the 1-km² grids that were partially covered by land, the percentage of sea area was calculated using GIS tools, and their SPSE and DPSE values were adjusted accordingly.

The following formulae were used to estimate SPSE and DPSE in each 1-km² grid within the study area:

$$\text{SPSE} = ((S / E) \times 100) / \text{SA\%}$$
$$\text{DPSE} = ((D / E) \times 100) / \text{SA\%}$$

where S = total number of on-effort sightings
D = total number of dolphins from on-effort sightings
E = total number of units of survey effort
SA% = percentage of sea area

- 2.3.4. Behavioural analysis – When dolphins were sighted during vessel surveys, their behaviour was observed. Different activities were categorized (i.e. feeding, milling/resting, traveling, socializing) and recorded on sighting datasheets. This data was then input into a separate database with sighting information, which can be used to determine the distribution of behavioural data with a desktop GIS. Distribution of sightings of dolphins engaged in different activities and behaviours would then be plotted on GIS and carefully examined to identify important areas for different activities of the dolphins.
- 2.3.5. Ranging pattern analysis – Location data of individual dolphins that occurred during the 3-month impact phase monitoring period were obtained from the dolphin sighting database and photo-identification catalogue. To deduce home ranges for individual dolphins using the fixed kernel methods, the program Animal Movement Analyst Extension, was loaded as an extension with ArcView[®] 3.1 along with another extension Spatial Analyst 2.0. Using the fixed kernel method, the program calculated kernel density estimates based on all sighting positions, and provided an active interface to display kernel density plots. The kernel estimator then calculated and displayed the overall ranging area at 95% UD level.

3. Monitoring Results

3.1. *Summary of survey effort and dolphin sightings*

- 3.1.1. During the period of September to November 2016, six sets of systematic line-transect vessel surveys were conducted to cover all transect lines in NWL and NEL survey areas twice per month.
- 3.1.2. From these surveys, a total of 892.57 km of survey effort was collected, with 96.5% of the total survey effort being conducted under favourable weather conditions (i.e. Beaufort Sea State 3 or below with good visibility). Among

the two areas, 341.30 km and 551.27 km of survey effort were conducted in NEL and NWL survey areas respectively.

- 3.1.3. The total survey effort conducted on primary lines was 640.35 km, while the effort on secondary lines was 252.22 km. Survey effort conducted on both primary and secondary lines were considered as on-effort survey data. A summary table of the survey effort is shown in Appendix I.
- 3.1.4. During the six sets of monitoring surveys in September to November 2016, a total of 13 groups of 48 Chinese White Dolphins were sighted. A summary table of the dolphin sightings is shown in Appendix II.
- 3.1.5. For the present quarterly period, all dolphin sightings were made during on-effort search, while all except one on-effort dolphin sightings were made on primary lines. In addition, all dolphin groups were sighted in NWL, and no dolphin was sighted at all in NEL. In fact, since August 2014, only two sightings of two lone dolphins were made respectively in NEL during HKLR03 monitoring surveys.

3.2. *Distribution*

- 3.2.1. Distribution of dolphin sightings made during monitoring surveys in September to November 2016 is shown in Figure 1.
- 3.2.2. Dolphin sightings made in the present quarter were mainly located around Sha Chau and Lung Kwu Chau near western territorial boundary (Figure 1). A few sightings were also made near Black Point, Pillar Point and Sham Wat respectively (Figure 1). On the other hand, the dolphins were completely absent from the central and western portions of North Lantau waters (Figure 1).
- 3.2.3. All dolphin sightings were located far away from the HKBCF and HKLR03 reclamation sites as well as along the alignment of Tuen Mun-Chek Lap Kok Link (TMCLKL). However, one group of two dolphins was sighted adjacent to the HKLR alignment near Sham Wat (Figure 1).
- 3.2.4. Sighting distribution of dolphins during the present impact phase monitoring period (September to November 2016) was drastically different from the one during the baseline monitoring period (September to November 2011) (Figure 1).
- 3.2.5. In the present quarter, dolphins have disappeared from the NEL region, which was in stark contrast to their frequent occurrence around the Brothers Islands, near Shum Shui Kok and in the vicinity of HKBCF reclamation site during the

baseline period (Figure 1). The nearly complete abandonment of NEL region by the dolphins has been consistently recorded in the past 15 quarters of HKLR03 monitoring, which has resulted in zero to extremely low dolphin encounter rates in this area.

3.2.6. In NWL survey area, dolphin occurrence was also significantly different between the baseline and impact phase periods. During the present impact monitoring period, much fewer dolphins occurred in this survey area (mostly around Lung Kwu Chau) than during the baseline period, when many dolphin groups were frequently sighted between Lung Kwu Chau and Black Point, around Sha Chau, near Pillar Point and to the west of the Chek Lap Kok Airport (Figure 1).

3.2.7. Another comparison in dolphin distribution was made between the four quarterly periods of autumn months in 2013-16 (Figure 2). Among the four autumn periods, dolphins were regularly sighted in NWL waters in 2013, but their usage there has gradually diminished in 2014 and subsequently to a very low level in 2015 and 2016 with only occurrences concentrated around the Sha Chau and Lung Kwu Chau Marine Park (Figure 2).

3.3. *Encounter rate*

3.3.1. During the present three-month study period, the encounter rates of Chinese White Dolphins deduced from the survey effort and on-effort sighting data from the primary transect lines under favourable conditions (Beaufort 3 or below) for each set of the surveys in NEL and NWL are shown in Table 2. The average encounter rates deduced from the six sets of surveys were also compared with the ones deduced from the baseline monitoring period (September – November 2011) (Table 3).

3.3.2. To facilitate the comparison with the AFCD long-term monitoring results, the encounter rates were also calculated for the present quarter using both primary and secondary survey effort. The encounter rates of sightings (STG) and dolphins (ANI) in NWL were 2.50 sightings and 9.21 dolphins per 100 km of survey effort respectively, while the encounter rates of sightings (STG) and dolphins (ANI) in NEL were both nil for this quarter.

Table 2. Dolphin encounter rates (sightings per 100 km of survey effort) during September – November 2016

SURVEY AREA	DOLPHIN MONITORING DATES	Encounter rate (STG) (no. of on-effort dolphin sightings per 100 km of survey effort)	Encounter rate (ANI) (no. of dolphins from all on-effort sightings per 100 km of survey effort)
		Primary Lines Only	Primary Lines Only
Northeast Lantau	Set 1 (13 & 14 Sep 2016)	0.00	0.00
	Set 2 (21 & 23 Sep 2016)	0.00	0.00
	Set 3 (4 & 7 Oct 2016)	0.00	0.00
	Set 4 (11 & 13 Oct 2016)	0.00	0.00
	Set 5 (2 & 7 Nov 2016)	0.00	0.00
	Set 6 (18 & 22 Nov 2016)	0.00	0.00
Northwest Lantau	Set 1 (13 & 14 Sep 2016)	0.00	0.00
	Set 2 (21 & 23 Sep 2016)	5.75	30.17
	Set 3 (4 & 7 Oct 2016)	4.13	9.64
	Set 4 (11 & 13 Oct 2016)	2.85	8.54
	Set 5 (2 & 7 Nov 2016)	1.66	1.66
	Set 6 (18 & 22 Nov 2016)	2.79	15.34

Table 3. Comparison of average dolphin encounter rates from impact monitoring period (September – November 2016) and baseline monitoring period (September – November 2011) (Note: encounter rates deduced from the baseline monitoring period have been recalculated based only on survey effort and on-effort sighting data made along the primary transect lines under favourable conditions; ± denotes the standard deviation of the average encounter rates)

	Encounter rate (STG) (no. of on-effort dolphin sightings per 100 km of survey effort)		Encounter rate (ANI) (no. of dolphins from all on-effort sightings per 100 km of survey effort)	
	September – November 2016	September – November 2011	September – November 2016	September – November 2011
Northeast Lantau	0.0	6.00 ± 5.05	0.0	22.19 ± 26.81
Northwest Lantau	2.86 ± 1.98	9.85 ± 5.85	10.89 ± 10.98	44.66 ± 29.85

3.3.3. In NEL, the average dolphin encounter rates (both STG and ANI) in the present three-month impact monitoring period were both zero with no on-effort sighting being made, and such extremely low occurrence of dolphins in NEL have been consistently recorded in the past 15 quarters of HKLR03 monitoring (Table 4). This is a serious concern as the dolphin occurrence in NEL in the past few years (0.0-1.0 for ER(STG) and 0.0-3.9 for ER(ANI)) have remained exceptionally low when compared to the baseline period (Table 4). Dolphins have been virtually absent from NEL waters since January 2014, with only

three groups of six dolphins sighted there since then despite consistent and intensive survey effort being conducted in this survey area.

Table 4. Comparison of average dolphin encounter rates in Northeast Lantau survey area from all quarters of impact monitoring period and baseline monitoring period (September-November 2011) (Note: encounter rates deduced from the baseline monitoring period have been recalculated based only on survey effort and on-effort sighting data made along the primary transect lines under favourable conditions; the encounter rates in autumn months were highlighted in **blue**; \pm denotes the standard deviation of the average encounter rates)

	Encounter rate (STG) (no. of on-effort dolphin sightings per 100 km of survey effort)	Encounter rate (ANI) (no. of dolphins from all on-effort sightings per 100 km of survey effort)
September-November 2011 (Baseline)	6.00 \pm 5.05	22.19 \pm 26.81
December 2012-February 2013 (Impact)	3.14 \pm 3.21	6.33 \pm 8.64
March-May 2013 (Impact)	0.42 \pm 1.03	0.42 \pm 1.03
June-August 2013 (Impact)	0.88 \pm 1.36	3.91 \pm 8.36
September-November 2013 (Impact)	1.01 \pm 1.59	3.77 \pm 6.49
December 2013-February 2014 (Impact)	0.45 \pm 1.10	1.34 \pm 3.29
March-May 2014 (Impact)	0.00	0.00
June-August 2014 (Impact)	0.42 \pm 1.04	1.69 \pm 4.15
September-November 2014 (Impact)	0.00	0.00
December 2014-February 2015 (Impact)	0.00	0.00
March-May 2015 (Impact)	0.00	0.00
June-August 2015 (Impact)	0.44 \pm 1.08	0.44 \pm 1.08
September-November 2015 (Impact)	0.00	0.00
December 2015-February 2016 (Impact)	0.00	0.00
March-May 2016 (Impact)	0.00	0.00
June-August 2016 (Impact)	0.00	0.00
September-November 2016 (Impact)	0.00	0.00

3.3.4. On the other hand, the average dolphin encounter rates (STG and ANI) in NWL during the present impact phase monitoring period (reductions of 71.0% and 75.6% respectively) were only small fractions of the ones recorded during the three-month baseline period, indicating a dramatic decline in dolphin usage of this survey area as well during the present impact phase period (Table 5).

3.3.5. During the same autumn quarters, dolphin encounter rates in NWL during 2016 reached to the lowest point among the autumn periods, and were much lower than the ones recorded in 2013 and 2014 (Table 5). Such temporal trend should be closely monitored in the upcoming monitoring quarters.

Table 5. Comparison of average dolphin encounter rates in Northwest Lantau survey area from all quarters of impact monitoring period and baseline monitoring period (September-November 2011) (Note: encounter rates deduced from the baseline monitoring period have been recalculated based only on survey effort and on-effort sighting data made along the primary transect lines under favourable conditions; the encounter rates in autumn months were highlighted in **blue**; \pm denotes the standard deviation of the average encounter rates)

	Encounter rate (STG) (no. of on-effort dolphin sightings per 100 km of survey effort)	Encounter rate (ANI) (no. of dolphins from all on-effort sightings per 100 km of survey effort)
September-November 2011 (Baseline)	9.85 \pm 5.85	44.66 \pm 29.85
December 2012-February 2013 (Impact)	8.36 \pm 5.03	35.90 \pm 23.10
March-May 2013 (Impact)	7.75 \pm 3.96	24.23 \pm 18.05
June-August 2013 (Impact)	6.56 \pm 3.68	27.00 \pm 18.71
September-November 2013 (Impact)	8.04 \pm 1.10	32.48 \pm 26.51
December 2013-February 2014 (Impact)	8.21 \pm 2.21	32.58 \pm 11.21
March-May 2014 (Impact)	6.51 \pm 3.34	19.14 \pm 7.19
June-August 2014 (Impact)	4.74 \pm 3.84	17.52 \pm 15.12
September-November 2014 (Impact)	5.10 \pm 4.40	20.52 \pm 15.10
December 2014-February 2015 (Impact)	2.91 \pm 2.69	11.27 \pm 15.19
March-May 2015 (Impact)	0.47 \pm 0.73	2.36 \pm 4.07
June-August 2015 (Impact)	2.53 \pm 3.20	9.21 \pm 11.57
September-November 2015 (Impact)	3.94 \pm 1.57	21.05 \pm 17.19
December 2015-February 2016 (Impact)	2.64 \pm 1.52	10.98 \pm 3.81
March-May 2016 (Impact)	0.98 \pm 1.10	4.78 \pm 6.85
June-August 2016 (Impact)	1.72 \pm 2.17	7.48 \pm 10.98
September-November 2016 (Impact)	2.86 \pm 1.98	10.89 \pm 10.98

3.3.6. As discussed recently in Hung (2016), the dramatic decline in dolphin usage of NEL waters in the past few years (including the declines in abundance, encounter rate and habitat use in NEL, as well as shifts of individual core areas and ranges away from NEL waters) was possibly related to the HZMB construction works that were commenced since 2012. It appeared that such noticeable decline has already extended to NWL waters progressively in the past few years, and with no sign of recovery even the HZMB-related construction activities has well past the peak.

3.3.7. A two-way ANOVA with repeated measures and unequal sample size was conducted to examine whether there were any significant differences in the average encounter rates between the baseline and impact monitoring periods.

The two variables that were examined included the two periods (baseline and impact phases) and two locations (NEL and NWL).

- 3.3.8. For the comparison between the baseline period and the present quarter (16th quarter of the impact phase being assessed), the p-values for the differences in average dolphin encounter rates of STG and ANI were 0.0051 and 0.0296 respectively. If the alpha value is set at 0.05, significant differences were detected between the baseline and present quarters in both the average dolphin encounter rates of STG and ANI.
- 3.3.9. For the comparison between the baseline period and the cumulative quarters in impact phase (i.e. first sixteen quarters of the impact phase being assessed), the p-values for the differences in average dolphin encounter rates of STG and ANI were 0.000004 and 0.000001 respectively. Even if the alpha value is set at 0.00001, significant differences were still detected in both the average dolphin encounter rates of STG and ANI (i.e. between the two periods and the locations).
- 3.3.10. As indicated in both dolphin distribution patterns and encounter rates, dolphin usage has been significantly reduced in both NEL and NWL survey areas during the present quarterly period, and such low occurrence of dolphins has also been consistently documented in previous quarters. This raises serious concern, as the timing of the decline in dolphin usage in North Lantau waters coincided well with the construction schedule of the HZMB-related projects (Hung 2016).
- 3.3.11. To ensure the continuous usage of North Lantau waters by the dolphins, every possible measure should be implemented by the contractors and relevant authorities of HZMB-related works to minimize all disturbances to the dolphins.
- 3.4. *Group size*
 - 3.4.1. Group size of Chinese White Dolphins ranged from one to eleven individuals per group in North Lantau region during September to November 2016. The average dolphin group sizes from these three months were compared with the ones deduced from the baseline period in September to November 2011, as shown in Table 6.

Table 6. Comparison of average dolphin group sizes from impact monitoring period (September – November 2016) and baseline monitoring period (September – November 2011) (Note: ± denotes the standard deviation of the average group size)

	Average Dolphin Group Size	
	September – November 2016	September – November 2011
Overall	3.69 ± 2.87 (n = 13)	3.72 ± 3.13 (n = 66)
Northeast Lantau	---	3.18 ± 2.16 (n = 17)
Northwest Lantau	3.69 ± 2.87 (n = 13)	3.92 ± 3.40 (n = 49)

3.4.2. The average dolphin group size in NWL waters during September to November 2016 was slightly lower than the one recorded during the three-month baseline period (Table 6). Most of these dolphin groups were composed of 1-4 individuals only, while there were three medium-sized groups of 5-7 individuals respectively, and one large group of eleven individuals.

3.4.3. Distribution of the larger dolphin groups (i.e. five individuals or more per group) during the present quarter is shown in Figure 3, with comparison to the one in baseline period. During the autumn months of 2016, the three medium-sized groups were sighted adjacent to Lung Kwu Chau and to the north of the island, while the one large group of eleven individuals was sighted to at the northeast corner of Lung Kwu Chau as well (Figure 3). Such distribution pattern was very different from the baseline period, when the larger dolphin groups were more frequently sighted and more evenly distributed in NWL waters, with a few more sighted in NEL waters (Figure 3).

3.5. *Habitat use*

3.5.1. From September to November 2016, the more important habitats utilized by Chinese White Dolphins were mostly located around Lung Kwu Chau (Figures 4a and 4b). One grid located to the west of Shum Wat just to the south of the HKLR09 alignment also recorded moderate density of dolphins. On the contrary, all grids near HKLR03/HKBCF reclamation sites as well as TMCLKL alignment did not record any presence of dolphins at all during on-effort search in the present quarterly period (Figures 4a and 4b).

3.5.2. However, it should be emphasized that the amount of survey effort collected in each grid during the three-month period was fairly low (6-12 units of survey effort for most grids), and therefore the habitat use pattern derived from the three-month dataset should be treated with caution. A more complete picture of dolphin habitat use pattern should be examined when more survey effort for each grid will be collected throughout the impact phase monitoring programme.

- 3.5.3. When compared with the habitat use patterns during the baseline period, dolphin usage in NEL and NWL has drastically diminished in both areas during the present impact monitoring period (Figure 5). During the baseline period, many grids between Siu Mo To and Shum Shui Kok in NEL recorded moderately high to high dolphin densities, which was in stark contrast to the complete absence of dolphins there during the present impact phase period (Figure 5).
- 3.5.4. The density patterns were also very different in NWL between the baseline and impact phase monitoring periods, with higher dolphin usage throughout the area, especially around Sha Chau, near Black Point, to the west of the airport, as well as between Pillar Point and airport platform during the baseline period. In contrast, the only areas with moderate to high dolphin densities were restricted to the waters near Lung Kwu Chau during the present impact phase period (Figure 5).
- 3.6. *Mother-calf pairs*
- 3.6.1. During the present quarterly period, neither unspotted calf nor unspotted juvenile was sighted with any female in the North Lantau region.
- 3.6.2. The absence of young calves in the past four consecutive quarters was in stark contrast to their regular occurrence in North Lantau waters during the baseline period. This should be of a serious concern, and the occurrence of young calves in North Lantau waters should be closely monitored in the upcoming quarters.
- 3.7. *Activities and associations with fishing boats*
- 3.7.1. Four of the thirteen dolphin groups were engaged in feeding activity, while none of them was engaged in socializing, traveling or milling/resting activity during the three-month study period.
- 3.7.2. The percentage of sightings associated with feeding activities (30.8%) was much higher than the one recorded during the baseline period (11.6%). However, it should be noted the sample size on total numbers of dolphin sightings during the present quarter (13 dolphin groups) was much lower than the baseline period (66 dolphin groups).
- 3.7.3. Distribution of dolphins engaged in various activities during the present impact phase period and the baseline period is shown in Figure 6. The four dolphin groups engaged in feeding activities were sighted around Lung Kwu Chau as well as to the west of Shum Wat near the HKLR09 alignment during the present quarterly period, which was very different from the baseline period when

various dolphin activities occurred throughout the North Lantau region (Figure 6).

- 3.7.4. Notably, one group of seven dolphins was found to be associated with an operating gill-netter adjacent to Lung Kwu Chau within the marine park during the present impact phase period.

3.8. *Summary of photo-identification works*

- 3.8.1. From September to November 2016, over 2,100 digital photographs of Chinese White Dolphins were taken during the impact phase monitoring surveys for the photo-identification work.

- 3.8.2. In total, 21 individuals sighted 34 times altogether were identified (see summary table in Appendix III and photographs of identified individuals in Appendix IV). All of these re-sightings were made in NWL. Six individuals (CH34, NL136, NL202, NL269, NL286 and NL320) were re-sighted multiple times during the three-month period (Appendix III).

- 3.8.3. Notably, none of these 21 individuals was also sighted in West Lantau waters during the HKLR09 monitoring surveys from September to November 2016. However, one individual (NL269) was sighted in both NWL and SWL survey areas during the same quarter, showing its extensive individual movement between different survey areas.

3.9. *Individual range use*

- 3.9.1. Ranging patterns of the 21 individuals identified during the three-month study period were determined by fixed kernel method, and are shown in Appendix V.

- 3.9.2. All identified dolphins sighted in the present quarter were utilizing NWL waters only, but have completely avoided NEL waters where many of them have utilized as their core areas in the past (Appendix V). This is in contrary to the extensive movements between NEL and NWL survey areas observed in the earlier impact monitoring quarters as well as the baseline period.

- 3.9.3. On the other hand, only one of these individuals consistently utilized both North Lantau waters in the past have extended their range use to SWL waters during the present quarter. In the upcoming quarters, individual range use and movements should be continuously monitored to examine whether there has been any consistent shifts of individual home ranges from North Lantau to West or Southwest Lantau, as such shift could possibly be related to the HZMB-related construction works (see Hung 2015, 2016).

4. Conclusion

- 4.1. During the present quarter of dolphin monitoring, no adverse impact from the activities of this construction project on Chinese White Dolphins was noticeable from general observations.
- 4.2. Although dolphins rarely occurred in the area of HKLR03 construction in the past and during the baseline monitoring period, it is apparent that dolphin usage has been dramatically reduced in NEL since 2012, and many individuals have shifted away completely from the important habitat around the Brothers Islands.
- 4.3. It is critical to continuously monitor the dolphin usage in North Lantau region in the upcoming quarters, to determine whether the dolphins are continuously affected by the various construction activities in relation to the HZMB-related works, and whether suitable mitigation measure can be applied to revert the situation.

5. References

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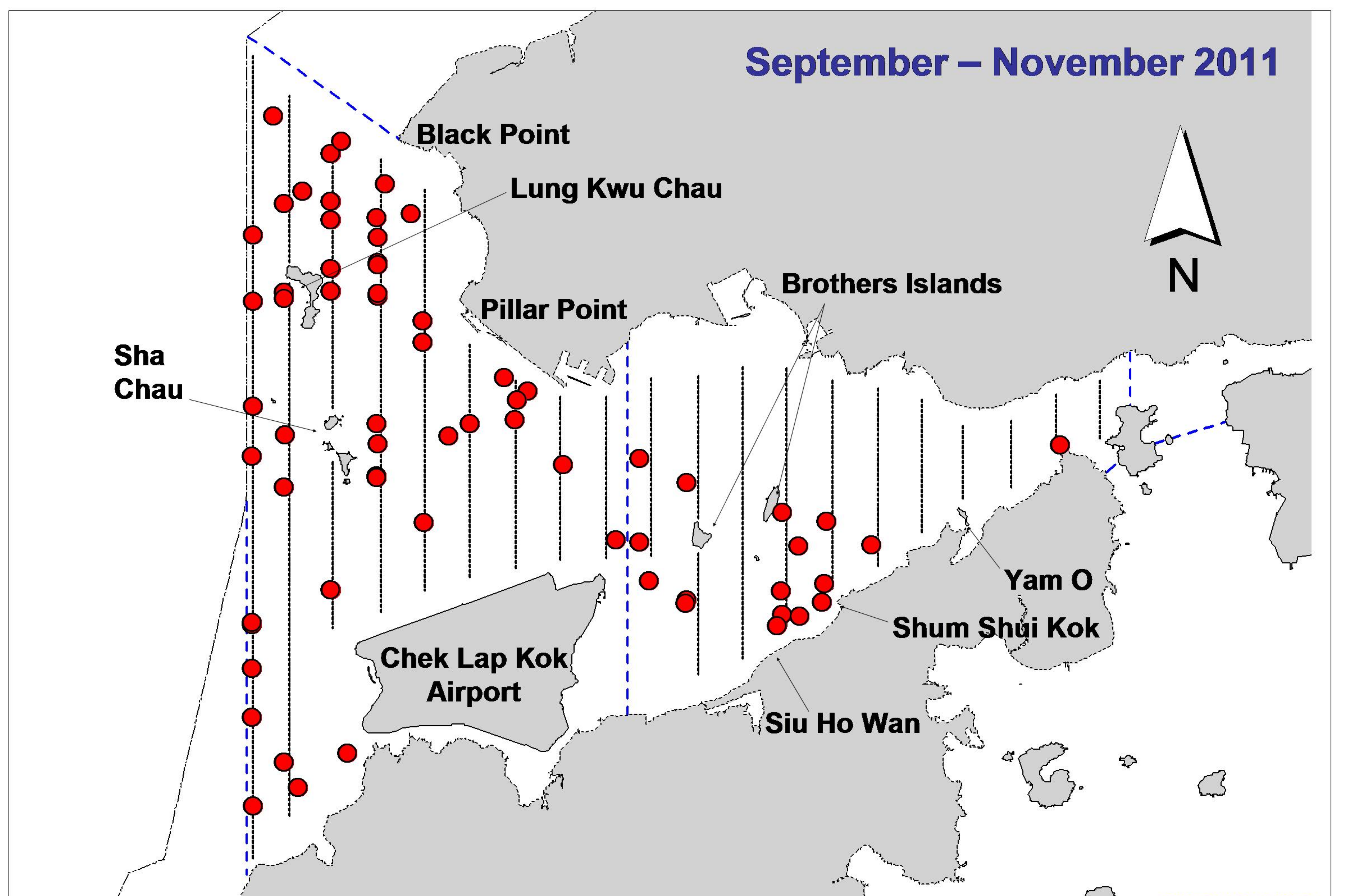
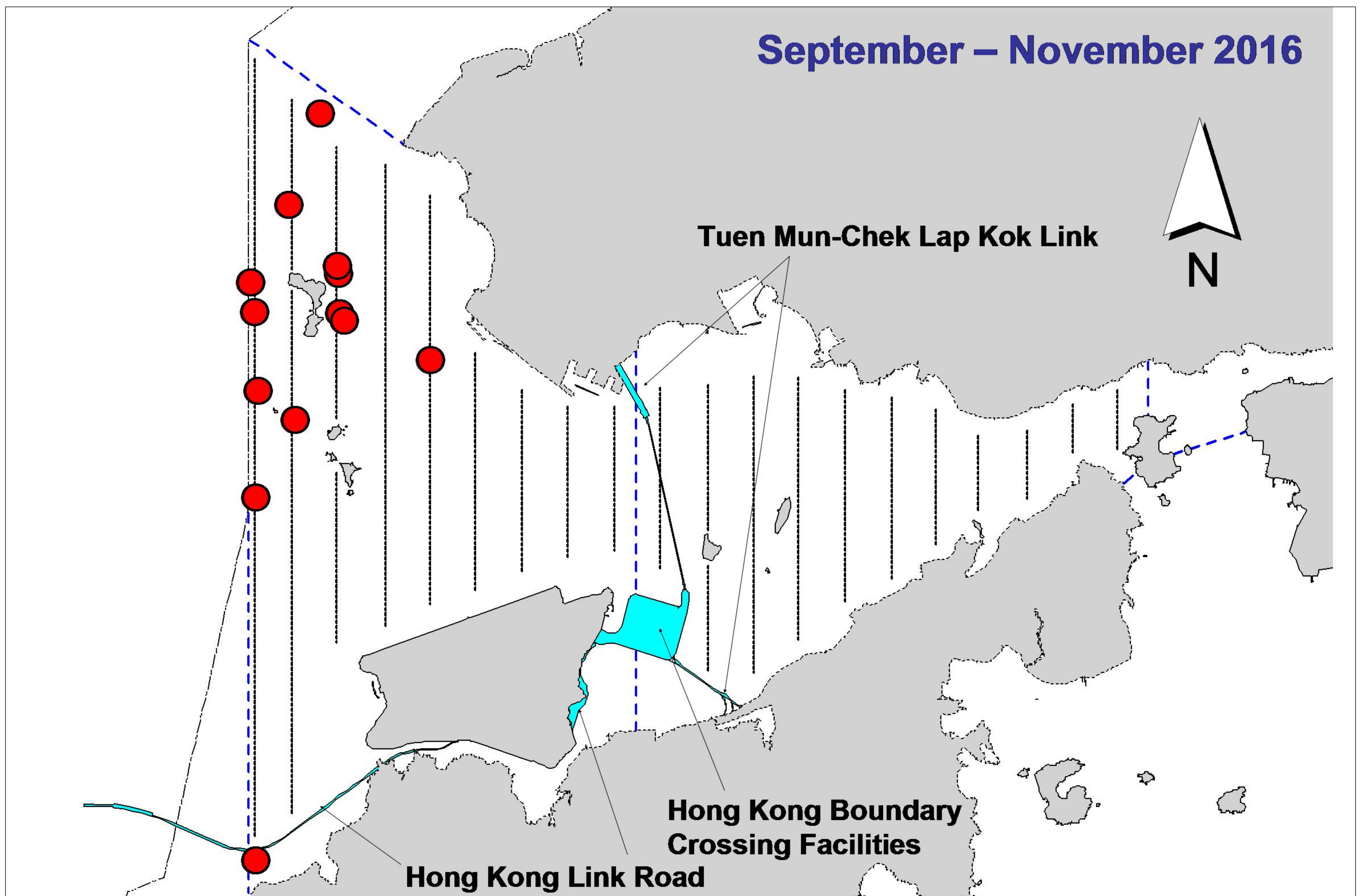


Figure 1. Distribution of Chinese white dolphin sighting in Northwest and Northeast Lantau during HKLR03 impact phase (top) and baseline monitoring surveys (bottom)

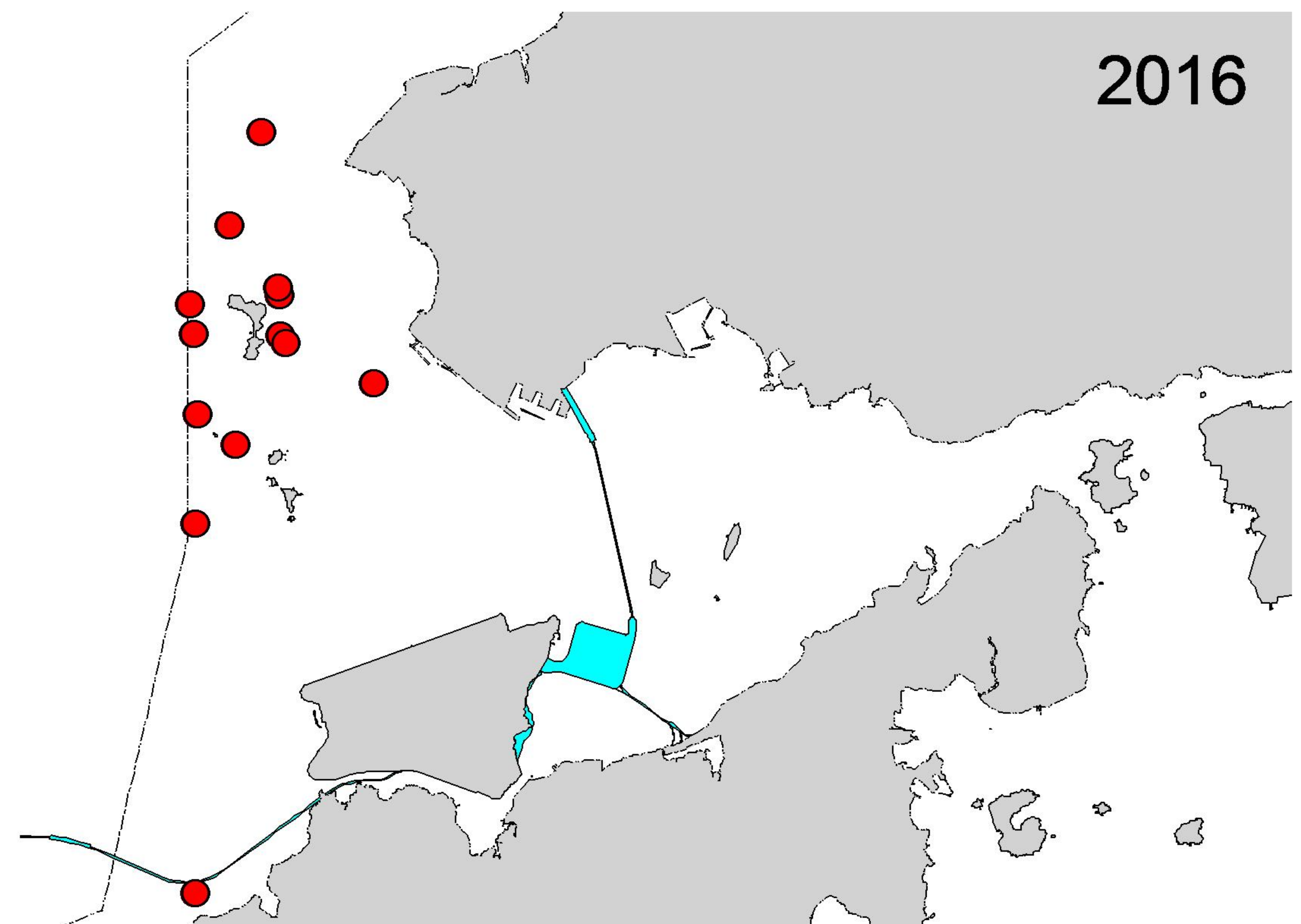
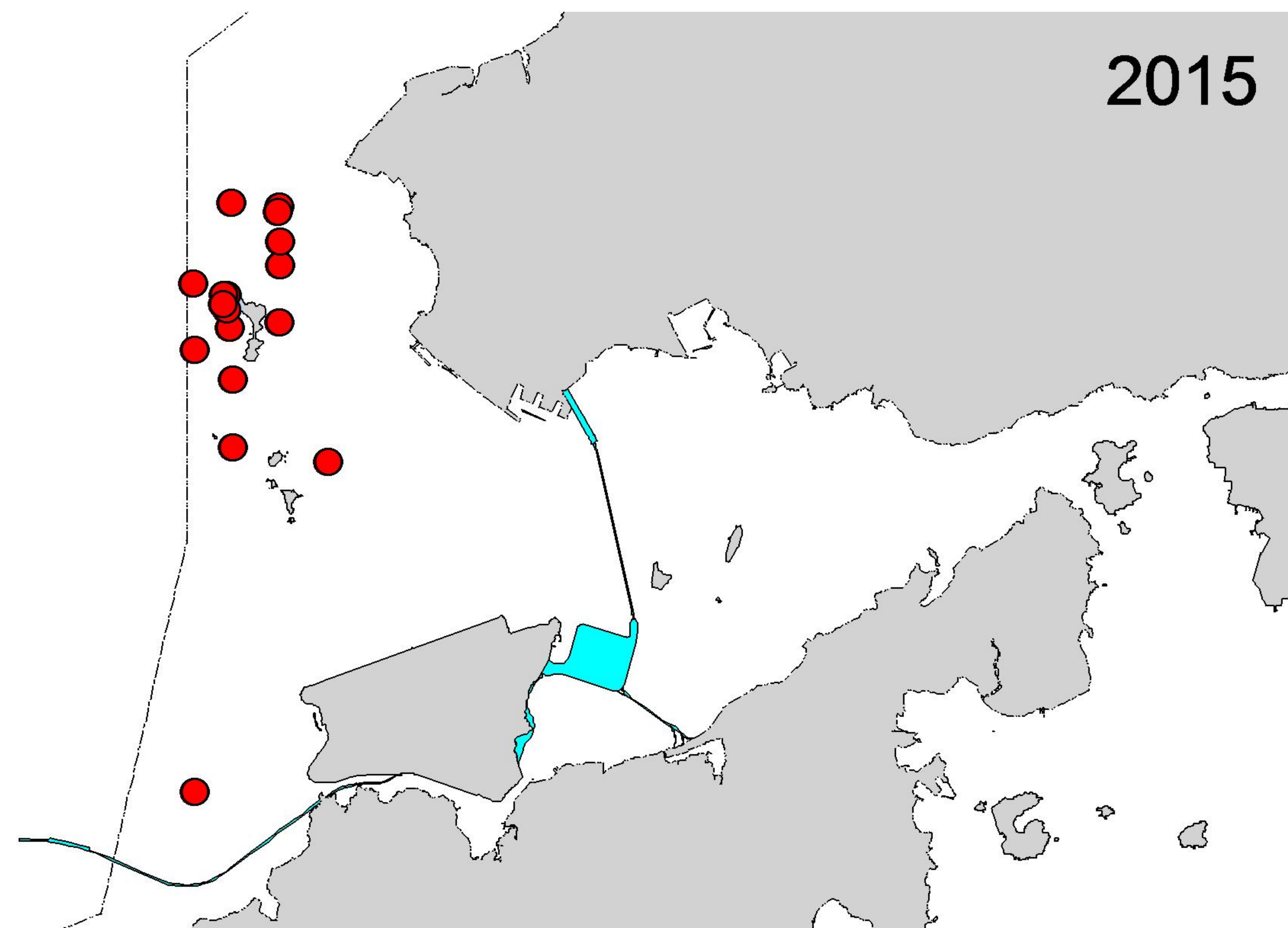
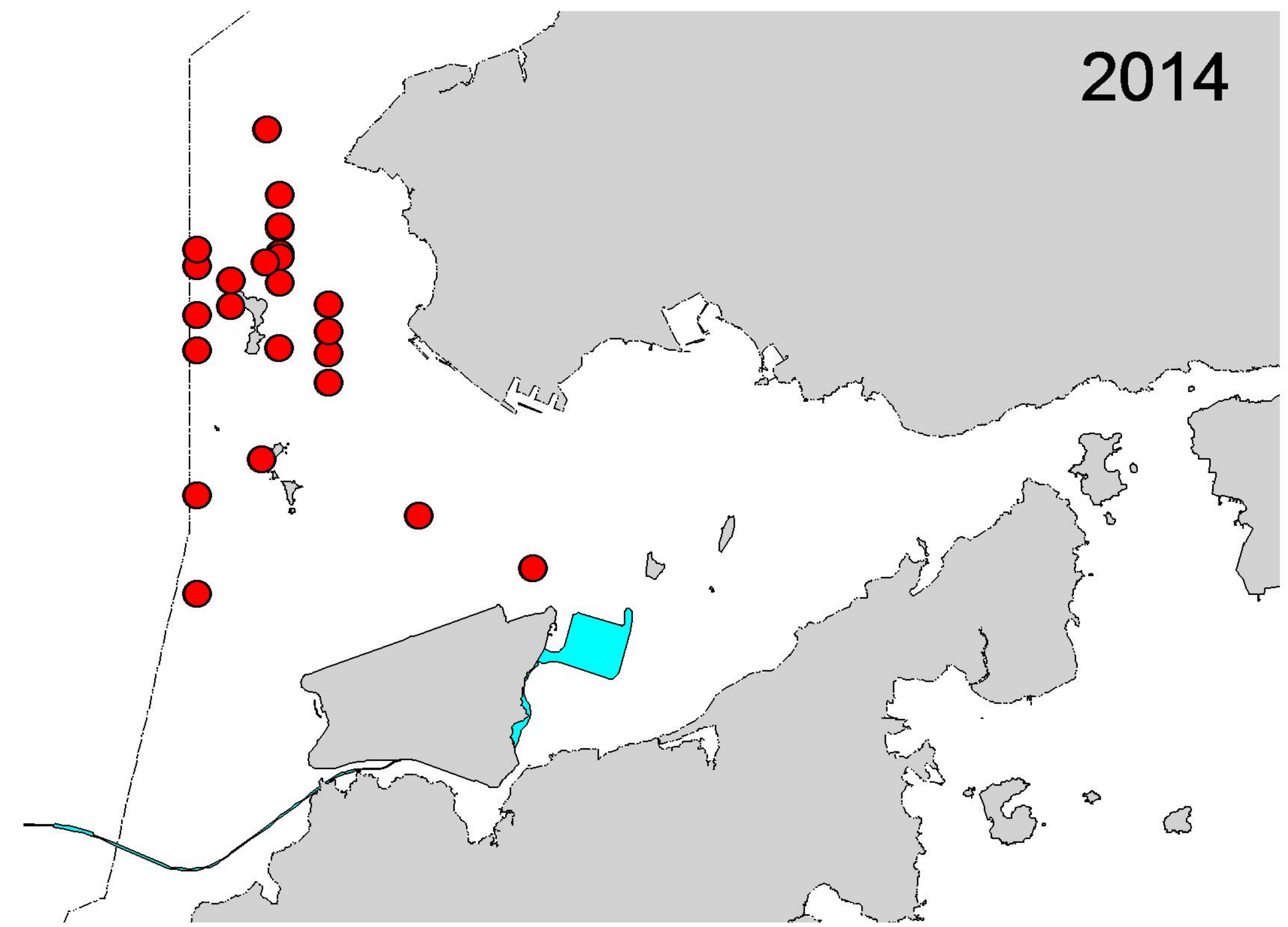
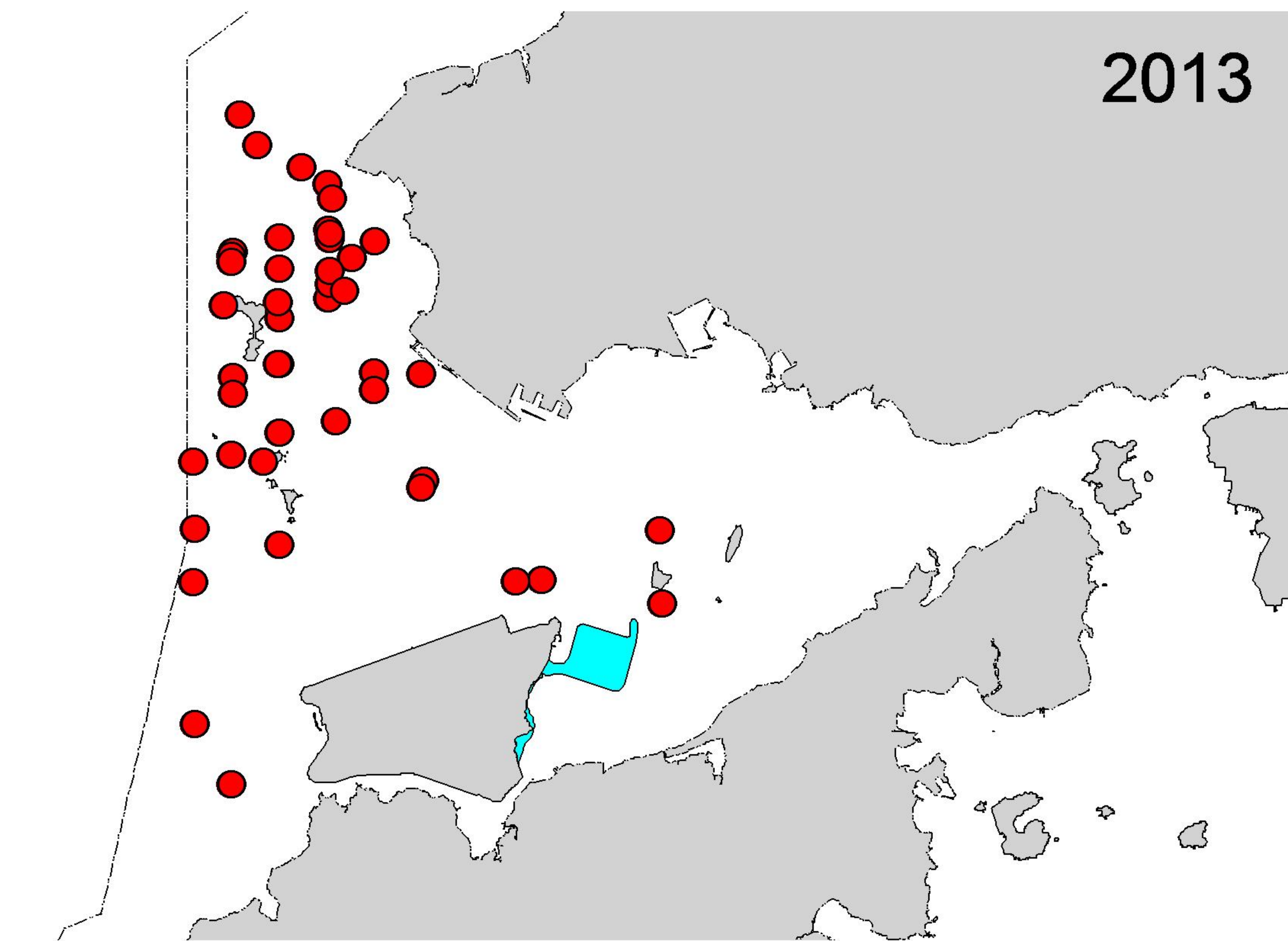


Figure 2. Distribution of Chinese white dolphin sightings in Northwest and Northeast Lantau during the same autumn quarters (September-November) of HKLR03 impact phase in 2013-16

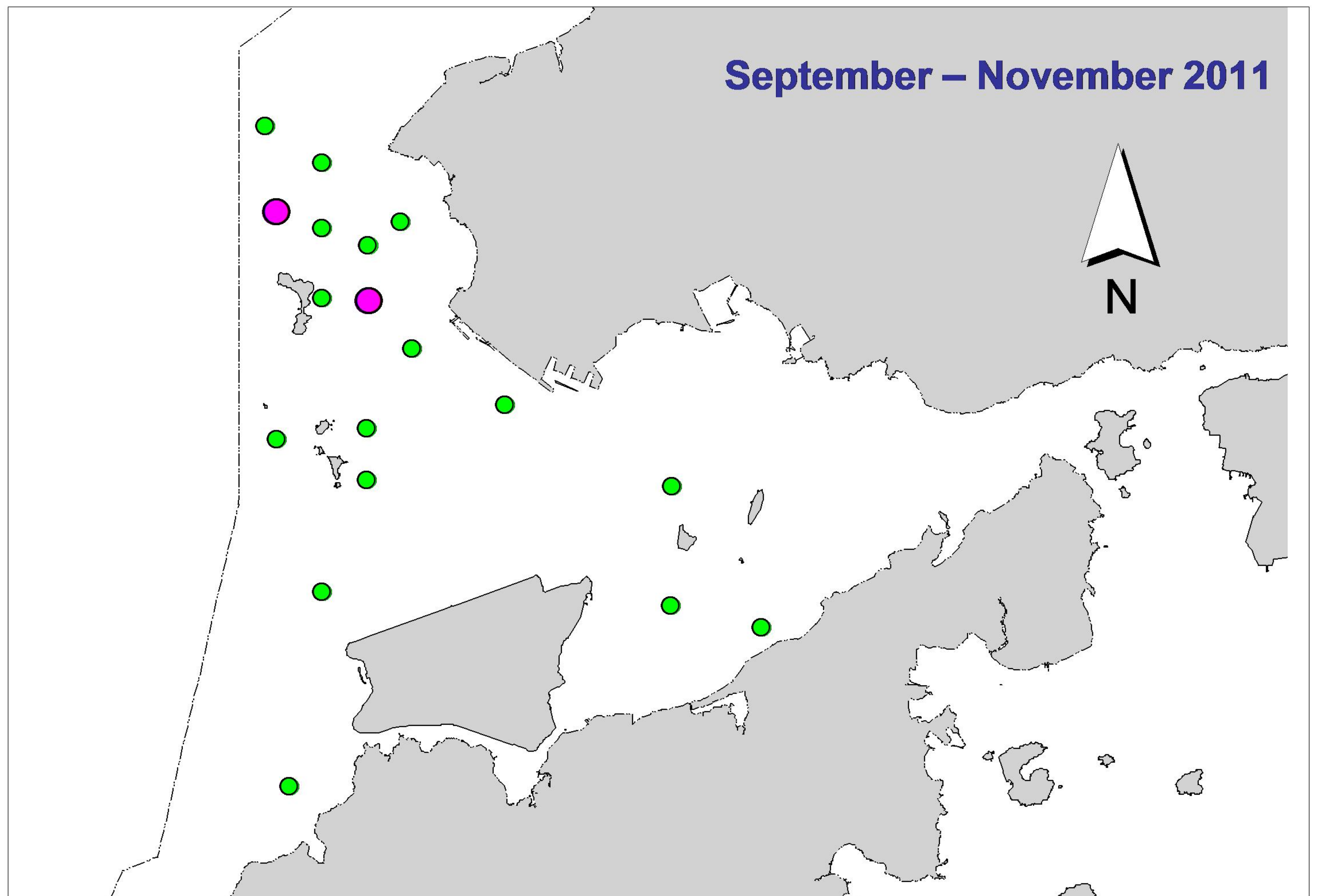
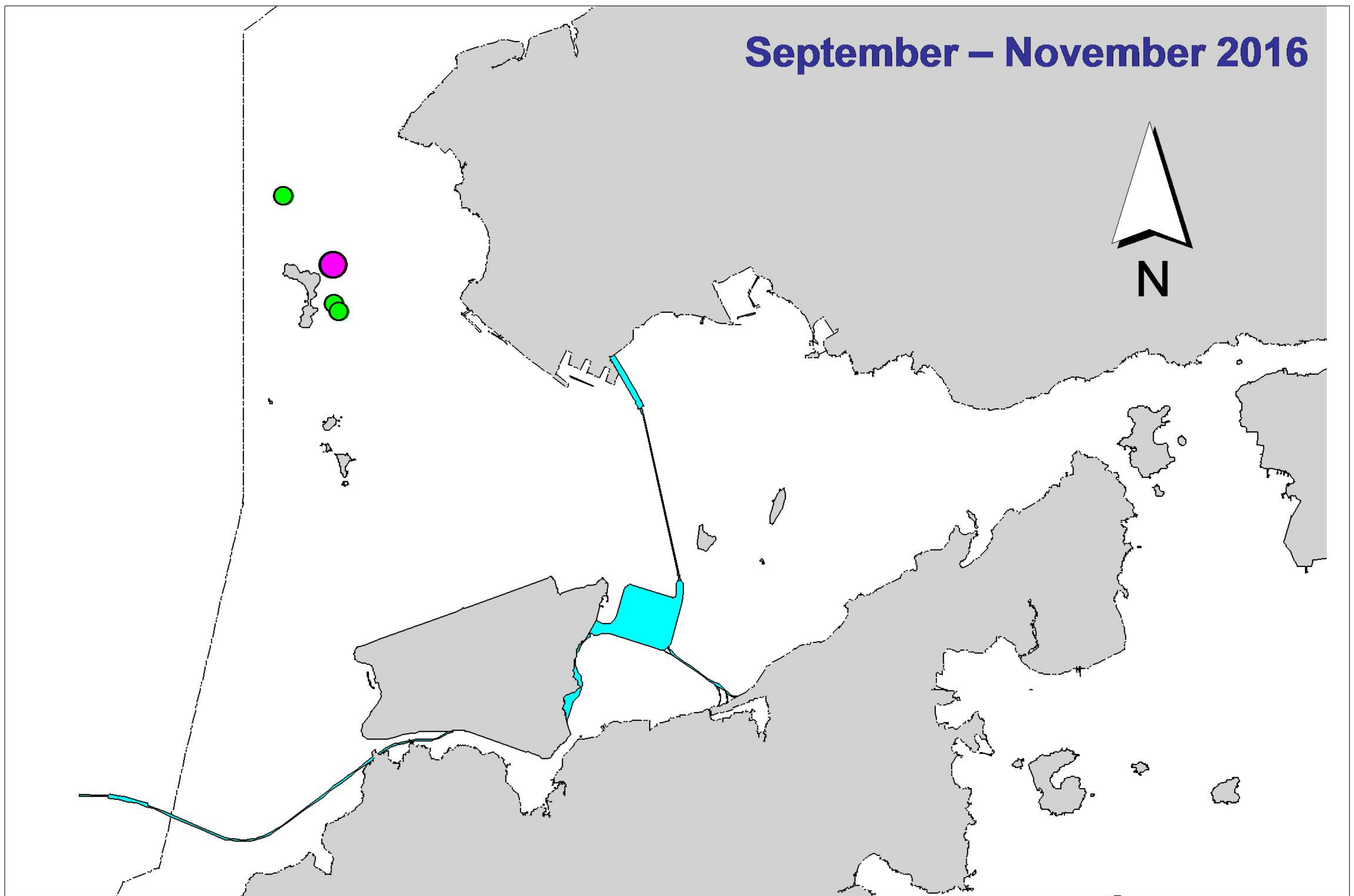


Figure 3. Distribution of Chinese white dolphins with larger group sizes during HKLR03 impact phase (top) and baseline monitoring surveys (bottom) (green dots: group sizes of 5 or more; purple dots: group sizes of 10 or more)

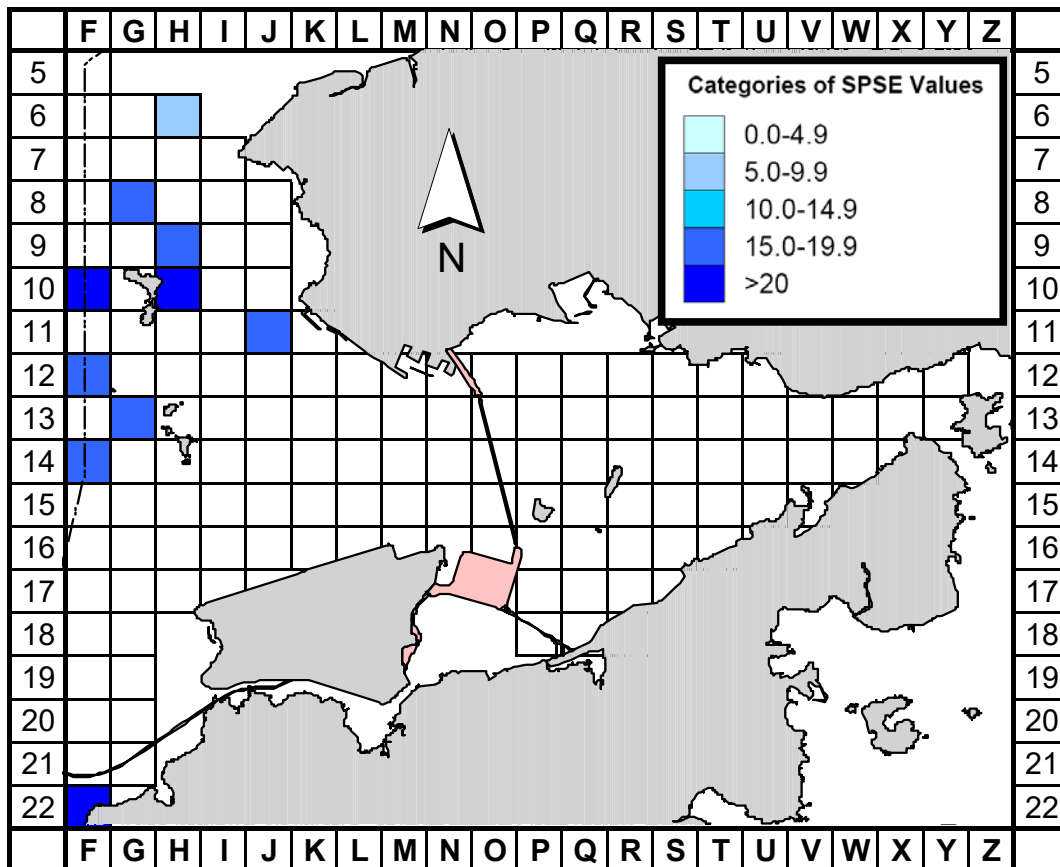


Figure 4a. Sighting density of Chinese white dolphins with corrected survey effort per km² in Northeast and Northwest Lantau survey areas, using data collected during HKLR03 impact monitoring period (Sep-Nov 2016) (SPSE = no. of on-effort sightings per 100 units of survey effort)

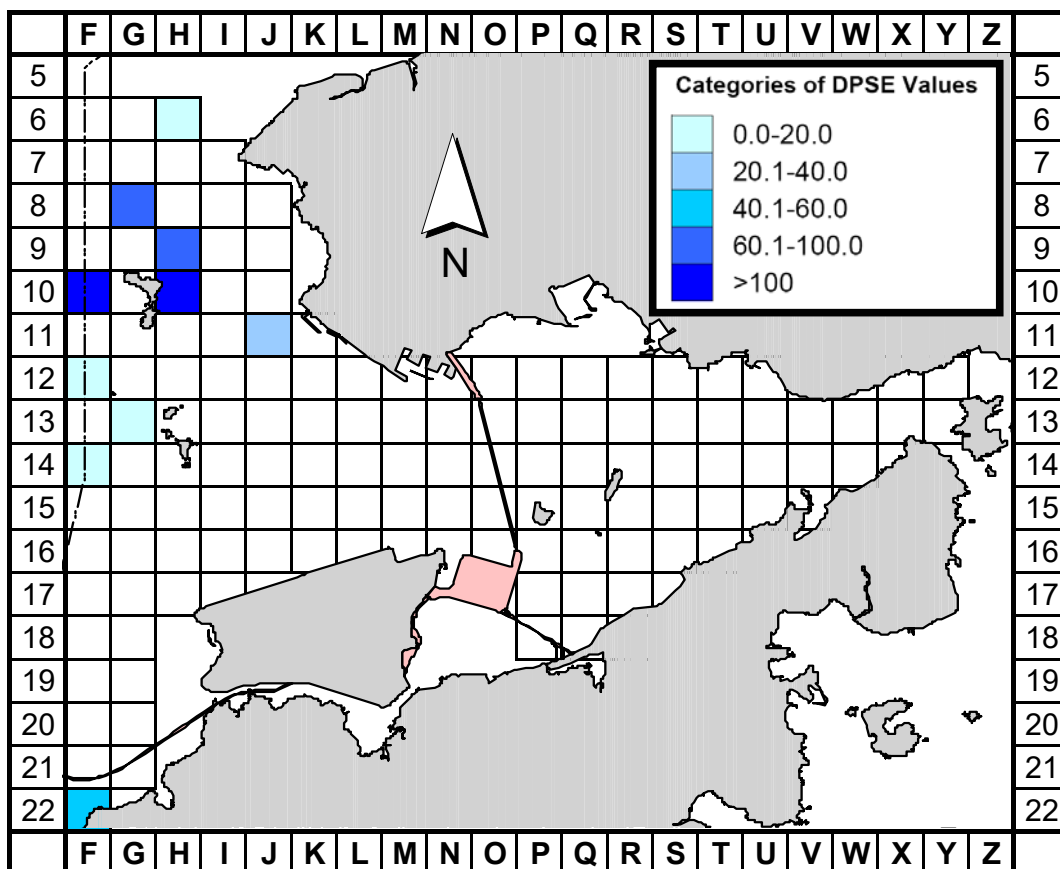


Figure 4b. Density of Chinese white dolphins with corrected survey effort per km² in Northeast and Northwest Lantau survey areas, using data collected during HKLR03 impact monitoring period (Sep-Nov 2016) (DPSE = no. of dolphins per 100 units of survey effort)

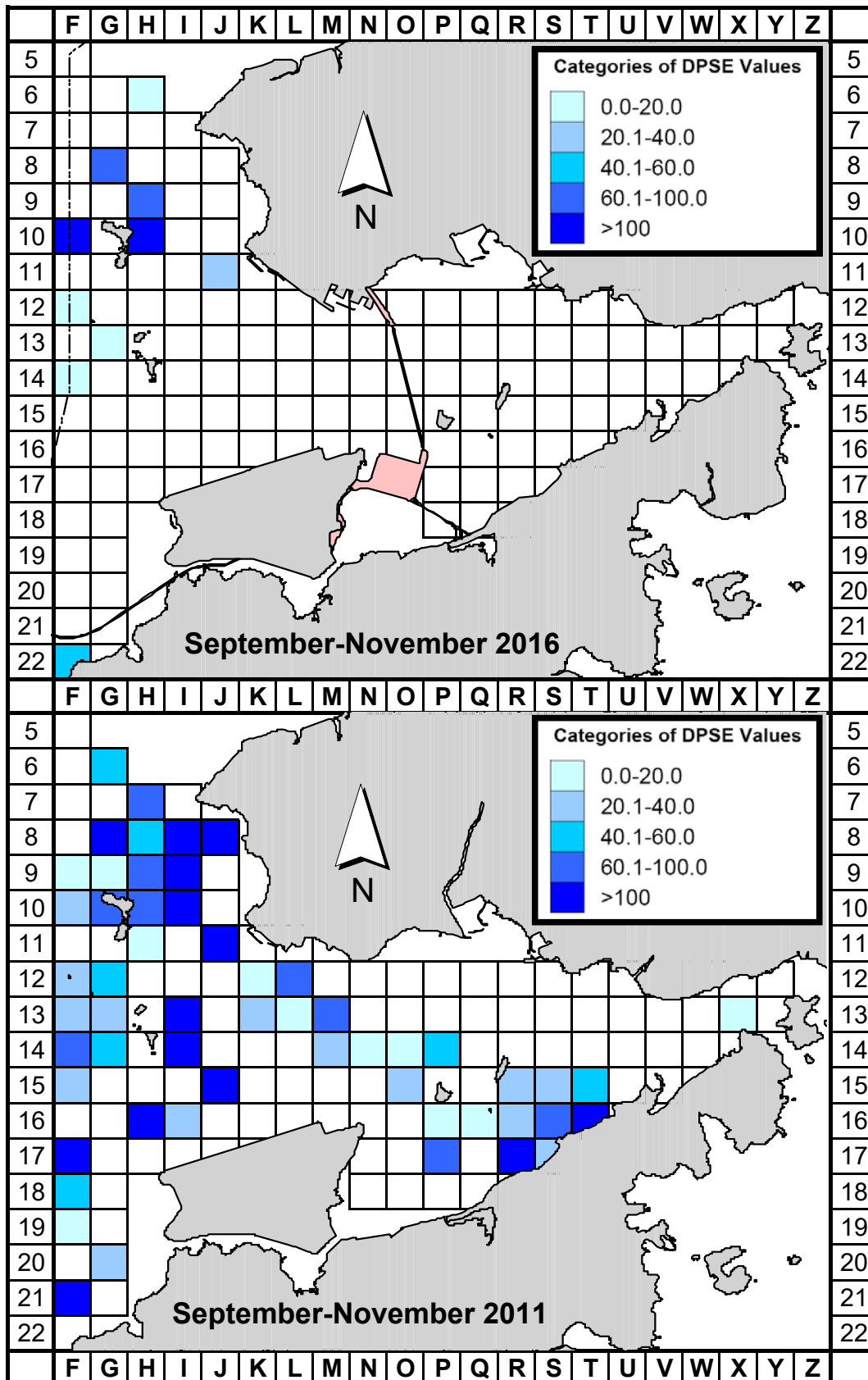


Figure 5. Comparison of density of Chinese white dolphins with corrected survey effort per km² in Northwest and Northeast Lantau survey area between the impact monitoring period (September-November 2016) and baseline monitoring period (September-November 2011) (DPSE = no. of dolphins per 100 units of survey effort)

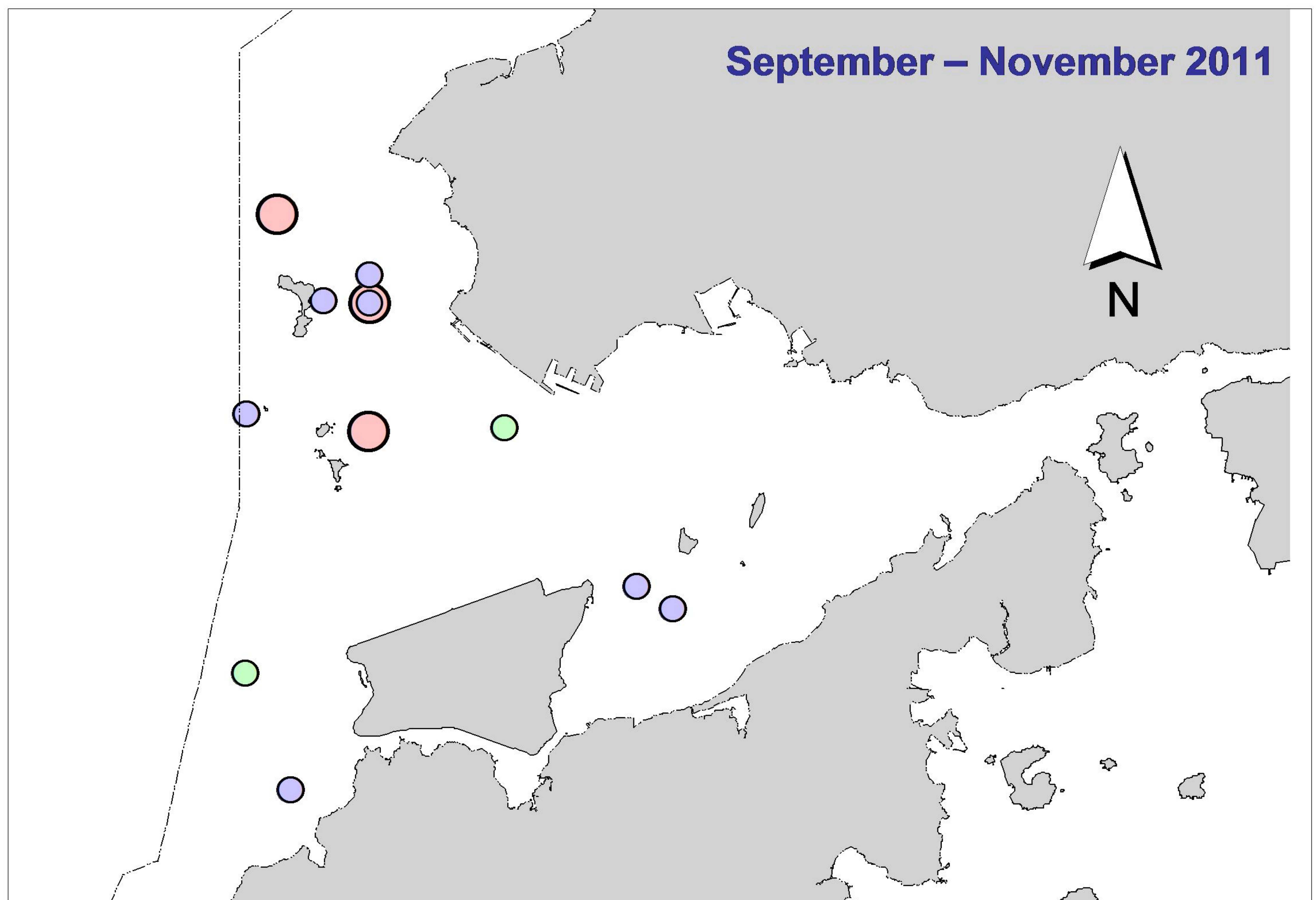
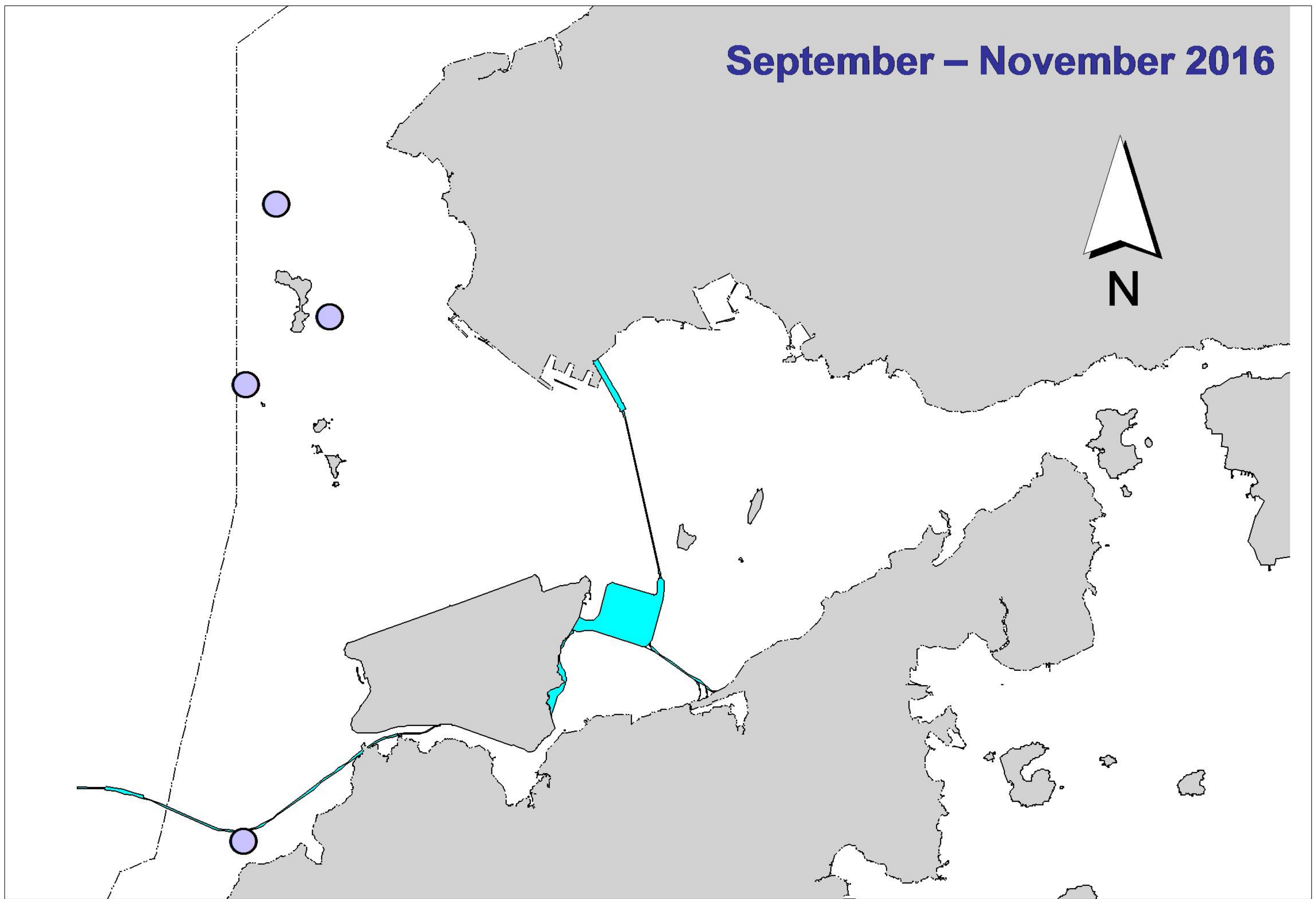


Figure 6. Distribution of Chinese white dolphins engaged in feeding (purple dots), socializing (pink dots) and traveling (green dots) activities during HKLR03 impact phase (top) and baseline monitoring surveys (bottom)

Appendix I. HKLR03 Survey Effort Database (September-November 2016)

(Abbreviations: BEAU = Beaufort Sea State; P = Primary Line Effort; S = Secondary Line Effort)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	TYPE	P/S
13-Sep-16	NE LANTAU	2	15.97	AUTUMN	STANDARD31516	HKLR	P
13-Sep-16	NE LANTAU	2	10.03	AUTUMN	STANDARD31516	HKLR	S
13-Sep-16	NW LANTAU	2	36.84	AUTUMN	STANDARD31516	HKLR	P
13-Sep-16	NW LANTAU	3	2.60	AUTUMN	STANDARD31516	HKLR	P
13-Sep-16	NW LANTAU	2	15.06	AUTUMN	STANDARD31516	HKLR	S
14-Sep-16	NW LANTAU	3	16.30	AUTUMN	STANDARD36826	HKLR	P
14-Sep-16	NW LANTAU	4	14.20	AUTUMN	STANDARD36826	HKLR	P
14-Sep-16	NW LANTAU	3	2.30	AUTUMN	STANDARD36826	HKLR	S
14-Sep-16	NW LANTAU	4	5.30	AUTUMN	STANDARD36826	HKLR	S
14-Sep-16	NW LANTAU	5	0.50	AUTUMN	STANDARD36826	HKLR	S
14-Sep-16	NE LANTAU	2	2.79	AUTUMN	STANDARD36826	HKLR	P
14-Sep-16	NE LANTAU	3	16.35	AUTUMN	STANDARD36826	HKLR	P
14-Sep-16	NE LANTAU	4	0.76	AUTUMN	STANDARD36826	HKLR	P
14-Sep-16	NE LANTAU	2	2.40	AUTUMN	STANDARD36826	HKLR	S
14-Sep-16	NE LANTAU	3	9.00	AUTUMN	STANDARD36826	HKLR	S
21-Sep-16	NW LANTAU	2	30.13	AUTUMN	STANDARD36826	HKLR	P
21-Sep-16	NW LANTAU	3	9.42	AUTUMN	STANDARD36826	HKLR	P
21-Sep-16	NW LANTAU	2	10.37	AUTUMN	STANDARD36826	HKLR	S
21-Sep-16	NW LANTAU	3	2.31	AUTUMN	STANDARD36826	HKLR	S
21-Sep-16	NE LANTAU	1	1.80	AUTUMN	STANDARD36826	HKLR	P
21-Sep-16	NE LANTAU	2	14.60	AUTUMN	STANDARD36826	HKLR	P
21-Sep-16	NE LANTAU	1	2.10	AUTUMN	STANDARD36826	HKLR	S
21-Sep-16	NE LANTAU	2	8.10	AUTUMN	STANDARD36826	HKLR	S
23-Sep-16	NE LANTAU	2	18.82	AUTUMN	STANDARD36826	HKLR	P
23-Sep-16	NE LANTAU	3	0.81	AUTUMN	STANDARD36826	HKLR	P
23-Sep-16	NE LANTAU	2	10.07	AUTUMN	STANDARD36826	HKLR	S
23-Sep-16	NW LANTAU	2	1.25	AUTUMN	STANDARD36826	HKLR	P
23-Sep-16	NW LANTAU	3	28.81	AUTUMN	STANDARD36826	HKLR	P
23-Sep-16	NW LANTAU	4	0.80	AUTUMN	STANDARD36826	HKLR	P
23-Sep-16	NW LANTAU	3	7.34	AUTUMN	STANDARD36826	HKLR	S
4-Oct-16	NW LANTAU	2	25.94	AUTUMN	STANDARD36826	HKLR	P
4-Oct-16	NW LANTAU	3	5.70	AUTUMN	STANDARD36826	HKLR	P
4-Oct-16	NW LANTAU	2	6.60	AUTUMN	STANDARD36826	HKLR	S
4-Oct-16	NE LANTAU	2	15.22	AUTUMN	STANDARD36826	HKLR	P
4-Oct-16	NE LANTAU	3	4.57	AUTUMN	STANDARD36826	HKLR	P
4-Oct-16	NE LANTAU	2	10.41	AUTUMN	STANDARD36826	HKLR	S
7-Oct-16	NE LANTAU	2	16.19	AUTUMN	STANDARD36826	HKLR	P
7-Oct-16	NE LANTAU	2	10.71	AUTUMN	STANDARD36826	HKLR	S
7-Oct-16	NW LANTAU	1	4.54	AUTUMN	STANDARD36826	HKLR	P
7-Oct-16	NW LANTAU	2	36.45	AUTUMN	STANDARD36826	HKLR	P
7-Oct-16	NW LANTAU	1	1.03	AUTUMN	STANDARD36826	HKLR	S
7-Oct-16	NW LANTAU	2	11.81	AUTUMN	STANDARD36826	HKLR	S
7-Oct-16	NW LANTAU	3	0.40	AUTUMN	STANDARD36826	HKLR	S
11-Oct-16	NW LANTAU	2	29.01	AUTUMN	STANDARD36826	HKLR	P
11-Oct-16	NW LANTAU	3	10.75	AUTUMN	STANDARD36826	HKLR	P
11-Oct-16	NW LANTAU	2	12.21	AUTUMN	STANDARD36826	HKLR	S
11-Oct-16	NW LANTAU	3	1.40	AUTUMN	STANDARD36826	HKLR	S
11-Oct-16	NE LANTAU	2	15.82	AUTUMN	STANDARD36826	HKLR	P
11-Oct-16	NE LANTAU	3	0.80	AUTUMN	STANDARD36826	HKLR	P
11-Oct-16	NE LANTAU	2	7.48	AUTUMN	STANDARD36826	HKLR	S
11-Oct-16	NE LANTAU	3	2.40	AUTUMN	STANDARD36826	HKLR	S

Appendix I. (cont'd)

(Abbreviations: BEAU = Beaufort Sea State; P = Primary Line Effort; S = Secondary Line Effort)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	TYPE	P/S
13-Oct-16	NW LANTAU	2	14.72	AUTUMN	STANDARD36826	HKLR	P
13-Oct-16	NW LANTAU	3	15.81	AUTUMN	STANDARD36826	HKLR	P
13-Oct-16	NW LANTAU	2	3.21	AUTUMN	STANDARD36826	HKLR	S
13-Oct-16	NW LANTAU	3	5.06	AUTUMN	STANDARD36826	HKLR	S
13-Oct-16	NE LANTAU	2	20.06	AUTUMN	STANDARD36826	HKLR	P
13-Oct-16	NE LANTAU	2	11.14	AUTUMN	STANDARD36826	HKLR	S
2-Nov-16	NW LANTAU	2	3.00	AUTUMN	STANDARD36826	HKLR	P
2-Nov-16	NW LANTAU	3	19.06	AUTUMN	STANDARD36826	HKLR	P
2-Nov-16	NW LANTAU	4	9.44	AUTUMN	STANDARD36826	HKLR	P
2-Nov-16	NW LANTAU	2	2.50	AUTUMN	STANDARD36826	HKLR	S
2-Nov-16	NW LANTAU	3	5.40	AUTUMN	STANDARD36826	HKLR	S
2-Nov-16	NE LANTAU	2	4.13	AUTUMN	STANDARD36826	HKLR	P
2-Nov-16	NE LANTAU	3	15.46	AUTUMN	STANDARD36826	HKLR	P
2-Nov-16	NE LANTAU	2	4.21	AUTUMN	STANDARD36826	HKLR	S
2-Nov-16	NE LANTAU	3	7.40	AUTUMN	STANDARD36826	HKLR	S
7-Nov-16	NW LANTAU	2	37.21	AUTUMN	STANDARD31516	HKLR	P
7-Nov-16	NW LANTAU	3	0.90	AUTUMN	STANDARD31516	HKLR	P
7-Nov-16	NW LANTAU	2	13.39	AUTUMN	STANDARD31516	HKLR	S
7-Nov-16	NE LANTAU	2	14.34	AUTUMN	STANDARD31516	HKLR	P
7-Nov-16	NE LANTAU	3	1.00	AUTUMN	STANDARD31516	HKLR	P
7-Nov-16	NE LANTAU	2	7.66	AUTUMN	STANDARD31516	HKLR	S
7-Nov-16	NE LANTAU	3	0.80	AUTUMN	STANDARD31516	HKLR	S
18-Nov-16	NW LANTAU	1	1.90	AUTUMN	STANDARD31516	HKLR	P
18-Nov-16	NW LANTAU	2	38.57	AUTUMN	STANDARD31516	HKLR	P
18-Nov-16	NW LANTAU	1	1.70	AUTUMN	STANDARD31516	HKLR	S
18-Nov-16	NW LANTAU	2	11.23	AUTUMN	STANDARD31516	HKLR	S
18-Nov-16	NE LANTAU	2	17.54	AUTUMN	STANDARD31516	HKLR	P
18-Nov-16	NE LANTAU	2	10.66	AUTUMN	STANDARD31516	HKLR	S
22-Nov-16	NE LANTAU	2	17.43	AUTUMN	STANDARD36826	HKLR	P
22-Nov-16	NE LANTAU	3	1.32	AUTUMN	STANDARD36826	HKLR	P
22-Nov-16	NE LANTAU	2	10.95	AUTUMN	STANDARD36826	HKLR	S
22-Nov-16	NW LANTAU	2	29.12	AUTUMN	STANDARD36826	HKLR	P
22-Nov-16	NW LANTAU	3	2.10	AUTUMN	STANDARD36826	HKLR	P
22-Nov-16	NW LANTAU	2	7.58	AUTUMN	STANDARD36826	HKLR	S

Appendix II. HKLR03 Chinese White Dolphin Sighting Database (September-November 2016)

(Abbreviations: STG# = Sighting Number; HRD SZ = Dolphin Herd Size; BEAU = Beaufort Sea State; PSD = Perpendicular Distance; BOAT ASSOC. = Fishing Boat Association P/S: Sighting Made on Primary/Secondary Line)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
21-Sep-16	1	1057	3	NW LANTAU	2	0	ON	HKLR	826211	804642	AUTUMN	NONE	P
21-Sep-16	2	1155	11	NW LANTAU	2	664	ON	HKLR	826983	806467	AUTUMN	NONE	P
21-Sep-16	3	1229	5	NW LANTAU	2	0	ON	HKLR	826185	806496	AUTUMN	NONE	P
21-Sep-16	4	1341	2	NW LANTAU	2	79	ON	HKLR	825218	808472	AUTUMN	NONE	P
4-Oct-16	1	1039	1	NW LANTAU	2	14	ON	HKLR	823995	805534	AUTUMN	NONE	P
4-Oct-16	2	1114	2	NW LANTAU	2	377	ON	HKLR	830283	806082	AUTUMN	NONE	S
7-Oct-16	1	1419	4	NW LANTAU	1	103	ON	HKLR	827149	806447	AUTUMN	NONE	P
7-Oct-16	2	1553	2	NW LANTAU	2	8	ON	HKLR	814927	804671	AUTUMN	NONE	P
11-Oct-16	1	1049	1	NW LANTAU	2	243	ON	HKLR	822391	804655	AUTUMN	NONE	P
13-Oct-16	1	1104	5	NW LANTAU	3	69	ON	HKLR	828391	805399	AUTUMN	NONE	P
7-Nov-16	1	1103	1	NW LANTAU	2	211	ON	HKLR	824583	804711	AUTUMN	NONE	P
18-Nov-16	1	1352	7	NW LANTAU	1	99	ON	HKLR	826019	806609	AUTUMN	GILLNET	P
18-Nov-16	2	1459	4	NW LANTAU	2	440	ON	HKLR	826820	804551	AUTUMN	NONE	P

Appendix III. Individual dolphins identified during HKLR03 monitoring surveys in September-November 2016

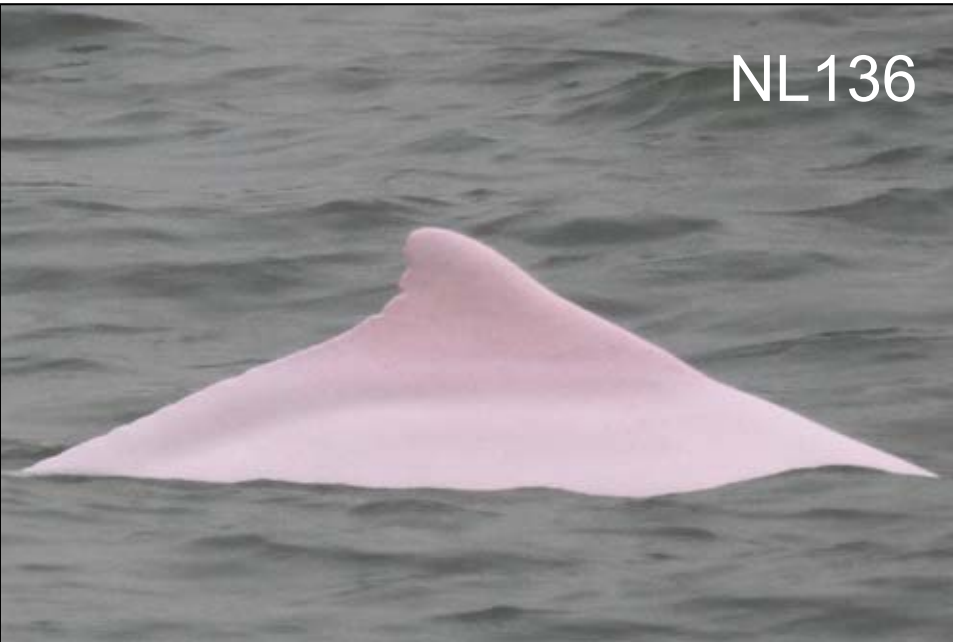
ID#	DATE	STG#	AREA
CH34	13/10/16	1	NW LANTAU
	18/11/16	1	NW LANTAU
	18/11/16	2	NW LANTAU
NL12	21/09/16	3	NW LANTAU
NL103	21/09/16	3	NW LANTAU
NL104	13/10/16	1	NW LANTAU
NL136	21/09/16	3	NW LANTAU
	04/10/16	2	NW LANTAU
	18/11/16	1	NW LANTAU
	18/11/16	2	NW LANTAU
NL182	04/10/16	2	NW LANTAU
NL202	21/09/16	2	NW LANTAU
	07/10/16	1	NW LANTAU
	13/10/16	1	NW LANTAU
	18/11/16	1	NW LANTAU
NL220	18/11/16	1	NW LANTAU
NL224	21/09/16	2	NW LANTAU
NL259	21/09/16	3	NW LANTAU
NL261	21/09/16	2	NW LANTAU
NL264	21/09/16	3	NW LANTAU
NL269	18/11/16	1	NW LANTAU
	18/11/16	2	NW LANTAU
NL272	21/09/16	2	NW LANTAU
NL286	21/09/16	2	NW LANTAU
	07/10/16	1	NW LANTAU
	13/10/16	1	NW LANTAU
NL288	21/09/16	3	NW LANTAU
NL307	21/09/16	2	NW LANTAU
NL319	21/09/16	2	NW LANTAU
NL320	21/09/16	2	NW LANTAU
	07/10/16	1	NW LANTAU
	18/11/16	1	NW LANTAU
NL321	13/10/16	1	NW LANTAU
WL243	07/10/16	2	NW LANTAU

Appendix IV. Twenty-one individual dolphins that were identified during September-November 2016 under HKLR03 impact phase monitoring surveys

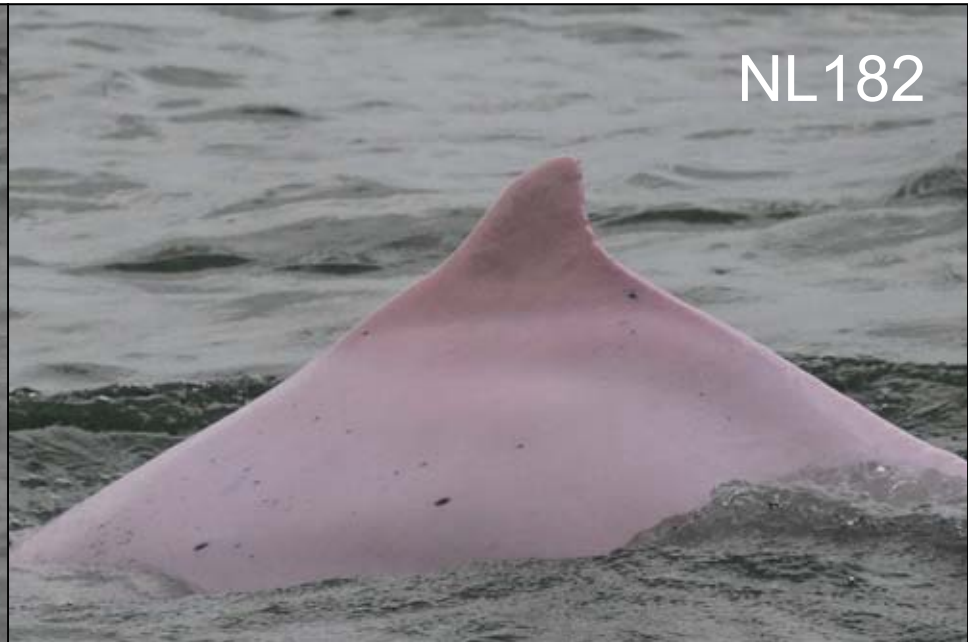


Appendix IV. (cont'd)

NL136



NL182



NL202



NL220



Appendix IV. (cont'd)

NL224



NL259



NL261



NL264



Appendix IV. (cont'd)



NL269



NL272



NL286



NL288

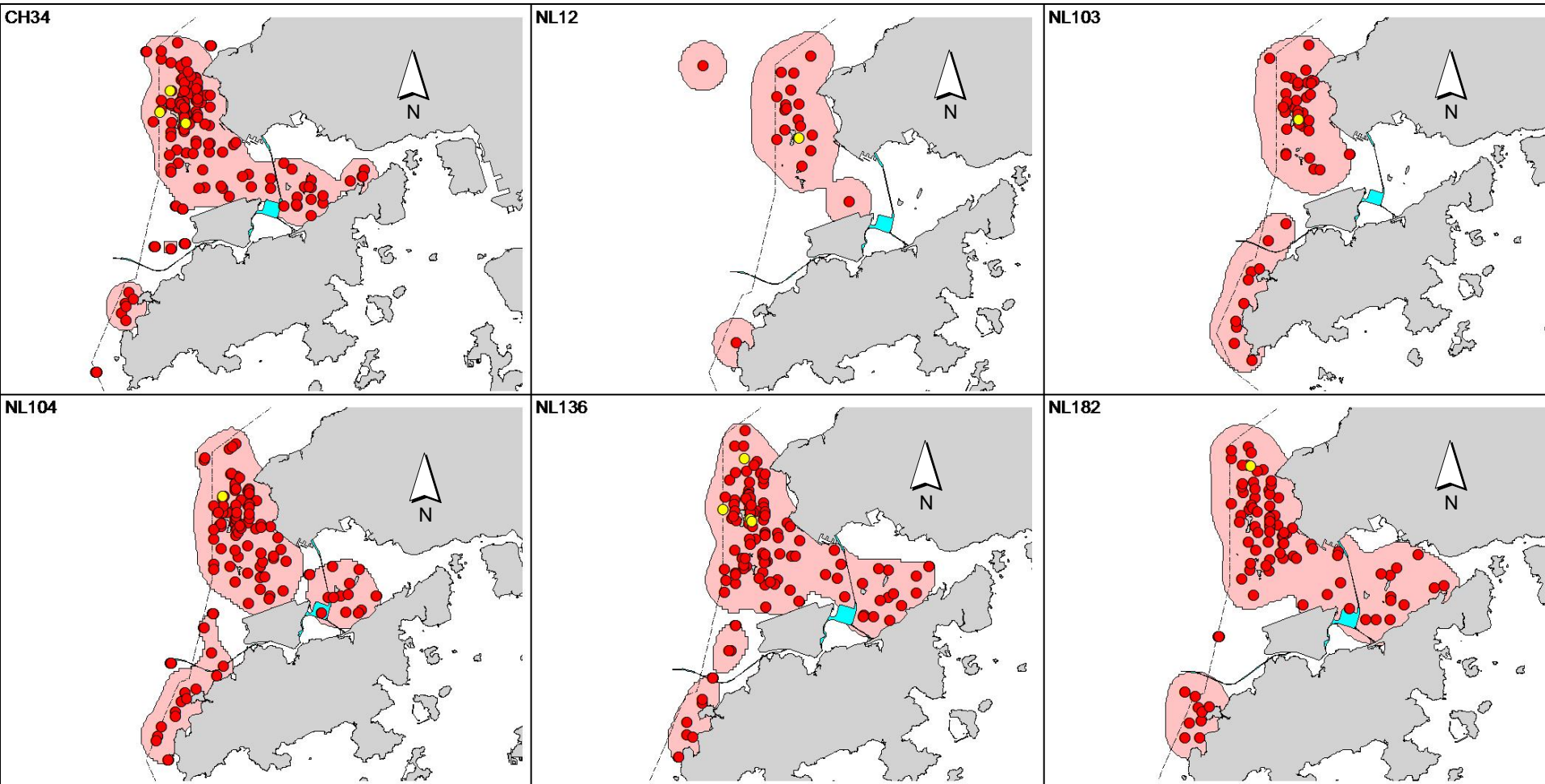
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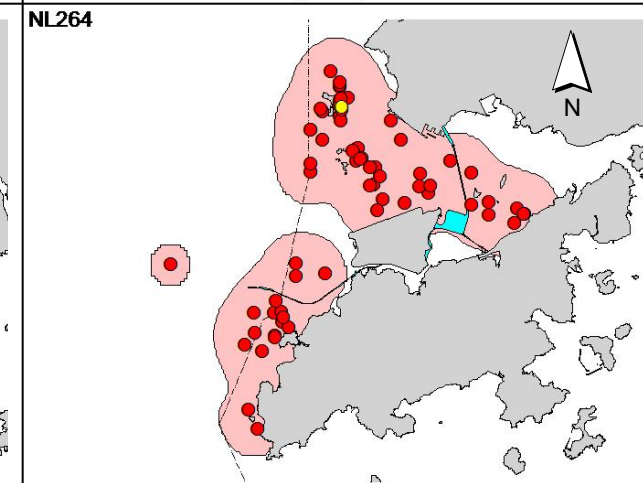
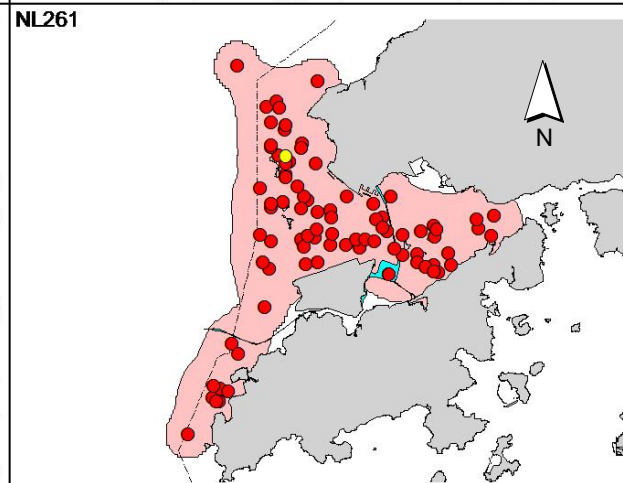
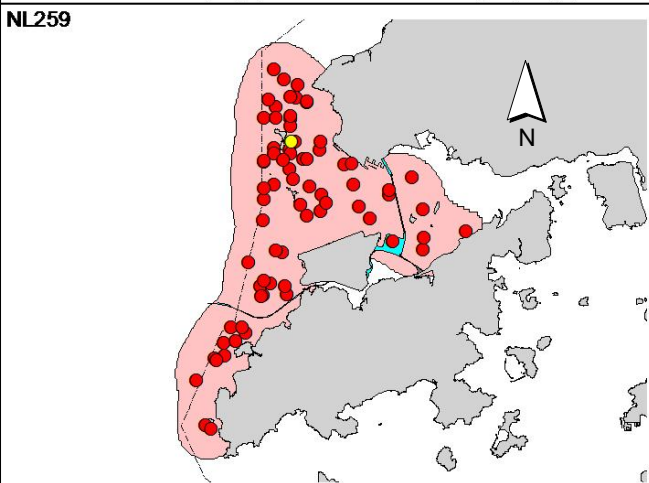
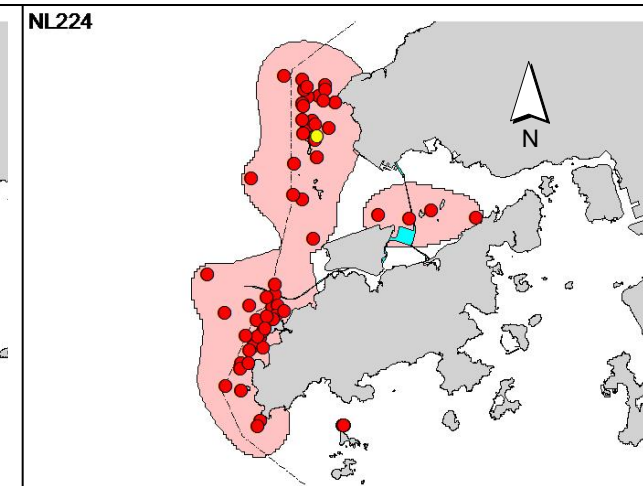
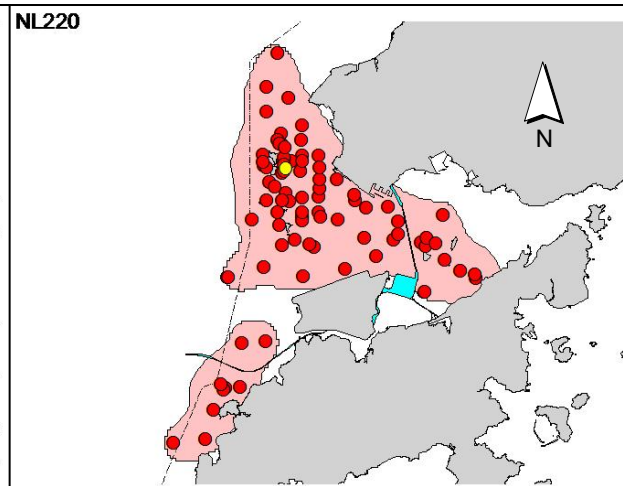
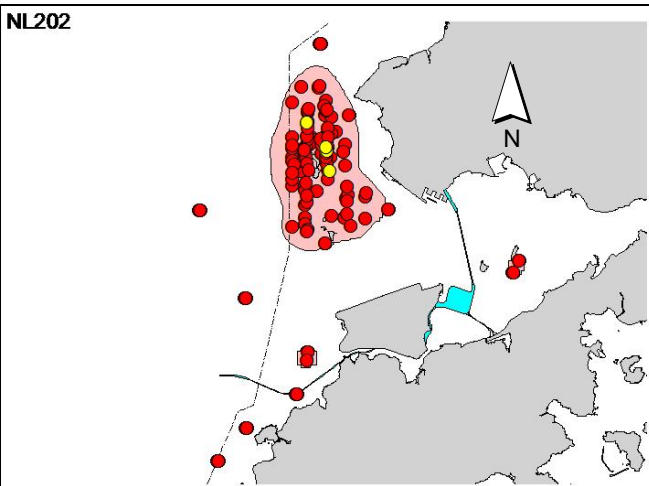
Appendix IV. (cont'd)



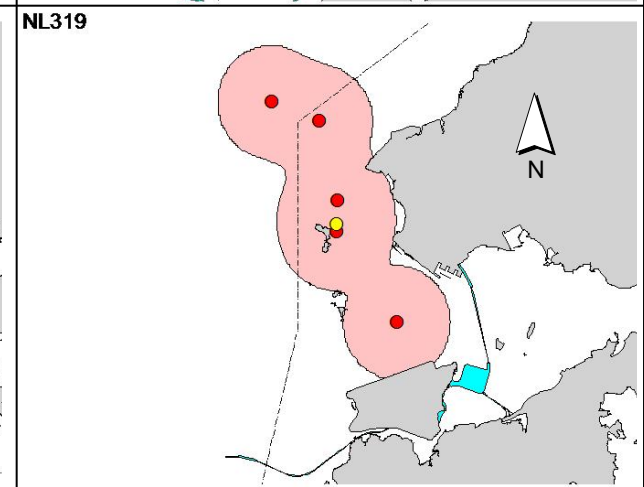
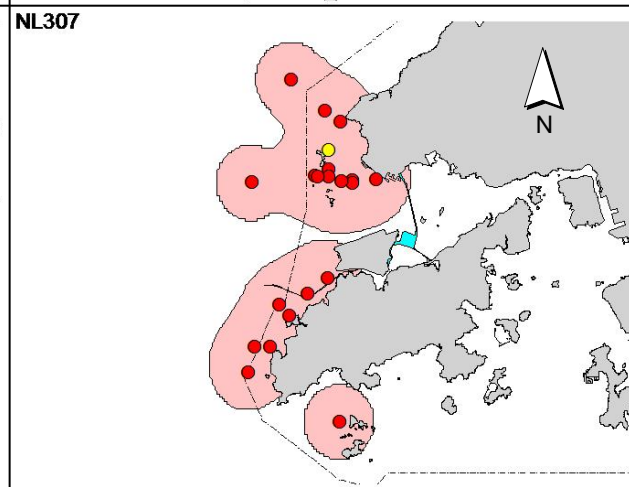
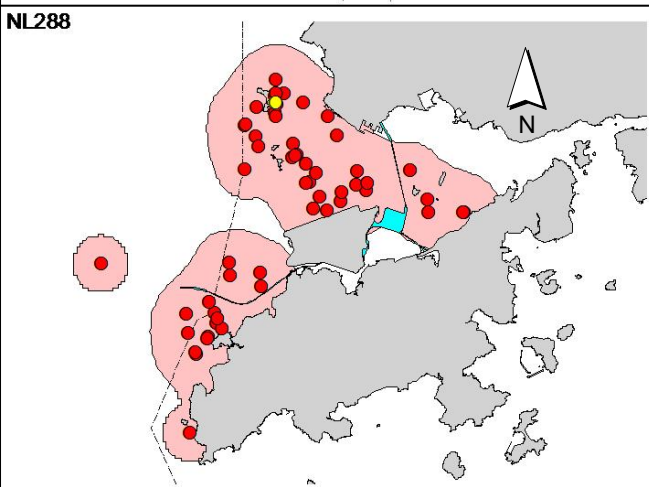
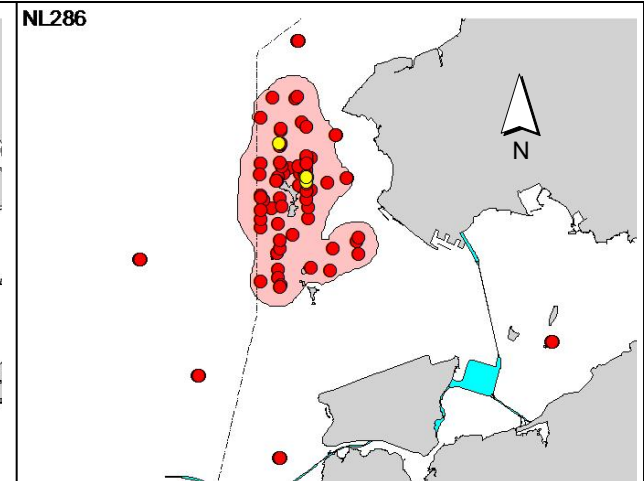
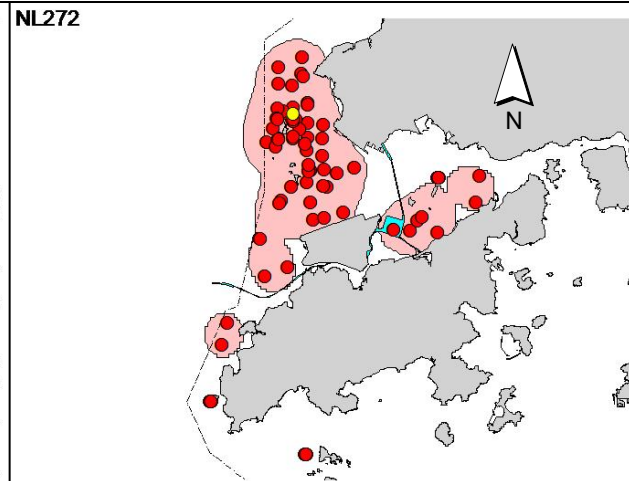
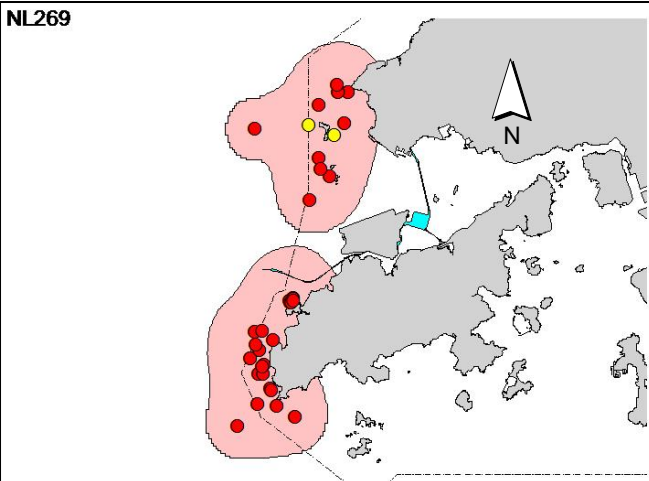
Appendix V. Ranging patterns (95% kernel ranges) of 21 individual dolphins that were sighted during HKLR03 impact phase monitoring period (note: yellow dots indicates sightings made in September-November 2016 during HZMB-related monitoring surveys)



Appendix V. (cont'd)



Appendix V. (cont'd)



Appendix V. (cont'd)

