Appendix H

Impact Dolphin Monitoring Survey

CONTRACT NO. HY/2012/08
Hong Kong-Zhuhai-Macao Bridge Tuen Mun – Chek Lap Kok Link (Northern Connection Sub-sea Tunnel Section)
Dolphin Quarterly Monitoring

23rd Quarterly Progress Report (June-August 2019)
submitted to Dragages – Bouygues Joint Venture & ERM Hong Kong Ltd.

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1. Introduction

1.1. As part of the Hong Kong-Zhuhai-Macao Bridge, the Tuen Mun-Chek Lap Kok Link (TM-CLKL) Northern Connection Sub-sea Tunnel Section (Contract no. HY/2012/08) comprises the sub-sea TBM tunnels (two tubes with cross passages) across the Urmston Road to connect Tuen Area 40 and Hong Kong Boundary Crossing Facilities (HKBCF) of approximately 4 km in length with dual 2-lane carriageway, the tunnels at both the southern landfall and the northern landfall for construction of approach roads to the sub-sea TBM tunnels of approximately 1.5 km in length, as well as the northern landfall reclamation of approximately 16.5 hectares and about 20.km long seawalls. Dragages – Bouygues Joint Venture (hereinafter called the "Contractor") was awarded as the main contractor for the Northern Connection Sub-sea Tunnel Section, and ERM Hong Kong Limited would serve as the Environmental Team to implement the Environmental Monitoring and Audit (EM&A) programme.

1.2. According to the updated EM&A Manual (for TM-CLKL), monthly line-transect vessel surveys for Chinese White Dolphin should be conducted to cover the Northwest (NWL) and Northeast Lantau (NEL) survey areas as in AFCD annual marine mammal monitoring programme. However, as such surveys have been undertaken by the HKLR03 and HKBCF projects in the same areas (i.e. NWL and NEL), a combined monitoring approach is recommended by the Highways Department, that the TM-CLKL EM&A project can utilize the monitoring data collected by HKLR03 or HKBCF project to avoid any redundancy in monitoring effort. Such exemption for the dolphin monitoring will end upon the completion of the dolphin monitoring carried out by HKLR03 contract.

1.3. In November 2013, the Director of Hong Kong Cetacean Research Project (HKCRP), Dr. Samuel Hung, has been appointed by ERM Hong Kong Limited as the dolphin specialist for the TM-CLKL Northern Connection Sub-sea Tunnel Section EM&A project. He is responsible for the dolphin monitoring study, including the data collection on Chinese White Dolphins during the construction phase (i.e. impact period) of the TM-CLKL project in Northwest Lantau (NWL) and Northeast Lantau (NEL) survey areas.

1.4. During the construction period of HKLR, the dolphin specialist would be in charge of reviewing and collating information collected by HKLR03 dolphin monitoring programme to examine any potential impacts of TM-CLKL construction works on the dolphins.

1.5. 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.

1.6. This report is the 23rd quarterly progress report under the TM-CLKL construction phase dolphin monitoring programme submitted to the Contractor, summarizing the results of the surveys findings during the period of June to August 2019, utilizing the survey data collected by HKLR03 impact phase monitoring project.

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 conducted by HKLR03 project

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	805476	820800		14	Start Point	817537	820220
2	End Point	805476	826654		14	End Point	817537	824613
3	Start Point	806464	821150		15	Start Point	818568	820735
3	End Point	806464	822911		15	End Point	818568	824433
4	Start Point	807518	821500		16	Start Point	819532	821420
4	End Point	807518	829230		16	End Point	819532	824209
5	Start Point	808504	821850		17	Start Point	820451	822125
5	End Point	808504	828602		17	End Point	820451	823671
6	Start Point	809490	822150		18	Start Point	821504	822371
6	End Point	809490	825352		18	End Point	821504	823761
7	Start Point	810499	822000		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	821176		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		24	Start Point	805476	815900
12	End Point	815542	824882		24	End Point	805476	819100

2.1.2. The HKLR03 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 22 years of marine mammal monitoring surveys in Hong Kong developed by HKCRP (see Hung 2018). 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^{o} and 90^{o} (in relation to the bow, which is defined as 0^{o}). 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, positions (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. 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 HKLR03 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. A professional digital camera (*Canon* EOS 7D model), 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. Only data collect under Beaufort 3 or below condition would be used for the encounter rate analyses. 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. 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-km^2 grids among NWL and NEL survey areas on GIS. Sighting densities (number of on-effort sightings per km^2) and dolphin densities (total number of dolphins from on-effort sightings per km^2) 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 **s**ightings **p**er 100 units of **s**urvey **e**ffort. In addition, the derived unit for actual dolphin density was termed DPSE, representing the number of **d**olphins **p**er 100 units of **s**urvey **e**ffort. Among the 1-km^2 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-km^2 grid within the study area:

SPSE = ((S / E) x 100) / SA%
DPSE = ((D / E) x 100) / 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, socializing, traveling, and milling/resting) 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 June to August 2019, six sets of systematic line-transect vessel surveys were conducted under the HKLR03 monitoring works to cover all transect lines in NWL and NEL survey areas twice per month.

3.1.2. From these HKLR03 surveys, a total of 785.23 km of survey effort was collected, with 96.0% 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, 287.33 km and 497.90 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 577.21 km, while the effort on secondary lines was 208.02 km. Survey effort conducted on both primary and secondary lines were considered to be on-effort survey data. A summary table of the survey effort is shown in Appendix I.

3.1.4. During the six sets of HKLR03 monitoring surveys from June to August 2019, only four

groups of eight Chinese White Dolphins were sighted. Three of the four dolphin sightings were made during on-effort search in this quarter, with two of them being made on primary lines. A summary table of dolphin sightings is shown in Appendix II.

3.1.5. In this quarterly period, 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 the HKLR03 monitoring surveys from June to August 2019 is shown in Figure 1. Two of the four dolphin groups were sighted near Black Point, while the other two were sighted at the southwestern corner of NWL survey area, or just to the south of the HKLR09 bridge alignment (Figure 1). And as consistently recorded in the previous monitoring quarters, the dolphins were completely absent from the central and eastern portions of North Lantau waters (Figure 1).

3.2.2. Notably, all dolphin sightings were located far away from the TM-CLKL alignment as well as the HKBCF and HKLR03 reclamation sites (Figure 1). However, two groups of two lone dolphins were sighted near the HKLR09 alignment during the quarterly period.

3.2.3. Sighting distribution of dolphins during the present impact phase monitoring period (June-August 2019) was drastically different from the one during the baseline monitoring period (Figure 1). 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 six years of HKLR03 monitoring, which has resulted in zero to extremely low dolphin encounter rates in this area.

3.2.4. In NWL survey area, dolphin occurrence was also drastically different between the baseline and impact phase periods. During the present impact monitoring period, dolphins were sighted infrequently here, and only at the northwestern and southwestern corners of the North Lantau region. This was in contrary to their frequent occurrences throughout the area during the baseline period (Figure 1).

3.2.5. Another comparison in dolphin distribution was made between the six quarterly periods of summer months in 2014-19 (Figure 2). Among the six summer periods, dolphins were sighted regularly in NWL waters in 2014, but their usage was progressively reduced to very low levels in the five subsequent summer periods, with their occurrences mostly restricted to the western portion of North Lantau waters (Figure 2).

3.3. Encounter rate

3.3.1. During the present quarterly 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 HKLR03 surveys in NEL and NWL are shown in Table 2. The average encounter rates deduced from the six sets of HKLR03 surveys were also compared with the ones deduced from the baseline

monitoring period (September-November 2011) (Table 3).

Table 2. Dolphin encounter rates (sightings per 100 km of survey effort) during June-August 2019

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 (3 & 6 Jun 2019)	0.00	0.00
	Set 2 (10 & 13 Jun 2019)	0.00	0.00
	Set 3 (16 & 18 Jul 2019)	0.00	0.00
	Set 4 (22 & 24 Jul 2019)	0.00	0.00
	Set 5 (13 & 14 Aug 2019)	0.00	0.00
	Set 6 (20 & 26, 29 Aug 2019)	0.00	0.00
Northwest Lantau	Set 1 (3 & 6 Jun 2019)	3.73	9.32
	Set 2 (10 & 13 Jun 2019)	0.00	0.00
	Set 3 (16 & 18 Jul 2019)	0.00	0.00
	Set 4 (22 & 24 Jul 2019)	0.00	0.00
	Set 5 (13 & 14 Aug 2019)	0.00	0.00
	Set 6 (20 & 26, 29 Aug 2019)	0.00	0.00

Table 3. Comparison of average dolphin encounter rates from impact monitoring period (June-August 2019) 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)	
	June – August 2019	September – November 2011	June – August 2019	September – November 2011
Northeast Lantau	0.0	6.00 ± 5.05	0.0	22.19 ± 26.81
Northwest Lantau	0.62 ± 1.52	9.85 ± 5.85	1.55 ± 3.80	44.66 ± 29.85

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 0.64 sightings and 1.50 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.

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 during the same summer quarters throughout the HKLR03 monitoring (Table 4).

Table 4. Comparison of average dolphin encounter rates in Northeast Lantau survey area from the same summer quarters of HKLR03 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; ± 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 ± 5.05	22.19 ± 26.81
June-August 2013 (Impact)	0.88 ± 1.36	3.91 ± 8.36
June-August 2014 (Impact)	0.42 ± 1.04	1.69 ± 4.15
June-August 2015 (Impact)	0.44 ± 1.08	0.44 ± 1.08
June-August 2016 (Impact)	0.00	0.00
June-August 2017 (Impact)	0.00	0.00
June-August 2018 (Impact)	0.00	0.00
June-August 2019 (Impact)	0.00	0.00

Table 5. Comparison of average dolphin encounter rates in Northwest Lantau survey area from the same summer quarters of HKLR03 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; ± 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 ± 5.85	44.66 ± 29.85
June-August 2013 (Impact)	6.56 ± 3.68	27.00 ± 18.71
June-August 2014 (Impact)	4.74 ± 3.84	17.52 ± 15.12
June-August 2015 (Impact)	2.53 ± 3.20	9.21 ± 11.57
June-August 2016 (Impact)	1.72 ± 2.17	7.48 ± 10.98
June-August 2017 (Impact)	2.20 ± 2.88	6.58 ± 8.12
June-August 2018 (Impact)	1.16 ± 1.39	2.87 ± 3.32
June-August 2019 (Impact)	0.62 ± 1.52	1.55 ± 3.80

3.3.4. On the other hand, the average dolphin encounter rates (STG and ANI) in NWL during the present quarterly period were only tiny fractions of the ones recorded during the three-month baseline period (with reductions of 93.7% and 96.5% respectively), indicating a dramatic decline in dolphin usage of this survey area during the present quarterly period as compared to the baseline period (Table 5).

3.3.5. When comparing among the seven summer quarters since 2013, the quarterly encounter rates in 2019 continued to plummet to the lowest level among all summer quarters during the HKLR03 impact monitoring period (Table 5). Such dramatic drop in dolphin occurrence in NWL should raise serious concerns, and the temporal trend should be closely monitored in the upcoming monitoring quarters as the construction activities of HZMB works will soon be completed in coming months.

3.3.6. 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).

3.3.7. For the comparison between the baseline period and the present quarter (27th quarter of the impact phase being assessed), the p-values for the differences in average dolphin encounter rates of STG and ANI were 0.0011 and 0.0062 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.

3.3.8. For the comparison between the baseline period and the cumulative quarters in impact phase (i.e. the first 27 quarters of the impact phase being assessed), the p-values for the differences in average dolphin encounter rates of STG and ANI were both 0.000000. 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).

3.3.9. 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 of the past few years.

3.3.10. The dramatic decline in dolphin usage of North Lantau region 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 2018). Apparently there has been no sign of recovery of dolphin usage even though almost all marine works associated with the HZMB construction have been completed, and the Brothers Marine Park has been established as a compensation measure for the permanent habitat loss in association with the HKBCF reclamation works.

3.4. Group size

3.4.1. Group size of Chinese White Dolphins ranged from one to four individuals per group in

North Lantau region during June to August 2019. 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 (June – August 2019) and baseline monitoring period (September – November 2011) (Note: ± denotes the standard deviation of the average group size)

	Average Dolphin Group Size	
	June – August 2019	**September – November 2011**
Overall	2.00 ± 1.41 (n = 4)	3.72 ± 3.13 (n = 66)
Northeast Lantau	---	3.18 ± 2.16 (n = 17)
Northwest Lantau	2.00 ± 1.41 (n = 4)	3.92 ± 3.40 (n = 49)

3.4.2. The average dolphin group size in NWL waters during June to August 2019 was much lower than the one recorded during the three-month baseline period, but it should also be noted that the sample size of only four dolphin groups in the present quarter was very small when compared to the 66 groups sighted during the baseline period (Table 6).

3.4.3. Notably, all four dolphin groups were small with 1-4 individuals per group only (Appendix II). This is in stark contrast to the baseline period when the larger groups were frequently sighted and evenly distributed in NWL, with a few also sighted in NEL waters.

3.5. Habitat use

3.5.1. From June to August 2019, only three grids in North Lantau waters recorded dolphin occurrence. The only grid with moderately high dolphin density was located near Black Point (Figures 3a and 3b). In contrast, the other two grids only recorded moderately low densities. Notably, all grids near TMCLKL alignment did not record any presence of dolphins at all during on-effort search in the present quarterly period (Figures 3a and 3b).

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 is 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 4). 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 4).

3.5.4. The density patterns were also very different in NWL between the baseline and impact

phase monitoring periods, with high 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, only one grid with moderately high density was located near Black Point during the present impact phase period (Figure 4).

3.6. Mother-calf pairs

3.6.1. During the present quarterly period, no young calf was sighted at all among the four groups of dolphins.

3.7. Activities and associations with fishing boats

3.7.1. Among the four dolphin groups, only one of them was engaged in feeding activity, while none of them was engaged in socializing, traveling or milling/resting activity during the quarterly period. The lone dolphin group engaged in feeding activity was located to the southwest corner of the NWL survey area (Figure 5).

3.7.2. Moreover, none of the four dolphin groups was found to be associated with any operating fishing vessel during the present impact phase period.

3.8. Summary of photo-identification works

3.8.1. From June to August 2019, about 300 digital photographs of Chinese White Dolphins were taken during the HKLR03 impact phase monitoring surveys for the photo-identification work.

3.8.2. In total, six individuals sighted six 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, and were re-sighted only once during the quarterly monitoring period (Appendix III).

3.8.3. Notably, one of the identified individuals (NL123) was also sighted in WL waters during the HKLR09 monitoring surveys under the same three-month period of June to August 2019.

3.9. Individual range use

3.9.1. Ranging patterns of the six 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. Moreover, only one individual (NL123) had extended its range use to WL waters during the quarterly period, even though such movements between North and West Lantau have been quite frequent in the past several years of HKLR03 dolphin monitoring (Appendix V).

4. Conclusion

4.1. During this quarter of dolphin monitoring, no adverse impact from the activities of the TMCLKL construction project on Chinese White Dolphins was noticeable from general observations.

4.2. Although the dolphins infrequently occurred along the alignment of TMCLKL southern connection viaduct in the past and during the baseline monitoring period, it is apparent that dolphin usage has been significantly reduced in NEL, and many individuals have shifted away from the important habitat around the Brothers Islands.

4.3. It is critical to 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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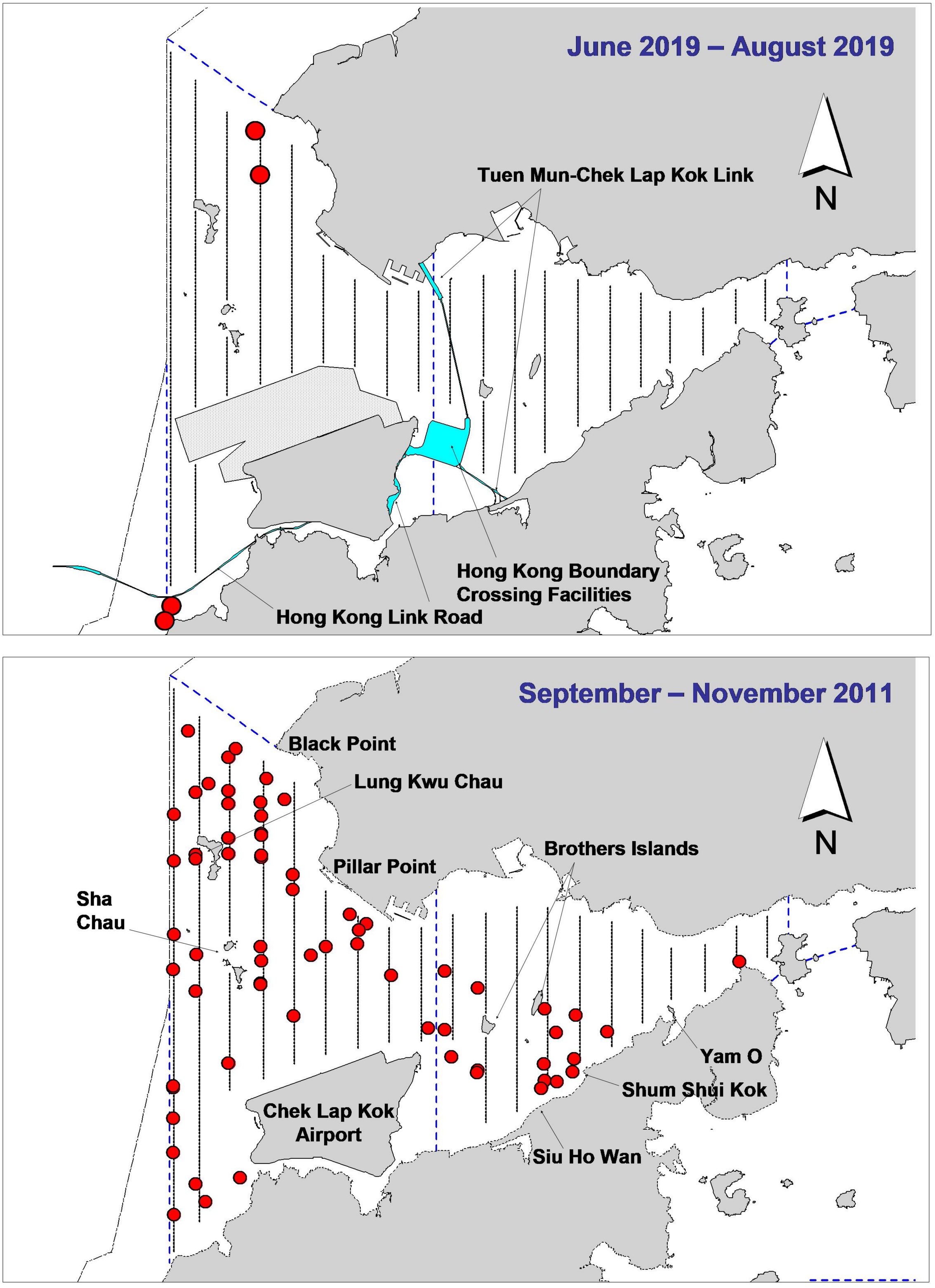

Figure 1. Distribution of Chinese white dolphin sightings in Northwest and Northeast Lantau during HKLR03 monitoring surveys (top) and baseline monitoring surveys (bottom)

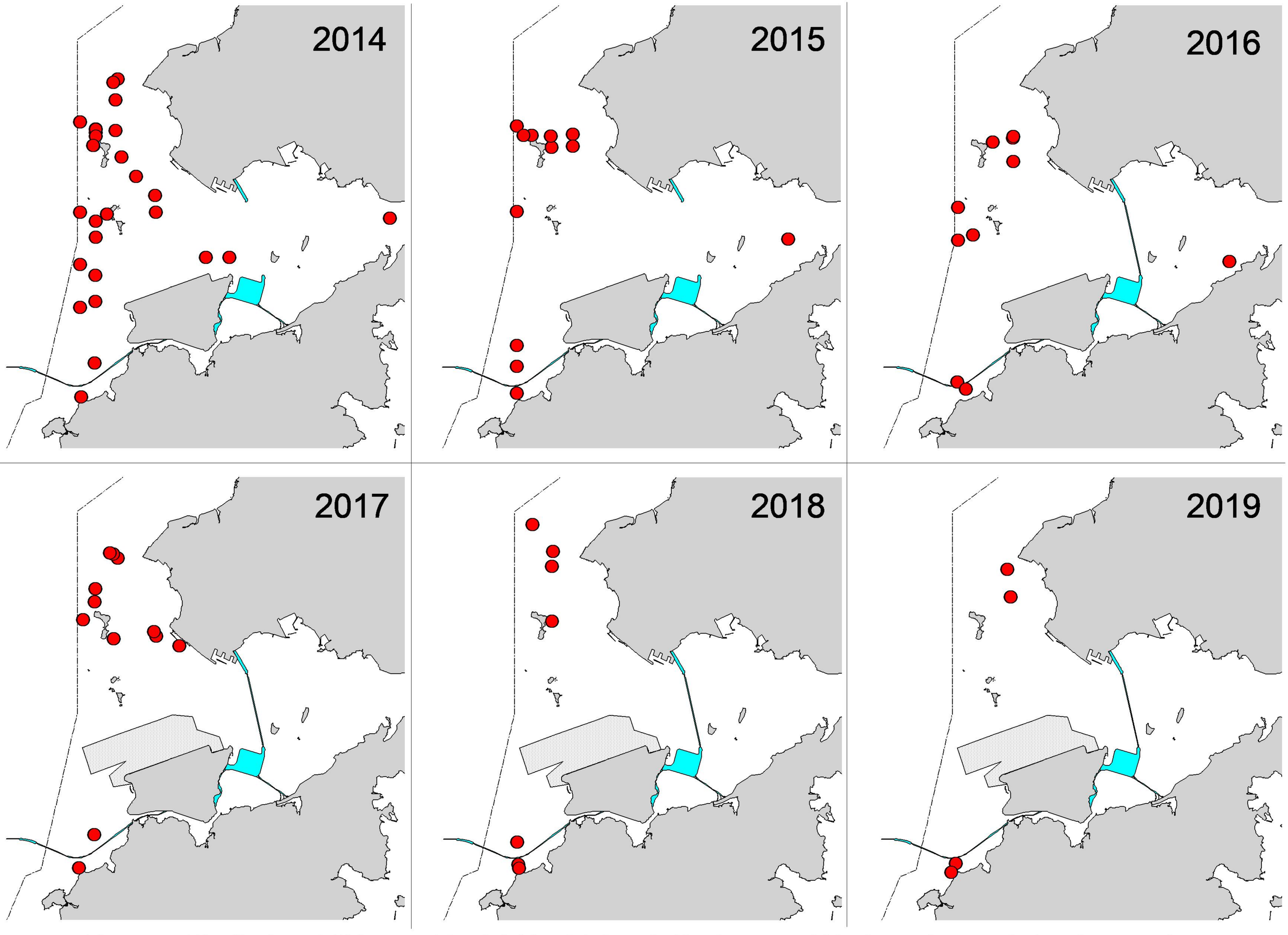

Figure 2. Distribution of Chinese white dolphin sightings in Northwest and Northeast Lantau during the past six summer quarters (June-August) of HKLR03 monitoring period in 2014-19

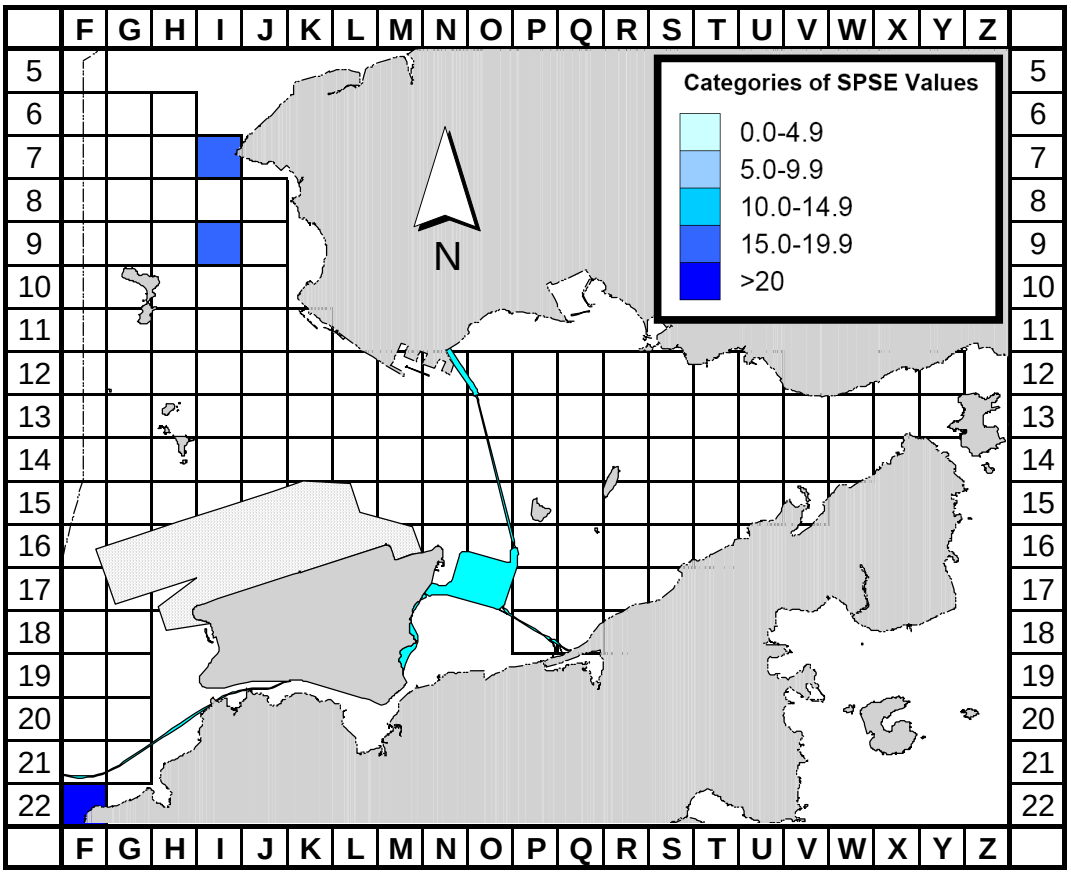

Figure 3a. Sighting density of Chinese white dolphins with corrected survey effort per km^2 in Northeast and Northwest Lantau survey areas, using data collected during HKLR03 impact monitoring period monitoring period (June-August 19) (SPSE = no. of on-effort sightings per 100 units of survey effort)

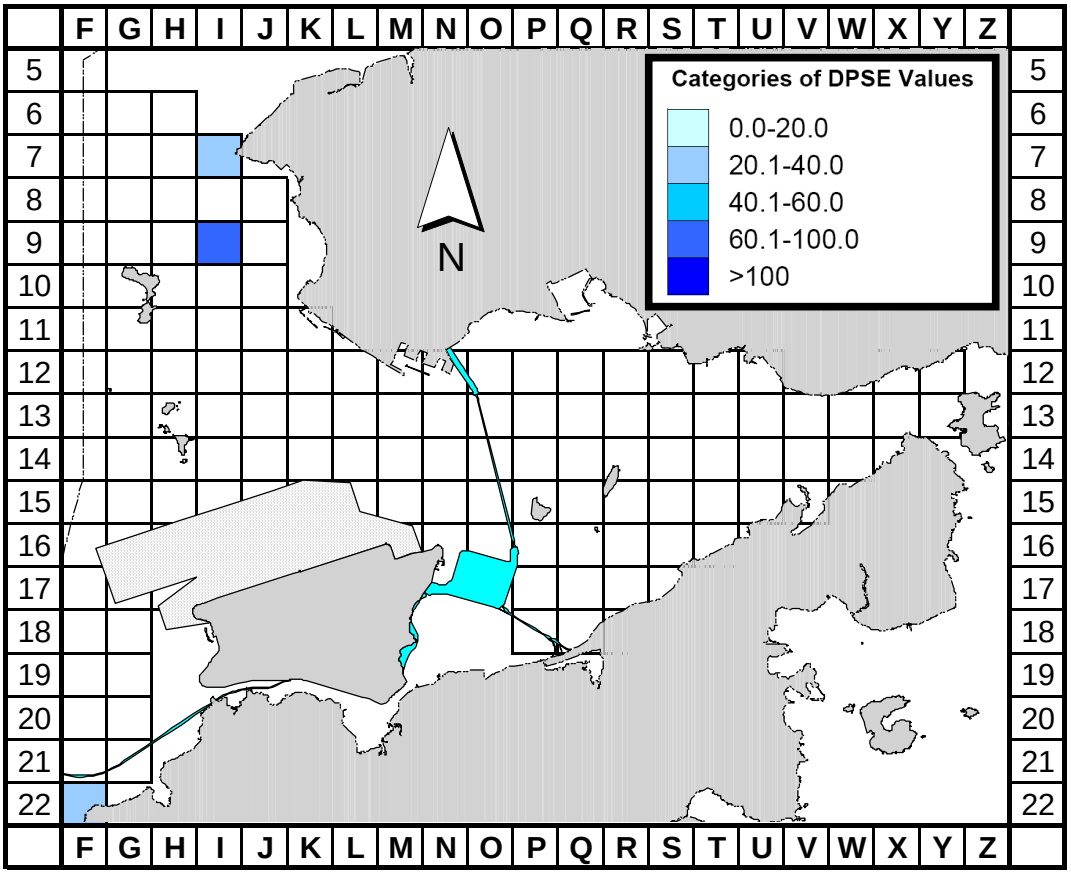

Figure 3b. Density of Chinese white dolphins with corrected survey effort per km^2 in Northeast and Northwest Lantau survey areas, using data collected during HKLR03 impact monitoring period (June-August 19) (DPSE = no. of dolphins per 100 units of survey effort)

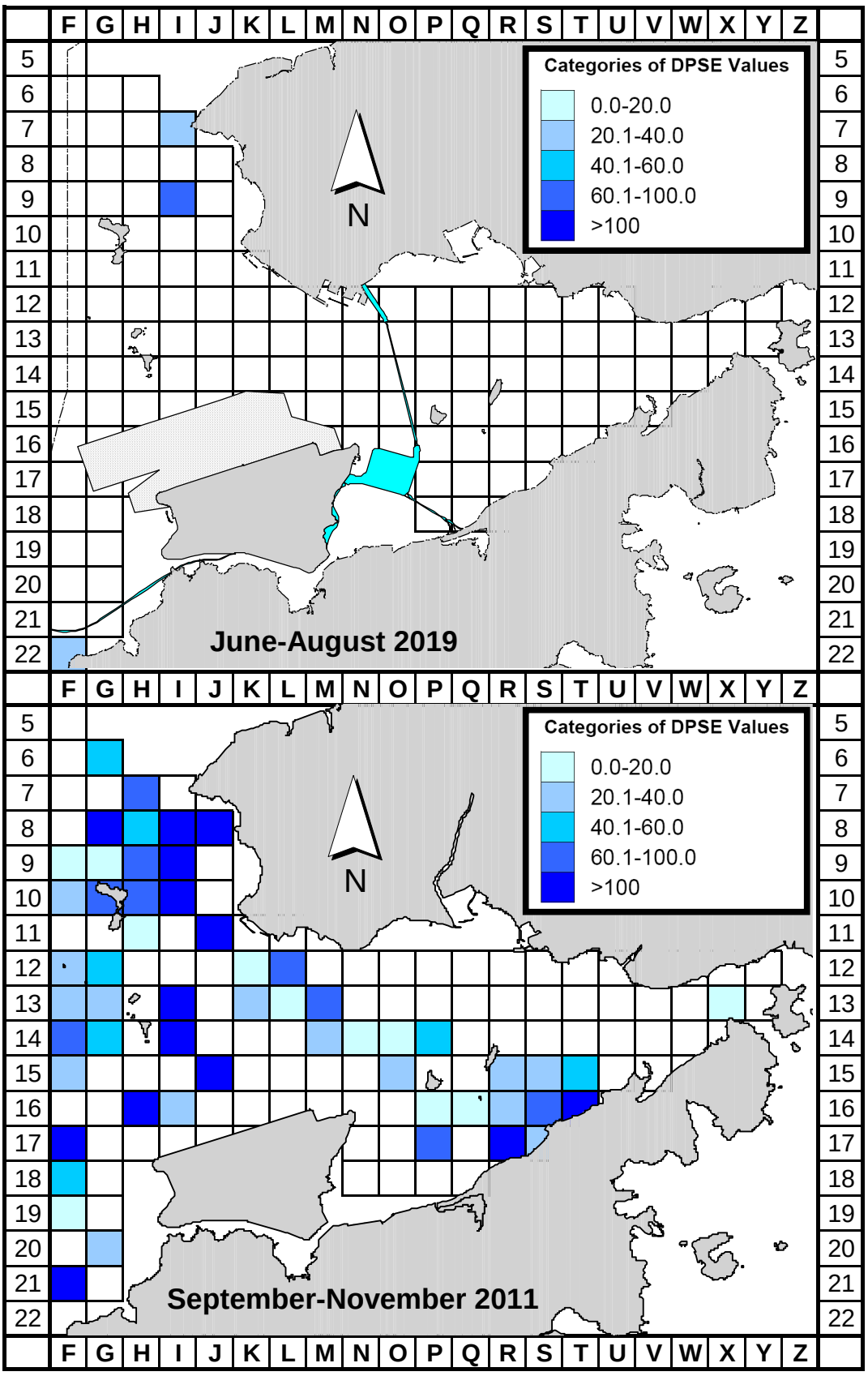

Figure 4. Comparison of density of Chinese white dolphins with corrected survey effort per km^2 in Northwest and Northeast Lantau survey area between the impact monitoring period (June - August 2019) and baseline monitoring period (September-November 2011)
(DPSE = no. of dolphins per 100 units of survey effort)

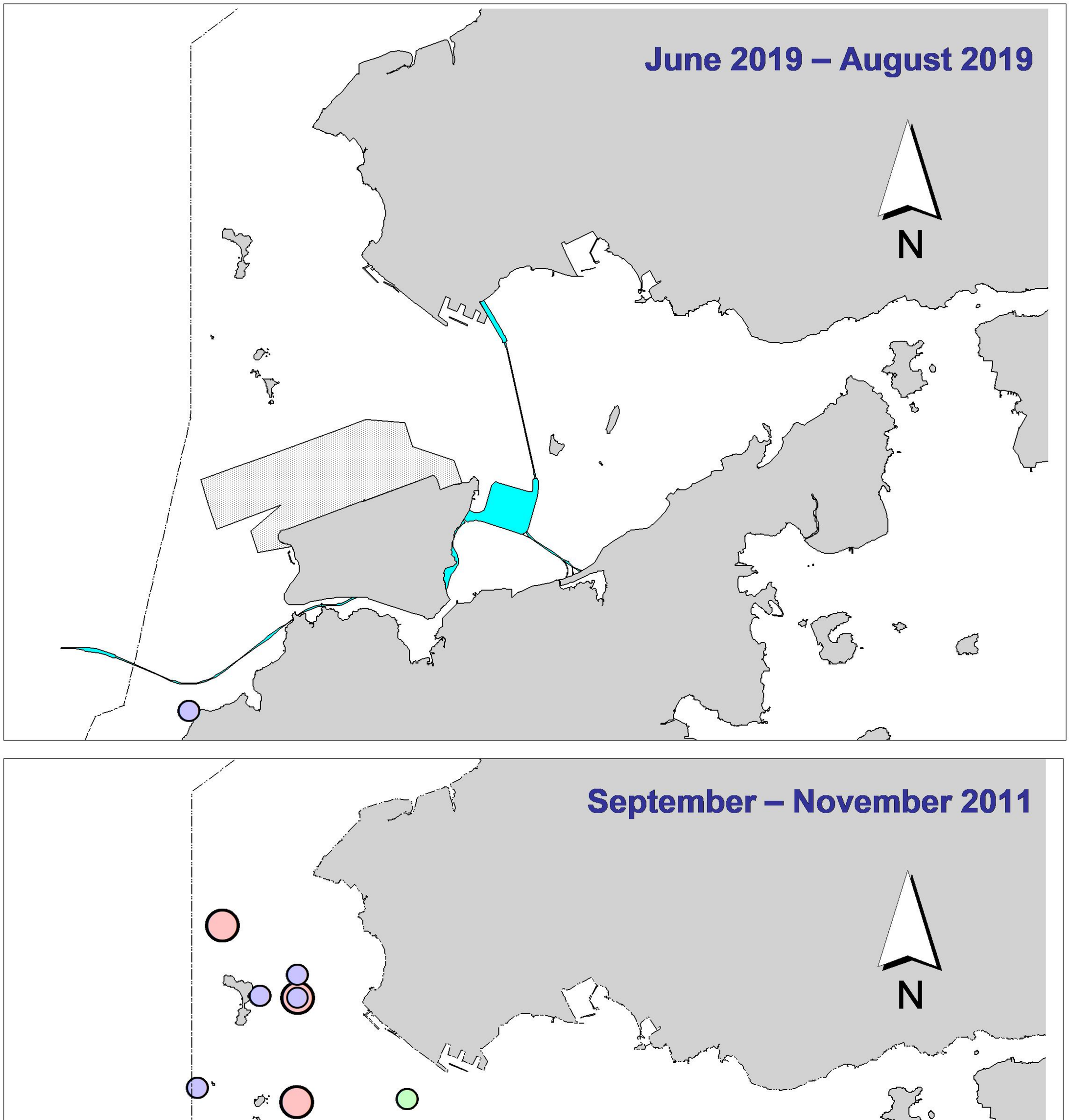

Figure 5. Distribution of Chinese white dolphins engaged in feeding (purple dots), socializing (pink dots) and traveling (green dots) activities during HKLR03 monitoring surveys (top) and baseline monitoring surveys (bottom)

Appendix I. HKLR03 Survey Effort Database (June-August 2019)

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

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	TYPE	P/S
3-Jun-19	NW LANTAU	3	25.81	SUMMER	STANDARD36826	HKLR	P
3-Jun-19	NW LANTAU	4	1.66	SUMMER	STANDARD36826	HKLR	P
3-Jun-19	NW LANTAU	3	11.38	SUMMER	STANDARD36826	HKLR	S
3-Jun-19	NW LANTAU	4	0.55	SUMMER	STANDARD36826	HKLR	S
3-Jun-19	NE LANTAU	2	24.60	SUMMER	STANDARD36826	HKLR	P
3-Jun-19	NE LANTAU	3	11.37	SUMMER	STANDARD36826	HKLR	P
3-Jun-19	NE LANTAU	2	11.83	SUMMER	STANDARD36826	HKLR	S
3-Jun-19	NE LANTAU	3	2.10	SUMMER	STANDARD36826	HKLR	S
6-Jun-19	NW LANTAU	2	8.26	SUMMER	STANDARD36826	HKLR	P
6-Jun-19	NW LANTAU	3	19.60	SUMMER	STANDARD36826	HKLR	P
6-Jun-19	NW LANTAU	4	3.70	SUMMER	STANDARD36826	HKLR	P
6-Jun-19	NW LANTAU	2	5.99	SUMMER	STANDARD36826	HKLR	S
6-Jun-19	NW LANTAU	3	4.25	SUMMER	STANDARD36826	HKLR	S
10-Jun-19	NW LANTAU	3	17.00	SUMMER	STANDARD36826	HKLR	P
10-Jun-19	NW LANTAU	4	10.53	SUMMER	STANDARD36826	HKLR	P
10-Jun-19	NW LANTAU	5	0.60	SUMMER	STANDARD36826	HKLR	P
10-Jun-19	NW LANTAU	3	7.07	SUMMER	STANDARD36826	HKLR	S
10-Jun-19	NW LANTAU	4	4.80	SUMMER	STANDARD36826	HKLR	S
10-Jun-19	NE LANTAU	2	19.40	SUMMER	STANDARD36826	HKLR	P
10-Jun-19	NE LANTAU	3	15.46	SUMMER	STANDARD36826	HKLR	P
10-Jun-19	NE LANTAU	2	8.04	SUMMER	STANDARD36826	HKLR	S
10-Jun-19	NE LANTAU	3	5.72	SUMMER	STANDARD36826	HKLR	S
13-Jun-19	NW LANTAU	2	24.25	SUMMER	STANDARD36826	HKLR	P
13-Jun-19	NW LANTAU	3	8.10	SUMMER	STANDARD36826	HKLR	P
13-Jun-19	NW LANTAU	2	10.05	SUMMER	STANDARD36826	HKLR	S
16-Jul-19	NW LANTAU	2	22.62	SUMMER	STANDARD36826	HKLR	P
16-Jul-19	NW LANTAU	3	5.34	SUMMER	STANDARD36826	HKLR	P
16-Jul-19	NW LANTAU	2	9.44	SUMMER	STANDARD36826	HKLR	S
16-Jul-19	NW LANTAU	3	0.80	SUMMER	STANDARD36826	HKLR	S
18-Jul-19	NW LANTAU	0	4.07	SUMMER	STANDARD36826	HKLR	P
18-Jul-19	NW LANTAU	1	3.86	SUMMER	STANDARD36826	HKLR	P
18-Jul-19	NW LANTAU	2	24.87	SUMMER	STANDARD36826	HKLR	P
18-Jul-19	NW LANTAU	1	2.20	SUMMER	STANDARD36826	HKLR	S
18-Jul-19	NW LANTAU	2	8.80	SUMMER	STANDARD36826	HKLR	S
18-Jul-19	NE LANTAU	2	30.03	SUMMER	STANDARD36826	HKLR	P
18-Jul-19	NE LANTAU	3	5.56	SUMMER	STANDARD36826	HKLR	P
18-Jul-19	NE LANTAU	2	11.89	SUMMER	STANDARD36826	HKLR	S
22-Jul-19	NW LANTAU	1	7.40	SUMMER	STANDARD36826	HKLR	P
22-Jul-19	NW LANTAU	2	19.85	SUMMER	STANDARD36826	HKLR	P
22-Jul-19	NW LANTAU	1	4.40	SUMMER	STANDARD36826	HKLR	S
22-Jul-19	NW LANTAU	2	7.65	SUMMER	STANDARD36826	HKLR	S
22-Jul-19	NE LANTAU	2	27.91	SUMMER	STANDARD36826	HKLR	P
22-Jul-19	NE LANTAU	3	5.70	SUMMER	STANDARD36826	HKLR	P
22-Jul-19	NE LANTAU	2	10.29	SUMMER	STANDARD36826	HKLR	S
22-Jul-19	NE LANTAU	3	2.80	SUMMER	STANDARD36826	HKLR	S
24-Jul-19	NW LANTAU	2	34.15	SUMMER	STANDARD36826	HKLR	P
24-Jul-19	NW LANTAU	3	9.95	SUMMER	STANDARD36826	HKLR	S
13-Aug-19	NE LANTAU	2	34.82	SUMMER	STANDARD36826	HKLR	P
13-Aug-19	NE LANTAU	3	2.90	SUMMER	STANDARD36826	HKLR	P
13-Aug-19	NE LANTAU	2	9.78	SUMMER	STANDARD36826	HKLR	S
13-Aug-19	NE LANTAU	3	1.90	SUMMER	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-Aug-19	NW LANTAU	2	0.84	SUMMER	STANDARD36826	HKLR	P
13-Aug-19	NW LANTAU	3	24.00	SUMMER	STANDARD36826	HKLR	P
13-Aug-19	NW LANTAU	4	7.90	SUMMER	STANDARD36826	HKLR	P
13-Aug-19	NW LANTAU	2	0.90	SUMMER	STANDARD36826	HKLR	S
13-Aug-19	NW LANTAU	3	8.66	SUMMER	STANDARD36826	HKLR	S
13-Aug-19	NW LANTAU	4	1.40	SUMMER	STANDARD36826	HKLR	S
14-Aug-19	NW LANTAU	2	27.12	SUMMER	STANDARD36826	HKLR	P
14-Aug-19	NW LANTAU	2	14.88	SUMMER	STANDARD36826	HKLR	S
20-Aug-19	NW LANTAU	2	27.37	SUMMER	STANDARD36826	HKLR	P
20-Aug-19	NW LANTAU	3	5.80	SUMMER	STANDARD36826	HKLR	P
20-Aug-19	NW LANTAU	2	11.23	SUMMER	STANDARD36826	HKLR	S
26-Aug-19	NW LANTAU	2	17.21	SUMMER	STANDARD138716	HKLR	P
26-Aug-19	NW LANTAU	3	11.36	SUMMER	STANDARD138716	HKLR	P
26-Aug-19	NW LANTAU	2	6.10	SUMMER	STANDARD138716	HKLR	S
26-Aug-19	NW LANTAU	3	4.13	SUMMER	STANDARD138716	HKLR	S
26-Aug-19	NE LANTAU	1	4.21	SUMMER	STANDARD138716	HKLR	P
26-Aug-19	NE LANTAU	2	26.68	SUMMER	STANDARD138716	HKLR	P
26-Aug-19	NE LANTAU	3	0.27	SUMMER	STANDARD138716	HKLR	P
26-Aug-19	NE LANTAU	1	1.10	SUMMER	STANDARD138716	HKLR	S
26-Aug-19	NE LANTAU	2	4.11	SUMMER	STANDARD138716	HKLR	S
26-Aug-19	NE LANTAU	3	0.97	SUMMER	STANDARD138716	HKLR	S
29-Aug-19	NE LANTAU	2	2.61	SUMMER	STANDARD36826	HKLR	P
29-Aug-19	NE LANTAU	3	2.42	SUMMER	STANDARD36826	HKLR	P
29-Aug-19	NE LANTAU	2	1.90	SUMMER	STANDARD36826	HKLR	S
29-Aug-19	NE LANTAU	3	0.96	SUMMER	STANDARD36826	HKLR	S

Appendix II. HKLR03 Chinese White Dolphin Sighting Database (June-August 2019)

(Abberviations: 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 Lines)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
3-Jun-19	1	1138	4	NW LANTAU	3	121	ON	HKLR	827734	807488	SUMMER	NONE	P
6-Jun-19	1	1312	1	NW LANTAU	3	77	ON	HKLR	814894	804681	SUMMER	NONE	P
16-Jul-19	1	1152	2	NW LANTAU	2	197	ON	HKLR	829052	807326	SUMMER	NONE	S
24-Jul-19	1	1330	1	NW LANTAU	2	ND	OFF	HKLR	814451	804453	SUMMER	NONE	

Appendix III. Individual dolphins identified during HKLR03 monitoring surveys in June-August 2019

ID#	DATE	STG#	AREA
NL123	03/06/19	1	NW LANTAU
NL136	03/06/19	1	NW LANTAU
NL202	03/06/19	1	NW LANTAU
NL286	03/06/19	1	NW LANTAU
NL293	06/06/19	1	NW LANTAU
WL218	24/07/19	1	NW LANTAU

Appendix IV. Six individual dolphins that were identified between June and August 2019 under HKLR03 monitoring surveys

Appendix IV. (cont’d)

Appendix V. Ranging patterns (95% kernel ranges) of six individual dolphins that were sighted during HKLR03 monitoring period (note: yellow dots indicate sightings made in June-August 2019 during HKLR03 monitoring surveys)