CONTRACT NO. HY/2013/04
Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities – Infrastructure Works Stage II (Southern Portion) Dolphin Monitoring (Operational Phase)

Third Quarterly Progress Report (September-November 2019)

Submitted to Mott MacDonald Hong Kong Limited &
China State Construction Engineering (Hong Kong) Limited

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1. Introduction

1.1. For the Hong Kong-Zhuhai-Macao Bridge (HZMB) Hong Kong Boundary Crossing Facilities (HKBCF), its operation requires the contractor (i.e. China State Construction Engineering (Hong Kong) Limited) and the associated Environmental Team, Mott MacDonald Hong Kong Limited, to implement the Environmental Monitoring and Audit (EM&A) programme during the operational phase.

1.2. According to the HKBCF EM&A Manual, monthly line-transect vessel surveys for Chinese White Dolphins should be conducted to cover the Northwest (NWL) and Northeast Lantau (NEL) survey areas, which should be the same as in AFCD annual marine mammal monitoring programme. However, as such monitoring surveys have been undertaken by the HKLR03/TMCLKL08 EM&A programmes in the same areas (i.e. NWL and NEL) during the construction phase of these projects, a combined monitoring approach is recommended by the Highways Department, that the HKBCF EM&A project should utilize the monitoring data collected by HKLR03/TMCLKL08 EM&A project to avoid any redundancy in monitoring effort.

1.3. In April 2019, the Director of Hong Kong Cetacean Research Project (HKCRP), Dr. Samuel Hung, has been appointed by the ET as the dolphin specialist for the operational phase of the HKBCF EM&A project. He is responsible for the dolphin monitoring study,

including the collection and collation of dolphin monitoring data from the HKLR03/ TMCLKL08 EM&A projects to examine any potential impacts during the operational phase of HKBCF project on the dolphins. From the monitoring results, any changes in dolphin occurrence within the study area will be reviewed for possible causes, and appropriate actions and additional mitigation measures will be recommended as necessary.

1.4. The present quarterly progress report of this HKBCF operational phase dolphin monitoring programme is submitted to the environmental team and the contractor, summarizing the result of the survey findings during the quarterly period of September to November 2019 utilizing the monitoring data collected through the HKLR03 Contract (for September 2019) and TMCLKL08 Contract (for October and November 2019). Moreover, the historical monitoring data from previous years obtained under the HKLR03 Contract are also referenced and compared. All these previous monitoring data was collected by the same HKCRP survey team, to ensure 100% consistency in monitoring methodology including vessel survey method as well as various analyses.

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 operational 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	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/TMCLKL08 survey teams 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 (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 continuously through 7 x 50 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}). At least one 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 (e.g. *Garmin eTrex Legend*). Data including time, position and vessel speed were also automatically and continuously logged by handheld GPS throughout the entire survey for subsequent review.

2.1.5. 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.

2.1.6. 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 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 (e.g. *Canon* EOS 7D model), 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. 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).

2.2.4. 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.

2.3.3. 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).

2.3.4. 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.

2.3.5. 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 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.

2.3.6. 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).

2.3.7. 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:

$$SPSE = ((S / E) \times 100) / SA\%$$

$$DPSE = ((D / E) \times 100) / SA\%$$

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

2.3.8. 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.

2.3.9. Ranging pattern analysis – Location data of individual dolphins that occurred during the quarterly 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. A total of six sets of systematic line-transect vessel surveys were conducted under the HKLR03/TMCLKL08 dolphin monitoring programmes during the period of September to November 2019, to cover all transect lines in NWL and NEL survey areas twice per month. From these surveys, 796.8 km of total survey effort was collected, and 97.9% of such effort was conducted under favourable weather conditions (i.e. Beaufort Sea State 3 or below with good visibility). Among the NEL and NWL survey areas, 293.7 km and 503.1 km of survey effort were collected respectively.

3.1.2. Moreover, 572.4 km of survey effort was conducted on primary lines, while another 224.4 km of survey effort was conducted on secondary lines. As mentioned in the methodology section, survey effort conducted on primary and secondary lines were all considered to be on-effort survey data. A summary table of the survey effort for the three-month monitoring period is shown in Appendix I.

3.1.3. From September to November 2019, only four groups of seven Chinese White Dolphins were sighted during the HKLR03/TMCLKL08 monitoring surveys, and the summary table of dolphin sightings is shown in Appendix II. All four groups were sighted during on-effort search, and three of these on-effort sightings were made on primary lines. All

dolphin groups were only sighted in NWL, with none being sighted in NEL at all during the three-month monitoring period.

3.2. Distribution

3.2.1. Distribution of the four dolphin groups being sighted during the HKLR03/TMCLKL08 monitoring surveys conducted between September and November 2019 is shown in Figure 1. Two of the four dolphin groups were sighted just to the north of Lung Kwu Chau, while the other two were sighted near Black Point and to the west of Sha Chau respectively (Figure 1). On the contrary, the dolphins were completely absent from the central and eastern portions of North Lantau waters.

3.2.2. Notably, all four groups were sighted very far away from the HKBCF and HKLR03 reclamation sites, as well as the TMCLKL and HKLR09 bridge alignments (Figure 1).

3.2.3. A comparison of dolphin distribution between the present quarterly period and the baseline monitoring period (September-November 2011) revealed considerable differences. For example, dolphin was not found in NEL during the present quarter but in the baseline survey they were frequently found in the same area, including the waters near Shum Shui Kok and in the vicinity of the HKBCF reclamation site (Figure 1).

3.2.4. Furthermore, dolphins were rarely sighted in NWL waters, and their distribution was restricted to the western portion of the North Lantau region during the present three-month period. This was in stark contrast with their frequent occurrences throughout the entire NWL survey area during the baseline period (Figure 1).

3.3. Encounter rate

3.3.1. The encounter rates of Chinese White Dolphins were 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 during the present three-month monitoring period, and 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).

Table 2. Dolphin encounter rates (sightings per 100 km of survey effort) during September-November 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 (4 & 11 Sep 2019)	0.00	0.00
	Set 2 (17 & 23 Sep 2019)	0.00	0.00
	Set 3 (8 & 9 Oct 2019)	0.00	0.00
	Set 4 (14 & 29 Oct 2019)	0.00	0.00
	Set 5 (5 & 19 Nov 2019)	0.00	0.00
	Set 6 (27 & 28 Nov 2019)	0.00	0.00
Northwest Lantau	Set 1 (4 & 11 Sep 2019)	1.64	3.28
	Set 2 (17 & 23 Sep 2019)	0.00	0.00
	Set 3 (8 & 9 Oct 2019)	1.68	1.68
	Set 4 (14 & 29 Oct 2019)	0.00	0.00
	Set 5 (5 & 19 Nov 2019)	1.67	1.67
	Set 6 (27 & 28 Nov 2019)	0.00	0.00

Table 3. Comparison of average dolphin encounter rates from present monitoring period (September-November 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)	
	September – November 2019	September – November 2011	September – November 2019	September – November 2011
Northeast Lantau	0.0	6.00 ± 5.05	0.0	22.19 ± 26.81
Northwest Lantau	0.83 ± 0.91	9.85 ± 5.85	1.10 ± 1.34	44.66 ± 29.85

3.3.2. To facilitate another comparison with the AFCD long-term monitoring data, the encounter rates were also calculated for the present quarter using both primary and secondary survey effort. Such encounter rates of sightings (STG) and dolphins (ANI) in NEL were both nil, while the ones the in NWL were 0.8 sightings and 1.4 dolphins per 100 km of survey

effort respectively for this quarter.

3.3.3. For the present three-month monitoring period, the average dolphin encounter rates (both STG and ANI) in NEL were both zero with no on-effort sighting being made. Such extremely low occurrence of dolphins in NEL has also been consistently recorded during the same autumn quarters throughout the HZMB monitoring period (Table 4).

Table 4. Comparison of average dolphin encounter rates in Northeast Lantau survey area from the same autumn quarters of HZMB monitoring periods 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)	**6.0 ± 5.05**	**22.2 ± 26.81**
September-November 2013 (HKLR03 Impact*)	1.0 ± 1.59	3.8 ± 6.49
September-November 2014 (HKLR03 Impact*)	0.0	0.0
September-November 2015 (HKLR03 Impact*)	0.0	0.0
September-November 2016 (HKLR03 Impact*)	0.0	0.0
September-November 2017 (HKLR03 Impact*)	0.0	0.0
September-November 2018 (HKLR03 Impact*)	0.0	0.0
September-November 2019 (HKBCF Operational)	0.0	0.0

* As explained in Section 1.4, the previous monitoring data from Contract No. HY/2011/03 (i.e. HKLR03) were adopted for comparison with the baseline and present monitoring period

3.3.4. On the other hand, the average dolphin encounter rates (STG and ANI) in NWL during the present monitoring period were only tiny fractions of the ones recorded during the three-month baseline period (with reductions of 91.6% and 97.5% 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).

Table 5. Comparison of average dolphin encounter rates in Northwest Lantau survey area from the same autumn quarters of HZMB monitoring periods 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)	**9.9 ± 5.85**	**44.7 ± 29.85**
September-November 2013 (HKLR03 Impact*)	8.0 ± 1.10	32.5 ± 26.51
September-November 2014 (HKLR03 Impact*)	5.1 ± 4.40	20.5 ± 15.10
September-November 2015 (HKLR03 Impact*)	3.9 ± 1.57	21.1 ± 17.19
September-November 2016 (HKLR03 Impact*)	2.9 ± 1.98	10.9 ± 10.98
September-November 2017 (HKLR03 Impact*)	3.1 ± 1.91	10.4 ± 9.66
September-November 2018 (HKLR03 Impact*)	1.5 ± 2.25	2.7 ± 3.78
September-November 2019 (HKBCF Operational)	0.8 ± 0.91	1.1 ± 1.34

* As explained in Section 1.4, the previous monitoring data from Contract No. HY/2011/03 (i.e. HKLR03) were adopted for comparison with the baseline and present monitoring period

3.3.5. Both dolphin encounter rates in NWL in the autumn of 2019 continued to plummet to the lowest level among all autumn quarterly periods since 2013 (Table 5). This is a very worrying trend as the dolphin occurrence is expected to recover somewhat after the completion of HKBCF reclamation works a few years ago as well as the remaining marine construction activities for the HKBCF being completed recently, but apparently that has not been the case.

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 post-construction monitoring periods. The two variables that were examined included the two periods (baseline and post-construction phases) and two locations (NEL and NWL).

3.3.7. For the comparison between the baseline period and the present quarter, the p-values for the differences in average dolphin encounter rates of STG and ANI were 0.0018 and 0.0124 respectively. If the alpha value is set at 0.05, significant differences were detected between the baseline and present quarter in both the average dolphin encounter rates of STG and ANI.

3.3.8. Both distribution patterns and encounter rates of Chinese White Dolphins indicated that their usage have been dramatically reduced in both NEL and NWL survey areas during the present quarterly period, and such low occurrence of dolphins has been consistently documented in recent years of HZMB dolphin monitoring. Apparently, there has been no sign of recovery in dolphin usage in the post-construction phase, even with most of the marine works associated with the HZMB construction being completed. Continuous dolphin monitoring would be critical to examine whether the downward trend would continue, stabilize or revert in upcoming quarters during the operational phase.

3.4. Group size

3.4.1. From September to November 2019, the group sizes of Chinese White Dolphins ranged from one to three individuals per group in North Lantau region. The average dolphin group sizes from the present three-month monitoring period 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 the present monitoring period (September-November 2019) and baseline monitoring period (September-November 2011) (Note: ± denotes the standard deviation of average group size)

	Average Dolphin Group Size	
	September – November 2019	**September – November 2011**
Overall	1.8 ± 0.96 (n = 4)	3.7 ± 3.13 (n = 66)
Northeast Lantau	---	3.2 ± 2.16 (n = 17)
Northwest Lantau	1.8 ± 0.96 (n = 4)	3.9 ± 3.40 (n = 49)

3.4.2. During the present quarter, the average dolphin group size in NWL was much lower than the one recorded during the baseline period. However, it should also be noted that the sample size in the present quarter (five groups) was a very small fraction of the sample size of the 66 groups sighted during the baseline period (Table 6).

3.4.3. All four dolphin groups sighted during the quarterly period were small with 1-3 individuals per group only (Appendix II). This is in stark contrary to the baseline period when the larger groups (at least with five animals) were frequently sighted and evenly distributed in NWL, with a few also sighted in NEL waters.

3.5. Habitat use

3.5.1. During the present quarter, the quantitative grid analysis revealed that only three grids recorded dolphin occurrences, and all three gird recorded moderately low to moderate dolphin densities (Figures 3a and 3b). 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 post-construction monitoring programme.

3.5.2. 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 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, but the dolphins have completely disappeared from this area during the present quarterly period (Figure 4).

3.5.3. Moreover, the dolphin density patterns were also very different in NWL between the baseline and present post-construction monitoring periods, with high usage throughout the area during the baseline period, while only three grids with only moderately low to moderate dolphin densities were recorded 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. During the present quarterly period, only one of the four dolphin groups was engaged in feeding activity, while none of them was engaged in socializing, traveling, milling/resting activities. The lone group engaged in feeding activity was located near Black Point (Figure 5).

3.7.2. Moreover, none of the four dolphin groups sighted during the present quarter was associated with any operating fishing vessels.

3.8. Summary of photo-identification works

3.8.1. Approximately 250 digital photographs of Chinese White Dolphins were taken from September to November 2019 for the photo-identification work during the HKLR03/ TMCLKL08 surveys. A total of four individuals were identified and re-sighted four times altogether (see summary table in Appendix III and photographs of identified individuals in Appendix IV). Re-sightings of individual dolphins were only made in NWL, while none was re-sighted in NEL during the quarterly period.

3.8.2. During the three-month monitoring period, all four individuals were re-sighted only once (Appendix III). None of them was sighted in WL waters during the HKLR09 monitoring surveys that were conducted concurrently during the same three-month period from September to November 2019.

3.9. Individual range use

3.9.1. Ranging patterns of the four individuals identified during the quarterly monitoring period were determined by fixed kernel method, and are shown in Appendix V.

3.9.2. While all four individuals were sighted only in NWL waters in the present quarter, none of them occurred in NEL waters (Appendix V), which was in stark contrast to the extensive movements of many individual dolphins between NEL and NWL survey areas during the baseline period as well as in the earlier HKLR03 monitoring quarters.

3.9.3. Moreover, none of the four individuals extended its range use to WL waters during this quarterly period, even though such movements between North and West Lantau waters have been common in the past several years of HZMB dolphin monitoring surveys.

3.9.4. Individual range use and movements should be continuously examined in the upcoming quarters during the post-construction monitoring, to determine whether there has been any consistent shift of individual home ranges from North Lantau to West or Southwest Lantau, or vice versa.

4. Conclusion

4.1. Although dolphins seldom occurred in the area of HKBCF construction in the past and during the baseline monitoring period, it is apparent that dolphin usage has been dramatically reduced in North Lantau waters in recent years, with many individual dolphins shifting away from this once-important habitat for the dolphins. There have been no sign of any recovery in dolphin usage during the present quarter of post-construction dolphin monitoring.

4.2. Nevertheless, it is critical to continuously monitor the dolphin usage in North Lantau region in the upcoming quarters, to determine whether there is any sign of recovery after the HZMB construction works have been completed.

5. References

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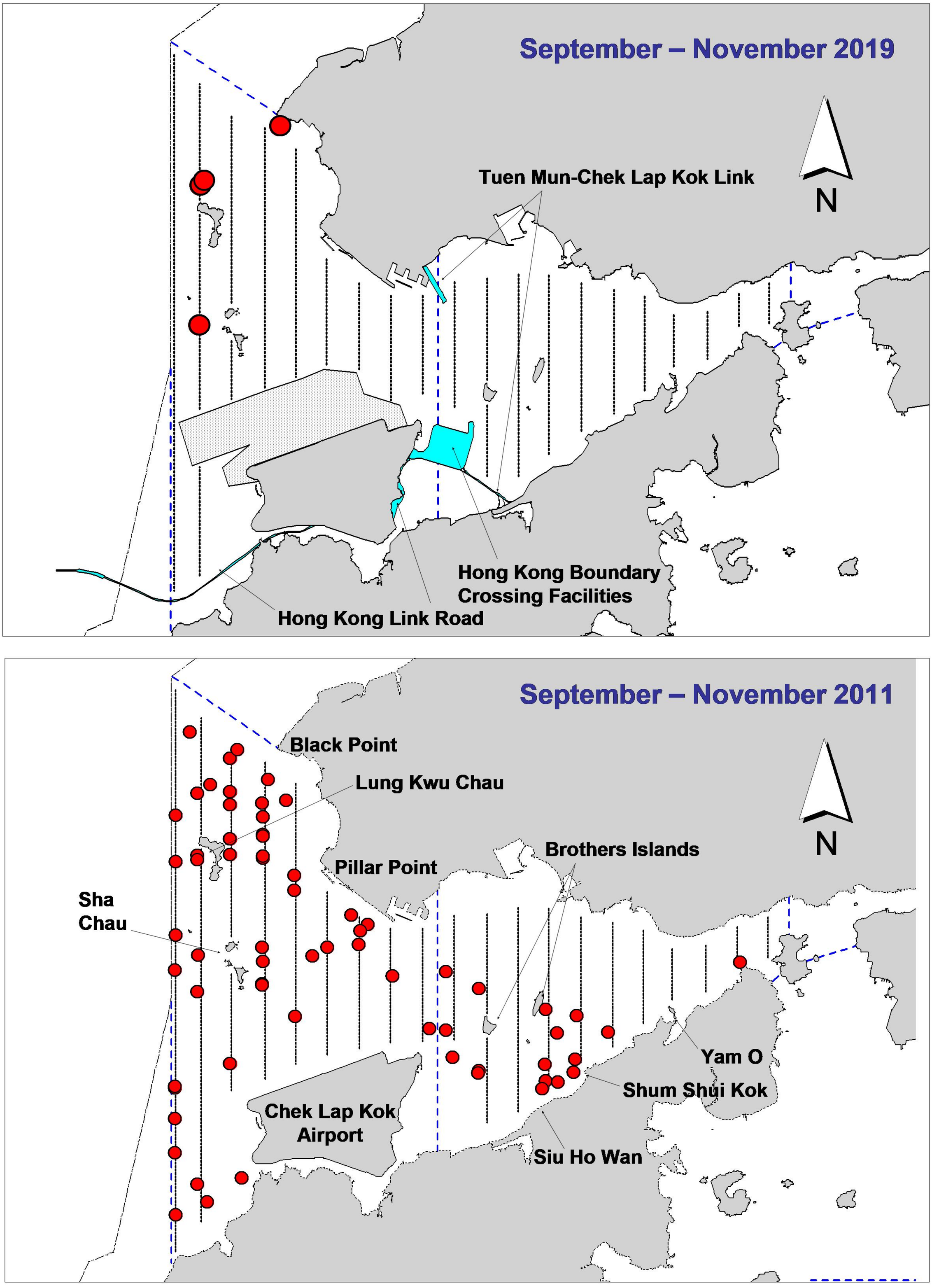


Figure 1. Distribution of Chinese white dolphin sighting in Northwest and Northeast Lantau during TMCLKL08/HKLR03 impact phase (top) and baseline monitoring surveys (bottom)

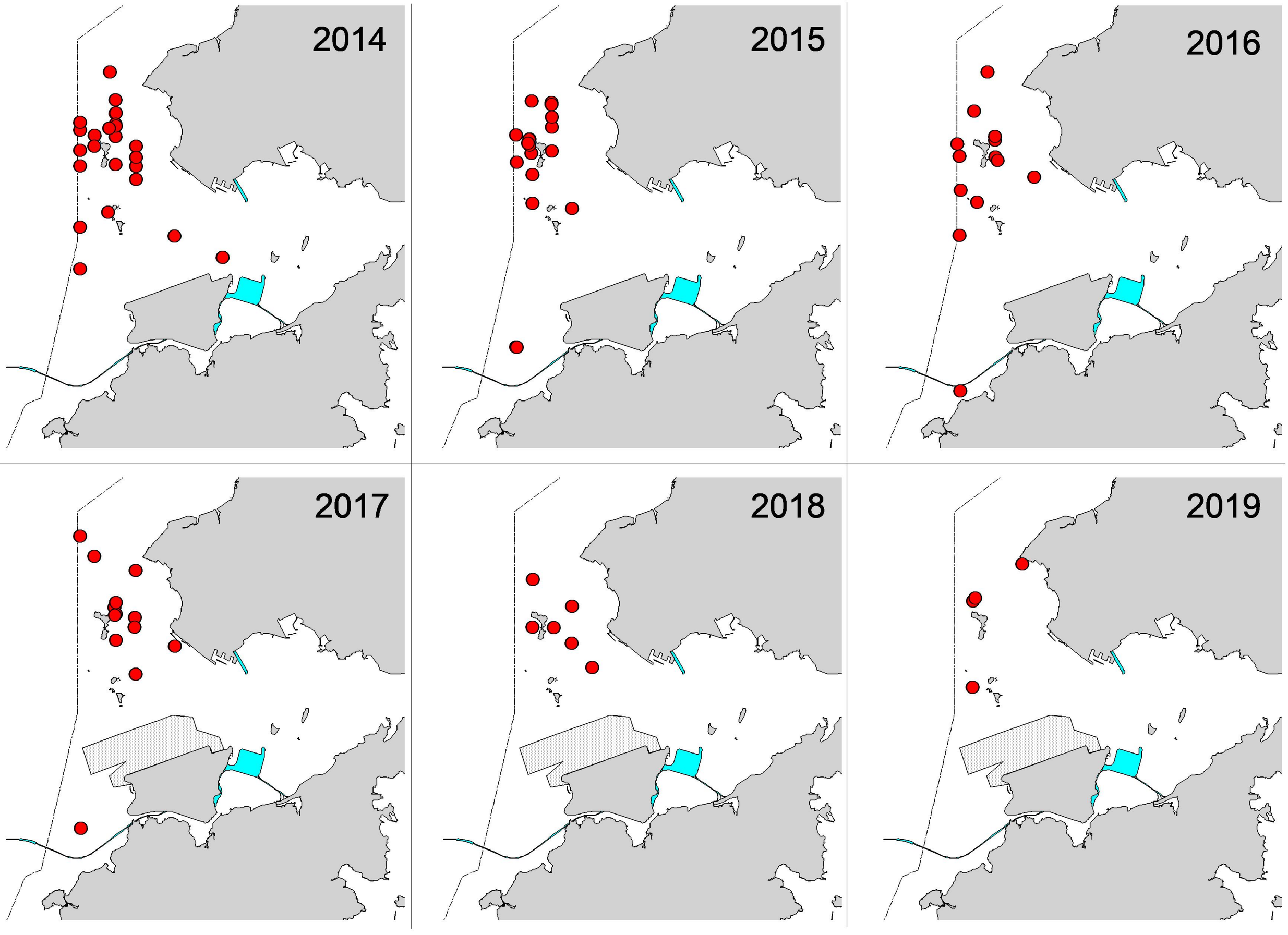


Figure 2. Distribution of Chinese white dolphin sightings in Northwest and Northeast Lantau during the past six autumn quarters (September-November) of TMCLKL08/HKLR03 impact phase in 2014-19

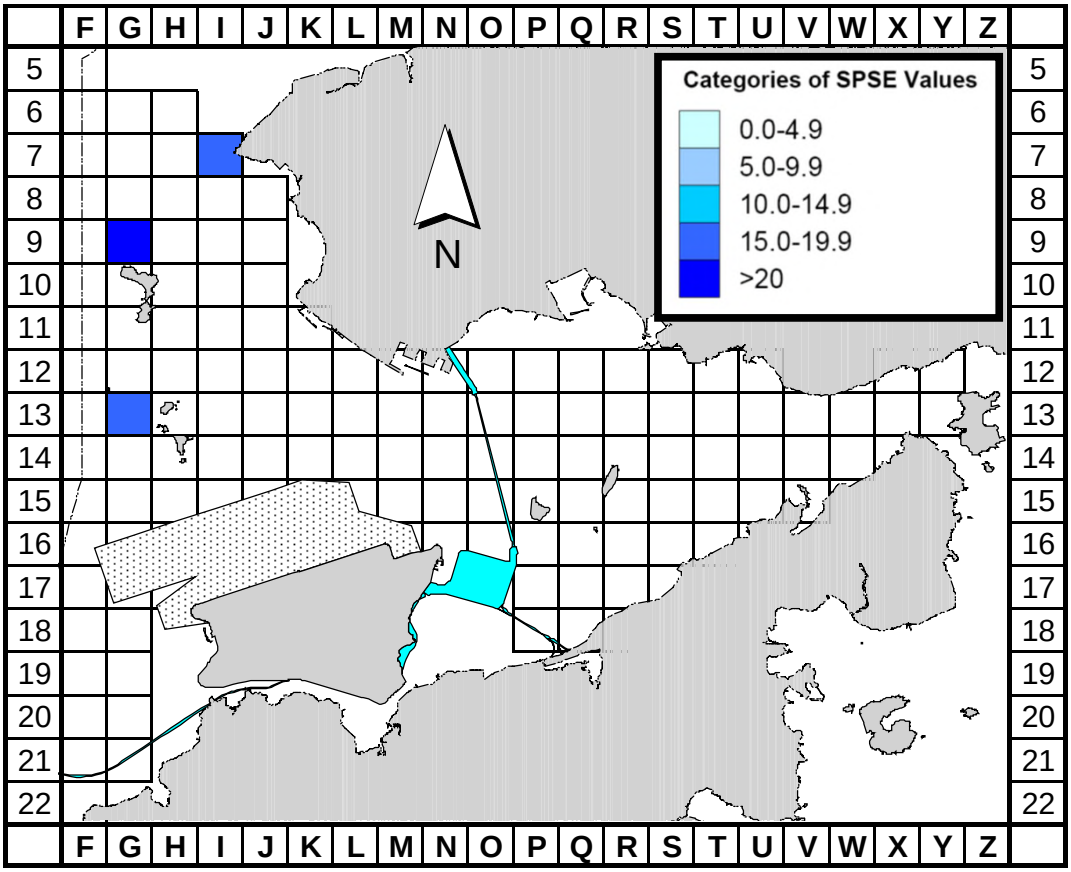


Figure 3a. Sighting density of Chinese white dolphins with corrected survey effort per km^2 in Northeast and Northwest Lantau survey areas, using data collected during TMCLKL08/HKLR03 impact monitoring period (September-November 2019) (SPSE = no. of on-effort sightings per 100 units of survey effort)

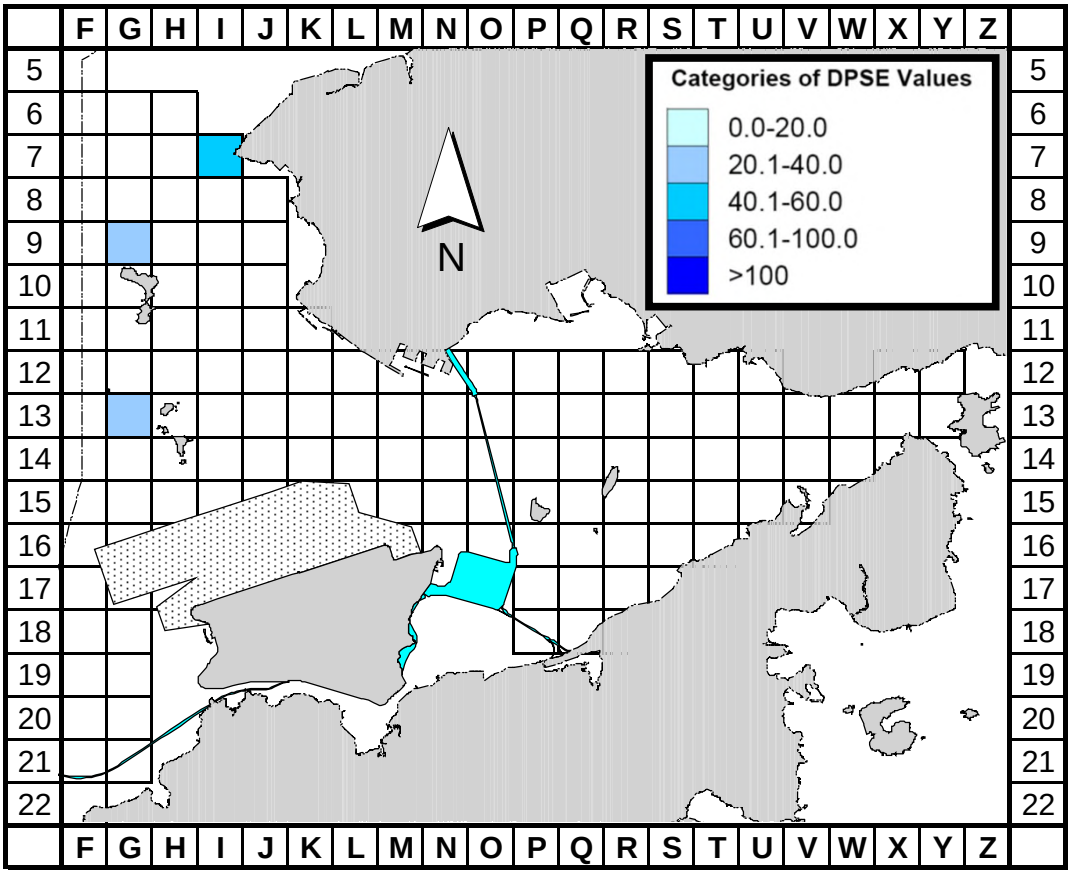


Figure 3b. Density of Chinese white dolphins with corrected survey effort per km^2 in Northeast and Northwest Lantau survey areas, using data collected during TMCLKL08/HKLR03 impact monitoring period (September-November 2019) (DPSE = no. of dolphins per 100 units of survey effort)

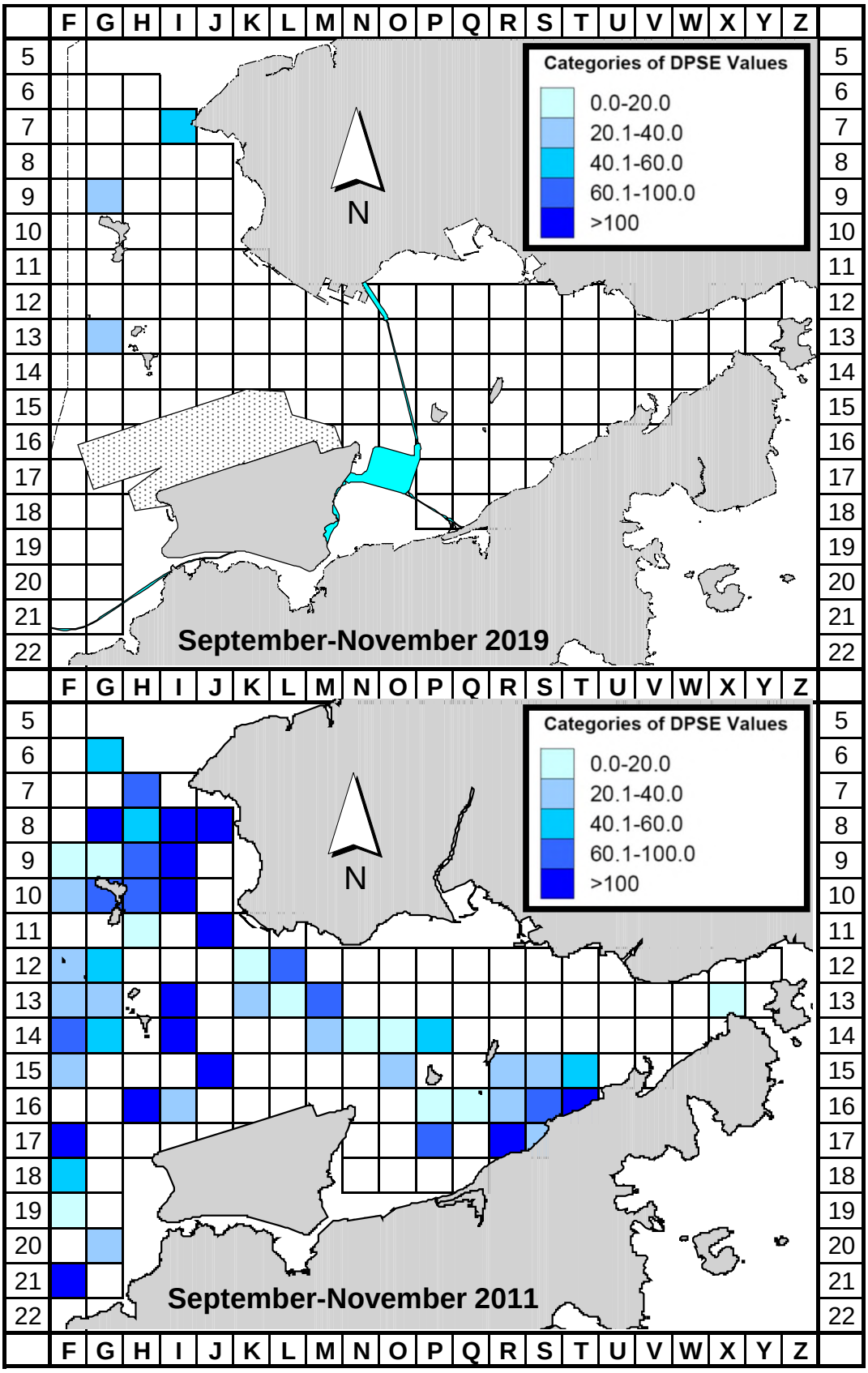


Figure 4. Comparison of density of Chinese white dolphins with corrected survey effort per km^2 in Northwest and Northeast Lantau survey area between the impact monitoring period (September - November 2019) and baseline monitoring period (September-November 2011)
(DPSE = no. of dolphins per 100 units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

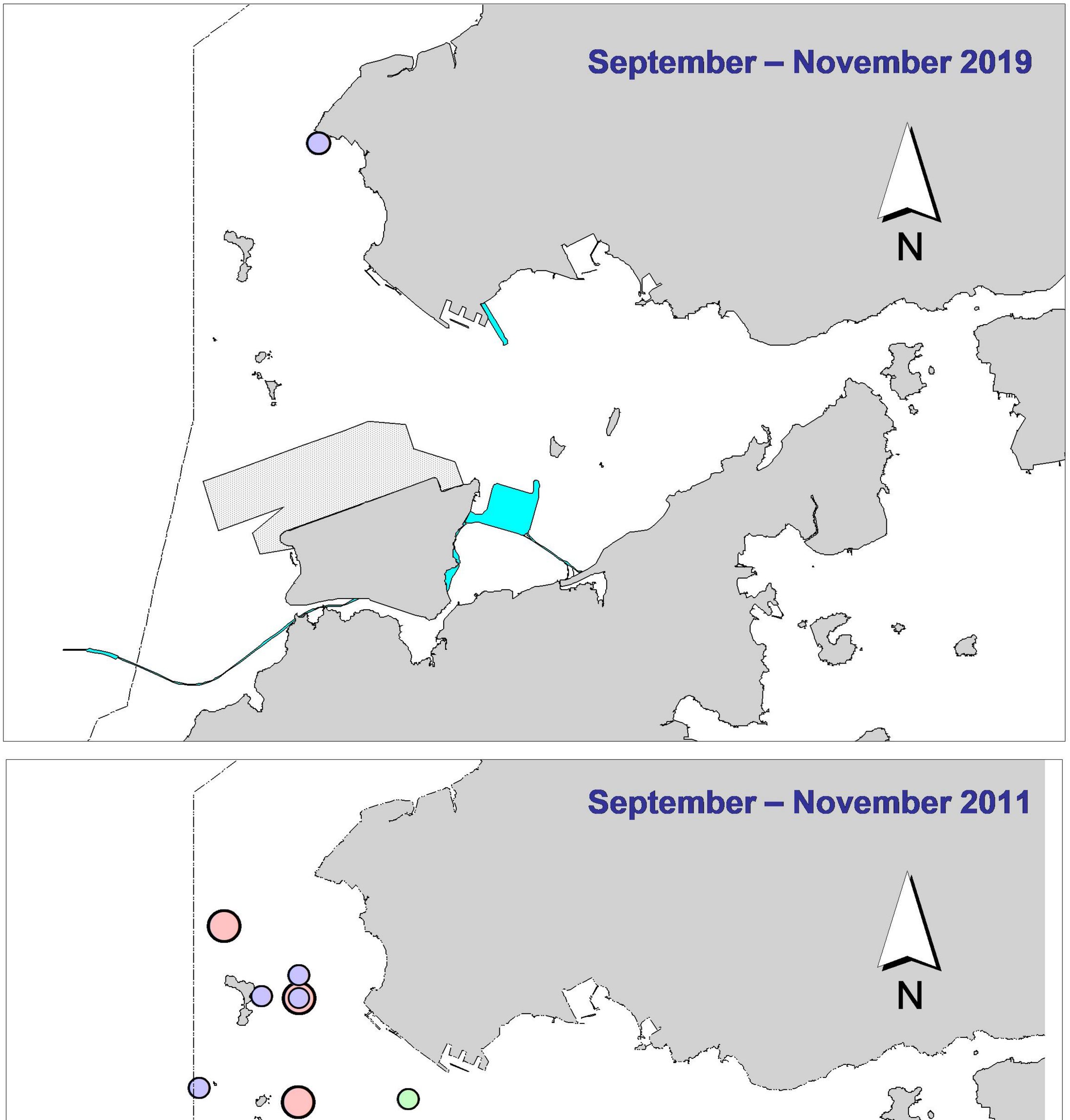


Figure 5. Distribution of Chinese white dolphins engaged in feedings (purple dots), socializing (pink dots) and traveling (green dots) activities during TMCLKL08/HKLR03 impact phase (top) and baseline monitoring surveys (bottom)

Appendix I. TMCLKL08/HKLR03 Survey Effort Database (Sep-Nov 2019)

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

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	TYPE	P/S
4-Sep-19	NW LANTAU	2	21.38	AUTUMN	STANDARD36826	HKLR	P
4-Sep-19	NW LANTAU	3	6.40	AUTUMN	STANDARD36826	HKLR	P
4-Sep-19	NW LANTAU	2	9.12	AUTUMN	STANDARD36826	HKLR	S
4-Sep-19	NW LANTAU	3	2.52	AUTUMN	STANDARD36826	HKLR	S
4-Sep-19	NE LANTAU	2	16.70	AUTUMN	STANDARD36826	HKLR	P
4-Sep-19	NE LANTAU	3	18.83	AUTUMN	STANDARD36826	HKLR	P
4-Sep-19	NE LANTAU	2	7.75	AUTUMN	STANDARD36826	HKLR	S
4-Sep-19	NE LANTAU	3	5.12	AUTUMN	STANDARD36826	HKLR	S
11-Sep-19	NW LANTAU	1	1.60	AUTUMN	STANDARD36826	HKLR	P
11-Sep-19	NW LANTAU	2	29.50	AUTUMN	STANDARD36826	HKLR	P
11-Sep-19	NW LANTAU	3	2.10	AUTUMN	STANDARD36826	HKLR	P
11-Sep-19	NW LANTAU	1	1.40	AUTUMN	STANDARD36826	HKLR	S
11-Sep-19	NW LANTAU	2	8.99	AUTUMN	STANDARD36826	HKLR	S
17-Sep-19	NW LANTAU	2	8.96	AUTUMN	STANDARD36826	HKLR	P
17-Sep-19	NW LANTAU	3	22.90	AUTUMN	STANDARD36826	HKLR	P
17-Sep-19	NW LANTAU	4	1.90	AUTUMN	STANDARD36826	HKLR	P
17-Sep-19	NW LANTAU	2	4.54	AUTUMN	STANDARD36826	HKLR	S
17-Sep-19	NW LANTAU	3	4.90	AUTUMN	STANDARD36826	HKLR	S
17-Sep-19	NW LANTAU	4	1.20	AUTUMN	STANDARD36826	HKLR	S
23-Sep-19	NW LANTAU	2	19.22	AUTUMN	STANDARD36826	HKLR	P
23-Sep-19	NW LANTAU	3	7.79	AUTUMN	STANDARD36826	HKLR	P
23-Sep-19	NW LANTAU	2	9.84	AUTUMN	STANDARD36826	HKLR	S
23-Sep-19	NW LANTAU	3	4.25	AUTUMN	STANDARD36826	HKLR	S
23-Sep-19	NE LANTAU	1	11.30	AUTUMN	STANDARD36826	HKLR	P
23-Sep-19	NE LANTAU	2	25.35	AUTUMN	STANDARD36826	HKLR	P
23-Sep-19	NE LANTAU	1	3.61	AUTUMN	STANDARD36826	HKLR	S
23-Sep-19	NE LANTAU	2	10.74	AUTUMN	STANDARD36826	HKLR	S
8-Oct-19	NW LANTAU	1	3.70	AUTUMN	STANDARD36826	TMCLKL	P
8-Oct-19	NW LANTAU	2	23.60	AUTUMN	STANDARD36826	TMCLKL	P
8-Oct-19	NW LANTAU	3	5.20	AUTUMN	STANDARD36826	TMCLKL	P
8-Oct-19	NW LANTAU	2	8.30	AUTUMN	STANDARD36826	TMCLKL	S
8-Oct-19	NW LANTAU	3	2.80	AUTUMN	STANDARD36826	TMCLKL	S
8-Oct-19	NE LANTAU	2	11.50	AUTUMN	STANDARD36826	TMCLKL	P
8-Oct-19	NE LANTAU	3	21.93	AUTUMN	STANDARD36826	TMCLKL	P
8-Oct-19	NE LANTAU	2	5.40	AUTUMN	STANDARD36826	TMCLKL	S
8-Oct-19	NE LANTAU	3	8.87	AUTUMN	STANDARD36826	TMCLKL	S
9-Oct-19	NW LANTAU	2	7.77	AUTUMN	STANDARD36826	TMCLKL	P
9-Oct-19	NW LANTAU	3	19.26	AUTUMN	STANDARD36826	TMCLKL	P
9-Oct-19	NW LANTAU	2	4.33	AUTUMN	STANDARD36826	TMCLKL	S
9-Oct-19	NW LANTAU	3	8.44	AUTUMN	STANDARD36826	TMCLKL	S
14-Oct-19	NW LANTAU	1	3.10	AUTUMN	STANDARD36826	TMCLKL	P
14-Oct-19	NW LANTAU	2	24.38	AUTUMN	STANDARD36826	TMCLKL	P
14-Oct-19	NW LANTAU	1	1.60	AUTUMN	STANDARD36826	TMCLKL	S
14-Oct-19	NW LANTAU	2	11.62	AUTUMN	STANDARD36826	TMCLKL	S
29-Oct-19	NW LANTAU	2	7.60	AUTUMN	STANDARD36826	TMCLKL	P
29-Oct-19	NW LANTAU	3	14.90	AUTUMN	STANDARD36826	TMCLKL	P
29-Oct-19	NW LANTAU	4	10.10	AUTUMN	STANDARD36826	TMCLKL	P
29-Oct-19	NW LANTAU	2	5.10	AUTUMN	STANDARD36826	TMCLKL	S
29-Oct-19	NW LANTAU	3	6.10	AUTUMN	STANDARD36826	TMCLKL	S
29-Oct-19	NE LANTAU	2	31.08	AUTUMN	STANDARD36826	TMCLKL	P
29-Oct-19	NE LANTAU	3	4.40	AUTUMN	STANDARD36826	TMCLKL	P

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
29-Oct-19	NE LANTAU	2	12.30	AUTUMN	STANDARD36826	TMCLKL	S
5-Nov-19	NW LANTAU	2	13.97	AUTUMN	STANDARD36826	TMCLKL	P
5-Nov-19	NW LANTAU	3	13.02	AUTUMN	STANDARD36826	TMCLKL	P
5-Nov-19	NW LANTAU	2	4.90	AUTUMN	STANDARD36826	TMCLKL	S
5-Nov-19	NW LANTAU	3	8.21	AUTUMN	STANDARD36826	TMCLKL	S
5-Nov-19	NE LANTAU	1	4.62	AUTUMN	STANDARD36826	TMCLKL	P
5-Nov-19	NE LANTAU	2	32.15	AUTUMN	STANDARD36826	TMCLKL	P
5-Nov-19	NE LANTAU	1	3.48	AUTUMN	STANDARD36826	TMCLKL	S
5-Nov-19	NE LANTAU	2	10.95	AUTUMN	STANDARD36826	TMCLKL	S
19-Nov-19	NW LANTAU	2	12.62	AUTUMN	STANDARD36826	TMCLKL	P
19-Nov-19	NW LANTAU	3	20.43	AUTUMN	STANDARD36826	TMCLKL	P
19-Nov-19	NW LANTAU	2	5.63	AUTUMN	STANDARD36826	TMCLKL	S
19-Nov-19	NW LANTAU	3	5.22	AUTUMN	STANDARD36826	TMCLKL	S
27-Nov-19	NW LANTAU	2	30.30	AUTUMN	STANDARD36826	TMCLKL	P
27-Nov-19	NW LANTAU	3	1.10	AUTUMN	STANDARD36826	TMCLKL	P
27-Nov-19	NW LANTAU	2	9.30	AUTUMN	STANDARD36826	TMCLKL	S
27-Nov-19	NW LANTAU	3	2.60	AUTUMN	STANDARD36826	TMCLKL	S
28-Nov-19	NW LANTAU	2	10.90	AUTUMN	STANDARD36826	TMCLKL	P
28-Nov-19	NW LANTAU	3	13.76	AUTUMN	STANDARD36826	TMCLKL	P
28-Nov-19	NW LANTAU	4	1.96	AUTUMN	STANDARD36826	TMCLKL	P
28-Nov-19	NW LANTAU	2	2.80	AUTUMN	STANDARD36826	TMCLKL	S
28-Nov-19	NW LANTAU	3	8.74	AUTUMN	STANDARD36826	TMCLKL	S
28-Nov-19	NW LANTAU	4	1.24	AUTUMN	STANDARD36826	TMCLKL	S
28-Nov-19	NE LANTAU	2	26.61	AUTUMN	STANDARD36826	TMCLKL	P
28-Nov-19	NE LANTAU	3	8.50	AUTUMN	STANDARD36826	TMCLKL	P
28-Nov-19	NE LANTAU	2	11.39	AUTUMN	STANDARD36826	TMCLKL	S
28-Nov-19	NE LANTAU	3	1.10	AUTUMN	STANDARD36826	TMCLKL	S

Appendix II. TMCLKL08/HKLR03 Chinese White Dolphin Sighting Database (September-November 2019)

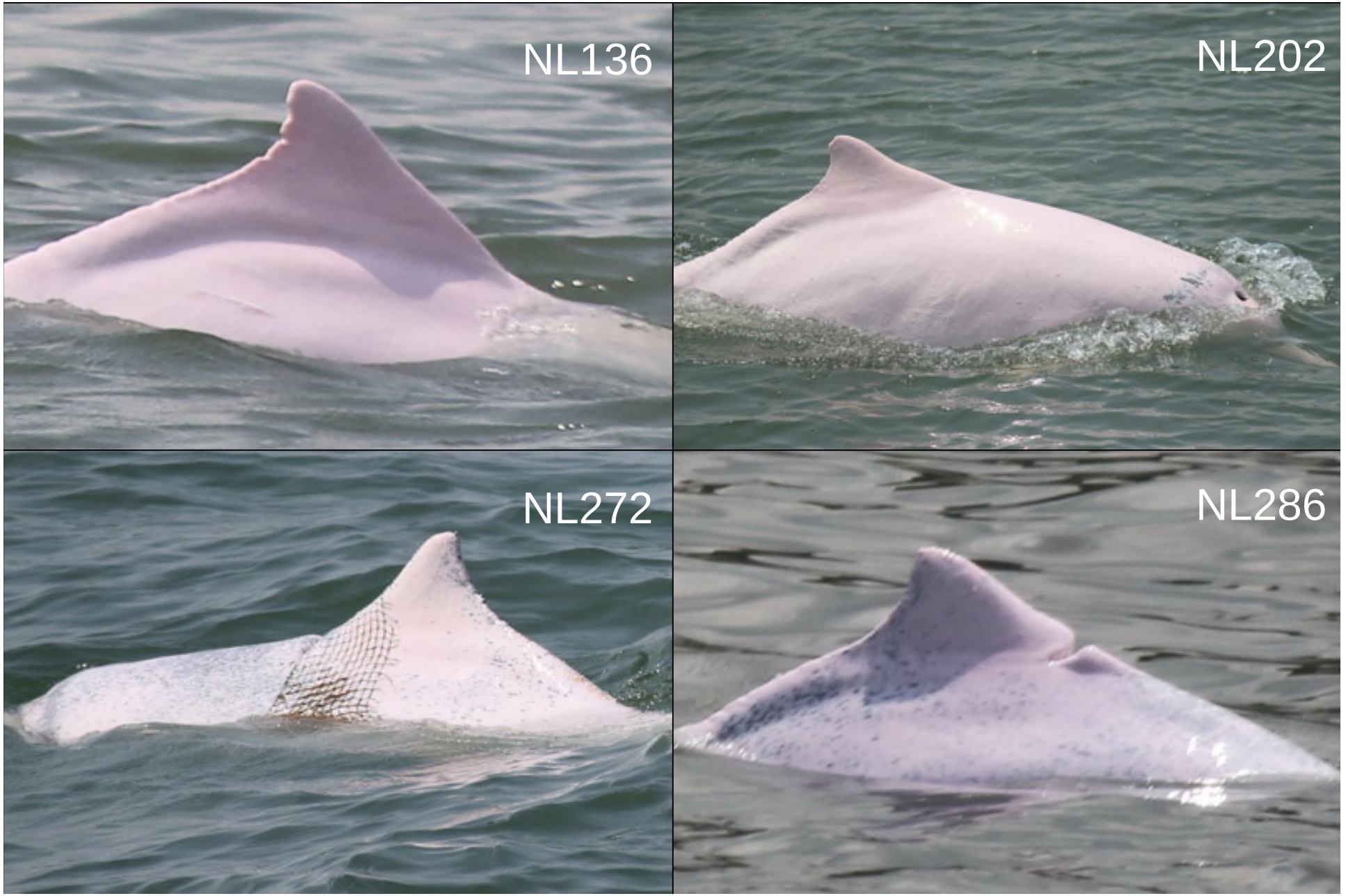
(Abberviations: STG# = Sighting Number; HRD SZ = Dolphin Herd Size; BEAU = Beaufort Sea State; PSD = Perpendicular Distance; BOAT ASSOC. = Fishing Boat Association; P/S: Sighting Made on Primary/Secondary Lines)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
4-Sep-19	1	1046	2	NW LANTAU	2	311	ON	HKLR	823375	805440	AUTUMN	NONE	P
11-Sep-19	1	1058	3	NW LANTAU	2	430	ON	HKLR	829316	807975	AUTUMN	NONE	S
9-Oct-19	1	1221	1	NW LANTAU	3	57	ON	TMCLKL	827538	805469	AUTUMN	NONE	P
19-Nov-19	1	1144	1	NW LANTAU	3	386	ON	TMCLKL	827671	805583	AUTUMN	NONE	P

Appendix III. Individual dolphins identified during TMCLKL08/ HKLR03 monitoring surveys in September-November 2019

ID#	DATE	STG#	AREA
NL136	11/09/19	1	NW LANTAU
NL202	11/09/19	1	NW LANTAU
NL272	19/11/19	1	NW LANTAU
NL286	11/09/19	1	NW LANTAU

Appendix IV. Four individual dolphins that were identified between September and November 2019 under TMCLKL08/HKLR03 monitoring surveys



Appendix V. Ranging patterns (95% kernel ranges) of four individual dolphins that were sighted during TMCLKL08/HKLR03 impact phase monitoring period (note: yellow dots indicate sightings made in September-November 2019 during TMCLKL08/HKLR03 monitoring surveys)