

Appendix C

## Operational Phase Dolphin Monitoring Survey

**AGREEMENT NO. HMWSD 1/2021 (EP)**  
**Post-Construction Monitoring of Chinese White Dolphin for**  
**Hong Kong-Zhuhai-Macao Bridge Tuen Mun – Chek Lap Kok Link**

*Quarterly Progress Report (September-November 2021)*  
*submitted to Dragages ERM Hong Kong Ltd.*

Submitted by  
Hong Kong Cetacean Research Project

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**1. Introduction**

- 1.1. As part of the Hong Kong-Zhuhai-Macao Bridge (HZMB), the Tuen Mun-Chek Lap Kok Link (TMCLKL) is a designated project under the Environmental Impact Assessment Ordinance (EIAO). The Environmental Impact Assessment (EIA) Report and Environmental Monitoring and Audit (EM&A) Manual (EIA Register No.: AEIAR-146/2009) for the project were approved by the Director of Environmental Protection in October 2009 and the Environmental Permit No. EP-354/2009 (EP) was issued in November 2009. The EP has been subject to several variations and the current one is EP No. EP-354/2009/D.
- 1.2. The TMCLKL was constructed under two works contracts namely Contract No. HY/2012/07 (Southern Connection Viaduct Section) and Contract No. HY/2012/08 (North Connection Sub-sea Tunnel Section). In accordance with the EP, the Contractors of Contract No. HY/2012/07 and Contract No. HY/2012/08 have separately employed their own Environmental Team (ET) and ET Leader to conduct construction phase monitoring of Chinese White Dolphin (CWD) in the North Lantau (NL) waters, which included the Northeast Lantau (NEL) and Northwest Lantau (NWL) survey areas, following the requirements specified in the EM&A Manual and the relevant contract specifications of the two contracts.
- 1.3. In accordance with Section 6.1 of the EM&A Manual and the EP, an ecological monitoring and audit programme is needed to monitor potential impacts through construction and operation activities of TMCLKL. The construction and post-construction (operational) EM&A objectives are to ensure that the ecological contract works and construction mitigation procedures recommended in the EIA are carried out as specified and are effective. Post-construction phase EM&A will comprise the audit of the measures as appropriate. In order for such monitoring to be effective, it needs to be divided into three phases: pre-disturbance (i.e. baseline phase), the entire period of disturbance (i.e. construction phase) and post-disturbance after the completion of construction works (i.e. post-construction phase). Survey techniques must be held constant from phase to phase, and survey equipment and personnel should ideally be the

same as well.

- 1.4. The main objective of the current assignment commissioned by the Highways Department is to conduct the post-construction monitoring of CWD in NL waters in compliance with the requirements stipulated in the EM&A Manual and the EP for the TMCLKL works. Such monitoring should be conducted for two years upon the completion of all marine-based construction activities for the TMCLKL according to the EM&A Manual, which were completed in May 2020. From June 2020 to August 2021, 15 months of post-construction dolphin monitoring had been carried out by the ET / ET Leader appointed under Contract No. HY/2012/08, while the remaining nine months of post-construction dolphin monitoring will be completed under this assignment, from September 2021 to May 2022.
- 1.5. In August 2021, the ERM Hong Kong (ERMHK) Limited has been appointed as the Consultant responsible for the nine months of post-construction monitoring of CWD in NL waters for the TMCLKL. Subsequently, the Hong Kong Cetacean Research Project (HKCRP) has been appointed by ERMHK to collaborate and undertake the dolphin monitoring tasks to conduct systematic line-transect vessel surveys.
- 1.4. The present quarterly progress report is submitted to the Contractor under the TMCLKL post-construction phase dolphin monitoring programme, which summarizes the results of the survey findings during the period of September to November 2021.

## 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 and post-construction monitoring period. The co-ordinates of all transect lines are shown in Table 1.

Table 1 Co-ordinates of transect lines conducted by TMCLKL08 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 TMCLKL 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 2020). 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, 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 TMCLKL 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<sup>®</sup> 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 monitoring period were plotted onto 1-km<sup>2</sup> grids among NWL and NEL survey areas on GIS. Sighting densities (number of on-effort sightings per km<sup>2</sup>) and dolphin densities (total number of dolphins from on-effort sightings per km<sup>2</sup>) 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-km<sup>2</sup> 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<sup>2</sup> 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, 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 post-construction 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<sup>®</sup> 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 2021, six sets of systematic line-transect vessel surveys were conducted under the TMCLKL post-construction dolphin monitoring works to cover all transect lines in NWL and NEL survey areas twice per month.
- 3.1.2. From these TMCLKL surveys, a total of 846.92 km of survey effort was collected, with 100% 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, 335.20 km and 511.72 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 582.80 km, while the effort on secondary lines was 264.12 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 TMCLKL08 monitoring surveys from September to November 2021, only three groups of five Chinese White Dolphins were sighted. All three dolphin sightings were made on primary lines during on-effort search in this quarter. 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 the HKLR/TMCLKL monitoring surveys.
- 3.2. *Distribution*
- 3.2.1. Distribution of dolphin sightings made during the TMCLKL monitoring surveys from September to November 2021 is shown in Figure 1. The three sightings were made to the northwest corner of Lung Kwu Chau, within the Urmston Road between Black Point and Lung Kwu Chau, and to the west of the airport platform, respectively (Figure 1). As consistently recorded in previous monitoring quarters in recent years, the dolphins were completely absent from the central and eastern portions of North Lantau waters (Figure 1).
- 3.2.2. Notably, all three dolphin groups were sighted far away from the TMCLKL alignment as well as the HKBCF and HKLR03 reclamation sites during the quarterly period (Figure 1).
- 3.2.3. Sighting distribution of dolphins during the present post-construction monitoring period 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 eight years of HZMB-related dolphin monitoring, which has resulted in zero to extremely low encounter rates in this area.
- 3.2.4. In NWL survey area, dolphin occurrences were also drastically different between the baseline and the present post-construction monitoring periods. During the present quarter, dolphins were rarely sighted here, and only at the western end 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 autumn months in 2016-21 (Figure 2). Dolphins were sighted mostly around the Sha Chau and Lung Kwu Chau Marine Park in NWL waters during the first three autumn



quarters, while their occurrence has progressively diminished in recent years (Figure 2). Notably, they were consistently absent from the NEL survey area as well as the eastern portion of NWL survey area throughout the six quarterly periods.

### 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 TMCLKL 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).

Table 2. Dolphin encounter rates (sightings per 100 km of survey effort) during September-November 2021

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 (7 & 13 Sep 2021)	0.00	0.00
	Set 2 (14 & 21 Sep 2021)	0.00	0.00
	Set 3 (7 & 19 Oct 2021)	0.00	0.00
	Set 4 (26 & 27 Oct 2021)	0.00	0.00
	Set 5 (1 & 9 Nov 2021)	0.00	0.00
	Set 6 (16 & 17 Nov 2021)	0.00	0.00
Northwest Lantau	Set 1 (7 & 13 Sep 2021)	1.60	1.60
	Set 2 (14 & 21 Sep 2021)	0.00	0.00
	Set 3 (7 & 19 Oct 2021)	0.00	0.00
	Set 4 (26 & 27 Oct 2021)	0.00	0.00
	Set 5 (1 & 9 Nov 2021)	0.00	0.00
	Set 6 (16 & 17 Nov 2021)	3.25	6.51

Table 3. Comparison of average dolphin encounter rates from the present post-construction monitoring period (September-November 2021) 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;  $\pm$  denotes the standard deviation of the average encounter rates)

	<b>Encounter rate (STG)</b> (no. of on-effort dolphin sightings per 100 km of survey effort)		<b>Encounter rate (ANI)</b> (no. of dolphins from all on-effort sightings per 100 km of survey effort)	
	<b>September – November 2021</b>	<b>September – November 2011</b>	<b>September – November 2021</b>	<b>September – November 2011</b>
<b>Northeast Lantau</b>	0.0	6.00 $\pm$ 5.05	0.0	22.19 $\pm$ 26.81
<b>Northwest Lantau</b>	0.81 $\pm$ 1.36	9.85 $\pm$ 5.85	1.35 $\pm$ 2.61	44.66 $\pm$ 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 0.59 sightings and 0.98 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 quarterly post-construction 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 autumn quarters throughout the HKLR/TMCLKL dolphin monitoring in the past nine consecutive years (Table 4).

Table 4. Comparison of average dolphin encounter rates in NEL survey area from the same autumn quarters of HKLR/TMCLKL impact and post-construction monitoring periods since 2012 and the 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;  $\pm$  denotes the standard deviation of the average encounter rates)

	<b>Encounter rate (STG)</b> (no. of on-effort dolphin sightings per 100 km of survey effort)	<b>Encounter rate (ANI)</b> (no. of dolphins from all on-effort sightings per 100 km of survey effort)
<b>September-November 2011 (Baseline)</b>	6.00 $\pm$ 5.05	22.19 $\pm$ 26.81
<b>September-November 2013 (Impact)</b>	1.01 $\pm$ 1.59	3.77 $\pm$ 6.49
<b>September-November 2014 (Impact)</b>	0.00	0.00
<b>September-November 2015 (Impact)</b>	0.00	0.00
<b>September-November 2016 (Impact)</b>	0.00	0.00
<b>September-November 2017 (Impact)</b>	0.00	0.00
<b>September-November 2018 (Impact)</b>	0.00	0.00
<b>September-November 2019 (Impact)</b>	0.00	0.00
<b>September-November 2020 (Post-Construction)</b>	0.00	0.00
<b>September-November 2021 (Post-Construction)</b>	0.00	0.00

- 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 91.8% and 97.0% respectively), indicating a dramatic decline in dolphin usage of this survey area during the present quarterly period as compared to the baseline period in 2011 (Table 5).
- 3.3.5. When comparing to the past eight autumn quarters in 2013-20, the quarterly encounter rates in 2021 dropped to the very low level (and at similarly low level as in the autumn months of 2019 and 2020) among all autumn quarters during the HKLR/TMCLKL monitoring period (Table 5). Such dramatic drop in dolphin occurrence in NWL raises serious concerns, and the temporal trend should be closely monitored in the upcoming monitoring quarters while all construction activities of HZMB works has already been completed.

Table 5. Comparison of average dolphin encounter rates in Northwest Lantau survey area from the same autumn quarters of HKLR/TMCLKL impact and post-construction monitoring periods since 2012 and the 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;  $\pm$  denotes the standard deviation of the average encounter rates)

	<b>Encounter rate (STG)</b> (no. of on-effort dolphin sightings per 100 km of survey effort)	<b>Encounter rate (ANI)</b> (no. of dolphins from all on-effort sightings per 100 km of survey effort)
<b>September-November 2011 (Baseline)</b>	9.85 $\pm$ 5.85	44.66 $\pm$ 29.85
<b>September-November 2013 (Impact)</b>	8.04 $\pm$ 1.10	32.48 $\pm$ 26.51
<b>September-November 2014 (Impact)</b>	5.10 $\pm$ 4.40	20.52 $\pm$ 15.10
<b>September-November 2015 (Impact)</b>	3.94 $\pm$ 1.57	21.05 $\pm$ 17.19
<b>September-November 2016 (Impact)</b>	2.86 $\pm$ 1.98	10.89 $\pm$ 10.98
<b>September-November 2017 (Impact)</b>	3.12 $\pm$ 1.91	10.35 $\pm$ 9.66
<b>September-November 2018 (Impact)</b>	1.51 $\pm$ 2.25	2.70 $\pm$ 3.78
<b>September-November 2019 (Impact)</b>	0.83 $\pm$ 0.91	1.10 $\pm$ 1.34
<b>September-November 2020 (Post-Construction)</b>	0.54 $\pm$ 0.84	1.09 $\pm$ 1.69
<b>September-November 2021 (Post-Construction)</b>	0.81 $\pm$ 1.36	1.35 $\pm$ 2.61

- 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 HKLR/TMCLKL 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 sixth quarter of the TMCLKL08 post-construction monitoring period being assessed), the p-values for

the differences in average dolphin encounter rates of STG and ANI were 0.0024 and 0.0357 respectively. If the alpha value is set at 0.05, significant differences were detected between the baseline period and present quarter 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 of the HKLR03/TMCLKL08 monitoring period (i.e. the first 36 quarters of the impact and post-construction phases 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 cumulative periods and the locations).
- 3.3.9. As indicated in both dolphin distribution patterns and encounter rates, dolphin usage has been significantly and dramatically reduced in both NEL and NWL survey areas during the present quarterly period, and such low occurrence of dolphins has also been consistently documented throughout the HKLR/TMCLKL monitoring period.
- 3.3.10. Even though all marine works associated with the HZMB construction have already been completed, and the Brothers Marine Park has been established as a compensation measure for the permanent habitat loss in association with the HZMB reclamation works since late 2016, apparently there has been no sign of recovery of dolphin usage in North Lantau waters at all, while such usage has continued to diminish to the lowest level.
- 3.4. *Group size*
- 3.4.1. Group sizes of the three Chinese White Dolphin sightings included two singletons and a group of three animals during September to November 2021. 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 the present post-construction monitoring period (September – November 2021) and baseline monitoring period (September – November 2011) (Note:  $\pm$  denotes the standard deviation of the average group size)

	Average Dolphin Group Size	
	September – November 2021	September – November 2011
<b>Overall</b>	1.67 $\pm$ 1.15 (n = 3)	3.72 $\pm$ 3.13 (n = 66)
<b>Northeast Lantau</b>	---	3.18 $\pm$ 2.16 (n = 17)
<b>Northwest Lantau</b>	1.67 $\pm$ 1.15 (n = 3)	3.92 $\pm$ 3.40 (n = 49)

- 3.4.2. The average dolphin group size in NWL waters during the present quarter 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 three dolphin groups in the present quarter was only a tiny fraction of the 66 dolphin groups sighted during the baseline period (Table 6).
- 3.5. *Habitat use*
- 3.5.1. From September to November 2021, only three grids in North Lantau waters have

recorded dolphin occurrences. Two of them recorded very low dolphin densities while another had moderate dolphin density (Figures 3a and 3b). 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. 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.
- 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 post-construction 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 quarter (Figure 4).
- 3.5.4. The density patterns were also very different in NWL between the baseline and present post-construction 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, all three grids with dolphin records were distributed at the western end of the NWL survey area in low to moderate densities during the present quarter (Figure 4).
- 3.6. *Mother-calf pairs*
- 3.6.1. During the present quarterly period, no mother-calf pair was sighted.
- 3.7. *Activities and associations with fishing boats*
- 3.7.1. From September to November 2021, all three dolphin groups did not engage in any activities. Furthermore, none of the groups was associated with any operating fishing vessel during this post-construction monitoring period.
- 3.8. *Summary of photo-identification works*
- 3.8.1. About 180 digital photographs of Chinese White Dolphins were taken during the present post-construction monitoring period for the photo-identification work.
- 3.8.2. In total, five individuals sighted five times altogether were identified (see summary table in Appendix III and photographs of identified individuals in Appendix IV). All re-sightings of these individual dolphins were made in NWL.
- 3.9. *Individual range use*
- 3.9.1. Ranging patterns of the five individuals identified during the present quarterly period were determined by fixed kernel method, and are shown in Appendix V.
- 3.9.2. All five 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. Furthermore, four of the five individuals (NL123, NL182, NL202 and WL05) have primarily centered their range use in North Lantau waters in the past, and were still re-sighted within their normal ranges during this quarterly period. On the contrary, the primary range of one individual (WL243) was in West Lantau waters in the past, but have extended to NWL waters during the present quarterly period (Appendix V).

#### 4. References

- Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., Borchers, D. L., and Thomas, L. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, London.
- Hung, S. K. 2020. Monitoring of marine mammals in Hong Kong waters – data collection: final report (2019-20). An unpublished report submitted to the Agriculture, Fisheries and Conservation Department of Hong Kong SAR Government, 138 pp.
- Jefferson, T. A. 2000. Population biology of the Indo-Pacific hump-backed dolphin in Hong Kong waters. Wildlife Monographs 144:1-65.

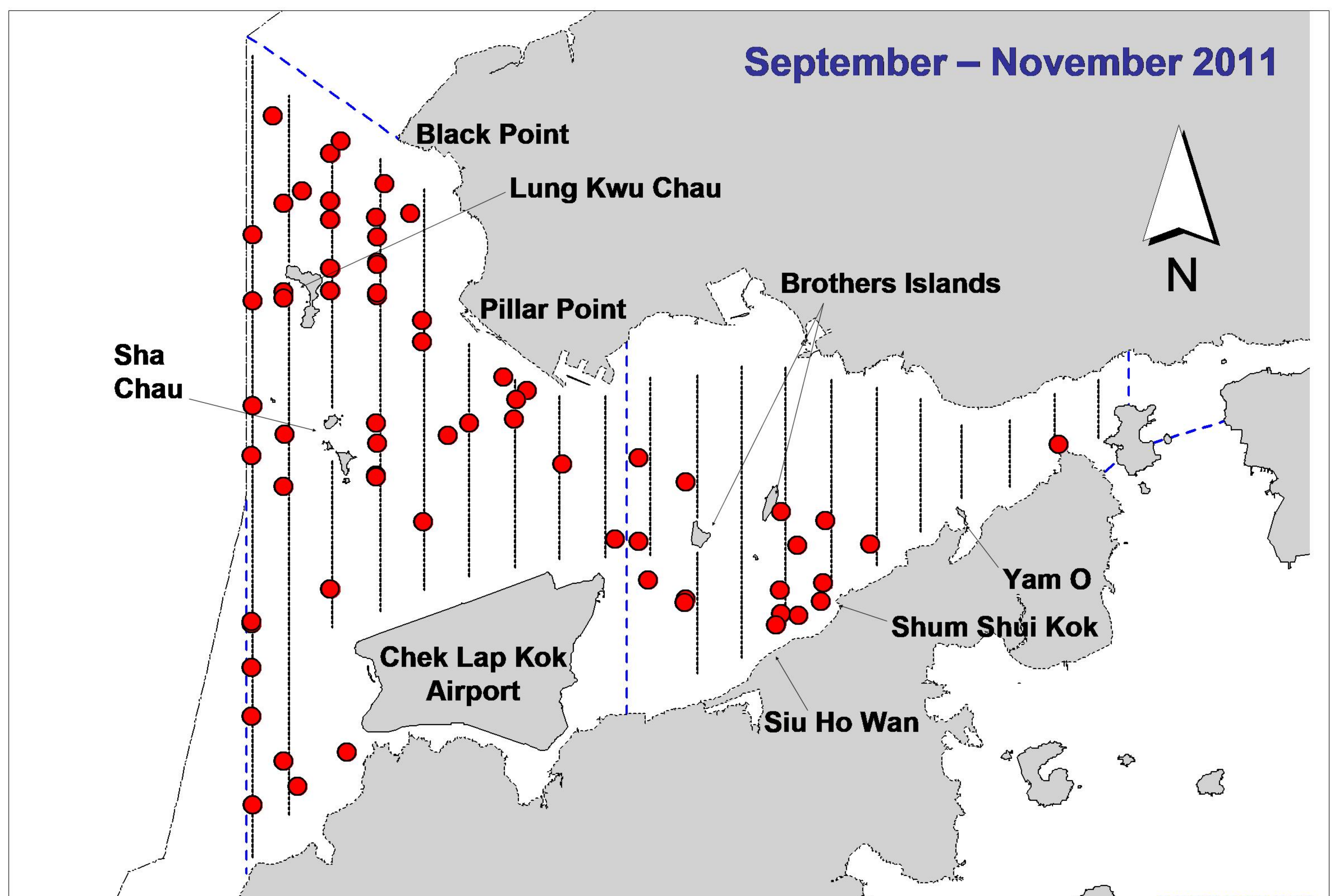
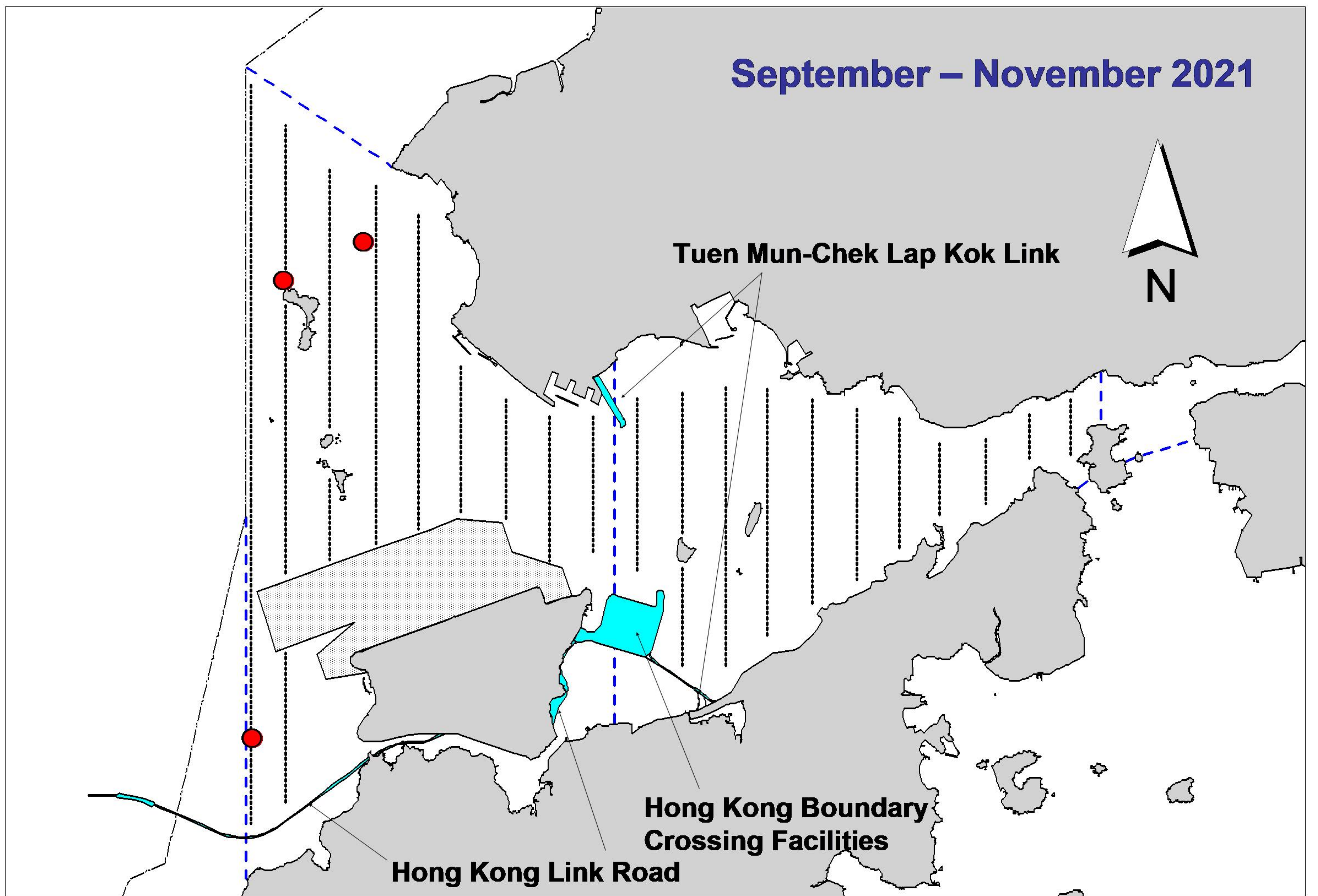


Figure 1. Distribution of Chinese White Dolphin sightings in Northwest and Northeast Lantau during the present TMCLKL monitoring period (top) and the baseline period in 2011 (bottom)

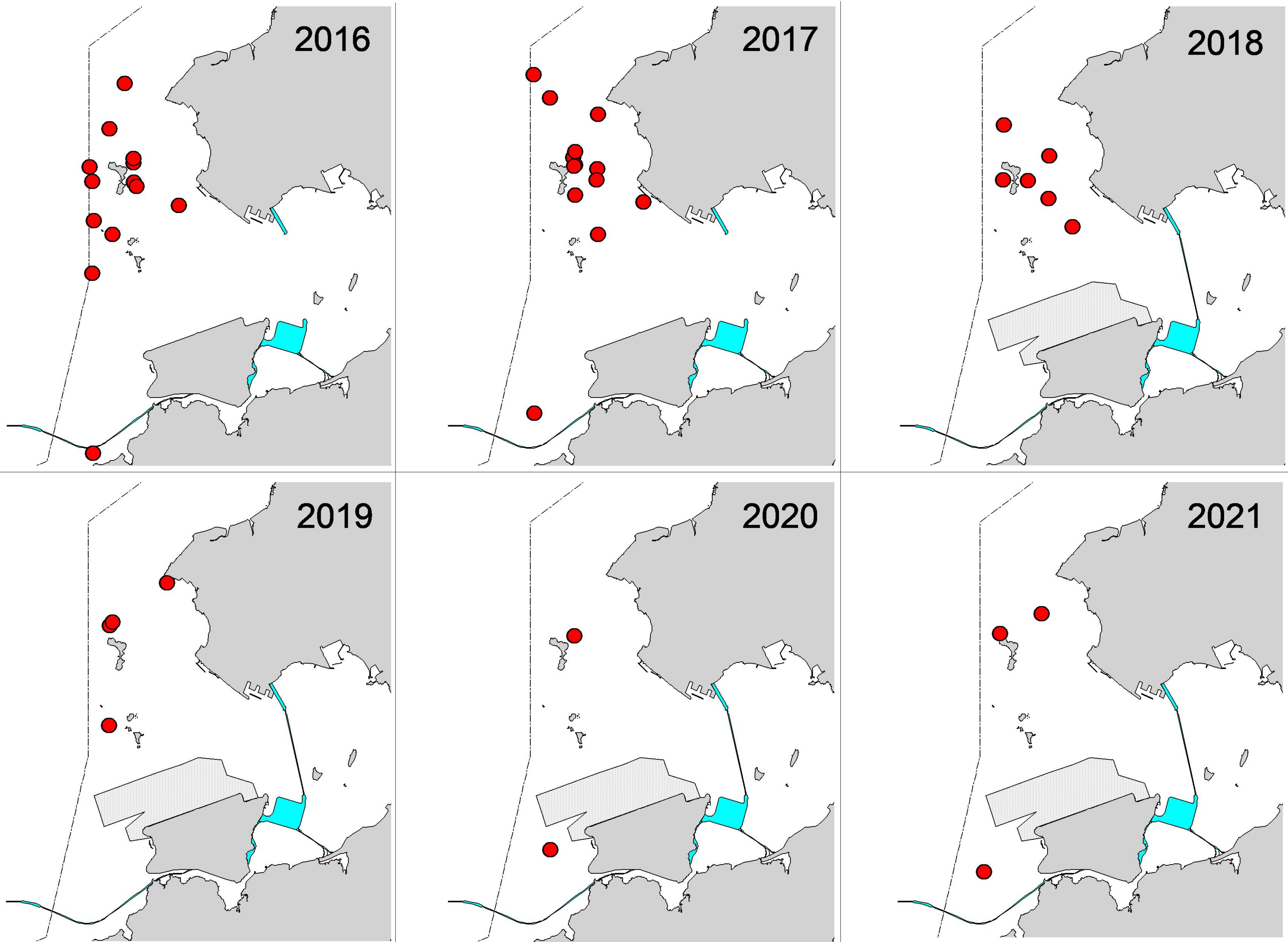


Figure 2. Distribution of Chinese White Dolphin sightings in Northwest and Northeast Lantau during the past six autumn quarters (September-November) of HKLR03/TMCLKL monitoring period in 2016-21



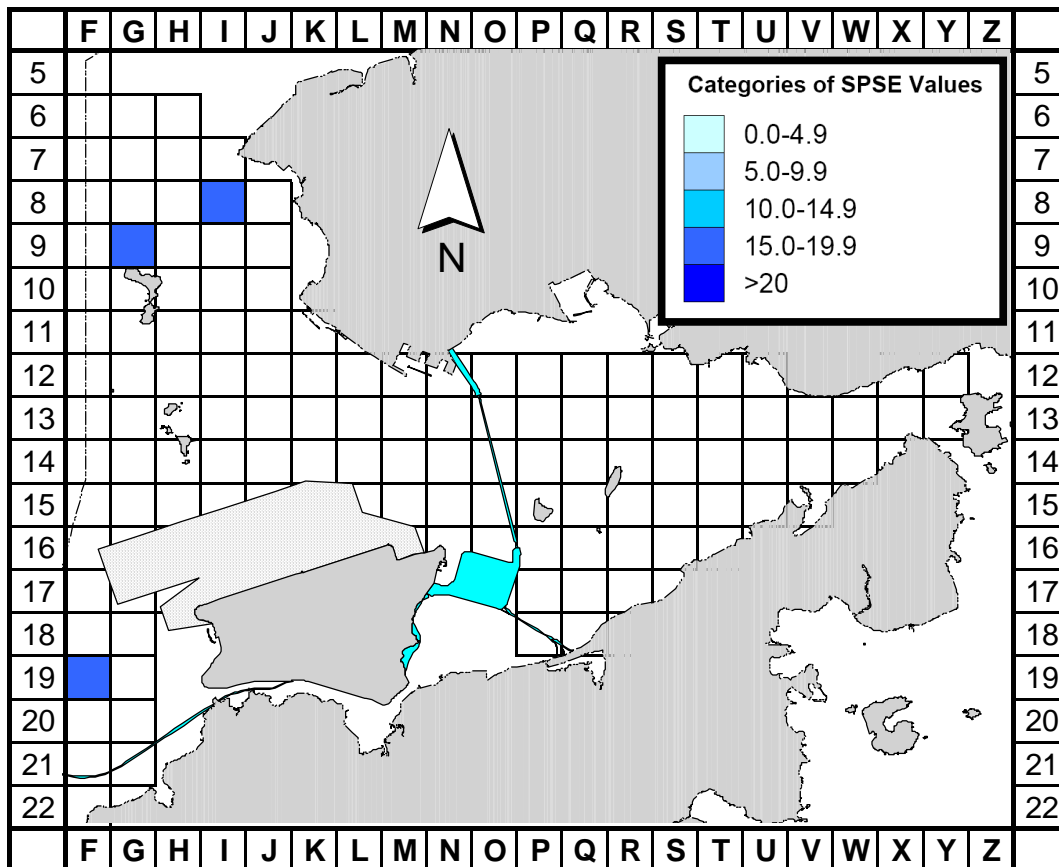


Figure 3a. Sighting density of Chinese White Dolphins with corrected survey effort per km<sup>2</sup> in Northeast and Northwest Lantau survey areas, using data collected during the TMCLKL monitoring period in September-November 2021 (SPSE = no. of on-effort sightings per 100 units of survey effort)

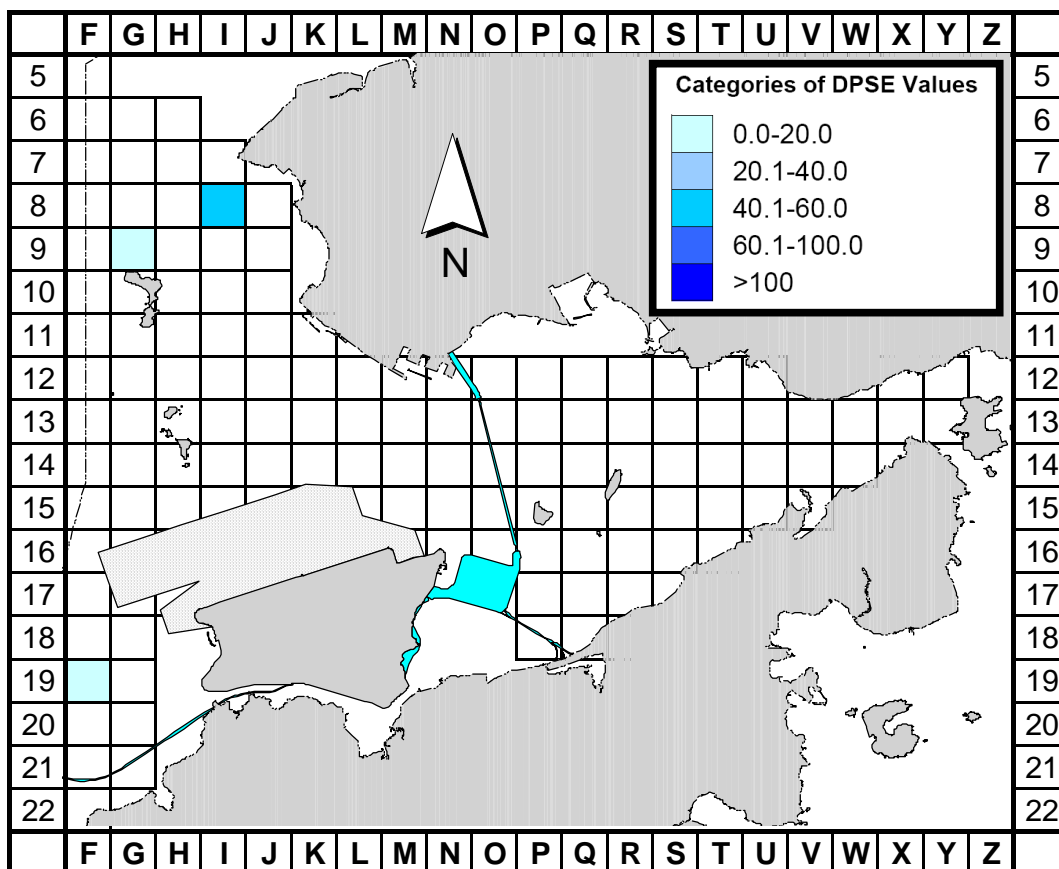


Figure 3b. Density of Chinese White Dolphins with corrected survey effort per km<sup>2</sup> in Northeast and Northwest Lantau survey areas, using data collected during the TMCLKL monitoring period in September-November 2021 (DPSE = no. of dolphins per 100 units of survey effort)

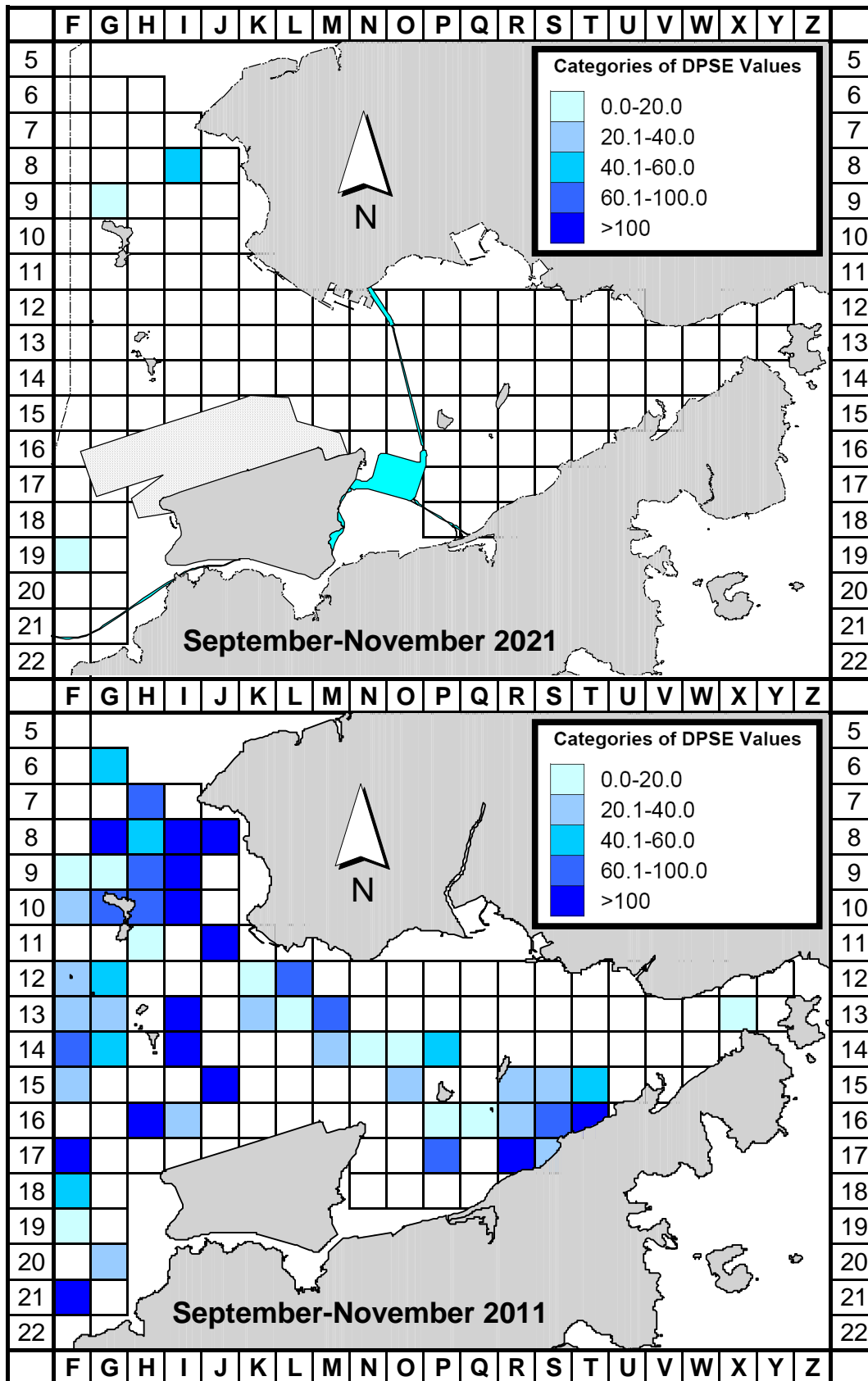


Figure 4. Comparison of density of Chinese White Dolphins with corrected survey effort per km<sup>2</sup> in Northwest and Northeast Lantau survey areas between the present TMCLKL08 monitoring period (September-November 2020) and baseline monitoring period (September-November 2011) (DPSE = no. of dolphins per 100 units of survey effort)

## Appendix I. TMCLKL Survey Effort Database (September-November 2021)

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

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	TYPE	P/S
7-Sep-21	NW LANTAU	1	0.40	AUTUMN	STANDARD36826	TMCLKL	P
7-Sep-21	NW LANTAU	2	32.70	AUTUMN	STANDARD36826	TMCLKL	P
7-Sep-21	NW LANTAU	3	4.00	AUTUMN	STANDARD36826	TMCLKL	P
7-Sep-21	NW LANTAU	1	1.10	AUTUMN	STANDARD36826	TMCLKL	S
7-Sep-21	NW LANTAU	2	6.70	AUTUMN	STANDARD36826	TMCLKL	S
7-Sep-21	NW LANTAU	3	5.50	AUTUMN	STANDARD36826	TMCLKL	S
7-Sep-21	NE LANTAU	2	12.16	AUTUMN	STANDARD36826	TMCLKL	P
7-Sep-21	NE LANTAU	3	3.69	AUTUMN	STANDARD36826	TMCLKL	P
7-Sep-21	NE LANTAU	2	6.02	AUTUMN	STANDARD36826	TMCLKL	S
7-Sep-21	NE LANTAU	3	3.33	AUTUMN	STANDARD36826	TMCLKL	S
13-Sep-21	NW LANTAU	2	25.31	AUTUMN	STANDARD138716	TMCLKL	P
13-Sep-21	NW LANTAU	2	10.49	AUTUMN	STANDARD138716	TMCLKL	S
13-Sep-21	NE LANTAU	1	1.20	AUTUMN	STANDARD138716	TMCLKL	P
13-Sep-21	NE LANTAU	2	18.20	AUTUMN	STANDARD138716	TMCLKL	P
13-Sep-21	NE LANTAU	1	1.80	AUTUMN	STANDARD138716	TMCLKL	S
13-Sep-21	NE LANTAU	2	8.40	AUTUMN	STANDARD138716	TMCLKL	S
14-Sep-21	NW LANTAU	2	27.80	AUTUMN	STANDARD36826	TMCLKL	P
14-Sep-21	NW LANTAU	3	6.90	AUTUMN	STANDARD36826	TMCLKL	P
14-Sep-21	NW LANTAU	2	8.10	AUTUMN	STANDARD36826	TMCLKL	S
14-Sep-21	NW LANTAU	3	4.80	AUTUMN	STANDARD36826	TMCLKL	S
14-Sep-21	NE LANTAU	2	16.76	AUTUMN	STANDARD36826	TMCLKL	P
14-Sep-21	NE LANTAU	2	9.34	AUTUMN	STANDARD36826	TMCLKL	S
14-Sep-21	NE LANTAU	3	0.40	AUTUMN	STANDARD36826	TMCLKL	S
21-Sep-21	NW LANTAU	2	25.33	AUTUMN	STANDARD36826	TMCLKL	P
21-Sep-21	NW LANTAU	2	10.67	AUTUMN	STANDARD36826	TMCLKL	S
21-Sep-21	NE LANTAU	2	13.40	AUTUMN	STANDARD36826	TMCLKL	P
21-Sep-21	NE LANTAU	3	5.60	AUTUMN	STANDARD36826	TMCLKL	P
21-Sep-21	NE LANTAU	2	6.10	AUTUMN	STANDARD36826	TMCLKL	S
21-Sep-21	NE LANTAU	3	4.20	AUTUMN	STANDARD36826	TMCLKL	S
7-Oct-21	NW LANTAU	3	25.70	AUTUMN	STANDARD138716	TMCLKL	P
7-Oct-21	NW LANTAU	3	10.20	AUTUMN	STANDARD138716	TMCLKL	S
7-Oct-21	NE LANTAU	2	7.50	AUTUMN	STANDARD138716	TMCLKL	P
7-Oct-21	NE LANTAU	3	11.60	AUTUMN	STANDARD138716	TMCLKL	P
7-Oct-21	NE LANTAU	2	2.80	AUTUMN	STANDARD138716	TMCLKL	S
7-Oct-21	NE LANTAU	3	6.50	AUTUMN	STANDARD138716	TMCLKL	S
19-Oct-21	NW LANTAU	2	24.98	AUTUMN	STANDARD36826	TMCLKL	P
19-Oct-21	NW LANTAU	3	10.76	AUTUMN	STANDARD36826	TMCLKL	P
19-Oct-21	NW LANTAU	2	10.36	AUTUMN	STANDARD36826	TMCLKL	S
19-Oct-21	NW LANTAU	3	3.70	AUTUMN	STANDARD36826	TMCLKL	S
19-Oct-21	NE LANTAU	2	16.49	AUTUMN	STANDARD36826	TMCLKL	P
19-Oct-21	NE LANTAU	2	10.71	AUTUMN	STANDARD36826	TMCLKL	S
26-Oct-21	NW LANTAU	2	12.60	AUTUMN	STANDARD36826	TMCLKL	P
26-Oct-21	NW LANTAU	3	14.65	AUTUMN	STANDARD36826	TMCLKL	P
26-Oct-21	NW LANTAU	2	6.90	AUTUMN	STANDARD36826	TMCLKL	S
26-Oct-21	NW LANTAU	3	2.15	AUTUMN	STANDARD36826	TMCLKL	S
26-Oct-21	NE LANTAU	2	19.60	AUTUMN	STANDARD36826	TMCLKL	P
26-Oct-21	NE LANTAU	2	10.90	AUTUMN	STANDARD36826	TMCLKL	S
27-Oct-21	NW LANTAU	2	31.21	AUTUMN	STANDARD36826	TMCLKL	P
27-Oct-21	NW LANTAU	3	4.09	AUTUMN	STANDARD36826	TMCLKL	P
27-Oct-21	NW LANTAU	2	13.10	AUTUMN	STANDARD36826	TMCLKL	S
27-Oct-21	NE LANTAU	2	15.95	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
27-Oct-21	NE LANTAU	2	9.85	AUTUMN	STANDARD36826	TMCLKL	S
1-Nov-21	NW LANTAU	2	30.50	AUTUMN	STANDARD138716	TMCLKL	P
1-Nov-21	NW LANTAU	3	4.60	AUTUMN	STANDARD138716	TMCLKL	P
1-Nov-21	NW LANTAU	2	11.40	AUTUMN	STANDARD138716	TMCLKL	S
1-Nov-21	NW LANTAU	3	2.40	AUTUMN	STANDARD138716	TMCLKL	S
1-Nov-21	NE LANTAU	2	8.53	AUTUMN	STANDARD138716	TMCLKL	P
1-Nov-21	NE LANTAU	3	8.07	AUTUMN	STANDARD138716	TMCLKL	P
1-Nov-21	NE LANTAU	2	8.81	AUTUMN	STANDARD138716	TMCLKL	S
1-Nov-21	NE LANTAU	3	1.39	AUTUMN	STANDARD138716	TMCLKL	S
9-Nov-21	NW LANTAU	2	15.50	AUTUMN	STANDARD36826	TMCLKL	P
9-Nov-21	NW LANTAU	3	12.36	AUTUMN	STANDARD36826	TMCLKL	P
9-Nov-21	NW LANTAU	2	7.50	AUTUMN	STANDARD36826	TMCLKL	S
9-Nov-21	NW LANTAU	3	1.94	AUTUMN	STANDARD36826	TMCLKL	S
9-Nov-21	NE LANTAU	2	17.85	AUTUMN	STANDARD36826	TMCLKL	P
9-Nov-21	NE LANTAU	3	1.40	AUTUMN	STANDARD36826	TMCLKL	P
9-Nov-21	NE LANTAU	2	10.45	AUTUMN	STANDARD36826	TMCLKL	S
16-Nov-21	NW LANTAU	2	11.17	AUTUMN	STANDARD36826	TMCLKL	P
16-Nov-21	NW LANTAU	3	25.75	AUTUMN	STANDARD36826	TMCLKL	P
16-Nov-21	NW LANTAU	2	6.00	AUTUMN	STANDARD36826	TMCLKL	S
16-Nov-21	NW LANTAU	3	7.00	AUTUMN	STANDARD36826	TMCLKL	S
16-Nov-21	NE LANTAU	2	12.07	AUTUMN	STANDARD36826	TMCLKL	P
16-Nov-21	NE LANTAU	3	2.30	AUTUMN	STANDARD36826	TMCLKL	P
16-Nov-21	NE LANTAU	2	12.13	AUTUMN	STANDARD36826	TMCLKL	S
17-Nov-21	NW LANTAU	2	22.62	AUTUMN	STANDARD138716	TMCLKL	P
17-Nov-21	NW LANTAU	3	1.93	AUTUMN	STANDARD138716	TMCLKL	P
17-Nov-21	NW LANTAU	2	10.85	AUTUMN	STANDARD138716	TMCLKL	S
17-Nov-21	NE LANTAU	1	4.20	AUTUMN	STANDARD138716	TMCLKL	P
17-Nov-21	NE LANTAU	2	15.37	AUTUMN	STANDARD138716	TMCLKL	P
17-Nov-21	NE LANTAU	1	1.80	AUTUMN	STANDARD138716	TMCLKL	S
17-Nov-21	NE LANTAU	2	8.33	AUTUMN	STANDARD138716	TMCLKL	S

**Appendix II. TMCLKL Chinese White Dolphin Sighting Database (September-November 2021)**

(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
13-Sep-21	1	1053	1	NW LANTAU	2	3	ON	TMCLKL	827184	805396	AUTUMN	NONE	P
16-Nov-21	1	1023	1	NW LANTAU	2	238	ON	TMCLKL	817297	804676	AUTUMN	NONE	P
17-Nov-21	1	1125	3	NW LANTAU	2	152	ON	TMCLKL	828000	807231	AUTUMN	NONE	P

**Appendix III. Individual dolphins identified during TMCLKL monitoring surveys in September-November 2021**

<b>ID#</b>	<b>DATE</b>	<b>STG#</b>	<b>AREA</b>
NL123	17/11/21	1	NW LANTAU
NL182	13/09/21	1	NW LANTAU
NL202	17/11/21	1	NW LANTAU
WL05	17/11/21	1	NW LANTAU
WL243	16/11/21	1	NW LANTAU

Appendix IV. Five individual dolphins that were identified between September-November 2021 during the TMCLKL post-construction monitoring surveys



Appendix IV. (cont'd)





Appendix V. Ranging patterns (95% kernel ranges) of five individual dolphins that were sighted during the present TMCLKL post-construction monitoring period (note: yellow dots indicate sightings made in September-November 2021 during TMCLKL monitoring surveys)

