

Monitoring of Chinese White Dolphins in Southwest Lantau Waters – Ninth Quarterly Report (March – May 2017)

Submitted to the Environmental Project Office for the HZMB HKLR, HZMB HKBCF and
TM-CLKL – Investigation

Submitted by
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1. Introduction

- 1.1. In March 2015, Hong Kong Cetacean Research Project (HKCRP) was appointed by the Environmental Project Office for the HZMB Hong Kong Projects to undertake a monitoring study of Chinese White Dolphins in Southwest Lantau (SWL) waters.
- 1.2. The objectives of the monitoring study are to quantify the abundance and density of Chinese White Dolphins in SWL waters, to identify individuals during the monitoring surveys, and to analyze their range use and movement patterns in Hong Kong and the wider Pearl River Estuary waters.
- 1.3. The monitoring study has been supplementing the on-going EM&A monitoring results of the HZMB Hong Kong Projects in North and West Lantau waters, and provides a more complete picture of dolphin usage and movements between different survey areas in western Hong Kong waters.
- 1.4. The present report is the ninth quarterly progress report under this dolphin monitoring study submitted to the Environmental Project Office, summarizing the results of the survey findings during the period of March – May 2017. It is also the Final Report under the contract and the successfulness of the monitoring programme are also reviewed.

2. Monitoring Methodology

2.1. Vessel-based Line-transect Survey

2.1.1. According to the requirement of the technical proposal submitted to the Environmental Project Office, the present dolphin monitoring programme should cover all transect lines in SWL survey area (see Figure 1) once per month upon instruction. The co-ordinates of all transect lines conducted during the dolphin monitoring survey are shown in Table 1.

Table 1. Co-ordinates of transect lines in SWL survey area (corresponding to transect line layout as shown in Figure 1)

Line #		Northing	Easting		Line #		Northing	Easting
SWL001	1	806180	802510		SWL007	13	807380	808520
	2	804250	802510			14	805600	808520
SWL002	3	806710	803480			15	804400	808520
	4	803450	803480			16	803000	808520
SWL003	5	807270	804500			17	802100	808520
	6	802690	804500			18	800470	808520
SWL004	7	807590	805450		SWL008	19	807380	809550
	8	802295	805450			20	805050	809550
SWL005	9	808490	806500			21	804400	809550
	10	801410	806500			22	800470	809550
SWL006	11	808500	807430		SWL009	23	807380	810550
	12	801250	807430			24	800470	810550
					SWL010	25	809410	811510
						26	801470	811510

2.1.2. The HKCRP 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 20 years of marine mammal monitoring surveys in Hong Kong developed by HKCRP (see Hung 2015, 2016). For each monitoring vessel survey, a 15-m inboard vessel with an open upper deck (about 4.5 m above water surface) was used to make observations from the flying bridge area.

- 2.1.3. Two experienced observers from HKCRP (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 observer was available on the boat to work in shift (i.e. rotate every 30 minutes) in order to minimize fatigue of the survey team members. All observers were experienced in small cetacean survey techniques and identifying local cetacean species.
- 2.1.4. During on-effort survey periods, the survey team recorded effort data including time, position (latitude and longitude), weather conditions (Beaufort sea state and visibility), and distance traveled in each series (a continuous period of search effort) with the assistance of a handheld GPS (*Garmin eTrex Legend*).
- 2.1.5. Data including time, position and vessel speed were also automatically and continuously logged by handheld GPS throughout the entire survey for subsequent review.
- 2.1.6. When dolphins were sighted, the survey team would end the survey effort, and immediately record the initial sighting distance and angle of the dolphin group from the survey vessel, as well as the sighting time and position. Then the research vessel was diverted from its course to approach the animals for species identification, group size estimation, assessment of group composition, and behavioural observations. The perpendicular distance (PSD) of the dolphin group to the transect line was later calculated from the initial sighting distance and angle.
- 2.1.7. Survey effort being conducted along the parallel transect lines that were perpendicular to the coastlines (as indicated in Figure 1) was labeled as “primary” survey effort, while the survey effort conducted along the connecting lines between parallel lines as well as the section around the Soko Islands was labeled as “secondary” survey effort. 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. 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. For individual dolphins that are not readily identifiable from the catalogue but have distinct features on their bodies, they will be placed in a pool of “potential new individuals”, with decision being made at the end of each year on whether any of them should be incorporated into the photo-ID catalogue.
- 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 (ER(STG)), and total number of dolphins sighted on-effort per 100 km of survey effort (ER(ANI))) were calculated in SWL survey area in relation to the amount of survey effort conducted during each month of monitoring survey. Only data collected under Beaufort 3 or below would be used for encounter rate analysis.

Dolphin encounter rates were calculated in two ways: 1) using primary survey effort alone; and 2) using both primary and secondary survey effort collected.

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

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

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

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

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

- 2.3.4. Behavioural analysis – When dolphins were sighted during vessel surveys, their behaviour was observed. Different activities were categorized (i.e. feeding, milling/resting, traveling, socializing) and recorded on sighting datasheets. This data was then input into a separate database with sighting information, which can be used to determine the distribution of behavioural data with a desktop GIS. Distribution of

sightings of dolphins engaged in different activities and behaviours would then be plotted on GIS and carefully examined to identify important areas for different activities of the dolphins.

- 2.3.5. Line-transect analysis –Density and abundance of Chinese White Dolphins in SWL in 2016 were estimated by line-transect analysis using systematic line-transect data collected under the present study. For the analysis, survey effort in each single survey day was used as the sample. Estimates were calculated from dolphin sightings and effort data collected during conditions of Beaufort 0-3, using line-transect methods. The estimates were made using the computer program DISTANCE Version 6.0, Release 2. The following formulae were used to estimate density, abundance, and their associated coefficient of variation:

$$\hat{D} = \frac{n \hat{f}(0) \hat{E}(s)}{2 L \hat{g}(0)}$$

$$\hat{N} = \frac{n \hat{f}(0) \hat{E}(s) A}{2 L \hat{g}(0)}$$

$$CV = \sqrt{\frac{\text{var}(n)}{n^2} + \frac{\text{var}[\hat{f}(0)]}{[\hat{f}(0)]^2} + \frac{\text{var}[\hat{E}(s)]}{[\hat{E}(s)]^2} + \frac{\text{var}[\hat{g}(0)]}{[\hat{g}(0)]^2}}$$

where D = density (of individuals),
n = number of on-effort sightings,
f(0) = trackline probability density at zero distance,
E(s) = unbiased estimate of average group size,
L = length of transect lines surveyed on effort,
g(0) = trackline detection probability,
N = abundance,
A = size of the survey area,
CV = coefficient of variation, and
var = variance.

A strategy of selective pooling and stratification was used in order to minimize bias and maximize precision in making the estimates of density and abundance. Distant sightings were truncated to remove outliers and accommodate modeling, and size-bias corrected estimate of group size was calculated by regressing \log_e of group size against distance. Three models (uniform, half-normal and hazard rate) were fitted to the data of perpendicular distances. The model with the lowest values of Akaike's Information Criterion (AIC) was chosen as the best model and used to estimate f(0) and the resulting

dolphin density and abundance.

- 2.3.6. Ranging pattern analysis – Location data of individual dolphins that occurred during the three-month 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 (utilization distribution) level. To examine the movement pattern within individual ranges, the locations of re-sightings made in the present quarterly period were visually examined and compared to those made in recent years, in order to determine whether any apparent shift in range use occurs in the present quarterly period.

3. Monitoring Results

3.1. *Summary of survey effort and dolphin sightings*

- 3.1.1. During the period of March to May 2017, three sets of systematic line-transect vessel surveys were conducted on March 6th, April 7th and May 10th to cover all transect lines in SWL survey area once per month. In addition, nine line-transect surveys were also conducted under the AFCD long-term marine mammal monitoring programme in SWL survey area on March 1st, March 13th, March 21st, April 5th, April 11th, April 13th, May 8th, May 12th and May 23rd (see Appendix I and Table 2). With the permission of AFCD, such monitoring survey data were also incorporated into the present study to increase the sample size for various analyses.
- 3.1.2. For the present study alone, a total of 211.70 km of survey effort was collected in SWL surveys during this quarter (Table 2), with 100.0% of the total survey effort being conducted under favourable weather conditions (i.e. Beaufort Sea State 3 or below with good visibility) (Appendix I). The total survey effort conducted on primary and secondary lines were 161.57 km and 50.13 km respectively during the three sets of surveys. For the combined monitoring dataset from both the present study and AFCD monitoring study, a total of 472.15 km of survey effort was collected in SWL waters during the three-month period.
- 3.1.3. During the present quarter, 12 groups of 19 Chinese White Dolphins were sighted from the present study's surveys and AFCD monitoring surveys conducted in SWL survey area

(Table 2, Appendix II). Nine of the 12 dolphin sightings were made during on-effort search, while six of the nine on-effort sightings were made on primary lines.

Table 2. Summary table of survey effort and dolphin sightings collected during the present quarter (i.e. March – May 2017)

Month	Date	Total Distance (km)	No. of CWD Sighting	No. of Individual
HYD				
March 2017	March 6 th	70.90	0	0
April 2017	April 7 th	70.43	1	1
May 2017	May 10 th	70.37	6	11
	Total	211.70	7	12
AFCD				
March 2017	March 1 st , 13 th , 21 st	101.49	3	5
April 2017	April 5 th , 11 th , 13 th	71.35	1	1
May 2017	May 8 th , 12 th , 23 rd	87.61	1	1
	Total	260.45	5	7

3.1.4. In addition, the Indo-Pacific finless porpoises were also sighted during the present quarter in SWL survey area, with a total of 28 groups of 78 animals sighted (Appendix III).

3.2. *Distribution*

3.2.1. Distribution of dolphin sightings made during the monitoring surveys from March to May 2017 is shown in Figure 1. Chinese White Dolphins occurred infrequently in SWL waters during this quarter, and their sightings were mostly concentrated at the western end of the survey area near Fan Lau. A few groups were also sighted near Shui Hau Peninsula and around the Soko Islands (Figure 1).

3.2.2. On the contrary, the finless porpoises were mostly sighted to the eastern and southeastern ends of the survey area, mainly to the east of the Soko Islands. There was very little overlap between the sightings of finless porpoises and Chinese White Dolphins during the quarterly period (Figure 1).

3.2.3. Notably, sighting distribution of dolphins in the present quarter (i.e. spring of 2017) was quite similar to the previous three spring periods of 2014-16 (Figure 2). During the spring months, dolphins mostly occurred near Fan Lau, with other sporadic occurrences near Shui Hau Peninsula and the Soko Islands (Figure 2).

3.3. *Encounter rate*

- 3.3.1. During the present three-month monitoring period (March-May 2017), 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) from the SWL survey area are shown in Table 3. The quarterly encounter rates were calculated by pooling the monthly survey effort and on-effort dolphin sightings from the three months during the present quarter, in order to compare them to the historical data. 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 (Table 3).
- 3.3.2. Both types of quarterly encounter rates (ER(STG) and ER(ANI)) deduced from the present quarter were also compared with the same spring quarters deduced from 2014, 2015 and 2016, while the quarterly encounter rates deduced using the primary and secondary survey effort combined was compared with the ones deduced from all spring months in the past decade (2005-14) (Table 3).

Table 3. Overall dolphin encounter rates (no. of sightings per 100 km of survey effort) from the present monitoring survey and combined database with AFCD monitoring survey conducted in March-May 2017 (i.e. spring of 2017) in SWL survey area in comparison to the ones deduced during spring periods of 2014, 2015 and 2016, as well as the ones in the past decade (2005-14)

	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	Both Primary and Secondary Lines	Primary Lines Only	Both Primary and Secondary Lines
Spring 2017	1.85	1.74	3.40	3.27
Spring 2016	1.92	2.03	2.24	3.61
Spring 2015	1.63	2.43	4.07	4.56
Spring 2014	2.35	3.40	2.35	8.26
Spring of 2005-14		1.54		4.14

- 3.3.3. Evidently, dolphin encounter rates have gradually diminished in the past four spring periods in SWL waters, and reached the lowest in spring 2017 for both quarterly encounter rates (i.e. ER(STG) and ER(ANI)). On the other hand, the encounter rates recorded in the present quarter was similar to the overall spring period of 2005-14 (Table 3).

3.4. *Group size*

- 3.4.1. Group sizes of Chinese White Dolphins ranged from one to three individuals per group in

SWL survey area between March and May 2017. The average dolphin group size for the three-month period was only 1.6, which was much lower than the one recorded during the spring period of 2005-14 (4.0).

3.4.2. Among the 12 dolphin groups sighted during this quarter, all were small groups composed of only 1-3 dolphins per group (Appendix II).

3.5. *Habitat use*

3.5.1. From March to May 2017, only ten grids have recorded dolphin presence in SWL survey area, with one on-effort sighting per grid for these 10 grids. Most grids recorded low dolphin densities, with the exception of the grids near Fan Lau that recorded moderate dolphin densities (Figures 3a and 3b). However, the results should be treated with cautions as the amount of survey effort collected among most grids during the three-month period was fairly low (5-10 units of survey effort for most grids).

3.5.2. When compared with the habitat use pattern recorded during the spring months of 2012-16, the one in 2017 was similar to the previous winter periods, but there were higher dolphin densities near Fan Lau and more even occurrences in the inshore waters of SWL in previous years of 2012-16 (Figures 4a and 4b).

3.6. *Mother-calf pairs*

3.6.1. During the three-month monitoring period, no young calf was sighted at all in SWL waters.

3.7. *Activities and associations with fishing boats*

3.7.1. From March to May 2017, four of the 12 sightings were associated with feeding activities (three sightings) and socializing activity (one sighting) during the quarterly period, and distribution of these sightings is shown in Figure 5.

3.7.2. Notably, two sightings of two lone dolphins were associated with operating purse-seiners near Fan Lau and to the east of Siu A Chau.

3.8. *Abundance estimation*

3.8.1. Using the line-transect analysis method, the abundance of Chinese White Dolphins in SWL survey area was estimated to be nine dolphins in 2016. The coefficient of variation (CV) of such estimate is fairly low (22%), and the resulted estimates should be quite reliable.

3.8.2. When compared to the previous two years (26 dolphins in 2014 and 24 dolphins in 2015

as per AFCD report), the estimate of dolphin numbers in SWL has dropped to a much lower level in 2016.

3.9. *Summary of photo-identification works*

- 3.9.1. Between March and May 2017, approximately 300 digital photographs of Chinese White Dolphins were taken during the SWL monitoring surveys for the photo-identification work.
- 3.9.2. In total, only four individuals sighted five times altogether were identified (see the summary table in Appendix IV and photographs of identified individuals in Appendix V). Three of the four identified individuals were sighted only once during the three-month period, while the other individual (WL91) was sighted twice during the quarterly period (Appendix IV). None of these individuals were sighted with any young calves.
- 3.10. *Individual range use in SWL waters*
- 3.10.1. Ranging patterns of these four individuals identified during the three-month study period in SWL waters were determined by the fixed kernel method. Their 95% kernel home ranges including their re-sightings during 2012, 2013, 2014 and 2015-17 are shown separately for each individual in Appendix VI to facilitate the examination of any temporal changes in their range use in recent years.
- 3.10.2. All four individuals were re-sighted well within their home ranges including SWL waters during this three-month period (Appendix VI). One individual (SL60) sighted in SWL waters during the present quarter was also sighted in WL waters during HKLR09 monitoring surveys in the same quarter. This individual showed extensive movements between different survey areas in this relatively brief period.
- 3.10.5. With their primary ranges centered in West Lantau waters in the past, three of the four individuals (i.e. WL15, WL62, WL91) showed apparent range expansion to Southwest Lantau waters in 2015-17 (Appendix VI). It remains to be seen whether some of these individuals would continue to spend more times in SWL waters as part of their ranges in the near future.
- 3.11. *Cross-boundary movements of individuals from photo-ID study in EPRE*
- 3.11.1. In addition to the photo-identification effort in SWL waters, a set of on-going large-scale surveys has recently been conducted in Lingding Bay (or the eastern section of the Pearl River Estuary, EPRE) by the South China Sea Fisheries Research Institute (SCSFRI), which is commissioned by the Hong Kong-Zhuhai-Macao Bridge Authority (HZMBA).

- 3.11.2. One of the goals of such surveys was to assess any cross-movements of individual dolphins from Hong Kong waters into Mainland waters in light of their dramatic decline in North Lantau waters in recent years. With the permission of HZMBA, such data was made available to this study in order to match photographs of dolphins taken from the EPRE surveys to the catalogue individual dolphins in Hong Kong maintained by HKCRP researchers. Such works can supplement our knowledge of dolphin movements in the wider PRE region especially on any cross-boundary movements.
- 3.11.3. During the one-year survey period between August 2015 to August 2016, ten sets of EPRE surveys were conducted in Lingding Bay, with a total of 173 groups of 791 dolphins being sighted among North Lingding Bay (NLDB), Central Lingding Bay (CLDB), South Lingding Bay (SLDB) and Macau (MA) survey areas.
- 3.11.4. Over 35,000 photographs were taken during the course of these surveys, and the photo-identification analysis by HKCRP researchers has identified 107 individual dolphins being sighted 167 times altogether (Appendix VII).
- 3.11.5. Among these 107 individuals sighted in Lingding Bay, 21 of them have never or rarely occurred in Hong Kong waters in the past (see Appendix VIII), while the rest have been frequently sighted among different survey areas in Hong Kong waters in the recent past (see Appendix IX).
- 3.11.6. Notably, many of these individuals (e.g. NL104, NL123, NL145, NL260, NL264) are year-round residents that regularly occurred in Hong Kong waters in the past, while a few (e.g. NL281 and WL66) have disappeared from Hong Kong waters for more than one to two years.
- 3.11.7. Moreover, during the same 12-month period of August 2015 to August 2016, a total of 63 individuals have shown cross-boundary movements (e.g. CH113, NL247, NL279, WL118, WL256), indicating their extensive movements away from Hong Kong waters. On the other hand, 27 individuals were sighted at or near the border of Hong Kong during the one-year period (e.g. EL01, NL104, NL285, WL79), and therefore these were not considered as cross-boundary movements.
- 3.12. *Summary of SWL monitoring programme and meeting objectives of the services*
- 3.12.1. This quarterly report concluded the present monitoring study in Southwest Lantau waters for the Environmental Project Office for the HZMB Hong Kong Projects started from March 2015 and ended in May 2017.

- 3.12.2. During the 27-month study period, 27 sets of line-transect vessel surveys were conducted, with a total of 1,903.16 km of survey effort collected. From these surveys, 78 groups of 208 dolphins and 37 groups of 100 porpoises were sighted in SWL waters.
- 3.12.3. Yearly abundance and density of dolphins in SWL were produced for 2015 and 2016 during the study period, utilizing the line-transect vessel surveys collected from the present study along with the AFCD monitoring data.
- 3.12.4. For the photo-identification works, a total of 56 individual dolphins were identified 118 times during these SWL surveys throughout the study period. The range use and movement patterns of individual dolphins were examined using these photo-identification data. Moreover, the photo-identification data collected in the eastern PRE waters, provided by HZMBA as detailed in Section 3.11 of the present report, were examined for any cross-boundary movements of individual dolphins.
- 3.12.5. The present study has greatly supplemented the on-going EM&A monitoring works of HZMB Hong Kong projects in North and West Lantau waters, and provided a more complete picture of dolphin usage and movements between different survey areas in western Hong Kong waters. It can be concluded that all objectives set for the present services have been successfully met.
- 3.12.6. As the dolphin encounter rate in SWL waters has been on a decline to a much lower level in 2017, and the previously observed range shifts of individuals from North Lantau to South Lantau were rarely documented in the past several quarters, we concluded that there is no critical need to continue such SWL surveys as supplement to the EM&A monitoring works in North and West Lantau waters.
- 3.12.7. However, if resources are available, it is highly recommended for HZMBA to conduct more surveys in the eastern PRE to continuously monitor the cross-boundary movements by individual dolphins, in light of their dramatic decline in utilization of Hong Kong waters in the past few years (see Hung 2015, 2016). Such additional surveys would provide a better understanding on the latest status of the PRE population of Chinese White Dolphins after the construction of HZMB has been completed.

4. References

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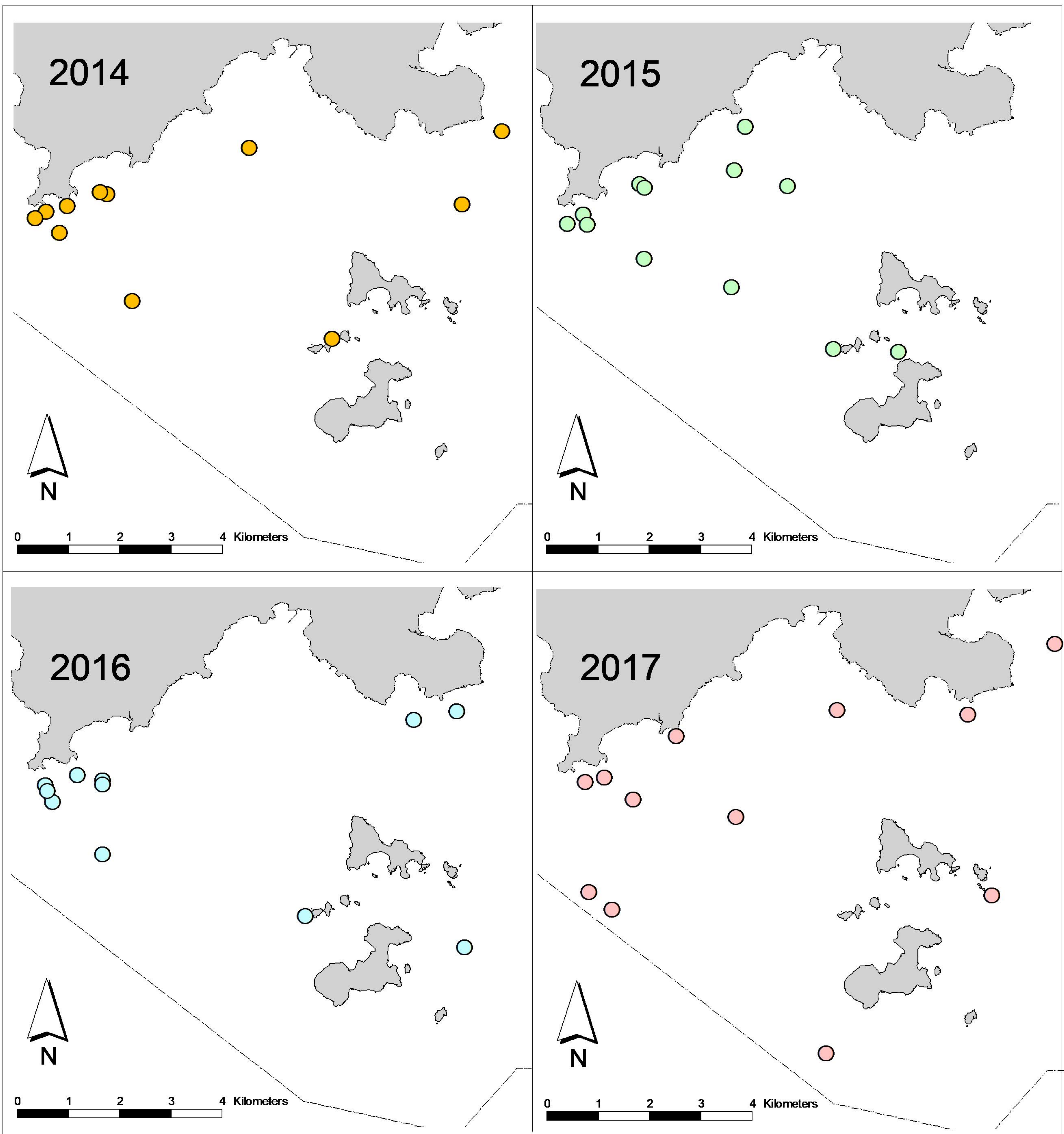


Figure 2. Comparisons on distribution of Chinese White Dolphin sightings in Southwest Lantau survey area during the four spring periods of 2014-2017

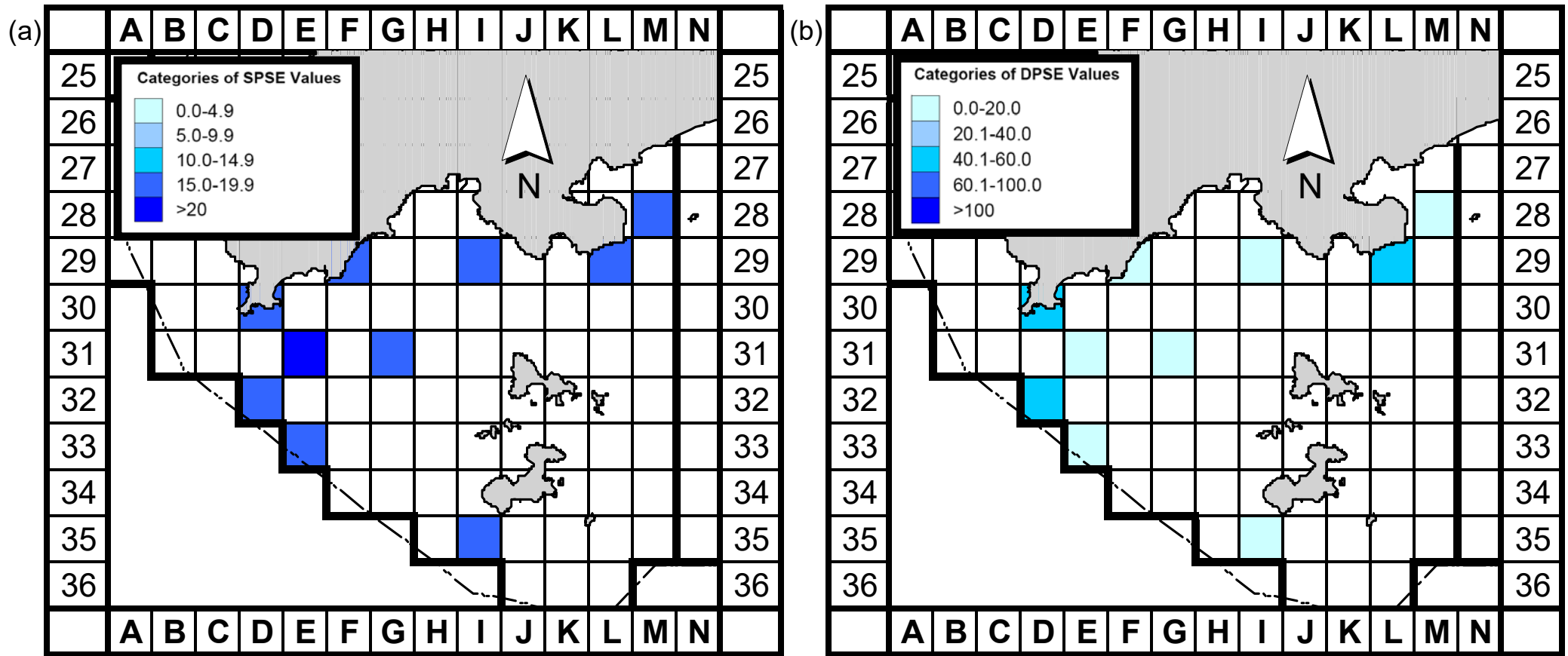


Figure 3a. Sighting density of Chinese white dolphins with corrected survey effort per km² in Southwest Lantau survey area during spring months (March-May) of 2017 (SPSE = no. of on-effort sightings per 100 units of survey effort)

Figure 3b. Density of Chinese white dolphins with corrected survey effort per km² in Southwest Lantau survey area during spring months (March-May) of 2017 (DPSE = no. of dolphins per 100 units of survey effort)

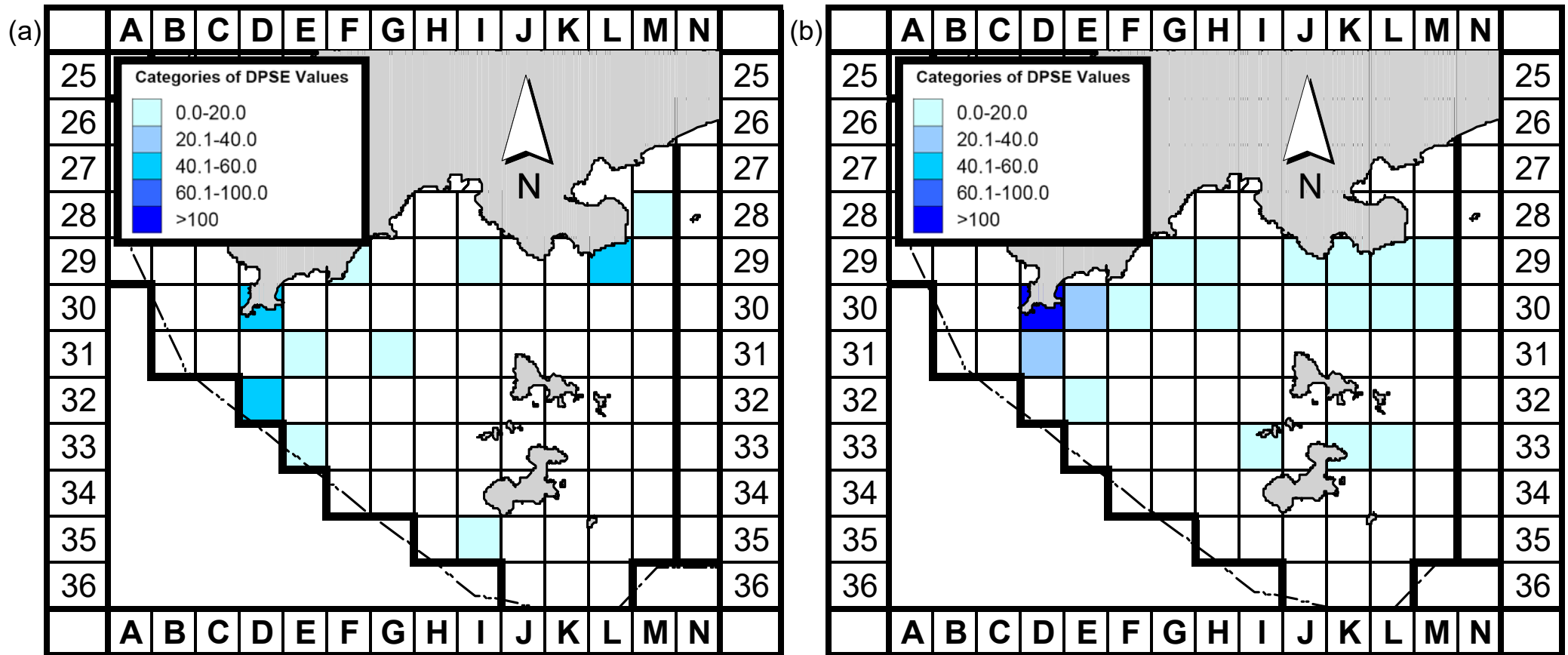


Figure 4a. Density of Chinese white dolphins with corrected survey effort per km² in Southwest Lantau survey area during spring months (March-May) of 2017 (DPSE = no. of dolphins per 100 units of survey effort)

Figure 4b. Density of Chinese white dolphins with corrected survey effort per km² in Southwest Lantau survey area during spring months (March-May) of 2012-2016 (DPSE = no. of dolphins per 100 units of survey effort)

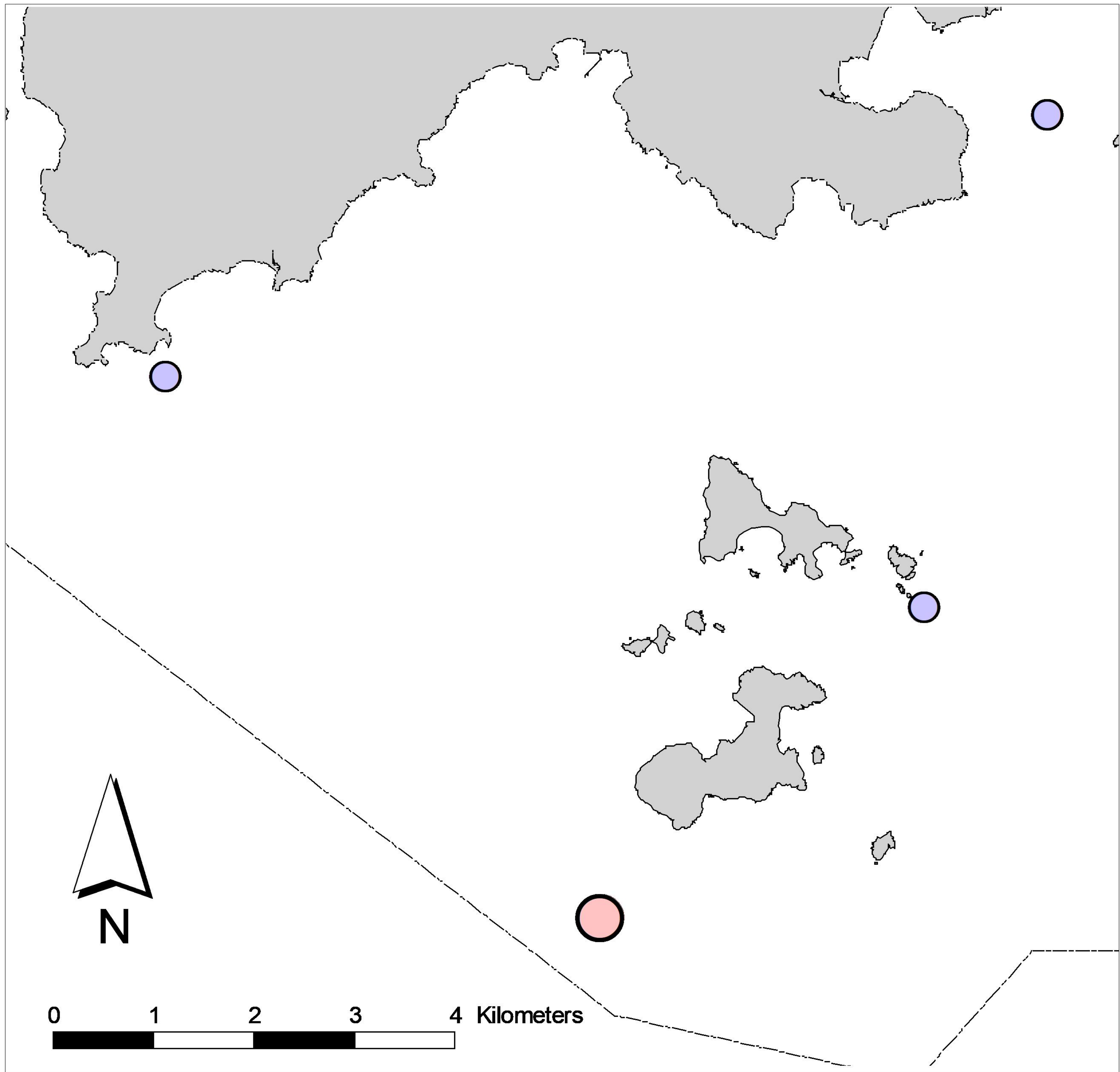


Figure 5. Distribution of Chinese White Dolphins engaged in feeding (purple dots) and socializing activities (pink dots) during SWL monitoring surveys conducted in March-May 2017

Appendix I. Survey Effort Database in SWL Survey Area (March-May 2017)

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

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	TYPE	P/S
1-Mar-17	SW LANTAU	2	8.68	SPRING	STANDARD36826	HKCRP	P
1-Mar-17	SW LANTAU	3	11.77	SPRING	STANDARD36826	HKCRP	P
1-Mar-17	SW LANTAU	4	3.08	SPRING	STANDARD36826	HKCRP	P
1-Mar-17	SW LANTAU	2	4.80	SPRING	STANDARD36826	HKCRP	S
1-Mar-17	SW LANTAU	3	7.15	SPRING	STANDARD36826	HKCRP	S
1-Mar-17	SW LANTAU	4	2.41	SPRING	STANDARD36826	HKCRP	S
6-Mar-17	SW LANTAU	1	8.60	SPRING	STANDARD36826	HYD-HZMB	P
6-Mar-17	SW LANTAU	2	43.55	SPRING	STANDARD36826	HYD-HZMB	P
6-Mar-17	SW LANTAU	3	1.90	SPRING	STANDARD36826	HYD-HZMB	P
6-Mar-17	SW LANTAU	1	2.10	SPRING	STANDARD36826	HYD-HZMB	S
6-Mar-17	SW LANTAU	2	14.75	SPRING	STANDARD36826	HYD-HZMB	S
13-Mar-17	SW LANTAU	1	1.58	SPRING	STANDARD36826	HKCRP	P
13-Mar-17	SW LANTAU	2	14.53	SPRING	STANDARD36826	HKCRP	P
13-Mar-17	SW LANTAU	3	6.81	SPRING	STANDARD36826	HKCRP	P
13-Mar-17	SW LANTAU	2	5.50	SPRING	STANDARD36826	HKCRP	S
13-Mar-17	SW LANTAU	3	2.36	SPRING	STANDARD36826	HKCRP	S
21-Mar-17	SW LANTAU	2	19.48	SPRING	STANDARD36826	HKCRP	P
21-Mar-17	SW LANTAU	3	1.30	SPRING	STANDARD36826	HKCRP	P
21-Mar-17	SW LANTAU	1	2.75	SPRING	STANDARD36826	HKCRP	S
21-Mar-17	SW LANTAU	2	6.89	SPRING	STANDARD36826	HKCRP	S
21-Mar-17	SW LANTAU	3	2.40	SPRING	STANDARD36826	HKCRP	S
5-Apr-17	SW LANTAU	2	7.51	SPRING	STANDARD33706	HKCRP	P
5-Apr-17	SW LANTAU	3	9.46	SPRING	STANDARD33706	HKCRP	P
5-Apr-17	SW LANTAU	2	3.70	SPRING	STANDARD33706	HKCRP	S
5-Apr-17	SW LANTAU	3	8.53	SPRING	STANDARD33706	HKCRP	S
7-Apr-17	SW LANTAU	1	0.50	SPRING	STANDARD36826	HYD-HZMB	P
7-Apr-17	SW LANTAU	2	49.66	SPRING	STANDARD36826	HYD-HZMB	P
7-Apr-17	SW LANTAU	3	3.72	SPRING	STANDARD36826	HYD-HZMB	P
7-Apr-17	SW LANTAU	1	3.50	SPRING	STANDARD36826	HYD-HZMB	S
7-Apr-17	SW LANTAU	2	13.05	SPRING	STANDARD36826	HYD-HZMB	S
11-Apr-17	SW LANTAU	1	2.99	SPRING	STANDARD33706	HKCRP	P
11-Apr-17	SW LANTAU	2	10.67	SPRING	STANDARD33706	HKCRP	P
11-Apr-17	SW LANTAU	2	3.45	SPRING	STANDARD33706	HKCRP	S
13-Apr-17	SW LANTAU	1	12.27	SPRING	STANDARD36826	HKCRP	P
13-Apr-17	SW LANTAU	2	6.00	SPRING	STANDARD36826	HKCRP	P
13-Apr-17	SW LANTAU	1	1.90	SPRING	STANDARD36826	HKCRP	S
13-Apr-17	SW LANTAU	2	4.87	SPRING	STANDARD36826	HKCRP	S
8-May-17	SW LANTAU	3	7.32	SPRING	STANDARD36826	HKCRP	P
8-May-17	SW LANTAU	4	2.96	SPRING	STANDARD36826	HKCRP	P
8-May-17	SW LANTAU	2	1.10	SPRING	STANDARD36826	HKCRP	S
8-May-17	SW LANTAU	3	8.61	SPRING	STANDARD36826	HKCRP	S
8-May-17	SW LANTAU	4	2.19	SPRING	STANDARD36826	HKCRP	S
10-May-17	SW LANTAU	1	37.72	SPRING	STANDARD36826	HYD-HZMB	P
10-May-17	SW LANTAU	2	15.92	SPRING	STANDARD36826	HYD-HZMB	P
10-May-17	SW LANTAU	1	5.91	SPRING	STANDARD36826	HYD-HZMB	S
10-May-17	SW LANTAU	2	9.02	SPRING	STANDARD36826	HYD-HZMB	S
10-May-17	SW LANTAU	3	1.80	SPRING	STANDARD36826	HYD-HZMB	S
12-May-17	SW LANTAU	2	26.28	SPRING	STANDARD36826	HKCRP	P
12-May-17	SW LANTAU	1	3.68	SPRING	STANDARD36826	HKCRP	S
12-May-17	SW LANTAU	2	6.24	SPRING	STANDARD36826	HKCRP	S
12-May-17	SW LANTAU	3	1.80	SPRING	STANDARD36826	HKCRP	S
23-May-17	SW LANTAU	2	5.25	SPRING	STANDARD36826	HKCRP	P
23-May-17	SW LANTAU	3	10.50	SPRING	STANDARD36826	HKCRP	P
23-May-17	SW LANTAU	4	1.91	SPRING	STANDARD36826	HKCRP	P

Appendix I. (cont'd)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	TYPE	P/S
23-May-17	SW LANTAU	2	7.43	SPRING	STANDARD36826	HKCRP	S
23-May-17	SW LANTAU	3	1.59	SPRING	STANDARD36826	HKCRP	S
23-May-17	SW LANTAU	4	0.75	SPRING	STANDARD36826	HKCRP	S

Appendix II. Chinese White Dolphin Sighting Database in SWL Survey Area (March-May 2017)

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

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
1-Mar-17	1	1308	3	SW LANTAU	3	181	ON	HKCRP	804145	802627	SPRING	PAIR	P
1-Mar-17	2	1529	1	SW LANTAU	2	ND	OFF	HKCRP	804097	810476	SPRING	PURSE-SEINE	
13-Mar-17	1	1307	1	SW LANTAU	2	ND	OFF	HKCRP	806260	802931	SPRING	PURSE-SEINE	
7-Apr-17	3	1552	1	SW LANTAU	2	ND	OFF	HYD-HZMB	808713	811700	SPRING	NONE	
13-Apr-17	1	1354	1	SW LANTAU	1	82	ON	HKCRP	805849	803487	SPRING	NONE	P
8-May-17	1	1437	1	SW LANTAU	4	298	ON	HKCRP	803834	803080	SPRING	NONE	S
10-May-17	1	1106	3	SW LANTAU	2	141	ON	HYD-HZMB	806172	802549	SPRING	NONE	P
10-May-17	2	1145	1	SW LANTAU	1	71	ON	HYD-HZMB	807021	804335	SPRING	NONE	S
10-May-17	3	1231	1	SW LANTAU	2	315	ON	HYD-HZMB	805535	805487	SPRING	NONE	P
10-May-17	4	1322	2	SW LANTAU	1	66	ON	HYD-HZMB	801190	807252	SPRING	NONE	P
10-May-17	5	1355	1	SW LANTAU	2	225	ON	HYD-HZMB	807491	807460	SPRING	NONE	P
10-May-17	7	1524	3	SW LANTAU	1	81	ON	HYD-HZMB	807420	810007	SPRING	NONE	S

Appendix III. Finless Porpoise Sighting Database in SWL Survey Area (March-May 2017)

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

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	P/S
1-Mar-17	3	1559	1	SW LANTAU	2	ND	OFF	HKCRP	802345	812154	SPRING	
6-Mar-17	1	1236	1	SW LANTAU	2	332	ON	HYD-HZMB	804946	806506	SPRING	P
6-Mar-17	2	1330	1	SW LANTAU	2	32	ON	HYD-HZMB	807833	808048	SPRING	S
13-Mar-17	2	1454	1	SW LANTAU	2	96	ON	HKCRP	802249	809678	SPRING	P
13-Mar-17	3	1523	4	SW LANTAU	2	141	ON	HKCRP	807717	810884	SPRING	S
21-Mar-17	3	1203	3	SW LANTAU	2	145	ON	HKCRP	802116	809719	SPRING	P
21-Mar-17	4	1307	3	SW LANTAU	2	147	ON	HKCRP	803143	811536	SPRING	P
21-Mar-17	5	1312	3	SW LANTAU	2	160	ON	HKCRP	802534	811608	SPRING	P
21-Mar-17	6	1315	3	SW LANTAU	2	6	ON	HKCRP	802080	811607	SPRING	P
7-Apr-17	1	1523	2	SW LANTAU	2	15	ON	HYD-HZMB	803265	811650	SPRING	P
7-Apr-17	2	1533	5	SW LANTAU	2	61	ON	HYD-HZMB	805280	811643	SPRING	P
11-Apr-17	9	1356	4	SW LANTAU	2	39	ON	HKCRP	804173	811497	SPRING	P
11-Apr-17	10	1403	1	SW LANTAU	1	323	ON	HKCRP	803575	811506	SPRING	P
11-Apr-17	11	1442	2	SW LANTAU	2	123	ON	HKCRP	804242	809867	SPRING	S
11-Apr-17	12	1507	2	SW LANTAU	2	ND	OFF	HKCRP	807462	811626	SPRING	
13-Apr-17	2	1524	7	SW LANTAU	1	54	ON	HKCRP	801264	809615	SPRING	S
13-Apr-17	3	1532	2	SW LANTAU	2	22	ON	HKCRP	802481	809937	SPRING	P
10-May-17	6	1502	4	SW LANTAU	1	207	ON	HYD-HZMB	803511	809856	SPRING	P
10-May-17	8	1544	6	SW LANTAU	2	57	ON	HYD-HZMB	803466	810475	SPRING	P
10-May-17	9	1548	2	SW LANTAU	1	45	ON	HYD-HZMB	802558	810483	SPRING	P
10-May-17	10	1556	1	SW LANTAU	1	53	ON	HYD-HZMB	800664	810491	SPRING	P
10-May-17	11	1611	2	SW LANTAU	1	58	ON	HYD-HZMB	803055	811464	SPRING	P
10-May-17	12	1621	3	SW LANTAU	1	183	ON	HYD-HZMB	805402	811561	SPRING	P
10-May-17	13	1624	4	SW LANTAU	1	106	ON	HYD-HZMB	806177	811510	SPRING	P
12-May-17	6	1252	4	SW LANTAU	2	73	ON	HKCRP	800311	809572	SPRING	P
12-May-17	7	1311	3	SW LANTAU	2	192	ON	HKCRP	802811	811567	SPRING	P
12-May-17	8	1322	2	SW LANTAU	2	81	ON	HKCRP	803242	811702	SPRING	P
23-May-17	1	1427	2	SW LANTAU	3	77	ON	HKCRP	800978	808490	SPRING	P

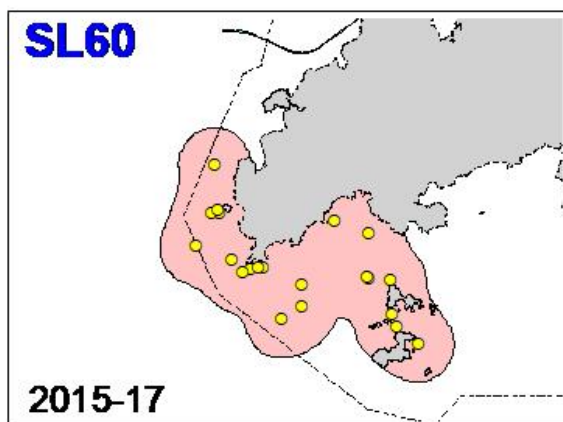
Appendix IV. Individual dolphins identified during SWL monitoring surveys in March-May 2017

ID#	DATE	STG#	TYPE
SL60	10/05/17	1	HYD-HZMB
WL15	13/04/17	1	HKCRP
WL62	13/03/17	1	HKCRP
WL91	07/04/17	3	HYD-HZMB
	10/05/17	1	HYD-HZMB

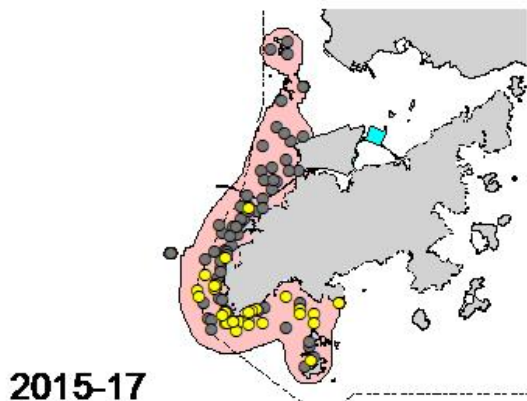
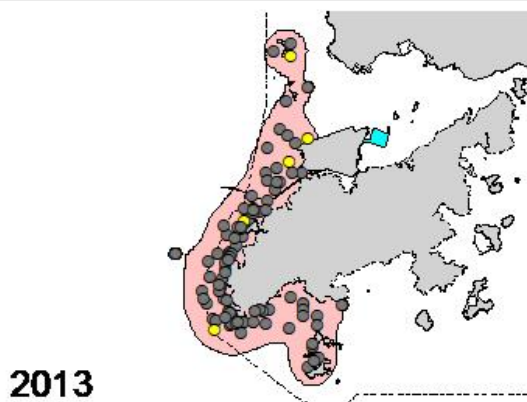
Appendix V. Four individual dolphins that were identified in Southwest Lantau survey area during March-May 2017



Appendix VI. Ranging patterns (95% kernel ranges) of four individual dolphins that were sighted in Southwest Lantau survey area during March-May 2017 (note: yellow dots indicates sightings made in the respective years of 2012-17)



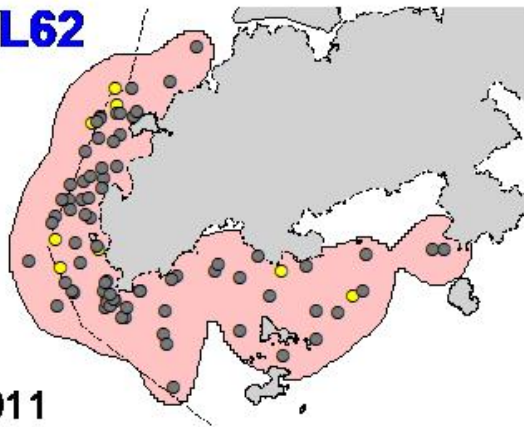
WL15



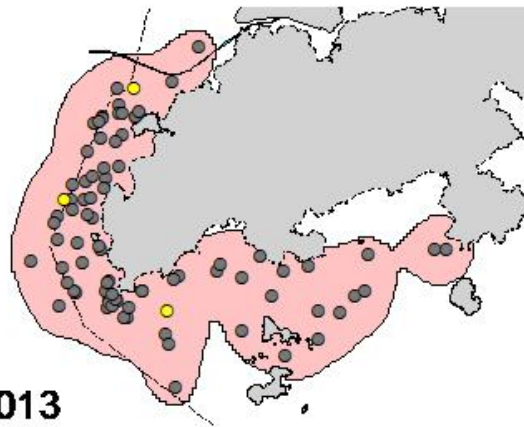
Appendix VI. (cont'd)

WL62

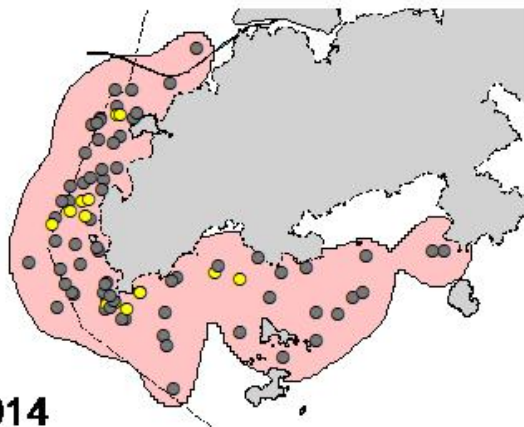
2011



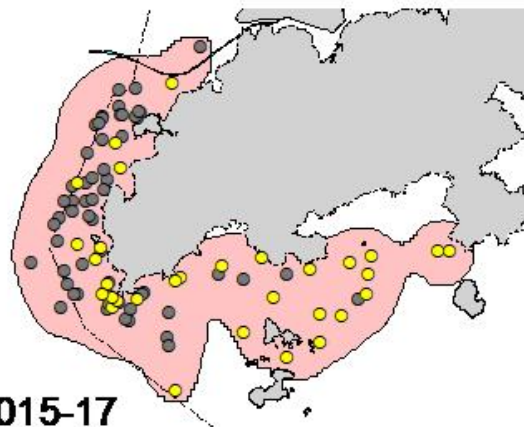
2013



2014

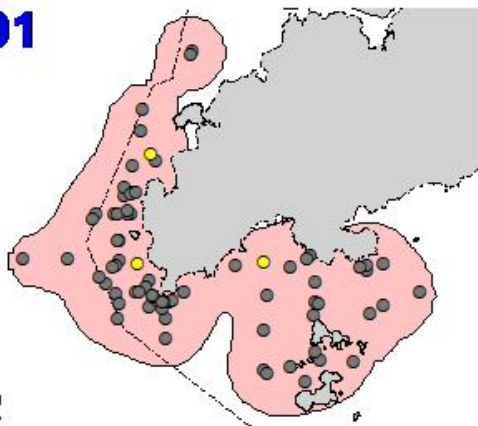


2015-17

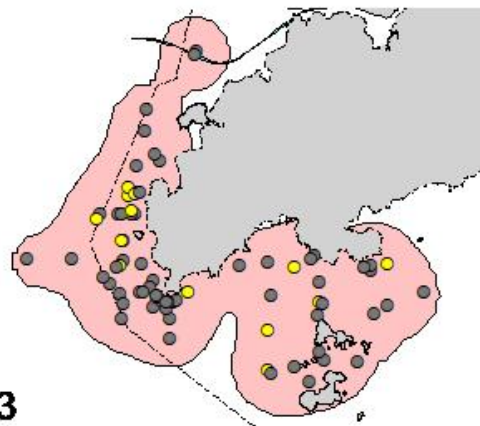


WL91

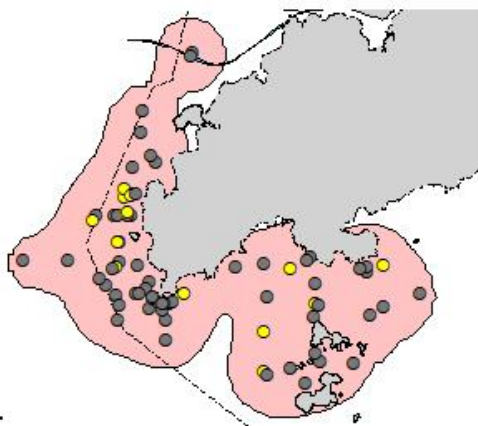
2012



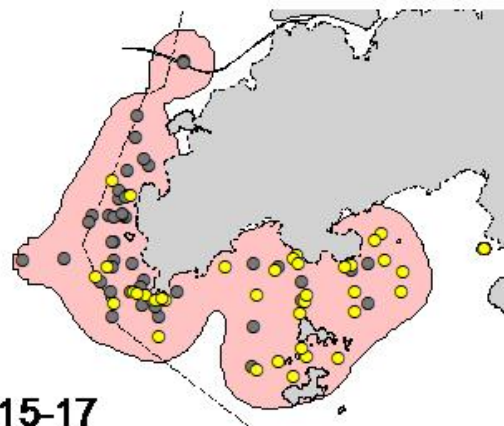
2013



2014



2015-17



Appendix VII. Individual dolphins identified in Lingding Bay during monitoring surveys conducted in the eastern section of the Pearl River Estuary during August 2015 to August 2016 by the South China Sea Fisheries Research Institute (courtesy of the Hong Kong-Zhuhai-Macao Bridge Authority for providing the data)

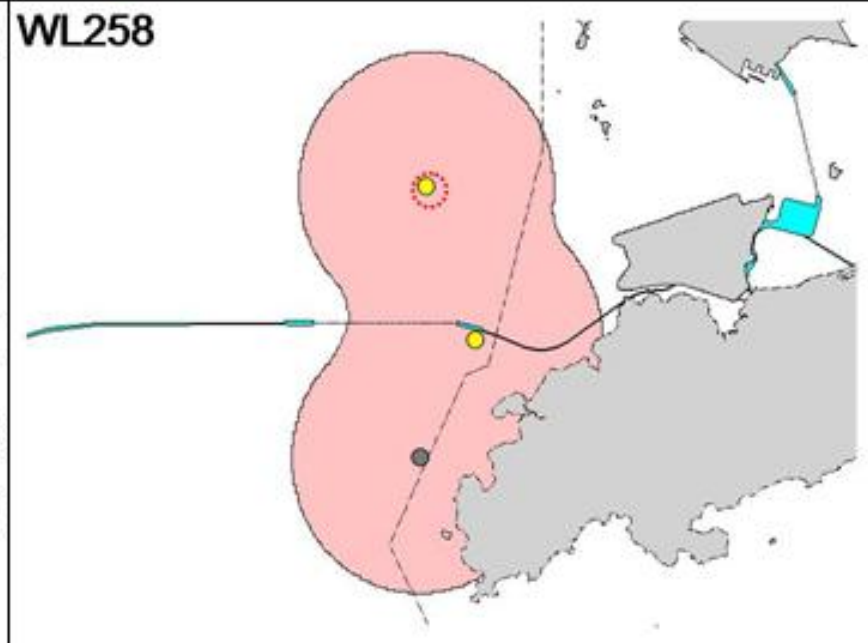
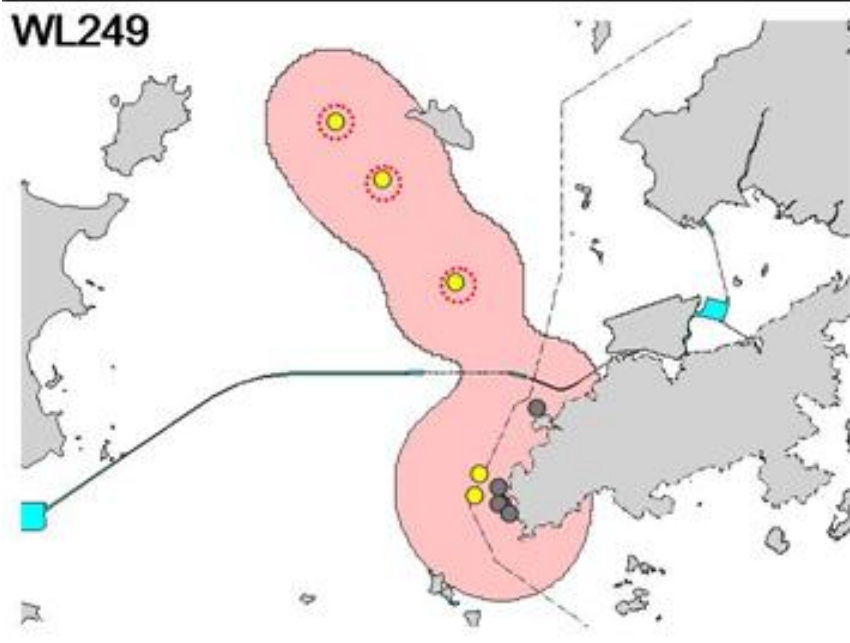
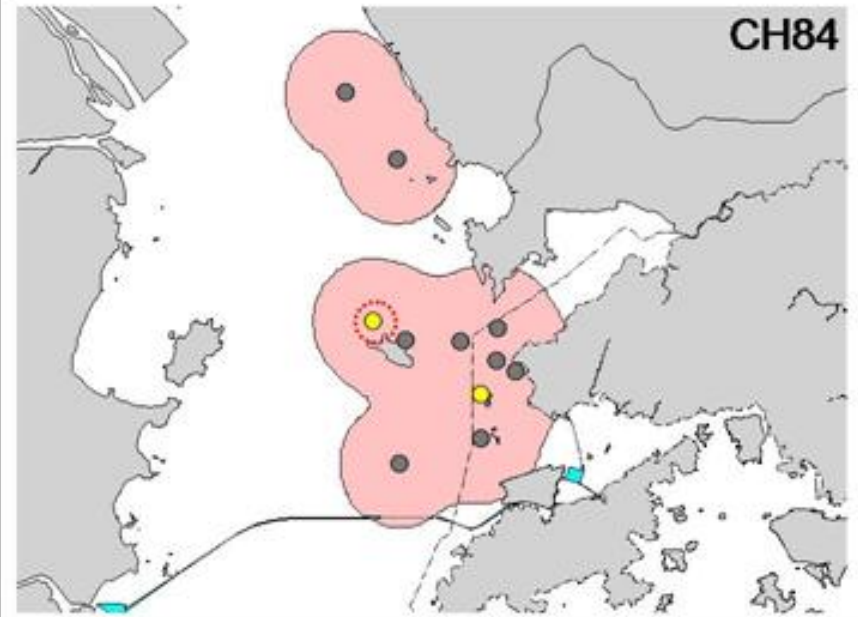
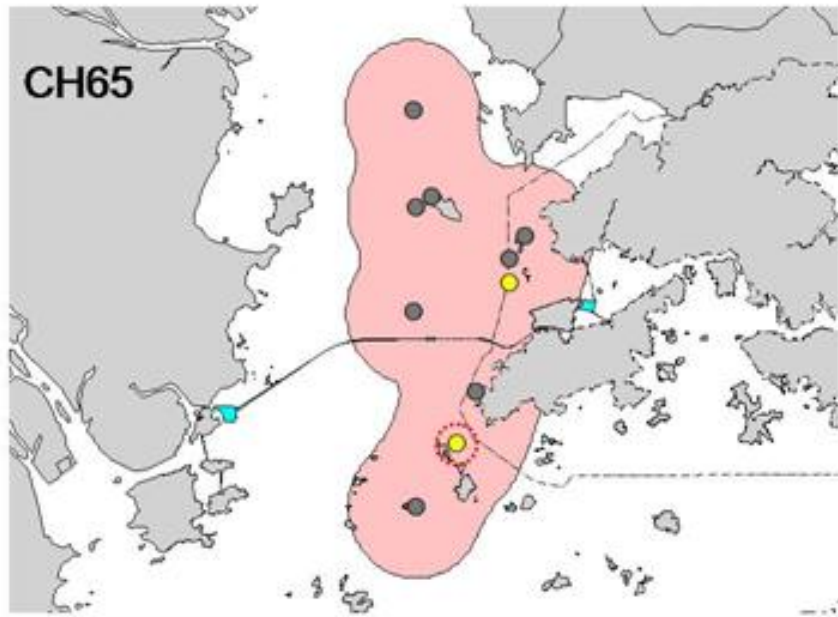
ID#	DATE	STG#	AREA
CH27	02/01/16	3	NLDB
	06/08/16	1	NLDB
CH38	05/01/16	1	SLDB
CH65	09/08/16	5	SLDB
CH84	23/10/15	3	CLDB
CH113	03/01/16	3	CLDB
CH153	09/08/16	2	SLDB
CH165	23/09/15	3	MA
	01/05/16	1	CLDB
	11/05/16	2	MA
CH174	23/10/15	1	CLDB
CH179	30/03/16	2	SLDB
	31/03/16	8	MA
	10/08/16	2	MA
CH180	31/03/16	7	MA
CH182	20/08/15	1	SLDB
	23/09/15	3	MA
	31/03/16	2	MA
CH189	02/01/16	2	NLDB
CH195	23/09/15	2	MA
	30/03/16	1	SLDB
CH198	06/01/16	6	MA
CH200	28/02/16	7	CLDB
CH205	08/12/15	5	CLDB
	04/01/16	1	CLDB
CH206	10/12/15	1	SLDB
CH209	28/02/16	9	CLDB
	28/04/16	2	CLDB
	13/05/16	1	CLDB
CH210	22/09/15	4	MA
CH213	24/10/15	5	SLDB
	18/03/16	2	CLDB
EL01	22/09/15	2	SLDB
MA38	20/08/15	5	MA
MA44	20/08/15	5	MA
	11/12/15	1	MA
NL12	23/10/15	2	CLDB
	28/02/16	5	CLDB
NL37	04/01/16	2	SLDB

ID#	DATE	STG#	AREA
NL80	20/09/15	3	CLDB
	23/10/15	7	CLDB
	18/03/16	1	CLDB
NL98	09/08/16	2	SLDB
NL103	18/03/16	1	CLDB
NL104	23/10/15	2	CLDB
	18/03/16	1	CLDB
NL120	09/08/16	2	SLDB
NL123	19/08/15	6	SLDB
	04/01/16	2	SLDB
NL145	04/01/16	2	SLDB
NL150	18/03/16	1	CLDB
NL202	18/03/16	3	CLDB
NL210	18/03/16	1	CLDB
NL224	19/08/15	9	SLDB
	18/03/16	1	CLDB
NL226	09/08/16	2	SLDB
NL233	23/10/15	2	CLDB
	18/03/16	1	CLDB
NL236	04/01/16	2	SLDB
NL247	17/08/15	1	CLDB
	12/05/16	2	SLDB
NL249	18/03/16	2	CLDB
NL256	28/02/16	3	CLDB
	18/03/16	1	CLDB
	12/05/16	3	SLDB
NL260	04/01/16	2	SLDB
NL261	23/10/15	8	CLDB
	28/02/16	3	CLDB
NL264	04/01/16	2	SLDB
NL269	09/08/16	5	SLDB
NL279	08/12/15	2	CLDB
	02/01/16	2	NLDB
	27/02/16	2	NLDB
NL281	20/09/15	3	CLDB
	23/10/15	7	CLDB
	24/10/15	5	SLDB
NL284	18/03/16	1	CLDB
NL285	19/08/15	6	SLDB
NL286	18/03/16	3	CLDB

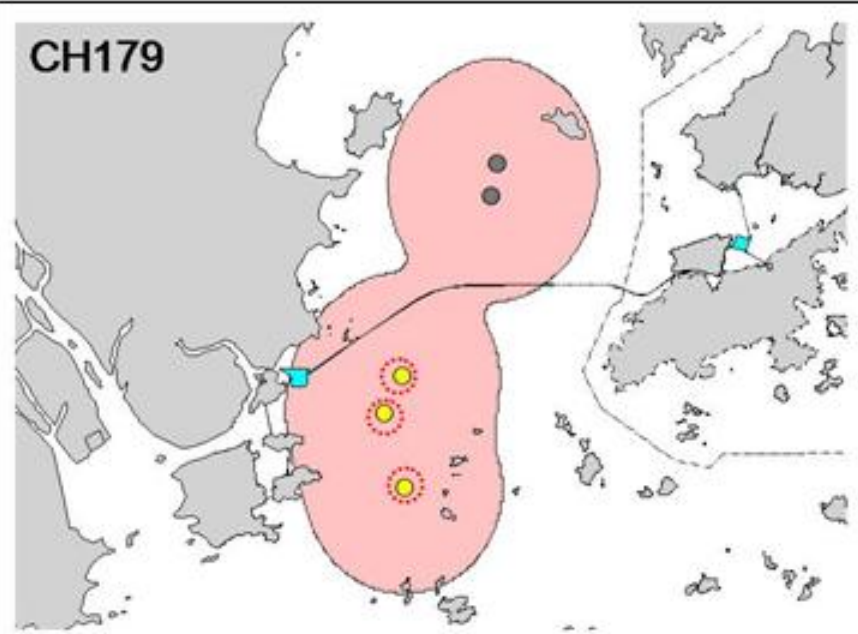
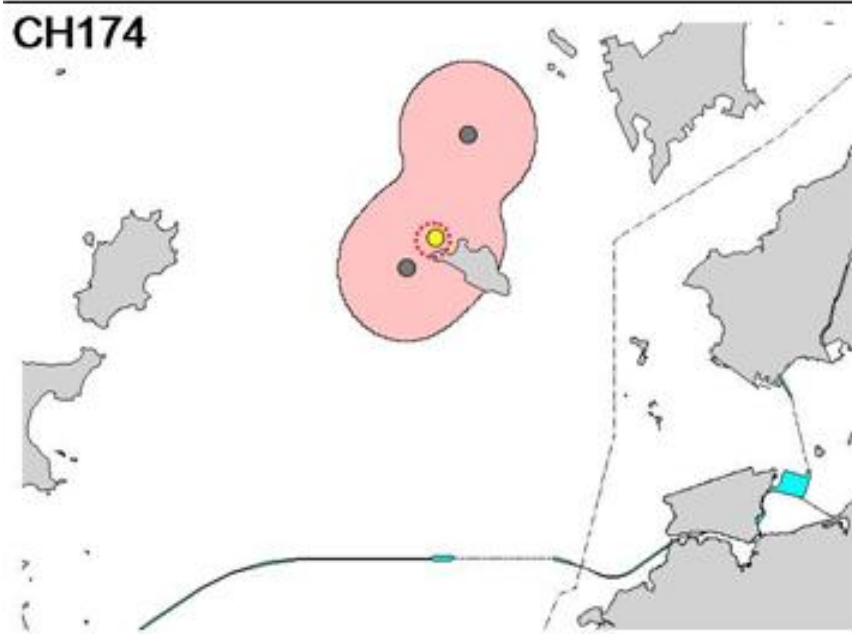
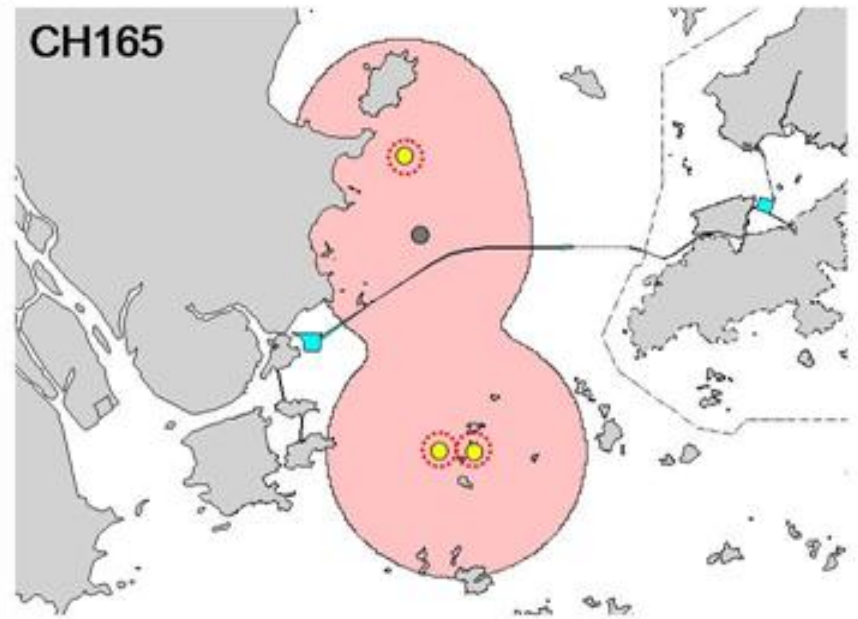
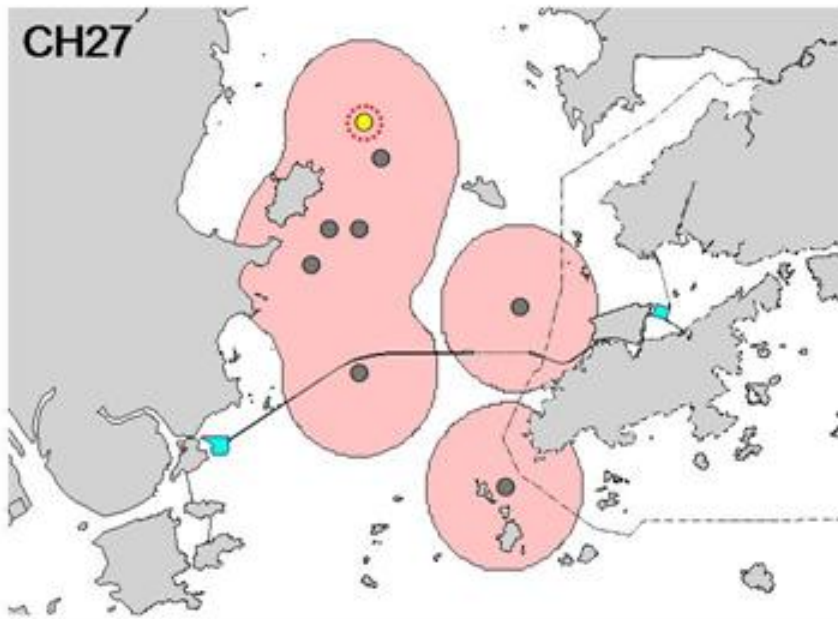
Appendix VII. (cont'd)

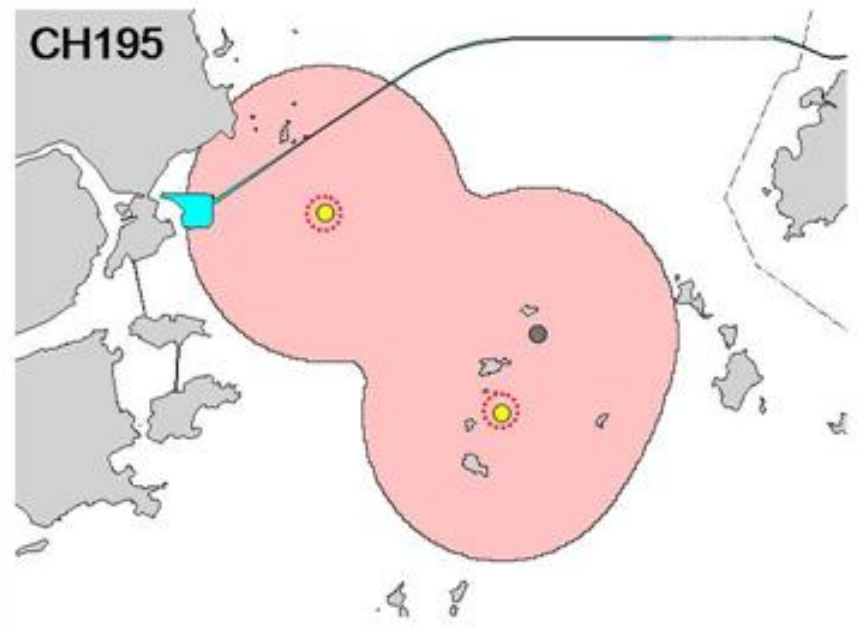
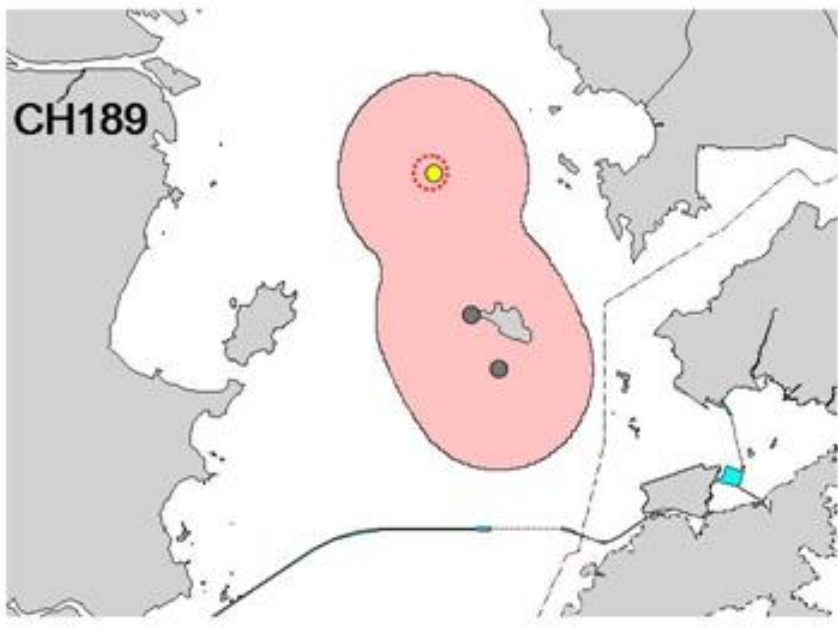
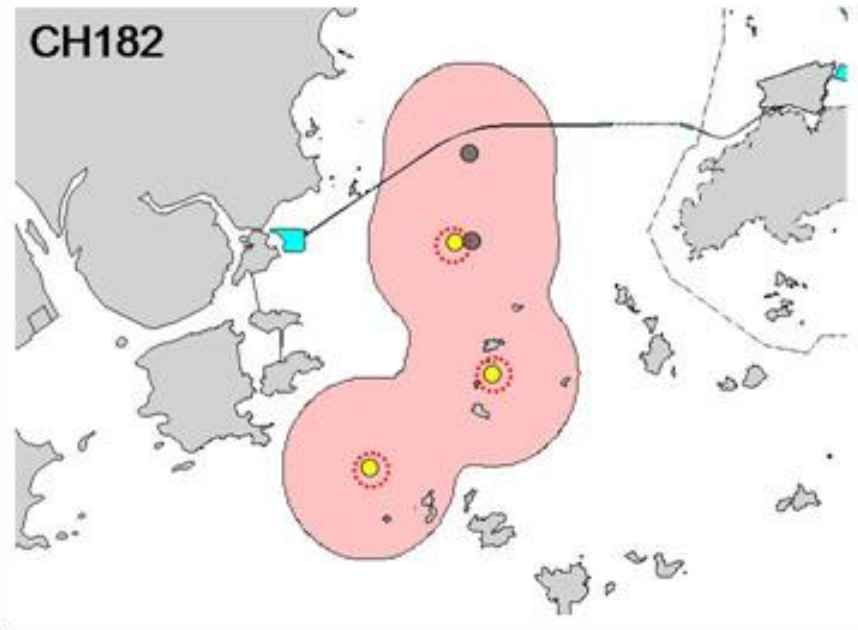
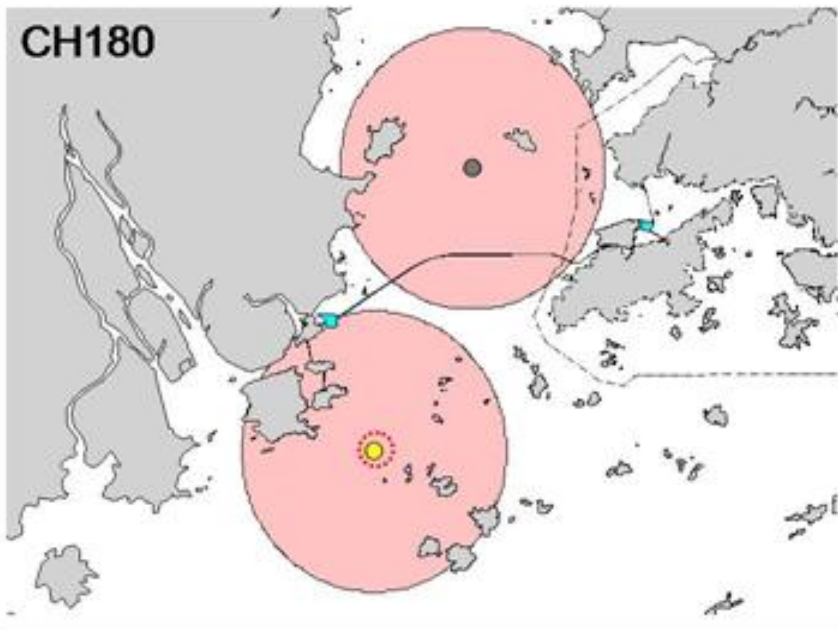
ID#	DATE	STG#	AREA
NL287	03/01/16	4	CLDB
	28/02/16	3	CLDB
NL288	04/01/16	2	SLDB
NL295	04/01/16	2	SLDB
	12/05/16	2	SLDB
NL296	04/01/16	2	SLDB
NL299	18/03/16	1	CLDB
NL301	20/09/15	3	CLDB
	18/03/16	1	CLDB
NL302	23/10/15	2	CLDB
	03/01/16	4	CLDB
	18/03/16	1	CLDB
NL303	20/09/15	3	CLDB
	04/01/16	2	SLDB
NL304	22/09/15	2	SLDB
	09/08/16	2	SLDB
NL307	03/01/16	4	CLDB
	28/02/16	3	CLDB
NL317	19/08/15	5	CLDB
	28/02/16	3	CLDB
	18/03/16	1	CLDB
NL319	28/02/16	3	CLDB
NL320	28/02/16	3	CLDB
NL321	23/10/15	2	CLDB
	18/03/16	1	CLDB
SL05	05/01/16	1	SLDB
SL59	12/05/16	2	SLDB
WL05	04/01/16	2	SLDB
	28/04/16	5	SLDB
WL17	23/10/15	2	CLDB
	03/01/16	4	CLDB
WL21	23/10/15	3	CLDB
	03/01/16	3	CLDB
WL28	22/09/15	2	SLDB
WL42	05/01/16	1	SLDB
WL44	05/01/16	1	SLDB
WL46	12/05/16	2	SLDB
WL58	27/02/16	2	NLDB
WL66	23/10/15	3	CLDB
	24/10/15	5	SLDB
	03/01/16	3	CLDB
WL69	20/08/15	3	SLDB
	01/03/16	1	SLDB
WL74	09/08/16	3	SLDB

ID#	DATE	STG#	AREA
WL79	19/08/15	5	CLDB
	28/02/16	11	CLDB
	12/05/16	3	SLDB
WL94	05/01/16	1	SLDB
	09/08/16	4	SLDB
WL114	10/12/15	1	SLDB
	05/01/16	1	SLDB
WL116	10/12/15	1	SLDB
WL118	04/01/16	3	SLDB
	29/02/16	4	SLDB
WL124	03/01/16	4	CLDB
WL128	10/12/15	1	SLDB
	09/08/16	3	SLDB
WL129	10/12/15	1	SLDB
WL131	05/01/16	1	SLDB
WL142	09/08/16	3	SLDB
WL144	10/12/15	1	SLDB
	05/01/16	1	SLDB
	30/03/16	5	SLDB
WL145	09/08/16	2	SLDB
WL163	30/03/16	5	SLDB
WL168	20/08/15	4	SLDB
	30/03/16	4	SLDB
	31/03/16	8	MA
WL193	03/01/16	4	CLDB
WL200	19/08/15	4	CLDB
	04/01/16	3	SLDB
	29/02/16	2	SLDB
WL206	09/08/16	2	SLDB
WL214	17/03/16	3	NLDB
WL216	23/10/15	3	CLDB
WL226	03/01/16	4	CLDB
WL231	28/02/16	3	CLDB
WL236	10/12/15	1	SLDB
WL249	08/12/15	3	CLDB
	04/01/16	1	CLDB
	07/08/16	2	CLDB
WL258	19/08/15	4	CLDB
WL260	05/01/16	1	SLDB
	09/08/16	4	SLDB
WL261	09/08/16	5	SLDB
WL262	20/08/15	4	SLDB
	05/01/16	1	SLDB
WL265	22/09/15	2	SLDB

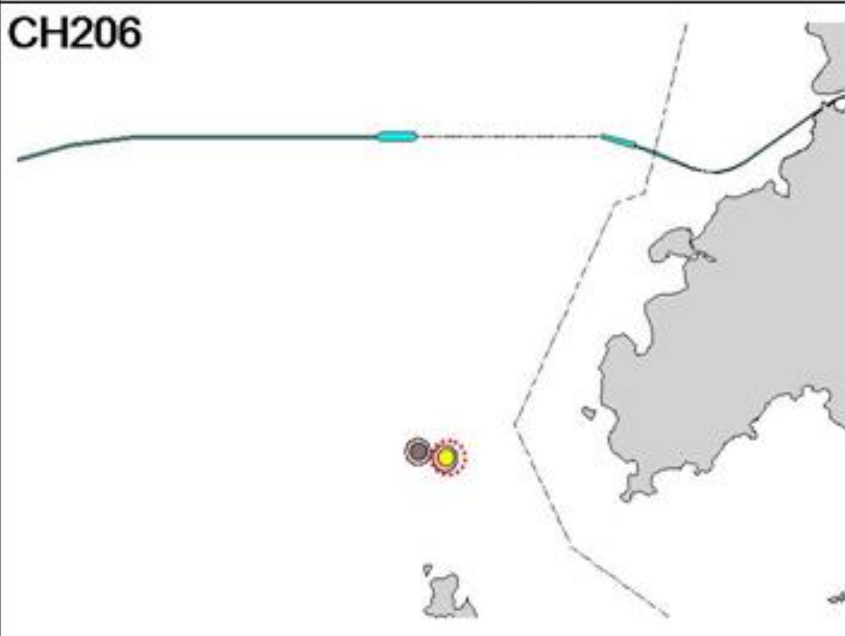
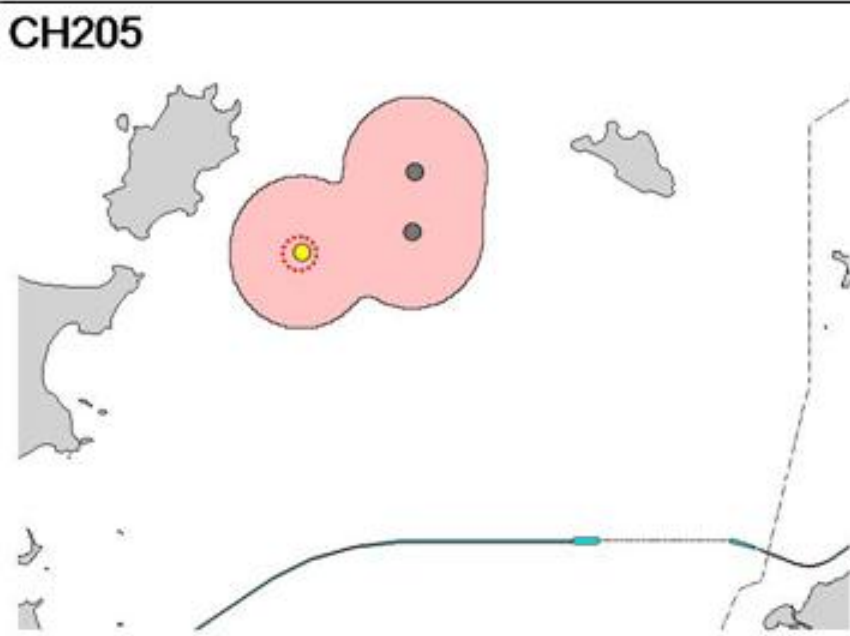
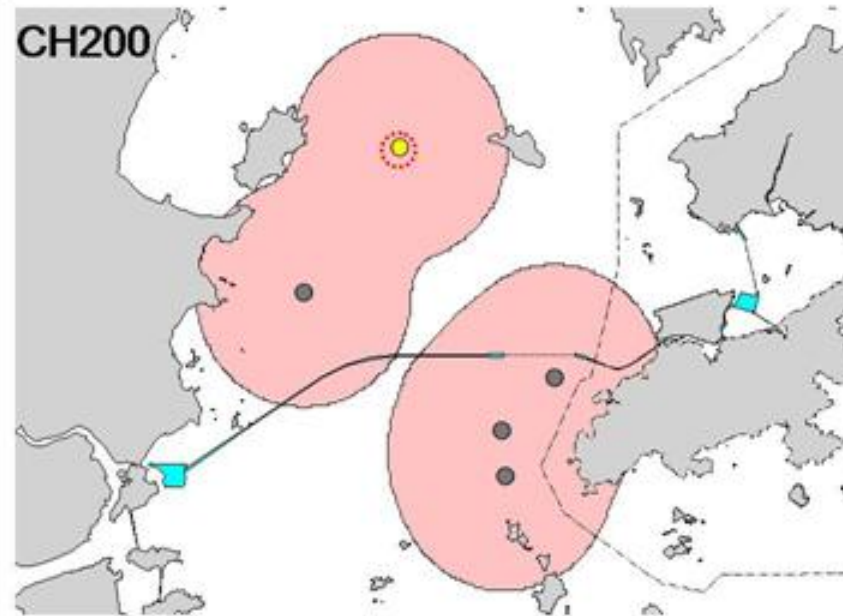
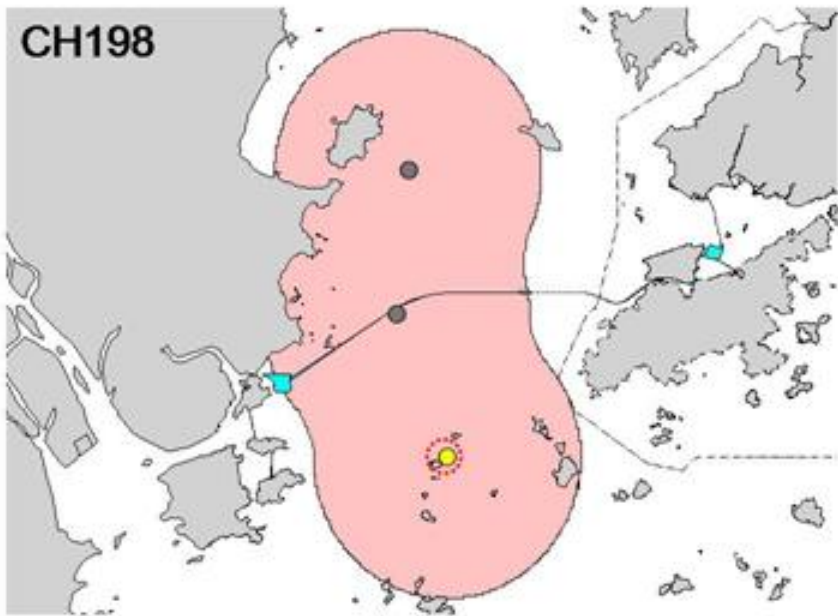


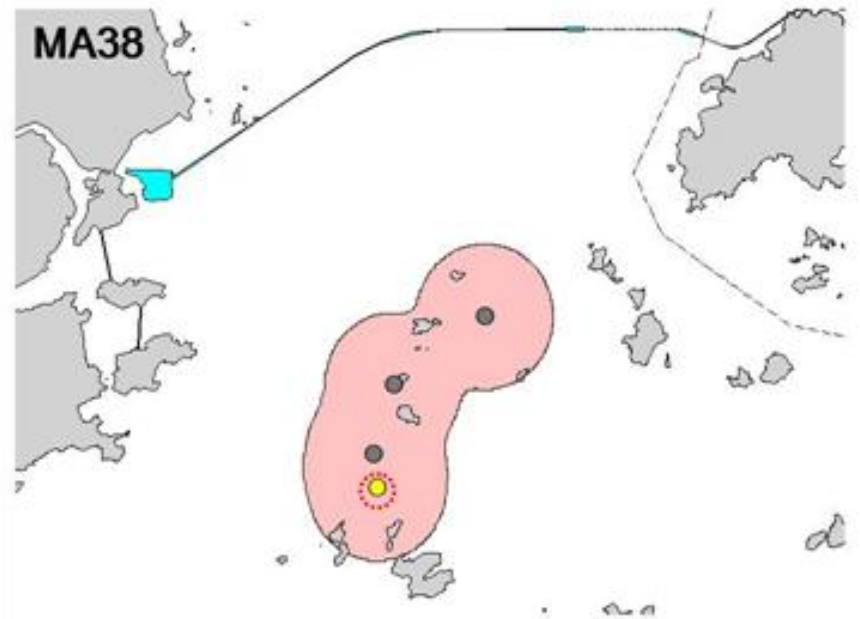
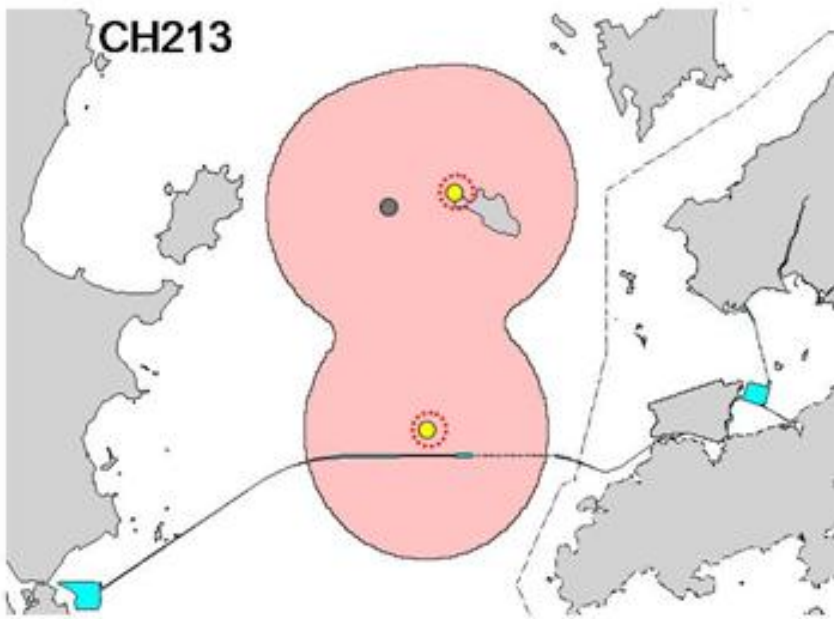
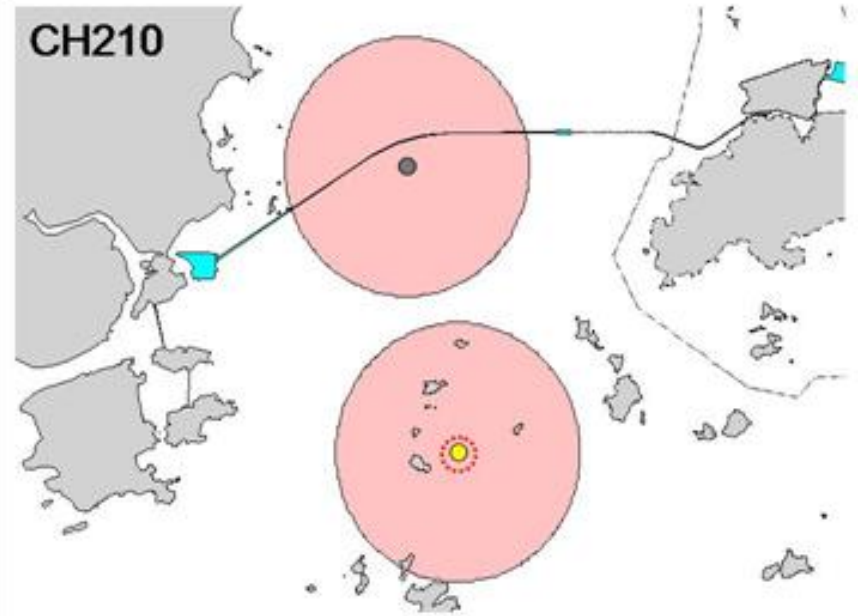
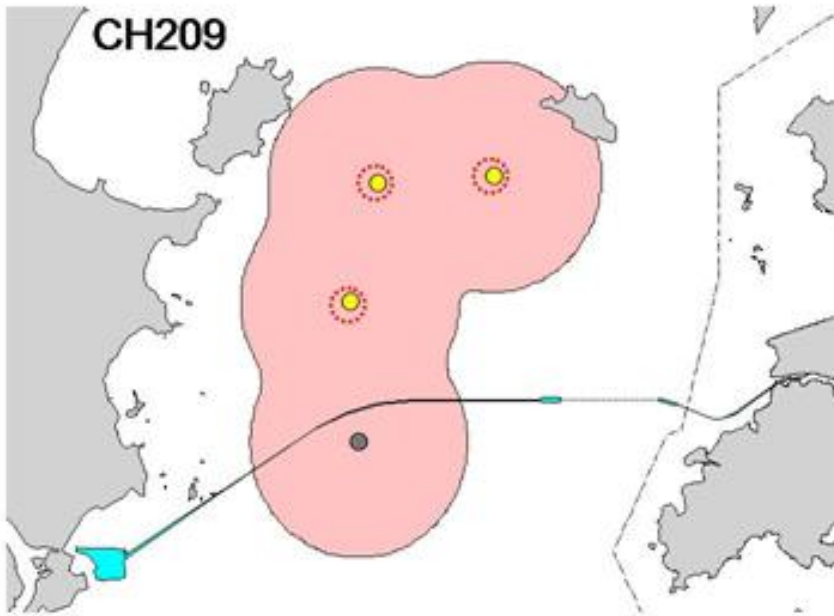
Appendix VIII. Twenty-one individuals sighted during the 2015-16 surveys in Lingding Bay that have never or rarely occurred in Hong Kong waters in the past (yellow dots: sightings made in 2015-16; red circle: sightings made during 2015-16 surveys in Lingding Bay)

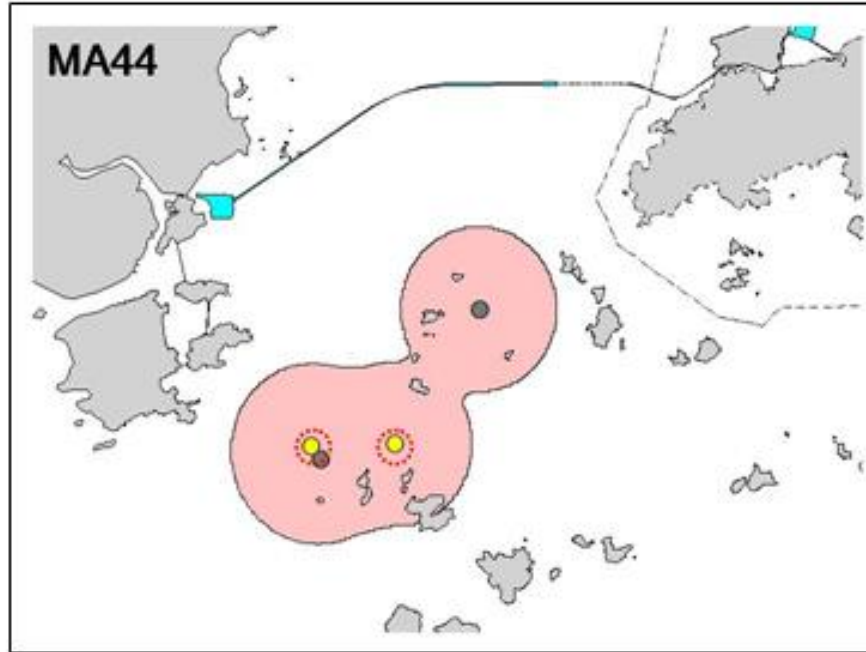




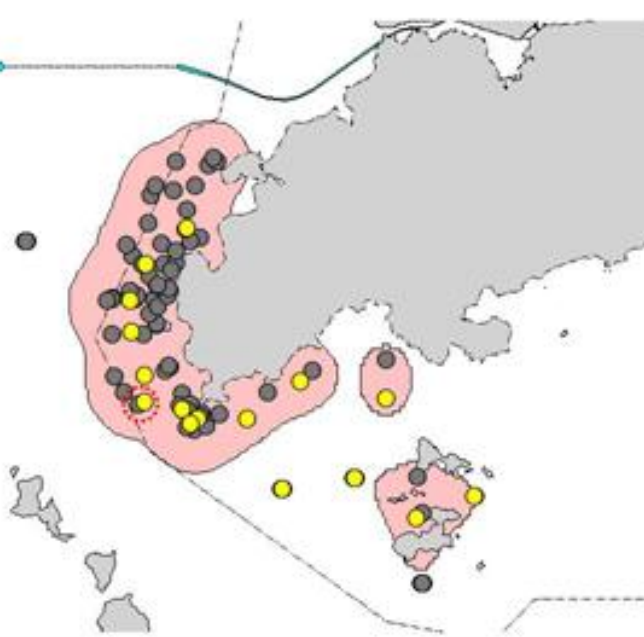
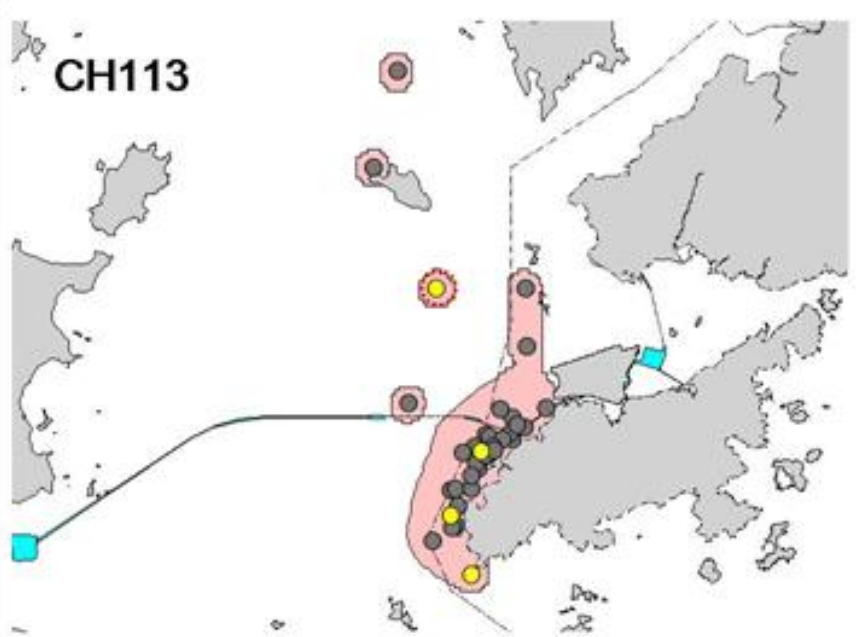
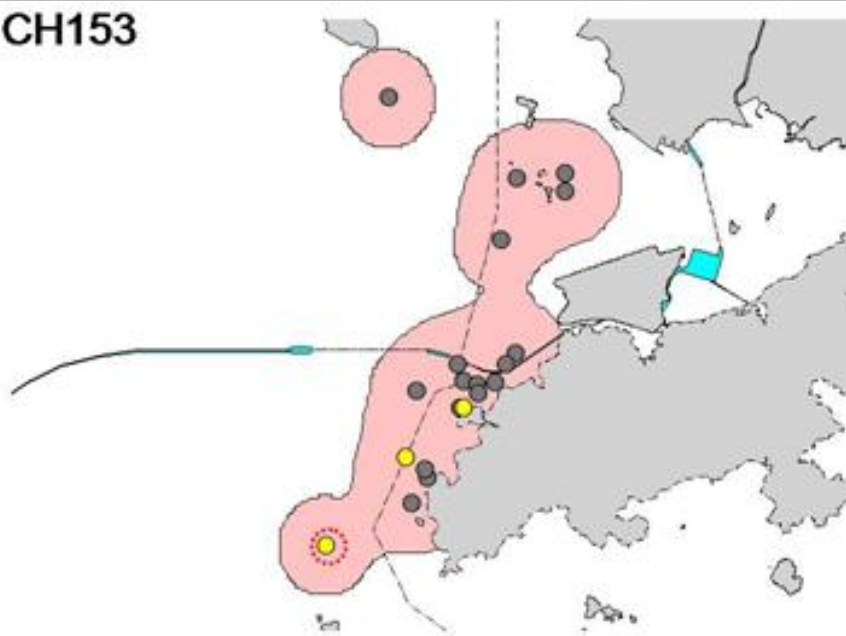
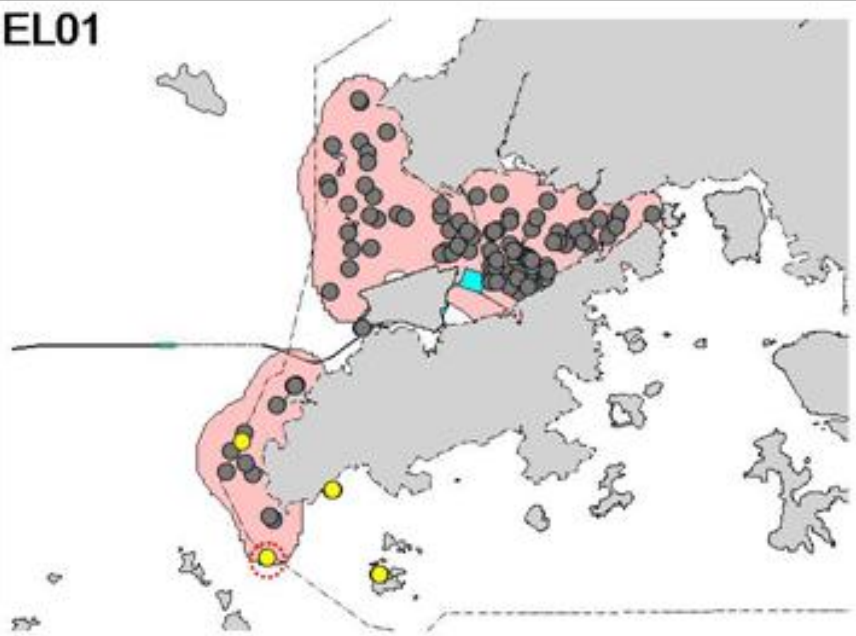
Appendix VIII. (cont'd)





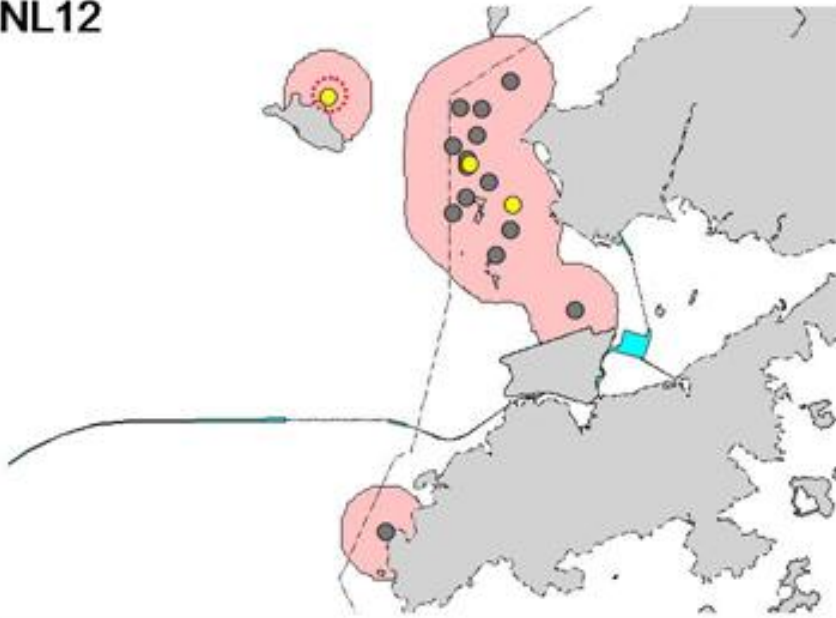


Appendix VIII. (cont'd)

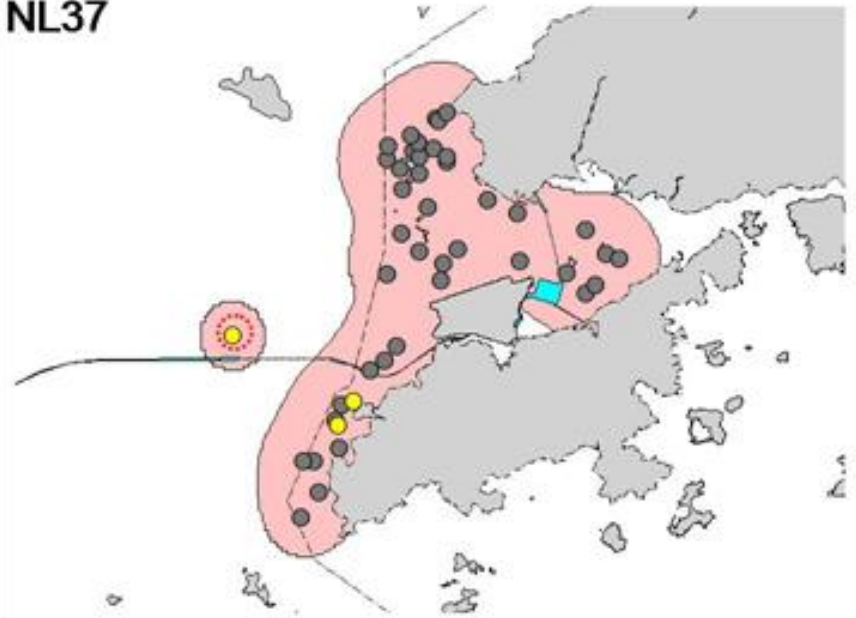
CH38**CH113****CH153****EL01**

Appendix IX. Eighty-six individuals sighted during the 2015-16 surveys in Lingding Bay that were also sighted in Hong Kong waters regularly (yellow dots: sightings made in 2015-16; red circle: sightings made during 2015-16 surveys in Lingding Bay)

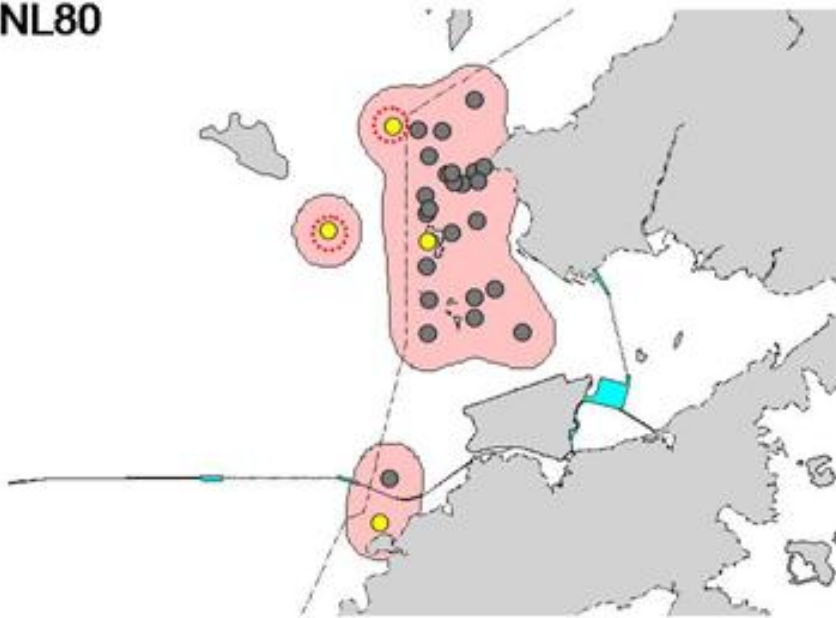
NL12



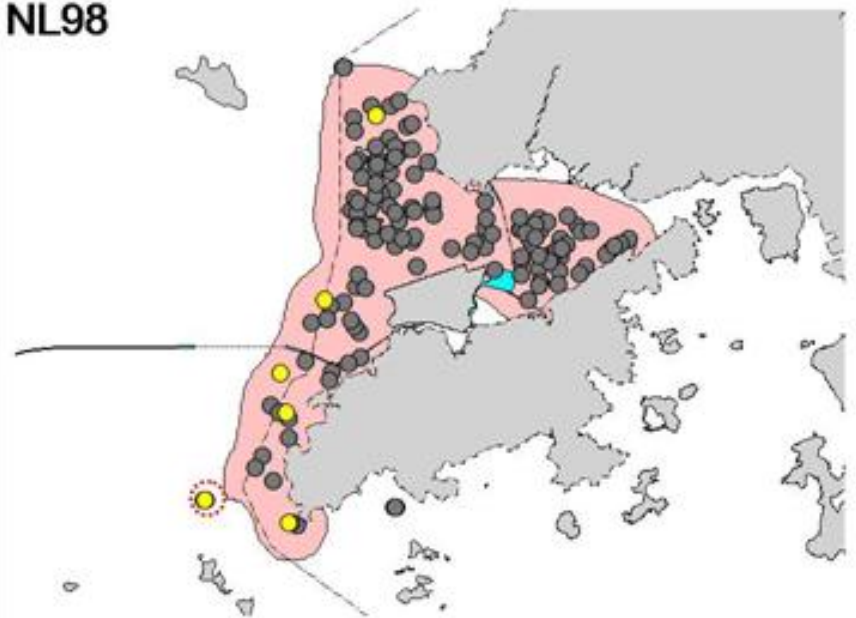
NL37



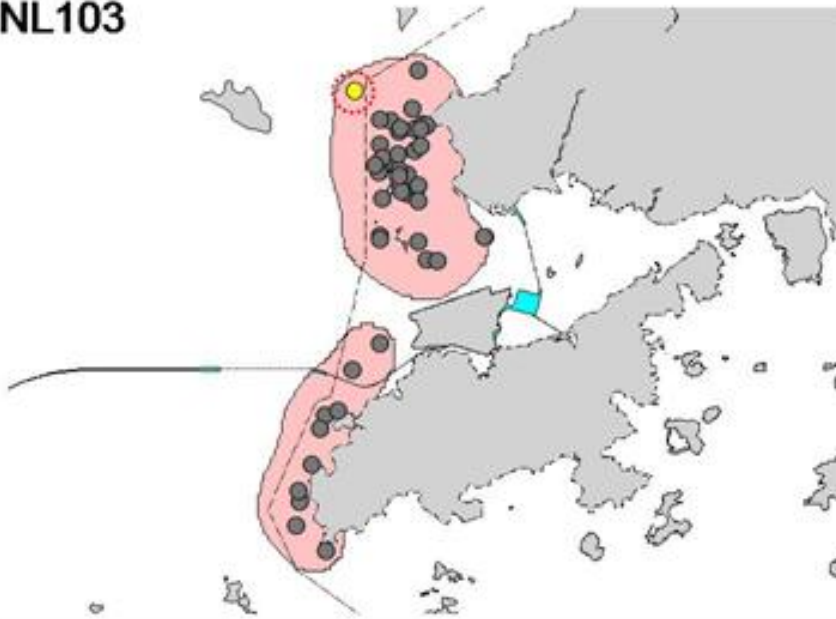
NL80



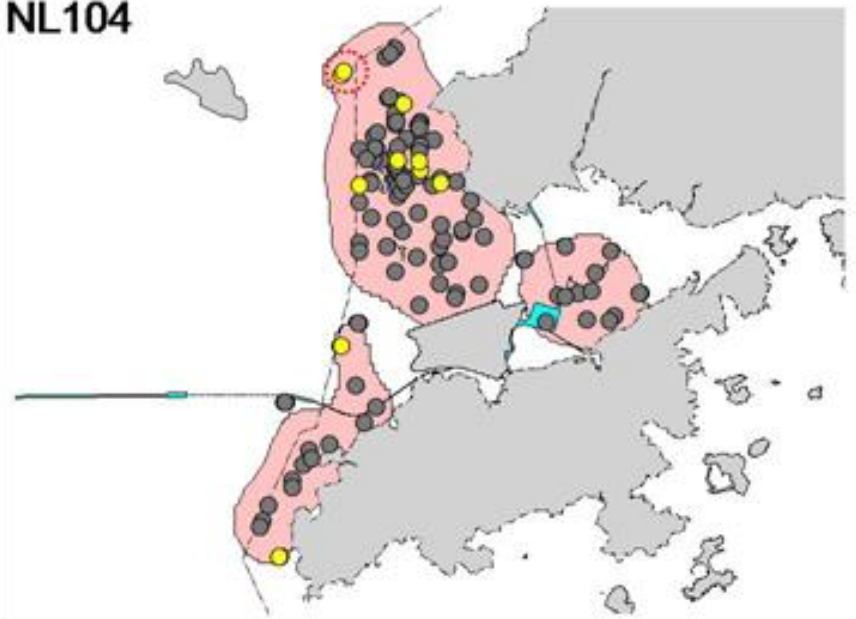
NL98



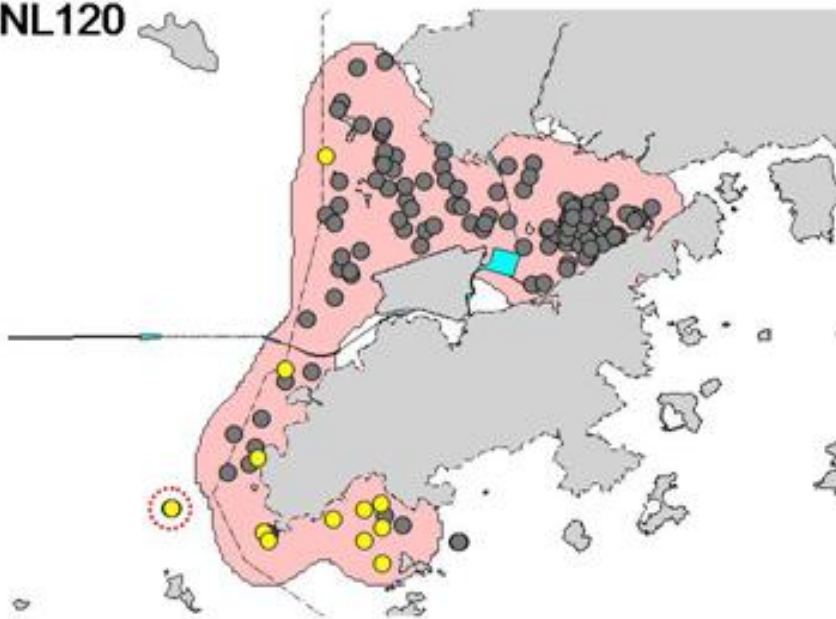
NL103



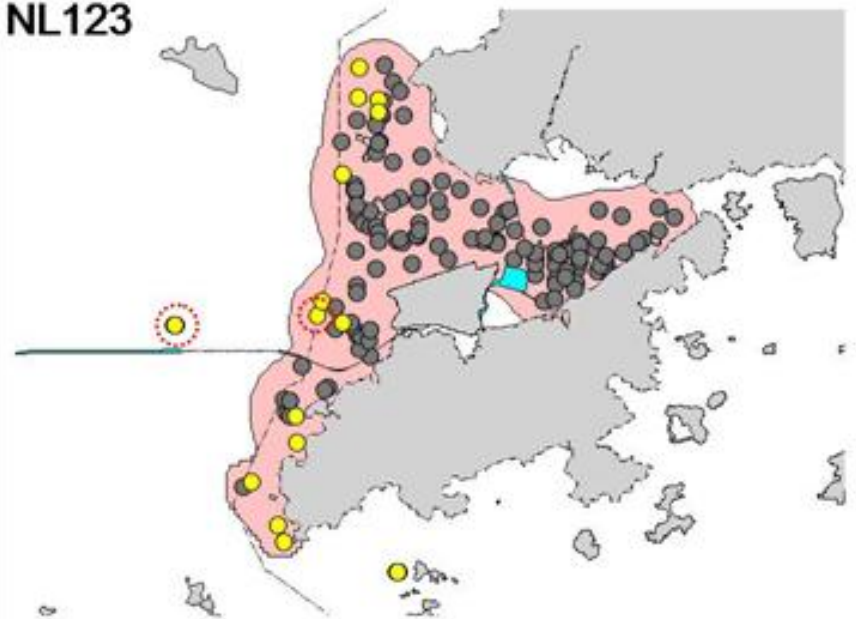
NL104



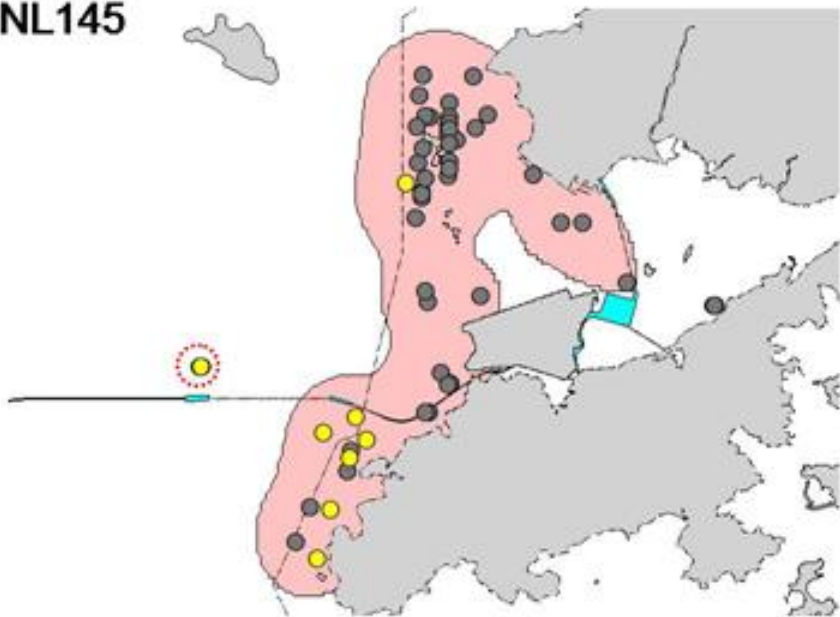
NL120



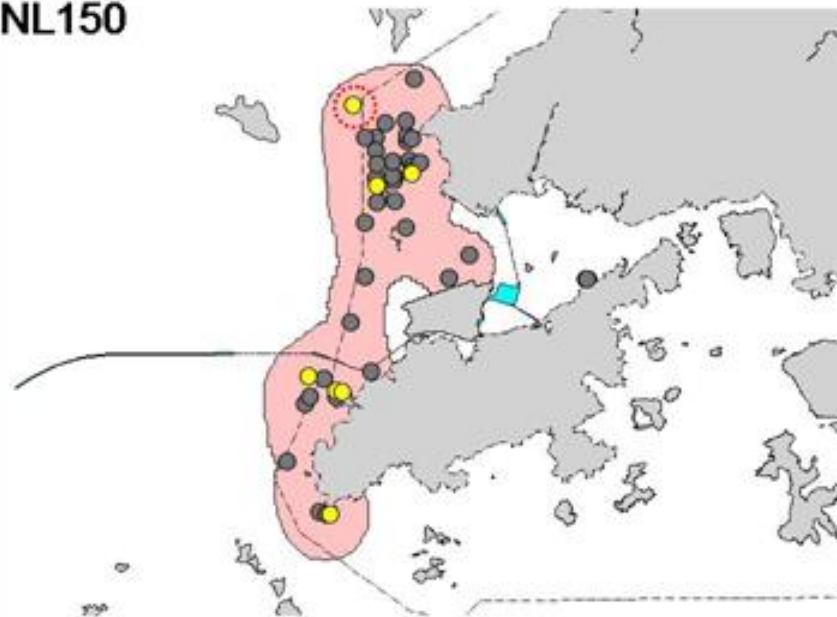
NL123



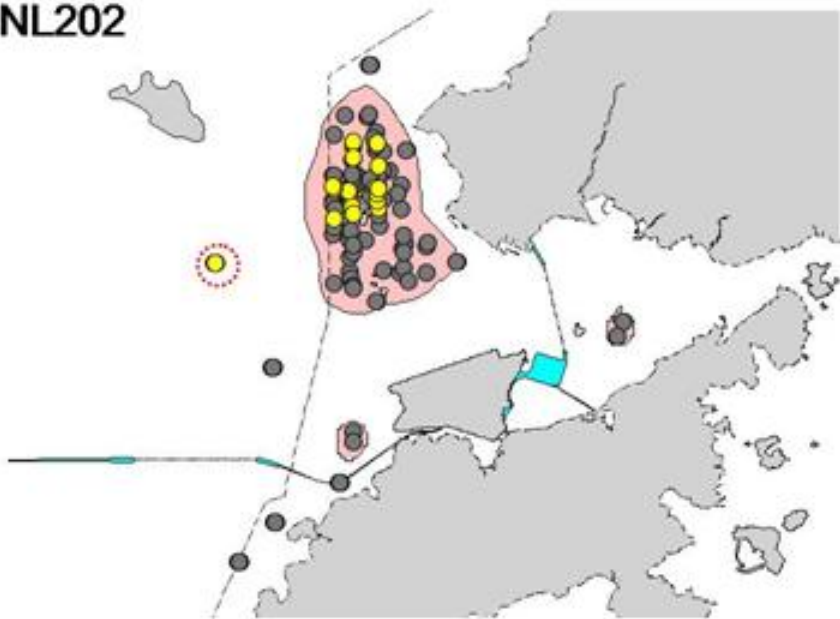
NL145



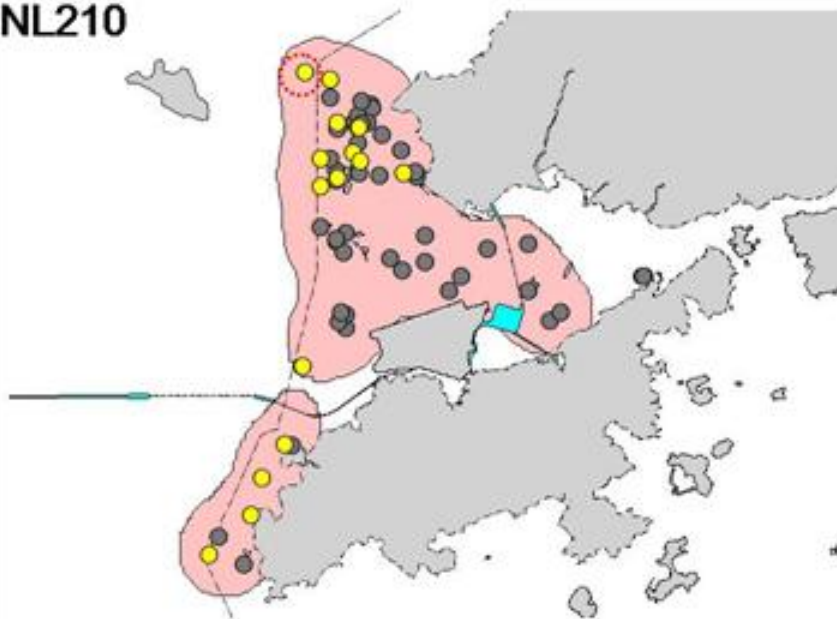
NL150



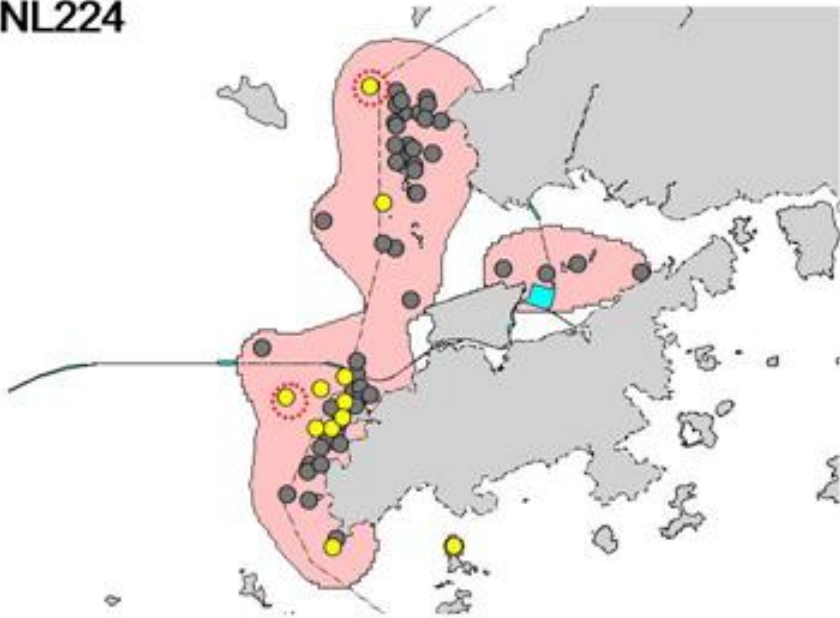
NL202



NL210



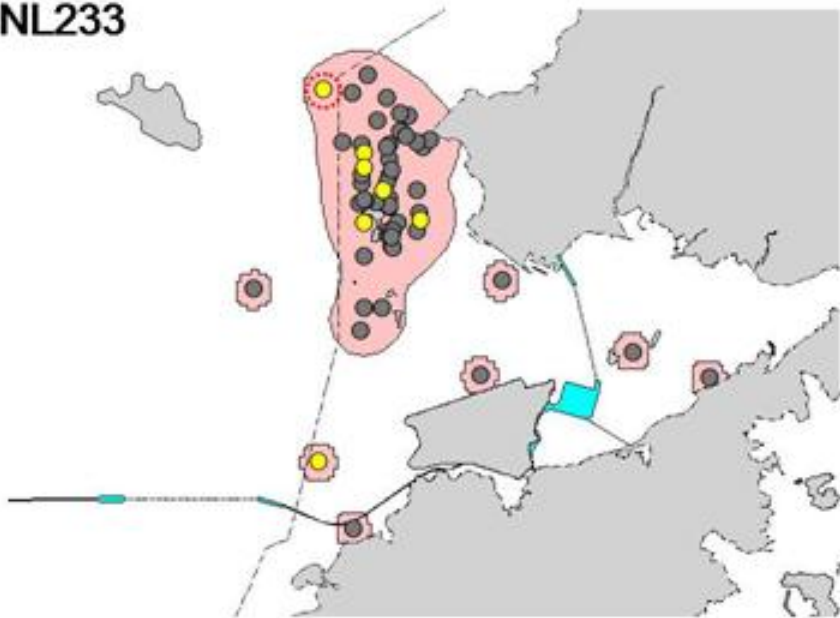
NL224



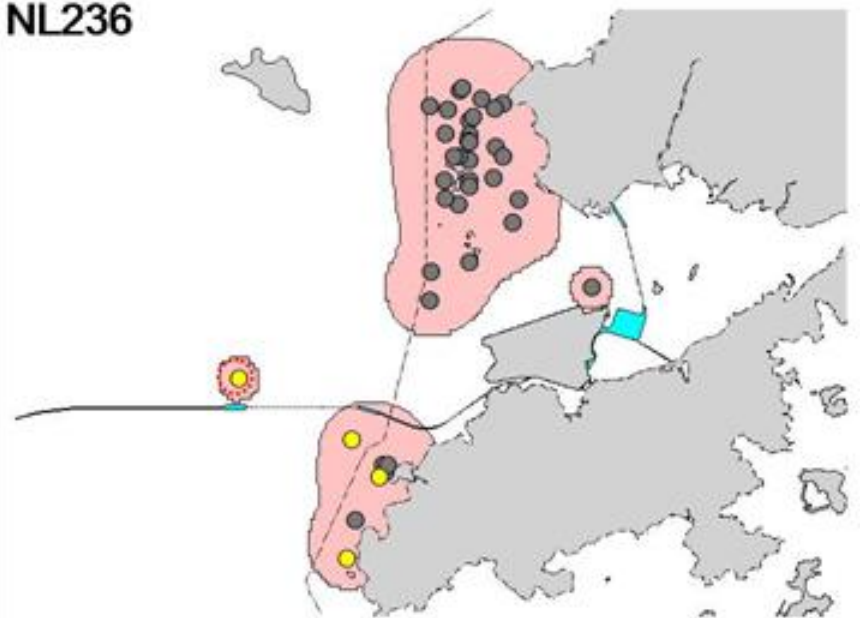
NL226



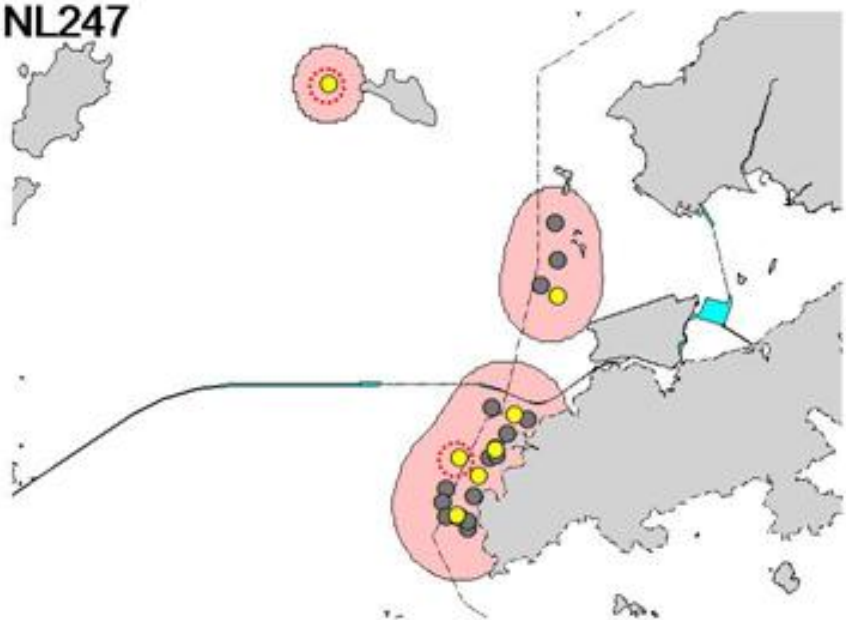
NL233



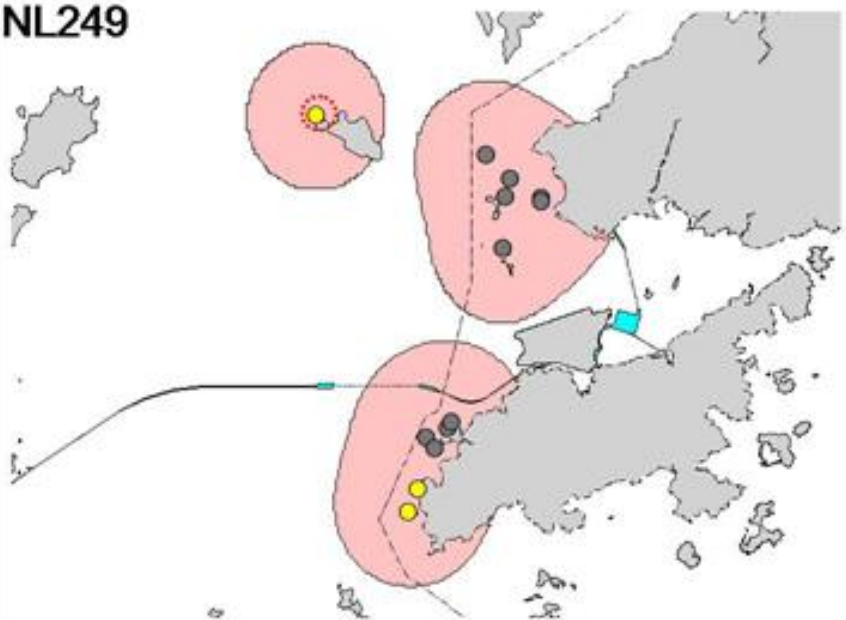
NL236



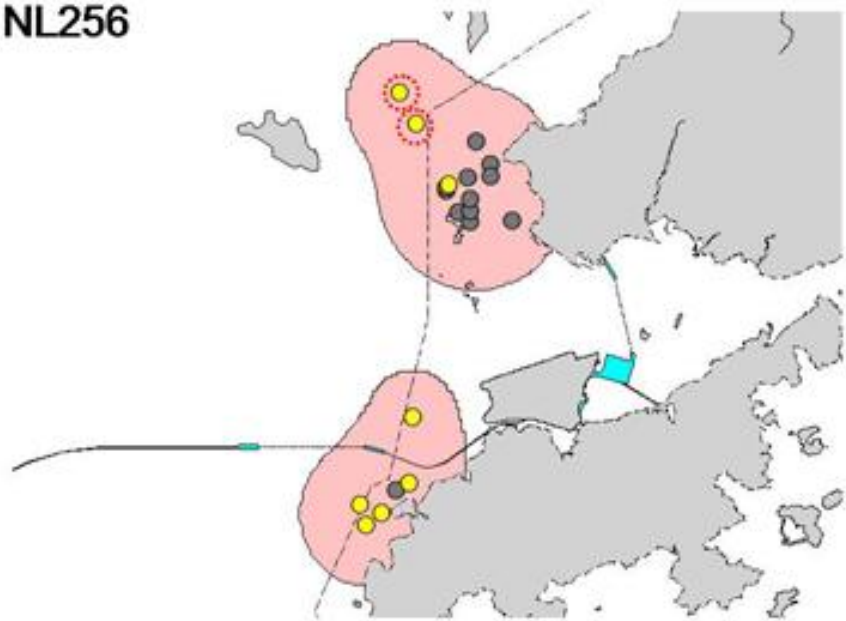
NL247



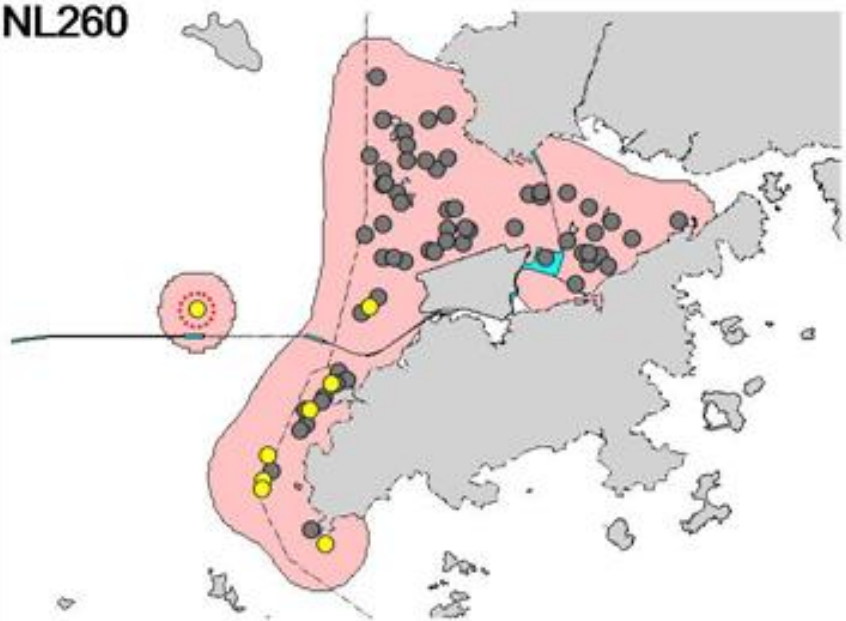
NL249



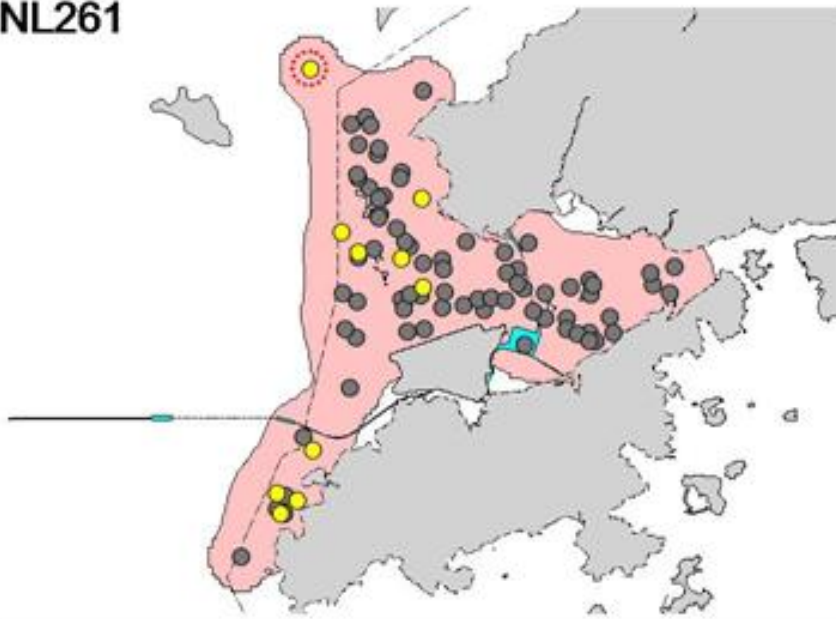
NL256



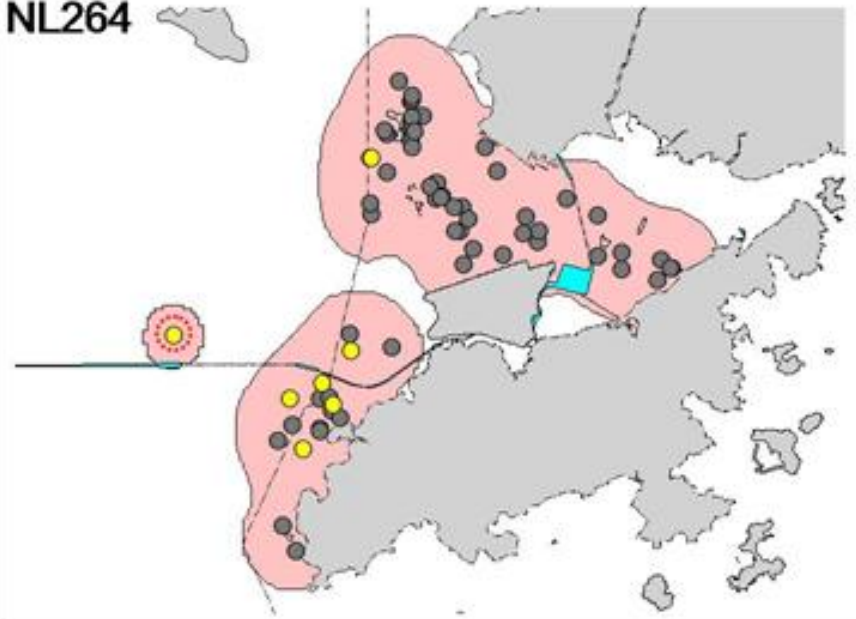
NL260



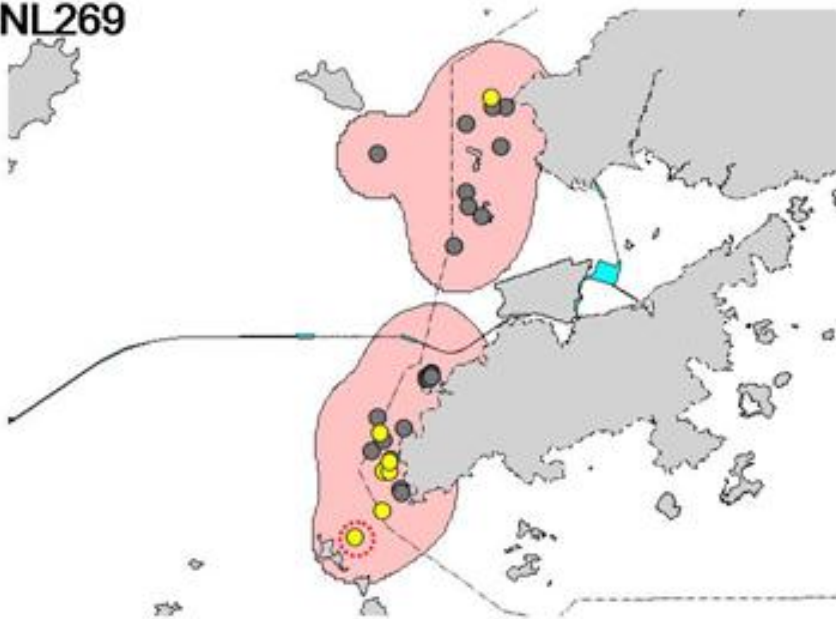
NL261



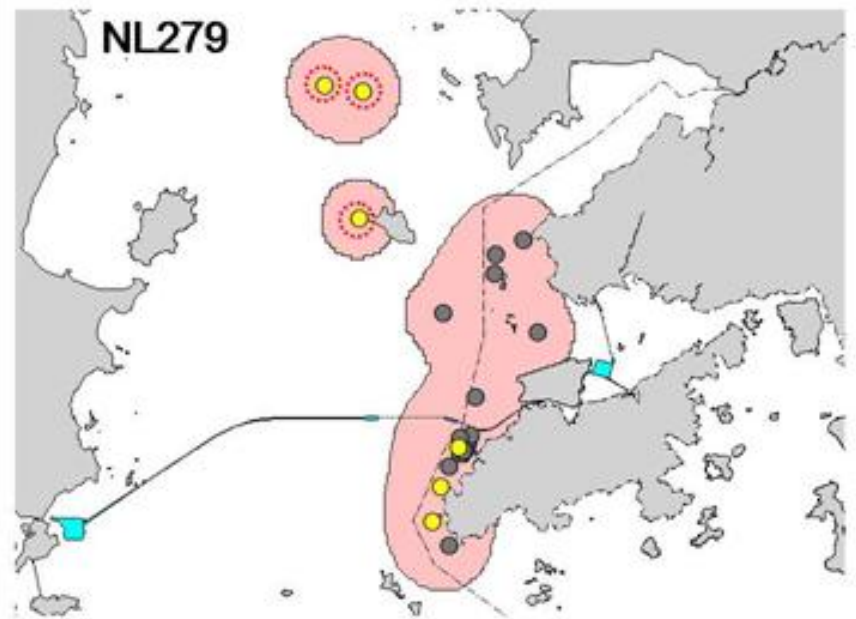
NL264



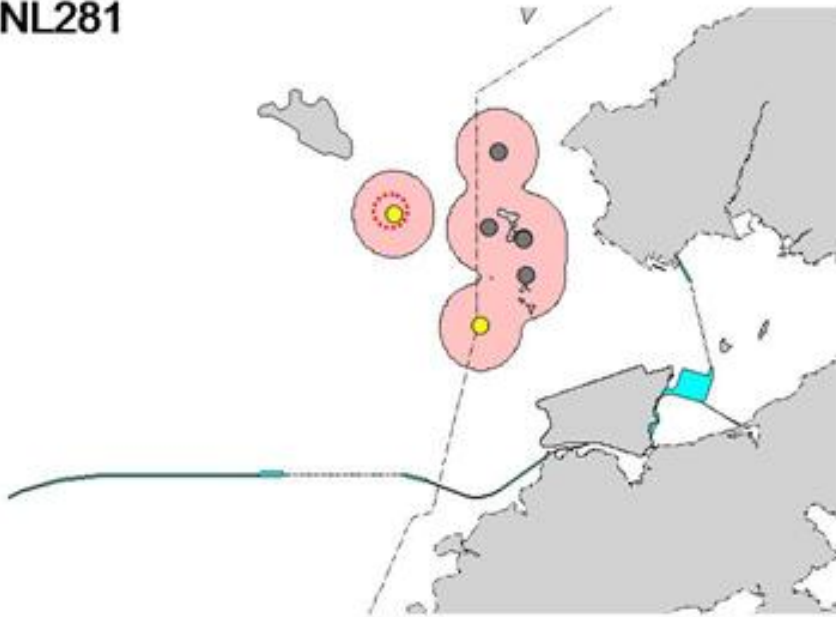
NL269



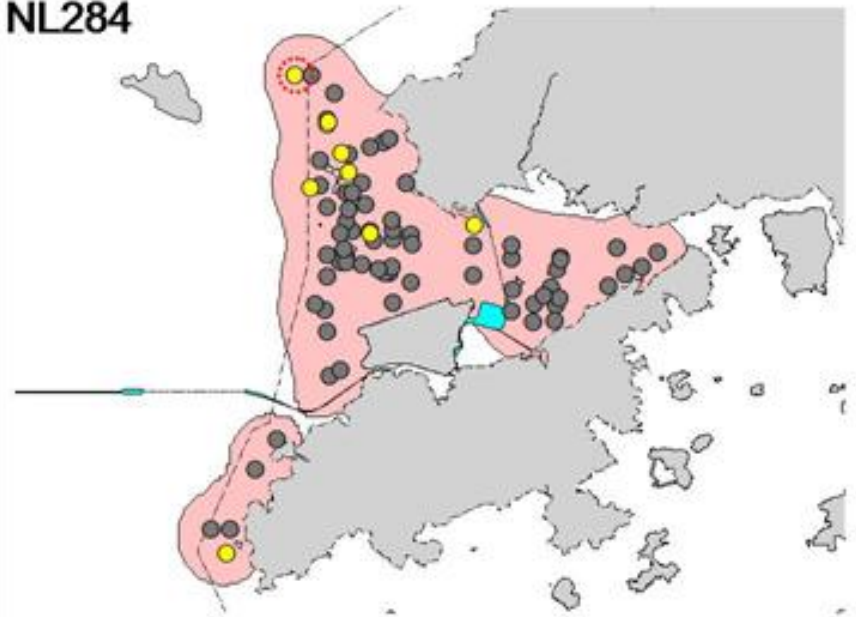
NL279



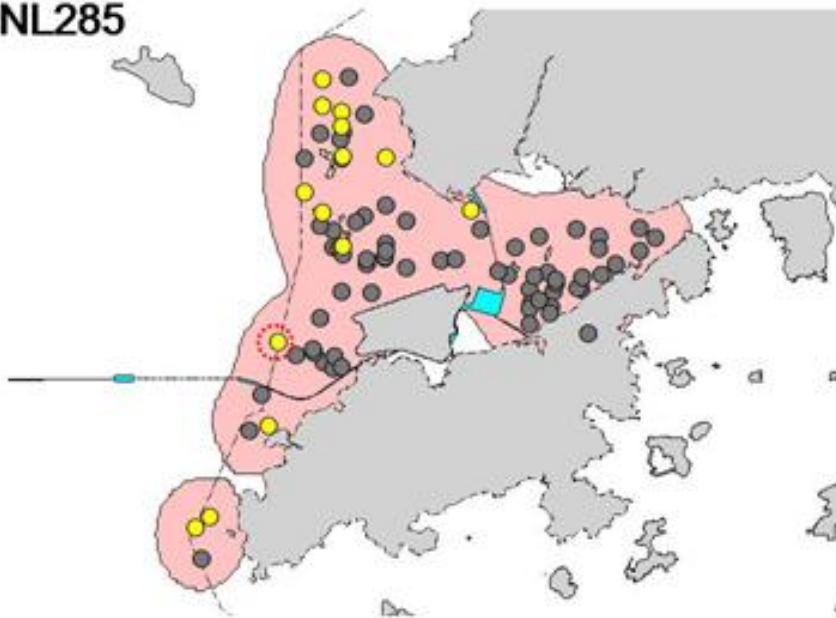
NL281



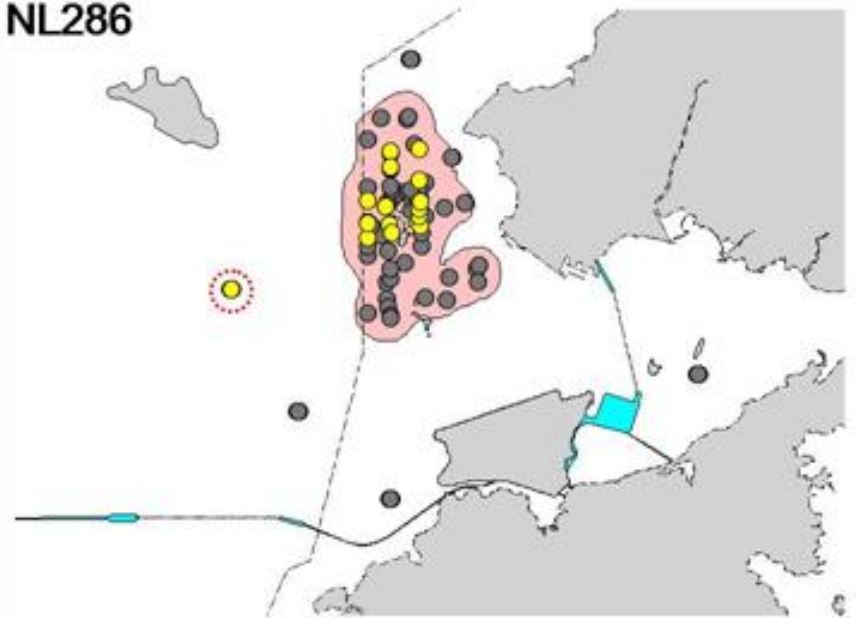
NL284



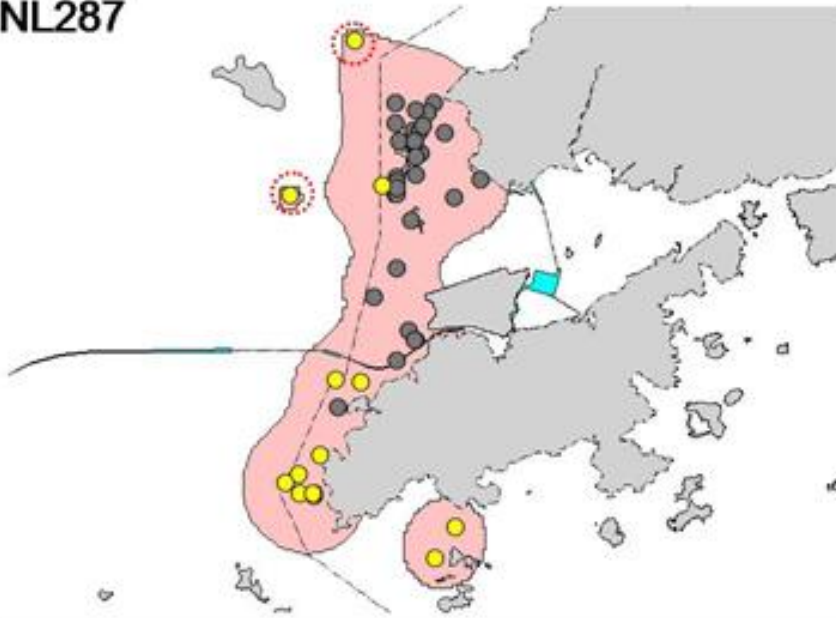
NL285



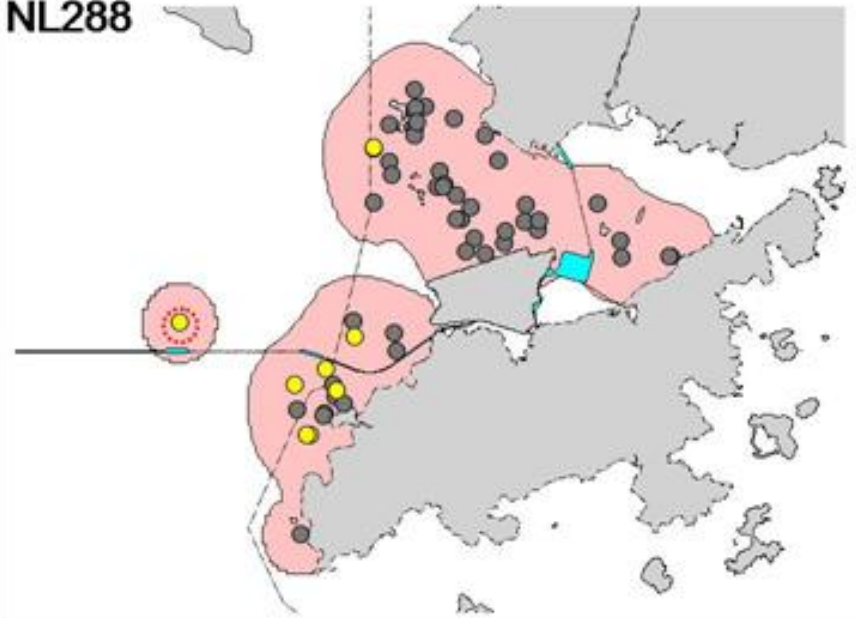
NL286



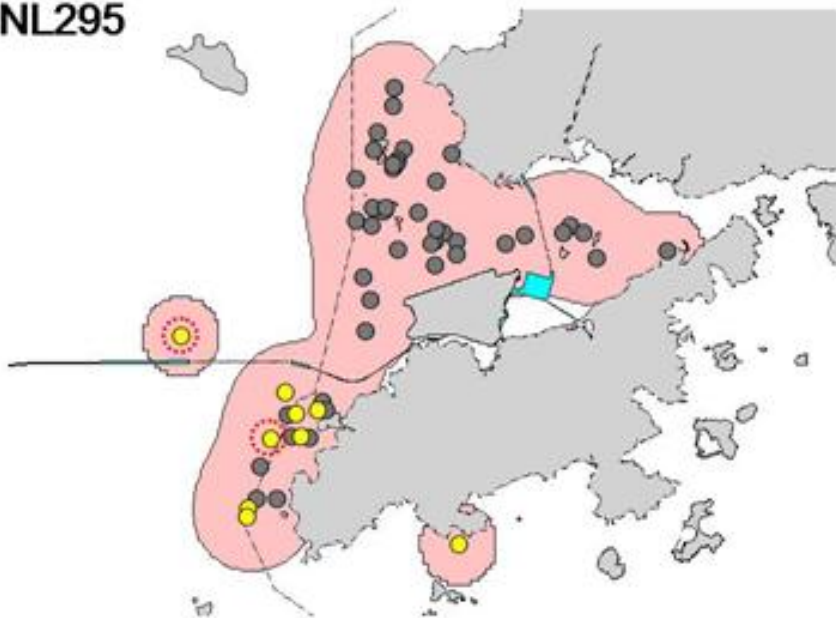
NL287



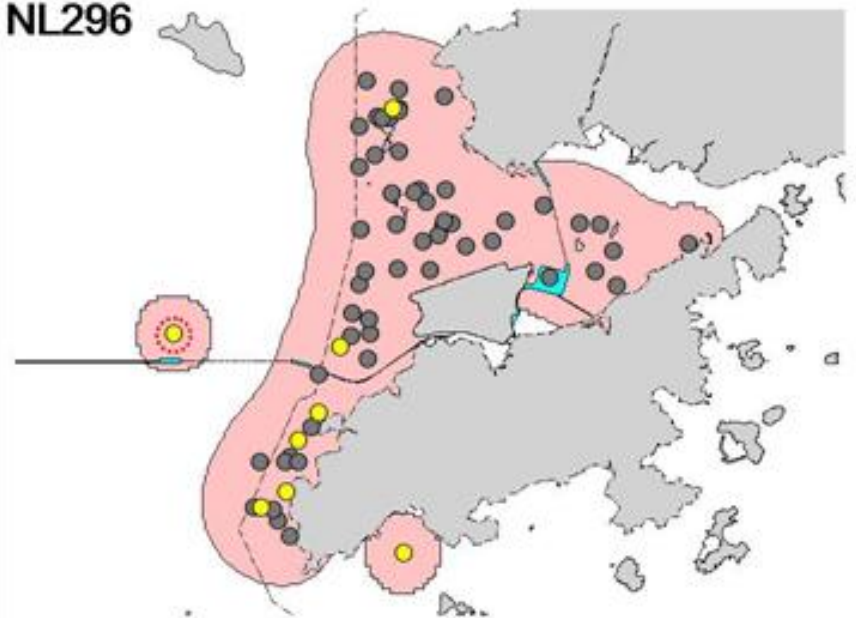
NL288



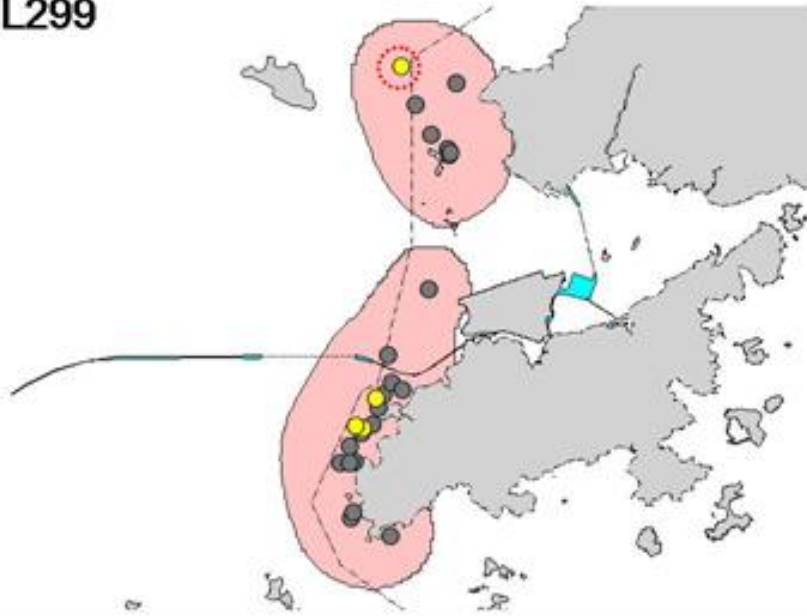
NL295



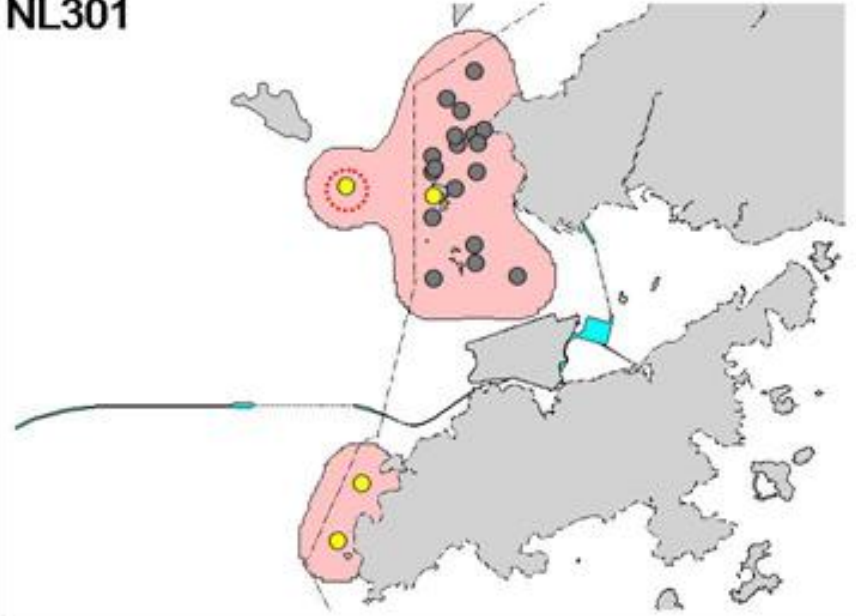
NL296



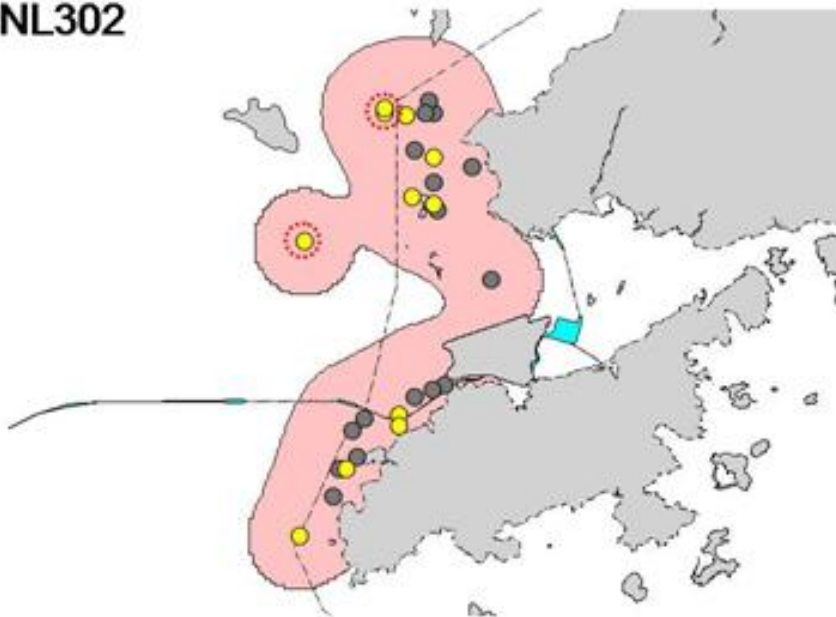
NL299



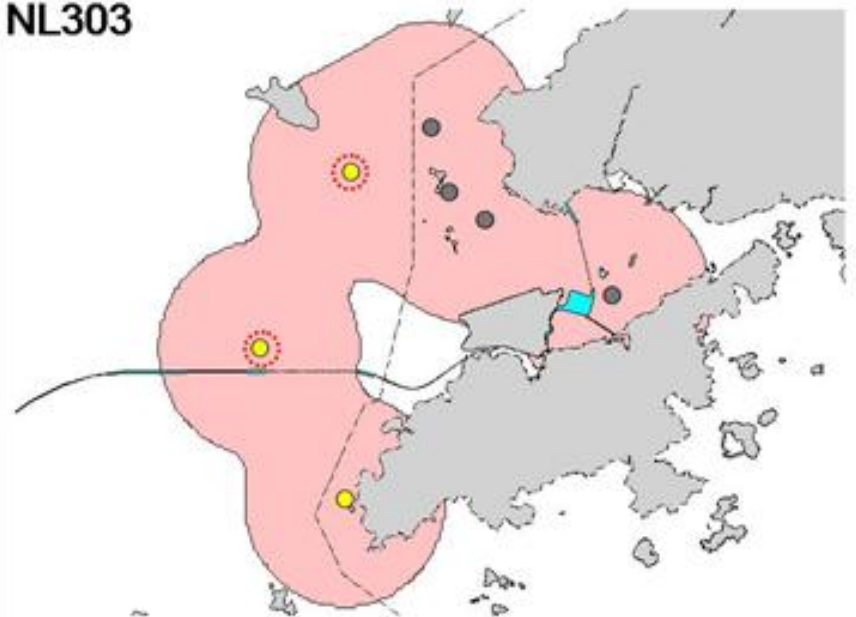
NL301

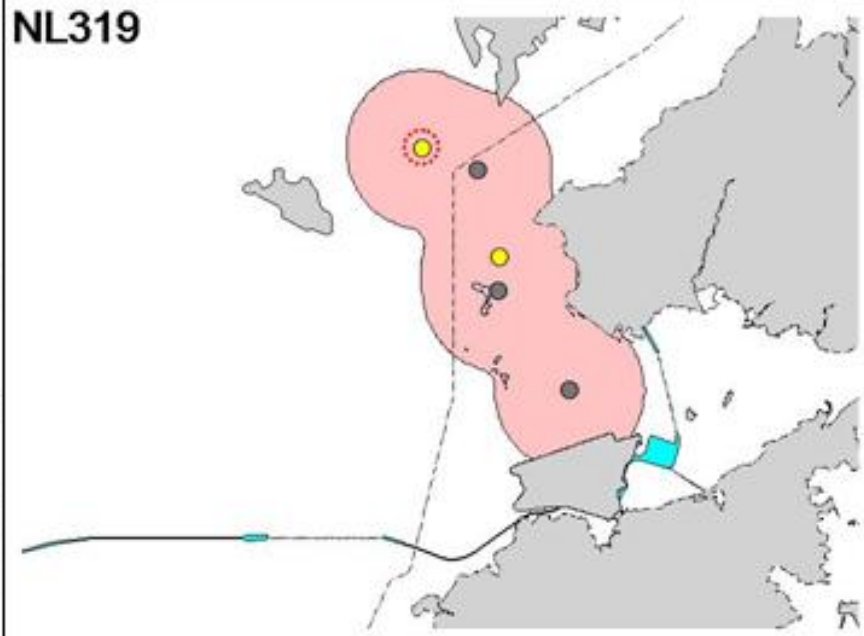
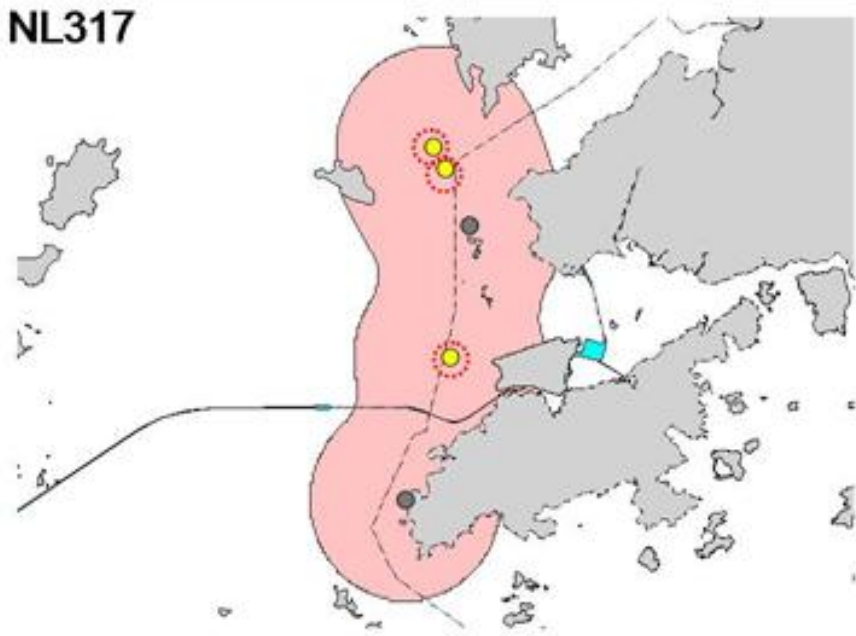
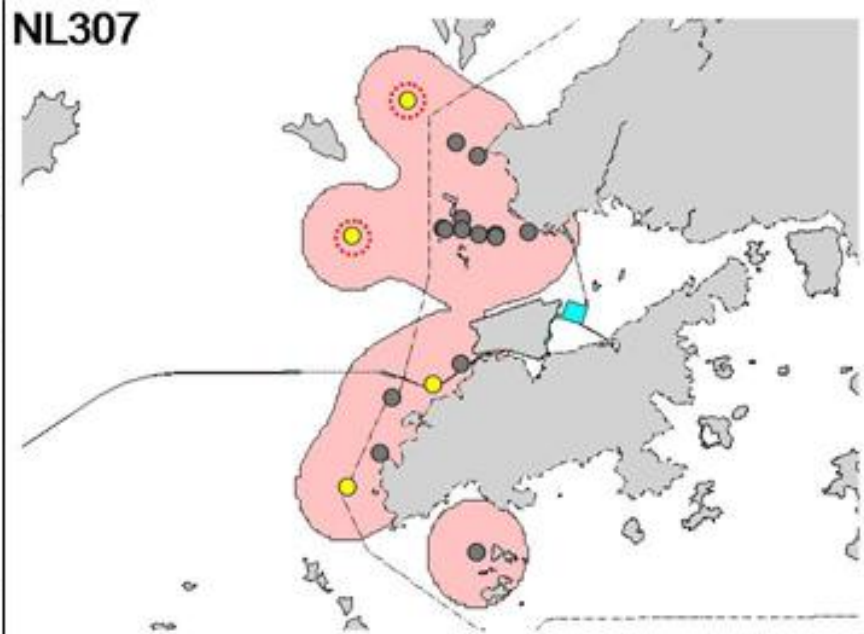
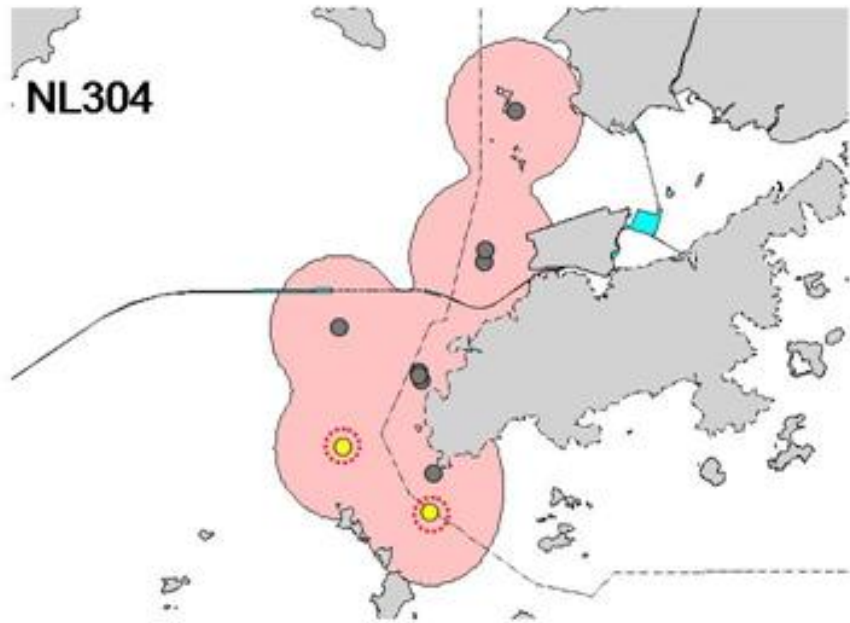


NL302

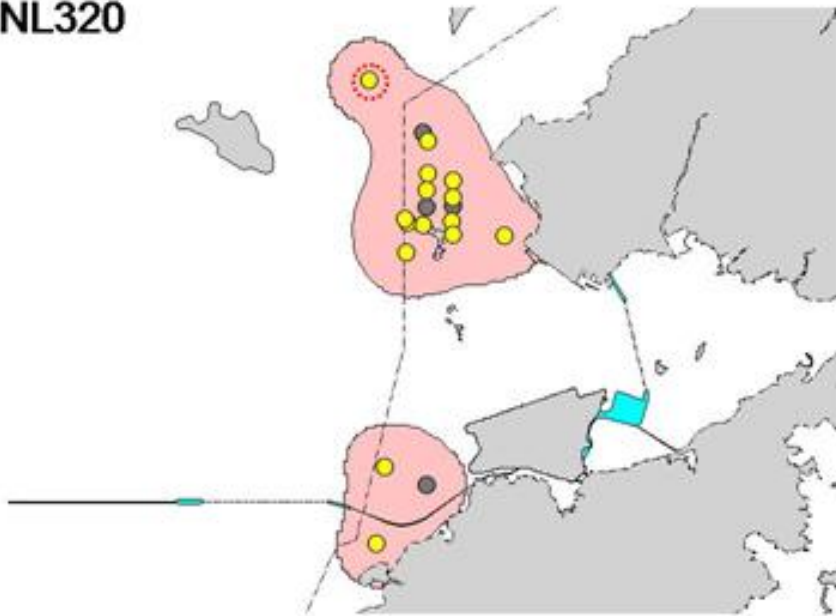


NL303

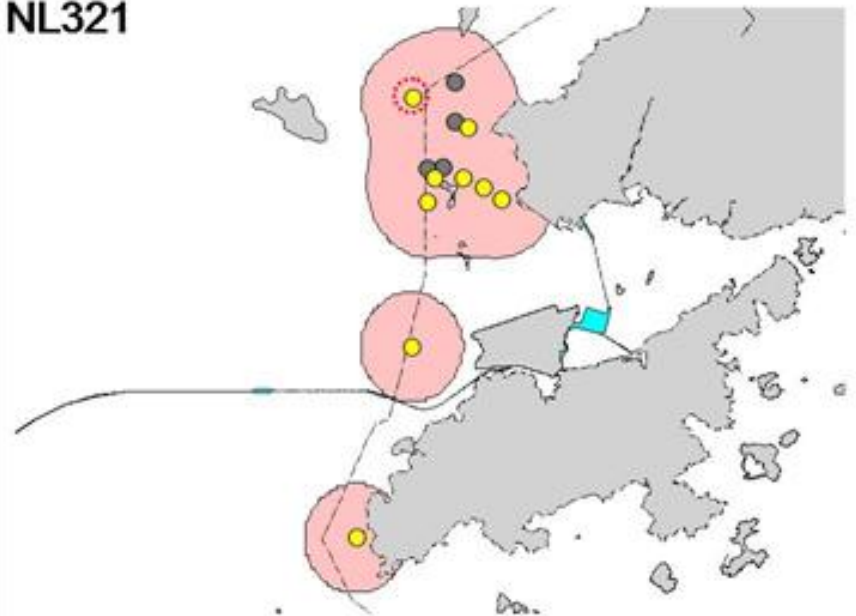




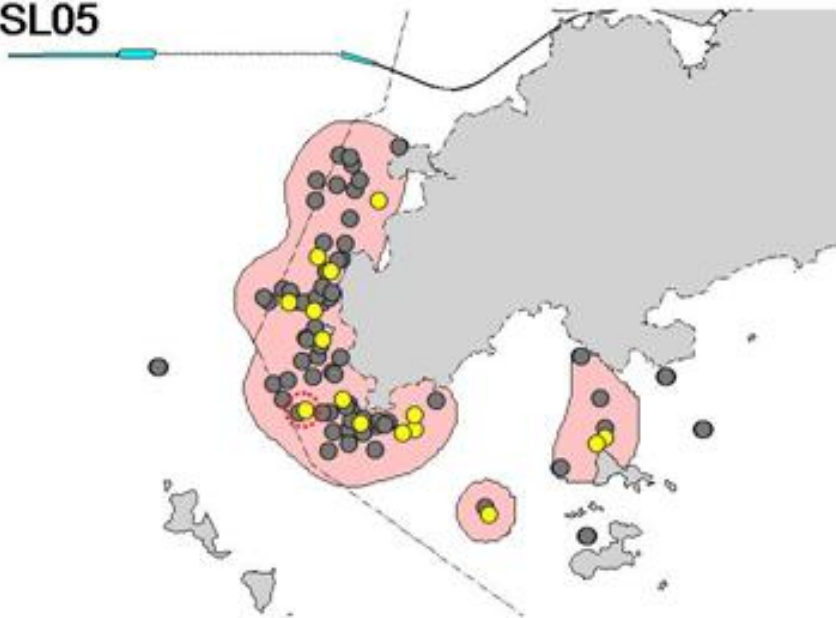
NL320



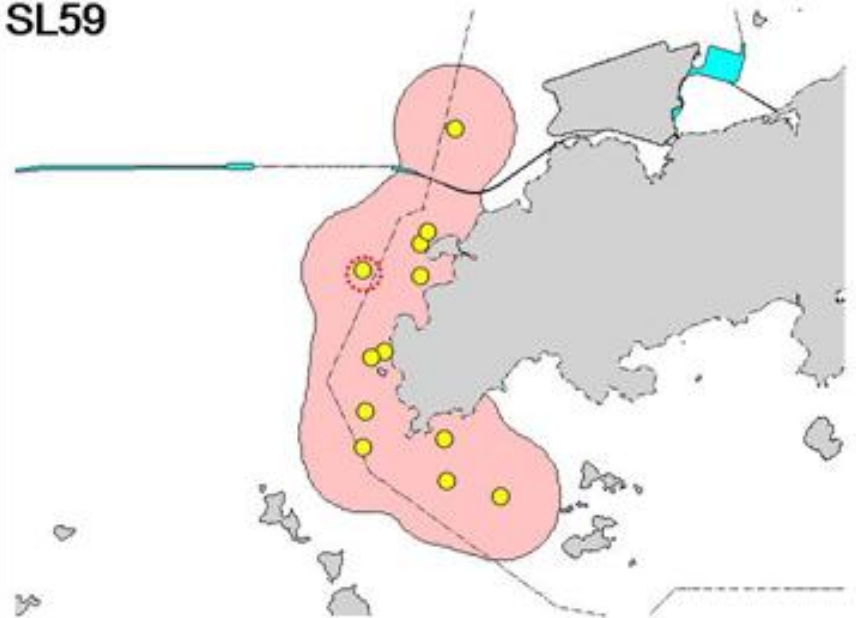
NL321



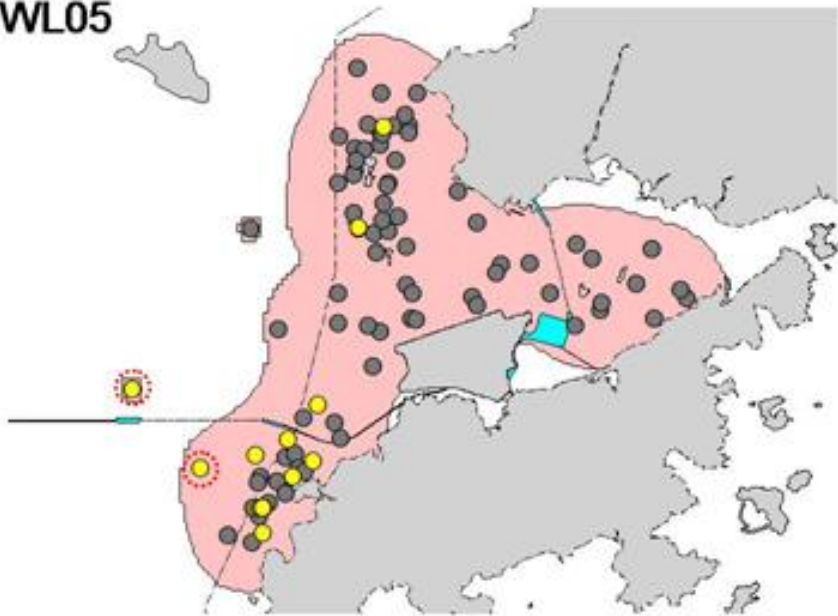
SL05



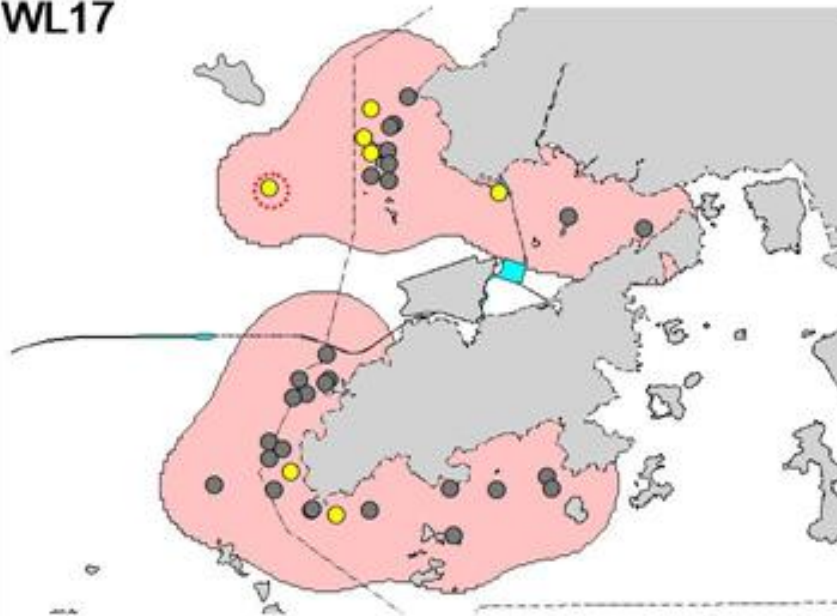
SL59



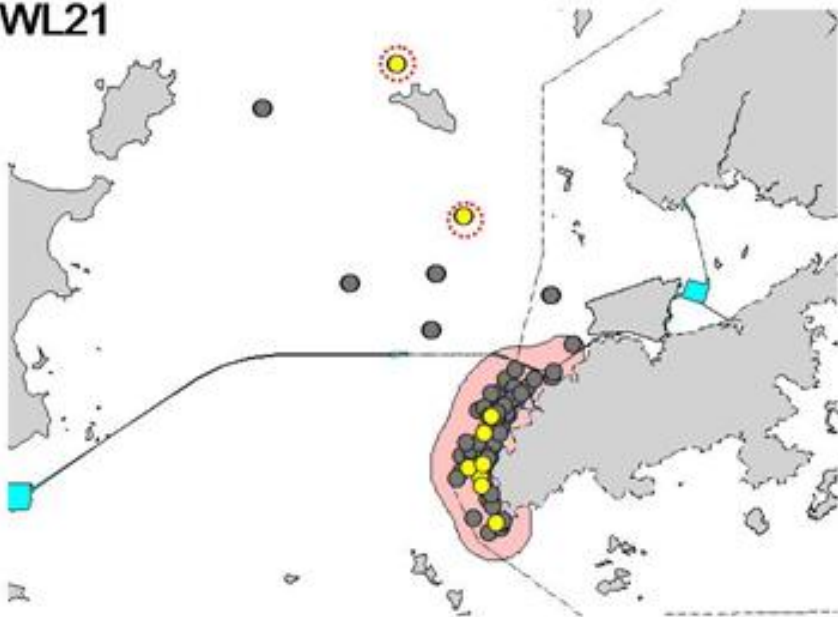
WL05



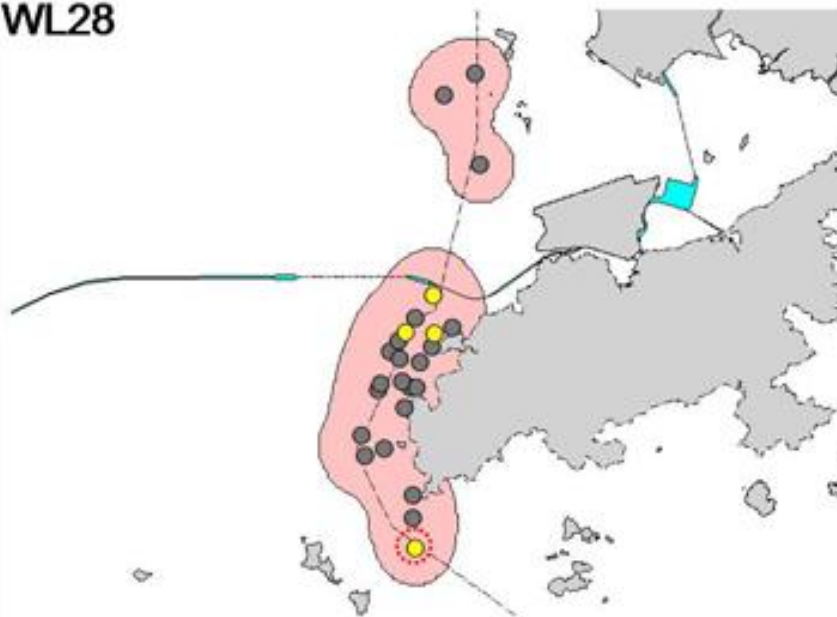
WL17



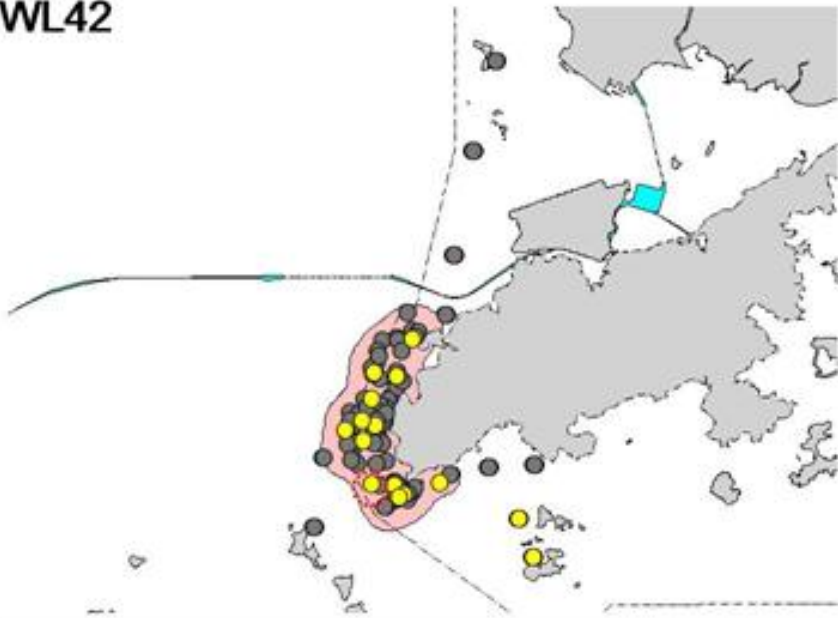
WL21



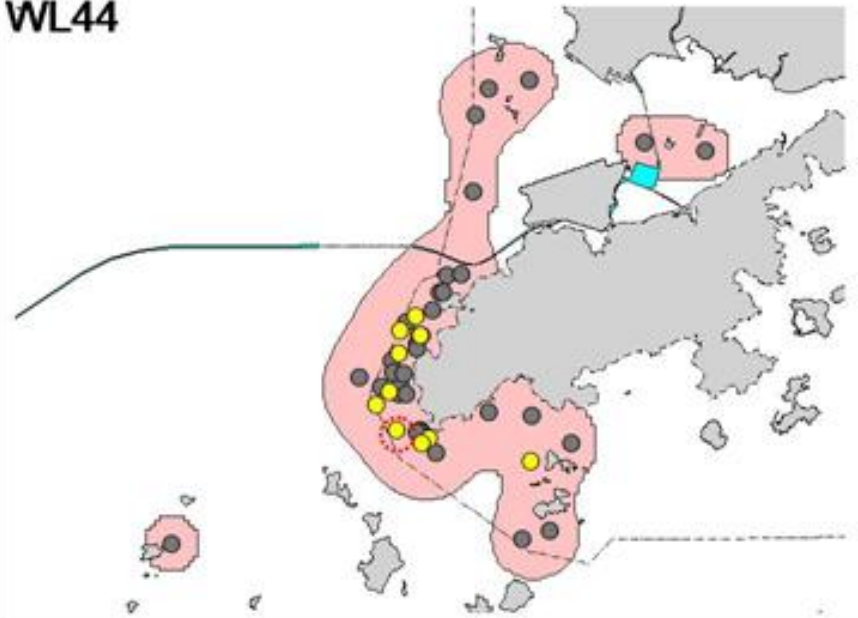
WL28



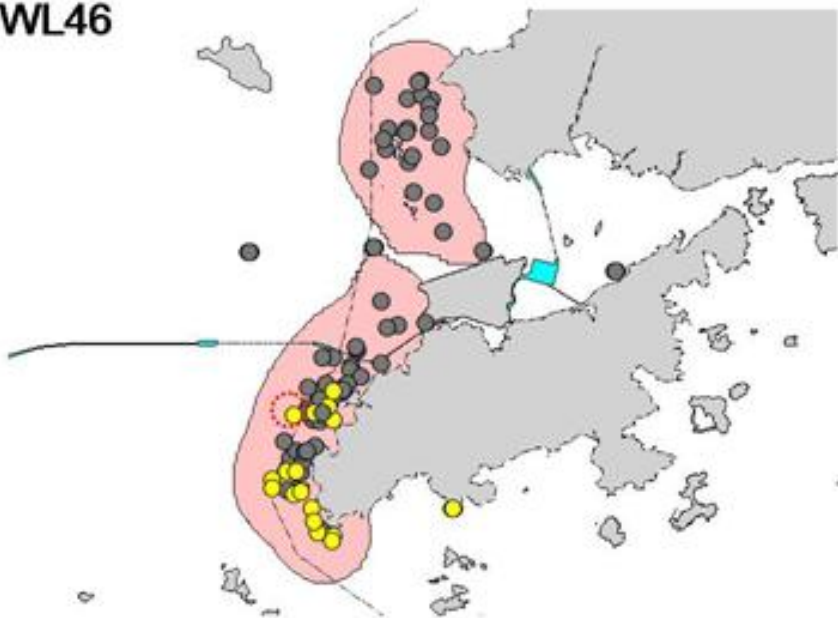
WL42



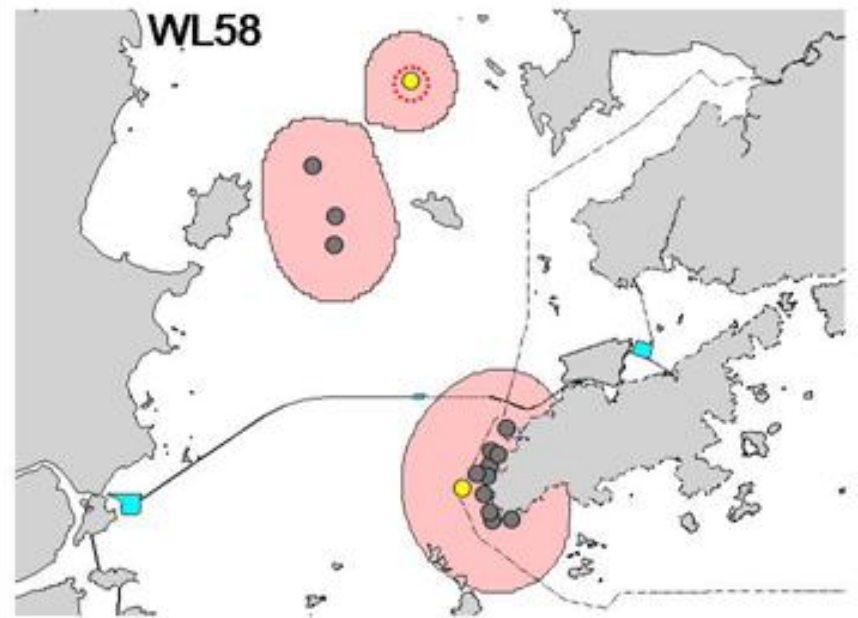
WL44



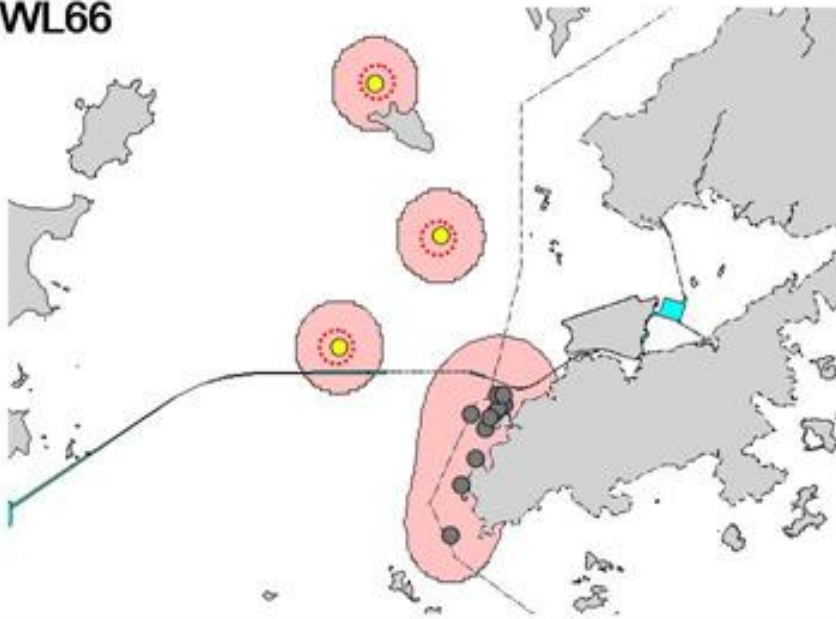
WL46



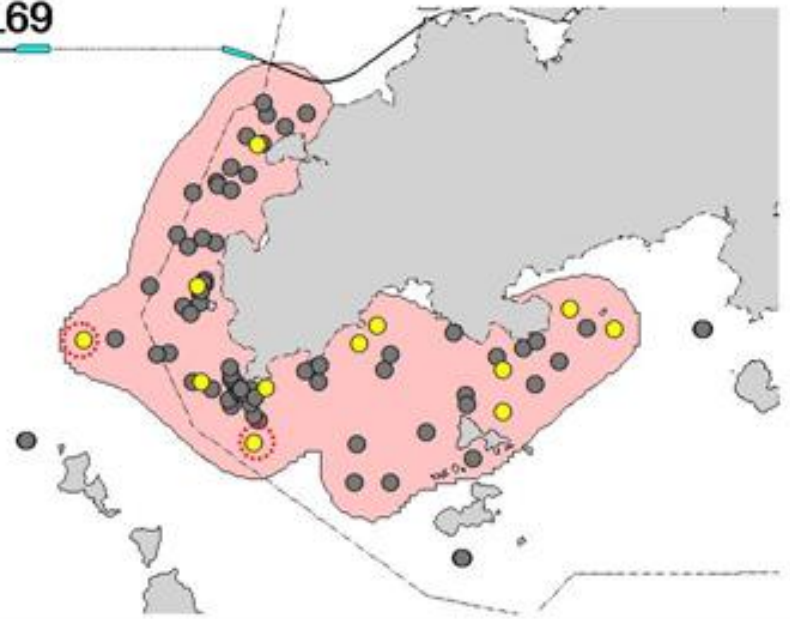
WL58



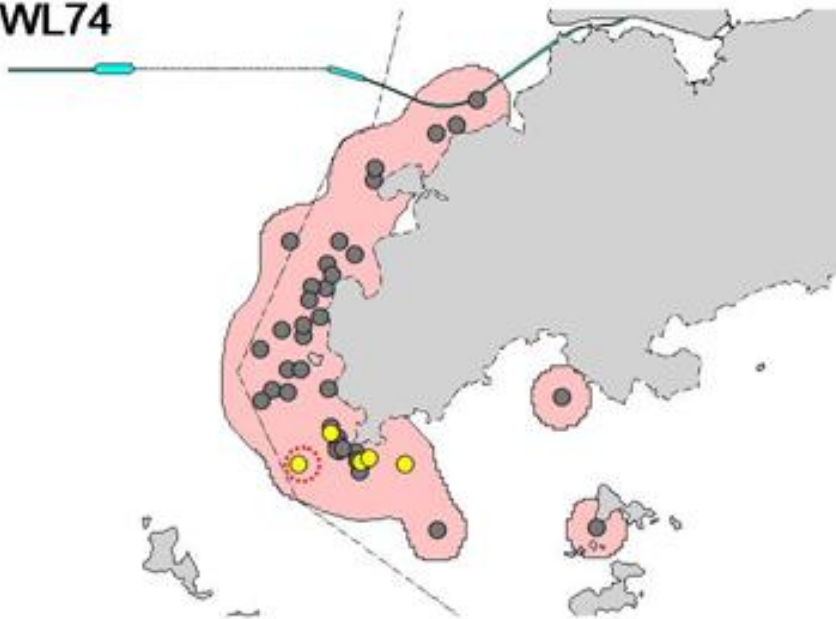
WL66



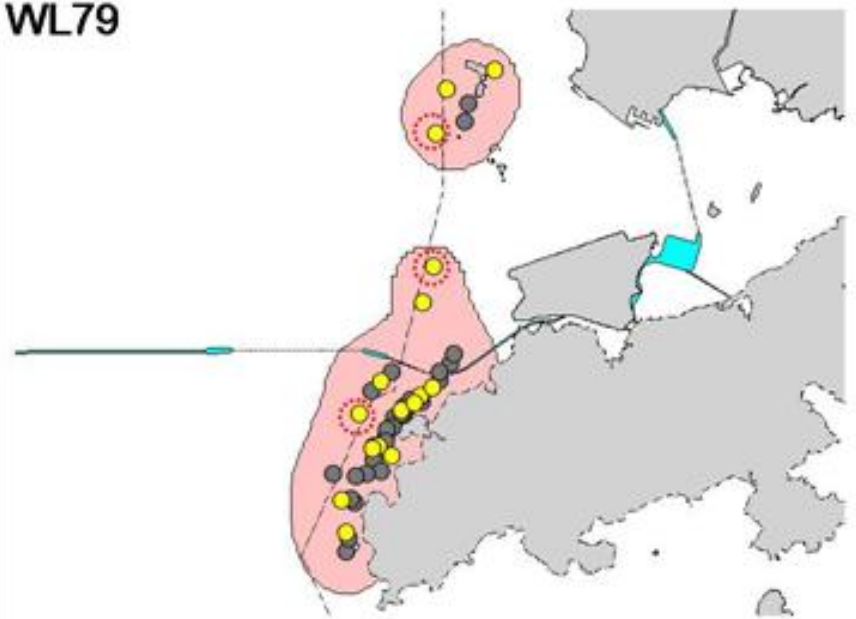
WL69



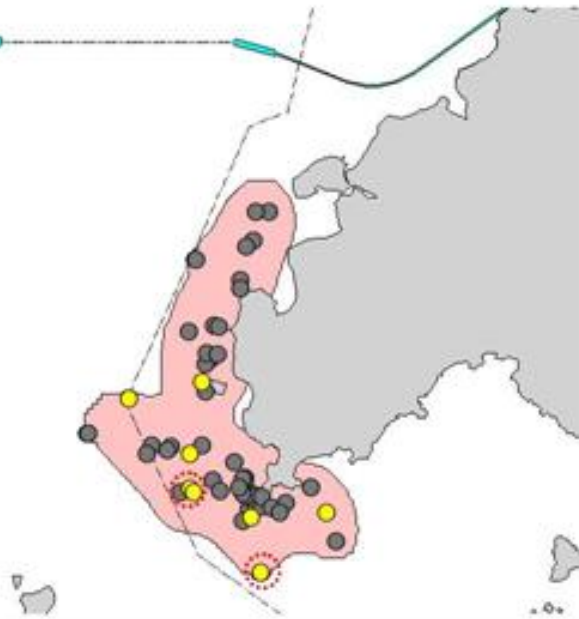
WL74



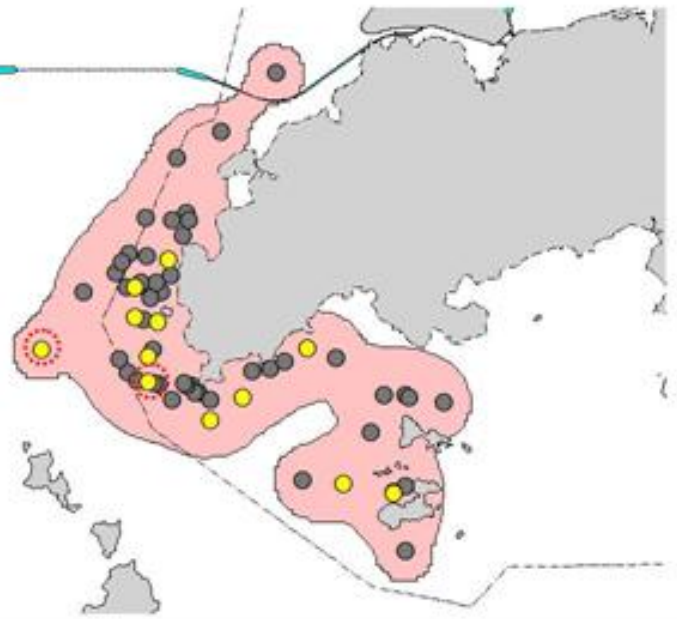
WL79



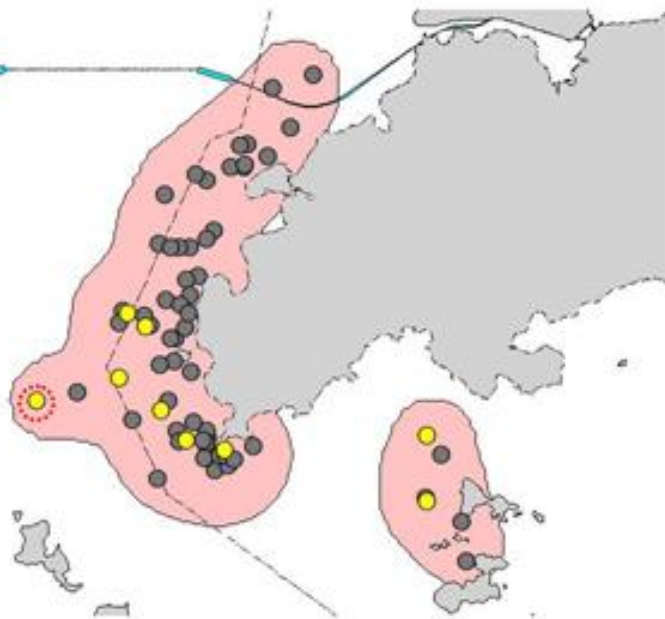
WL94



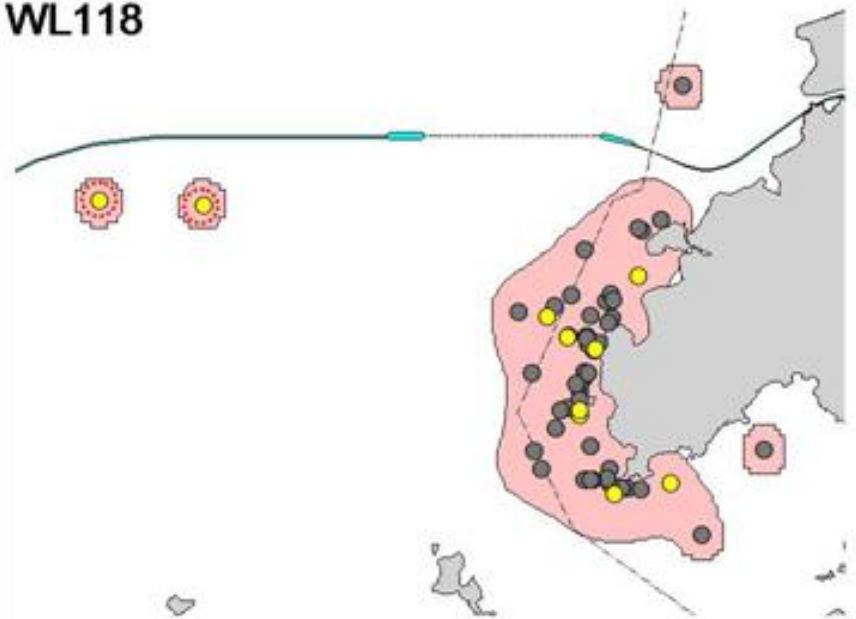
WL114



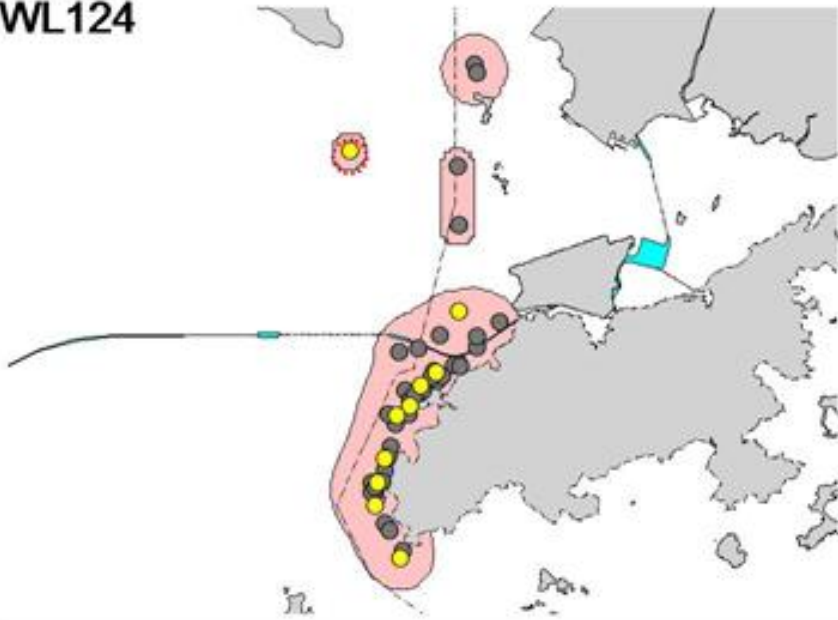
WL116



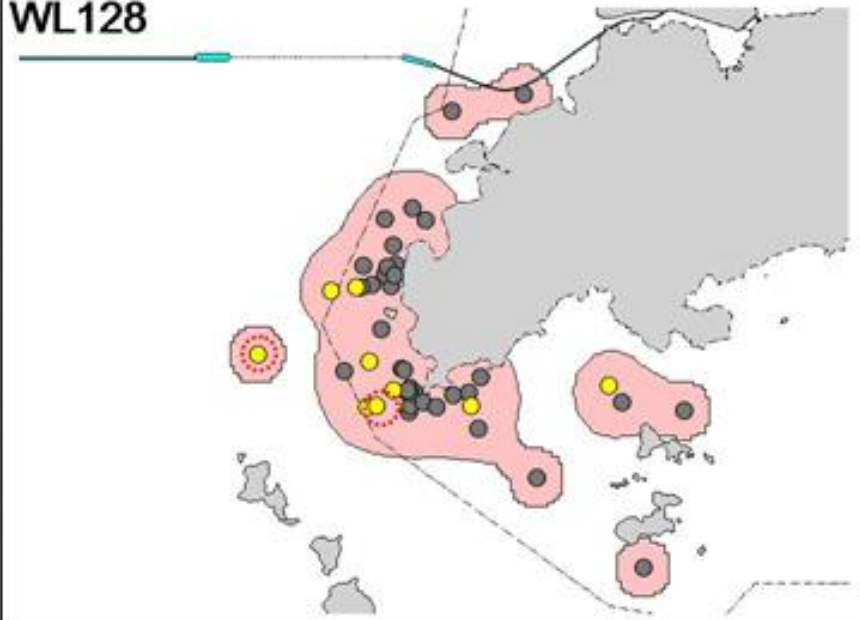
WL118



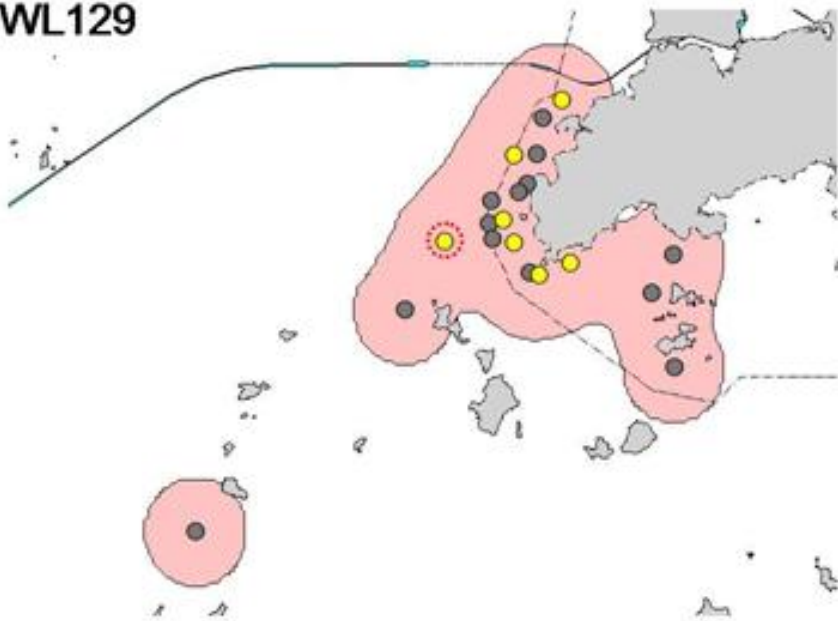
WL124



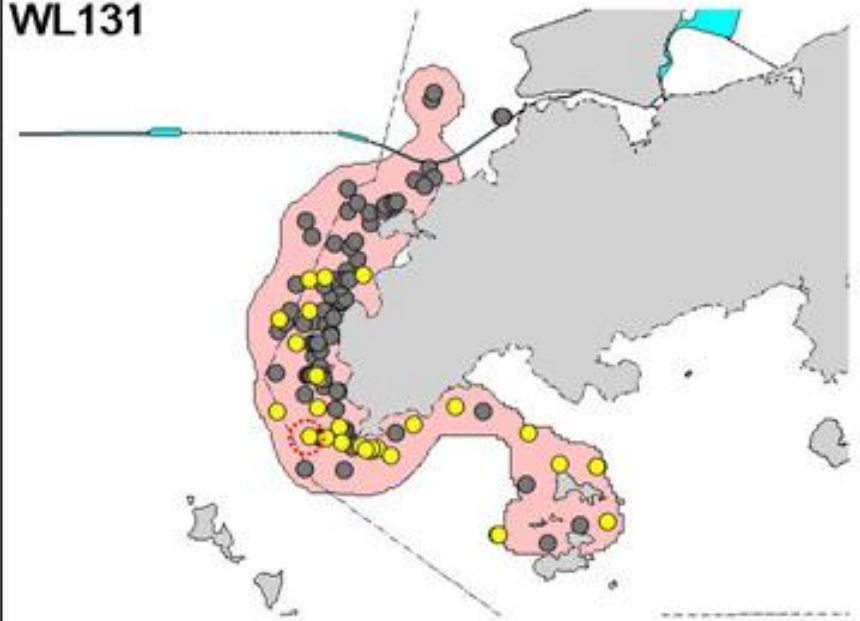
WL128



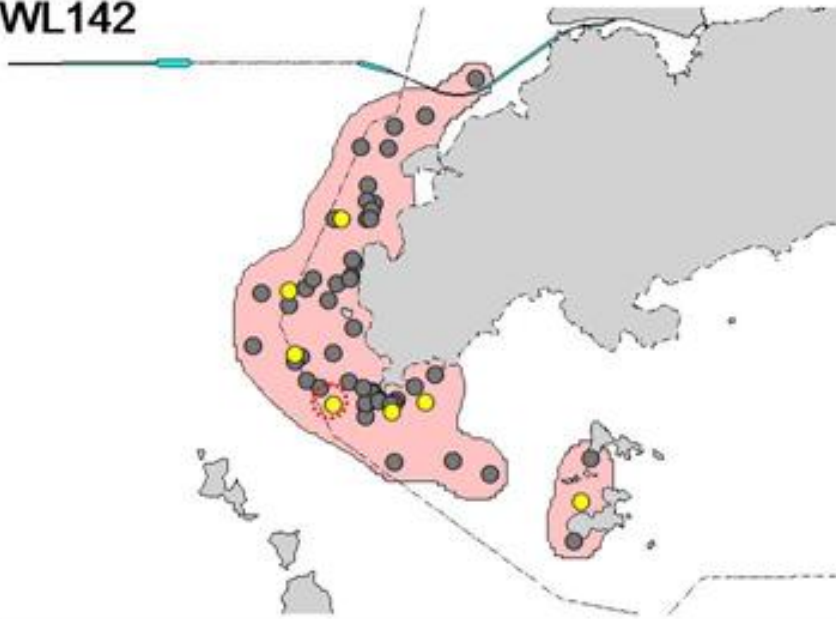
WL129



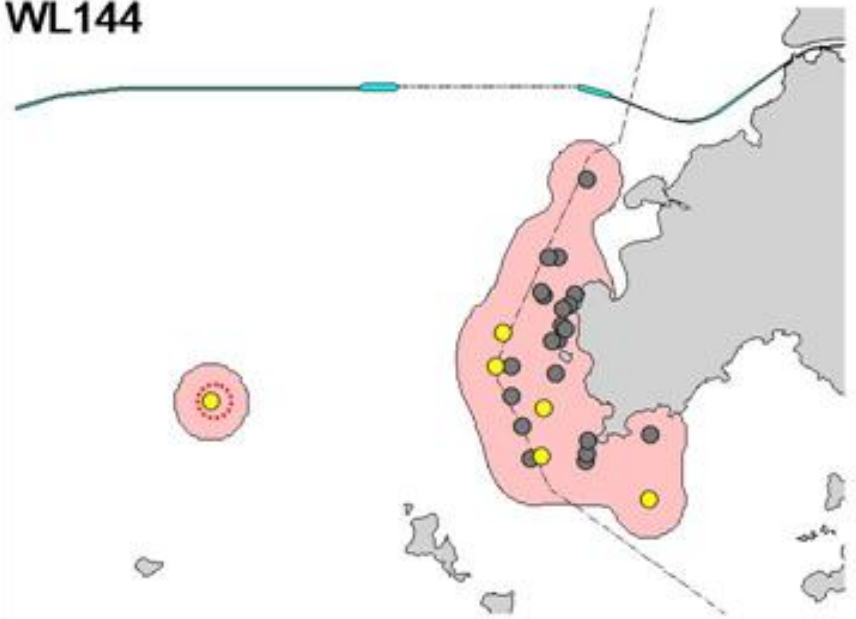
WL131



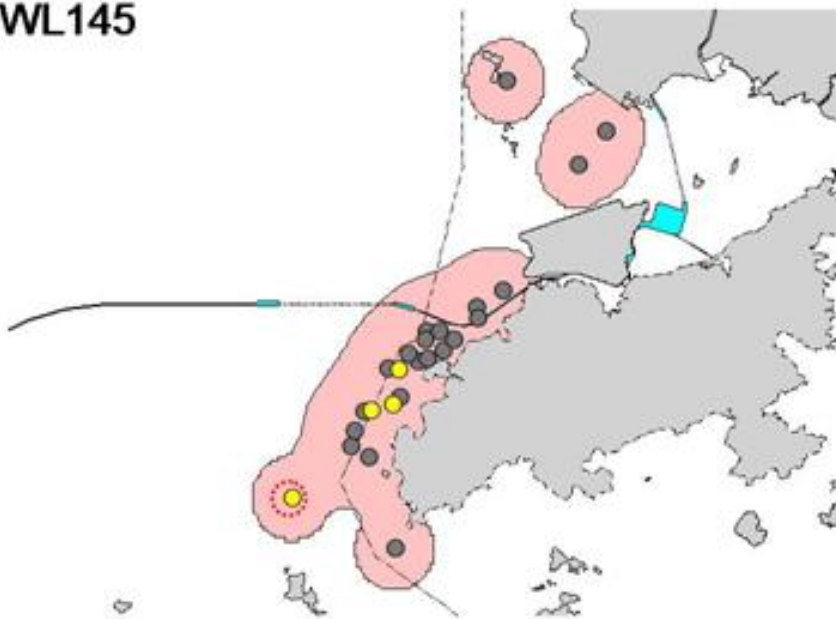
WL142



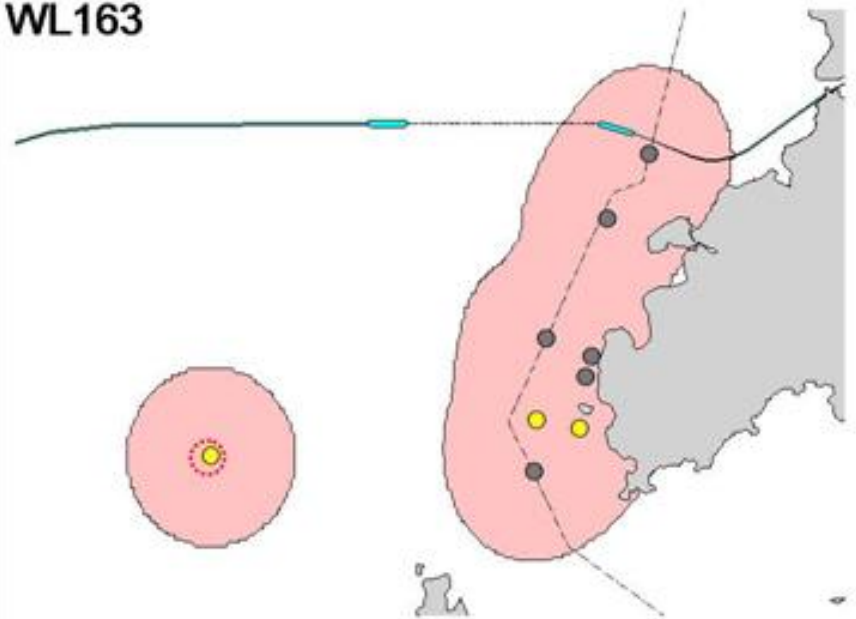
WL144



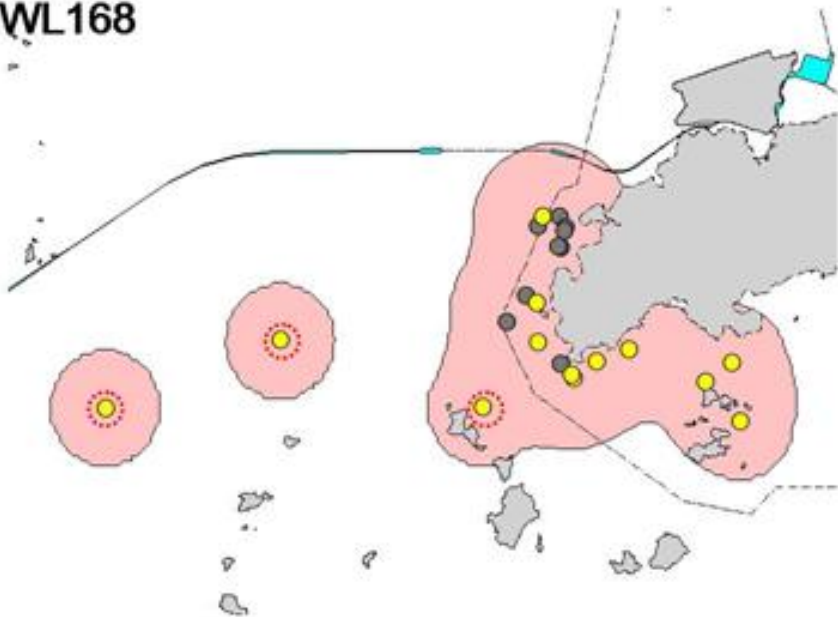
WL145



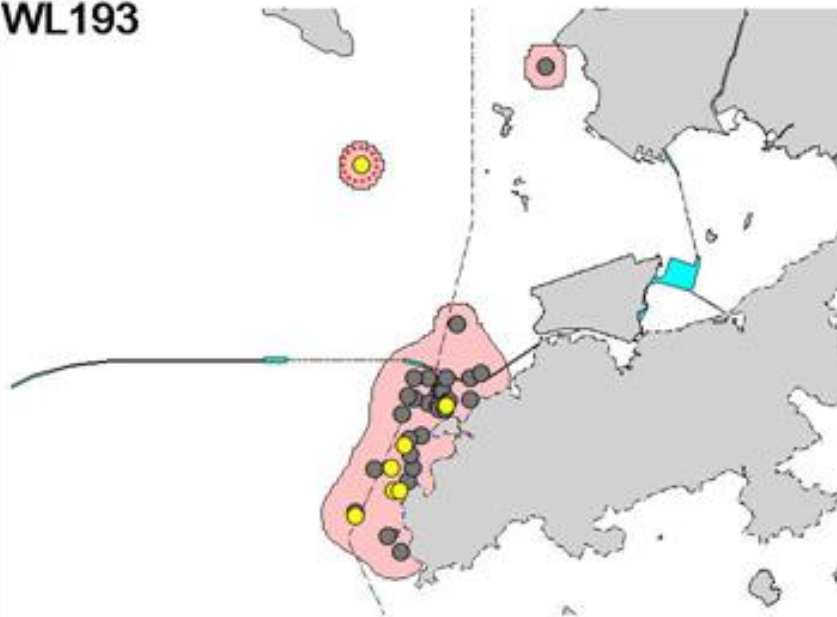
WL163



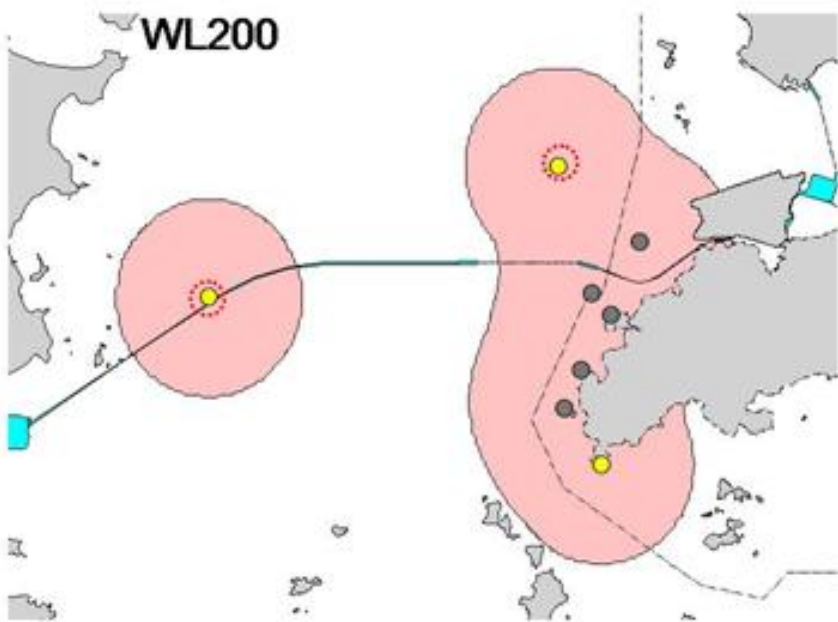
WL168



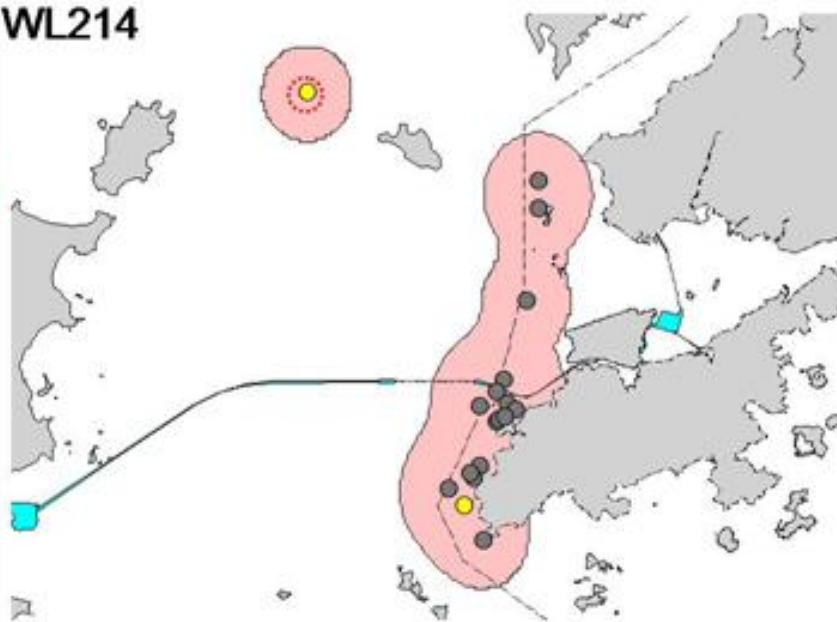
WL193



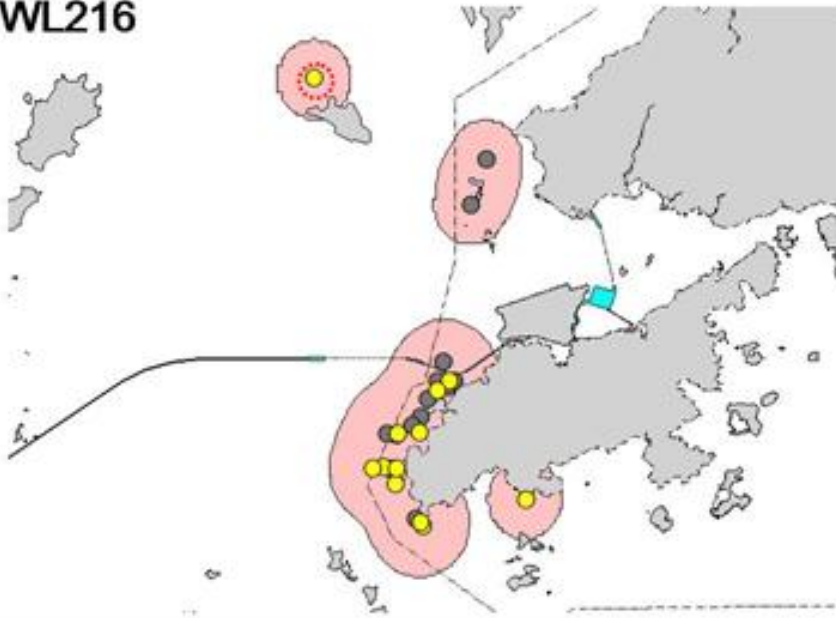
WL200



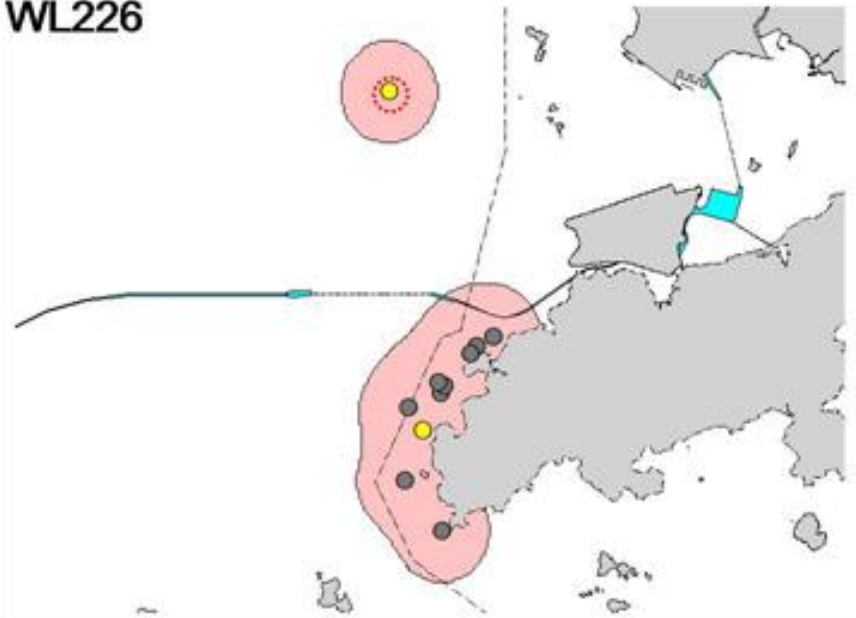
WL214



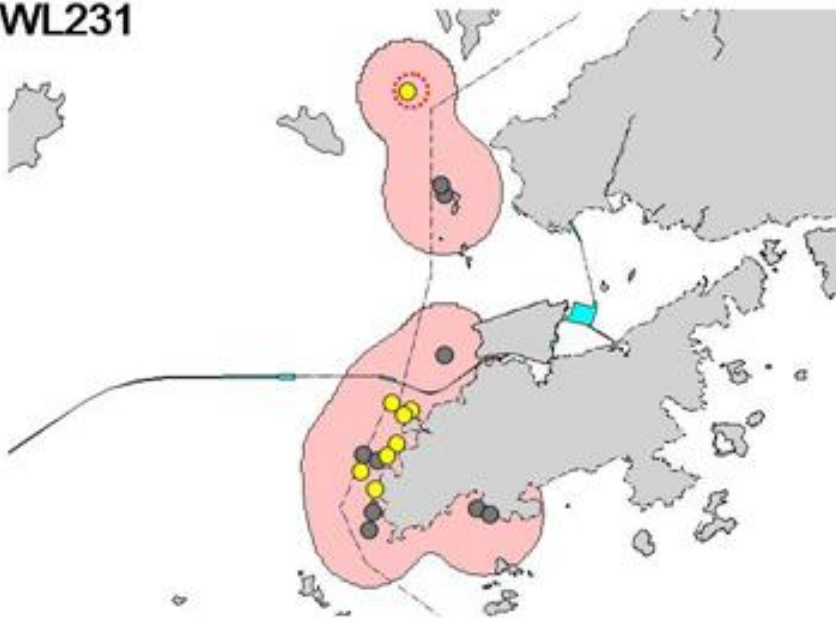
WL216



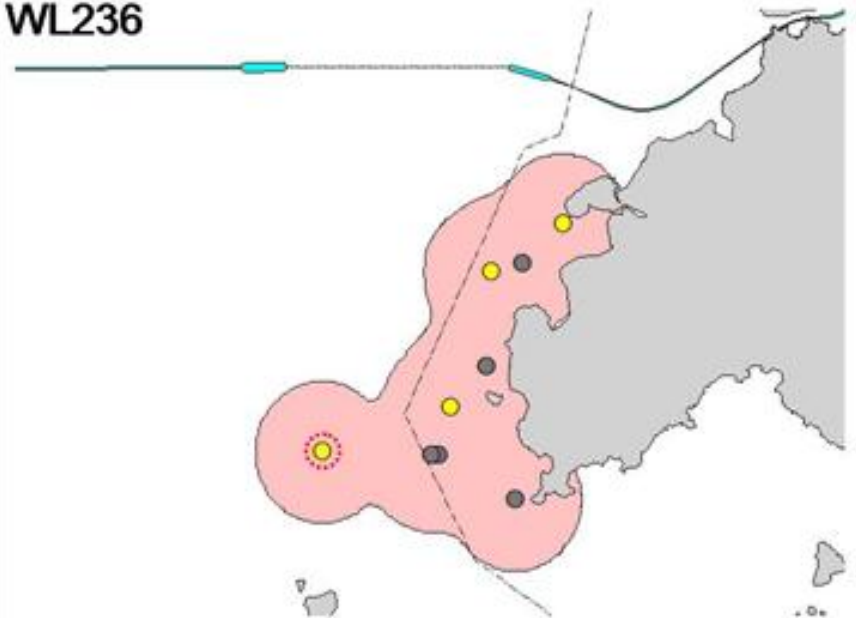
WL226



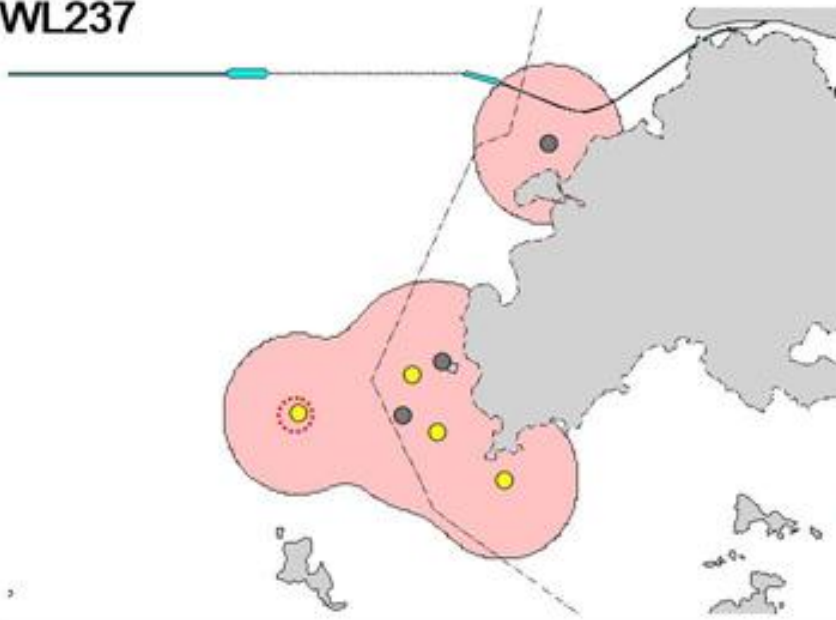
WL231



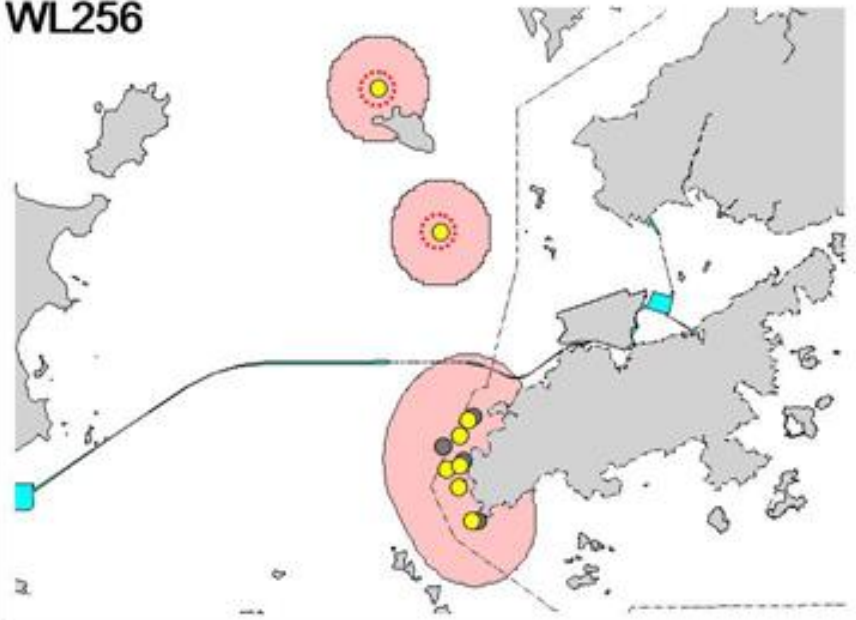
WL236



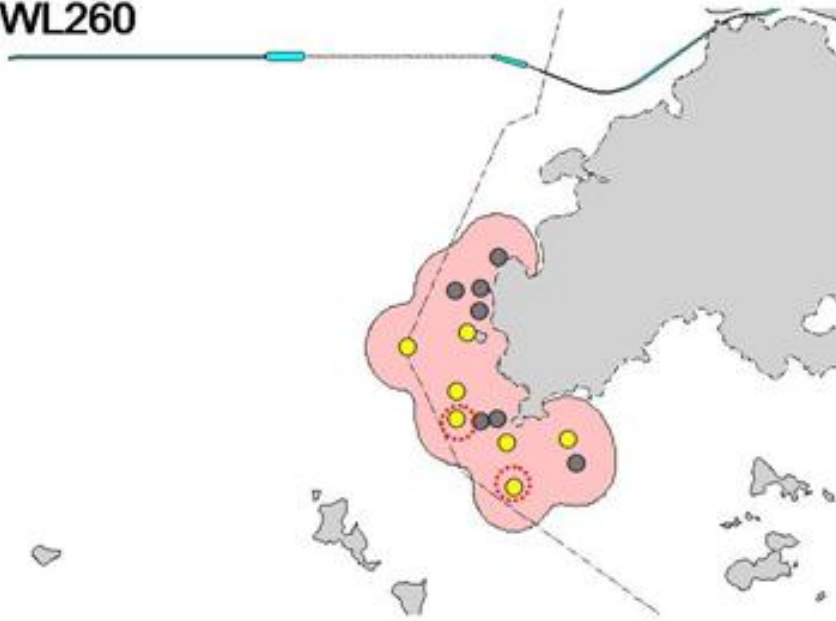
WL237



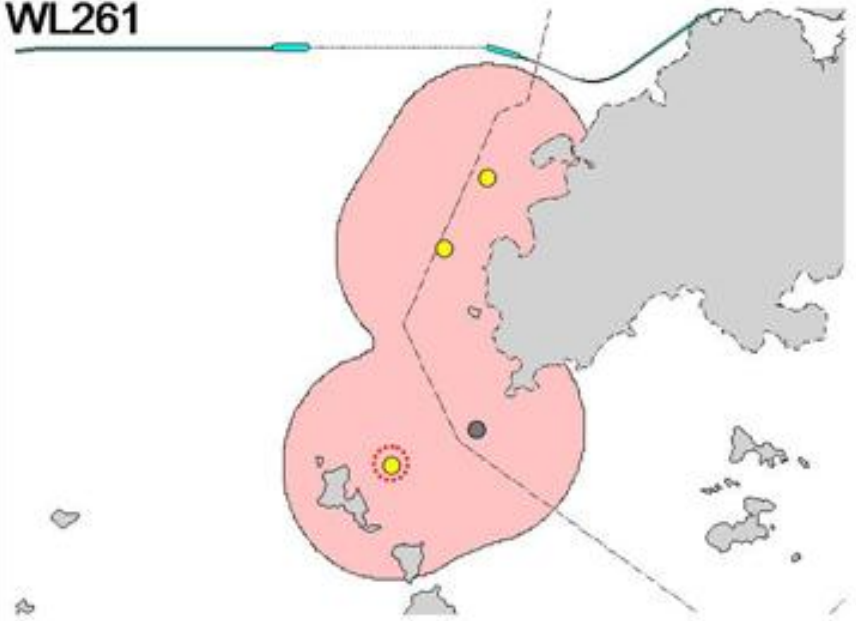
WL256



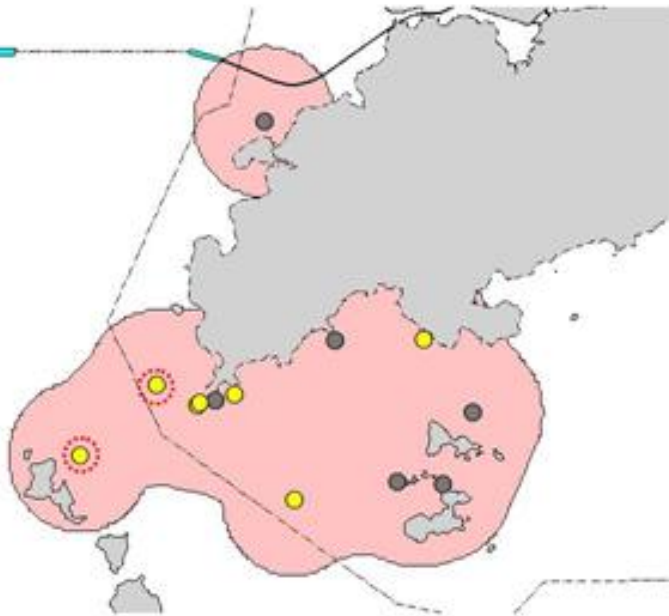
WL260



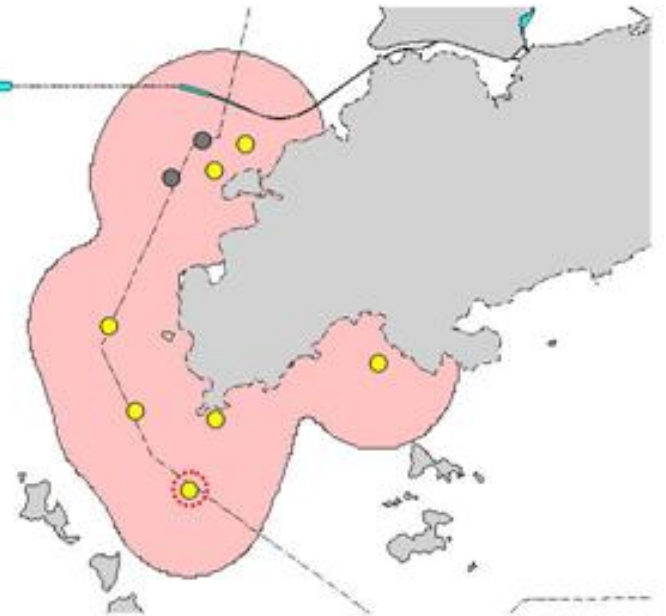
WL261



WL262



WL265



Appendix IX. (cont'd)