MONITORING OF MARINE MAMMALS IN HONG KONG WATERS (2013-14)

FINAL REPORT
(1 April 2013 to 31 March 2014)

Submitted by

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EXECUTIVE SUMMARY

A longitudinal study on Chinese White Dolphins (also known as the Indo-Pacific humpback dolphin, *Sousa chinensis*) and Indo-Pacific finless porpoises (*Neophocaena phocaenoides*) has been conducted in Hong Kong since 1995. With the funding support from Agriculture, Fisheries and Conservation Department, the present monitoring project represents a continuation and extension of this long-term research study that covers the period of April 2013 to March 2014. During the 12-month study period, 171 line-transect vessel surveys with 4,998 km of survey effort were conducted among nine survey areas in Hong Kong. A total of 317 groups of 1,052 Chinese White Dolphins and 113 groups of 260 finless porpoises were sighted during vessel, land-based and helicopter surveys. Most dolphin sightings were made in West Lantau (WL) and Northwest Lantau (NWL) survey areas, but they were infrequently sighted near the construction areas in association with the Hong Kong-Zhuhai-Macau Bridge (HZMB) construction. Much fewer dolphins occurred in Northeast Lantau (NEL), especially around the Brothers Islands, in 2013 than in previous years. Porpoises were mostly sighted between the Soko Islands and Shek Kwu Chau in southern waters of Hong Kong during the monitoring period.

Dolphin encounter rate in North Lantau region dropped to the lowest in 2013 since 2002. In NEL, noticeable drops in dolphin encounter rates between 2011 and 2012 (and furthermore in 2013) coincided with the commencement of reclamation works of HK Boundary Crossing Facilities (HKBCF) and HK Link Road (HKLR) in association with HZMB construction commenced in 2012. The combined estimate of dolphin abundance in WL, NWL and NEL survey areas in 2013 was 62 dolphins, which was similar to 2012 estimate, and both estimates were the lowest in the past decade of monitoring. The declining trends in dolphin abundance were significant among all three areas. Both trends in encounter rates and abundance estimates indicated that the recent decline in dolphin usage of NEL waters was possibly related to the HZMB construction works. Several recommendations in management strategies have been made to address this serious issue, including the establishment of marine parks, and avoidance of further reclamation around Lantau waters until a thorough assessment of cumulative impacts from different construction works is completed.

Habitat use patterns of Chinese White Dolphins revealed a noticeable decline in dolphin densities from 2011-2013, especially around the Brothers Islands and Sham Shui Kok. Dolphin habitat index established for the period of 2001-12 indicated that

the priority habitats of dolphins were clustered around Lung Kwu Chau and Sha Chau, along the Urmston Road in NWL, around the Brothers Islands, as well as along the entire stretch of coastal waters in WL; all these areas should deserve special protection as marine parks. The diminished importance of the grids in the middle of North Lantau region as dolphin habitats in recent years could be related to the increased vessel traffic from Sky Pier. During 2004-13, the important porpoise habitats were located to the south of Tai A Chau, around Shek Kwu Chau, and the waters between these two islands during the dry season; around Po Toi Islands and at the juncture of Po Toi and Ninepins survey areas during the wet season.

Throughout the monitoring period, 162 individuals with 497 re-sightings were identified, with most of these made in WL and NWL. Even though many individuals moved extensively across different survey areas in 2013, there was also a significant portion of dolphins that were sighted repeatedly within a single survey area, and such restricted movements could be related to infrastructure projects. Moreover, only a small number of individuals were sighted repeatedly in NEL in 2013, further confirming the greatly diminished usage by dolphins in this area. Differential use at various core areas was observed among year-round and seasonal residents respectively, such as the Brothers Islands being utilized primarily by year-round residents. Ranging pattern analysis indicated that a majority of individuals examined have shifted their overall ranges away from the Brothers Islands after January 2013, and only some of them have expanded their range use into WL waters. A high proportion of individuals also showed a clear shift in their core area use away from the Brothers Islands, which could be related to the construction works in nearby waters. Probable range shift of individuals occurred regularly in WL waters to southern portion of their range was noted. Their avoidance of crossing the HKLR bridge alignment also suggested that they may be affected by the bridge construction works, and this issue should be further examined.

Results from focal follow studies and shore-based theodolite tracking works indicated that the east-west movement between Lung Kwu Chau and the Brothers Islands was mainly through the traveling corridors at the northern edge of the airport platform and the Urmston Road, while the north-south movement between Sha Chau and WL waters was mainly through the traveling corridor along the western border of NWL, the western side of airport platform, and the northwestern coastline of Lantau near Sham Wat. If these traveling corridors are obstructed due to infrastructure project (e.g. reclamation, bridge construction) or vessel traffic, many individuals would suffer from restricted movements between their core areas.

A passive acoustic monitoring study through the application of C-POD were conducted at four sites near Fan Lau, Sham Wat, Lung Kwu Tan and Siu Ho Wan in 2013. The results indicated that strong diel patterns were shown at Siu Ho Wan and near Sham Wat, with a lot more acoustic detections made at night than during the day. Dolphins also occurred regularly at night-time at the other two sites. The passive acoustic monitoring works can fill an important data gap on night-time dolphin habitat use, which has not been studied in the past.

Through the use of GIS, the historical cumulative human impacts on the local dolphins were assessed, which showed that a localized area in the eastern zone of North Lantau has experienced significant declines in dolphin densities in relation to overall cumulative human impacts in that region. The best spatial scale of the effect was determined to be around the Brothers Islands extending to the northeast corner of the airport, which correlated in time with the implementation of a new high-speed ferry route in 2004. The study concluded that the cumulative impacts (particularly the addition of high-speed ferry traffic from the Sky Pier) seemed to have disrupted the natural dolphin distribution in North Lantau.

A habitat modeling study, utilizing remotely sensed chlorophyll a, sea surface temperature and water depth, was conducted to define the niche for the Chinese White Dolphins, and project that niche across unsurveyed areas in the Pearl River Estuary. Habitat classified as suitable for the dolphins is primarily inshore, and stretches further east and west than areas that have currently been surveyed for this species. Another habitat modeling study on finless porpoises aims to examine the relationship between the porpoises and their living environment in the context of on-going and future threats in their habitats. Based on the three variables including temperature, salinity and chlorophyll a, the results of the model confirmed previous knowledge on the seasonal variation in porpoise distribution in Hong Kong, in which the models showed high suitability areas in the eastern waters during summer/autumn and the southern waters in winter/spring. Using spatial prioritization results, the South Lantau Vessel Fairway was shown to be a higher threat to finless porpoises during winter/spring, and specifically in areas south of Lantau Island.

During the study period, HKCRP researchers delivered 14 education seminars at local schools regarding the conservation of local dolphins and porpoises. Through this integrated approach of long-term research and publicity programme, the Hong Kong public can gain first-hand information from researchers.

行政摘要 (中文翻譯)

本地中華白海豚及印度太平洋江豚的長期研究，自 1995 年起開始。這項為期一年 (由 2013 年 4 月至 2014 年 3 月)、獲香港特別行區政府漁農自然護理署資助的研究，正是這長期監察的延伸。在十二個月的研究期間，研究員共進行了 171 次樣條線船上調查，在全港九個調查區共航行了 4,998 公里，並觀察到共 317 群中華白海豚 (總數達 1,052 隻)及 113 群江豚 (總數達 260 隻)。中華白海豚大多出沒於大嶼山西面及西北面水域，但卻甚少在與港珠澳大橋相關的工程範圍附近出現。相比前數年的出沒紀錄，2013 年中華白海豚在大嶼山東北水域(尤其在大小磨刀洲一帶)的出現次數大為減少。另一方面，江豚主要在香港南面一帶水域活動，並集中在石鼓洲及索罟群島之間一帶水域出沒。

中華白海豚於北大嶼山區域的目擊率，於 2013 年間降至自 2002 年以來最低的水平，相比 2011 年，2012 年於東北大嶼山的海豚目擊率明顯下降(2013 年亦如是)，時間上與港珠澳大橋之口岸人工島及香港接線工程的展開吻合。2013 年，中華白海豚在三個主要出沒區域的整體數目估計為 62 隻；此數字與 2012 年的估計相近，均為過去十年來所估計的最低數目，而且三個區域的估計數目均呈現明顯的下降趨勢。在大嶼山東北水域之海豚目擊率及數目均於過去兩年雙雙下降，可能與港珠澳大橋工程之開展有關。為應對此嚴峻情況，我們提出數項建議，包括要求當局成立海岸公園，並在未完全掌握不同工程對白海豚的累積影響之前，應儘量避免在大嶼山水域進行額外的基建工程。

量化生境使用分析顯示，在 2011-13 年期間，中華白海豚於大小磨刀洲及深水角一帶水域的使用率明顯下降。從 2001-12 年間數據所計算出的海豚棲息地指標顯示，重要的海豚棲息地包括：大嶼山西北的龍鼓洲、沙洲及龍鼓水道，大嶼山東北的大小磨刀洲附近，及大嶼山以西整片近岸水域。這些棲息地均值得劃作海岸公園，並加以適當保護。大嶼山以北的中部水域，其作為海豚棲息地的重要性近年來有所減少，相信與來自航天碼頭的航運交通增長有關。此外，在 2004-13 年期間，在旱季期被確認為重要的江豚生境包括：大鴉洲以南，石鼓洲附近，及大鴉洲與石鼓洲之間水域；在雨季期間，江豚使用量較高的生境，則集中在蒲台群島一帶附近水域，及蒲台與果洲兩個調查區域交界之水域。

在 2013-14 年度，研究員辨認出 162 隻個別海豚，共有 497 次的目擊紀錄，其中大部分均出現在大嶼山北面及西北面水域。雖然有部份海豚仍頻繁地在大嶼山周圍的不同調查區來回穿梭，但亦有相當多海豚只在同一個調查區內不斷出沒，牠們的移動幅度減小可能與基建工程影響有關。此外，只有一小撮海豚在 2013 年於大嶼山東北水域多次出現，進一步確定海豚已大量減少於該處水域出沒。全年出現及季節性出現在香港水域的海豚，兩者利用不同活動核心區的情況

有所分別，例如使用大小磨刀洲作其活動核心區的，大多是全年出現的海豚個體。再者，個別海豚活動範圍分析發現，自 2013 年 1 月以後，大多數曾經常活躍於大小磨刀洲的海豚，其活動範圍已轉移至其他地方，當中只有少數海豚因此而較多出現於大嶼山以西水域。另外，亦有相當高比例的海豚，其活動核心區明顯地轉離大小磨刀洲水域，而此轉變可能與附近的建築工程有關。一些活躍於西大嶼山水域的海豚，部份似乎只集中在較為南面的範圍出沒，避開了港珠澳大橋香港接線的路徑，顯示牠們有可能是受到工程影響，因此應進一步研究這課題。

透過聚焦跟蹤及利用陸上經緯儀的追蹤，發現中華白海豚主要透過機場北緣及龍鼓水道的移動路線，於龍鼓洲及大小磨刀洲之間東西往來；另一方面，有些海豚則利用西部水域邊界、機場以西及深屈附近的大嶼山西北沿岸水域的移動路線，於沙洲及西大嶼山水域南北穿梭。如這些移動通道因為一些基建工程 (如填海、興建橋墩等) 或海上交通而受到某程度上的阻隔，將會令眾多海豚來往不同活動核心區時受到影響。

「被動水底聲音監察」這研究項目，於 2013 年在分流、深屈、龍鼓灘及小蠔灣四處地點，放置一種名為 C-POD 的水底監聽器。研究發現，海豚於小蠔灣及深屈附近水域，在夜間的發聲行為比日間明顯地更為活躍，而牠們亦於夜間經常使用分流及龍鼓灘附近水域。由於以往的研究忽略了海豚夜間活動的情況，此水底聲音監察工作能提供重要數據，以填補過往資料的不足。

透過地理資訊系統的分析，一項針對過去十數年人為威脅對本地海豚帶來的累積影響的研究發現，於北大嶼山東部的一處水域，海豚數目的明顯下降與整體人為影響的累積有明顯關係。而受此累積影響最明顯的地點，主要集中在大小磨刀洲至機場東北角一帶的水域，而該水域海豚使用率下降的趨勢，在時間上與一條於 2004 年新開的高速船航線吻合，顯示北大嶼山水域的累積影響，尤其是航天碼頭新增高速船隻航行為海豚帶來的滋擾，似乎已改變了海豚於北大嶼山水域的出沒。

棲息地模型研究，是利用葉綠素 a、海面溫度及水深等遙感數據，以確定適合中華白海豚的生境，並以此推測於珠江口其餘適合中華白海豚生活、但卻未被調查覆蓋的生境。研究發現，適合海豚棲息的生境主要為近岸水域，並推測這些適合生境伸延至調查範圍外以東及以西的水域。另一項有關江豚的棲息地研究，透過建立棲息地模型，檢視江豚與其生活環境(包括一些現有及將來的威脅)之相互關係。利用水溫、鹽度及葉綠素 a 等環境數據，棲息地模型分析顯示適合江豚的生境，在夏秋兩季集中在香港東面水域，而在冬春兩季則集中在香港南面水域；這結果確立了以往對江豚在香港季節性分佈的認知。此外，這項研究亦指出高速船於南大嶼山的一條主要航道為江豚的威脅，此威脅於冬春兩季的情況尤為

嚴重。

在本年度，研究員為本地中小學主持了共14場講座，內容主要圍繞香港中華白海豚及江豚的最新保育狀況。透過揉合長期研究監察及公眾教育活動，香港市民可從研究員獲得更多有關鯨豚的最新資訊。

1. INTRODUCTION

Since 1995, the Hong Kong Cetacean Research Project (HKCRP) has been conducting a longitudinal study on Chinese White Dolphins (also known as the Indo-Pacific humpback dolphin, *Sousa chinensis*) and Indo-Pacific finless porpoises (*Neophocaena phocaenoides*) in Hong Kong and the Pearl River Delta region. The study has been primarily funded by the Agriculture, Fisheries and Conservation Department (AFCD) as well as various government departments and NGOs. The multi-disciplinary research programme aims at providing critical scientific information to the Hong Kong SAR Government to formulate sound management and conservation strategies for the local populations of dolphins and porpoises (e.g. Hung 2012, 2013).

In addition, HKCRP has been extensively involved in numerous environmental consultancy studies to assess potential impacts of marine construction works on cetaceans in Hong Kong waters and the Pearl River Estuary, and to provide suggestions and guidance on mitigation measures to lessen the pressures of the development projects on dolphins and porpoises. Results from these integrated studies have been used to establish several systematic databases, which can be used to estimate population size, to monitor trends in abundance, distribution, habitat use and behaviour over time, and to keep track of levels and changes in mortality rates of local cetaceans (e.g. Hung 2008, 2012, 2013; Jefferson et al. 2002, 2006, 2009, 2012).

The present monitoring project represents a continuation and extension of this research programme, with funding support from AFCD of the HKSAR Government. The main goal of this one-year monitoring study is to collect systematic data for assessment of the distribution and abundance of Chinese white dolphins and Indo-Pacific finless porpoises in Hong Kong, to take photographic records of individual dolphins, and to analyze the monitoring data for better understanding of the various aspects of local dolphin and porpoise populations. The one-year project covers the period of 1 April 2013 to 31 March 2014. And this final report is submitted to AFCD to summarize the status of the monitoring project covering the entire 12-month study period.

2. OBJECTIVES OF PRESENT STUDY

The main goal of this one-year monitoring study was to collect systematic data for assessment of distribution, abundance and habitat use of Chinese White Dolphins and Indo-Pacific finless porpoises in Hong Kong, to take photographic records of individual dolphins, and to analyze the monitoring data for better understanding of the various aspects of local dolphin and porpoise populations. To achieve this main goal, several specific objectives were set for the present study.

The first one was to assess the spatial and temporal patterns of distribution, abundance and habitat use of Chinese White Dolphins and Indo-Pacific finless porpoises in Hong Kong in detail. This objective was achieved through data collection on dolphins and porpoises by conducting regular systematic line-transect vessel surveys and helicopter surveys. The second objective was to identify individual Chinese White Dolphins by their natural markings using photo-identification technique. This objective was achieved by taking high-quality photographic records of Chinese White Dolphins for photo-identification analysis. Photographs of re-sighted and newly identified individuals were compiled and added to the current photo-identification catalogue, with associated descriptions for each newly identified individual. Photographic records of finless porpoises were also taken during vessel and helicopter surveys for educational purposes.

The third objective was to analyze the monitoring data for better understanding of the various aspects of local dolphin and porpoise populations. This objective was achieved by conducting various data analyses, including line-transect analysis, encounter rate analysis, distribution analysis, behavioural analysis and quantitative grid analysis to assess the spatial and temporal patterns of abundance, distribution and habitat use and trends of occurrence of local dolphins and porpoises using systematic line-transect survey data; and acoustic data analysis and theodolite tracking data analysis to assess the anthropogenic noise impacts on local dolphins. The fourth objective was to conduct ranging pattern and residency pattern analyses to examine individual core area use, ranging pattern, movement pattern, habitat use and association pattern based on the data obtained from both the line-transect survey and the photo-identification work.

The final objective was to educate the members of the public on local dolphins and porpoises, by disseminating the study findings from the long-term monitoring research programme. This objective was achieved by providing public seminars through the arrangement of AFCD.

3. RESEARCH TASKS

During the study period, several tasks were completed to satisfy the objectives set for the present marine mammal monitoring study. These tasks were:

- to collect data for assessment on spatial and temporal patterns of distribution, abundance and habitat use of local dolphins and porpoises through systematic line-transect vessel surveys and helicopter surveys;
- to analyze data for assessment on spatial and temporal patterns of distribution, abundance, habitat use and trends of occurrence of dolphins and porpoises in Hong Kong;
- to take photographic records of Chinese White Dolphins for photo-identification analysis and update the photo-identification catalogue;
- to analyze photo-identification data of individual Chinese White Dolphins to assess their ranging patterns, core area use and movement patterns;
- to conduct dolphin-related acoustic studies;
- to conduct shore-based theodolite tracking works;
- to take photographic records of finless porpoises; and
- to assist AFCD in arousing public awareness on local dolphins and porpoises through school seminars.

4. METHODOLOGY

4.1 Vessel Survey

The survey team used standard line-transect methods (Buckland et al. 2001) to conduct regular vessel surveys, and followed the same technique of data collection that has been adopted in the past 17 years of marine mammal monitoring surveys in Hong Kong developed by HKCRP (Hung 2005, 2013; Jefferson 2000a, b; Jefferson et al. 2002). The territorial waters of Hong Kong Special Administrative Region are divided into twelve different survey areas, and line-transect surveys were conducted among nine survey areas (i.e. Northwest (NWL), Northeast (NEL), West (WL), Southwest (SWL) & Southeast Lantau (SEL), Deep Bay (DB), Lamma (LM), Po Toi (PT)and Ninepins (NP)) (Figure 1).

Starting from the present monitoring period, several minor revisions have been made on several sets of surveys lines in NWL, NEL, WL and DB due to various reasons (Figure 1). In NWL, the southern end of the transect lines near the airport platform has been slightly shortened, to ensure that the survey vessel would not enter into the airport exclusion zone. In NEL, the westernmost transect line was shortened by half, as the southern end of that line has been completely and permanently blocked by the reclamation site of the Hong Kong Boundary Crossing Facilities (HKBCF). Moreover, the transect lines in the inner Deep Bay area have been blocked by some additional oyster farms in the area, and therefore such lines have been slightly shortened. Finally, the WL transect lines near the inshore waters of Tai O Peninsula has been slightly shortened, where the water is too shallow for the boat to enter due to navigational difficulty.

For each 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. 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* or *Steiner* marine binoculars. Both observers searched the sea ahead of the vessel, between 270^o and 90^o (in relation to the bow, which is defined as 0^o). One to two additional experienced observers were available on the boat to work in shift (i.e. rotate every 30 minutes) in order to minimize fatigue of the survey team members. All observers were experienced in small cetacean survey techniques and identifying local cetacean species. Beforehand they had participated in rigorous at-sea training program provided by the PI.

During on-effort survey periods, the survey team recorded effort data including time, position (latitude and longitude), weather conditions (Beaufort sea state and visibility), and distance traveled in each series (a continuous period of search effort) with the assistance of a handheld GPS (e.g. *Garmin eTrex Legend H*). When dolphins or porpoises were sighted, the survey team would end the survey effort, and immediately record the initial sighting distance and angle of the dolphin/porpoise 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/porpoise group to the transect line was later calculated from the initial sighting distance and angle. The line-transect data collected during the present study were compatible with the long-term databases maintained by HKCRP in a way that it can be analyzed by established computer programmes (e.g. all recent versions of DISTANCE programme including version 6.0, ArcView© GIS programme) for examination of population status including trends in abundance, distribution and habitat use of Chinese white dolphins and finless porpoises.

4.2 Helicopter Survey

Several helicopter surveys arranged by the Government Flying Service (GFS) through AFCD were conducted during the study period to survey mainly the remote survey areas that were relatively inaccessible by boat (e.g. Ninepins, Sai Kung, Mirs Bay) (Figure 2). The survey coverage of each helicopter survey largely depended on weather conditions such as visibility, sea state, cloud cover and wind direction, and the planned flight route could be changed with some flexibility according to the final decision by the GFS pilot. The helicopter survey usually lasted 1.5 hours, flying at an altitude of about 150 m and a speed of 150-200 km/hr. Three observers were on board to search for dolphins and porpoises on both sides of the helicopter. Data on sighting position, environmental conditions, group size and behaviour of the dolphins or porpoises were recorded when they were sighted. The off-effort helicopter surveys were mainly used to collect data for distribution of Chinese White Dolphins and finless porpoises, but individual dolphins with very distinct identifying features were occasionally identified from pictures taken from the helicopter.

4.3 Photo-identification Work with Focal Follow Study

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 each dolphin in the group, and even photograph both sides of the dolphins, since the colouration and markings on both sides may not be symmetrical. One to two professional digital cameras (*Canon* EOS 7D and 60D models), each equipped with long telephoto lenses (100-400 mm zoom), were available on board for researchers to take sharp, close-up photographs of dolphins as they surfaced. The images were shot at the highest available resolution and stored on Compact Flash memory cards for downloading onto a computer.

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 details, and were carefully compared to over 800 identified dolphins in the PRE Chinese White Dolphin photo-identification catalogue. 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 2000a; Jefferson and Leatherwood 1997). 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. Any new individuals were given a new identification number, and their data were also added to the catalogue, along with text descriptions including age class, gender, any nickname or unique markings. The updated photo-identification catalogue incorporated all new photographs of individual dolphins taken during the present study.

Focal follow observations of individual dolphins were also conducted to examine their movement patterns and behaviour in greater detail. The focal follow study can gain knowledge on their utilization of different parts of the dolphins' ranges and core areas, and to determine whether important traveling corridors exist for individuals or different social clusters to transit between different parts of North and West Lantau waters. The targets of this focal follow study were individual dolphins or small stable groups of Chinese White Dolphins with members that could be readily identified with unaided eyes during observations. When such targets were encountered during vessel surveys and the weather condition was favourable, the on-effort search would be aborted and extended periods would be spent to follow the targeted dolphin or dolphin groups.

During focal follows, the research vessel was driven parallel to the group, matching the dolphin(s) heading and speed and at such a distance as to minimize influencing the dolphin(s) movements (Würsig and Jefferson 1990; Markowitz et al. 2004). The positions and time data were continuously logged by handheld GPS to track their movement. In addition, information including the environmental condition, the dolphin's reaction to research vessel, boat association, sub-group size and composition, behavioural state of the dolphins, as well as the occurrence of moving vessels around the targeted individuals were recorded at five-minute intervals. The sampling duration for each focal follow session was extended as long as possible, in order to provide the best representative sampling of individual movement patterns.

4.4 Dolphin-related Acoustic Works

4.4.1. Calibrated hydrophone

For acoustic data collection, a set of calibrated hydrophones were deployed 3 to

7 metres below the sea surface by a 2-metre long spar buoy from the stern of the research vessel, with the vessel engine switched off and the vessel drifting. Recordings of background ambient noise and broadband dolphin sounds were made with a Cetacean Research Technology spot-calibrated hydrophone (model: CR1; sensitivity: -197.7 dB, re. 1 V/μPa; usable frequency response listed as 4 Hz-68 kHz +3/-12 dB connected to a 1 MΩ input impedance; linear frequency range: 0.2-48 kHz ± 3 dB). The spar buoy acted to prevent excessive hydrophone movement from wave and boat motion. The recordings were then streamed into a digital memory field recorder (model: Fostex FR-2; frequency response: 20 Hz-80kHz ±3 dB) with a pre-amplified signal conditioner (model: PC200-ICP; precision gain: x0.1-x100; frequency range: >100 kHz; system response: 1 Hz-100 kHz ± 3 dB) to prevent overloading and minimize cable noise. The recordings were stored in a 4 GB Compact Flash Card, to be downloaded onto a laptop computer for further analysis.

During regular line-transect surveys, the HKCRP research vessel would stop at various monitoring stations set up along the transect lines in North, West and South Lantau waters (Figure 3) to collect ambient sound level and existing/potential anthropogenic noises within the dolphin habitat. Date, start and end times, hydrophone and water depths, Beaufort sea state, area, start and end locations, gain, event, and notes were taken for each recording. Additional locations were also included opportunistically to collect vocalizations of dolphins when they came close to the stern of the research vessel.

4.4.2. Towed hydrophone

HKCRP research team also used a towed hydrophone array developed by Mr. Josh Jones from the Whale Acoustic Lab at Scripps Institution of Oceanography, to enhance the overall capability of the current acoustic data collection regime on local dolphins. The hydrophone array was set in an oil-filled tube and was composed of two Burns Electronic CR-100 hydrophones and two inline amplifiers with 3 db high-pass filters. It was connected to 50 metres of reinforced cable and was plugged into an amplifier/filter box onboard the HKCRP research vessel. The filters were designed to remove ship and flow noise for real-time listening and to facilitate automated detection of clicks and whistles produced by the Chinese White Dolphins (and possibly finless porpoises). The entire system was connected to a laptop with computer programs *Logger* 2000 and *Ishmael* 1.0, which allowed visual display of the signals in a real-time spectrogram, and to perform automated detection and localization of clicks and whistles.

4.5. Shore-based Theodolite Tracking Work

During the present study period, a long-term behavioural study on Chinese White Dolphins using a shore-based theodolite tracking technique continued, to determine if dolphin movement patterns and behaviours change in the presence of different types of vessels (Piwetz et al. 2012).

Shore-based theodolite tracking sessions were mainly conducted from three different stations at Tai O, Sham Wat and Fan Lau during the present study period, with different research goals in mind at each station (Figure 4). Observation from Tai O aimed to examine the impacts of dolphin-watching and fishing activities as well as to collect information on undisturbed behaviours of Chinese White Dolphins. From Fan Lau, shore-based observation targeted the movement of high-speed ferries traversing between Hong Kong, Macau and mainland Chinese cities, which may have created immense acoustic disturbance to dolphins occurring in this area (see Hung 2012; Sims et al. 2012). The station near Sham Wat was set up for collecting information to examine impacts of HZMB construction on dolphins, including the acoustic disturbance from bored piling activities as well as the potential obstruction of limiting north-south movement of dolphins underneath the bridge. All three stations were selected based on height above sea level (>20 metres; Würsig et al. 1991), close proximity to shore, and unobstructed views of dolphin habitat. In addition, during the course of the present study, additional stations were set up at Lung Kwu Tan, Siu Ho Wan, Tai Ho Wan and Sha Chau to monitor dolphin behaviours and movement patterns in the North Lantau region as well (Figure 4), and some additional tracking sessions were conducted among these sites.

To conduct theodolite tracking from one of these stations, on each survey day observers searched systematically throughout the study area for Chinese White Dolphins using the unaided eye and 7x50 handheld binoculars. A theodolite tracking session was initiated when an individual dolphin or group of dolphins was located, and focal follow methods were used to track the dolphins. Within a group, a focal individual was selected for the purposes of tracking the behaviour and movement of the group, based on its distinctive feature such as colouration or severe injury mark. The focal individual was then tracked continuously via the theodolite, with positions recorded whenever the dolphin surfaced. If an individual could not be positively distinguished from other members, the group would be tracked by recording positions based on a central point within the group when the dolphins surfaced. Tracking would continue until animals were lost from view, moved beyond the range of reliable visibility (>5 km), or when environmental conditions obstructed visibility (e.g. intense haze, high sea state, or sunset).

Behavioural state data (i.e. resting, milling, traveling, feeding and socializing) were also recorded every 5 minutes for the focal individual or group. This interval was long enough to allow for determination of the behavioural state, and short enough to capture behavioural responses to the bored piling activities. Moreover, when multiple groups or individuals were present in the study area, attempts would be made to record the behaviours of all groups/ individuals every 10 minutes, with spotters assisting in determining behaviour of the dolphins.

Positions of dolphins, boats and construction activities were measured using a Sokkisha DT5 digital theodolite with ± 5-sec precision and 30-power magnification connected to a laptop computer running the program *Pythagoras* Version 1.2 (Gailey and Ortega-Ortiz 2002). This program calculates a real-time conversion of horizontal and vertical angles collected by the theodolite into geographic positions of latitude and longitude each time a fix is initiated. *Pythagoras* also displays positions, movements, and distances in real-time. When possible, the position of the focal dolphin was recorded at every surfacing with use of *Pythagoras*. The position, type, and activity of all vessels within 5 km of the focal dolphin were also recorded. An effort was made to obtain at least several positions for each vessel, and additional positions were acquired when vessels changed course or speed.

4.6 Data Analyses

4.6.1. Distribution pattern analysis

The line-transect survey data was integrated with Geographic Information System (GIS) in order to visualize and interpret different spatial and temporal patterns of dolphin and porpoise distribution using sighting positions. Location data of dolphin and porpoise 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, fishing boat associations, young calves and activities. Data from the long-term sighting databases were used to compare past distribution patterns of dolphins and porpoises in recent years to the one in the present study period.

4.6.2. Encounter rate analysis

Since the line-transect survey effort was uneven among different survey areas and across different years, the encounter rates of Chinese White Dolphins and finless porpoises (number of on-effort sightings per 100 km of survey effort) were calculated in each survey area in relation to the amount of survey effort conducted. In addition, the encounter rates of young dolphin calves, and dolphin groups engaged in different activities were calculated to compare with previous monitoring periods and to detect any temporal changes. The encounter rate could be used as an indicator to determine areas of importance to dolphins and porpoises within the study area.

4.6.3. Line-transect analysis

Density and abundance of Chinese White Dolphins 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 (see Jefferson 2000a), using line-transect methods (Buckland et al. 2001). The estimates were made using the computer program DISTANCE Version 6.0, Release 2 (Thomas et al. 2009). The following formulae were used to estimate density, abundance, and their associated coefficient of variation:

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

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

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

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 (see Buckland et al. 2001). 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 (Buckland et al. 2001).

Besides estimating dolphin abundance in 2013, annual abundance estimates were also generated for every year since 2001 in NWL and NEL survey areas and since 2003 in WL survey area, to investigate any significant temporal trend using linear regression model. To perform such trend analysis, the linear regression model is considered in the three areas by Dr. Gilbert Lui from the Department of Statistics and Actuarial Science of the University of Hong Kong, as follow:

$$x_t = a + bt + u_t \qquad \text{for} t = 1, \ldots, n$$

where x_t denotes the abundance data of dolphin at time t, n is the number of observations, and u_t is an error term which follows normal distribution with mean zero and variance σ^2.

4.6.4. Quantitative grid analysis on habitat use

To conduct quantitative grid analysis of habitat use (Hung 2008), positions of on-effort sightings of Chinese White Dolphins and finless porpoises were retrieved from the long-term sighting databases, and then plotted onto 1-km^2 grids among the nine survey areas on GIS. Sighting densities (number of on-effort sightings per km^2) and dolphin/porpoise densities (total number of dolphins/porpoises from on-effort sightings per km^2) were then calculated for each 1 km by 1 km grid with the aid of GIS. Sighting density grids and dolphin/porpoise 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/porpoise density of each grid were then normalized (i.e. divided by the unit of survey effort).

The newly-derived unit for sighting density was termed SPSE, representing the number of on-effort **s**ightings **p**er 100 units of **s**urvey **e**ffort. In addition, the derived unit for actual dolphin/porpoise density was termed DPSE, representing the number of **d**olphins **p**er 100 units of **s**urvey **e**ffort. Among the 1-km^2 grids that were partially covered by land, the percentage of sea area was calculated using GIS tools, and their SPSE and DPSE values were adjusted accordingly. The following formulae were used to estimate SPSE and DPSE in each 1-km^2 grid within the study area:

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

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

where S = total number of on-effort sightings

D = total number of dolphins / porpoises from on-effort sightings

E = total number of units of survey effort

SA% = percentage of sea area

Both SPSE and DPSE values can be useful in examining dolphin/porpoise usage within a one square kilometre area. For the present study, both SPSE and DPSE values were calculated in each 1-km^2 grid among all survey areas for the entire one-year period in 2013, and in recent years of monitoring (2009-13 for Chinese White Dolphins and 2004-13 for finless porpoises).

4.6.5. Behavioural analysis

When dolphins were sighted during vessel surveys, their behaviour was observed. Different behaviours were categorized (i.e. feeding, milling/resting, traveling, socializing) and recorded on sighting datasheets. This data were then input into a separate database with sighting information, which were used to determine the distribution of behavioural data using 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. The behavioural data was also used in the quantitative analysis on habitat use to identify important dolphin habitats for various activities.

4.6.6. Ranging pattern analysis

For the ongoing ranging pattern study, location data of individual dolphins with 10 or more re-sightings that were sighted during the present study 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, created by the Alaska Biological Science Centre, USGS (Hooge and Eichenlaub 1997), 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. The core areas of individuals with 15+ re-sightings at two different levels (50% and 25% UD) were also examined to investigate their range use in greater detail.

4.6.7. Residency pattern analysis

To examine the monthly and annual occurrence patterns of individual dolphins, their residency patterns in Hong Kong were carefully evaluated. "Residents" were defined as individuals that were regularly sighted in Hong Kong for at least eight years during 1995-2013, or five years in a row within the same period. Other individuals that were intermittently sighted during the past years were defined as "Visitors". In addition, monthly matrix of occurrence was also examined to differentiate individuals that occurred year-round (i.e. individuals that occur in every month of the year) or seasonally (i.e. individuals that occur only in certain months of the year). Using both yearly and monthly matrices of occurrence, "year-round residents" were the individual dolphins that were regularly sighted in Hong Kong throughout the year, while "seasonal visitors" were the ones that were sighted sporadically in Hong Kong and only during certain months of the year within the study period.

4.6.8. Movement pattern analysis

Individual movement across different survey areas were broadly examined using the photo-identification data in 2013, while detailed movement patterns of individual dolphins were further assessed using the focal follow observation data collected from 2012-14. Locations of these identified individuals from the focal follows were plotted on Google Earth® to illustrate their tracklines for visual interpretation on movement pattern.

5. RESULTS AND DISCUSSIONS

5.1. Summary of Data Collection

5.1.1. Survey effort

During the monitoring period from April 2013 to March 2014, 171 line-transect vessel surveys were conducted among nine survey areas in Hong Kong waters. These included 24 surveys in NEL, 34 surveys in NWL, 40 surveys in WL, 23 surveys in SWL, 20 surveys in SEL, 11 surveys in DB, seven surveys in LM, six surveys in PT and six surveys in NP. The details of these survey effort data are shown in Appendix I.

More survey effort has been allocated to survey areas outside of North Lantau and West Lantau waters during the present monitoring period, where additional surveys have been conducted by HKCRP research team under the Hong Kong Link Road (HKLR) regular line-transect monitoring surveys as part of the EM&A works for the Hong Kong-Zhuhai-Macau Bridge (HZMB) construction. These HKLR dolphin monitoring surveys employed the same survey methodology, personnel and research vessel to ensure consistency and compatibility with the AFCD long-term dolphin monitoring programme, and the survey data have been made publicly available with regular updates through the Environmental Project Office (ENPO) website (www.hzmbenpo.com). Such EM&A data were combined with the AFCD monitoring data for various data analyses presented throughout this report to increase the overall sample size and provide supplementary information on dolphin occurrence during the present monitoring period.

In addition, with the support of the Government Flying Service, five helicopter surveys were arranged by AFCD on June 3rd, September 16th, October 16th, November 4th and March 24th. These surveys mainly covered the eastern and southern waters of Hong Kong, and off-effort data on local dolphins and porpoises collected from these surveys were also included in the distribution analysis and group size analysis.

During the 12-month monitoring period, 607.0 hours were spent to collect 4,998.0 km of survey effort among the nine survey areas in Hong Kong. The majority of survey effort (64.4% total) was conducted in five survey areas where dolphins regularly occur, in which 32.3% of total effort were spent in NEL/NWL, 13.8% in WL, 13.9% in SWL and 4.4% in DB. In addition, 49.5% of total survey effort was also allocated to survey areas in southern and eastern waters (SWL, SEL, LM, PT and NP) of Hong Kong where porpoise occurrences were more frequent. It should be mentioned that 92.9% of total survey effort was conducted under favourable sea conditions (Beaufort 3 or below with good visibility). Such high percentage of survey effort conducted in favourable conditions is crucial to the success of the marine mammal data collection programme in Hong Kong, as only such data can be used in various analyses to examine encounter rate, habitat use, and estimation of density and abundance.

In addition, during the same 12-month monitoring period, a total of 4,296.7 km of survey effort was conducted in NEL, NWL and WL under the HKLR03 (Section between Scenic Hill and HKBCF) and HKLR09 (Section between HKSAR Boundary and Scenic Hill) EM&A dolphin monitoring surveys respectively. This brings the total survey effort to 6,599.9 km for the combined dataset from AFCD and HKLR surveys within these survey areas. Over 90% of the survey effort of HKLR surveys was conducted under favourable sea conditions, which can be combined with the AFCD monitoring survey data for various analyses.

Since 1996, the long-term marine mammal monitoring programme coordinated by HKCRP has collected a total of 149,954 km of line-transect survey effort in Hong Kong and Guangdong waters of the Pearl River Estuary under different government-sponsored monitoring projects, consultancy studies and private studies, with 52.9% of the effort funded by AFCD. The survey effort in 2013 alone comprised 7.3% of the total survey effort collected since 1996.

5.1.2. Marine Mammal Sightings

Only two species of marine mammals were sighted during the present monitoring period, namely the Chinese White Dolphins and Indo-Pacific finless porpoises.

Chinese White Dolphin sightings

From AFCD surveys alone, 317 groups of Chinese White Dolphins, numbering 1,052 individuals, were sighted during April 2013 to March 2014 (see Appendix II). With the additional sightings from HKLR surveys, a total of 633 groups of 2,162 individuals were sighted during the same period. Among these dolphin groups, 533 were sighted during on-effort line-transect vessel surveys, while the rest were made during off-effort search. Most dolphins were sighted in WL (322 sightings) and NWL (203 sightings), comprising 82.9% of the total. On the other hand, dolphins occurred in a lesser extent in SWL (80 sightings), and infrequently in NEL (17 sightings) and DB (11 sightings) despite the consistent survey effort that was conducted in these two areas. As in the previous monitoring period, no dolphin was sighted in SEL, LM, PT or NP survey areas.

Finless porpoise sightings

During the 12-month study period, 113 groups of finless porpoises totaling 260 individuals were sighted during vessel surveys (see Appendix III). Ninety-three sightings were made during on-effort search, which can be used in the encounter rate analysis and habitat use analysis. The porpoise groups were mainly sighted in SEL (54 groups) and SWL (34 groups), and another 21 groups were also sighted in LM. Only four sightings of five porpoises were made in NP survey area, while no porpoise was sighted at all in PT despite a considerable amount of survey effort was conducted there. As in the past, no porpoise was sighted in DB, NWL, NEL and WL survey areas during the monitoring period.

5.1.3. Photo-Identification of Individual Dolphins

From April 2013 to March 2014, over 35,000 digital photographs of Chinese White Dolphin were taken during AFCD monitoring surveys for the photo-identification of individual dolphins. All photographs taken in the field were compared with existing individuals in the photo-identification catalogue that has been compiled by HKCRP since 1995. All new photographs identified as existing or new individuals during the study period, as well as any updated information on gender and age class of individuals dolphins, were incorporated into the photo-identification catalogue. Additional photo-identification data were also contributed from the HKLR surveys.

Up to January 2014, a total of 841individual Chinese White Dolphins have been identified by HKCRP researchers in Hong Kong waters and the rest of the Pearl River Estuary. These included 24 new individuals being added to the catalogue during 2013, all of which were identified in Hong Kong waters. In the current catalogue, 474 individuals were first identified within Hong Kong territorial waters, while the rest were first identified in Guangdong waters of the Pearl River Estuary. Moreover, 214 individuals have been seen 10 times or more; 171 individuals have been seen 15 times or more; 92 individuals have been seen 30 times or more; and 47 individuals have been seen 50 times or more. Individual dolphin NL24 has the highest number of re-sightings, which has been regularly seen 224 times in Hong Kong since 1996. On the contrary, more than half of the identified individuals (50.7%) have only been seen once or twice, with most of these being first identified in Guangdong waters (301 out of 367 individuals). Temporal trends in total number of identified individuals, the total number of re-sightings made, and the number of individuals within several categories of number of re-sightings showed that good progress in photo-identification work has been made in 2013 (Figure 5).

During the present monitoring period from April 2013 to March 2014, a total of 162 individuals, sighted 497 times altogether, were identified during AFCD regular vessel surveys, helicopter surveys and shore-based theodolite tracking works (Appendix IV). In addition, 167individuals were also identified 578 times during HKLR monitoring surveys in NEL, NWL and WL. The majority of re-sightings made during AFCD and HKLR surveys in the 12-month period were in WL and NWL survey areas, comprising 47.3% and 36.3% respectively. A fair portion of the re-sightings were made in SWL (121), despite less survey effort being conducted in this survey area when compared to NWL and WL survey areas. On the contrary, only 39 and 17 sightings were made in NEL and DB survey areas, due to the small amount of dolphin sightings made in these two areas during the 12-month period.

Among the identified individuals sighted over the 12-month study period during AFCD and HKLR surveys, most of them were sighted only a few times, but some have been sighted repeatedly, indicating their strong reliance of Hong Kong as an important part of their home ranges. For example, 20 individuals were sighted more than 10 times from the combined dataset, with three of them (NL24, NL33 and WL25) sighted more than 15 times during the relatively short study period. Notably most of these repeatedly-sighted individuals are considered year-round residents (see Section 5.8.1), and several individuals were females that have been frequently seen with their young calves in Hong Kong (e.g. NL33, NL98, NL104). Although the majority of these frequently sighted individuals centered their range use in North Lantau waters, a few individuals (e.g. WL25, WL152, WL123) that centered their range use in WL and SWL waters were also sighted repeatedly.

5.1.4. Dolphin-related Acoustic Studies

For the long-term acoustic monitoring work that aims to improve the overall understanding of the natural sound habitat and anthropogenic noises within dolphin habitat around Lantau Island, a total of 8 hours and 23 minutes of recordings in 122 sound samples were collected from 19 acoustic monitoring stations around Lantau and in Deep Bay during the 12-month monitoring period (see Appendix V). Opportunistic recordings of dolphin sounds were also collected at different locations from calibrated hydrophone system and towed hydrophone array.

The acoustic data collected under the present study were all integrated into a long-term database, which can serve as useful baseline information for future studies. For instance, an on-going study will combine dolphin distribution and density data, as well as ambient noise recordings, to construct GIS layers that can describe dolphin habitat use in relation to underwater noise levels. Characterization of sound profiles of all sound sources (both anthropogenic and natural sounds) within the dolphin habitat is also in progress to determine how different sources of noise contribute to the overall soundscape of the waters within dolphin habitats.

5.1.5. Shore-based Theodolite Tracking

During the 12-month study period, a total of 43 sessions with over 209 hours of theodolite tracking were conducted from Tai O (8 sessions), Sham Wat (17 sessions), Fan Lau (10 sessions), Siu Ho Wan (3 sessions), Tai Ho Wan (3 sessions) and Lung Kwu Tan (2 sessions) shore-based stations (Appendix VI). Considerably more effort was spent at the Sham Wat station during the present monitoring period, as part of an on-going effort to determine the impact of HKLR09 construction on the north-south movement of dolphins in that area. These data can also be used as supplementary information on individual movement and examination of traveling corridor between the Sha Chau and Lung Kwu Chau Marine Park and West Lantau waters (see Section 5.8.3).

From these sessions, 140 groups of Chinese White Dolphins with 3,751 fixes of their positions were collected. Another 11,523 fixes were also made from locations of dolphin-watching boats, fishing boats, high-speed ferries and other type of vessels. The theodolite tracking data under the present study were integrated into a long-term database, to evaluate the fine-scale movement patterns (e.g. speed, reorientation rate and linearity) and surface-active behaviours of dolphins in relation to vessel movements as well as construction activities. The fix positions from individual tracks during each focal follow session would also be used to examine movement patterns of local dolphins.

5.2. Distribution

5.2.1 Distribution of Chinese White Dolphins

From April 2013 to March 2014, dolphins were sighted regularly to the north, west and south of Lantau Island during AFCD surveys (Figure 6) and HKLR surveys (Figure 7). In 2013, dolphins were mostly sighted at the northwestern portion of NWL survey area, with concentration within and adjacent to the Sha Chau and Lung Kwu Chau Marine Park as well as between Lung Kwu Chau and Black Point (Figure 8). They also occurred more often at the mouth of Deep Bay near Black Point, near Pillar Point, to the northeast and southwest of Chek Lap Kok airport platform, around the Brothers Islands and near Yam O (Figure 8).

Since April 2012, the water adjacent to the east side of the airport platform was blocked off by the reclamation works of the Hong Kong Boundary Crossing Facilities (HKBCF), which was no longer available for the dolphins. In fact, dolphins rarely occurred in the proximity of the reclamation site in 2013 even though extensive amount of survey effort was conducted around in NEL and NWL survey areas (Figure

8). Moreover, bored piling works of HKLR09 also began in March 2013, with most of the construction activities concentrated along the coastal waters between Sham Wat and the western entrance of airport channel. In 2013, dolphins infrequently occurred in that HKLR09 construction area as well (Figure 8).

In WL waters, dolphins were sighted throughout the survey area in 2013, with concentration of sightings made along the coastline, particularly around Tai O Peninsula, Kai Kung Shan, Peaked Hill and around Fan Lau, and further extending toward Kau Ling Chung in SWL survey area (Figure 9). As in previous monitoring periods, more dolphins were sighted inshore than in the offshore waters in WL survey area. However, dolphins were less frequently sighted at the northern end of the survey area, especially near the HKLR alignment. In fact, only a few sightings were made along the alignment of HKLR in 2013, which was in stark contrast to the high dolphin usage throughout the rest of the survey area (Figure 9).

Temporal change in annual distribution records (2010-13)

Using AFCD survey data alone, dolphin distribution records in the previous three years (2010-12) was compared with the one in 2013 to examine any temporal change in dolphin usage around Lantau waters (Figure 10). Several notable differences were observed. First, there were much fewer dolphins occurred in NEL in 2013 than in previous years, and they mostly disappeared from the north shore of Lantau, especially around Sham Shui Kok and Yam O where dolphins used to occur regularly. Only a few dolphin sightings were made around the Brothers Islands, where this area has been identified as important dolphin habitat in past years of long-term monitoring. In fact, concern has been raised in the previous monitoring period that the HKBCF reclamation works have been affecting dolphin usage in NEL (Hung 2013), and it appears that the situation has worsened in 2013, with even fewer dolphins utilizing this important area as part of the population range.

Another notable difference is the paucity of dolphin sightings made to the west of airport platform in 2013 (Figure 10), where dolphins were frequently found in the past few years (Hung 2013). It has been emphasized that this juncture between NWL and WL survey areas near Sham Wat is an important region where individual dolphins from both northern and southern social clusters in Hong Kong come into contact (Dungan et al. 2012). There have also been concerns that the north-south movement of Chinese White Dolphins in this area would be affected by the HKLR09 bridge alignment. As the absence of dolphins from the coastal waters between Sham Wat and the western entrance of the airport channel coincided well with the commencement of HKLR09 construction activities during the same year, it is very likely that the dolphin occurrence in this area has been seriously affected by these construction works and associated vessel movements in this area that has been significantly increased (see Section 5.9.2). As the intensity of HKLR09 construction works will increase in 2014, and the spacing between the bridge piers will become narrower progressively, the overall dolphin usage over the bridge alignment area as well as the north-south movement pattern of individual dolphins should be closely examined to determine whether their absence from this important area would continue.

On the contrary, it appears that more dolphins utilized the DB and SWL survey areas in 2013 than in the past (Figure 10). In particular, more dolphins were sighted along the coastal waters between Fan Lau and Kau Ling Chung. It is possible that in light of the HZMB-related construction works, dolphins may have to expand their range use to other less favourable habitats to avoid anthropogenic disturbance, and such potential range shift is further examined in Section 5.8.2.

<u>Seasonal variation in dolphin distribution</u>

In 2013, seasonal variation in dolphin distribution was evident (Figure 11). In North Lantau, dolphins rarely occurred in NEL during spring and summer months, but were sighted more frequently in winter months (Figure 11). Moreover, more dolphins were sighted within Deep Bay in winter months than the other three seasons. In South Lantau waters, dolphins were infrequently sighted in spring and summer months, but occurred more often during autumn months. It appeared that seasonal variation was more pronounced in the peripheral areas of the population range, where seasonal influence of the Pearl River outflow is more distinct. On the contrary, seasonal difference in dolphin occurrence in NWL and WL was less evident (Figure 11).

5.2.2. Distribution of finless porpoises

During the 12-month study period in 2013-14, most finless porpoise sightings were made between the Soko Islands and Shek Kwu Chau, and the porpoises were also sighted around the Soko Islands, south of Cheung Chau, east of Lamma Island and south of the Ninepins Islands (Figure 12). On the contrary, porpoises were not sighted around the Po Toi Islands, the northwestern portion of South Lantau waters, and between Cheung Chau and Lamma Island. Moreover, the few sightings made in South Lantau waters during summer and autumn months were located at offshore waters, while all four sightings to the south of Ninepins Islands were made in the summer months (Figure 12).

Comparison of annual porpoise distribution patterns from 2010-2013 revealed that a lot more porpoise sightings were made in South Lantau waters in 2013, with the majority of these sightings made around Soko Islands, Shek Kwu Chau, Cheung Chau and between Soko Islands and Shek Kwu Chau (Figure 13). Porpoises were also present along the South Lantau coastline (mainly around the Shui Hau Peninsula), where they were mostly absent in the previous three years. Due to the uneven amount of survey effort on both sides of Lamma Island, more porpoises were sighted between Cheung Chau and Lamma in 2013 than in previous years (Figure 13). Another notable difference was that no porpoise was sighted around Po Toi Islands in 2013, despite the considerable amount of survey effort was conducted in PT survey area (Figure 13)

5.3. Encounter Rate

5.3.1. Encounter rates of Chinese White Dolphins

To calculate encounter rates of Chinese White Dolphins, only data collected in Beaufort 0-3 conditions was included in the analysis, since dolphin encounter rate was considerably lower in Beaufort 4-5 conditions (4.6 sightings per 100 km of survey effort) than in Beaufort 0-3 conditions (7.3) during the study period. From April 2013 to March 2014, the combined encounter rate of Chinese White Dolphins from NWL, NEL, WL and SWL was 7.2. Over the past 12 monitoring periods, the overall encounter rates remained relatively stable within the range of 6.3-8.6, with the exception of 2003/04 and 2007/08 when dolphin occurrences were exceptionally high (Figure 14). In particular, the overall encounter rates in the past three monitoring periods were very similar to each other, all within the range of 7.2-7.7 (Figure 14). Among the five survey areas around Lantau, the encounter rate was the highest in WL, which was 2-3 times higher than in SWL and NWL, or 28 times higher than in NEL (Figure 15). Notably, the dolphin encounter rate in SWL was generally much lower in the past, but for the first time it was even higher than the one in NWL during the present monitoring period.

<u>Temporal trend in annual encounter rate</u>

Temporal trends in annual dolphin encounter rates were examined for the overall combined areas, as well as the two main areas of dolphin occurrence in North Lantau and WL/SWL regions, where the two social clusters of individual dolphins occur respectively. Overall, the combined encounter rates in NWL, NEL, WL and SWL showed a gradual decline to the lowest in 2012, but slightly bounced back in 2013

(Figure 16). This was likely contributed by the substantial increase in dolphin usage of WL/SWL region in 2013. In the North Lantau region, dolphin encounter rate dropped to the lowest in 2013 since 2002, after a significant rebound in 2011 during the 12-year period (Figure 16). On the contrary, since a noticeable decline from the highest in 2003 to the lowest in 2011, dolphin encounter rates in WL/SWL region rose back to a higher level in 2013, which was also the highest since 2007 (Figure 16). It should be further examined whether the opposite trend of dolphin occurrence in 2013 among the two regions was prompted by range shift of some individuals from North to WL/SWL region, as this can address the important issue on whether the entire population in Hong Kong has been on a decline, or individual dolphins are just shifting from one area to another to avoid anthropogenic impacts in certain part of their ranges.

<u>Temporal change in encounter rate in relation to HZMB construction</u>

To investigate further on the potential impacts of the HZMB-related construction activities on dolphin usage in North Lantau region, the quarterly encounter rates of dolphins in NEL and NWL were examined for the three periods in 2011-2013. As the HKBCF and HKLR03 reclamation works commenced in April 2012 (second quarter of 2012) and October 2012 (fourth quarter) respectively, the quarterly encounter rates among the four quarters of 2011 and first quarter of 2012 were considered as baseline values. Temporal trend in each quarter of the three-year period were examined independently, since seasonal variation in dolphin occurrence has been evident in North Lantau region, especially in NEL survey area (see Section 5.2.1; Hung 2012, 2013).

In NEL, there were noticeable drops in dolphin encounter rates between 2011 and 2012 during the second and third quarters when the HKBCF reclamation works commenced, and such slump was even more distinctive during the fourth quarter, when the HKLR03 reclamation works also commenced (Figure 17). In 2013, the dolphin encounter rate dropped even further throughout all four quarters in NEL, especially during the first quarter when HKBCF reclamation works have not started in 2012 (Figure 17). On the other hand, such decline in dolphin encounter rates was only detected during the second and third quarters in NWL throughout the three-year period. There was only a slight drop between 2011 and 2012 during the fourth quarter, and the dolphin encounter rates were very similar between 2012 and 2013 during the same quarter (Figure 17). Conversely, there was a gradual increase in dolphin encounter rates during the first quarter in the three-year period. Notably, the entire North Lantau region (NEL and NWL combined) showed similar trends in dolphin encounter rate as in NWL.

It is apparent that dolphin usage in NEL has drastically shrunken since the commencement of HKBCF reclamation and subsequently with the additional works of HKLR03 reclamation. Evidently, such decline was not related to seasonal variation, as the encounter rates were compared for each quarter separately among different years to eliminate such variation, and the decline in dolphin usage were consistent throughout all four quarters. Since the commencement of HKBCF reclamation, at least 160 hectares of dolphin habitat was permanently lost, and the surrounding silt curtain also temporarily blocked off additional dolphin habitat. More importantly, the reclamation area as well as the stationary and moving vessels just outside the silt curtain may potentially obstruct the movement for dolphins to move from NWL to NEL, and they would have to take the path further north near the Urmston Road while traveling through intensive boat traffic in order to reach the Brothers Islands and the rest of NEL (see Section 5.8.3).

Notably, even though the HKLR03 reclamation along the east coast of the airport platform involved only 23 hectares of sea area where dolphins were rarely sighted in the past decade, it appeared that the drop in dolphin encounter rates in the fourth quarter between 2011 and 2012 was the largest when both reclamation works of HKBCF and HKLR03 took place. It is possible that the additional HKLR reclamation works on top of the HKBCF reclamation works have brought even more cumulative disturbance to deter dolphin usage in NEL with more construction-related vessels occurring in the same area, or the construction works of HKBCF has intensified toward the end of 2013. Nonetheless, even though the prediction from the original HZMB EIA documents concluded that the impacts to dolphins are acceptable with appropriate mitigation measures, the current situation revealed that dolphin usage in the important habitat in NEL has continued to dwindle to a record low after the reclamation works have commenced.

Under the Event and Action Plans for HKBCF and HKLR, the project contractors should identify the source(s) of impacts and discuss additional dolphin monitoring and any other measures with relevant parties when the Action and Limit Levels (i.e. the percentage difference in dolphin encounter rates between baseline and impact phases) are triggered. In fact, both Action and Limit Levels have been triggered multiple times under these two monitoring works since the Event and Action Plan was implemented. In light of the dramatic decline of dolphin usage in NEL since the commencement of both projects, follow-up actions should be taken seriously and immediately, to revert such decline and ensure the integrity of NEL waters as one of the major dolphin habitats in Hong Kong. As the construction works associated with the reclamation works and viaduct construction for the Tuen Mun-Chek Lap Kok Link (TM-CLKL) within NEL waters have also commenced in the last quarter of 2013, it is very worrisome whether dolphins would abandon the NEL waters altogether without any proactive conservation measures to safeguard this dolphin habitat.

It should be noted that dolphin usage in NWL waters have not been seriously affected by the HZMB-related reclamation works yet, probably since such works are outside of this survey area. Nevertheless, decline in dolphin usage was apparent in the second and third quarters during the three-year period in NWL as well as in the entire North Lantau region (Figure 17), and such trend should be continuously monitored. In fact, if dolphins have diminished their usage in NEL, individuals from the northern social clusters should have spent more time in NWL within their home ranges, which should result in higher dolphin encounters in NWL due to the potential displacement. However, such increase only occurred during the first quarters of 2011-2013 in NWL, while the overall dolphin usage in North Lantau has declined in the last three quarters during the three-year period. At present, it is undetermined whether some dolphins may have shifted their range use to West Lantau or into Chinese waters, or may have suffered to the point that would lead to eventual death. These possibilities should warrant for further investigation.

5.3.2. Encounter rates of finless porpoises

Encounter rates of finless porpoises were calculated using data collected in Beaufort 0-2 conditions, since the porpoise encounter rate was considerable lower in Beaufort 3-5 conditions (1.3 sightings per 100 km of survey effort) than in Beaufort 0-2 conditions (4.7). In 2013-14, the combined encounter rate of SWL, SEL, LM and PT was 6.44 porpoise sightings per 100 km of survey effort, which was higher than the ones in previous monitoring periods. Among the five survey areas, porpoise encounter rate was the highest in SEL (12.5). The ones in SWL (7.4) and LM (7.6) was higher than the average, while the encounter rate in NP (2.00) fell below the average. Even though 227.4 km of survey effort was spent in PT, no porpoise was sighted in this area, which was used to be considered as an important porpoise habitat in the past.

The temporal trend of annual porpoise encounter rates indicated that porpoise usage of Hong Kong waters varied considerably in the past decade. The one in 2013 was the fourth highest since 2002, and was the highest since 2010 (Figure 18a). Among the four survey areas, the inconsistency in porpoise usage was even more evident, with no apparent trend in any of these four areas (Figure 19). Nevertheless, it should be noted that both porpoise encounter rates in SWL and SEL were the highest in 2013 since 2002, and were 2.5 times higher than the ones in 2012 (Figure 19). Moreover, after experiencing an exceptionally high encounter rate in LM in 2012, the porpoise encounter rate dropped to a lower level, but was still the second highest since 2002. On the other hand, the annual encounter rate in PT in 2013 dropped to the lowest since 2004, with no porpoise being sighted in this area during 2013 (Figure 19).

To account for the potential frequent movements across SEL, SWL and LM in winter and spring months, the data from these three areas were pooled to calculate the annual porpoise encounter rate in southern waters of Hong Kong and examined its trend in the past decade. In 2013, porpoise usage in the southern waters of Hong Kong was higher among recent years (but very similar to the one in 2012), and such high encounter rate was likely contributed by their high occurrence in SEL and SWL (Figure 18b). However, several infrastructure projects (e.g. reclamation for Integrated Waste Management Facilities at Shek Kwu Chau, artificial islands in central waters of Hong Kong, offshore windfarm and pipeline-laying in Southwest Lamma) are currently under planning within the porpoise habitats in southern waters of Hong Kong, and therefore their annual encounter rate should be continuously monitored to examine any temporal change in habitat use in these waters.

5.4. Density and Abundance

5.4.1. Estimates of dolphin density and abundance in 2013

Using line-transect analysis method, the density and abundance of Chinese White Dolphins in NWL, NEL and WL were estimated, following the same methodology as in previous years of dolphin monitoring in Hong Kong (Hung 2012, 2013). Only effort and sighting data collected under conditions of Beaufort 0-3 were used in the analysis, which included 5,199.6 km of on-effort survey effort and 380 groups of Chinese White Dolphins for the density and abundance estimation in 2013.

In 2013, WL recorded the highest dolphin densities among the three survey areas, with 82.8 individuals/100 km^2 for the year, which was higher than the one in 2013 (61.5) but lower than the one in 2011 (100.4). In NWL, a density of 41.0 individuals/100 km^2 was recorded, which was very similar to the ones during the period of 2008-12, and was the second lowest since 2001. Finally, NEL recorded remarkably low dolphin density in 2013 with only 4.8 individuals/100 km^2, which was only 24% and 59% of the dolphin densities estimated in 2011 and 2012.

The abundance estimates of Chinese White Dolphins in 2013 were 23, 36 and 3 individuals respectively in WL, NWL and NEL, with the combined estimate of 62 dolphins from the three areas (Figure 20). This 2013 estimate was very similar to the 2012 estimate (61 dolphins), but was much lower than the ones in 2010 (75 dolphins) and 2011 (78 dolphins). It should be noted that the coefficient of variations (CV) remained fairly low (10% in WL, 14% in NWL and 39% in NEL) for 2013 estimates, indicating that the annual estimates generated in 2013 should be reliable.

5.4.2. Temporal trend in dolphin abundance

Temporal trends of annual dolphin abundance in each of the three survey areas and collectively were further examined since 2001. All three areas showed noticeable declining trends during the past decade (Figure 21). In WL, individual abundance has steadily decreased from 54 dolphins in 2007 to only 17 dolphins in 2012, but slightly rebounded in 2013 with 23 dolphins (still the second lowest since 2003). Dolphin abundance in NEL also dropped from the highest in 2001-03 (18-20 dolphins) to the lowest in 2013 (3 dolphins), and the most noticeable decline occurred between 2011-13, with a 76% decline in densities from 19.9 to only 4.8 in just two years. Such marked declines also occurred during 2003-04 and 2008-09.

On the contrary, after a steady decline in dolphin abundance between 2001-08 in NWL, their numbers appeared to become stabilized in recent years, and remained in the range of 35-40 dolphins from 2009-2013 (Figure 21). Notably, the NWL abundance estimate in 2013 with 36 dolphins was the second lowest since 2001, with the lowest estimate in 2010 with only 35 dolphins. Moreover, when combining NEL and NWL to examine the trend for the entire North Lantau region, dolphin abundance dropped from the highest in 2003 (102 dolphins) to the lowest in 2013 (39 dolphins), with a 62% decline in the past decade (Figure 20).

Using the linear regression model, the test statistics for hypotheses $H_0:b=0$ vs. $H_1:b<0$ in the respective three areas were found to be as follow:

- WL (2003-13): the test statistic for the hypotheses was -5.8894 whose p-value was 0.0002 <5%. Therefore, the hypothesis H_0 is rejected at 5% level of significance and the abundance data of dolphin in WL was concluded to possess a significant downward sloping trend.

- <u>NWL (2001-13)</u>: the test statistic for the hypotheses was -7.3872 whose *p*-value was ≈ 0.0000 <5%. Therefore, the hypothesis H_0 is rejected at 5% level of significance and the abundance data of dolphin in NWL was concluded to possess a significant downward sloping trend.
- <u>NEL (2001-13)</u>: the test statistic for they hypotheses was -4.6300 whose *p*-value was 0.0007 <5%. Therefore, the hypothesis H_0 is rejected at 5% level of significance and the abundance data of dolphin in NEL was also concluded to possess a significant downward sloping trend.
- <u>Combined estimates from WL, NWL and NEL (2003-13)</u>: the test statistic for the hypotheses was -7.6271 whose *p*-value was ≈ 0.0000 <5%. Therefore, the hypothesis H_0 is rejected at 5% level of significance and the combined abundance data of dolphin from WL, NWL and NEL was concluded to possess a significant downward sloping trend.

In summary, there was a significant downward slopping trend detected in all three major areas of dolphin occurrence in Hong Kong. After a sharp decline in dolphin numbers in the past few years, the abundance estimates in 2012 and 2013 were very similar, indicating that the dolphin numbers did not dwindle further in the past year as a whole. However, the combined estimates of NEL and NWL continued to drop to the lowest in 2013, which is a very worrying trend. In the previous and present monitoring periods, the sharp decline in dolphin numbers in NEL was suggested to be linked to the increased amount of high-speed ferry traffic from the Sky Pier since 2003 (Hung 2012; Section 6.2 in the present report), and then further attributed by the on-going HZMB-related construction works since 2012 (Hung 2013). In fact, the present monitoring study further confirmed that the noticeable drop in dolphin encounter rate in NEL coincided well with the commencement of HKBCF and HKLR03 reclamation works, and such decline has worsened in 2013 (Section 5.3.1). The habitat use pattern (Section 5.5.1), individual range use (Section 5.8.1) and individual movement pattern (Section 5.8.2) all revealed a dramatically diminished dolphin usage of the NEL waters, especially around the Brothers Islands and Sham Shui Kok which were identified as important dolphin habitats in Hong Kong (Section 5.5.1).

As discussed in Section 5.3.1 and the rest of the report, there is an urgent need to safeguard the important dolphin habitat in NEL waters and the North Lantau region as a whole, in which the responsibility falls on the project proponent of HZMB (i.e. Highways Department), the Airport Authority and Marine Department to control marine traffic from the Sky Pier, and the Hong Kong Government as a whole. To further reiterate the suggestions as mentioned in the previous monitoring report (Hung 2013), it is critical that the Administration should give a high priority in insuring the Chinese White Dolphin's continuous utilization of Hong Kong waters as part of their range, which is also the overall long-term goal of the Chinese White Dolphin Conservation Plan adopted by the Hong Kong SAR Government (AFCD 2000). To achieve this goal, a presumption against further reclamation around Lantau waters would be needed, such that only fully-justified reclamation proposals with over-riding public needs would be considered. These proposals should also consider the latest findings presented in this and previous monitoring reports, including the new information such as the traveling corridors (Section 5.8.3) and night-time habitat use (Section 6.1). The presumption against reclamation could only be relaxed when the declining trend of dolphin usage has been reversed, or reviewed when research effort has managed to establish the threshold of development pressure and other on-going threats that the local dolphin population can cope with (such as the cumulative effect assessment as mentioned in Section 6.2, or the spatial modeling exercises as mentioned in Section 6.3 and 6.4). Only through this adaptive management strategy, and the establishment of more marine protected areas in their priority habitats (see Section 5.5.2), the local Chinese White Dolphins could be conserved in Hong Kong in a long run.

5.5. Habitat Use

5.5.1. Habitat use patterns of Chinese White Dolphins

For the quantitative grid analysis on habitat use, the SPSE and DPSE values (i.e. sighting densities and dolphin densities respectively) were calculated in all grids among the six survey areas where Chinese White Dolphins regularly occurred during 2013, as well as the recent five-year period in 2009-13. During 2013, the important dolphin habitats in WL and SWL waters with high dolphin densities were identified near Tai O Peninsula, Kai Kung Shan, Peaked Hill, around Fan Lau and Kau Ling Chung, with most grids in West Lantau recorded high to very high dolphin densities (Figure 22). In Northwest Lantau, the high dolphin density grids were mostly located to the east of Lung Kwu Chau, between Lung Kwu Chau and Sha Chau, around Pak Chau, near Black Point and the middle portion of Outer Deep Bay (Figure 22). However, it should be cautioned that the results in Deep Bay could be biased with relatively low amount of survey effort collected within the 12-month period. It should also be noted that due to the low number of dolphins being sighted in NEL in 2013, only 17 of the 49 grids that were covered by regular line-transect survey effort recorded dolphin sightings, and all 17 grids only recorded very low to moderately low densities of dolphins.

Temporal changes in habitat use patterns during 2011-13

A comparison was made among the habitat use patterns in the past three years (i.e. 2011, 2012 and 2013) to examine whether there was any recent temporal change in densities at various important dolphin habitats (Figure 23). Dolphin habitat use patterns in WL waters were similar across the three years, although their densities were generally lower among some WL grids in 2012 (Figure 23). In NWL, there appeared to be a declining trend of dolphin usage around Black Point, although the waters around Lung Kwu Chau were consistently used by dolphins to a very high extent throughout the three-year period (Figure 23). In NEL waters, there was a noticeable change in dolphin densities during the three-year period, with high to very high usage around the Brothers Islands and Sham Shui Kok in 2011, to very low usage in the same area in 2013. This general area has been identified as important dolphin habitat in the past, and since the construction of HZMB-related projects (including the HKBCF and HKLR03 reclamation) commenced in mid-2012, dolphin usage has diminished dramatically to a very low level in 2013 (see Section 5.3.1 also).

Habitat use patterns for the period of 2009-13

To examine dolphin habitat use in recent years with a larger sample size and longer study period, all survey effort and on-effort dolphin sightings from 2009-13 were pooled to calculate the overall SPSE and DPSE values during the five-year period, and compared to the ones in the previous five-year period in 2004-08. During 2009-13, among grids in North, West and Southwest Lantau that were covered by consistent amount of survey effort, most of them were utilized by Chinese White Dolphins at different levels (Figure 24). The high-density grids mostly concentrated along the west coast of Lantau (particularly around Tai O Peninsula, Kai Kung Shan, Peaked Hill and Fan Lau), around Lung Kwu Chau, and between Black Point and Lung Kwu Chau (Figure 24). These areas should be recognized as the most important dolphin habitats in recent years. Notably, the one grid that was identified with very high dolphin density (Grid M16) at the northeast corner of the airport platform was biased with small amount of survey effort.

On the contrary, the grids in the entire NEL waters, to the north and west of the airport platform, in Inner Deep Bay, and the most part of SWL waters (except near Kau Ling Chung and Fan Lau) only recorded very low to moderately low dolphin densities (Figure 24). In particular, the low level of dolphin usage in NEL during the five-year period could be influenced by the very low dolphin densities recorded in 2012 and 2013 since the commencement of HZMB-related construction activities (see previous section). In SEL waters, only a few grids have been utilized by dolphins at a very low level in the past five years (Figure 24).

Dolphin habitat use patterns between 2009-13 and 2004-08 were largely similar, with the most important dolphin habitats identified around Lung Kwu Chau and along the west coast of Lantau (Figure 25). In addition, dolphin densities appeared to be slightly higher in SWL waters and the outer Deep Bay during 2009-13 than in 2004-08. Another noteworthy difference was found in NEL waters, where two grids at the Spoon Island and Sham Shui Kok around the Brothers Islands were identified as important dolphin habitats in 2004-08, but not any more in 2009-13 (Figure 25). As explained before, such diminished usage occurred around 2012 and 2013, which coincided with the commencement of reclamation works in association with HZMB construction.

Temporal changes in habitat use patterns at six key habitats

The temporal trends in dolphin usage at six key habitats were also examined between 2004-13, which included one existing marine park around Sha Chau and Lung Kwu Chau, three proposed marine parks at the Brothers Islands, Fan Lau (i.e. Southwest Lantau) and Soko Islands, and two "dolphin hot spots" (Tai O and Black Point) where they regularly occurred in the past decade (Figure 26). To examine dolphin usage over these six key habitats that encompass a suite of grids, the number of on-effort sightings and unit of survey effort were pooled together from those grids, to calculate dolphin densities (DPSE) as a whole for each year during the 10-year study period of 2004-13 in order to examine their temporal trends.

Among the one existing marine park and three proposed marine parks, the Southwest Lantau Marine Park (12 grids) recorded the highest level of dolphin usage during the ten-year period (Figure 27). After an apparent decline in dolphin usage from 2004-2009, the DPSE values rose back to a higher level there in recent years, reaching the highest in 2013. The only marine park established in the western waters of Hong Kong, the Sha Chau and Lung Kwu Chau Marine Park (17 grids), also recorded a declining usage from the highest in 2004 to the lowest in 2010 (Figure 27). However, since 2010 there was another noticeable increasing trend in the past few years. As the only marine park that was established for dolphin conservation purposes, dolphin usage there would present useful reference on whether such conservation measure would be an effective tool to safeguard dolphins from further development and some potential threats (e.g. vessel traffic and lack of prey resources).

On the contrary, there was a consistent declining trend within the proposed Brothers Islands Marine Park (12 grids) from the highest in 2004 to the second lowest in 2010, which coincided well with the temporal trend within the Sha Chau and Lung Kwu Chau Marine Park during the same period (Figure 27). After a significant rebound to a higher level in 2011, dolphin usage at the proposed Brothers Island Marine Park markedly declined to the lowest level in 2013 during the 10-year study period (Figure 27). As this area will be established to become a marine park in 2016 as a compensation measure for the habitat loss resulted from the HKBCF reclamation, dolphin usage at this important dolphin habitat should be closely monitored, since this is a vital area for many resident dolphins in Hong Kong.

Throughout the ten-year period, dolphin densities at the proposed Soko Islands Marine Park (20 grids) remained at a low level with no consistent trend. However, dolphin occurrence within this proposed marine park has been exceptionally low in 2012 and 2013 with only a handful of sightings made within the park (Figure 27). Nevertheless, finless porpoises frequently use this proposed marine park area as one of their prime habitat in the past and present (e.g. Hung 2008, 2013), and this area should still be warranted for urgent protection, since this is one of the few habitats in Hong Kong that is shared by both resident cetacean species in Hong Kong (Hung 2008).

As one of the dolphin hot spots in western waters of Hong Kong, the waters around Tai O Peninsula (four grids) consistently recorded high dolphin densities throughout the past decade (Figure 27). However, after a gradual increasing trend from 2004 to the highest in 2009, dolphin usage of this important habitat has declined noticeably to the lowest level in 2012. The diminished usage of dolphins in this important habitat could be related to the increased amount of dolphin-watching boats originated from Tai O fishing village, and the recent decline could also be contributed by the extensive reclamation works in Guangdong waters (only about two kilometres from Tai O Peninsula) just across the western border of Hong Kong in association with the HZMB construction that began in 2011.

On the other hand, dolphin usage at Black Point (four grids) has greatly fluctuated with no apparent trend (Figure 27). Interestingly, dolphin densities there can go from exceptionally high (DPSE>120) in 2011 to extremely low (DPSE=2.5) in the following year. Nevertheless, the level of dolphin usage at Black Point maintained at similar level to the Brothers Islands area (Figure 27), indicating the importance of this area to the dolphins in the past decade. As this area is situated at the border of the proposed reclamation site at Lung Kwu Tan, special attention should be paid on dolphin occurrence in this general area.

5.5.2. Dolphin habitat index (2001-12)

A habitat rating system and associated habitat index for Chinese White Dolphins in Hong Kong was established by Hung (2008) to locate their priority habitats, with the objective to set up protected areas for conserving important and critical dolphin habitats. To establish the dolphin habitat index, quantitative data on various aspects of dolphin habitat use are used, including the SPSE and DPSE values deduced among 352 grids around Lantau Island. The ten criteria of identifying critical dolphin habitats in Hong Kong were selected with reference to recommendations by Hoyt (2005) and Evans and Pascual (2001), that the critical habitat should encompass areas with high overall dolphin densities (i.e. high SPSE and DPSE values of overall densities), important areas for feeding and socializing activities (i.e. high SPSE values for feeding and socializing activities), as well as important areas for raising young calves (i.e. high DPSE values of unspotted calves and unspotted juveniles). Moreover, critical dolphin habitats should include areas that have been used consistently over time, with the areas recorded dolphin occurrence with the largest number of months and years during the study period. From the individual dolphin perspective, the critical habitat should also include areas with intensive use by a majority of resident dolphins as their core areas (i.e. the areas with overlapping 50% and 25% UD core areas of the largest number of resident dolphins).

Each of these ten criteria was assessed among individual 1-km^2 grids within the study area, and a score of 1 (not important) to 5 (very important) was given for each criterion to develop the dolphin habitat index and assess the relative importance of each grid area to the dolphins (Hung 2008). After summing up the scores from the ten criteria, the habitat rating of each grid was assessed based on the total overall score, with the maximum possible total score of 50. Dolphin habitats were rated as marginal for grids with total scores of 10 or below. Conversely, the grids with total scores of over 40 and 31-40 were rated as critical and important dolphin habitats respectively. Such dolphin habitat index has been developed for the study period of 1996-2005 in Hung (2008). Since then, a great amount of dolphin monitoring data have been collected, and another updated set of dolphin habitat index is established here using the data collected during 2001-12, to examine the latest habitat index for dolphin conservation purposes.

During 2001-12, dolphin habitat use patterns around Lantau Island under each of the ten criteria were summarized as follow:

(1) Overall densities (SPSE/DPSE) – The grids with higher sighting densities (SPSE) and dolphin densities (DPSE) of Chinese White Dolphins were located around Tai O Peninsula, Kai Kung Shan, Peaked Hill and Fan Lau in WL; around Lung Kwu Chau in NWL; at Sham Shui Kok in NEL; and at Kau Ling Chung and between the Soko Islands in SWL (Figure 28).

(2) Feeding/Socializing Activities (SPSE) – The grids with higher sighting densities associated with feeding activities were similar to the overall densities, which were mainly concentrated around Sha Chau and Lung Kwu Chau, the Brothers Islands, Tai O Peninsula, Kai Kung Shan, Peaked Hill, Fan Lau, Kau Ling Chung and the Soko Islands (Figure 29). On the other hand, moderately high to high densities of dolphin sightings associated with socializing activities can be found at the Outer Deep Bay, around Lung Kwu Chau, around the Brothers Islands including Sham Shui Kok, around Tai O Peninsula, and near Kau Ling Chung (Figure 29).

(3) Unspotted Calves/Juveniles (DPSE) – Grids with higher densities of newborn calves (i.e. UC) were concentrated around Lung Kwu Chau, near Tai O Peninsula and Kai Kung Shan, and around Fan Lau (Figure 30). The densities of older calves (i.e. UJ) were higher at Tai O Peninsula, Kai Kung Shan, Peaked Hill, Fan Lau, Kau Ling Chung, around Lung Kwu Chau, between Lung Kwu Chau and Black Point, and around the Brothers Islands (Figure 30).

(4) Annual and monthly dolphin usage – Grids that recorded consistent dolphin usage (i.e. 10-12 years with dolphin sightings) during 2001-12 were mostly located along the entire coast of West Lantau extending around Fan Lau to Kau Ling Chung, all around the Sha Chau and Lung Kwu Chau Marine Park, along the Urmston Road between Black Point, Lung Kwu Chau and Pillar Point, around the Brothers Islands and at Sham Shui Kok (Figure 31). In addition, the grids that recorded year-round dolphin usage (all 12 months with dolphin sightings) during 2001-12 were found along the entire coast of West Lantau, around the Brothers Islands and Lung Kwu Chau (Figure 31).

(5) Individual range use – a total of 70 and 66 individual dolphins with 15+ re-sightings were found to have their core areas in North and West Lantau waters respectively. After overlaying their 50% and 25% UD core areas onto the grids, two locations in North Lantau (i.e. Lung Kwu Chau and the Brothers Islands)

and one location in West Lantau (i.e. the entire coastal waters from Tai O Peninsula to Fan Lau) recorded the intensive dolphin core area use with the highest proportion of individuals. At 50% UD level, the grids with core areas of high proportion of individuals occurred at the 22 grids around Lung Kwu Chau with core area use by 31-52 individuals, as well as at the 16 grids around the Brothers Islands (including Sham Shui Kok) with core area use by 22-32 individuals (Figure 32). Moreover, there were 31-59 individuals utilizing the 27 grids along the west coast of Lantau Island as their 50% UD core areas. At 25% UD level, the grids with core areas of high proportion of individuals occurred at the 25 grids along the west coast of Lantau with core are use by 16-43 individuals, at the 13 grids around Lung Kwu Chau with core area use by 18-46 individuals, and at 12 grids around the Brothers Islands with core area use by 11-22 individuals (Figure 32).

After summing up the scores from each of the 10 scoring criteria, dolphin habitat ratings were given to all 352 grids around Lantau Island (Figure 33). Among these, 78 grids did not receive any score, while another 131 grids were considered marginal habitats with total scores of 10 or below. The majority of these marginal habitats were located in SEL, SWL, DB, at the peripheral area of NEL (especially along the southwestern coastline of New Territories from Ma Wan to Tuen Mun), and to the east and west of the airport platform (mainly due to the airport restricted zone with limited survey effort) (Figure 33). On the other hand, 34 grids were considered above average habitats, and another 38 grids were considered important and critical habitats in western waters of Hong Kong. The majority of grids rated as above average, important and critical habitats (i.e. habitat rating of 20+) were clustered around Lung Kwu Chau, Sha Chau and along the Urmston Road, around the Brothers Islands and near Sham Shui Kok, between the Soko Islands, and the entire stretch of coastal waters in West Lantau extending from Tai O Peninsula, Kai Kung Shan and Peaked Hill to Fan Lau and Kau Ling Chung (Figure 34). These should be classified as priority habitats that deserve special protection as marine park, or safeguarded from human threats (e.g. vessel traffic) and future development.

<u>Limitations of current habitat rating system</u>

It should be cautioned that even though the current habitat rating system is designed to be as comprehensive as possible by incorporating various aspects of dolphin habitat use, the importance of certain habitats around Lantau Island identified as marginal or average habitats for the local dolphins could still be overlooked. For example, several traveling corridors were identified between the three core areas of dolphin activities where priority habitats were also identified (see Section 5.8.3), and these traveling corridors between Lung Kwu Chau/Sha Chau, the Brothers Islands and west coast of Lantau were rated as either marginal or average habitats under the current habitat rating system. Certainly, the importance of these traveling corridors as dolphin habitats should not be overlooked.

Moreover, the passive acoustic monitoring works indicated that there are areas with strong diel patterns where dolphins mostly occurred in night-time but rarely in day-time (see Section 6.1). As the dolphin habitat index was established solely based on survey data collected during day-time, the importance of certain habitats that were primarily used by dolphins during night-time can also be overlooked. An example of this occurred near Sham Wat, where the habitat around that area was only identified as marginal, but dolphins mostly occurred there at night based on the results of passive acoustic monitoring (see Section 6.1). Certainly, the current habitat ratings should be recommended for serious considerations for dolphin conservation effort and avoidance for infrastructure projects, but other aspects of the dolphin habitat use that cannot be incorporated into the current habitat rating system should also be examined in greater details for a more thorough evaluation of dolphin habitats.

<u>Comparison of dolphin habitat index between 1996-2005 and 2001-12</u>

The habitat ratings established for the period of 2001-12 were also compared to the ones for an earlier period of 1996-2005 (from Hung 2008). It is apparent that the three general areas that were identified as priority habitats (i.e. the Brothers Islands, around Lung Kwu Chau and the west coast of Lantau) were consistently the same during the two periods (Figure 33). Nevertheless, two notable differences occurred in NWL, where more grids were identified as priority habitats around Lung Kwu Chau in 2001-12 than in 1996-2005 (Figure 34). Moreover, a number of grids that connected between Lung Kwu Chau and the Brothers Islands were identified as priority habitats in 1996-2005, which was not the case in 2001-12 (Figure 34). The diminished importance of this middle portion of North Lantau as dolphin habitat is of great concern, as the individual movement patterns indicated that this is an important traveling corridor for individuals from the North Lantau social cluster to move between the two core areas (Section 5.8.3).

As examined in Hung (2012), the increased amount of high-speed ferry traffic originated from the Sky Pier since 2003 has contributed to the decline in dolphin abundance in North Lantau, which may have seriously disrupted the traveling corridor between the two core areas in North Lantau waters. This may explain why the utilization of the middle portion of North Lantau by the dolphins has diminished during 2001-12. In light of the impacts by the HZMB-related construction activities on dolphin utilization of NEL waters, it is critical to protect this traveling corridor to ensure that dolphins can move between Lung Kwu Chau and the Brothers Islands without any obstruction.

<u>Habitat index in relation to marine protected areas</u>

Currently, there was only one existing marine park established around Sha Chau and Lung Kwu Chau since 1996, and most of the grids within the marine park were identified as priority habitats in 2001-12 (Figure 34), further confirming the importance of this marine protected area establishment for dolphin conservation purposes. The area around the Brothers Islands will also be established as a marine park in 2016, upon the completion of HKBCF, as a compensation measure for the habitat loss due to the HKBCF reclamation. As discussed in Section 5.5.1, dolphin densities in this area remained moderately high until 2012, when dolphin densities plummeted to a record low in 2013. This dramatic decline in dolphin usage is likely related to the nearby reclamation works in relation to the HZMB construction. As a priority habitat for dolphins identified during 2001-12 (Figure 34), this area should be urgently protected from further human disturbance, and the project contractors of HZMB should strive to avoid any negative impacts to the dolphins within and adjacent to this priority habitat. Since the high-speed ferry traffic has also been identified as one of the major contributing factor for the decline in dolphin usage in NEL waters (Hung 2012), the relevant authorities should discuss the possibility of reducing the ferry traffic speed as well as limiting the number of vessel movements in this important area.

Another proposed marine park at Southwest Lantau (or Fan Lau Marine Park) was proposed to be designated in 2001-02 in the Chief Executive Policy Address in 2000, but such proposal is still pending for approval. Based on the dolphin habitat index in 2001-12, the proposed marine park boundaries are well justified, which include many priority habitats at the southwest corner of Lantau Island (Figure 34). However, as suggested in Hung (2008), and further confirmed in the present habitat index in 2001-12, there is a strong need to further extend the current proposed boundary to cover more priority habitats that were identified adjacent to the proposed marine park boundary. Notably, dolphin densities within this proposed marine park have been consistently very high in the past decade (see Section 5.5.1), further justifying the need to establish this marine park as soon as possible.

Another area that was also proposed as a marine park in Chief Executive Policy Address in 2000 was located around the Soko Islands. Although only one grid was identified as priority habitat between the Soko Islands (Figure 34), this area was also regularly utilized by finless porpoises, and the waters to the south of Tai A Chau was identified as very important porpoise habitat in the past decade (see Section 5.5.3). As this area is one of the very few habitats that records regular occurrence of both local cetacean species, it should also be established as a marine park for their conservation purposes.

5.5.3. Habitat use patterns of finless porpoises

The habitat use patterns of finless porpoises were examined by calculating SPSE and DPSE values among the grids in the five areas where they regularly occurred (i.e. SWL, SEL, LM, PT and NP) for the entire year of 2013 and the ten-year period in 2004-13. The spatial patterns of finless porpoise habitat use revealed that their most heavily utilized habitats in 2013 included the waters just south of Tai A Chau, between the Soko Islands and Shek Kwu Chau, to the south of Cheung Chau, and to the southwest and east of Lamma Island (Figure 35). However, even though the few grids in NP and to the east of Lamma Island recorded very high porpoise densities (Figure 35), the results there could be heavily biased by the relatively low amount of survey effort conducted during the 12-month study period.

For that reason, the SPSE and DPSE values of porpoise habitat use were also calculated by pooling the survey effort and on-effort porpoise sightings from 2004-13 with a larger sample size and a longer study period. Since finless porpoise in Hong Kong exhibited pronounced seasonal pattern of distribution, with rare occurrence in each survey area during certain period of the year (Hung 2005, 2008; Jefferson et al. 2002), the ten-year dataset was stratified into winter/spring (December through May) and summer/autumn (June through November) to deduce habitat use patterns of porpoises for the dry and wet seasons separately.

For the examination of porpoise habitat use patterns during the dry season (winter and spring months) in 2004-13, in which survey effort was mostly allocated to SWL, SEL and LM survey areas, the grids with high porpoise densities were mostly located in South Lantau waters (Figure 36). In particular, important porpoise habitats during the dry season were located to the south of Tai A Chau, around Shek Kwu Chau, south of Cheung Chau, and the waters between Shek Kwu Chau and the Soko Islands (Figure 36). Porpoise densities were also moderately high at the southwest corner (i.e. near Ha Mei Tsui) and eastern side (i.e. a few kilometres away from Tung O Wan) of Lamma Island (Figure 36). On the contrary, most grids toward the western end of SWL and the southern waters of Lamma only recorded moderately low to low densities of porpoises. They generally avoided the northern end of Lamma Island, and the offshore area at the juncture of SEL and LM survey areas (Figure 36).

On the contrary, more survey effort were allocated to the eastern survey areas (i.e. PT and NP) during the wet season (summer and autumn months), while the survey effort remained the same in SWL and SEL but was very little in LM (Figure 37). During the wet season, porpoise densities were higher around the Po Toi Islands, and at the juncture of PT and NP survey areas (Figure 37). Although porpoise densities at some grids in NP were very high, these results could be biased as the survey effort accumulated over the ten-year period in this survey area was still relatively low. On the other hand, even though porpoises occurred in South Lantau and Lamma waters during the wet season, their densities were generally low with no apparent habitat preference in these areas during these months. In fact, most of the grids that recorded porpoise densities in the wet season were located to the southern ends of SWL, SEL and LM survey areas (Figure 37), indicating their infrequent visits across the southern territorial boundary of Hong Kong during the wet season.

5.6. Group Size, Activities and Association with Fishing Boats

5.6.1. Group sizes of dolphins and porpoises

During the 12-month study period, group sizes of Chinese White Dolphins ranged from singles to 21 animals, with an overall mean of 3.4 ± 2.69. Among the five areas where dolphins occurred in 2013-14, the mean group size was the lowest in NEL (3.18) and highest in DB (4.00), although the latter only had a very small sample size of 11 dolphin groups. During the four seasons, mean group sizes were relatively lower in spring and summer months but higher in winter months.

The majority of dolphin groups sighted during the 2013-14 monitoring period were very small, with 48.0% of the groups composed of 1-2 animals, and 73.5% of the groups with fewer than five animals (Figure 38). Only 13 out of the 633 groups contained 10 animals or more. In 2013, the smaller dolphin groups were evenly distributed throughout the survey areas around Lantau Island, especially in the peripheral population range in NEL and SWL as well as the middle section of North Lantau region where larger groups were seldom found (Figure 39). Conversely, the large groups were mainly concentrated along the west coast of Lantau, around Lung Kwu Chau and between Black Point and Lung Kwu Chau (Figure 39).

Long-term trend in mean dolphin group sizes during 2002-13 indicated that the 2013 mean group size remained at relatively low level, but has slightly increased from the lowest level in 2012 (Figure 40). Besides 2003 with exceptionally high mean dolphin group size, the annual means were relatively stable during the 12-year period, ranging form 3.2-4.0 among these years (Figure 40).

From April 2013 to March 2014, porpoise group sizes ranged from singles to 18 animals, with an overall mean of 2.3 ± 2.06. This mean group size was one of the lowest among recent monitoring periods. The majority of porpoise groups were very small, with 72.6% of porpoises groups composed of 1-2 animals, and all groups except nine were with less than five animals per group (Figure 41). The mean group sizes in SWL and LM were relative high (2.82 and 2.57 respecitvely) when compared to the overall mean. Distinct seasonal variations in mean group sizes were found, with the higher mean group sizes in spring months but lower means in summer and autumn months.

5.6.2. Activities of dolphins

Throughout the 12-month study period in 2013-14, a total 75 and 22 groups of dolphins were found to be engaged in feeding and socializing activities, comprising of 11.8% and 3.5% of the total dolphin sightings respectively. Moreover, 12 other groups were engaged in traveling, while only one group was observed with resting/milling behaviour.

In 2013, most of the feeding and socializing activities were concentrated around Lung Kwu Chau and along the west coast of Lantau (Figure 42). Notably, feeding was the only activity observed among sightings made in SWL waters, suggesting that dolphins occurred there primarily for feeding activities. The areas where traveling activities occurred mostly overlapped with the traveling corridors identified in Section 5.8.3 (e.g. to the west of airport platform), but such activities was not observed to the north of the airport platform where traveling corridor was identified during the focal follow study (Figure 42).

Temporal trend in annual percentages of feeding and socializing activities revealed that both activities in 2013 occurred at the lowest levels during the 12-year period of 2002-13, with an apparent downward trend since 2009-10 (Figure 43). Such temporal trend should be closely monitored, as these two activities serve important functions in the long-term survival of dolphins in Hong Kong waters.

5.6.3. Dolphin associations with fishing boats

Among the 633 dolphin groups sighted in 2013-14, only 29 were associated with operating fishing boats, or 4.6% of all dolphin groups. The percentage in 2013 was the lowest since 1996, with a continuous downward trend since such percentage was monitored in 2002. Apparently, the decline in fishing boat association was partly related to the fishing trawl ban that was implemented in 2013, as dolphins were only associated with a handful of trawlers that operated illegally along the western boundary of Hong Kong territory (see Section 5.9 on fix positions of fishing activities from shore-based theodolite tracking sites).

On the other hand, dolphins were observed to be associated with purse-seiners and gill-netters 21 and 4 times respectively during the study period of 2013-14. Dolphin associations with these two types of fishing vessels have been very rare in the past, and such associations only occurred seven and eight times respectively among nearly 5,000 dolphin sightings from 2002-12. It is possible that the implementation of trawl ban in 2013 may have increased the fishery resources. This could in turn benefit the livelihood of alternative fishing gears which do not involve bottom trawling method. However, it is inconclusive at this point whether the trawl ban implementation has brought significant benefits to the dolphins and increased the prey availability for them, in light of various threats they are facing in Hong Kong. Nevertheless, their foraging activities, especially the associations with different fishing vessels, will be closely monitored in the future monitoring works.

Spatial distribution of dolphin groups associated with different types of fishing boats revealed that most of these associations in 2013 occurred around Lung Kwu Chau and along the west coast of Lantau as in the past (Figure 44). As mentioned above, the associations with illegally operating bottom trawlers mainly occurred near the western border of Hong Kong territorial waters. The few associations with fishing boats in SWL waters were primarily with purse-seiners (Figure 44).

5.7. Calf occurrence

Of the 2,162 dolphins sighted during 12-month study period in 2013-14, 58.0% were categorized into six age classes. Similar to previous monitoring periods, the spotted juveniles (20.2%) and spotted adults (13.7%) comprised of the majority of dolphins that were identified with their age classes. In addition, a total of 21 unspotted calves (UC) and 104 unspotted juveniles (UJ) were sighted, with these young calves comprised of 5.8% of the total.

Distribution of young calves in 2013 was similar to the overall dolphin distribution, with main concentration occurred around Lung Kwu Chau and along the west coast of Lantau (Figure 45). The occurrences of young calves in NEL and eastern end of NWL were relatively infrequent. They were also mostly absent from SWL waters, even though dolphins were frequently sighted along the coastline between Fan Lau and Shui Hau Peninsula during 2013-14 monitoring period. No UC was observed in NEL or SWL waters at all during the monitoring period (Figure 45).

Temporal trend in annual calf occurrence

Temporal trend in annual occurrence of young calves revealed that the percentage of UCs in 2013 was the fourth highest during the 12-year period in 2002-13 (Figure 46). The percentage of UJs in 2013 were also higher than the previous two years in 2011 and 2012, but was still lower than the ones in 2009-2010 (Figure 46). It is apparent that the percentages of UCs and UJs were relatively unstable during the 12-year period with no apparent trend (Figure 46). As mother-calf pairs are more susceptible to anthropogenic disturbances, their occurrence and calf survival should be closely monitored throughout the HZMB construction period in light of their impacts as discussed above.

Unusual cases of epimeletic behaviour in 2013

Although the percentage of newborn calves was relatively high in 2013, there were at least 12 dead calves of Chinese White Dolphins either stranded ashore (five cases) or discovered (at least seven cases) during various monitoring surveys. Based on the date of their discovery and their decomposition states, there should be no overlap between the ones stranded ashore and discovered during vessel surveys. Among the 12 dead calves, seven cases involved individual dolphins (or dolphin groups) carrying dead calves for extended period when discovered at sea. Such behaviour has been observed in both captive and free-ranging cetaceans (e.g. Cockcroft and Sauer 1990; Félix 1994; Fertl and Schiro 1994), and is considered as a form of epimeletic behaviour. Epimeletic behaviour can be either nurturant (care is directed toward young) or succorant (care is directed towards individual in distress) (Caldwell and Caldwell 1966). The brief account of each case of possible epimeletic behaviour is provided here in details:

- **April 9th, 2013**: a group of 12 dolphins were observed in West Lantau waters. A dead newborn calf was repeatedly supported by an adult later identified as

CH12. As the calf was not bloated, it kept sinking below water surface and disappeared until CH12 pushed it back up repeatedly to the water surface. Notably, the gender of CH12 was undetermined according to its record in the photo-identification catalogue, as this animal was never seen with a dolphin calf or biopsied before.

- **April 12th, 2013**: a group of 8 dolphins were observed to the northwest of airport platform in NWL. A freshly dead newborn calf was repeatedly supported by a spotted subadult later identified as NL120. Other surrounding dolphins were very active, with repeated breaching, spy-hopping and tail-slapping behaviours. Although NL120 was not sighted with a calf before since she was first identified in March 1999, she was biopsied in December 2008, and was confirmed to be a female through DNA sexing of her skin sample.

- **April 28th, 2013**: a group of four individuals were sighted to the west of Lung Kwu Chau in NWL by Hong Kong Dolphinwatch Limited during a dolphin-watching trip. A freshly dead newborn calf was repeatedly supported by a spotted subadult within the group, which was later identified as WL04. The calf appeared to always sink below water surface, but WL04 attempted to push her back to the water surface repeatedly with her rostrum. Other identified individuals, including NL202 and her calf NL286, also kept surfacing close to WL04 and her dead calf. The gender of WL04 was unknown, as she was never sighted with any dolphin calf since she was first identified in July 2002.

- **May 3rd, 2013**: a group of eight individuals were observed to the east of Sha Chau in NWL, again by Hong Kong Dolphinwatch Limited. A number of identified individuals (e.g. NL98 with her calf, NL188 with her calf, NL120, NL264) were observed together with NL242, but it was NL242 which repeatedly held a decomposed newborn calf with her rostrum. Notably, NL242 was determined as a female through a biopsy sample taken in December 2006, and subsequently she was also sighted with her calves on several occasions in 2007, 2011 and 2012.

- **May 18th, 2013**: a group of at least five dolphins were observed to support a dead calf to water surface near Sha Chau pier by AFCD Marine Park staff during their regular patrol. The moderately decomposed calf was later recovered by the Marine Park staff and brought back to Ocean Park for further necropsy. The female calf was 103-cm long and 10-kg in weight, and her cause of death was undetermined. It was also uncertain whether the calf was supported by her mother within the dolphin group when first discovered, as the photo quality was too poor to confirm which dolphin was supporting the dead calf repeatedly during the sighting.

- **July 12th, 2013**: a group of seven dolphins were first sighted to the west of the airport platform, with numerous identified individuals in the group (e.g. NL24, NL123 with her calf, NL242, NL145, NL244 and NL262). A badly decomposed calf was floating on the water surface, and surrounded by this group of dolphins, with no apparent individual that repeatedly supported the calf. In fact, several juveniles interacted with the floating calf alternately. During the focal follow of the dolphin group, some individuals left, while additional dolphins also joined in. It was possible that one of the identified individuals was the mother of the calf, as several of them (e.g. NL24, NL123, NL244) have calving history in the past.

- **October 18th, 2013**: a group of seven dolphins were observed near Fan Lau, with a dead calf accompanied by several of these individuals. As the dead calf kept sinking below water surface most of the time, it was uncertain which animal could possibly be her mother; however, it appeared that CH108 was the one that surfaced multiple times with the dead calf on her rostrum. According to her photo-identification record, CH108 was previously sighted with a unspotted juvenile in December 2008, and confirmed to be a female.

Besides these seven cases of dead calves being carried by groups of dolphins, there was also one unconfirmed case on May 7th, but it was uncertain whether that overlapped with the case on May 5th. Nevertheless, these cases occurred only over a stretch of six-month period, with five of them occurred over a six-week period. The high frequency of such incidents was in stark contrast to past records, as there were only four confirmed cases in October 2003 (with unconfirmed adult), July 2008 (with NL176), November 2009 (with WL11) and August 2011 (with CH34) in the past decade. Such frequent occurrence of epimeletic behaviours of Chinese White Dolphins in 2013 could be a coincidence, as vessel survey effort in North and West Lantau waters increased significantly in 2013, and there were more opportunities to encounter such rare incidence. In fact, calf mortality of Chinese White Dolphins in Hong Kong was generally high in the past based on past stranding records, and most of the 2013 cases occurred during the peak months of calving period.

Nevertheless, the high death toll of dolphin calves should deserve special attention, as the general situation of dolphins have worsened in North and West Lantau in 2013 due to various construction works in relation to HZMB construction, in addition to the lingering problems of water pollution and acoustic disturbance from vessel traffic that can also contribute to the high calf mortality. This situation should be continuously monitored, and special attention should also be paid to track the temporal trend in percentage of calf occurrence recorded during vessel surveys.

5.8. Range Use, Residency and Movement Pattern

5.8.1. Individual range use and residency pattern

In order to examine individual range use, the 95% kernel ranges of 141 individuals that occurred in 2013 through photo-identification works were deduced using the fixed kernel method, and their ranging patterns are shown in Appendix VII.

<u>Overall range use and residency pattern</u>

In addition, 150 individual dolphins that were sighted ≥15 times and occurred in recent years were further examined for their range use and residency patterns (Table 1). Among these individuals, most of them have occurred in WL (90.0%), NWL (78.6%), NEL (37.3%), SWL (45.3) and DB (14.7%) survey areas. On the contrary, only a handful of individual dolphins have been sighted in EL or SEL survey areas as part of their ranges. Moreover, 42.6% of these 150 individuals occupied ranges that spanned from Hong Kong across the border to Guangdong waters, and all except three also occurred in WL waters, indicating the frequent cross-boundary movements of individual dolphins identified in Hong Kong waters.

The residency patterns of 125 individuals were assessed by examining their annual and monthly occurrences. The other 25 individuals were identified and re-sighted only in past few years, and therefore their annual occurrence cannot be properly assessed. All except two of these 125 individuals were considered residents in Hong Kong, as they have been sighted consistently in the past decade, or at least five years in a row. The proportion of visitors that utilized Hong Kong waters is very likely underestimated, as these visitors would have infrequently utilized Hong Kong waters, and it will be harder for them to reach the minimum requirement on the number of re-sightings for this analysis. Based on the monthly occurrences, 40.6% of individuals only occurred in Hong Kong during certain months of the year, while the rest occurred here year-round (Table 1). Overall, 64 and 59 individuals were identified as year-round and seasonal residents respectively, while two seasonal visitors were also identified.

Core area use

From a previous study on social structure (Dungan et al. 2012), two social clusters of individual dolphins were identified around Lantau Waters, with the northern cluster primarily centered their range use in NEL and NWL waters and core area use around Lung Kwu Chau and the Brothers Islands, while the members from the southern cluster primarily centered their range use in WL and SWL waters and core area use along the west coast of Lantau including Tai O, Peaked Hill and Fan Lau. Based on their overall range use at 95% UD level and core area use at 50% and 25% UD levels, the 150 individuals were classified into the two social clusters accordingly. The results indicated that 65 individuals (43.3%) belong to the northern cluster, while 78 individuals (52.0%) belong to the southern cluster. Another seven individuals spanned their range use across North and West Lantau waters with frequent occurrence in both waters, and therefore cannot be classified to either of the two social clusters based on their range use.

From the core area analysis, three major core areas of dolphin activities were located around Lung Kwu Chau, the Brothers Islands and along the west coast of Lantau, with the latter further subdivided into Tai O, Peaked Hill and Fan Lau (Table 1). Among the 150 individuals, 70 and 61 individuals occupied Lung Kwu Chau as their 50% and 25% UD core areas respectively, while 22 and 16 individuals occupied the Brothers Islands as their 50% and 25% UD core areas respectively. Almost all of these individuals that utilized Lung Kwu Chau and the Brothers Islands as their core areas belonged to the northern social cluster. On the other hand, 84 and 76 individuals occupied along the west coast of Lantau as their 50% UD and 25% UD core areas respectively, with the majority of them belonged to the southern social clusters. Among the 76 individuals that occupied WL waters as their 25% UD core areas, 46%, 67% and 53% of them primarily utilized Tai O, Peaked Hill and Fan Lau respectively within West Lantau waters (Table 1).

Differential use among year-round and seasonal residents

Differential use was observed among year-round residents and seasonal residents at the various core areas. For example, among the individuals that utilized Lung Kwu Chau as their 25% core areas, 51% and 48% of them were year-round and seasonal residents respectively. Conversely, for those that utilized the Brothers Islands as their 25% core areas, 93% and 7% of them were year-round and seasonal residents respectively. This result indicated that the Brothers Islands were utilized primarily by year-round residents, while seasonal residents infrequently ventured to the NEL waters. On the other hand, both seasonal and year-round residents utilized Lung Kwu Chau regularly as their core areas. Moreover, it appeared that more seasonal residents (63%) utilized Tai O waters as their 25% UD core areas than the year-round residents (37%), which was the opposite at Fan Lau, where more year-round residents (57%) utilized here as their 25% UD core areas than the seasonal residents (43%) (Table 1).

The exceptionally high proportion of year-round residents that utilized the Brothers Islands as their core areas should be noted, as their level of usage have been quickly diminished since the commencement of reclamation works in association with the HZMB construction. As discussed in the Section 5.8.2 on individual movement pattern, shifts in core area use and overall range use away from the Brothers Islands were apparent among many year-round residents. This is a disturbing trend, as this important dolphin habitat will be established as a marine park in 2016, while it faces numerous pressure from present and future development projects as well as high-speed ferry traffic. The traveling corridor between the Brothers Islands and Lung Kwu Chau would also likely be seriously affected during and after construction of the potential third runway if this project goes ahead, further hampering the chance of recovery in dolphin usage in the Brothers Islands that are utilized by many year-round residents. In coming years, the ranging pattern and residency pattern of the resident dolphins should be closely monitored, especially the year-round residents from the North Lantau social cluster, to determine whether such diminished use around the Brothers Islands would improve, and whether the future Brothers Islands Marine Park would be an effective compensation measure for the habitat loss in relation to the HZMB-related construction works.

5.8.2. Individual movement pattern

Combined with all photo-identification data collected through the present monitoring study and other studies, movement patterns of individual dolphins within Hong Kong territorial waters in 2013 were broadly examined. During the 12-month period in 2013, 206 individuals were re-sighted a total of 1,260 times, with 166 individuals sighted more than once (i.e. occurred at more than one location).

By examining their movement patterns between re-sightings, it was observed that 61 individuals moved extensively across different survey areas around Lantau Island in 2013. For example, 51 individuals were re-sighted in both NWL and WL survey areas, while 31 individuals occurred across NWL and NEL survey areas. Another forty-seven individuals utilized both WL and the SWL. Moreover, a number of individuals moved extensively across three or more survey areas. For example, 18 individuals utilized NEL, NWL and WL survey areas, while another 11 individuals utilized NWL, WL and SWL survey areas as part of their ranges in 2013. Three individuals, NL49, NL120 and NL165, were even sighted in all four survey areas of NEL, NWL, WL and SWL, almost covering the entire range of the local dolphin population. Notably, five individuals from the northern social cluster (EL01, NL49, NL120, NL165 and NL188) were sighted in SWL waters for the first time in 2013, where they have never occurred before in the past decade. This range expansion could be related to anthropogenic disturbance, as some of these individuals have shifted their range use in 2013 (see below on shift in individual range use).

With such a large sample size in 2013, there were still a significant portion of dolphins that were sighted repeatedly within just a single survey area but not in the neighbouring areas. For example, among the dolphins that were sighted at more than one location, 20 individuals occurred exclusively in NWL survey areas, while 36 dolphins were sighted exclusively in WL survey areas. Undoubtedly, some of these animals may have ventured across the territorial border and utilized Guangdong waters as part of their ranges, but their restricted movements within Hong Kong waters could still be a concern, as this could be related to potential obstruction from human activities (e.g. vessel traffic) and infrastructure project (e.g. reclamation).

<u>Range shift of individual dolphins in relation to HZMB projects</u>

In light of the HZMB construction works and the associated decline in dolphin usage in NEL since the second quarter of 2012 when HKBCF reclamation works commenced, a closer examination of dolphin movement patterns between NWL and NEL was examined in 2013. During this year, a total of 31 individuals occurred in NEL, and most of these are year-round residents that have also been sighted in NWL. However, it was noted that 15 of these 31 individuals were only sighted once in NEL in 2013, and 11 individuals were sighted only in January 2013 but not for the rest of the year. Therefore, only 12 of these 31 individuals were sighted more than once from February-December 2013 in NEL waters. The greatly diminished usage of NEL waters by individual dolphins in 2013 was consistent with the findings in previous year, when a number of individual dolphins used to utilize the Brothers Islands as their core areas appeared to spend less time there in 2012 (Hung 2013).

In addition, the ranging pattern of 36 individuals that occurred regularly around the Brothers Islands in the past three years (i.e. 2011, 2012 and 2013) were examined, to determine whether an overall range shift or a core area shift has occurred in 2013 for any of these individuals. Among these 36 individuals, all of them regularly occurred in both Lung Kwu Chau and the Brothers Islands in 2011-12, but 23 of them have shifted their ranges away from the Brothers Islands starting in February 2013 (note: 12 of them were still sighted near the Brothers Islands in January 2013, but not ever since). Several examples of such range shift are shown in Figure 47.

Notably, for the 23 individuals with apparent range shift, only six of them showed increased usage in WL, while the rest either did not expand their ranges to WL at all in 2013, or have utilized WL in 2013 at the same level as in 2011-12. Therefore, for those that have shifted their range use away from the Brothers Islands, only a small proportion of them have expanded their range use into WL waters. As discussed in Section 5.4, the abundance estimates in NEL and NWL have both dropped to the lowest in 2013 during the past decade, while WL has rebounded in 2013 from the lowest in 2012. It can be concluded that the range shift of individual dolphins from North Lantau to West Lantau waters can only partially explain for the decline in dolphin numbers in NEL/NWL waters and the increased dolphin numbers in WL in 2013.

In examination of the 50% UD core areas of 15 individuals that were sighted at least 15 times in both periods of 2011-12 and 2013, 12 of them showed a clear shift in core area use away from the Brothers Islands (see examples in Figure 48), while the other three (NL33, NL123 and NL296) appeared to have utilized the Brothers Islands as one of their core areas even though they were primarily sighted in NWL waters in 2013 (Figure 49). It is apparent that the majority of dolphins that used to utilize the Brothers Islands as important parts of their ranges have abandoned this area in 2013. It should be further monitored in the next few years whether these substantial shifts in range use away from the Brothers Islands are only temporary or permanent in nature.

As discussed in previous sections, the Brothers Islands have been identified as an important habitat for the local dolphin population (Section 5.5.2), and as the core areas of activities for many individual year-round residents in the past decade (Section 5.8.1). The rare occurrence of individual dolphins in NEL (and complete absence for some) in the past two years indicated that they may have already abandoned this area as part of their home ranges, which coincided well with the significant drop in dolphin abundance in the past two years in NEL waters (Section 5.4.2). Apparently, the most obvious cause for this shift of range use in the past two years has been the reclamation works in association with the HZMB construction, which may have partially obstructed dolphin movement between their core areas in Lung Kwu Chau and the Brothers Islands (see Section 5.8.3). This is a critical issue that needs to be urgently addressed, as this area will be designated as a marine park in 2016, as an important compensation measure for the HKBCF reclamation. In light of the possibility for another massive reclamation of the third runway project that will be situated within the traveling corridor between Lung Kwu Chau and the Brothers Islands, the viability of the future Brothers Islands Marine Park as a conservation measure for local Chinese White Dolphins would be seriously undermined.

On the other hand, at least 51 of the 166 individuals still moved extensively between NWL and WL survey areas, presumably along the traveling corridor between Lung Kwu Chau and WL waters (see Section 5.8.3). However, many individuals that regularly occurred in WL were not sighted in neighbouring waters, including 47 individuals sighted in WL and SWL but not in NWL waters. A detailed examination of individual ranging patterns indicated that a number of individuals (e.g. NL206, SL27, WL21, WL69) from the southern cluster of dolphins (with primary range in WL and SWL waters) only occurred in the southern part of the WL survey area, but rarely ventured further north and across the alignment of HKLR, where they used to occur (see Appendix VII).

One plausible explanation of the probable range shift of individuals to the southern portion of WL survey area could be the avoidance of the construction activities in association with the HZMB bridge construction (i.e. HKLR09 construction works). However, the sample size is still too small in 2013 to ascertain whether any range shift or core area shift has occurred that may be related to the HZMB-related construction activities, and this should be further examined in the next few years. As the spacing between various bridge pier sites becomes narrower in the coming months, the north-south movement of dolphins that travel across the bridge alignment can be potentially affected, and such movement between NWL and WL should be closely monitored through photo-identification works as well as shore-based theodolite tracking at Sham Wat Station.

5.8.3. Focal follow to examine traveling corridors

In the previous monitoring period, a pilot focal follow study was initiated to examine the fine-scale movement of individual dolphins in greater details (Hung 2013). The aim of the focal follow study was to establish where the important traveling corridors exist in order to facilitate their movement between the core areas of occurrence within the Sha Chau and Lung Kwu Chau Marine Park, the Brothers Islands and the stretch of coastline between Tai O and Fan Lau. Preliminary results of the pilot study indicated that dolphins were likely moving along the western side of the airport to travel between WL and NWL waters, and along the northern waters of the airport platform to travel between NEL and NWL waters (Hung 2013). Continuous effort on focal follow observation was conducted during the present monitoring period, to provide further information on individual movement pattern and examination of the traveling corridors.

During 2012-14, dedicated focal follow observations were conducted during vessel surveys, and a total of 21 individuals or dolphin groups were engaged in traveling activity for extended periods of time during the course of the observations. The tracks of these dolphin groups were plotted on Google Earth® using the positions continuously logged by GPS during the focal follow sessions. The movement patterns from these 21 tracks revealed that dolphins mainly moved within the same survey areas, with only three tracks spanned across NWL and NEL survey areas (Figure 50). The lack of extensive movements across these survey areas was probably due to the limited amount of time in tracking their movement during each focal follow session, or other potential obstruction between the two areas (see below). Nevertheless, many of these tracks suggested that dolphins tended to move eastward or westward between Lung Kwu Chau and the Brothers Island through the northern edge of the airport platform or the Urmston Road (Figure 51). It should be noted that the dolphin movements during the study period may have been affected by the physical barrier of the reclamation site with silt curtain of HKBCF since April 2012, as well as numerous stationary and moving vessels around the work site at the northeast corner of airport platform. The potential obstruction could force the dolphins to move further north through the Urmston Road with heavy shipping traffic during traveling, while they approach or depart from the NEL waters.

On the other hand, there appeared to be some north-south movement between the Sha Chau and Lung Kwu Chau Marine Park and the west coast of Lantau, mainly through the western border of North Lantau waters and the northwestern coastline near Tai O Peninsula and Sham Wat (Figures 50-51), but there was a lack of tracks to connect the two areas. Therefore, the individual or group tracks generated from shore-based theodolite tracking at Sham Wat station were also examined as supplementary information, to determine whether dolphins move through this void between the marine park and Tai O Peninsula. In 2013, 15 tracks of individuals or groups of dolphins engaged in traveling activities were obtained from the Sham Wat theodolite tracking sessions. From these tracks, it was apparent that dolphins either move directly from Tai O Peninsula northward to the marine park area (and vice versa), or move along the northwest shore of Lantau between Tai O and Sham Wat then head northward (and vice versa) (Figure 52). When the theodolite tracks and focal follow tracks were overlaid, it is apparent that dolphins move between the marine park and Tai O Peninsula through the western side of the airport platform (Figure 52).

The present study on individual movements through focal follow and shore-based observations further confirmed that traveling corridors (or traveling routes) existed between NWL, NEL and WL survey areas. The one that connected the two core areas of marine park and the Brothers Islands exists along the northern edge of the airport and the Urmston Road, while the one that connected the marine park and the west coast of Lantau lies along the western side of the airport platform. The traveling activities along these corridors facilitated the extensive movement of individual dolphins between the three survey areas of NWL, NEL and WL observed in the past monitoring periods, in order to gain assess to the three prime habitats in Hong Kong.

By examining the range use of the 150 individuals from Table 1, a rough estimation on the proportion of identified individuals utilizing the two main traveling corridors between the three core areas were made. Of the 150 individuals, 106 appeared to have utilized the two traveling corridors at certain extent in the past. Fifty-five individuals would have utilized the traveling corridor between Lung Kwu Chau and the Brothers Islands, with many of them utilizing both areas as their 50% and 25% UD core areas. Moreover, about two-third of these 55 individuals are year-round residents, while the other one-third are identified as seasonal residents, indicating the importance of this traveling corridor to the year-round residents. On the other hand, almost all individuals (94%) have utilized the traveling corridor between Lung Kwu Chau and the west coast of Lantau in some extent, but it was noted that about half of these individuals have infrequently utilized this traveling corridor with only a few occasions sighted at either end of the traveling corridor. The proportions estimated above would suggest the number of individuals that could be affected if the traveling corridors are somewhat obstructed by anthropogenic impacts such as reclamation, bridge building or high-speed ferry traffic.

Notably, individual movement patterns from the photo-identification works indicated that some dolphins may have abandoned the Brothers Islands as the HZMB-related construction activities intensified in the past two years (see Section 5.8.2), and the traveling corridor along the northern edge of the airport could possibly be obstructed by the physical barrier of HKBCF reclamation site and the surrounding silt curtain, resulting in less movements through this area. In addition, dolphin usage and traveling activities to the northern side of the airport may have been seriously affected by the frequent high-speed ferry traffic originated Sky Pier (see Hung 2012), which is likely a significant factor contributing to the decline in dolphin numbers in NEL in recent years by affecting dolphins to move from NWL to NEL waters through this important traveling corridor. Therefore, the original intensity of dolphin movement through this traveling corridor could be underestimated at present. In fact, the northeast corner of the airport platform as part of this traveling corridor was identified as an important dolphin habitat in the earlier years (Hung 2008), but dolphin usage at this location have been greatly diminished since the opening of the Sky Pier. When considering the rapid decline in dolphin usage in NEL as a result of the physical obstruction for dolphin movement from the HKBCF reclamation works as well as the high-speed ferry traffic, the traveling corridor to the northern edge of the airport should be urgently protected by diverting the Sky Pier vessel traffic away from this area, to facilitate more dolphin movements to and from the important dolphin habitat around the Brothers Islands.

It appeared that dolphin movement through the traveling corridor to the west of the airport has not been seriously affected by the current bridge piling works near Sham Wat, and extensive movement of individual dolphins still recorded frequently between NWL and WL (see Section 5.8.2). However, there were already some signs indicating that some dolphins have shifted their range use to the southern side of the West Lantau away from the bridge alignment (Section 5.8.2), and the physical barrier of the bridge piers extending across the traveling corridors can potentially affect the north-south movement of dolphins between the marine park and WL waters. Continuous monitoring through focal follow observations, shore-based theodolite tracking as well as photo-identification works should be conducted throughout the construction period of HKLR09, to examine whether such traveling corridor would eventually be affected by the bridge construction works by limiting the north-south movement of dolphins across the bridge alignment.

5.9. Vessel movements and presence of dolphins observed during shore-based theodolite tracking

In the past, through shore-based theodolite tracking it was found that dolphin behaviours could be affected by vessel movements wherever the two overlap extensively (Piwetz et al. 2012; Hung 2013). To provide further insight on whether the intensity of vessel movements can affect the spatial distribution of dolphins, their occurrence as well as the types, intensity and spatial distribution of all vessels within the same study area were characterized among the four shore-based theodolite tracking sites during the present monitoring period. To achieve this, the fix positions of all objects (e.g. Chinese White Dolphins, and different types of vessels) collected from each theodolite tracking station were plotted and displayed on GIS map for more detailed examinations.

5.9.1 Tai O Station

Chinese White Dolphins were frequently sighted from the Tai O station, with a total of 32 sightings and 1,259 fix positions collected during eight tracking sessions in 2013-14. The high number of fix positions per dolphin sighting indicated that dolphins generally stayed in this area longer with more opportunities for the tracker to obtain their positions during each surfacing. In fact, this area was identified as one of the important dolphin habitats with the highest density in 2013 in western waters of Hong Kong (Section 5.5.1). The dolphin positions were mainly concentrated along the northwestern edge of Tai O Peninsula, probably due to the limited view toward the northeast and southwest of the peninsula (Figure 53). Some dolphin sightings were made at and across the western boundary of Hong Kong territorial waters. Four main types of vessels occurred there during the tracking sessions, including dolphin-watching tour boats originated from Tai O (354 fix positions), fishing vessels (166), high-speed ferries and speed boats (255) as well as construction-related boats (27). Not surprisingly, the activities of dolphin-watching tour boats mainly overlapped with the dolphin positions, but rarely they would go offshore near the border and would rather concentrate their search for dolphins in the nearshore waters near the Tai O Peninsula (Figure 53).

On the other hand, the fishing boats observed from Tai O Station were evenly distributed in the study area, and some of them were trawlers that operated illegally along the western border of Hong Kong. There appeared to be less overlap between the dolphins and fishing boat activities (Figure 53). The traffic of high-speed ferries and speed boats was relatively intense around the Tai O Peninsula, and most of the traffic overlapped with the highest density of dolphin positions in this area (Figure 53). Construction-related boats were seldom observed in this area as compared to the nearby Sham Wat area, and were distributed mostly along the western border of Hong Kong, with very little overlap with the dolphins. In general, it appeared that the dolphin-watching tour boats and high-speed ferries/speed boats had the most intense overlaps with dolphin occurrence, which may affect their movement and usage in the area.

5.9.2 Sham Wat Station

From Sham Wat Station, dolphins were regularly sighted, with a total of 27 sightings and 771 fix positions collected during 14 tracking sessions in 2013-14. When compared to Tai O, the usage of this area by the dolphins was relatively less, and they spent less time there with a lower number of fix positions per dolphin sighting. In fact, it was revealed in Section 5.8.3 that dolphins often pass through this area quickly as their traveling corridor. Even though a lot of these fix positions were concentrated nearshore, they also travel southward or northward through this area quickly in the more offshore waters (Figure 54). This area is only a kilometre north of Tai O, but dolphin-watching tour boats were almost non-existing; instead many fishing boats (164 fix positions), high-speed ferries and speed boats (335), construction-related boats (440) and many other different types of vessels (2,077) have utilized this area.

In the waters near Sham Wat, fishing boats regularly occurred either very close to the shoreline, or near the western border of Hong Kong where illegal trawling activities were often observed (Figure 54). Intense traffic with high-speed ferries and speed boats were often found close to shore in this area, which greatly overlapped with dolphin occurrence (Figure 54). Since the commencement of HKLR09 construction works, a great number of construction-related boats occurred along the bridge alignment, and it appeared that dolphins generally avoid these boats as they occurred very close to the shoreline with only slight overlap (Figure 54). Finally, many other boats were also observed in this area, which was in stark contrast to earlier years with infrequent vessel movements in this area (Hung pers. obs). In relation to the HKLR09 construction works, the intense boat traffic in the area would likely affect dolphin usage in this general area, and temporal comparison before and during construction in their occurrence, behaviour and movement (especially their north-south movement across the bridge alignment) will shed light on whether the dolphins are seriously affected by the bridge construction works.

5.9.3. Fan Lau Station

As a very important dolphin habitat identified with high densities in Section 5.5.1, Fan Lau was frequently visited by dolphins, with a total of 72 groups and 1,567 fix positions collected during nine tracking sessions in 2013-14. Similar to Sham Wat, the number of fix positions per dolphin sighting was lower than at Tai O, implying that dolphins did not spend much time here and most of them moved through this area quickly. Interestingly, almost all fix positions of dolphins were very close to shore, with only a few tracks of dolphins occurred a kilometre offshore (Figure 55).

This area was characterized by a huge volume of high-speed ferries and speed boats, with a total of 1,710 fix positions among nine sessions. These vessel traffic occurred throughout the entire search area, but there appeared to be two traffic routes for most of the high-speed ferry traffic (Figure 55). The intense ferry traffic overlapped somewhat with the dolphin occurrence, and appeared to have forced the dolphins in utilizing the inshore waters and prompting them to move through this area more quickly. In fact, the case study presented in the previous monitoring reports (Hung 2012, 2013) revealed that the high-speed ferry traffic has caused some acoustic disturbance on the dolphins (i.e. higher ambient noise level within the traffic lane), which may have resulted in short-term behavioural change and long-term displacement of dolphins in this area. In addition, this area was also frequented by container boats and fuel tankers (435 fix positions), and was regularly used by fishing boats (264) and construction-related boats (90). However, these vessels only overlapped with the dolphin occurrence to a smaller extent (Figure 55).

5.9.4. Tai Ho Wan Station

The Tai Ho Wan station was recently established in 2013 for the monitoring of dolphin movement in relation to the construction works of the TMCLKL. The waters near Tai Ho Wan have been rarely visited by dolphins in the past, but they did occur in the nearby Siu Ho Wan and Sham Shui Kok regularly, which are situated within the search range from this tracking station. During the three tracking sessions in 2013-14, only three dolphin groups were briefly sighted far away from the station. In fact, during the recent TMCLKL baseline and construction phase monitoring with shore-based theodolite tracking works from this same station, dolphins rarely occurred within the search area throughout the 60-day monitoring period.

This area was also characterized by very frequent movements of transportation boats and ferries (593 fix positions), high-speed ferries and speed boats (150) and construction-related boats (134). Besides the ferries that served regularly between Tung Chung and Tuen Mun, most of these vessels are associated with the construction activities of HKBCF and HKLR09 projects at the time of tracking in August 2013. The transportation boats, ferries and speed boats mainly traversed along the edge of the silt curtain around HKBCF reclamation site, with the greatest concentration at the southern edge of the silt curtain (Figure 56). Moreover, the construction-related boats were either moving through or stationary to the northwest of the silt curtain, which were situated very close to the Brothers Islands. As discussed in previous sections, dolphin usage has been greatly reduced in NEL waters especially around the Brothers Islands since 2013, and this decline was likely related to the presence of the physical barrier of HKBCF silt curtain as well as the stationary and moving vessels surrounding the site, which was illustrated in Figure 56 from the three tracking sessions.

6. CASE STUDIES ON SPECIAL TOPICS

6.1. ***Examination of Diel Patterns of Dolphin Occurrence through PAM Application*** (Collaborator: Mr. Jordan Hoffman at Trent University)

In the previous monitoring period, a pilot study on the application of a passive acoustic monitoring (PAM) system, the C-POD (Chelonia Limited, *www.chelonia.co.uk*), was conducted to examine the daily and diel pattern of dolphin occurrence through click train detection (Hung 2013). The C-POD system has the ability to address research questions related to the presence and occurrence of both dolphins and porpoises in Hong Kong waters by detecting and logging cetacean click trains.

The successful deployment at Lung Kwu Chau in 2012 showed the potential for C-PODs to be used for long-term passive acoustic monitoring in areas with ongoing or planned construction projects where 24-hour monitoring is not feasible using standard visual techniques (e.g. vessel based surveys or shore-based theodolite tracking) (Hung 2013). With the assistance of Mr. Jordan Hoffman (a graduate student at Trent University), and the funding support of HKCRP, the C-POD PAM project further expands, with the aims to improve the understanding of dolphin habitat usage when vessel surveys are not feasible (e.g. night, poor visibility, inclement weather). In 2013, C-PODs were deployed at four sites in western waters of Hong Kong waters for extended periods, including Fan Lau, Sham Wat, Lung Kwu Tan, and Siu Ho Wan (see Figure 57). In this case study, analysis of both daily and diel dolphin click train detection including the number of clicks, detection positive minutes (DPM), duration of click trains, and dolphin encounter rates are provided to examine various aspects of their occurrences at these four sites around Lantau.

<u>Materials and Methods</u>

The C-POD system consists of an 80-cm long plastic pipe with a hydrophone at one end below which an electronic filter and amplifier are positioned. The hydrophone recorded all sounds omni-directionally within the frequency range of 20-160 kHz. Moreover, the data collected by C-PODs were automatically filtered to remove clicks from ambient noise and boat sonar. Data analysis was largely automated as well, although some visual verification was essential for calibration and to ensure the accuracy of automated detection. Cetacean clicks were logged on a 4GB SD card within the C-POD. Data files were downloaded and analyzed using PC software developed by Chelonia Limited (*CPOD.exe*).

The C-POD detects tonal clicks and logs the time, duration and other click features to a 5-microsecond resolution. Cetacean clicks are 'tonal' because a narrow band of frequencies within a small range contains more energy than the rest of the broadband frequency range (Richardson et al. 2005). Cetacean clicks were logged when exceeding a user-defined threshold frequency of 20 kHz with a range up to 160 kHz. The C-POD software detects cetacean click trains with a user-defined range of 5-255 clicks in a single train (in this study, a click train was defined as ≥5 clicks). Cetacean clicks of only moderate and high probability of originating from cetaceans were analyzed. Four parameters on dolphin occurrence were analyzed and presented, which included:

1) **Number of clicks**: The number of clicks was a count of the total clicks from click trains (≥5 clicks). Clicks may come from a single dolphin in the area or may be the sum of clicks produced by a number of dolphins in the area surrounding the C-POD. Number of clicks was calculated per hour to detect diel patterns, and per day to determine activity level at the site. To assess diel patterns, the day period is defined as 06:00 to 17:59 and night period is 18:00 to 05:59. Normally, the start and end of each recording period did not contain a full 24 hours of data, but generally contained more than 12 hours of data.

2) **Detection positive minutes (DPM)**: To measure the duration the dolphins spent in an area, the DPM was used by calculating the total amount of minutes where at least one click train was detected within a one minute time period. Contrary to the number of clicks, using DPM eliminates the possibility of counting individual click trains produced by more than one dolphin, as the number of dolphins detected is unknown. DPM was calculated per hour to detect diel patterns and per day to determine activity level at the site.

3) **Train duration**: As the actual duration of acoustic presence of dolphins, train

duration is measured from the start to the end of a specific click train, which is the sum duration of trains logged by the C-POD. This is the minimum time present as not all click trains will be logged if they do not hit the C-POD in the right direction. Train duration eliminates the possibility inflating the time of acoustic presence by not including the start of clicking to the end of clicking in a sequence, potentially where many dolphins are simultaneously producing click trains. The time present within the range of the C-POD is equivalent to the average density in the area over the same period of time. Train duration was calculated per hour to detect diel patterns, and per day to determine activity level at the site.

4) **Encounter rate**: Encounter rate is the number of dolphin echolocation click train (>5 clicks) encounters per hour of acoustic measurement with the C-POD. A single encounter is classified when a click train or group of click trains is separated by a period of silence with a minimum duration of 30 minutes. The length of the encounter encompasses all click trains detected from the initial click train to the final click train before a 30-minute period of silence. There is a potential that the same individual dolphins or groups of dolphins may be counted as separate encounters if dolphins move in and out of proximity to the C-POD for an extended period of time. Additionally, encounters with many trains could be due to one animal moving slowly over an area or many animals moving quickly over the same area.

Results and Discussions

Site at Fan Lau – Three recording periods were completed at Fan Lau between February and May in 2013, with a total of 107 recording days. Dolphin clicks were detected in 99% of the C-POD data analyzed, with the only day on March 30th with no dolphin clicks detected. If dolphins were present on that day, there may have been a large amount of noise (e.g. sediment transport, sonar noise, snapping shrimp), or the dolphins may have been outside the detection range of the C-POD (i.e. at least a kilometre away).

In summary, the mean number of clicks per day at Fan Lau site was 14,643 clicks (S.D. ± 16,337 clicks), while the mean DPM per day was 119 minutes (S.D. ± 119 minutes). Moreover, the mean duration of click trains per day was 519.8 seconds (S.D. ± 545.8 seconds). The number of clicks detected per day, DPM per day and duration of click trains per day over the recording period at Fan Lau site were shown in Figures 58a-c. Figure 59 shows the number of encounters per day and the mean duration of encounters for each day. Throughout the entire recording period, 601 dolphin encounters were made. The mean encounter rate was 5.6 encounters per day, which lasted an average of 39.2 minutes (S.D. ± 47.0 minutes).

The diel patterns of the number of clicks through the entire recording period at the site of Fan Lau are shown in Figure 60, with the mean number of clicks during the day and at night as 703 clicks/hour (S.D. ± 1,508 clicks/hour) and 578 clicks/hour (S.D. ± 1,338 clicks/hour) respectively (Figure 60a). Figure 60b shows the diel patterns of the DPM through the entire recording period, with the means during the day and at night as 5.9 minutes (S.D. ± 11.2 minutes) and 4.5 minutes (S.D. ± 9.2 minutes) respectively. For the duration of click train, the diel patterns are shown in Figure 60c, with the means during the day and at night as 25.5 seconds (S.D. ± 51.7 seconds) and 21.1 seconds (S.D. ± 46.3 seconds) respectively. Overall, the peaks of acoustic activities of Chinese White Dolphins at Fan Lau occurred between 7:00 and 10:59 and between 18:00 and 18:59 (Figures 60a-c).

Site near Sham Wat – Three recording periods were completed near Sham Wat between February and June in 2013, with a total of 113 recording days. Dolphin clicks were detected in 81% of the C-POD data analyzed at this site (i.e. 92 out of 113 recording days). The C-POD data collected from Sham Wat indicated that the mean number of clicks per day was 2,580 clicks (S.D. ± 7,243 clicks). Moreover, the mean DPM per day and mean duration of click trains per day were 22 minutes (S.D. ± 39 minutes) and 89.2 seconds (S.D. ± 199.0 seconds) respectively. Figures 61a-c shows each of these three parameters per day over the recording period at the site near Sham Wat. Finally, the number of encounters per day and the mean duration of encounters for each day are shown in Figure 59. Throughout the entire recording period, 136 dolphin encounters were made at the site near Sham Wat, with the mean encounter rate as 1.2 encounters per day, which lasted an average of 19.2 minutes (S.D. ± 20.6 minutes). However, it should be mentioned that due to an unspecified error in the analysis, *CPOD.exe* was unable to determine encounters for the second recording period in late February to April at this site (Figure 59).

The diel patterns of the number of clicks, DPM and duration of click trains throughout the entire recording period near Sham Wat are shown in Figures 62a-c. In summary, the mean number of clicks during the day and at night were 19 clicks/hour (S.D. ± 88 clicks/hour) and 189 clicks/hour (S.D. ± 800 clicks/hour) respectively, while the mean DPM during the day and at night were 0.2 minutes (S.D. ± 1.0 minutes) and 1.7 minutes (S.D. ± 5.3 minutes). Moreover, the mean train duration during the day and at night were 0.8 seconds (S.D. ± 3.7 seconds) and 6.7 seconds (S.D. ± 25.4 seconds). Overall, the peak of dolphin acoustic activity at the

Sham Wat site occurred between 20:00 and 00:59 (Figures 62a-c).

Site at Lung Kwu Tan – Two recording periods were completed at Lung Kwu Tan from August to December 2013, with a total of 99 recording days. Dolphin clicks were detected in 82% of the C-POD data analyzed (i.e. 81 out of 99 recording days). The mean number of clicks per day, mean DPM per day and mean duration of click trains were 642 clicks (S.D. ± 857 clicks), 9 minutes (S.D. ± 10 minutes) and 39.5 seconds (S.D. ± 47.1 seconds) respectively. Each of these three parameters per day over the recording period at the Lung Kwu Tan site are shown in Figures 63a-c. Moreover, the number of encounters per day and the mean duration of encounters for each day is shown in Figure 59, with a total of 219 dolphin encounters throughout the recording period. The mean encounter rate was 2.2 encounters per day, which lasted an average of 8.0 minutes (S.D. ± 8.8 minutes).

The diel patterns of the number of clicks, DPM and duration of click trains throughout the entire recording period at Lung Kwu Tan are shown in Figures 64a-c. In summary, the mean number of clicks during the day and at night were 15 clicks/hour (S.D. ± 70 clicks/hour) and 36 clicks/hour (S.D. ± 139 clicks/hour), while the mean DPM during the day and at night were 0.3 minutes (S.D. ± 1.0 minutes) and 0.5 minutes (S.D. ± 1.6 minutes) respectively. The mean train duration during the day and at night were 0.9 seconds (S.D. ± 3.9 seconds) and 2.3 seconds (S.D. ± 8.6 seconds) respectively. There were two peaks of dolphin acoustic activities between 18:00 and 21:59, and at around 02:00 (Figures 64a-9c).

Site at Siu Ho Wan – Two recording periods were completed at Siu Ho Wan from August 2013 to January 2014, with a total of 129 recording days. Dolphin clicks were detected in 78% of the C-POD data analyzed (i.e. 100 out of 129 recording days). For the number of clicks, DPM and duration of click trains per day at Siu Ho Wan, their means were 6,591 clicks (S.D. ± 10,467 clicks), 67 minutes (S.D. ± 83 minutes) and 233.7 seconds (S.D. ± 343.7 seconds) respectively. Figures 65 a-c shows each of these three parameters over the recording period. Moreover, the number of encounters per day and the mean duration of encounters for each day at Siu Ho Wan are shown in Figure 59. Throughout the entire recording period, 325 dolphin encounters were made, with the mean encounter rate as 2.5 encounters per day, which lasted an average of 51.4 minutes (S.D. ± 56.7 minutes).

The diel patterns of the number of clicks, DPM and duration of click trains throughout the entire recording period at Siu Ho Wan are shown in Figures 66a-c. In summary, the mean number of clicks during the day and at night were 126 clicks/hour (S.D. ± 444 clicks/hour) and 416 clicks/hour (S.D. ± 1283 clicks/hour). On the other hand, the mean DPM during the day and at night were 1.5 minutes (S.D. ± 4.6 minutes) and 4.0 minutes (S.D. ± 9.7 minutes), while the mean train duration during the day and at night were 5.1 seconds (S.D. ± 17.3 seconds) and 14.1 seconds (S.D. ± 39.5 seconds). At Siu Ho Wan, the peak of dolphin acoustic activity occurred at two peaks between 05:00 and 06:59 as well as between 21:00 and 22:59 (Figures 66a-c).

Comparison of dolphin acoustic activities among the four sites

Among the four sites at Fan Lau, near Sham Wat, at Lung Kwu Tan and Siu Ho Wan, it was apparent that Fan Lau was the most acoustically active site during the study period with the highest mean number of clicks per day, mean DPM and mean encounter rate. This result coincided well with the habitat use analysis, in which this site has been consistently identified with very high dolphin densities in the past decade (see Section 5.5.1).

Siu Ho Wan was also a site with lots of dolphin acoustic activities, even though the percentage of click detection was the lowest among the four sites. The smaller amount of recording days that contained dolphin acoustic activities at Siu Ho Wan generally agreed with the encounter rate results in 2013, in which dolphins have infrequently utilized the Brothers Islands during this year when the C-POD was deployed at the nearby Siu Ho Wan (see Section 5.3.1). Moreover, on average dolphins were acoustically present at Siu Ho Wan for a longer period than the other three sites once an encounter was made. From the focal follow observations and shore-based theodolite tracking works, dolphins tended to spend more time milling and foraging around the Brothers Islands (see Hung 2013), and this may explain why the mean time for each encounter would be longer than the other three sites.

Conversely, acoustic activities of dolphins near Sham Wat were somewhat lower than at Fan Lau and Siu Ho Wan. Although this area was identified with low to moderate dolphin densities in the past, dolphin rarely occurred in this area in 2013, which is likely related to the HKLR09 bridge construction (see Section 5.2.1). This area is also situated at the middle of traveling corridor between Sha Chau and the west coast of Lantau, and dolphins may have moved through this area quickly (Section 5.8.3), which would make acoustic detection more difficult. Interestingly, strong diel patterns with more acoustic detections were made a night at this site, suggesting that this site is a far more important habitat than the habitat index indicated using just the day-time visual monitoring survey data (Section 5.5.2).

At the Lung Kwu Tan site, dolphin acoustic activities were the least among the four sites. In fact, this area was not frequently visited by dolphins in the past, and dolphin densities were generally low in the inshore waters of Lung Kwu Tan (Section 5.5.1). However, dolphin acoustic activity was slightly higher at this site during night-time, and therefore the past knowledge on dolphin habitat use at Lung Kwu Tan should be updated with the additional information on the night-time usage of this area. This is especially important as the general area around this site has been proposed for large-scale reclamation, and the impact assessment should fully evaluate dolphin usage of this area both during the day and at night.

Among these four sites, strong diel patterns were shown at Siu Ho Wan and near Sham Wat, with a lot more acoustic detections made at night than during day-time, and the peak of activities occurring at night and early in the morning before sunrise. Diel patterns at Lung Kwu Tan were less pronounced (especially for the mean DPM), but it appeared that dolphins also utilized this area more at night than during the day, with the peak of activity occurred after dark. Fan Lau is the only sites among the four that dolphins were acoustically present relatively equally between day and night. The peak of dolphin acoustic activity also occurred during the day, but dolphins are still very active at night-time as well. The diel patterns of dolphin occurrence at Fan Lau were fairly similar to the one at Lung Kwu Chau recorded in the previous monitoring period (Hung 2013).

The present study provided strong indication that dolphins occurs both during day-time and night-time at many sites around Lantau, and in some cases their acoustic activities were a lot higher at night-time than in day-time. These results filled an important data gap on dolphin habitat use, in which night-time usage of dolphins have been largely overlooked in the past. As discussed in Hung (2013), the strong diel patterns of dolphin acoustic activities could possibly be linked to increased feeding activities and increased echolocation rates to compensate for a lack of vision at night, or related to habitat use or prey availability. Moreover, it could be postulated that the dolphin acoustic activity has been affected by intensive vessel traffic at various locations within their habitats (also see Hung 2012), and the lower level of vessel traffic at night could facilitate their foraging activities, hence higher level of echolocations. In any case, the diel pattern of dolphin activities and their night-time habitat use should be considered for better conservation effort for the dolphins, such as the designation of marine protected areas, control of construction activities and anthropogenic disturbance (e.g. high-speed ferry traffic) at night-time, and evaluation of the importance of dolphin habitats.

Conclusion and Future Directions

The continuation of the PAM study using the C-POD has allowed questions to be addressed on the long-term acoustic activity of Chinese White Dolphins. It has become clear that dolphins use sites around Hong Kong waters at different time intervals and to different intensities. The results of this study have shown that PAM is a useful method for monitoring areas that may be impacting Chinese White Dolphins (e.g. high vessel traffic areas, construction areas). PAM is especially useful for 24-hour monitoring when standard visual techniques (e.g. vessel based surveys or theodolite observations) are not feasible. Since there are good indications of diel patterns of dolphin occurrence among different sites, night time construction activities should only proceed with caution by ensuring that impacts on their behaviour or foraging activities would not be seriously affected.

Future studies may address the effectiveness of different PAM systems by comparing the detection capabilities of Ecological Acoustic Recorders (EARs) and the C-POD, as the EARs have been deployed for a number of EIA and EM&A studies since 2012 as another standardized PAM method in Hong Kong. The two systems differ as C-PODs are constantly monitoring while the EARs are monitoring on a five-minute cycle. However, C-PODs rely on detecting train sources that may also come from natural sources (e.g. sediment transport, snapping shrimp) and boat sonar, which is not the case for EARs. In addition, click train details such as inter-click intervals and frequency distributions of click trains may be further analyzed from C-POD data to make inferences about dolphin behaviour at each site. Finally, even though the four sites are good representatives of habitats around Lantau waters, more C-PODs should be deployed in a more systematic scheme throughout the dolphin habitats, to understand the differential use of different locations both during day-time and night-time among different seasons, especially in areas where dolphin densities tended to be lower. Such PAM application should become a standard method for all EIA studies to formulate better baseline information of dolphin usage at a potentially affected area.

6.2. ***Mapping Cumulative Impacts on Chinese White Dolphins in HK*** (Collaborator: Ms. Danielle Marcotte at Concordia University)

In light of the decline in dolphin abundance, and a myriad of existing threats and on-going development pressure faced by the local Chinese White Dolphins, there is an urgent need to develop the methodology for proper cumulative effects assessment (CEA) in order to properly address the issues of cumulative impacts. Currently, Hong Kong's practice of CEA has suffered a lack of statutory guidelines, weak analytical methods, and limited spatial and temporal scope (Xue et al. 2007), hence the present study aims to establish an improved CEA methodology. Through the use of a GIS, the historical cumulative human impacts on the local dolphins were quantitatively assessed, as a reference for further the field of CEA in Hong Kong. Moreover, the study also provided insight into how GIS can (and cannot) be applied to assess cumulative marine impacts.

Methodology

Assessing cumulative impacts requires the relevant comparison of the spatio-temporal data on human activities as well as the biophysical data on the species and habitat under study. The different human activities in the area of interest (North Lantau waters) were accessed through the Hong Kong Environmental Assessment website (www.epd.gov.hk/eia) and the Marine Department websites (www.mardep.gov.hk). These activities were grouped into: 1) land reclamation projects; 2) pile driving works; 3) dredging works; 4) cargo shipping traffic; and 5) high-speed ferry traffic. Dolphin distribution data for each year of the assessment was accessed from HKCRP long-term monitoring database, with significant amount of the data contributed through AFCD long-term dolphin monitoring programme.

Due to time and resource limitations, only certain human activities and criteria were taken into consideration for the present CEA, which included all pertinent marine traffic and projects in the study area since 1996, assuming that these activities represented the major impacts that have affected dolphin occurrence during the past two decades.

To map cumulative human impacts by transforming the multiple human activities into GIS impact layers, many steps and decision were undertaken using ArcGIS. The first is to create fuzzy membership functions for each human activity (i.e. the distance to which the effect of the impact was likely to reach), which was based on the dolphin exclusion zones for past EM&A works, and background literature. Membership functions of the same impact-type were then summed onto the same GIS layer to account for any additive impact interactions. The resulting five impact-type layers were then combined based on their respective weighting factors (the weighting was based on individual severities toward dolphin survival), to produce a final cumulative impact map. This process was repeated for each of the temporal scales (i.e. 1996-2013), in which 18 cumulative impact maps were produced with an attempt to depict how human impacts in North Lantau waters changed throughout time.

To map the dolphin distributions, systematic line-transect survey data was used from the HKCRP long-term monitoring database and entered into ArcGIS for quantitative grid analysis as described in Section 4.6.4. The DPSE values per 1-km^2 grids were then mapped for each year onto a GIS raster layer using 1-km resolution to give the 18 resulting DPSE maps, which depict the change through time in dolphin distribution.

To analyze any present relationships between the cumulative impacts and the dolphin distribution, changes over time were assessed using linear regression analysis to find any significant trends. Statistical correlations using Pearson correlation analysis were run to determine any existing relationships between dolphin densities and human impact levels. An iterative process of data analyses was employed, by going through multiple rounds of analyses in order to investigate a series of five questions.

Cumulative impacts and dolphin density at the entire scale of the study area

The first question was to ask whether there was any general relationship between increasing human impacts and decreasing dolphin density at the overall scale of the study area. To address this, the temporal trends in the data were assessed, and the mean DPSE values of dolphins were compared with the mean cumulative human impact scores. During the entire 18-year span of the study in North Lantau (1996-2013), no significant trend was observed in overall dolphin densities (Figure 67a), although there was some distinct cyclical fluctuations from year to year. Furthermore, although the cumulative human impacts showed a significant increasing trend (Figure 67b), they were not correlated in any way to the overall change in DPSE ($r=-0.01$, $p>0.9$). Therefore, such relationship was not established between increasing human impacts and any trends in dolphin population at the overall scale of the study area during the 18-year period.

Cumulative impacts and dolphin density on local scales of the study area

The second question attempted to investigate any negative relationships between impacts and dolphin density on local scales within the analysis extent, as the cumulative activities may induce impacts on more local scale rather than the entire scale of the study area. This was addressed through iterative rounds of analyses at the finest scale available (i.e. at each 1-km^2 pixel/grid). At each pixel, the DPSE value was plotted through time, with significant declining trends in DPSE values detected for certain pixels located in the eastern zone of the analysis, and increasing trends detected in the western zone (Figure 68). In particular, four cells around the Brothers Islands experienced significant decline in DPSE ($R^2 = 0.24$, $p<0.05$) and showed a negative correlation with the overall impacts ($r=-0.56$, $p<0.05$). This finding confirmed the importance of choosing the appropriate spatial scale in the field of impact assessment (Joao 2000).

Local scale decrease in dolphin density in the eastern zone

The third question asked on what spatial extent this effect of the local dolphin densities in the eastern zone of the North Lantau was occurring. Focusing on the area around the Brothers Islands and systematically expanding the spatial scale through four iterative rounds of statistical calculations would allow the estimation of the spatial extent of the effect. The four spatial scales that were assessed included: 1) four grid cells near the Brothers Islands; 2) the whole area of the Brothers Islands including Sham Shui Kok; 3) the Brothers Islands (including Sham Shui Kok) extending to the northeast region of the airport; and 4) all grid cells to the east of the airport (see Figure 69). All four scales showed a decreasing trend in DPSE over time, and a negative correlation with cumulative impacts. Scale 3 (including the Brothers Islands extending to the northeast region of the airport) depicted the strongest decreasing trend ($R^2=0.53$, $p<0.01$) and strongest correlation ($r=-0.75$, $p<0.01$), in which the spatial extent of the impact was reflected most accurately among the four spatial scales.

Correlation between decrease in dolphin density and increase of cumulative impacts

The fourth question was to ask if the dolphin density decline experienced in Scale 3 was correlated with the temporal trend in cumulative impacts. As shown in Figure 67b, there appeared to be an significant increase in overall cumulative impacts in 2004, which was attributed to the implementation of a new high-speed ferry routes departing from the Sky Pier at the airport (see Hung 2012), and no other impacts occurred in that year besides this new ferry traffic implementation (Figure 70). This question was assessed by a correlation test between the trend in DPSE values in Scale 3 and the cumulative impact trend. The results indicated a strong negative correlation ($r=-0.74$), suggesting that the new ferry traffic route in the already-developed waters of North Lantau may contribute to the dolphin population decline. A linear regression analysis was also performed between the average DPSE values of Scale 3 and the overall cumulative impact values to determine whether the dolphin densities at Scale 3 were a function of the increasing cumulative impact scores

(Figure 71). Depicting an R^2 value of 0.55 ($p<0.01$), the regression established a significant negative relationship between the cumulative impacts within North Lantau waters and the declining dolphin densities (DPSE values) near the Brothers Islands and the northeast corner of the airport.

Cumulative impacts and displacement of dolphins in the study area

The final question asked if the cumulative impacts are disrupting the natural dolphin distribution by displacing the Chinese White Dolphins from the Brothers Islands and the northeast corner of the airport to elsewhere in the study area, which was addressed through a fine-scale analysis of each pixel. From the earlier analyzed results, it was noted that certain cells within the Sha Chau and Lung Kwu Chau Marine Park experienced significant increases in dolphin densities, which was correlated in time with the high-speed ferry implementation in 2004. The same iterative process was run as above, to determine that a grouping of three pixels within the marine park showed the strongest trend with an R^2 value of 0.22 ($p<0.05$) and a Pearson correlation coefficient (with impacts) of $r=0.57$ ($p<0.05$) (Figure 72). This effect was eventually diluted out and stabilized very quickly with larger spatial scales with no increasing trends after iterative rounds of analyses. Due to these stabilizing conditions and the numerous effects experienced, it remained inconclusive about the significant increasing trend in the western zone in North Lantau. However, for the western zone in general, it was apparent that the dolphin occurrence was at least stable throughout the time frame of the present study. This further confirmed the specificity of the localized decreasing trend in the eastern zone of North Lantau, which is correlated in time with the accumulating impacts and specifically the implementation of the high-speed ferry traffic into this cumulative environment. It can be concluded that the cumulative impacts have disrupted the spatial distribution of dolphin in North Lantau waters.

Conclusions and recommendations

The present study provided insight into the spatial and temporal dynamics between acting cumulative human impacts and dolphin density distributions since 1996 in the North Lantau waters of Hong Kong. Through the investigation of five distinct questions, it was found that although cumulative impacts are not inducing any trends on the North Lantau dolphin population as a whole, a localized area in the eastern zone has experienced significant declines in dolphin densities, which were correlated with overall cumulative human impacts in the region. Furthermore, the spatial sale of the effect was determined to be best presented around the Brothers Islands and the northeast corner of the airport, which correlated in time with the implementation of the new high-speed ferry route in 2004. Finally, it was determined that specific locations in the western zone of the study area experienced correlated increases in dolphin density. Although the spatial extent of the displacement of dolphins was not identified with confidence, it was concluded that the cumulative impacts seemed to have disrupted the natural dolphin distribution in North Lantau, and that the timing of these cumulative impacts highlights the addition of high-speed ferry traffic as a potential contributing factor in the localized dolphin density decline. This result concurred with past and present monitoring results, indicating that the movement of individual dolphins was disrupted by the increase of high-speed ferry traffic (Hung 2012; Section 5.8.3).

It should be mentioned that the list of human impacts for the present was not exhaustive, without considering other factors such as climate change effects, water pollution and prey resource distribution. Also, some assumptions and simplifications were made with the use of GIS, such as assuming the ferry traffic would follow exactly the same route, and edge effects were not accounted for in this assessment. In fact, the past literature demonstrated the difficulties in terms of data limitations, understanding of ecological phenomena and incorporation of temporal dynamics when conducting a CEA (deYoung et al. 2004; Atkinson and Canter 2011). Through the use of fuzzy logic, GIS can help address some of these uncertainties (Bojo'Rquez-Tapia et al. 2001), but others often require some assumptions or simplifications, which can taint results with imprecision and inaccuracies (Stenhouse 2003). Nevertheless, with certain approximations in the methodology, the findings of the present study have improved the understanding of cumulative impacts on cetacean populations by highlighting the addition of high-speed ferry traffic as a likely contributing factor in the diminished presence of dolphins in North Lantau.

In light of this study, a better understanding on the effects of cumulative impacts would be needed, especially since several other development projects (especially proposed reclamation) are planned for the future. In addition to the 160 hectares of reclamation for the HKBCF, the additional reclamation proposals in North Lantau region include areas at Tung Chung East (175 hectares), Sunny Bay (60-100 hectares), Siu Ho Wan (100-150 hectares), Lung Kwu Tan (200-300 hectares), and the third runway expansion to the north of the Chek Lap Kok Airport (650 hectares). In particular, the proposed site of the third runway proposal with massive reclamation is situated within the dolphin habitat which overlaps with the traveling corridor (see Section 5.8.3) as well as the high-speed ferry traffic that has been affecting dolphin movement (Figure 73). If the ferry traffic will be diverted because of the proposed reclamation, there will be further complications on dolphin movement in addition to the devastating effect of huge habitat loss for the dolphins. Therefore, a thorough cumulative impact assessment should be conducted for this and other reclamation proposals, to ensure that dolphins can continue utilizing North Lantau region as part of their population range.

6.3. *Predicting Suitable Habitat for the Chinese White Dolphins in the Pearl River Estuary* (Collaborator: Lauren Dares at Trent University)

The Pearl River Estuary (PRE), located in the south of China, is home to the largest known population of Chinese White Dolphins with abundance estimates of around 2500 individuals (Chen et al. 2010). The majority of research efforts for the PRE population of Chinese White Dolphins has to date been primarily focused on the waters around Hong Kong, with relatively little information being collected about this population in other parts of the habitat. Well-known as an estuarine species (Parsons 1998; Jefferson 2000; Jefferson and Hung 2004; Hung 2008), suitable habitat for Chinese White Dolphins may be found further to the west of the largest outlets of the Pearl River, which empty into Lingding Bay, because of the four smaller outlets that empty into the South China Sea west of Macau. The estuarine distribution of this species is likely due to the conditions produced by the mixing of the nutrient-rich freshwater plume discharged by the river with saline waters from the South China Sea. These conditions create an ideal habitat for the phytoplankton populations, resulting in high productivity that attracts a number of prey species of the Chinese White Dolphin (Barros et al. 2004).

Species distribution modelling has become a widely used tool that uses conditions in the known distribution of a species to predict other areas of occurrence. Correlative species distribution models define a species' niche based on environmental variables measured at locations of sightings of a species, then project this niche onto a larger area to determine other suitable habitats (Soberón and Peterson 2005). A key step in developing species distribution models is choice of environmental variables to be used as predictors of species occurrence (Elith and Leathwick 2009). Chlorophyll-a (ChA), sea surface temperature (SST) and water depth are three environmental variables that have been linked with distributions of multiple cetacean species (Spyrakos et al. 2011; Redfern et al. 2006), often relating to their prey distribution, and can be detected via remote sensing instruments which measure radiance at different wavelengths to differentiate between variables.

Remotely sensed data have many applications important to conservation, including allowing researchers to sample areas that are difficult to sample *in situ*, and to look at habitats on a larger scale than ever before (Kerr and Ostrovsky 2003). Here remotely sensed ChA, SST and water depth data are used to define a niche for the Chinese White Dolphins, and project that niche across unsurveyed areas in the PRE to determine potential suitable habitat for this species in previously unexplored waters.

Methods

Monthly remotely sensed environmental data were downloaded from NASA's OceanColor data archive (http://www.oceancolor.gsfc.nasa.gov) for July 2002-December 2011 (Figure 74). ChA concentration and SST were obtained from the AquaMODIS satellite at 4km x 4km resolution, and data encompassing the study area were extracted from world-wide data files using SeaDAS 7.0 software (NASA 2013; Figure 75). Depth data were assumed to be consistent over time, and was measured via satellite altimetry by NASA's Topex satellite (http://topex.ucsd.edu/) at 1-minute spatial resolution. Monthly data were divided into wet season (May-September) and dry season (October-April), and seasonal means were taken for each grid. ChA, SST and depth were interpolated via empirical Bayesian kriging (ArcGIS 10.1) to create continuous surfaces of each environmental variable, and measurements of ChA and SST in wet and dry seasons were compared via Wilcoxon signed-rank test for paired samples.

Environmental conditions during Chinese White Dolphin sightings in each season were characterized by re-sampling the interpolated surfaces at locations of sightings made during line-transect surveys from 2002-2011 (Figure 76). Each sighting was considered a single "presence" of Chinese White Dolphins regardless of number of individual animals present, and values of SST, ChA and depth were extracted at the locations of each presence. A Maximum Likelihood Classification (ArcGIS 10.1) was then used to classify the rest of the study area as suitable or unsuitable habitat based on values of SST, ChA and depth.

Results

Significant differences were observed in both SST ($p<0.05$) and ChA ($p<0.05$) measurements between wet and dry seasons (Figure 77). SST values varied from 21.0-34.6 ^{o}C in the wet season, reflecting the warmer air temperatures during the summer, while temperatures in the dry season were lower, varying from 15.0-31.4 ^{o}C (Figure 78a). ChA values were consistent in both seasons, varying from 0.05-95.9

mg/m^3 in the wet season and 0.08-90.1 mg/m^3 in the dry season (Figure 78b). Definition of Chinese White Dolphins' niche in terms of the three environmental variables included here was done by re-sampling interpolated layers at sightings locations to obtain values of SST, ChA and water depth (Figure 79). SST at sighting locations varied from 27.4-28.0 ^{o}C in the wet season and from 21.6-22.1 ^{o}C in the dry season. ChA at sighting locations varied from 3.0-10.6 mg/m^3 in the wet season and from 1.9-6.0 mg/m^3 in the dry season, and depth varied from 4.2-37.2 m in the wet season to 4.3-33.8 m in the dry season.

The niche definition was used to classify the rest of the study area based on suitability of the habitat for Chinese White Dolphins (Figure 80). Suitable habitat appears to extend both westward and eastward of the main study area, however with lower confidence than the waters to the northwest of Hong Kong where a large amount of survey effort was focused. Less habitat was classified as suitable to the east of the PRE in the dry season than in the wet season, presumably due to the decreased influence of the freshwater plume as a result of less rainfall during the dry season. Inclusion of some areas as suitable habitat as well as levels of confidence in that suitability varied between seasons, and some areas, despite being surrounded by suitable habitat, were classed as unsuitable habitat in both wet and dry seasons.

Discussion

Remotely sensed SST values were more varied in both the wet and dry seasons when compared to measurements taken in situ by Yin (2002), which varied between 28 and 30 ^{o}C in summer and between 15 and 17 ^{o}C in winter. Although there was a significant difference in median ChA measurements in wet and dry seasons, the similar range of ChA concentrations observed here during the wet and dry seasons is contrary to the findings of Huang et al. (2004), who reported summer ChA values four times higher than during winter in the PRE, citing a marked change in phytoplankton abundance between the seasons. These differences may be a result of the larger area sampled in this study; Yin (2002) used data collected from water quality stations situated around Hong Kong, while Huang et al. (2004) sampled further west; however, some measurements used here were still taken over a hundred kilometres from the main sampling areas in those two studies, including less productive offshore areas that would account for the lower range of ChA measurements.

Habitat classified as suitable for Chinese White Dolphins is primarily inshore, and stretches further east and west than areas that have currently been surveyed for this species. Chen et al. (2010) reported sightings of Chinese White Dolphins as far west as Shangchuan Island and noted that the distribution of this population likely extends further west beyond surveyed waters, which is supported by the environmental information here. Few sightings of Chinese White Dolphins have been made in the waters to the east of Hong Kong, although results in this study indicate there is suitable habitat along the coastline; this may be due to barriers to dispersion, preventing animals from traveling eastwards to access that suitable habitat, or it may be a result of the omission of one or more key variables in the determination of suitable habitat for the species. Turbidity, salinity and sea floor slope, among other factors, have been known to correlate with cetacean distributions (Cañadas et al. 2001; Forney 2000; Redfern et al. 2006), and could potentially be a limiting factor for Chinese White Dolphin distribution in the PRE.

Inclusion of known absences in this analysis would refine the definition of suitable habitat and increase confidence in the classifications (Brotons et al. 2004). Some inshore areas, and other areas surrounded by suitable habitat were not classified as suitable with a high degree of confidence, and thus were considered to be unsuitable despite a handful of sightings in these areas (in particular the deep waters near the southwest corner of Lantau). It is possible that these areas are indeed unsuitable habitat in terms of SST, ChA and water depth and that the sightings that were made in these areas were a result of animals traveling across unsuitable habitat to reach suitable habitat, but it may also be that these areas have been incorrectly classified without further information on areas that Chinese White Dolphins do not occupy. In addition, the majority of sightings were concentrated in the waters to the north and west of Hong Kong as a result of the disproportionate amount of survey effort in the waters surrounding Hong Kong. Since effort was not accounted for when defining the species' niche, that definition is more heavily influenced by the conditions in areas where sightings were concentrated and thus may not take into account the range of conditions in which Chinese White Dolphins may be found.

In conclusion, suitable habitat for the Chinese White Dolphins appears to extend further west and east along the coastland of mainland China than have currently been surveyed. In order to direct survey efforts in determining the western boundary of this population and whether exchange of individuals potentially occurs between this and other populations of Chinese White Dolphins, a larger area should be included in future analyses to investigating whether suitable habitat extends beyond what has been used here, including data extending further north into the estuary. Other relevant environmental variables, including turbidity, salinity and sea floor slope should be included to further refine the niche definition, and model selection procedures should be utilized to determine the significance of each variable. Although true absences are difficult to obtain for many species, inclusion of absences in the analysis would improve the accuracy of habitat suitability classifications; alternatively, a method that uses background samples of the seascape as pseudoabsences such as Maxent could also potentially improve upon the analyses included here.

6.4. Habitat Modeling for Finless Porpoises in Hong Kong (Collaborators: Timothé Vincent and Ellen Hines at San Francisco State University)

In the context of on-going and future threats and coastal development the Indo-Pacific finless porpoises face within Hong Kong waters, the present study aims to examine the relationship between the porpoises and their living environment. To study and predict habitat use of the porpoises, their sightings from the long-term monitoring programme and water quality data from EPD were used, and anthropogenic impacts of high-speed ferries on finless porpoises within Hong Kong territorial waters were also addressed.

There were three objectives for the present study: 1) identify candidate environmental variables that drive finless porpoises to specific habitats, and determine a threshold for habitat suitability based on patterns between sightings and water quality data; 2) map predicted suitable habitat; and 3) identify where these resulting habitats are most at risk by selecting where these areas conflicts with high-speed ferry lines. The results of the successive models are also used to make recommendations for future management planning and protected areas.

<u>Methodology</u>

The geographic area of this analysis is Hong Kong territorial waters, and this research utilized 1,012 finless porpoise sightings obtained from 1996 to 2011 as dependent variables. For environmental data, temperature, salinity and chlorophyll a were selected as independent environmental variables, and models were run using only surface and mid-water quality data. Monthly data of these three variables at both depths were downloaded from the 76 monitoring stations at EPD website. For human activities, high-speed ferry traffic has been particularly problematic for finless porpoises (Hung 2012). One specific route, the South Lantau Vessel Fairway (SLVF), overlaps areas where finless porpoises regularly occur. To analyze the impact of the SLVF within porpoise habitat, a spatial prioritization tool was run using the suitability maps resulting from the models and overlapped the SLVF.

To process and manipulate the data, the species distribution modeling (SDM) technique was utilized, which extrapolated sighting data over time and space based on a statistical mode. Using statistical models, SDM provides spatial information about species, and offers insights into the suitability of habitat for a particular species. By assessing patterns between porpoise sightings and environmental variables, changes in environmental variables influencing distribution and habitat use for finless porpoises in Hong Kong can be better understood.

SDM and mapping habitat suitability involves learning from the data (Franklin 2009; Redfern et al. 2006). As finless porpoise distribution has shown distinct seasonal variation (Jefferson et al. 2002; Hung 2005), the porpoise distribution data were divided into summer/autumn and winter/spring from 1996-2011 as two dependent variable datasets. In order to extract the values of candidate variables under each sighting, continuous layers of the variables in question was created throughout the study area. Specifically, raster layers were created by interpolating water quality data on a monthly basis for the three candidate variables (i.e. temperature, salinity and chlorophyll a) at both selected depths (surface and mid-water) over the 16 years period. To ensure the consistency between water quality data and porpoise sighting data, the interpolated environmental data and created data layers were averaged for each of the three variables at the surface and mid-water levels over the same time frame as the porpoise sighting data. This resulted in layers of water quality data at both selected depths and over the summer/autumn and winter/spring in 1996-2011 (Figure 81).

By dividing the porpoise sighting data into two seasonal groups over the 16-year study period, it resulted in 248 sightings in summer/autumn and 764 sightings in winter/spring. Maxent, a statistical program specifically designed for SDM with presence only data, was used to split each datasheet into two groups randomly, selecting 75% of the occurrences as the training data, and the remaining 25% as the testing data. Then each model over the 16-year period for the two selected seasons and two selected water depths were run, which resulted in four output files.

To assess the models, evaluate the results and attempt to identify the variables that may have an impact on porpoise distribution, successive descriptive statistical tools available with Maxent were run. First, the "Analysis of Omission and Commission" was run to test whether the datasheets were independent. Then an "Area Under the Curve" (AUC) test was used to show how well the model performs in predicting occurrences compared to a random selection of points. To examine variable importance, "Jackknifing" was used to process the model several times over each time leaving out one variable, estimate the model when variables were not included, and allow for the contribution of each variable to be computed. Then the response curves were created to show how each environmental variable affects the suitability prediction (Franklin 2009; Philips 2006; Zuur et al. 2010).

Finally, another tool Marxan was used to identify which areas within the SLVF would conflict the most with suitable porpoise habitat of varying suitability threshold. Marxan is commonly used in spatial prioritization for conservation and specifically for the design of marine and terrestrial habitats, and it can act as a support tool to provide solutions that meet the minimum socio-economic costs and established conservation targets (Ball et al. 2009; McGowan et al. 2013).

<u>Results and Discussion</u>

Predictive habitat suitability maps for all four models are shown in Figure 82, which showed high suitability areas in the eastern waters during summer and autumn and in the southern waters in winter and spring. Based on the three variables used in the models, the results confirm the previous knowledge about the seasonal variation in finless porpoise distribution. The models also map specific suitable habitats (Figure 82) and determine a relative suitability threshold at the surface and mid-water level throughout the study area. Using the AUC test to assess the models for their predictive power, all four AUC results showed the models performing better than a random prediction, with a range of high values from 0.77 to 0.89.

The Jackknifing results revealed that the most important variable in the mid-water level in the summer/autumn model was temperature (followed by salinity), which also contains the most information not contained in any other candidate variables. At the same mid-water level in the winter/spring model, salinity was the most important variable, followed closely by temperature, and the latter was again the variable with the most information not contained in any other variable. In contrary to the models runs in the mid-water level that showed very distinct variable importance with better model performance, results from the surface-water level models indicated the candidate variables contributing significantly less to the overall model performance.

Using the Marxan's spatial prioritization results, it showed that SLVF is a higher threat to finless porpoises during winter/spring, and specifically in areas south of

Lantau Island (Figure 83). The results also highlight the most suitable habitats within the SLVF buffer.

The present study addressed various aspects of modeling, and the results from the consecutive models were used to identify patterns between finless porpoise distribution and their environment. These results also tested and confirmed the previous knowledge about finless porpoises' seasonal distribution, and predicted their distribution patterns. The suitable habitats as a function of a relative suitability threshold was mapped, and areas within SLVF that conflict the most with the predicted suitable habitats were identified.

The results presented in this modeling exercise would enable management authorities to make more appropriate mitigation recommendations regarding on-going threats within finless porpoise habitats. Having demonstrated the coincidence of high-speed ferries on finless porpoise habitats, stricter regulations should be applied to regulate vessel movement within the important porpoise habitat with higher threat. The capabilities of modeling is also demonstrated in the present study, and this research can act as a first step for further modeling studies in the future.

7. SCHOOL SEMINARS AND PUBLIC AWARENESS

During the study period, HKCRP researchers continued to provide assistance to AFCD to increase public awareness on the conservation of local cetaceans. In total, HKCRP researchers delivered 14 education seminars at local primary and secondary schools regarding the conservation of Chinese White Dolphins and finless porpoises in Hong Kong.

For these school talks, a PowerPoint presentation was produced with up-to-date information on both dolphins and porpoises gained from the present long-term monitoring programme. The talks also included content such as the threats faced by local cetaceans, and conservation measures that AFCD has implemented to protect them in Hong Kong. Through this integrated approach of the long-term monitoring programme and publicity/education programme, the Hong Kong public can gain first-hand information from our HKCRP researchers. Their support will be vital to the long-term success in conservation of local cetaceans.

8. KEY FINDINGS

Summary of Data Collection (April 2013-March 2014)

- 171 line-transect vessel surveys were conducted among nine survey areas.
  - 607.0 hours were spent to collect 4,998.0 km of survey effort.
  - 317 groups of 1,052 Chinese White Dolphins were sighted.
  - 113 groups of 260 Indo-Pacific finless porpoises were sighted.
- 162 individual dolphins, sighted 497 times altogether, were identified.
- 8 hours and 23 minutes of recordings in 122 sounds samples were collected.
- 43 sessions with over 209 hours of theodolite tracking were conducted.
  - 140 dolphins groups with 3,751 fixes of their positions were collected.
  - Another 11,523 fixes were made from locations of moving vessels.

Distribution

- Chinese White Dolphins were mostly sighted at the northwestern portion of NWL in 2013, with concentration within and adjacent to the marine park area. They were also sighted throughout West Lantau, but were infrequently sighted near the HZMB-related construction sites including HKBCF (reclamation), HKLR03 (reclamation) and HKLR09 (bridge construction).
- Much fewer dolphins occurred in NEL and to the west of airport platform in 2013 than in 2010-12.
- In 2013, finless porpoises were mostly sighted between the Soko Islands and Shek Kwu Chau as well as around the Soko Islands. There were a lot more porpoise sightings made in South Lantau waters in 2013 than in 2010-12.

Encounter Rate

- In North Lantau, dolphin encounter rate dropped to the lowest in 2013 since 2002. In West and Southwest Lantau, a gradual increase in encounter rates occurred in 2013 to the highest level since 2007.
- In NEL, noticeable drops in dolphin encounter rates occurred between 2011 and 2012, which coincided with the commencement of HKBCF and HKLR works in the second and fourth quarters of 2012 respectively.
- Both porpoise encounter rates in SWL and SEL were the highest in 2013 since 2002, while the one in PT was the lowest since 2004 with no porpoise sighted.

Abundance

- The combined estimate of dolphin abundance in 2013 were 62 dolphins from WL, NWL and NEL, which was very similar to the 2012 estimate
- Significant downward sloping trend was detected in all three areas individually

and collectively during the past decade.

Habitat Use

- There was a noticeable decline in dolphin densities from 2011 to 2013, especially around the Brothers Islands and Sham Shui Kok.
- Temporal trends in dolphin habitat use at key habitats indicated that the proposed marine park in Southwest Lantau recorded consistently high dolphin usage in the past decade. After a decline during 2004-10, dolphin usage in the Sha Chau and Lung Kwu Chau Marie Park has increased noticeably in recent years. On the contrary, a consistent declining trend in dolphin densities was detected within the proposed Brothers Islands Marine Park, to the lowest in 2013.
- Dolphin habitat index established for the period of 2001-12 indicated that the priority habitats of dolphins were clustered around Lung Kwu Chau, Sha Chau and along the Urmston Road in NWL, around the Brothers Islands and Sham Shui Kok in NEL, and from Tai O Peninsula to Kau Ling Chung in WL coastal waters. All these areas should deserve special protection as marine parks.
- Comparison of habitat index between 1996-2005 and 2001-12 revealed that the grids connecting Lung Kwu Chau and the Brothers Islands were no longer priority habitats in the latter period, and the diminished importance of this traveling corridor could be related to the increased marine traffic from Sky Pier.
- Important porpoise habitats during the dry season were located to the south of Tai A Chau, at Shek Kwu Chau, south of Cheung Chau and between Shek Kwu Chau and Soko Islands. Porpoise densities were higher around Po Toi Islands, and at the juncture between PT and NP survey areas during the wet season.

Group Size, Activities and Associations with Fishing Boats

- Mean dolphin group size in 2013 remained at a relatively low level during 2002-13, but has slightly increased from the lowest level in 2012.
- Mean porpoise group size in 2013 was the lowest among recent monitoring periods. All except two groups were with less than five animals per group.
- Both feeding and socializing activities in 2013 occurred at the lowest levels during the past 12-year period.
- The percentage of dolphin sightings associated with fishing boats in 2013 was the lowest since 1996, which was partly related to the fishing trawl ban implemented in 2013. However, a lot more dolphin groups were associated with purse-seiners and gill-netters when compared to the past.
- The percentage of young dolphin calves was relatively higher in 2013.

Range Use, Residency and Movement Patterns

- Differential use was observed among year-round and seasonal residents at the various core areas. For example, the Brothers Islands and Tai O Peninsula were primarily utilized by year-round residents.
- Among the 166 individuals with the movement patterns assessed in 2013, 61 of them moved extensively across different survey areas around Lantau Island. On the contrary, a significant portion of dolphins were sighted repeatedly within just a single survey area. Such restricted movements may be related to potential obstruction from human activities and infrastructure projects.
- Only 12 individuals were sighted repeatedly in NEL since February 2013.
- 23 of 36 individuals that occurred regularly around the Brothers Islands in 2011-13 have shifted their ranges away from the Brothers Islands since February 2013, with only a small proportion of them expanded their range use into WL.
- 12 of 15 individuals showed a clear shift in core area use away from the Brothers Islands, indicating that they may have abandoned this area as part of their ranges.
- A number of individuals with their primary ranges in WL/SWL only occurred in the southern part of WL survey area but rarely ventured further north and across the bridge alignment, indicating a probable range shift for some individual dolphins in 2013 due to HKLR construction works.
- Examination of traveling corridors revealed that dolphins tends to move eastward or westward between Lung Kwu Chau and the Brothers Islands through the northern edge of airport platform or Urmston Road, while their north-south movements between Sha Chau and WL waters mostly occurred along the western border of NWL, the western side of the airport and northwestern coastline of Lantau near Sham Wat.
- There were signs that these traveling corridors are somewhat obstructed by anthropogenic impacts, which would need urgent protection.

Case Studies on Special Topics

- *Examination of diel patterns through PAM*
  - ■ Strong diel patterns were shown at Siu Ho Wan and near Sham Wat, with a lot more acoustic detections made at night than during day-time. Dolphins were also very active acoustically at night-time at Lung Kwu Tan and Fan Lau. The current night-time habitat use information filled an important data gap that has been overlooked in the past.
- *Mapping Cumulative impacts on HK dolphins*
  - ■ Cumulative impacts seemed to have disrupted the natural dolphin distribution in North Lantau, and that the timing of these cumulative

impacts highlights the addition of high-speed ferry traffic as a potential contributing factor in the localized dolphin density decline.

- *Predicting suitable habitats for PRE dolphins*
  - Habitat classified as suitable for Chinese White Dolphins through remotely sensed data is primarily inshore, and stretches further east and west than areas that have currently been surveyed for this species
- *Habitat modeling for HK porpoises:*
  - Habitat models based on temperature, salinity and chlorophyll a confirm the previous knowledge about the seasonal variation in porpoises distribution in Hong Kong, and spatial prioritization results indicated that the high-speed ferry traffic south of Lantau was shown to be a higher threat to the porpoises during winter and spring.

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Table 1. Range use (50%/25% UD core areas and sighting coverage) and residency pattern of 150 individuals with 15+ sightings from the PRE humpback dolphin photo-ID catalogue during 1995-2013.

(abbreviations: SR=Seasonal Resident; YR=Year-round Resident; SV=Seasonal Visitor; UD= Utilization Distribution; LKC = Lung Kwu Chau Marine Park; CLK= northeast corner of airport; BR= Brothers Islands; TO= Tai O; PH= Peaked Hill; FL= Fan Lau; WL= West Lantau; DB= Deep Bay; EL= East Lantau; NEL= Notheast Lantau; NWL= Northwest Lantau; SWL= Southwest Lantau; SEL= Southeast Lantau; CH=Chinese waters; * denotes individuals that have their gender determined by biopsy sampling)

	Last				Occurrence in Survey Areas								50% UD Core Area					25% UD Core Area				
ID#	Sighted	# STG	Gender	Residency	DB	EL	NEL	NWL	WL	SWL	SEL	CH	LKC	BR	TO	PH	FL	LKC	BR	TO	PH	FL
CH12	11/12/13	41	?	SR					√	√		√			√	√	√				√	
CH25	06/05/11	16	F	SR				√	√			√			√	√	√			√	√	
CH34	14/12/13	97	F	YR	√		√	√	√			√	√					√				
CH37	08/02/13	19	?	SR					√	√		√			√	√	√				√	√
CH38	11/12/13	50	?	YR					√	√		√				√	√				√	
CH98	14/11/13	64	?	YR	√			√	√				√					√				
CH108	31/10/13	57	F	SR				√	√	√		√				√	√				√	
CH113	19/09/13	25	F	SR				√	√			√			√					√		
EL01	05/12/13	105	M*	YR		√	√	√	√	√				√					√			
NL06	03/08/12	21	?	YR			√	√					√	√				√				
NL11	22/10/13	91	F	YR	√			√				√	√					√				
NL12	18/06/13	24	F	SR	√		√	√		√		√	√					√				
NL18	24/03/13	107	F	YR			√	√	√			√	√	√					√			
NL24	19/12/13	224	F	YR			√	√	√			√	√	√				√	√			
NL33	08/11/13	111	F*	YR			√	√	√					√					√			
NL37	20/11/13	63	?	SR		√	√	√	√				√					√				
NL46	14/12/13	63	F*	YR				√	√			√	√					√				
NL48	09/12/13	82	?	SR	√		√	√	√				√					√				
NL49	10/12/13	45	F*	SR			√	√	√				√					√				
NL80	30/12/13	23	F	SR	√			√	√				√					√				
NL93	01/11/13	55	F	SR			√	√	√				√					√				
NL98	19/12/13	136	F*	YR			√	√	√			√	√	√				√	√			
NL103	20/11/13	47	?	SR	√			√	√				√					√				
NL104	14/12/13	95	F	YR			√	√	√			√	√					√				
NL105	22/11/13	25	?	SR				√	√			√	√					√				
NL112	18/02/13	22	M*	SR	√		√	√	√				√					√				
NL120	31/10/13	100	F*	YR			√	√	√					√					√			
NL123	14/11/13	130	F	YR	√		√	√	√			√		√					√			
NL128	06/11/13	47	M*	SR			√	√	√	√	√	√			√	√	√			√	√	√
NL136	09/12/13	78	F*	SR			√	√	√				√					√				
NL139	09/12/13	122	F	YR			√	√	√			√	√	√					√			
NL145	01/11/13	36	F	SR			√	√	√				√					√				
NL150	08/11/13	27	?	SR	√		√	√	√				√					√				
NL153	20/06/12	18	F	SR				√				√	√					√				
NL156	20/12/13	39	?	SR				√	√	√			√		√	√		√		√	√	
NL165	09/12/13	75	?	SR			√	√	√	√			√	√				√				
NL179	02/10/13	73	?	YR			√	√					√	√				√	√			
NL182	14/12/13	55	?	YR	√		√	√					√					√				
NL188	20/12/13	63	F	YR			√	√	√	√			√					√				
NL191	29/10/13	61	?	YR			√	√	√			√	√	√					√			
NL202	25/10/13	70	F	YR			√	√	√				√					√				
NL206	06/12/13	39	F*	YR				√	√	√						√	√				√	√
NL210	20/11/13	39	?	YR			√	√	√				√					√				
NL212	08/11/13	24	F	SR				√	√			√			√	√				√	√	
NL213	14/11/13	19	?	SR				√					√					√				
NL214	22/11/13	27	?	SR	√			√					√					√				
NL215	19/02/12	19	F	SR			√	√	√					√								
NL219	26/02/12	20	?	SR				√					√					√				
NL220	22/11/13	56	?	YR			√	√	√				√					√				
NL221	14/12/13	22	F	SR				√	√			√	√					√				
NL224	10/09/13	39	?	YR	√		√	√	√			√	√					√				

Table 1. (cont'd)

	Last				Occurrence in Survey Areas								50% UD Core Area					25% UD Core Area				
ID#	Sighted	# STG	Gender	Residency	DB	EL	NEL	NWL	WL	SWL	SEL	CH	LKC	BR	TO	PH	FL	LKC	BR	TO	PH	FL
NL226	05/12/13	47	?	YR	√		√	√	√	√				√					√			
NL233	07/11/13	43	F	YR	√		√	√	√				√					√				
NL236	08/11/13	28	?	YR				√	√				√					√				
NL241	13/09/12	21	?	SR				√					√					√				
NL242	19/12/13	73	F*	YR			√	√	√				√	√				√				
NL244	20/12/13	68	F	YR			√	√	√				√	√				√				
NL246	01/02/13	41	?	YR			√	√					√	√				√	√			
NL258	04/07/12	18	?	SR				√	√	√			√					√				
NL259	10/12/13	53	?	YR			√	√	√				√					√				
NL260	20/11/13	51	?	SR			√	√	√				√	√				√	√			
NL261	20/12/13	58	?	YR	√		√	√	√				√	√					√			
NL262	09/12/13	37	?	SR	√			√	√				√					√				
NL264	27/09/13	51	F	YR			√	√	√				√					√				
NL272	01/12/13	48	?	YR	√		√	√					√					√				
NL280	17/02/13	17	?	N.D.	√			√					√					√				
NL284	20/12/13	52	?	N.D.			√	√					√	√				√	√			
NL285	14/11/13	58	?	N.D.			√	√	√				√	√					√			
NL286	25/10/13	44	?	N.D.			√	√					√					√				
NL287	25/10/13	25	?	N.D.				√	√				√					√				
NL288	27/09/13	42	?	N.D.			√	√	√				√					√				
NL293	12/08/13	17	?	N.D.				√	√						√					√		
NL295	22/11/13	32	?	N.D.			√	√	√				√	√				√				
NL296	05/11/13	41	?	N.D.			√	√	√				√					√				
NL299	30/12/13	15	?	N.D.	√			√	√	√			√		√	√				√	√	
SL05	03/12/13	52	F	YR					√	√						√	√					√
SL27	06/12/13	35	M	SR				√	√	√					√		√			√		√
SL35	20/12/13	84	?	YR				√	√	√	√	√			√	√	√				√	√
SL40	21/08/13	39	F	YR					√	√		√				√	√				√	√
SL44	06/11/13	15	?	SR					√	√					√	√	√			√	√	
SL47	09/07/13	21	?	YR					√	√		√			√	√	√			√	√	√
WL04	09/12/13	45	?	YR	√		√	√	√				√		√			√		√		
WL05	09/12/13	65	?	YR			√	√	√			√	√		√			√				
WL09	26/11/10	20	?	SR				√	√	√		√				√					√	
WL11	15/11/13	58	F*	YR			√	√	√			√	√					√				
WL15	11/12/13	68	M*	YR			√	√	√	√					√	√	√			√	√	√
WL17	27/08/13	22	?	SR			√	√	√	√	√	√	√		√	√				√	√	
WL21	31/07/13	47	F	SR				√	√	√		√			√	√				√	√	
WL25	20/12/13	139	F	YR				√	√	√		√			√	√	√			√	√	√
WL29	20/02/13	24	F	SR					√	√		√			√	√				√	√	
WL37	15/08/12	20	?	SR					√	√		√			√	√	√			√	√	
WL40	14/05/11	18	F*	SV				√	√			√	√					√				
WL42	22/07/13	67	?	YR				√	√	√		√				√	√				√	
WL44	09/07/13	31	?	SR			√	√	√	√		√	√		√	√	√				√	
WL46	09/12/13	46	?	YR			√	√	√	√			√		√			√				
WL47	25/01/13	20	?	SV	√			√	√	√	√	√			√	√	√				√	√
WL48	11/02/12	15	F	SR			√	√	√			√	√		√	√		√		√		
WL50	03/12/13	59	F*	YR				√	√	√		√			√	√				√		
WL55	04/07/12	28	?	SR				√	√	√					√	√	√			√	√	√
WL61	03/12/13	46	?	SR					√	√						√	√				√	√
WL62	06/12/13	45	F	YR					√	√	√	√			√	√	√			√		
WL68	19/09/13	25	F*	YR					√	√					√	√					√	
WL69	11/12/13	47	?	YR					√	√		√				√	√					√
WL72	31/10/13	62	F	YR				√	√	√					√	√				√	√	
WL73	18/10/13	37	?	YR					√	√						√	√				√	√
WL74	06/12/13	30	?	SR					√	√						√	√					√
WL79	08/11/13	17	?	SR				√	√			√				√				√		
WL84	09/04/13	20	F	SR					√	√					√	√	√				√	√
WL86	25/11/13	46	F	YR					√	√							√					√
WL87	22/03/13	36	?	YR					√	√	√	√				√	√					√
WL88	29/11/11	31	F	YR				√	√	√	√				√	√	√			√	√	√

Table 1. (cont'd)

ID#	Last Sighted	# STG	Gender	Residency	Occurrence in Survey Areas								50% UD Core Area					25% UD Core Area				
					DB	EL	NEL	NWL	WL	SWL	SEL	CH	LKC	BR	TO	PH	FL	LKC	BR	TO	PH	FL
WL91	06/12/13	30	?	YR					√	√		√				√	√				√	√
WL92	22/03/13	18	?	SR					√	√		√				√	√					√
WL93	03/12/13	28	?	YR				√	√	√							√					√
WL94	19/06/13	23	F	SR					√	√		√					√					√
WL98	08/11/13	21	F	YR				√	√			√			√					√		
WL108	18/05/10	21	M*	N.D.					√	√						√	√					√
WL109	03/12/13	50	?	YR				√	√	√		√			√	√					√	
WL111	13/11/12	18	F*	SR			√	√	√				√					√				
WL114	06/11/13	26	?	YR				√	√	√		√				√	√				√	√
WL116	03/12/13	41	?	SR				√	√	√		√			√	√	√			√	√	√
WL118	26/08/13	31	F	YR					√	√						√	√				√	
WL120	11/09/13	22	?	SR				√	√						√					√		
WL122	26/11/13	15	?	SR				√	√			√			√					√		
WL123	06/12/13	56	F	YR				√	√	√		√				√	√					√
WL124	08/11/13	24	F	SR				√	√						√	√				√	√	
WL128	18/10/13	18	?	SR					√	√						√	√				√	√
WL130	11/10/13	38	?	SR				√	√	√						√	√					√
WL131	11/12/13	55	?	YR				√	√	√					√	√				√	√	
WL132	11/12/13	24	F	N.D.					√	√	√	√			√	√	√				√	√
WL137	11/12/13	31	F	YR				√	√	√		√				√					√	
WL138	20/02/12	21	?	SR				√	√							√					√	
WL142	06/12/13	33	F	YR					√	√		√					√					√
WL144	31/10/13	15	?	SR					√							√					√	
WL145	26/11/13	20	F	SR				√	√							√					√	
WL152	11/12/13	31	?	N.D.				√	√	√					√	√					√	
WL153	11/09/13	20	?	N.D.				√	√			√			√	√				√		
WL157	06/11/13	18	?	N.D.					√	√		√			√					√		
WL159	11/09/13	18	F	N.D.				√	√			√			√					√		
WL165	25/11/13	35	?	N.D.					√	√						√	√					√
WL170	06/12/13	20	?	N.D.				√	√	√		√					√					√
WL173	11/12/13	15	?	SR					√	√						√	√				√	√
WL179	09/12/13	18	F	SR				√	√				√			√	√	√				
WL180	06/12/13	37	F	N.D.					√	√		√			√	√	√				√	√
WL191	18/10/13	17	?	N.D.				√	√			√			√	√	√			√	√	√
WL193	09/10/13	20	?	N.D.				√	√						√					√		
WL199	18/10/13	17	?	N.D.				√	√				√		√	√	√				√	√
WL201	18/10/13	28	?	N.D.					√	√		√				√	√				√	√
WL215	11/12/13	18	?	N.D.				√	√	√		√				√	√				√	√
WL221	20/12/13	15	?	N.D.				√	√						√					√		

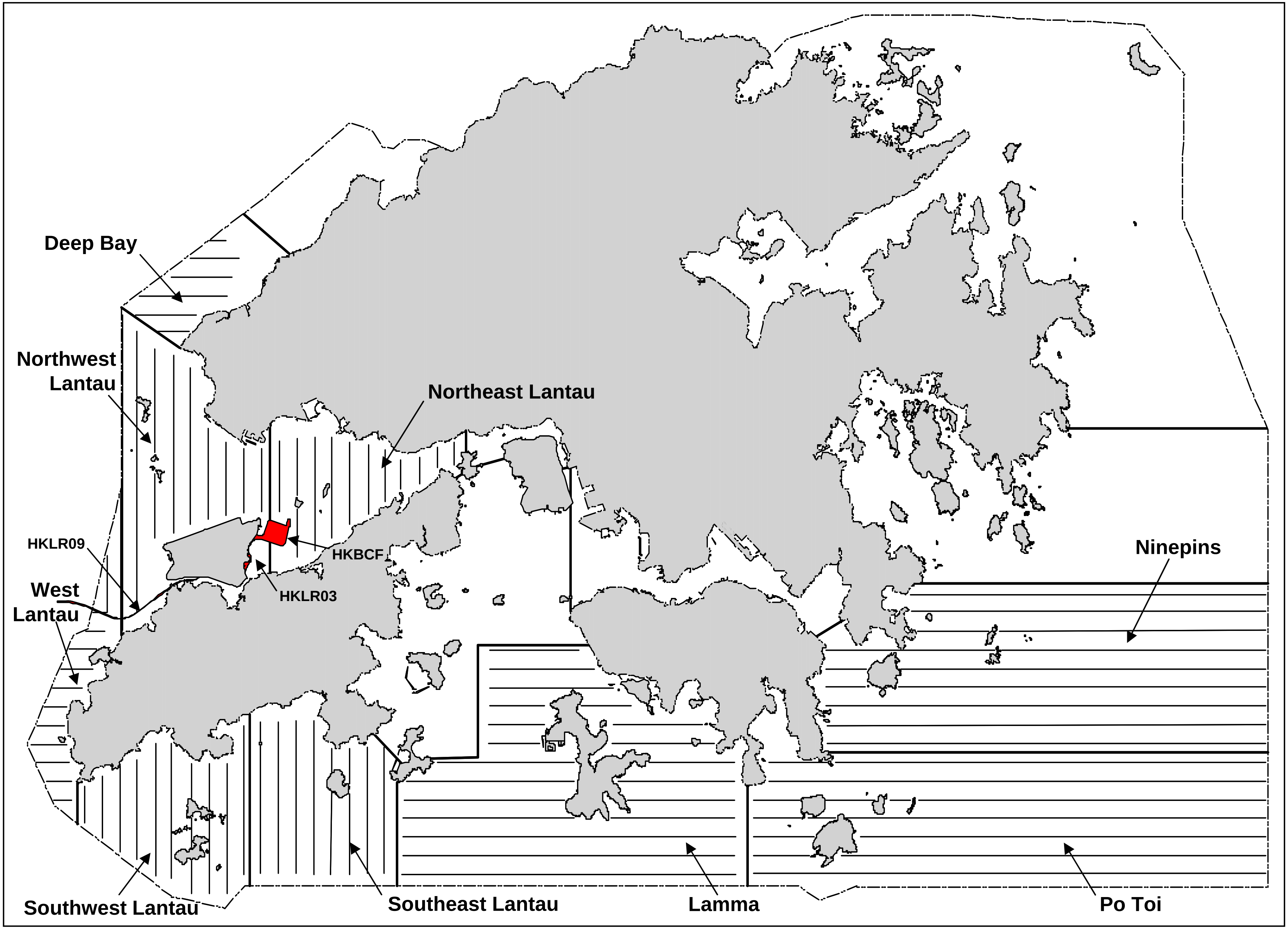


Figure 1. Nine Line-transect Survey Areas within the Study Area during 2013-14

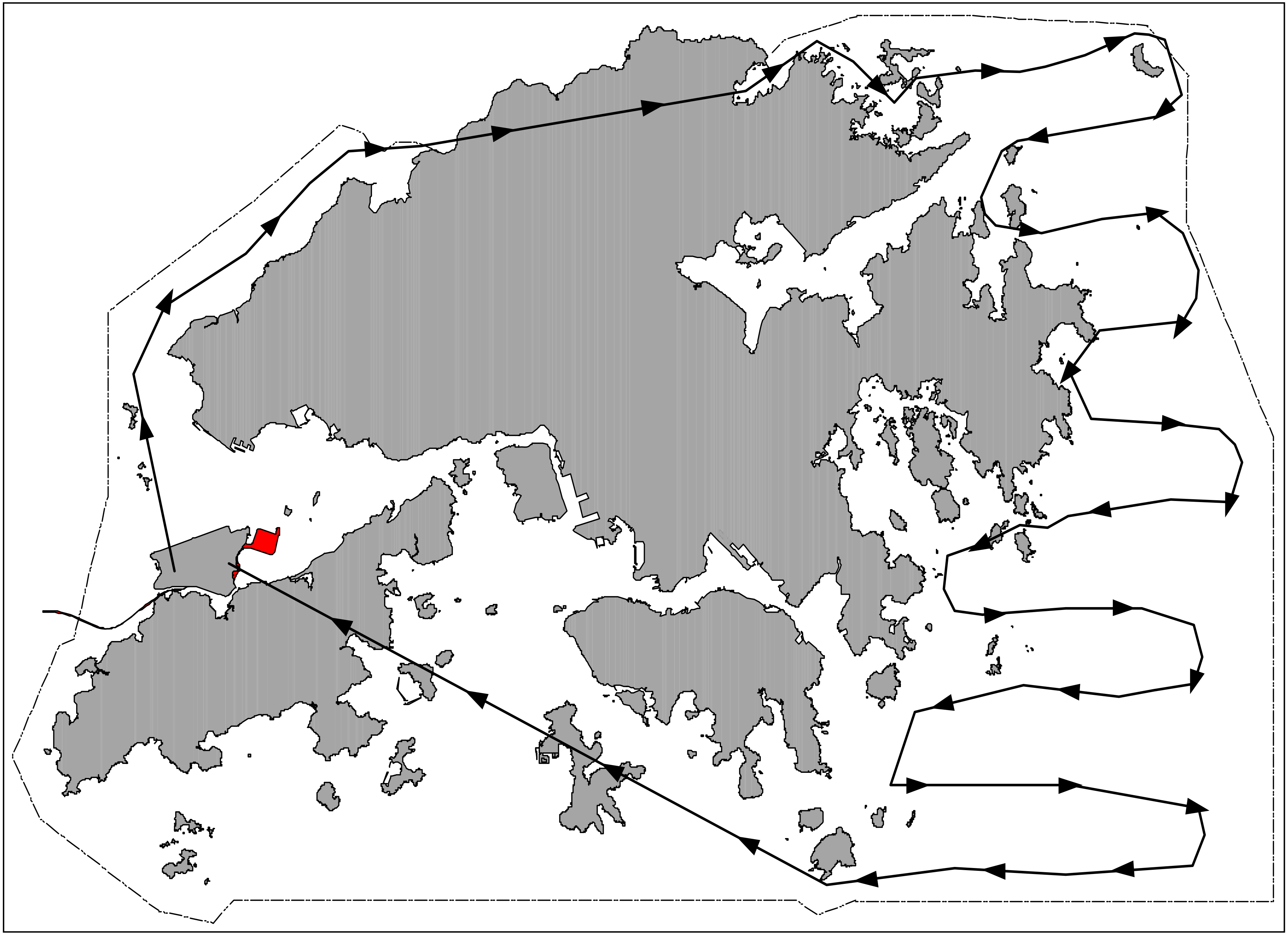


Figure 2. Survey Route for Helicopter Surveys in Eastern and Southern Waters of Hong Kong

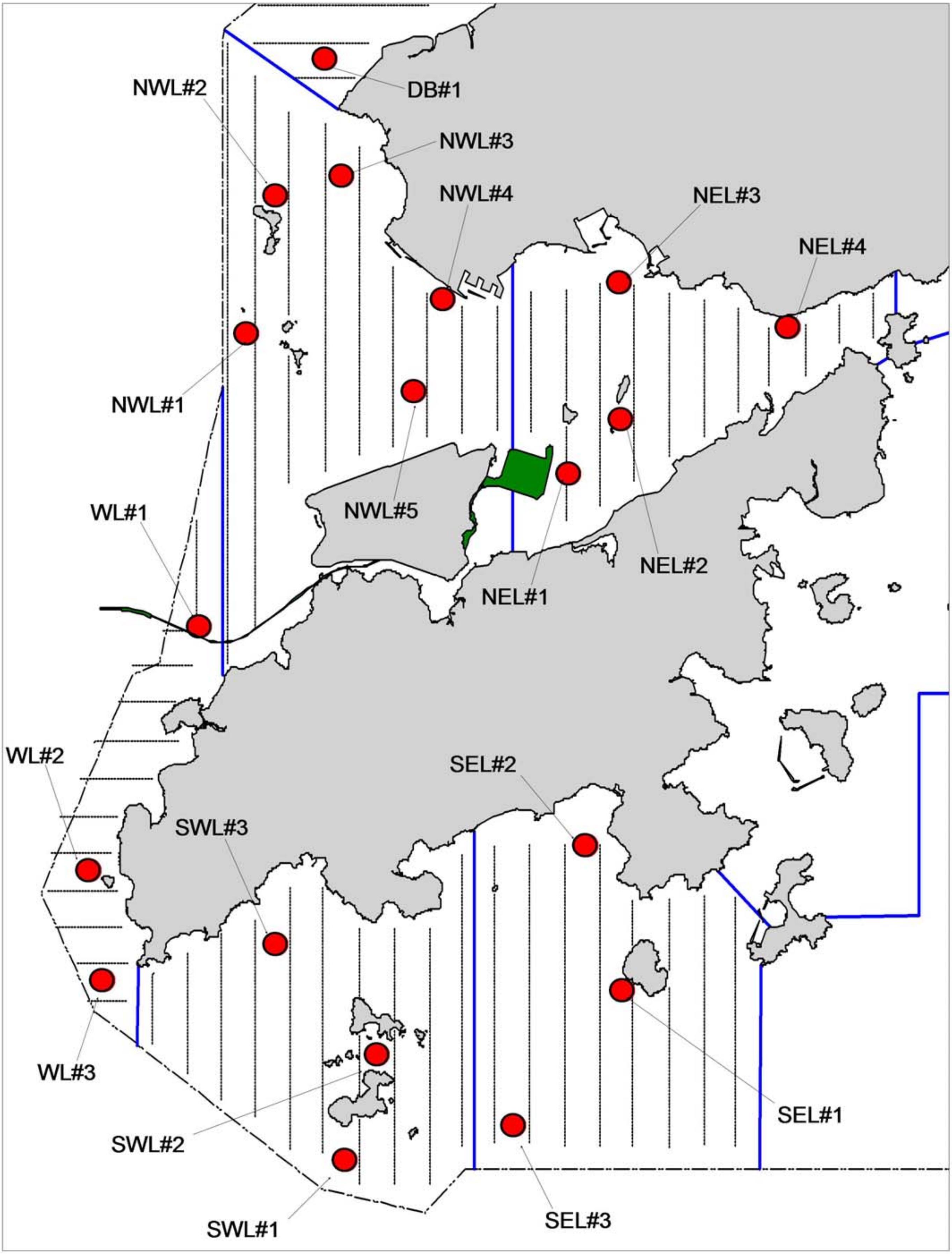


Figure 3. Locations of 19 acoustic monitoring stations around Lantau waters

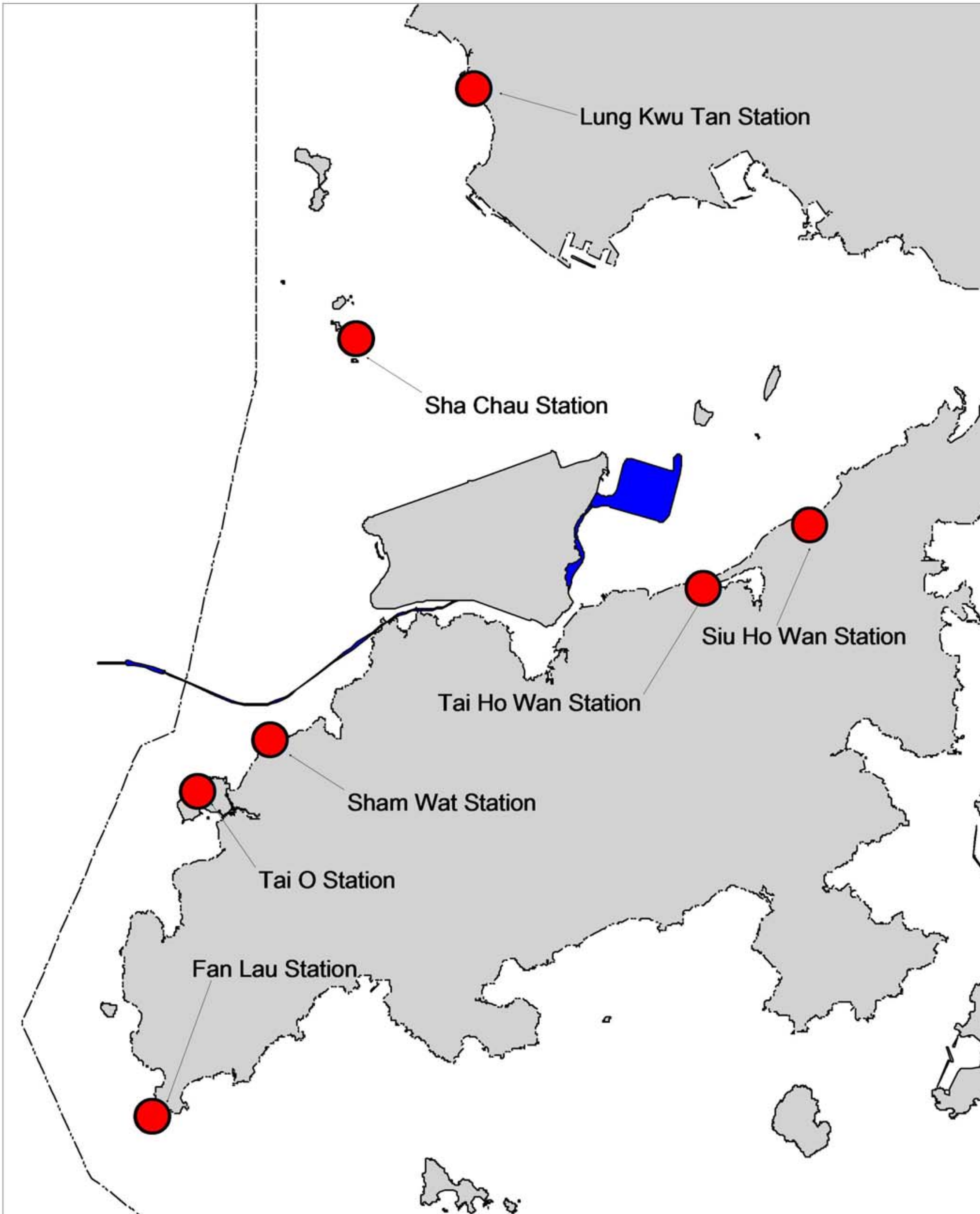


Figure 4. Theodolite-tracking stations set up along the coastline in North and West Lantau waters

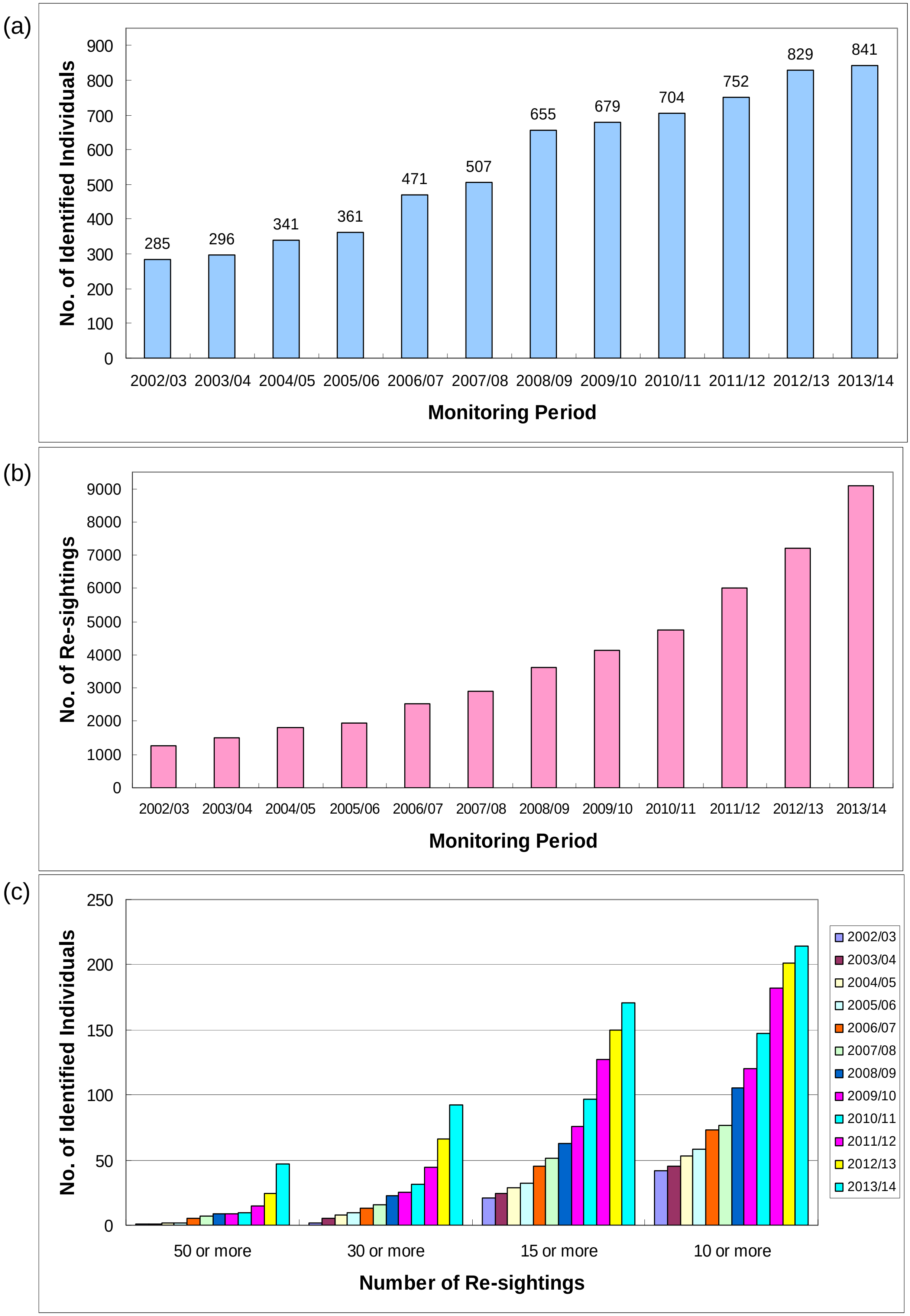


Figure 5. Temporal trends of (a) total number of identified individuals; (b) total number of re-sightings made; and (c) number of identified individuals within several categories of number of re-sightings in the past 12 monitoring periods since 2002

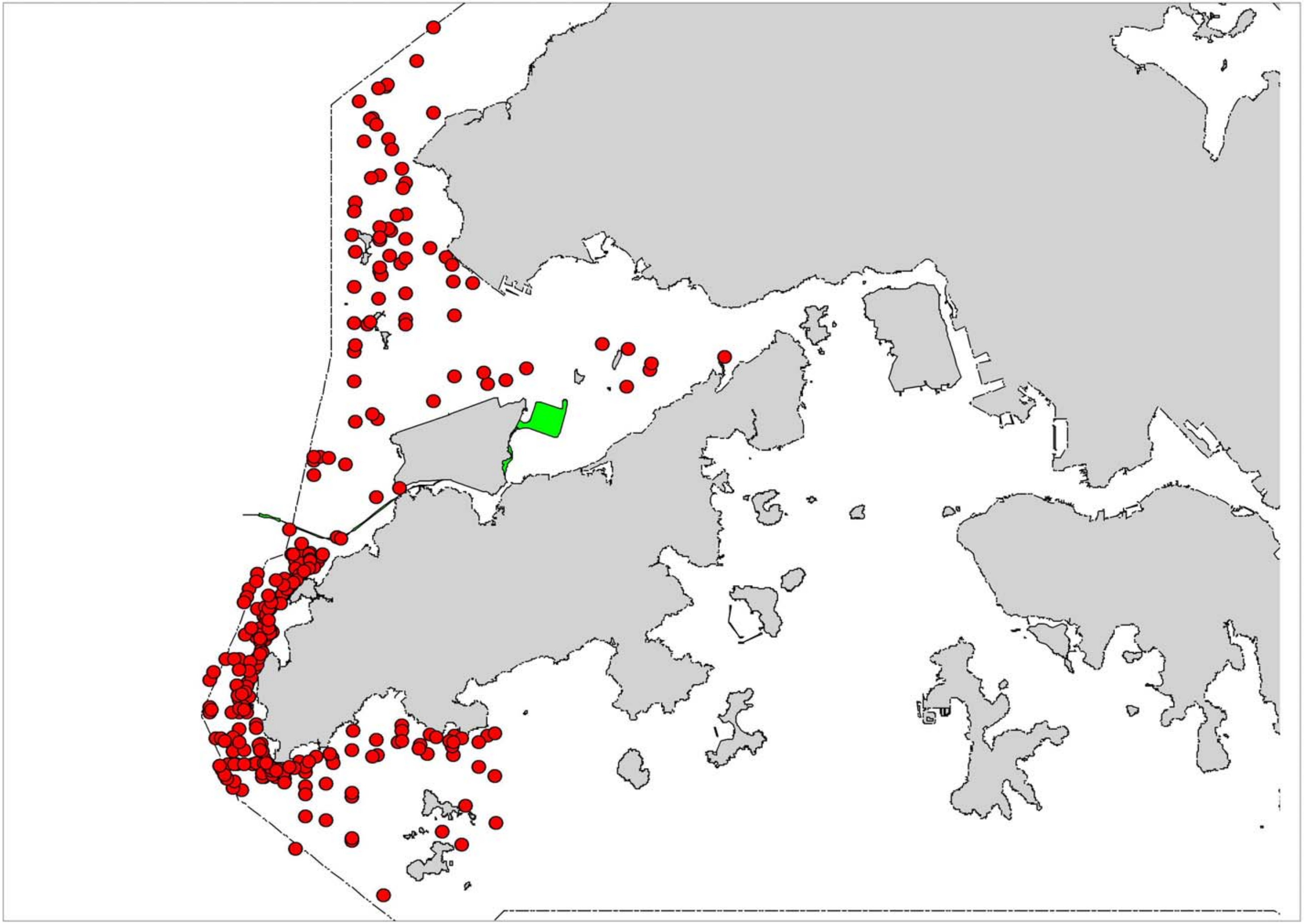


Figure 6. Distribution of Chinese white dolphin sightings made during AFCD surveys (April 2013 – March 2014)

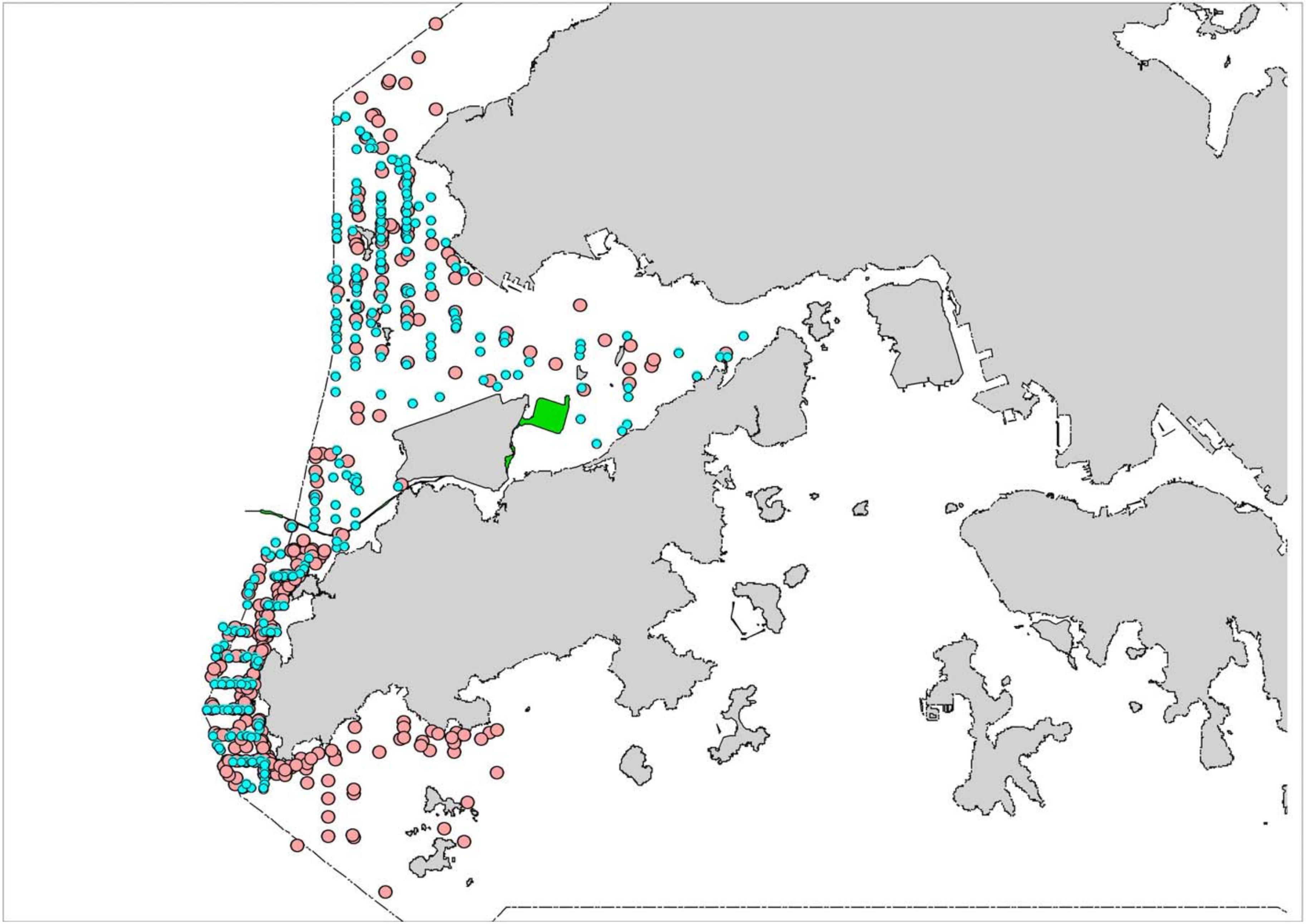


Figure 7. Distribution of Chinese white dolphin sightings in Hong Kong waters in 2013
(pink dots: AFCD survey sightings; blue dots: HKLR survey sightings)

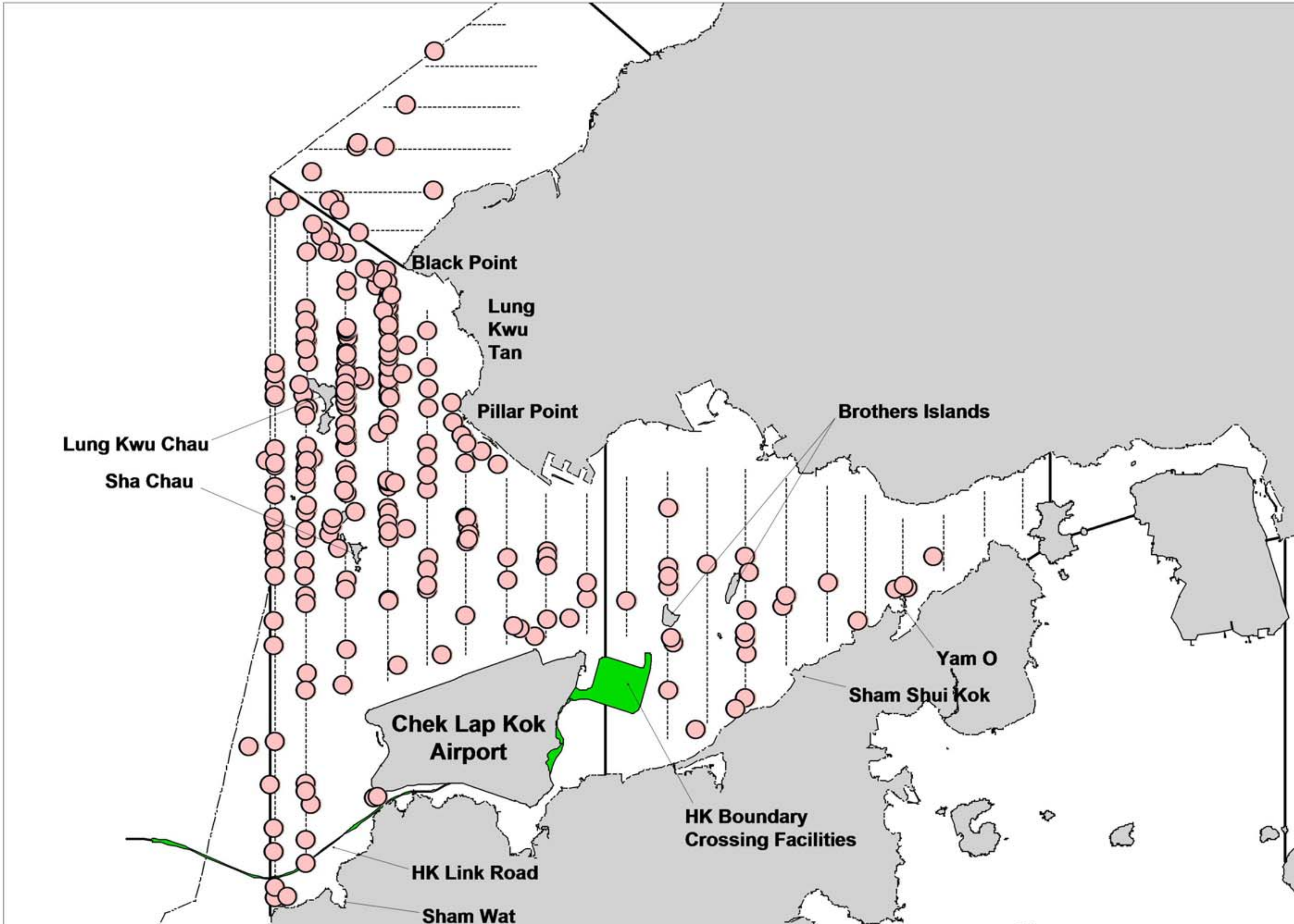


Figure 8. Distribution of Chinese white dolphin sightings in North Lantau and Deep Bay (2013)

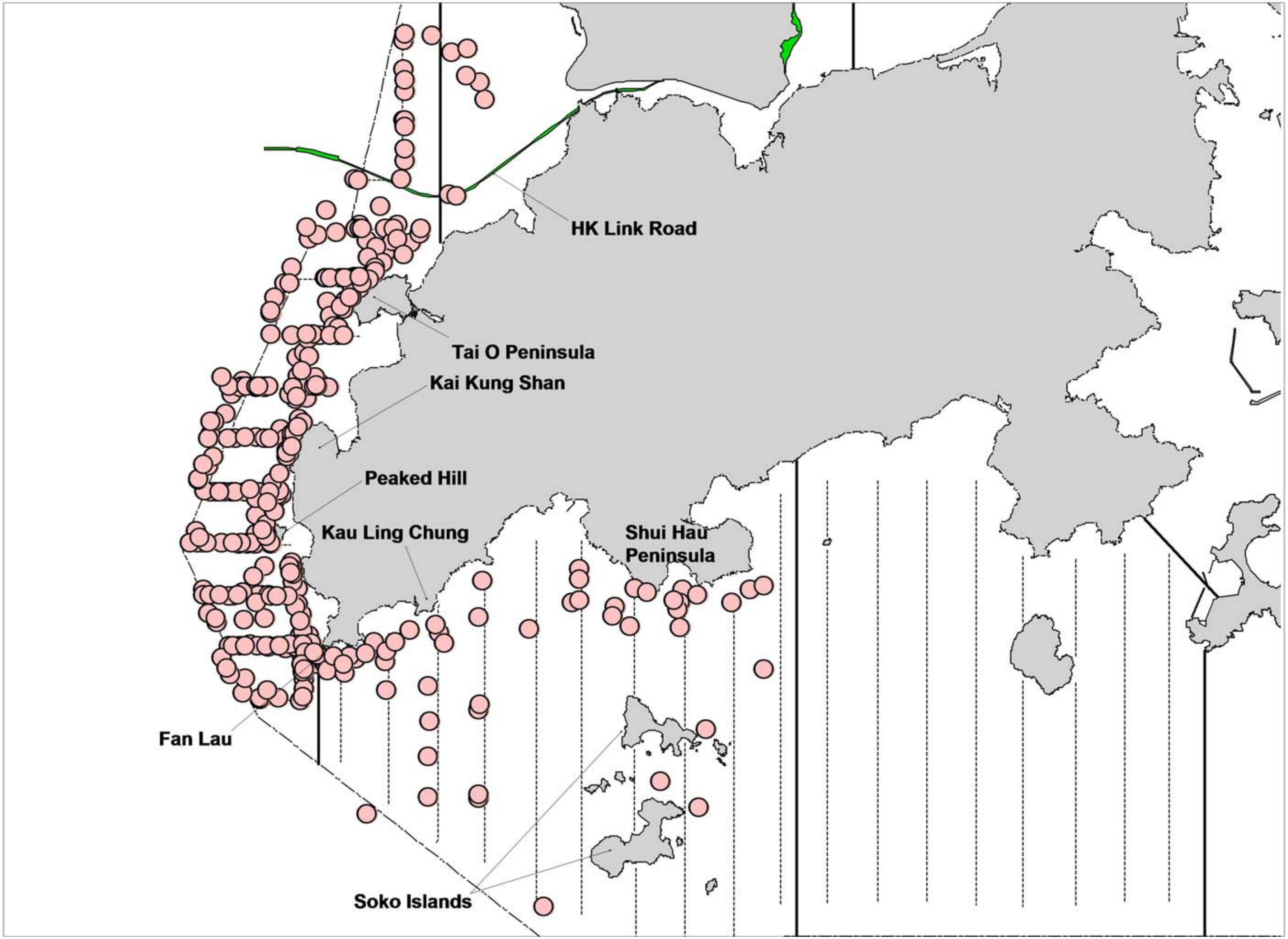


Figure 9. Distribution of Chinese white dolphin sightings in West and Southwest Lantau waters (2013)

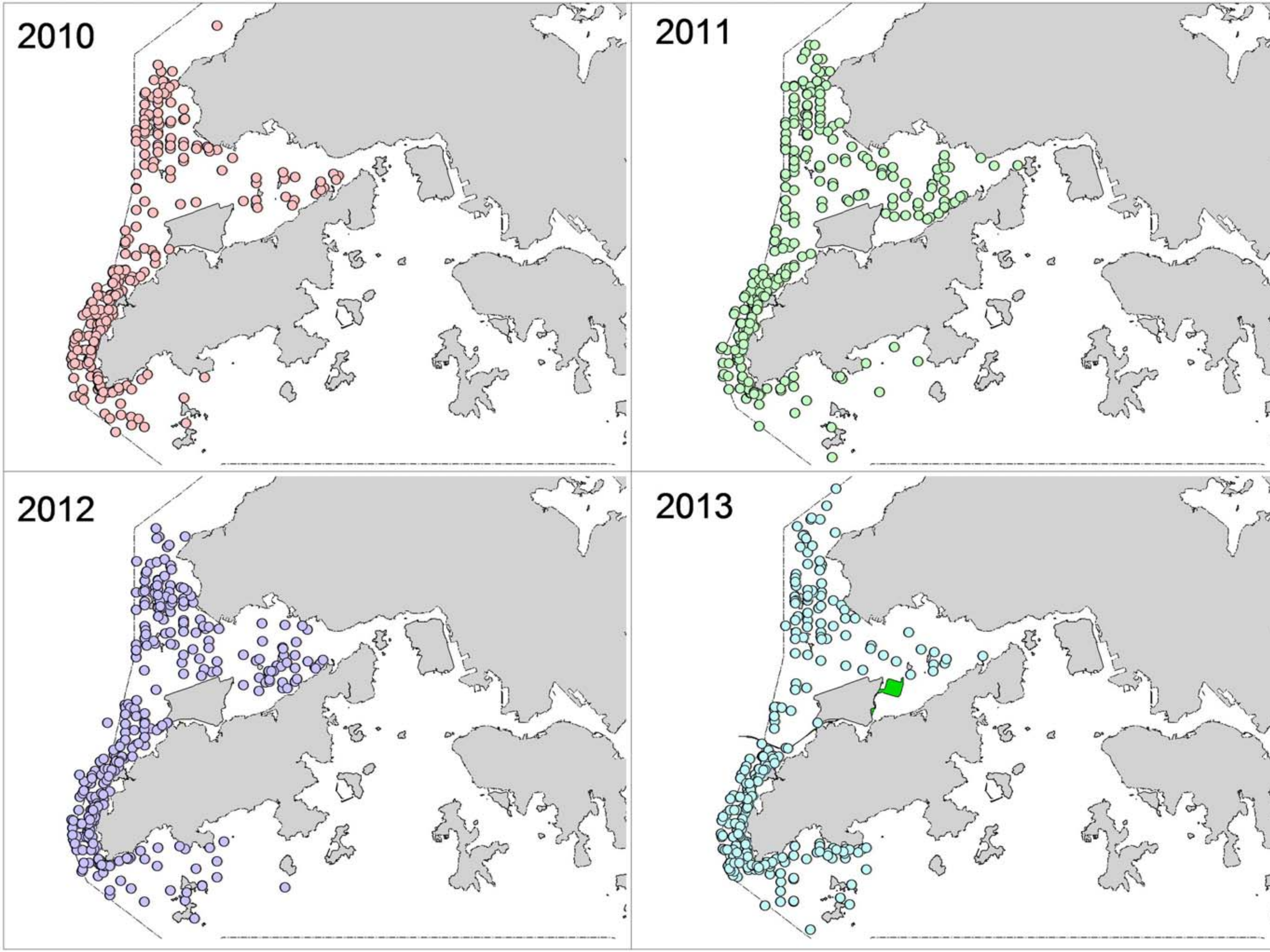


Figure 10. Comparison of annual dolphin distribution patterns from the past 4 years using AFCD monitoring data

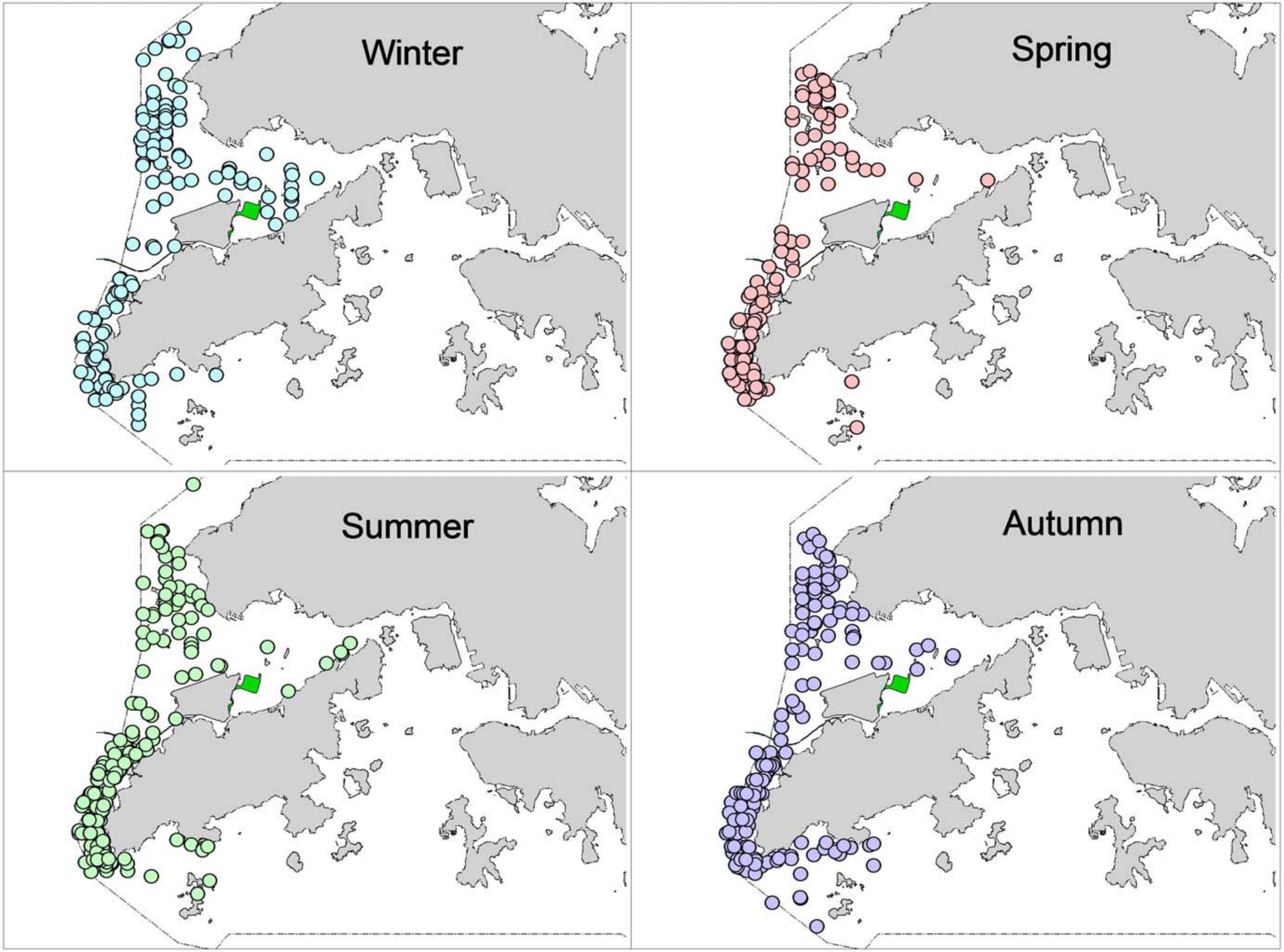


Figure 11. Seasonal distribution of Chinese white dolphins in Hong Kong waters in 2013

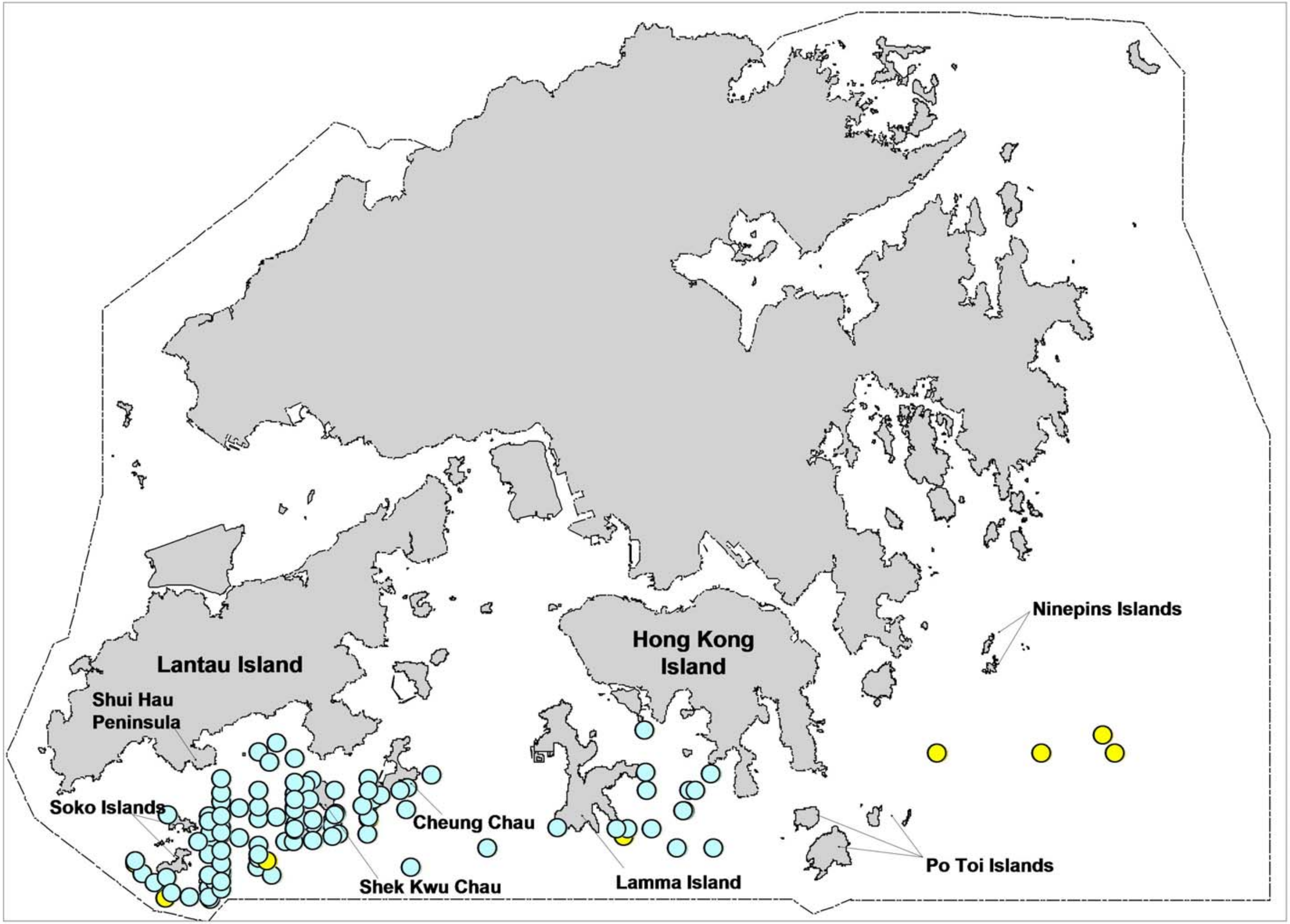


Figure 12. Distribution of finless porpoise sightings made during AFCD surveys (April 2013 – March 2014)
(yellow dots: sightings made during summer/autumn months)

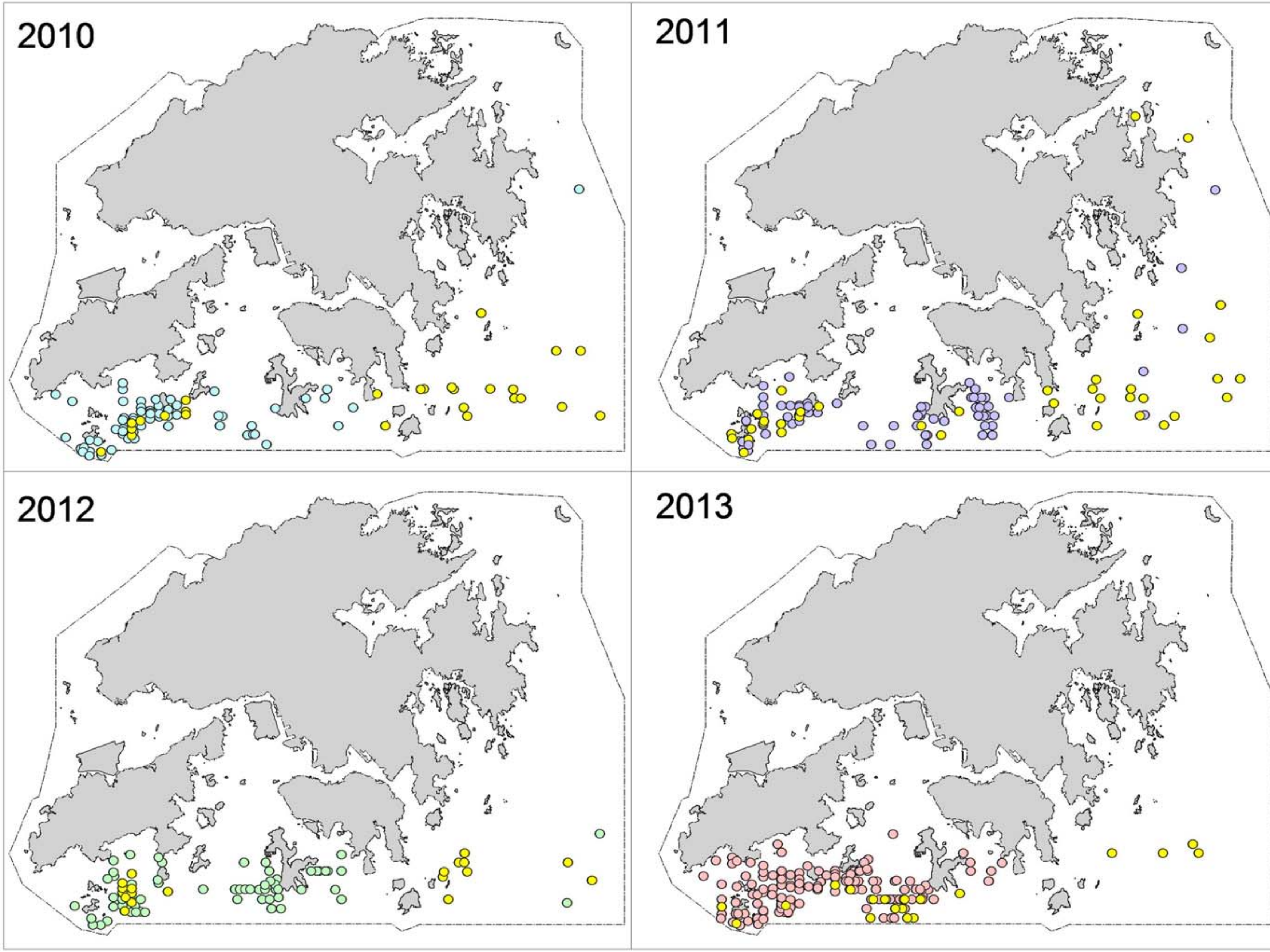


Figure 13. Comparison of annual porpoise distribution patterns from the past four years
(yellow dots: sightings made during summer/autumn months)

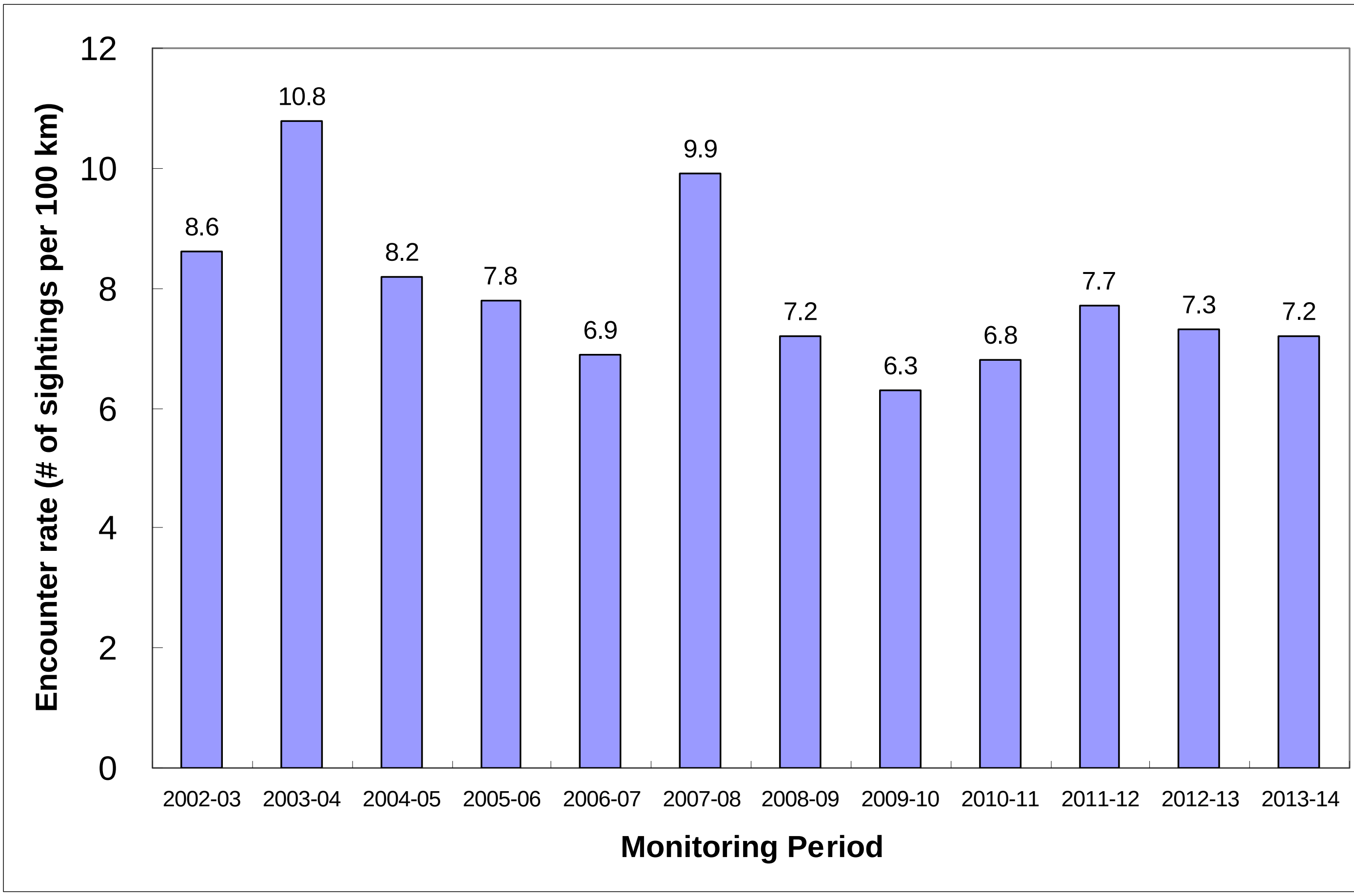


Figure 14. Temporal trend in encounter rates of Chinese white dolphins (combined from WL, NWL, NEL and SWL survey areas) in the past twelve monitoring periods from 2002-14

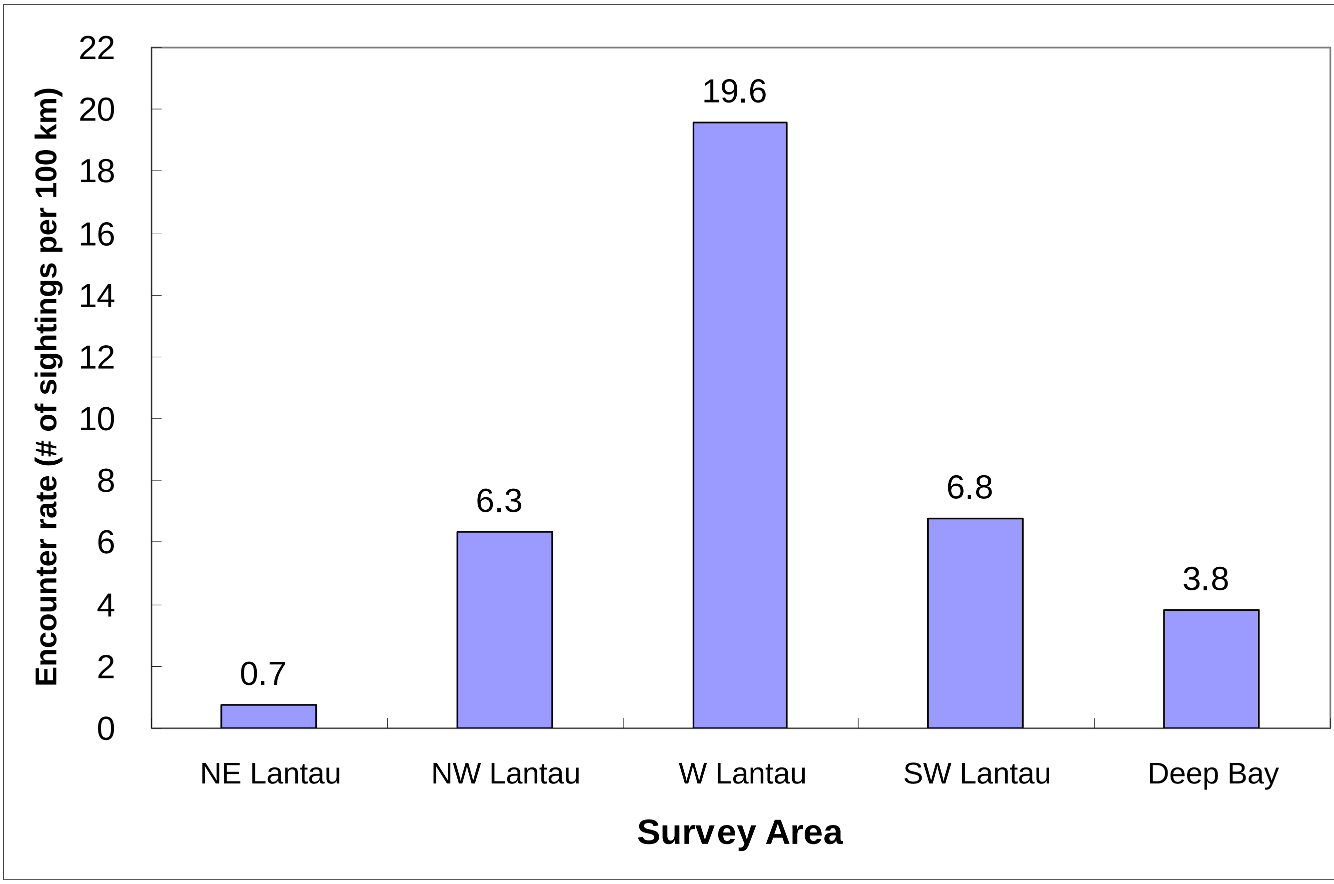


Figure 15. Encounter rates of Chinese white dolphins among different survey areas (April 2013 – March 2014)

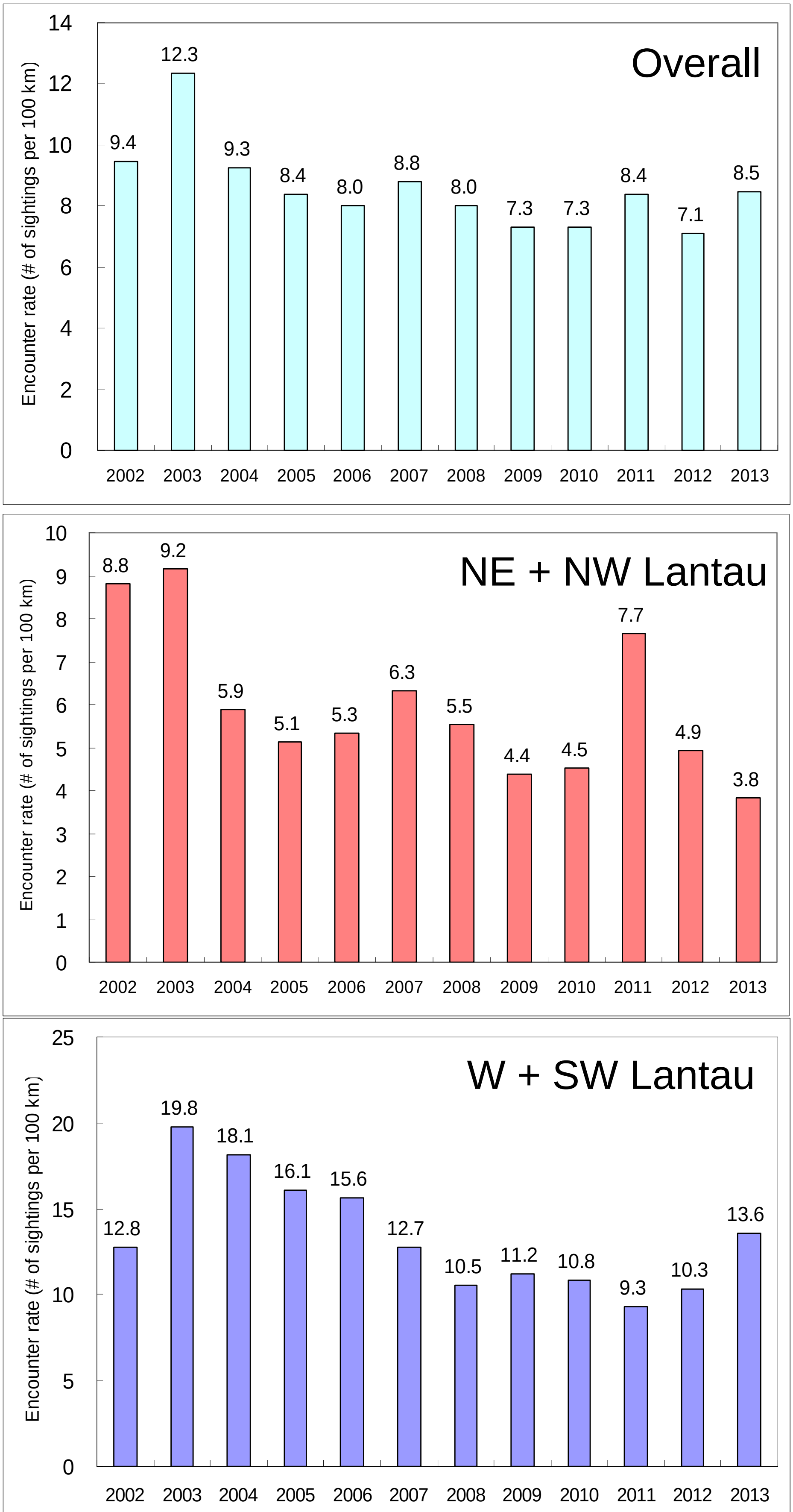


Figure 16. Long-term trends in annual dolphin encounter rates in different survey areas

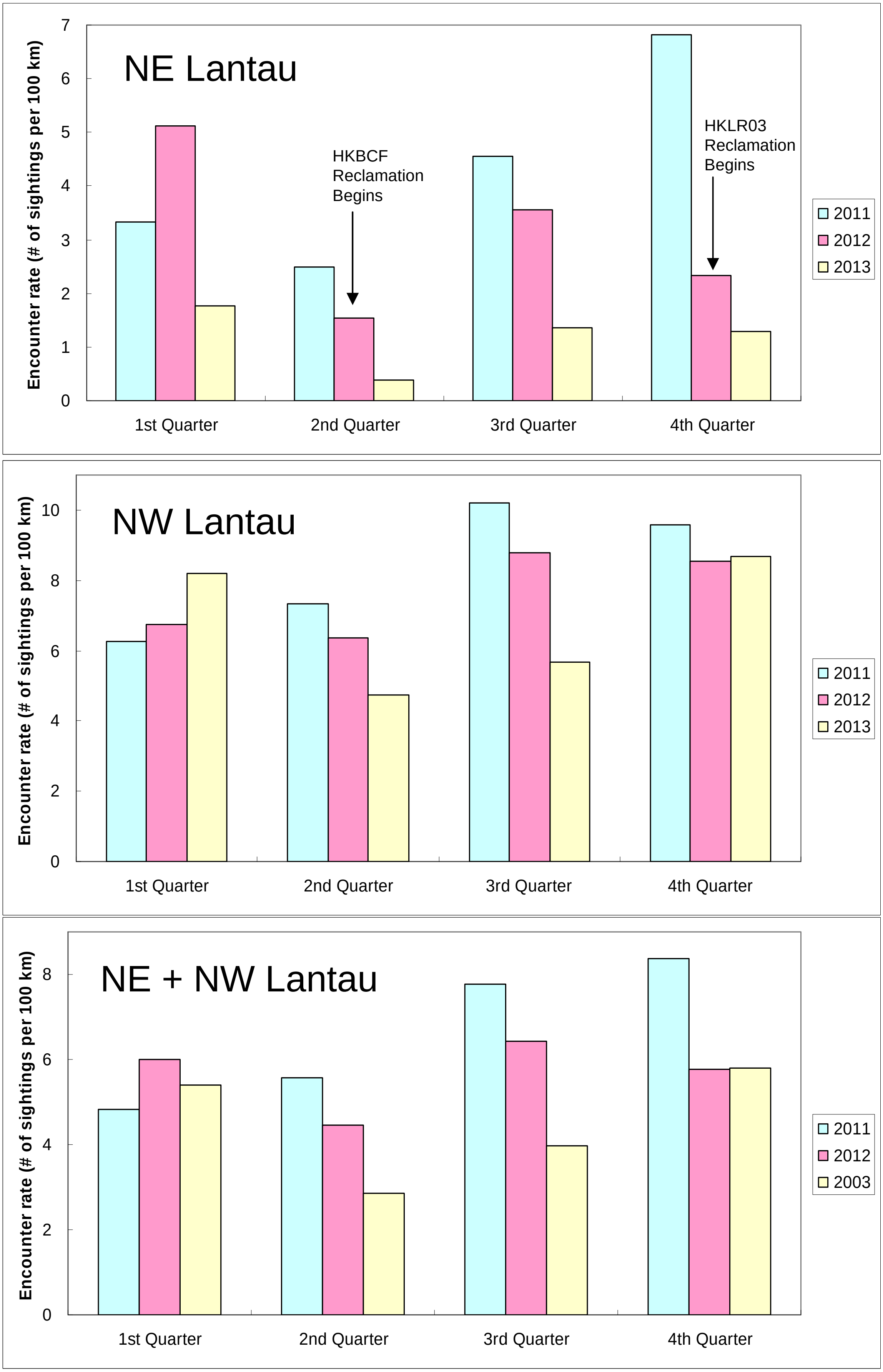


Figure 17. Temporal trends in quarterly dolphin encounter rates in North Lantau region from 2011-13

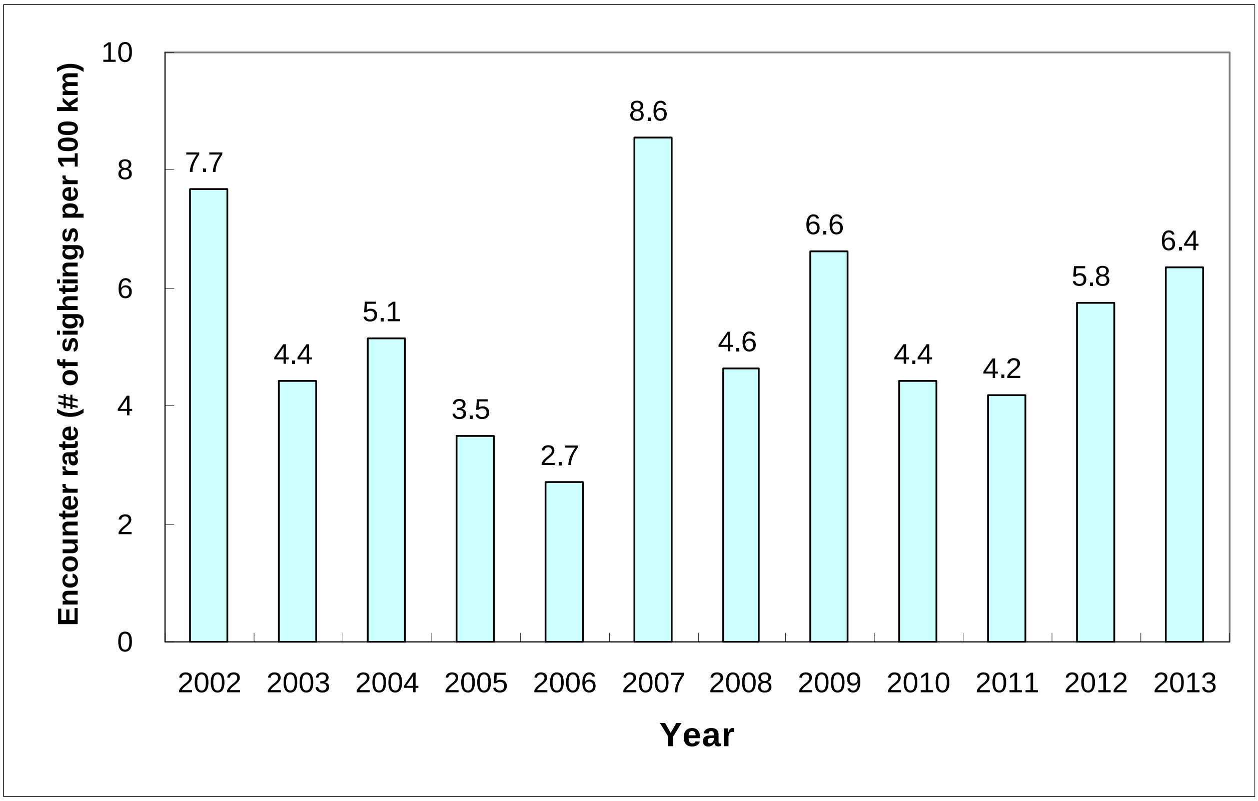


Figure 18a. Temporal trend of annual encounter rates of finless porpoises (combined from SWL, SEL, LM and PT survey areas) from 2002-13

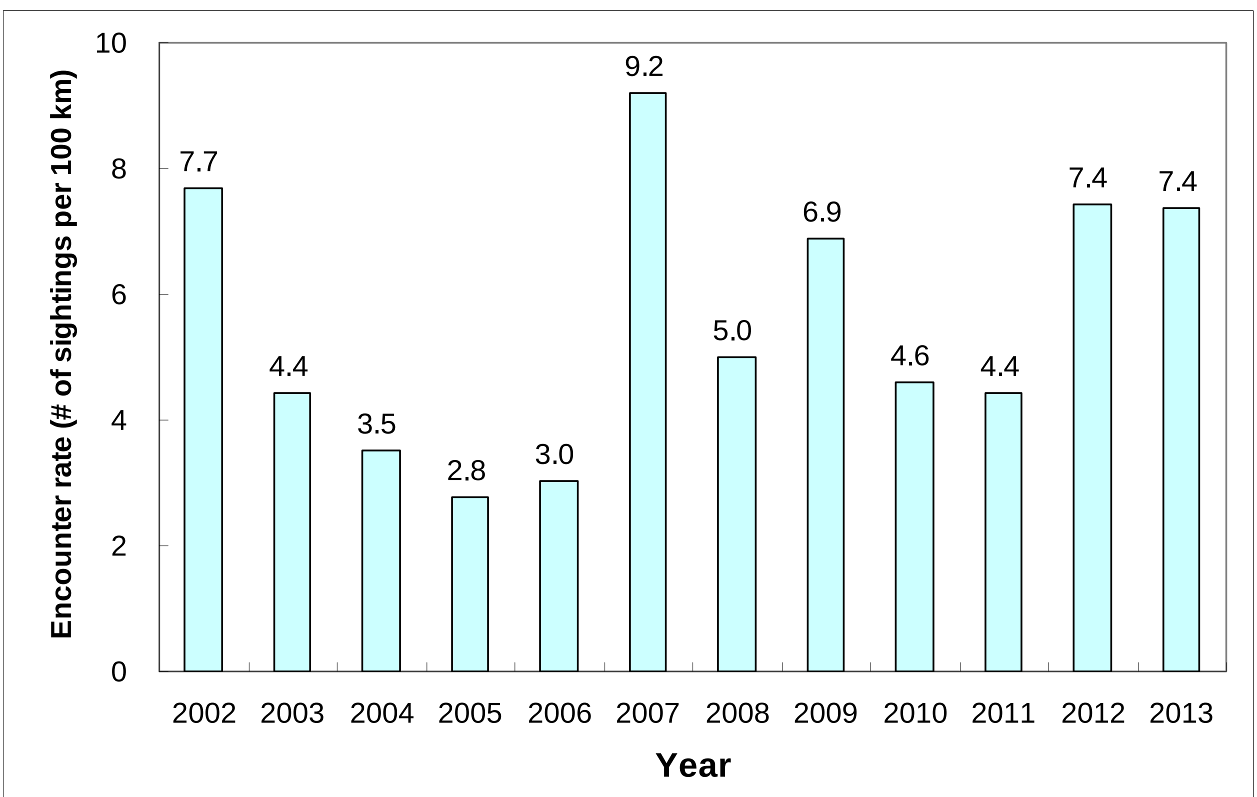


Figure 18b. Temporal trend of porpoise encounter rates in South Lantau and Lamma waters combined from winter/spring months of 2002-13

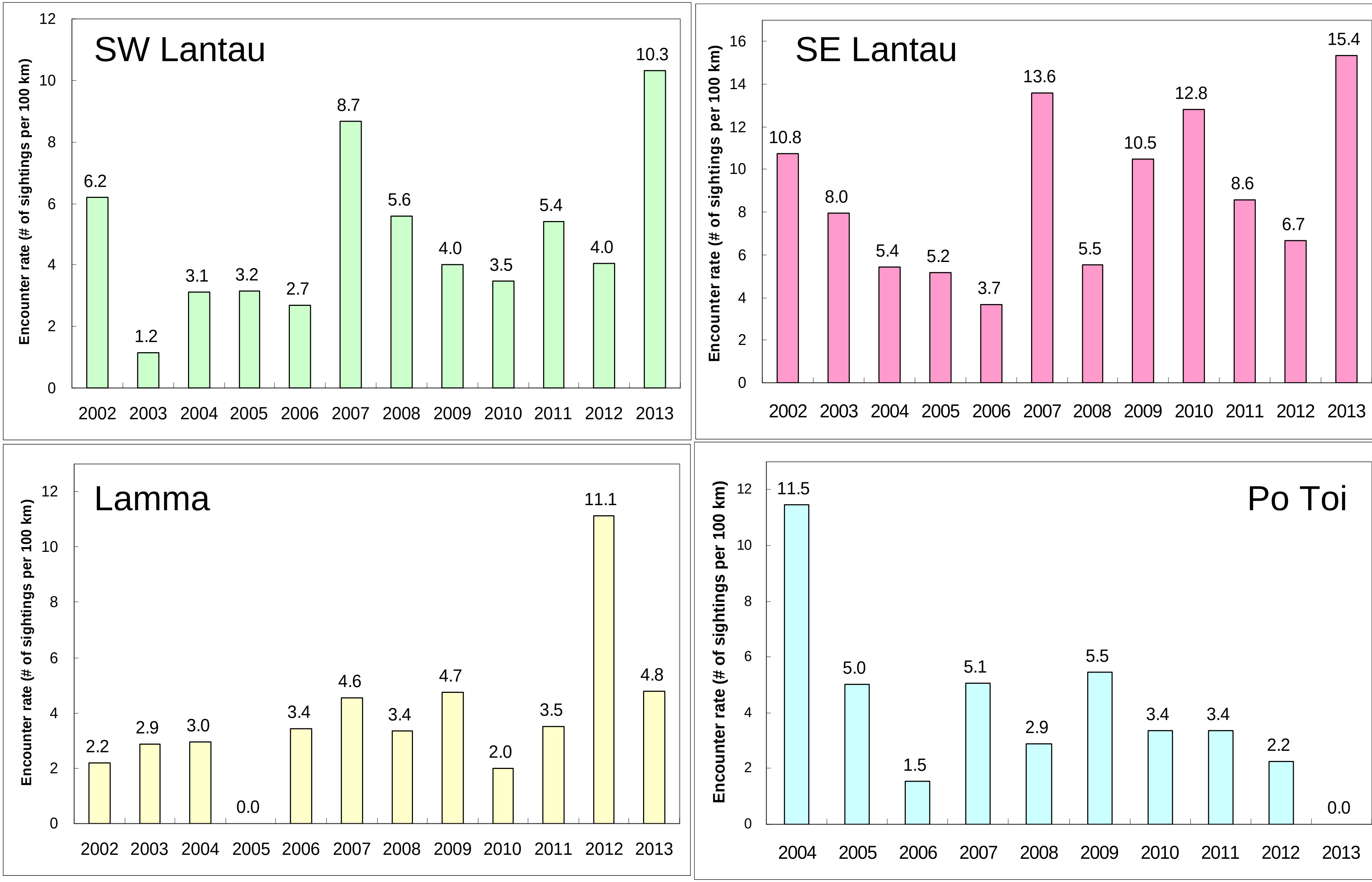


Figure 19. Temporal trends in annual encounter rates of finless porpoises among different survey areas

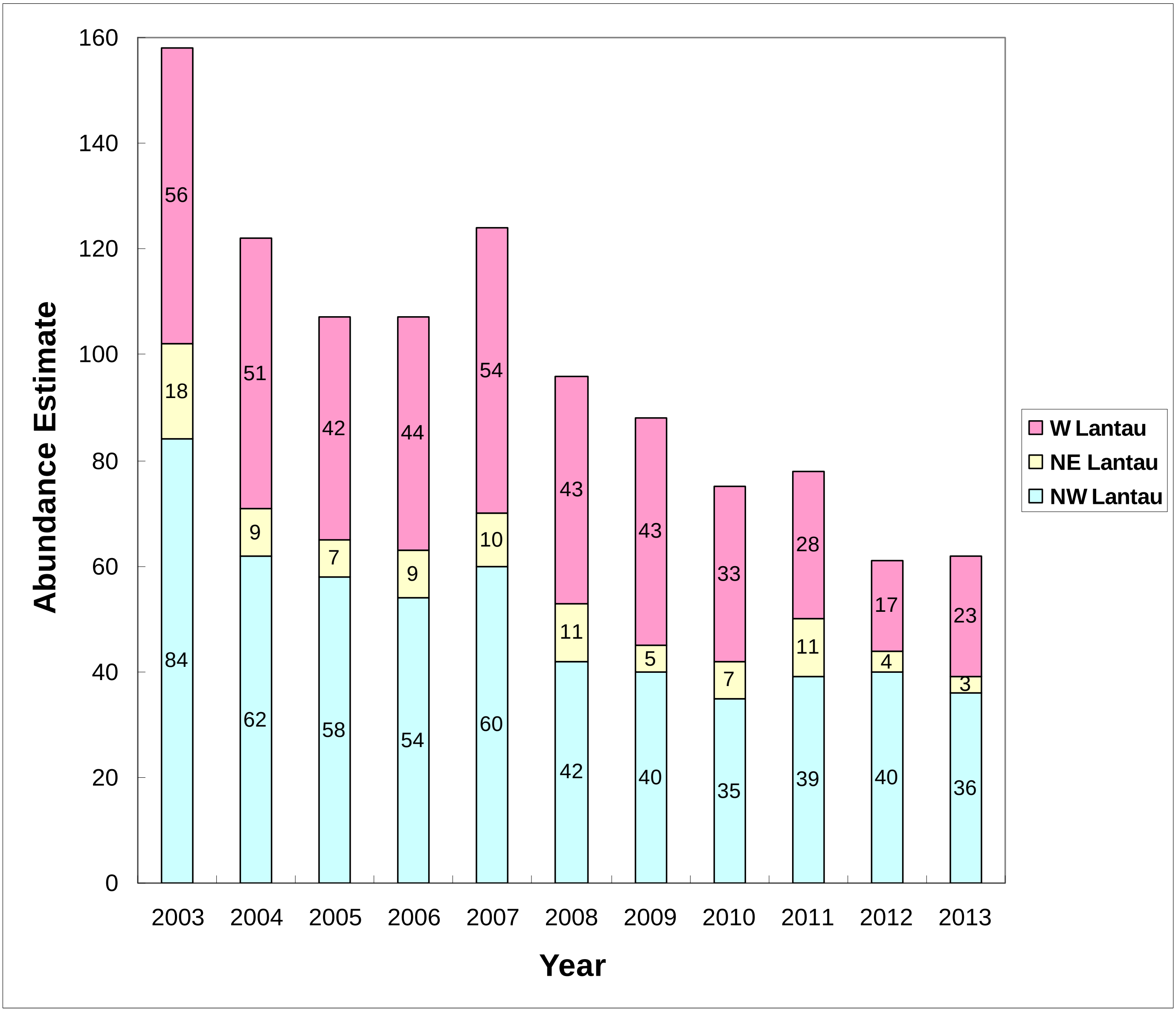


Figure 20. Temporal trends in combined abundance estimates of Chinese white dolphins in West, Northwest & Northeast Lantau from 2003-13

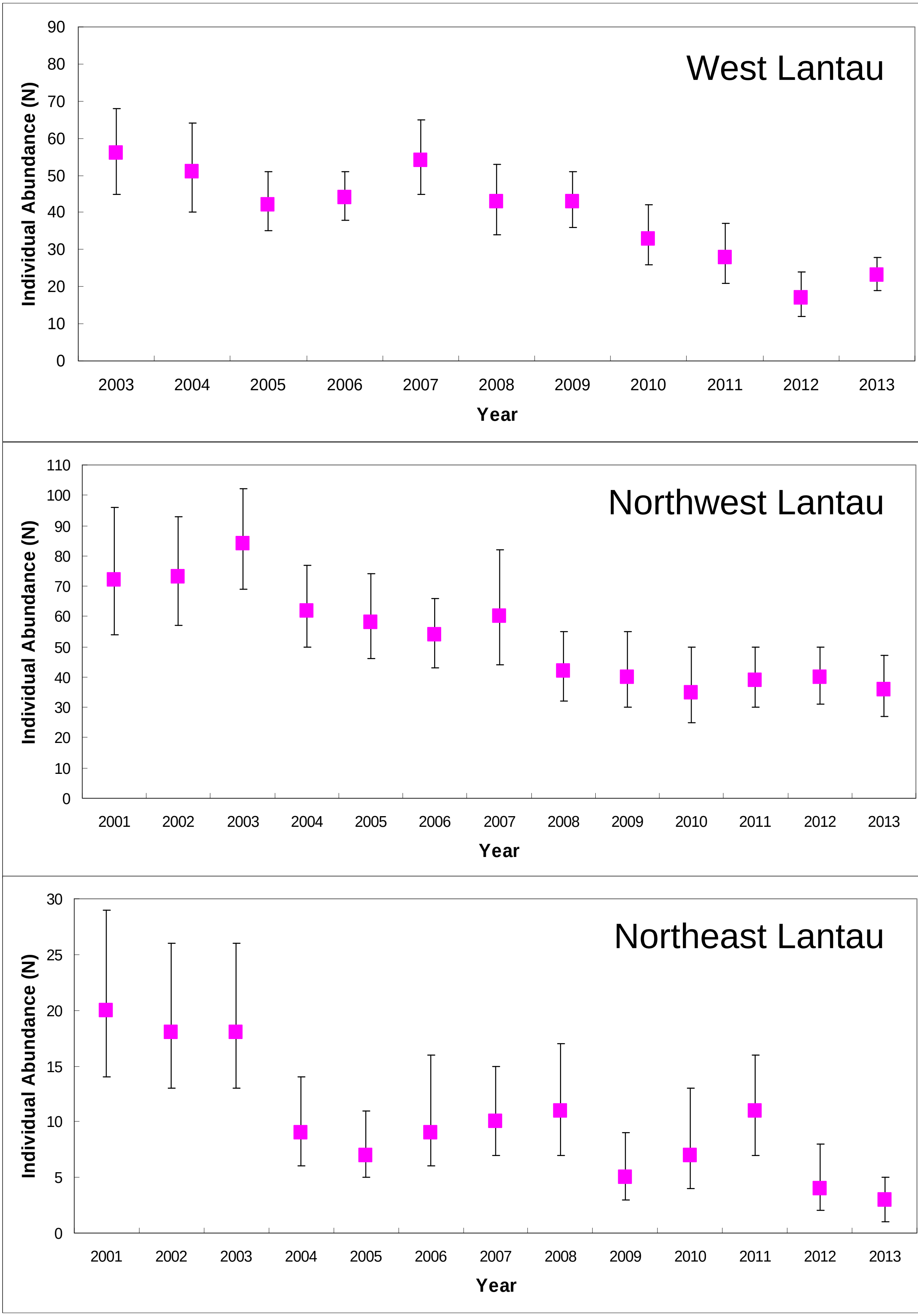


Figure 21. Temporal trends in abundance estimates of Chinese white dolphins in West, Northwest & Northeast Lantau from 2001-13 (error bars: 95% confidence interval of abundance estimates)

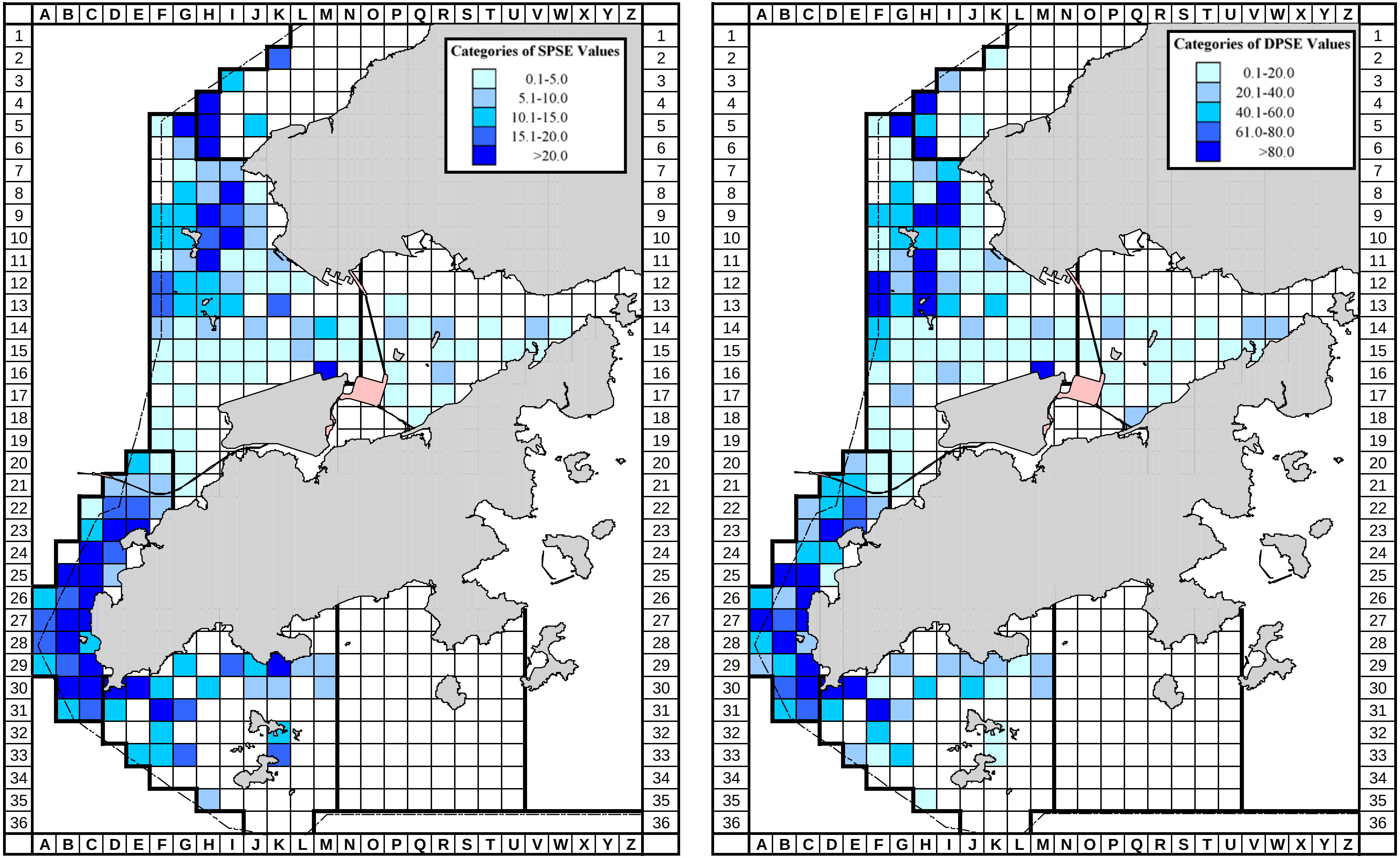


Figure 22. (left) Sighting density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau Island (number within grids represent "SPSE" = no. of on-effort dolphin sightings per 100 units of survey effort) (using data from January - December 2013)

(right) Density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau Island (number within grids represent "DPSE" = no. of dolphins per 100 units of survey effort) (using data from January - December 2013)

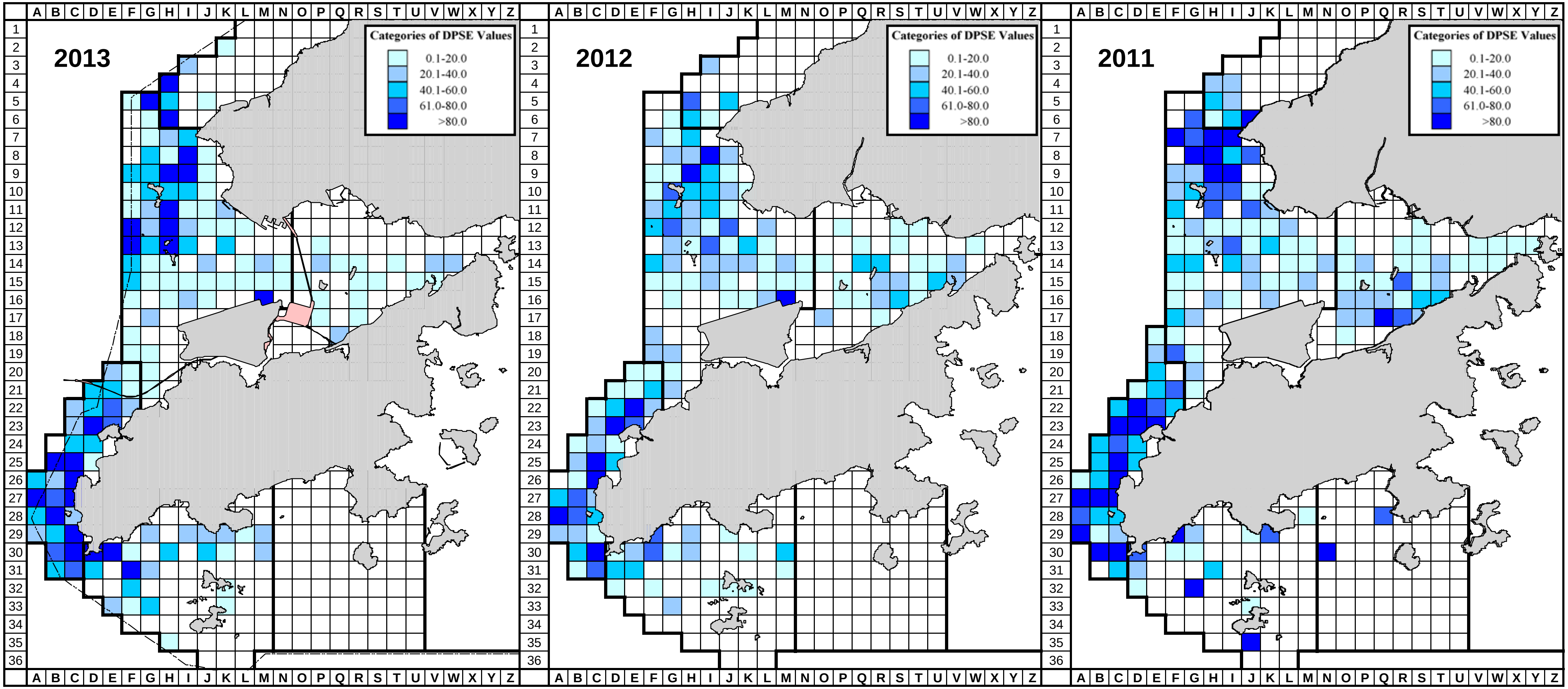


Figure 23. (right) Comparison of Chinese white dolphin densities with corrected survey effort per km^2 in waters around Lantau Island in 2011-13 (number within grids represent "DPSE" = no. of dolphins per 100 units of survey effort)

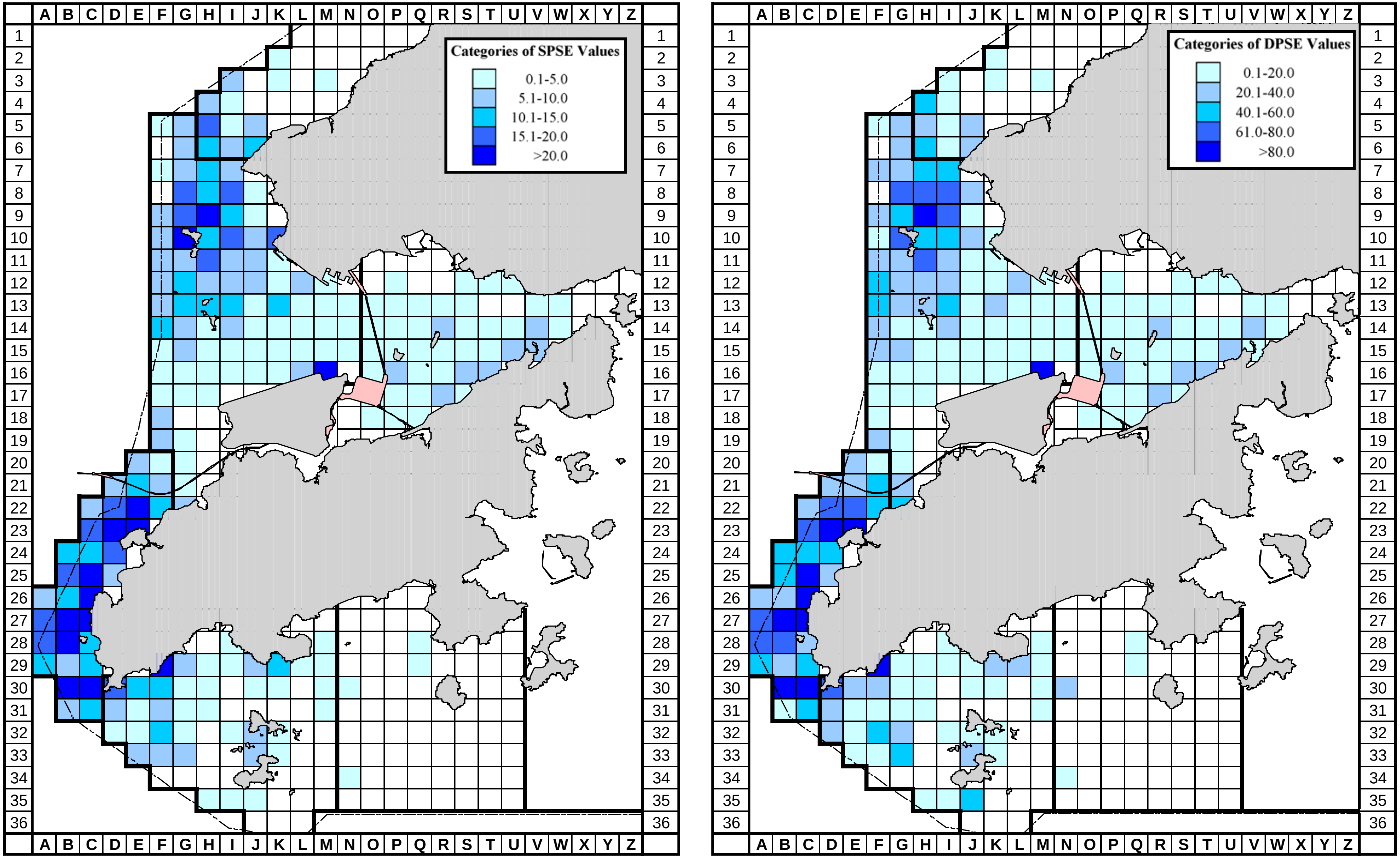


Figure 24. (left) Sighting density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau Island during 2009-13 (number within grids represent "SPSE" = no. of on-effort sightings per 100 units of survey effort)

(right) Density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau Island during 2009-13 (number within grids represent "DPSE" = no. of dolphins per 100 units of survey effort)

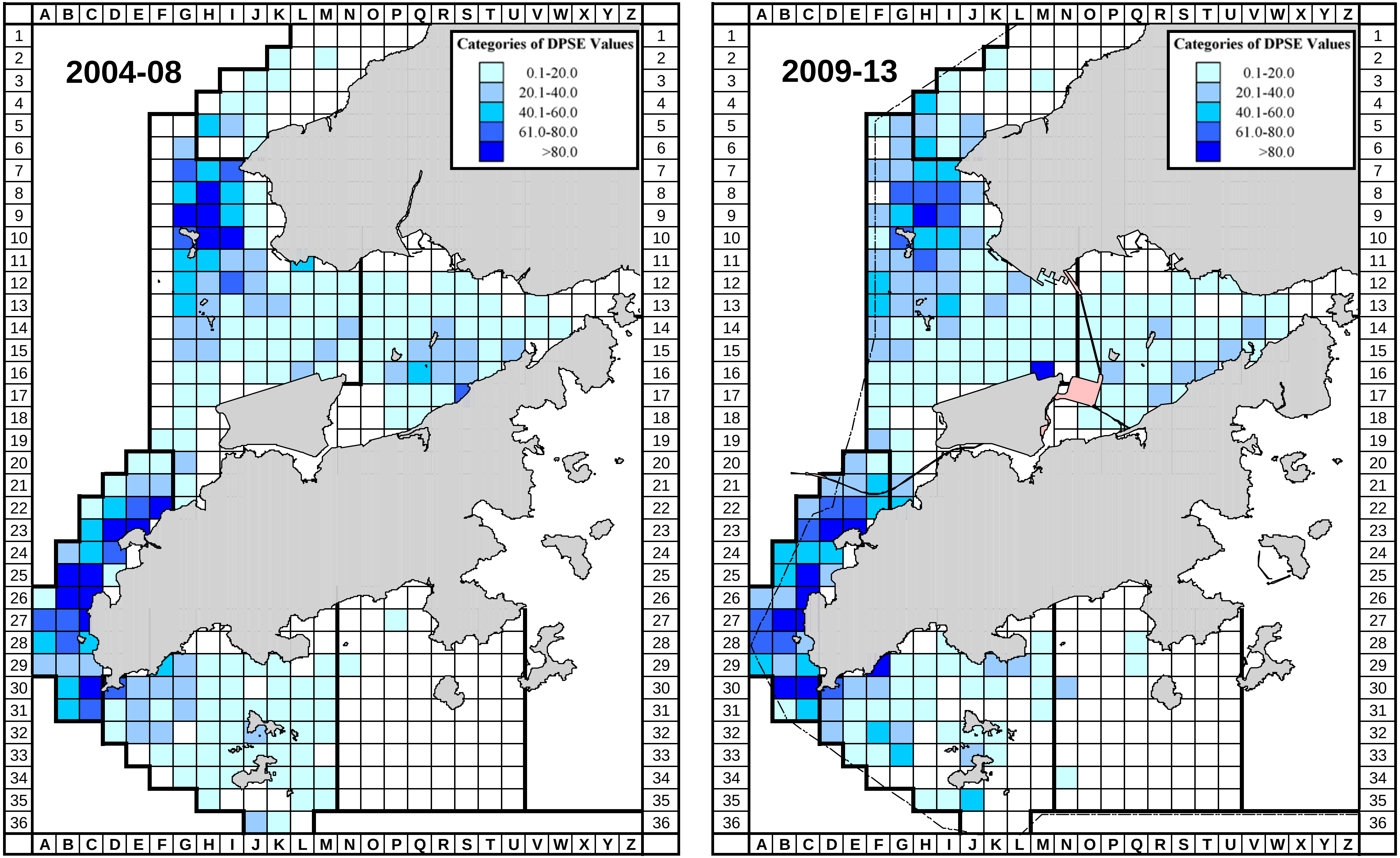


Figure 25. (left) Density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau Island during 2004-08 (numbers within grids represent "DPSE" = no. of dolphins per 100 units of survey effort)

(right) Density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau Island during 2009-13 (numbers within grids represent "DPSE" = no. of dolphins per 100 units of survey effort)

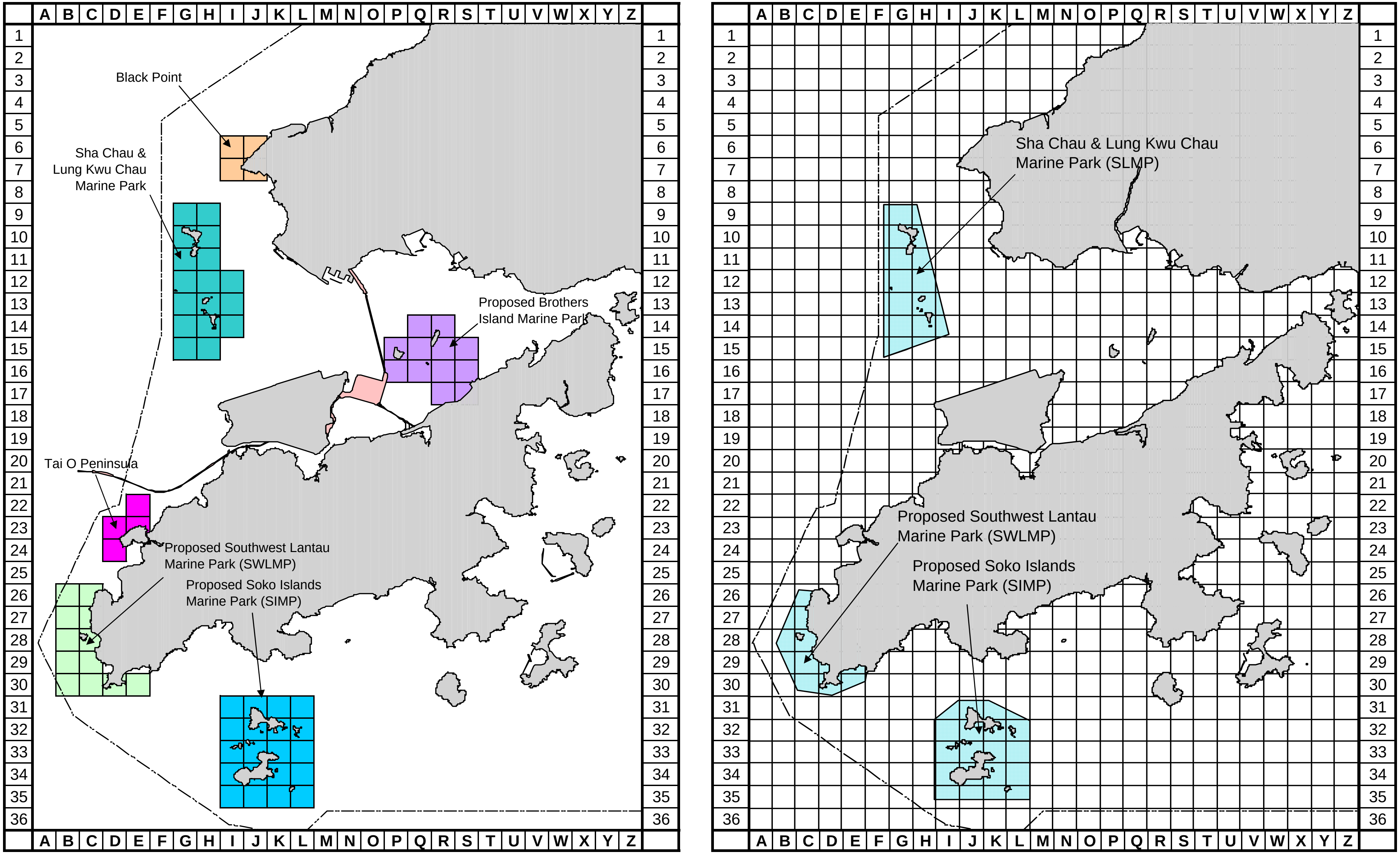


Figure 26. Grids of six key dolphin habitats that were examined for temporal trend in dolphin densities

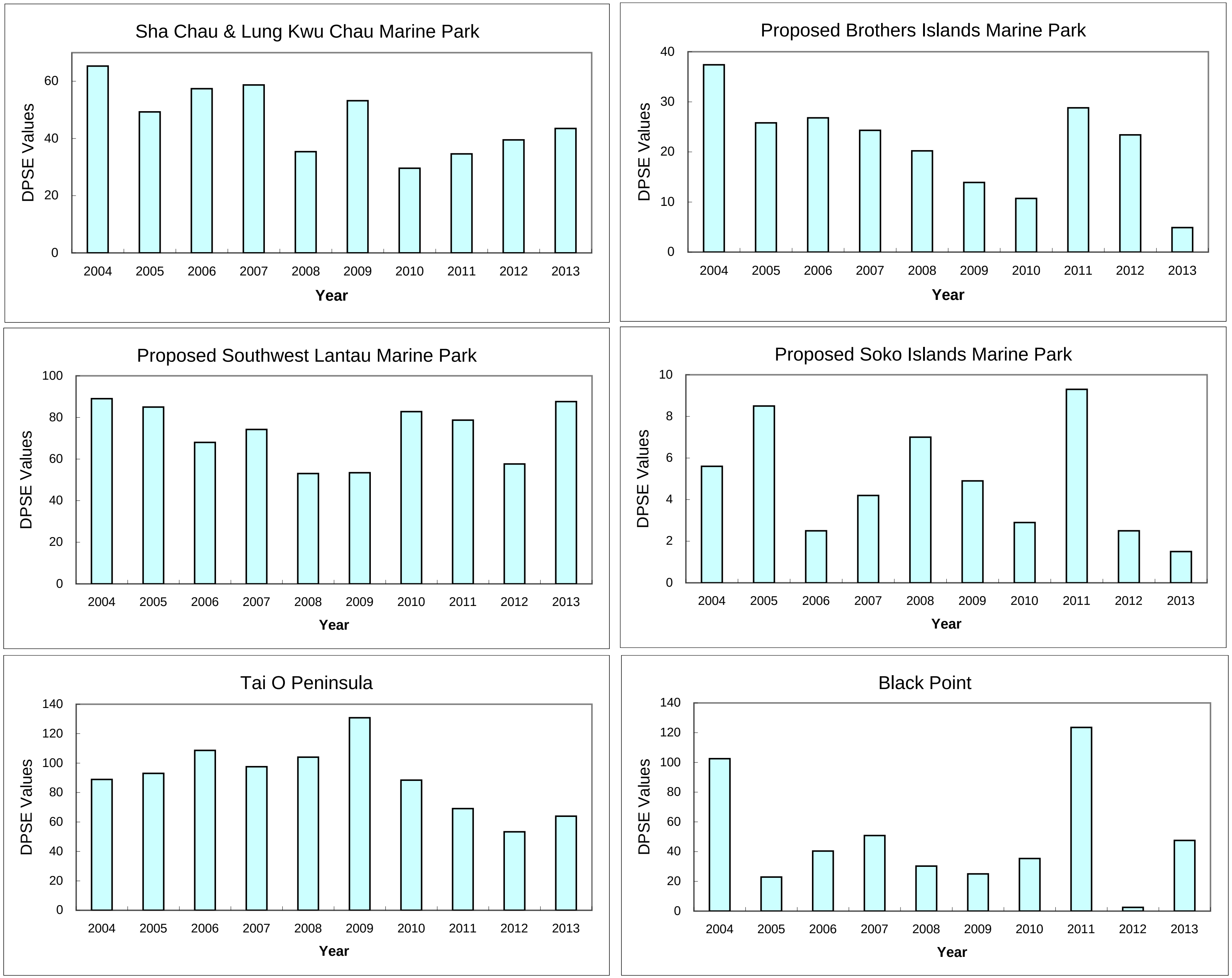
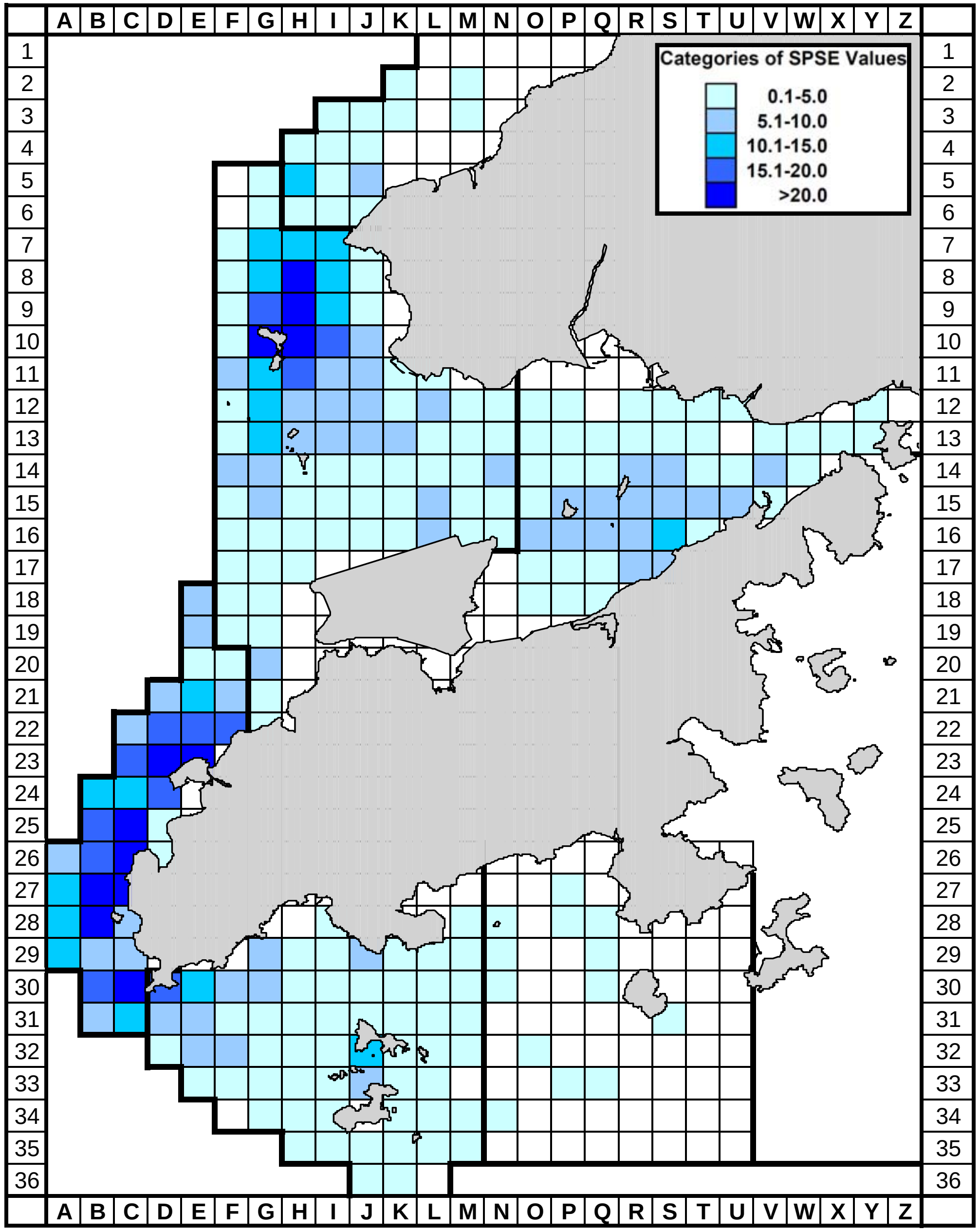


Figure 27. Temporal trend of dolphin densities (DPSE Values) at six key dolphin habitats in Lantau waters



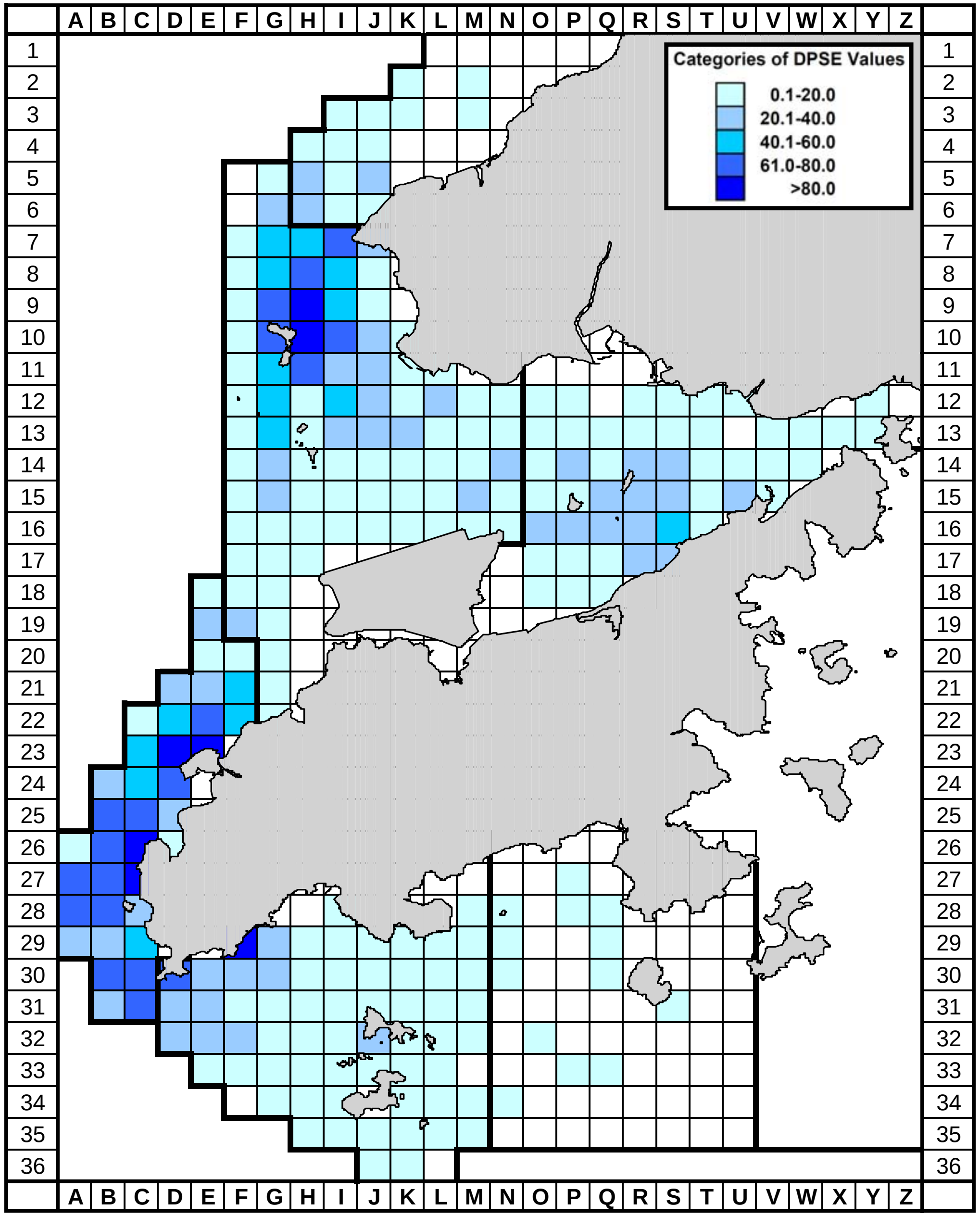


Figure 28. (left) Overall sighting density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau Island, using data collected during 2001-12 (SPSE = no. of on-effort sightings per 100 units of survey effort)

(right) Overall density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau Island, using data collected during 2001-12 (DPSE = no. of dolphins per 100 units of survey effort)

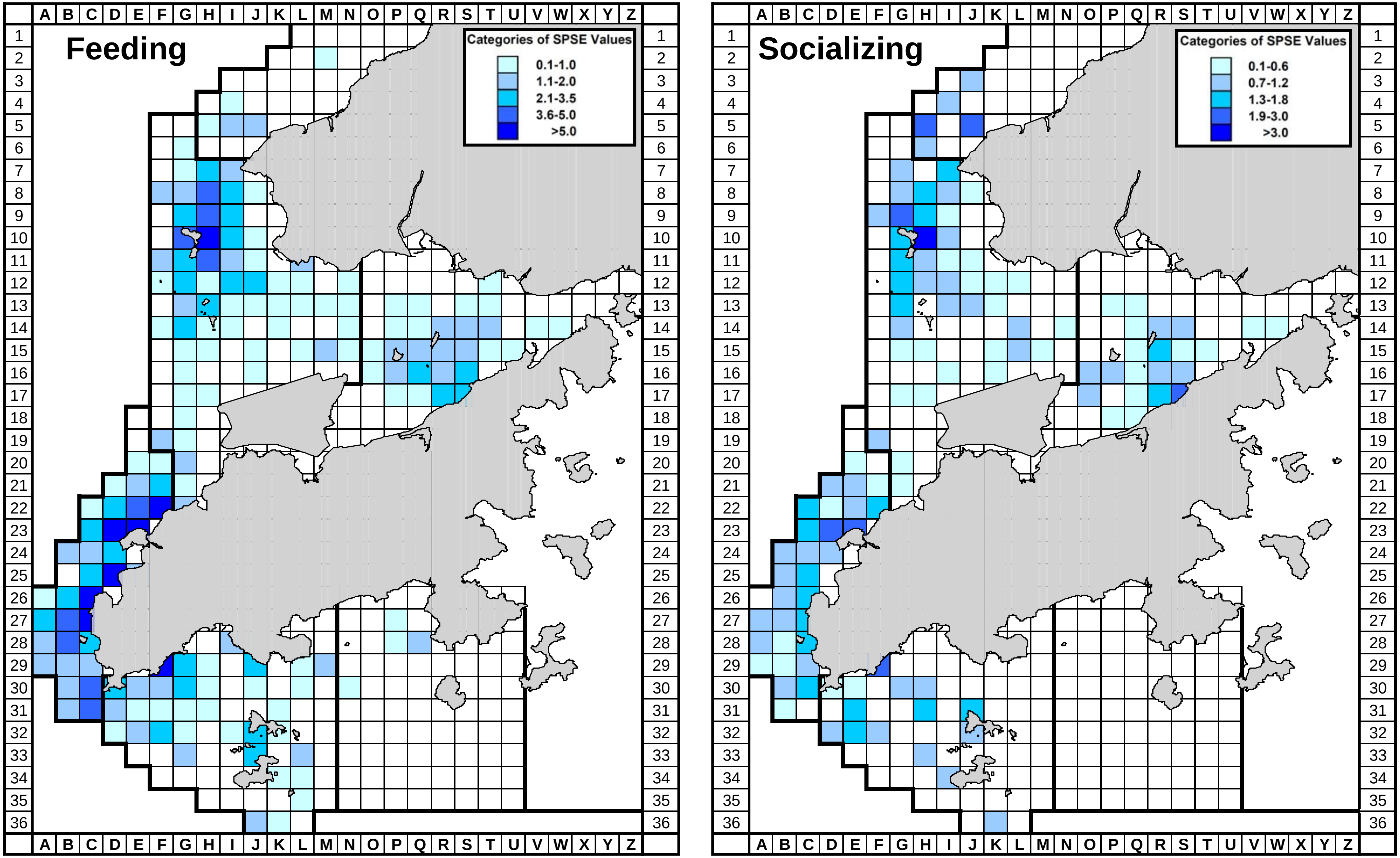
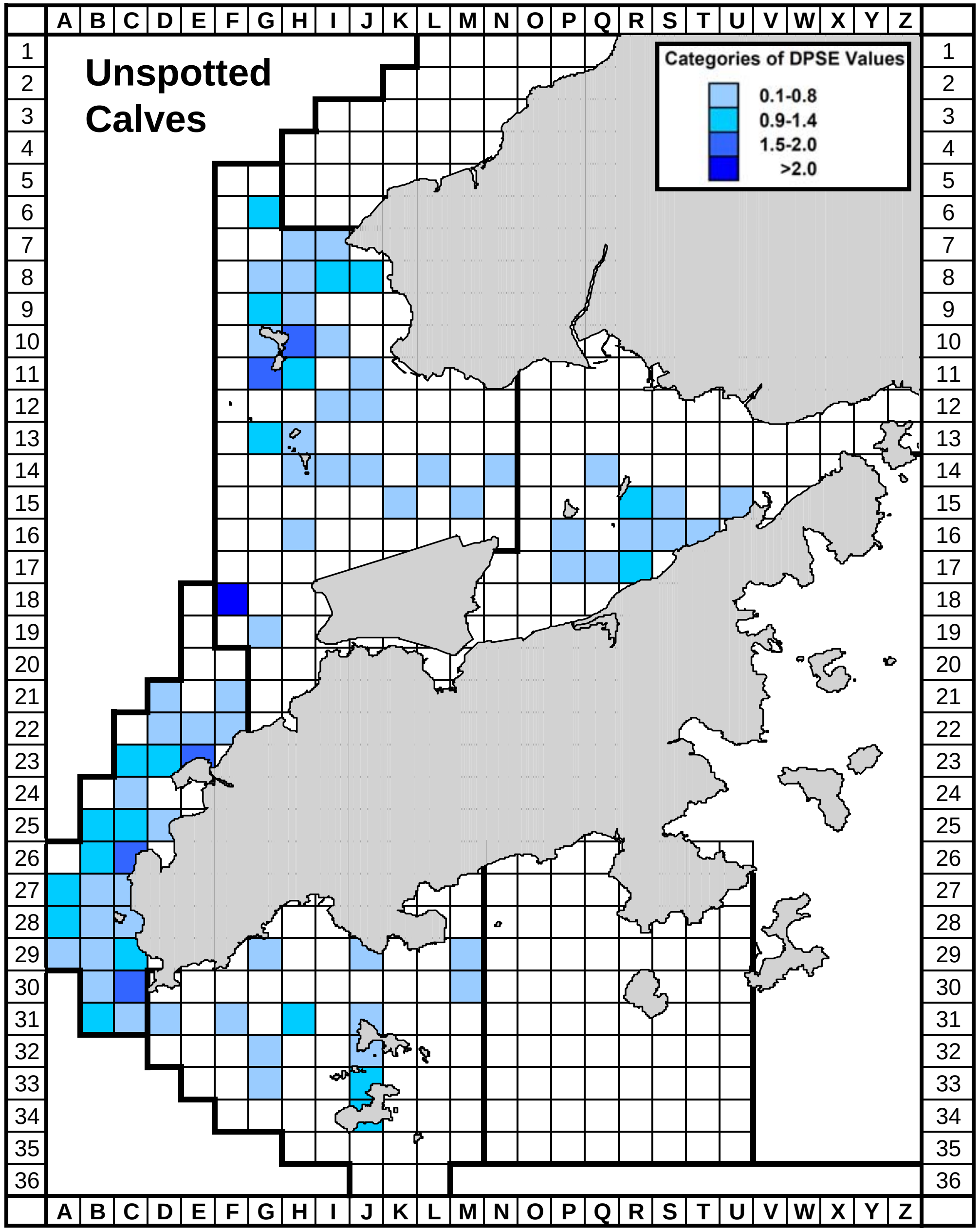


Figure 29. (left) Sighting density of Chinese white dolphins per km^2 engaged in feeding activities in waters around Lantau Island from 2001-12 (SPSE = no. of on-effort dolphin sightings per 100 units of survey effort)

(right) Sighting density of Chinese white dolphins per km^2 engaged in socializing activities in waters around Lantau Island from 2001-12 (SPSE = no. of on-effort dolphin sightings per 100 units of survey effort)



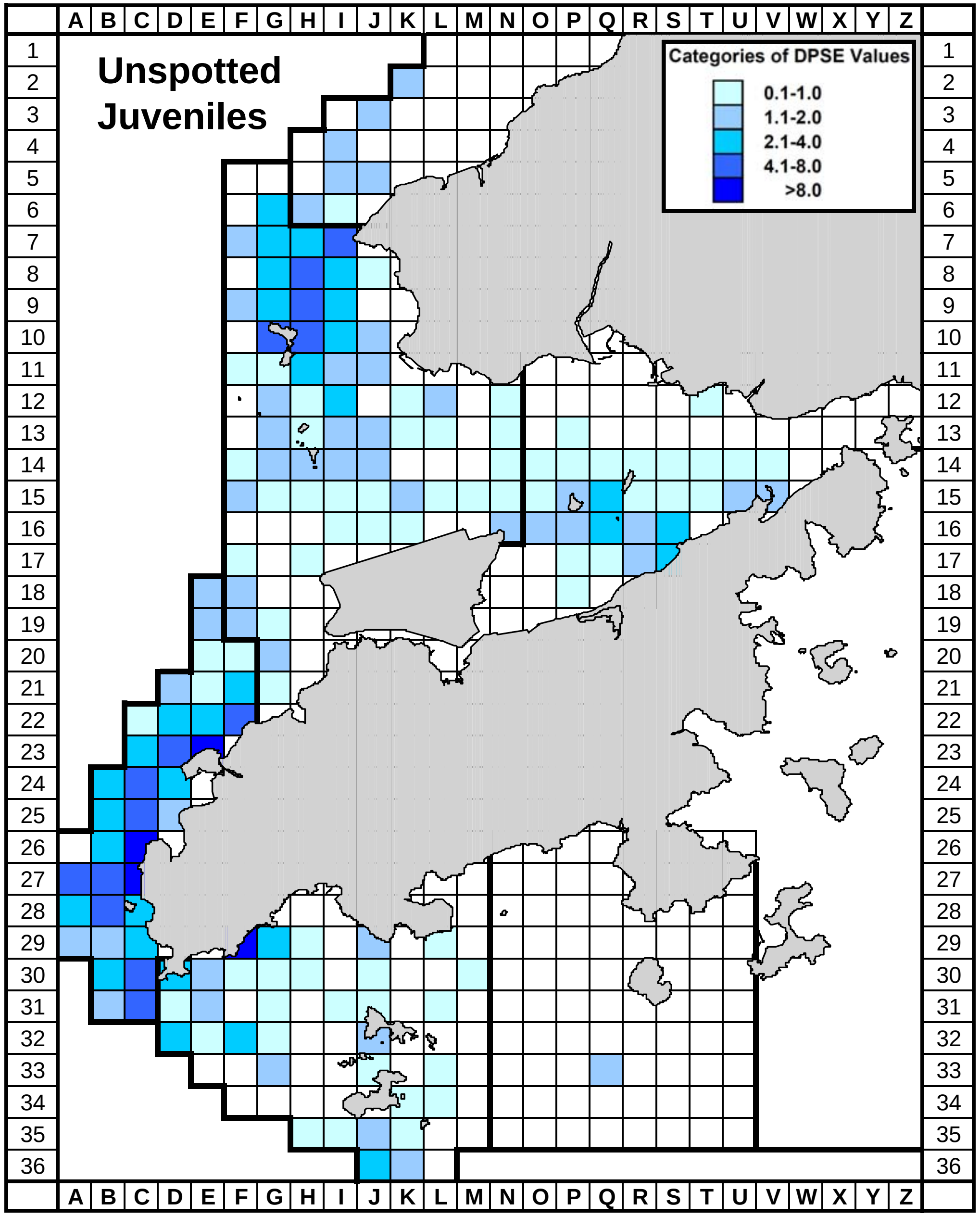


Figure 30. (left) Density of unspotted calves of Chinese white dolphins per km^2 in waters around Lantau Island from 2001-12 (DPSE = no. of unspotted calves per 100 units of survey effort)

(right) Density of unspotted juveniles of Chinese white dolphins per km^2 in waters around Lantau Island from 2001-12 (DPSE = no. of unspotted juveniles per 100 units of survey effort)

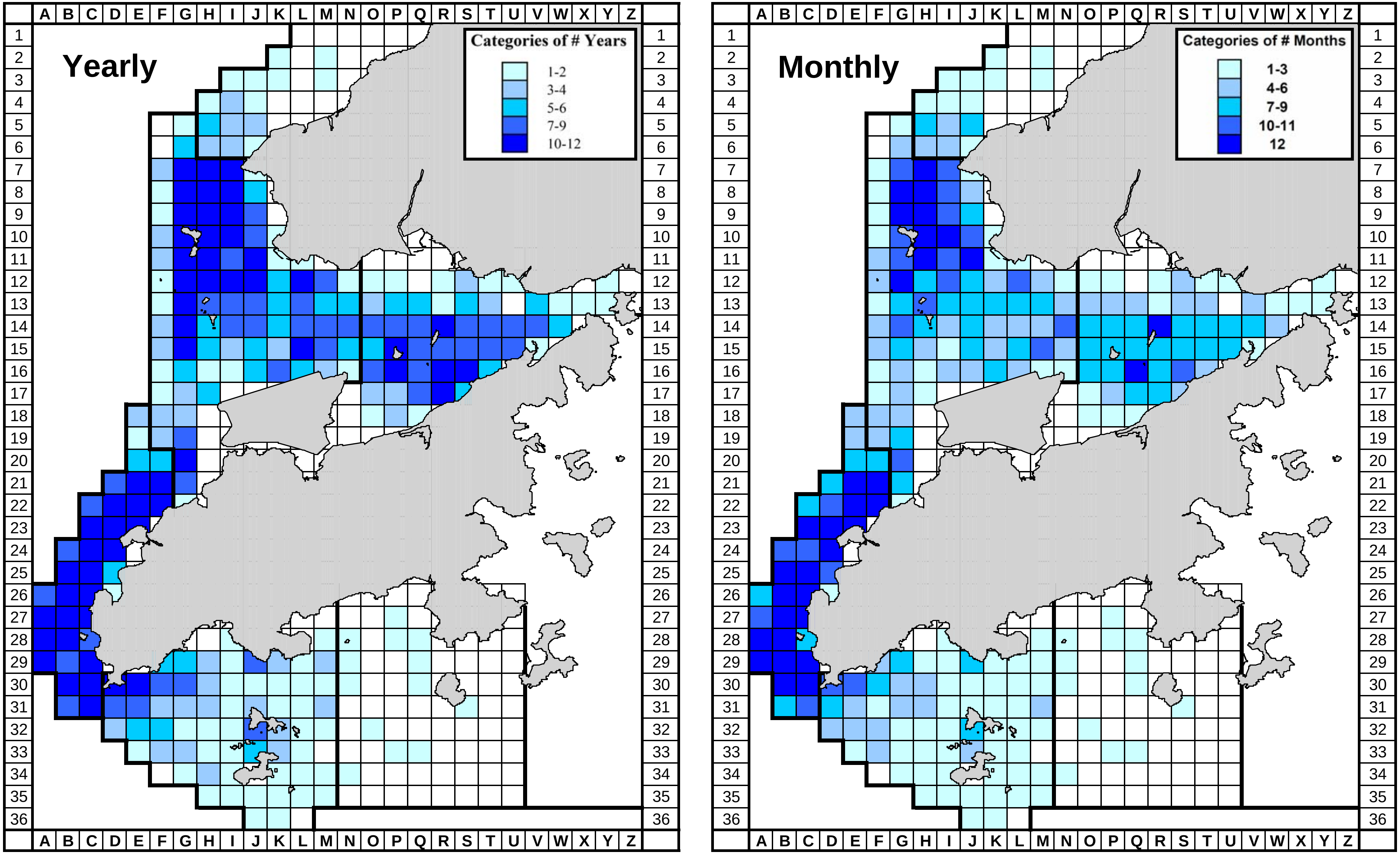


Figure 31. (left) Number of years with Chinese white dolphin sighting records per km^2 in waters around Lantau Island from 2001-12
(right) Number of months with Chinese white dolphin sighting records per km^2 in waters around Lantau Island from 2001-12

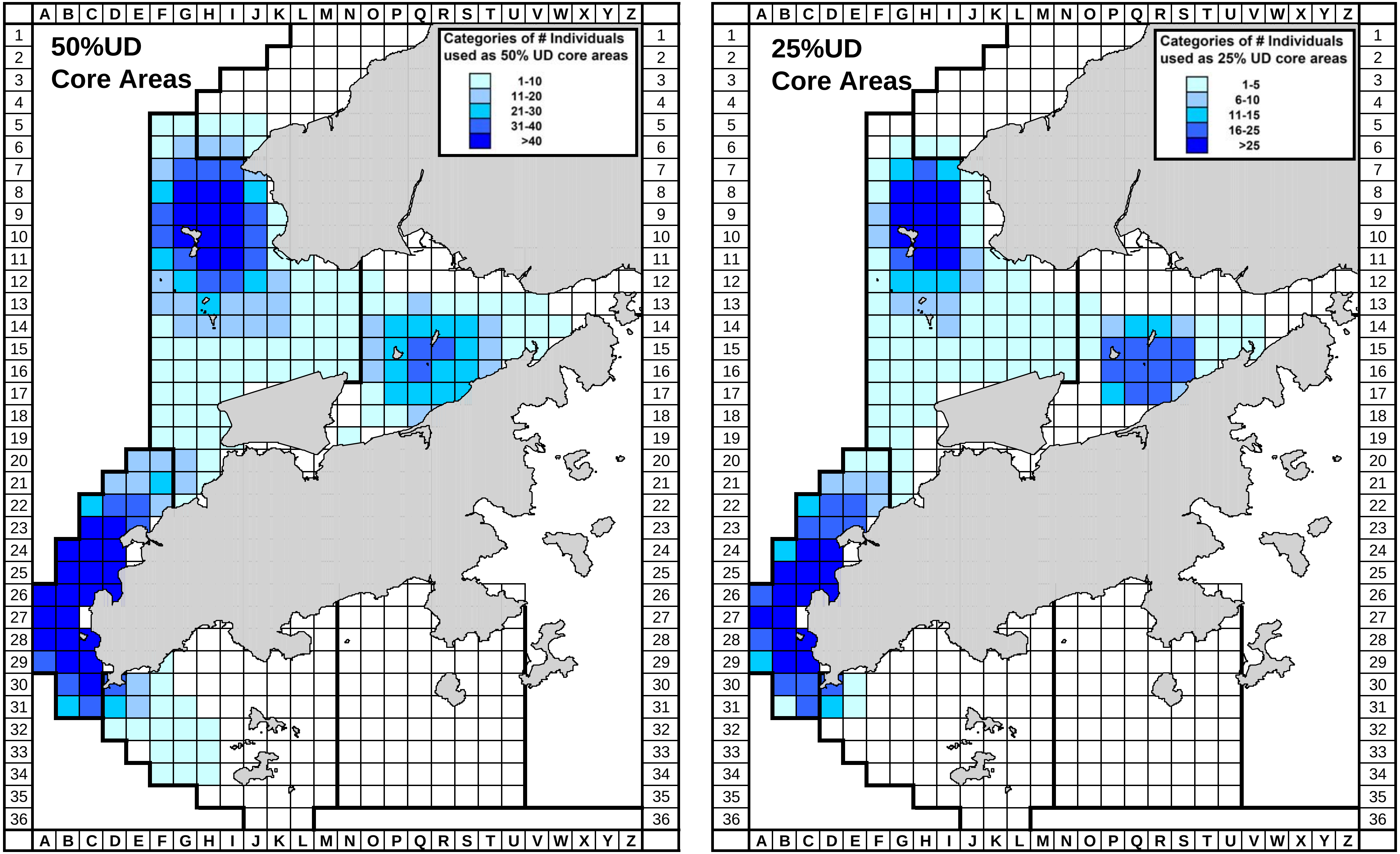


Figure 32. (left) No. of individual Chinese white dolphins with their 50% UD core areas overlapped with each 1 km^2 grid in waters around Lantau Island from 2001-12
(right) No. of individual Chinese white dolphins with their 25% UD core areas overlapped with each 1 km^2 grid in waters around Lantau Island from 2001-12

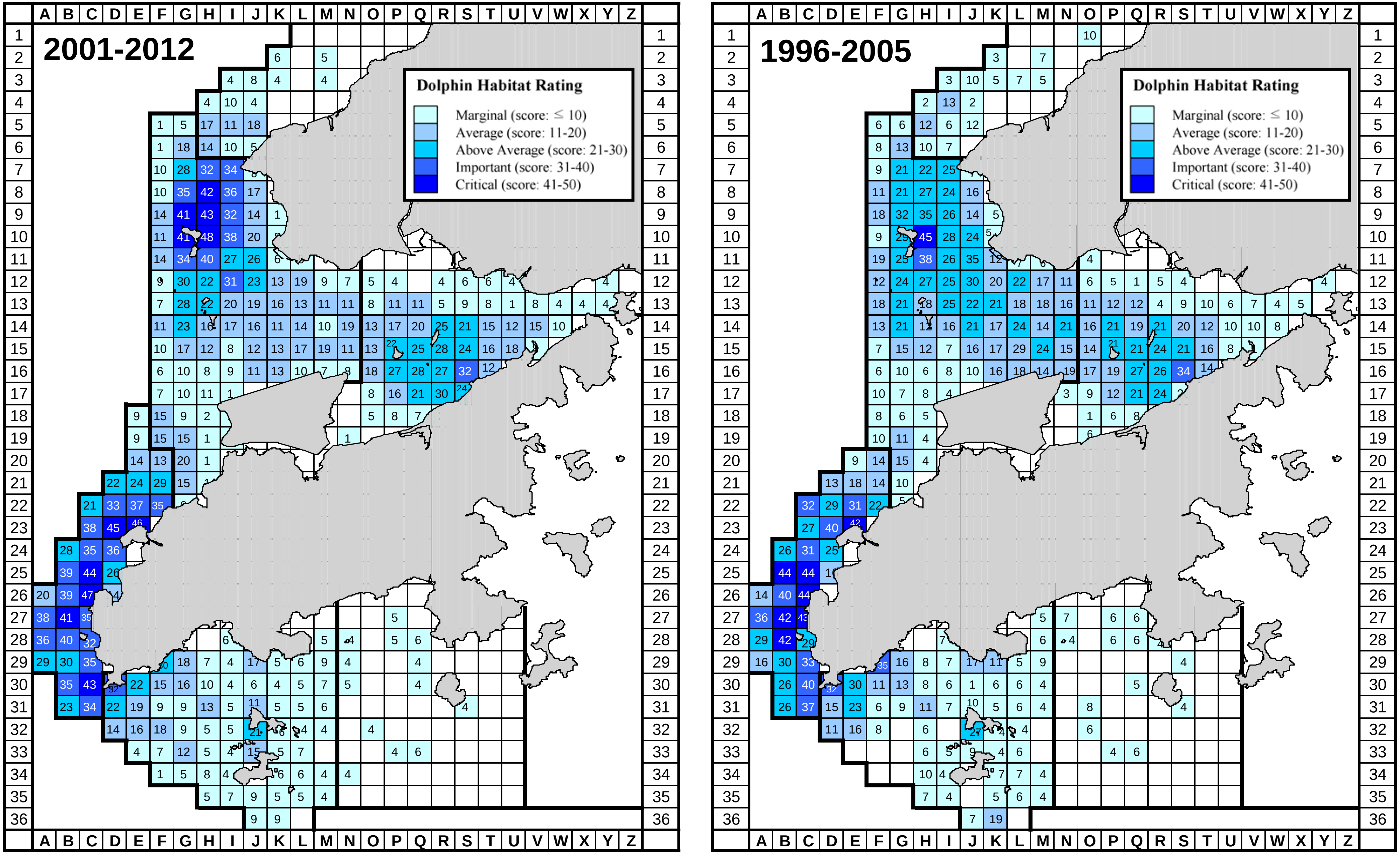


Figure 33. Habitat rating of Chinese white dolphins in Hong Kong using quantative habitat use information collected during 2001-12 and 1996-2005 (number within grids represents the sum of scores totaled from 10 selection criteria)

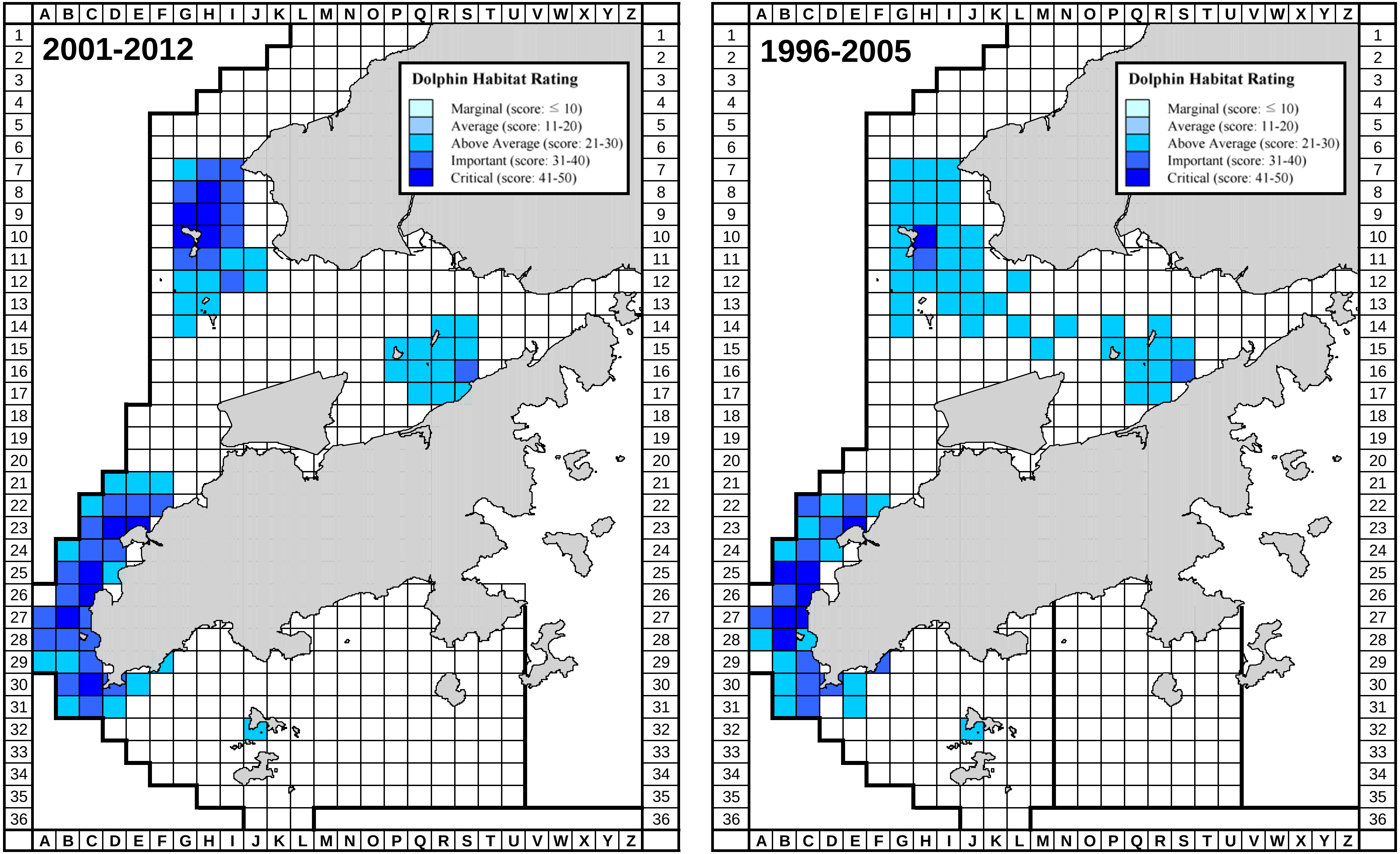
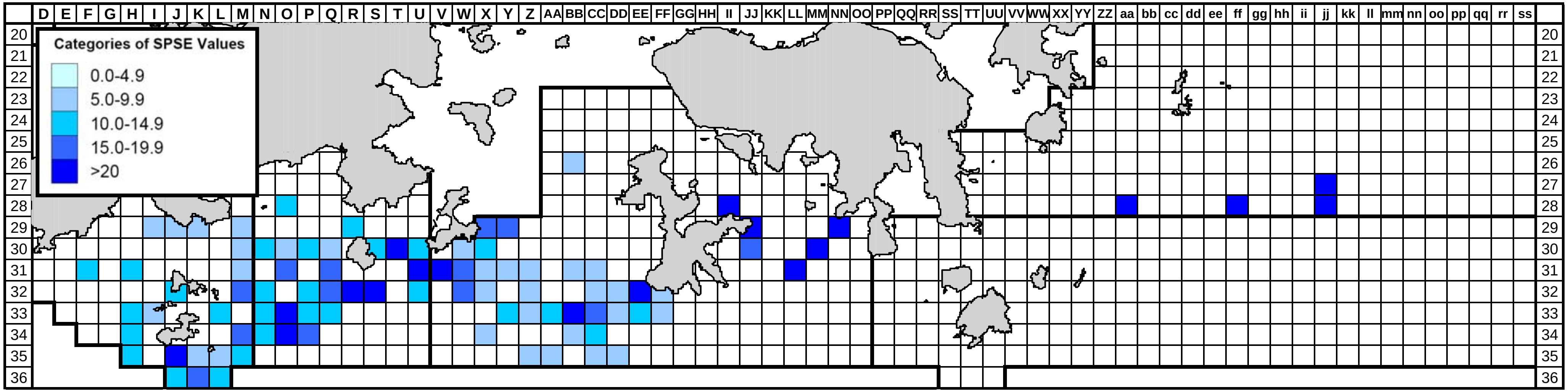


Figure 34. Comparions between 2001-12 and 1996-2005 for grids that are rated as above average, important and critical dolphin habitat that should deserve habitat protection for dolphin conservation purposes



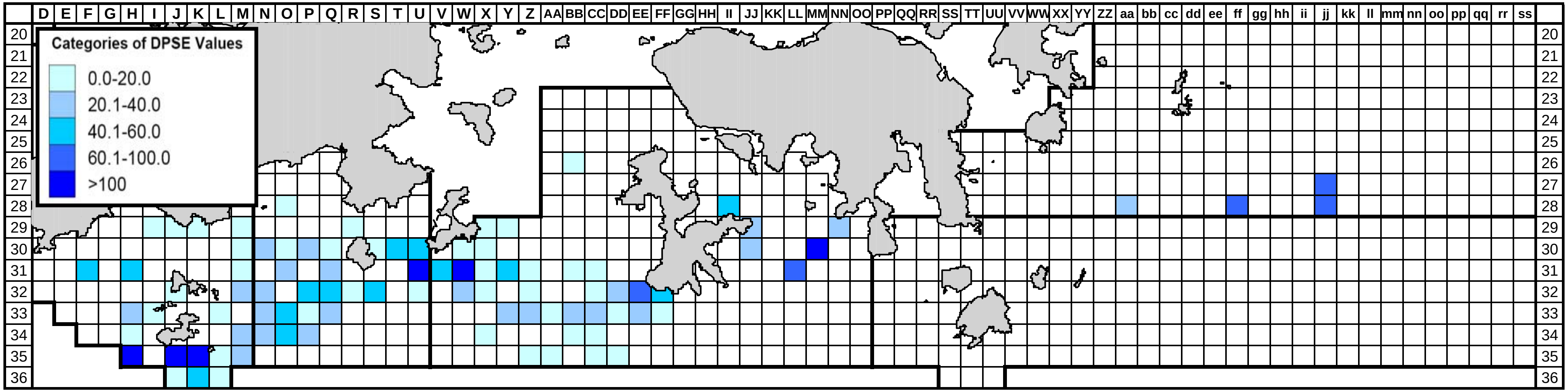


Figure 35. (top) Sighting density of finless porpoises with corrected survey effort per km^2 in southern waters of Hong Kong (number within grids represent "SPSE" = no. of on-effort porpoise sightings per 100 units of survey effort) (using data from January - December 2013)

(bottom) Density of finless porpoises with corrected survey effort per km^2 in southern waters of Hong Kong (number within grids represents "DPSE" = no. of porpoises per 100 units of survey effort) (using data from January - December 2013)

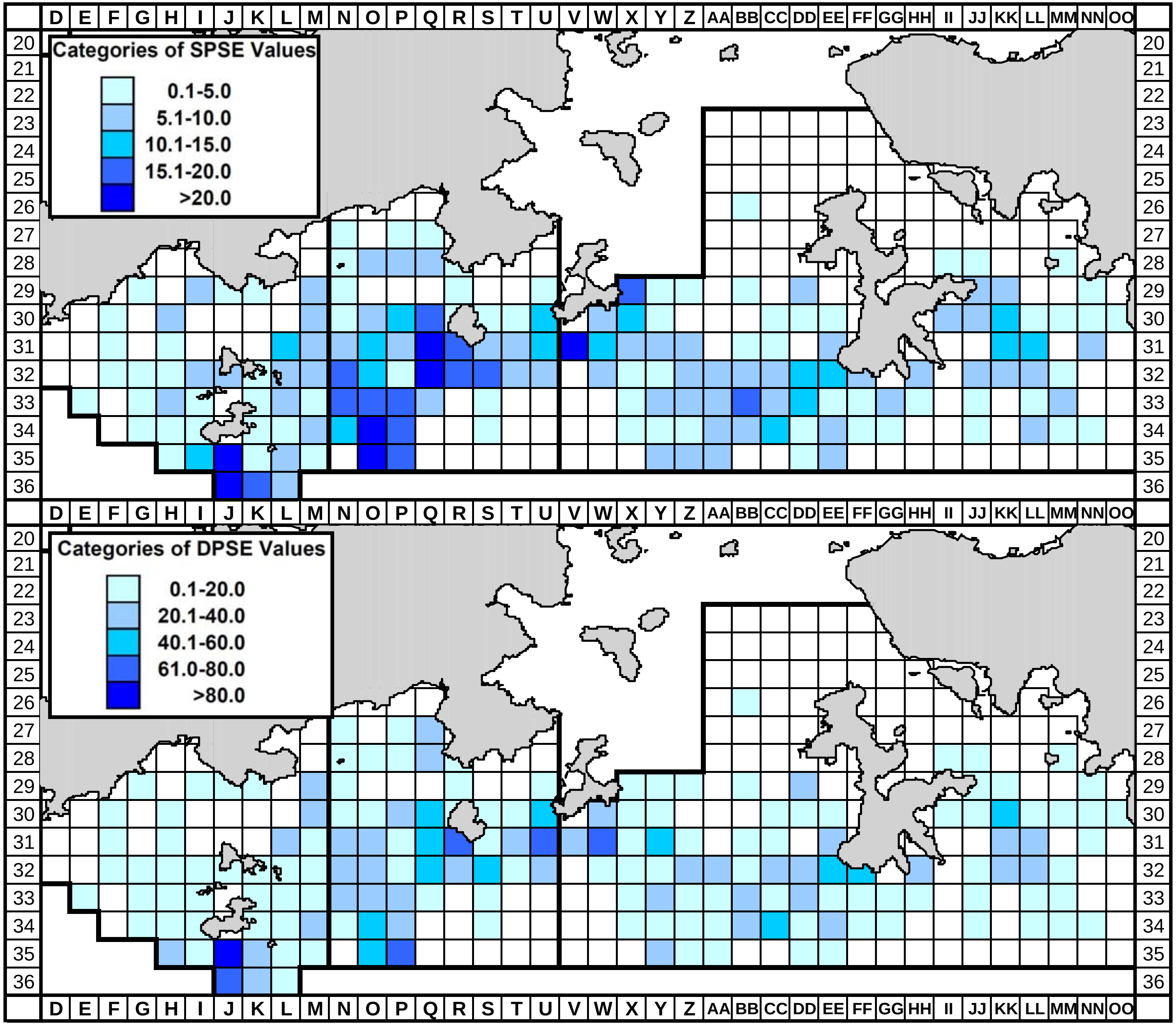


Figure 36. Density of finless porpoises with corrected survey effort per km^2 in southern waters of Hong Kong during dry season (December to May), using data collected during 2004-13 (SPSE = no. of on-effort porpoise sightings per 100 units of survey effort; DPSE = no. of porpoises per 100 units of survey effor

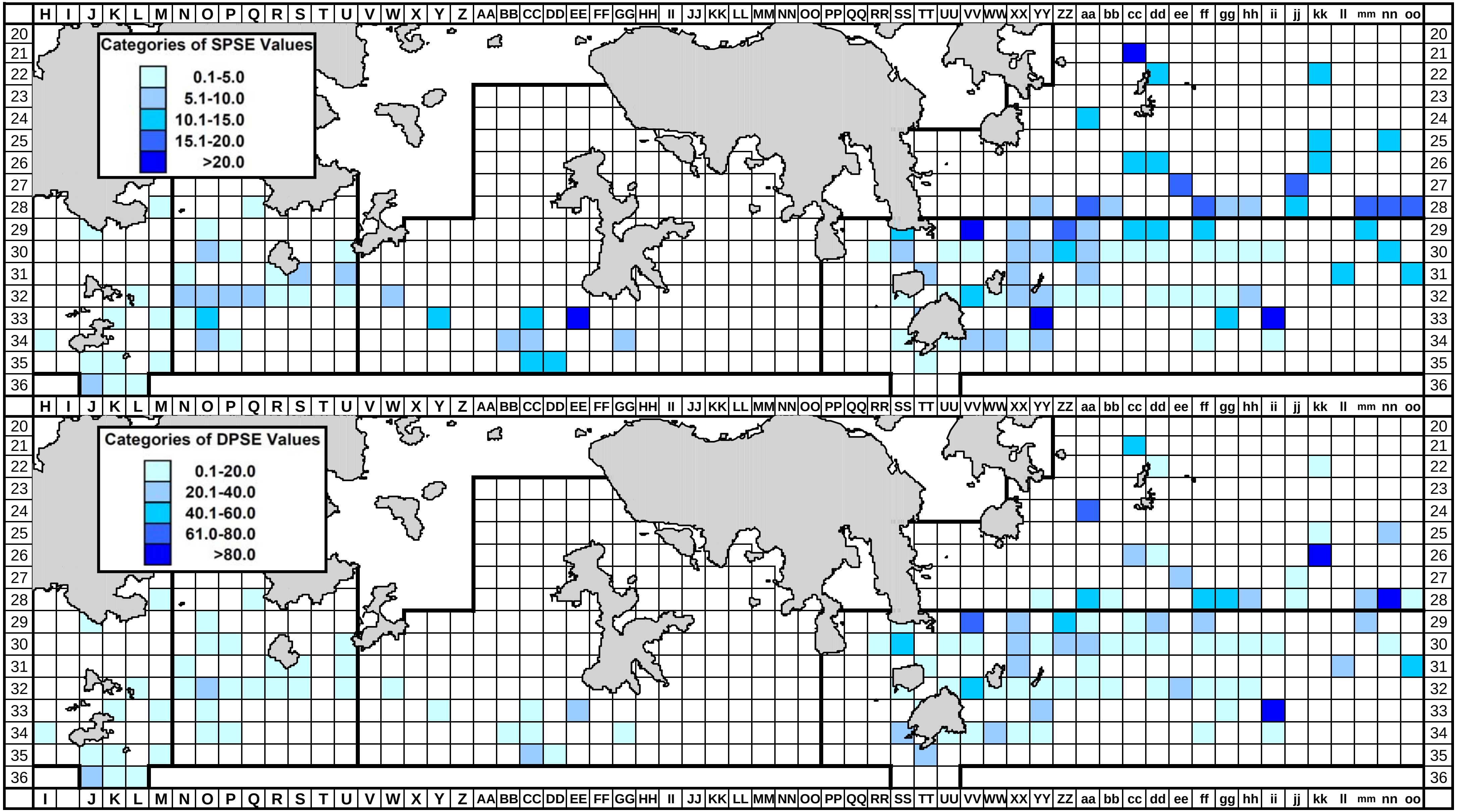


Figure 37. Density of finless porpoises with corrected survey effort per km^2 in southern waters of Hong Kong during wet season (June to November), using data collected during 2004-13 (SPSE = no. of on-effort porpoise sightings per 100 units of survey effort; DPSE = no. of porpoises per 100 units of survey effort

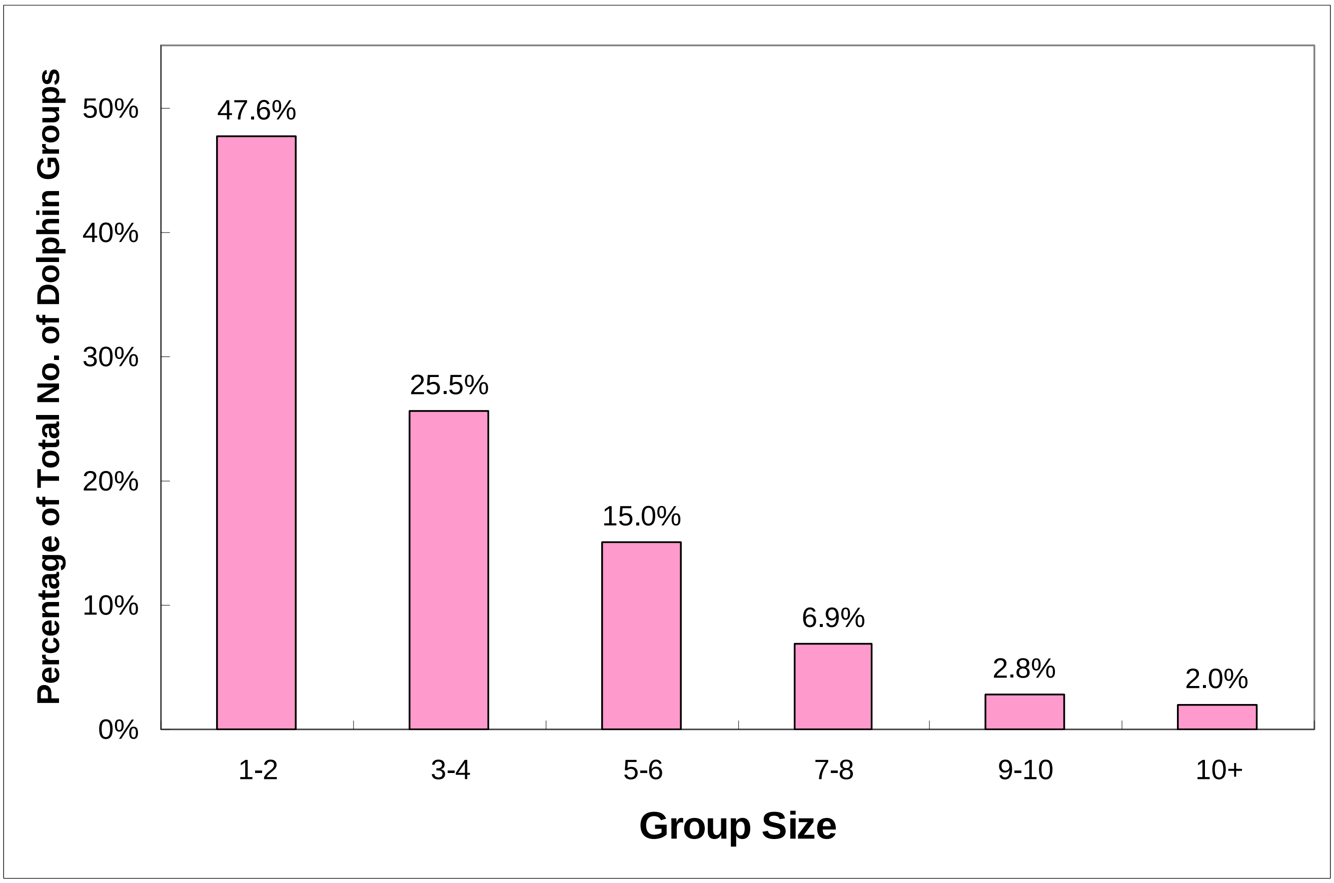


Figure 38. Percentages of different group sizes of Chinese white dolphins in Hong Kong during April 2013 to March 2014

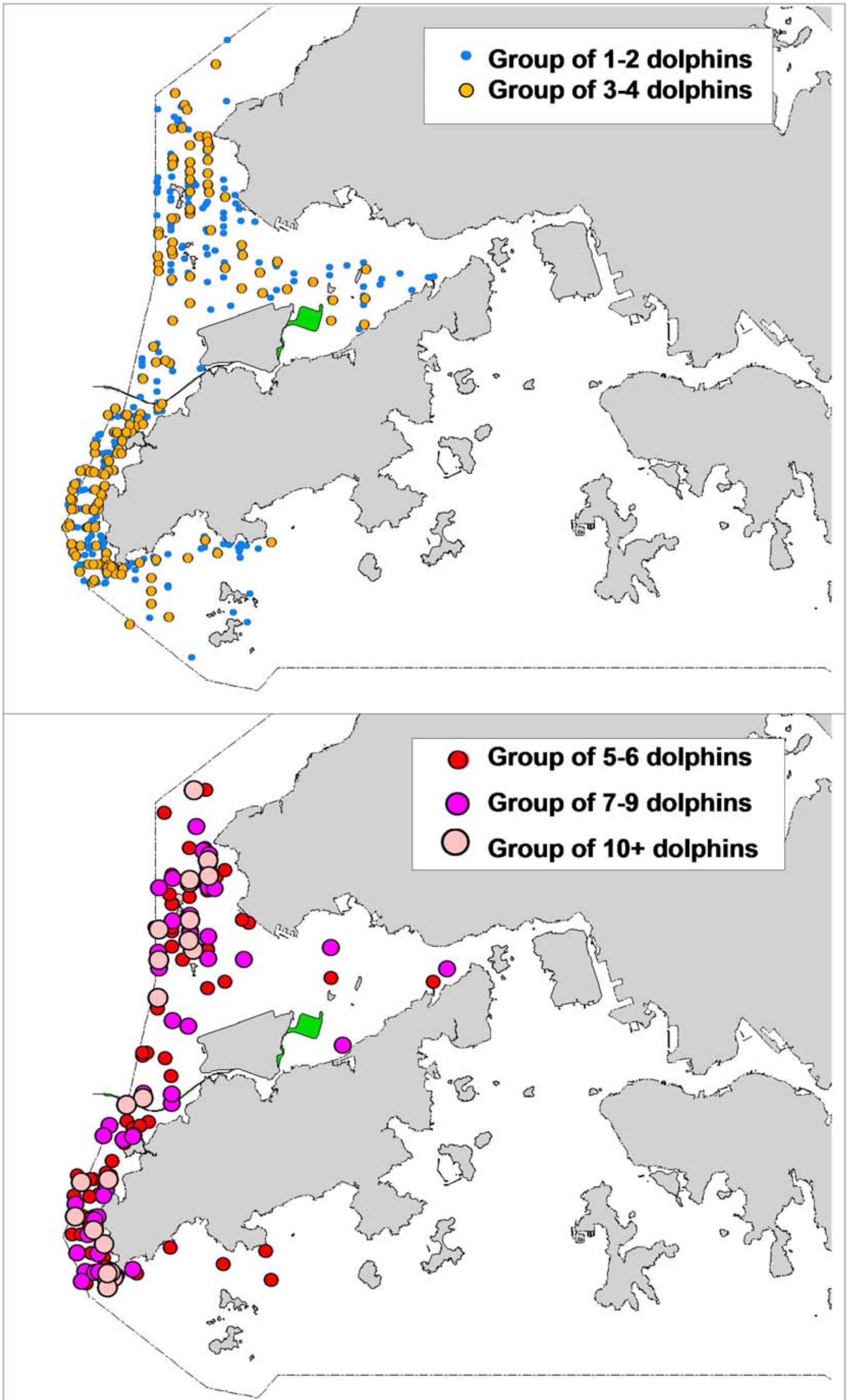


Figure 39. Distribution of Chinese white dolphins with different group sizes in 2013

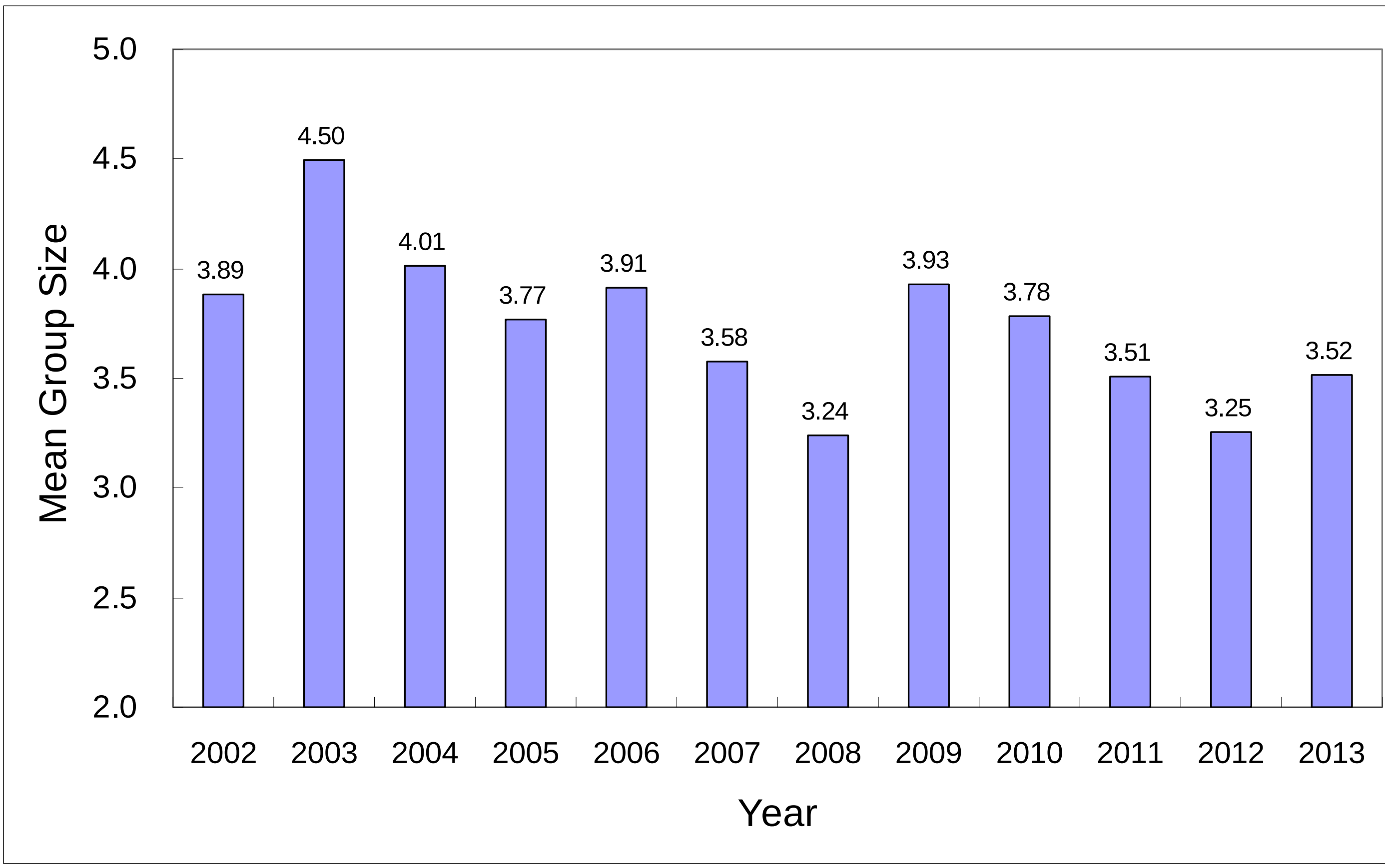


Figure 40. Temporal trend of mean dolphin group size in 2002-13

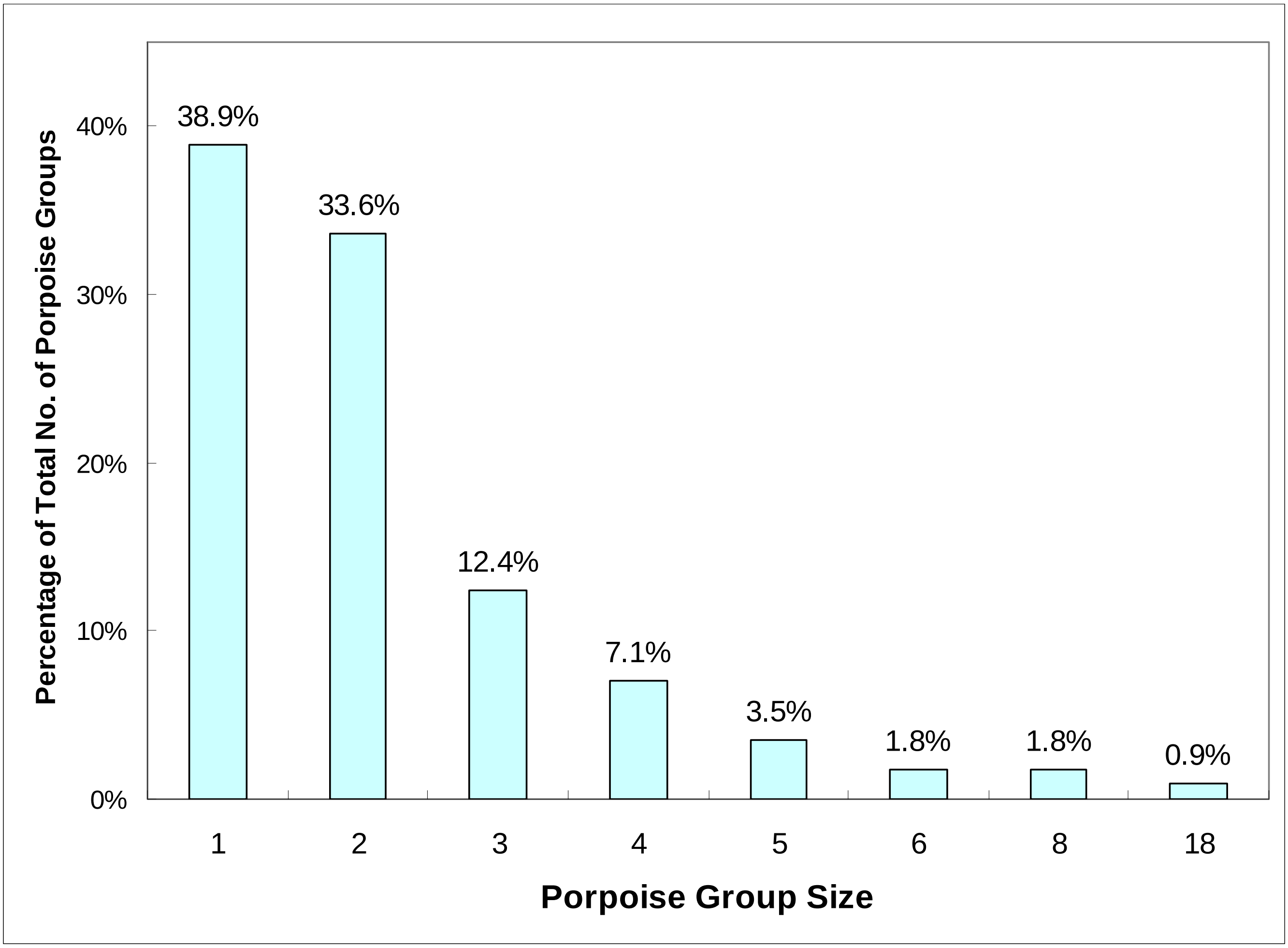


Figure 41. Percentages of different group sizes of finless porpoises in Hong Kong during April 2013 to March 2014

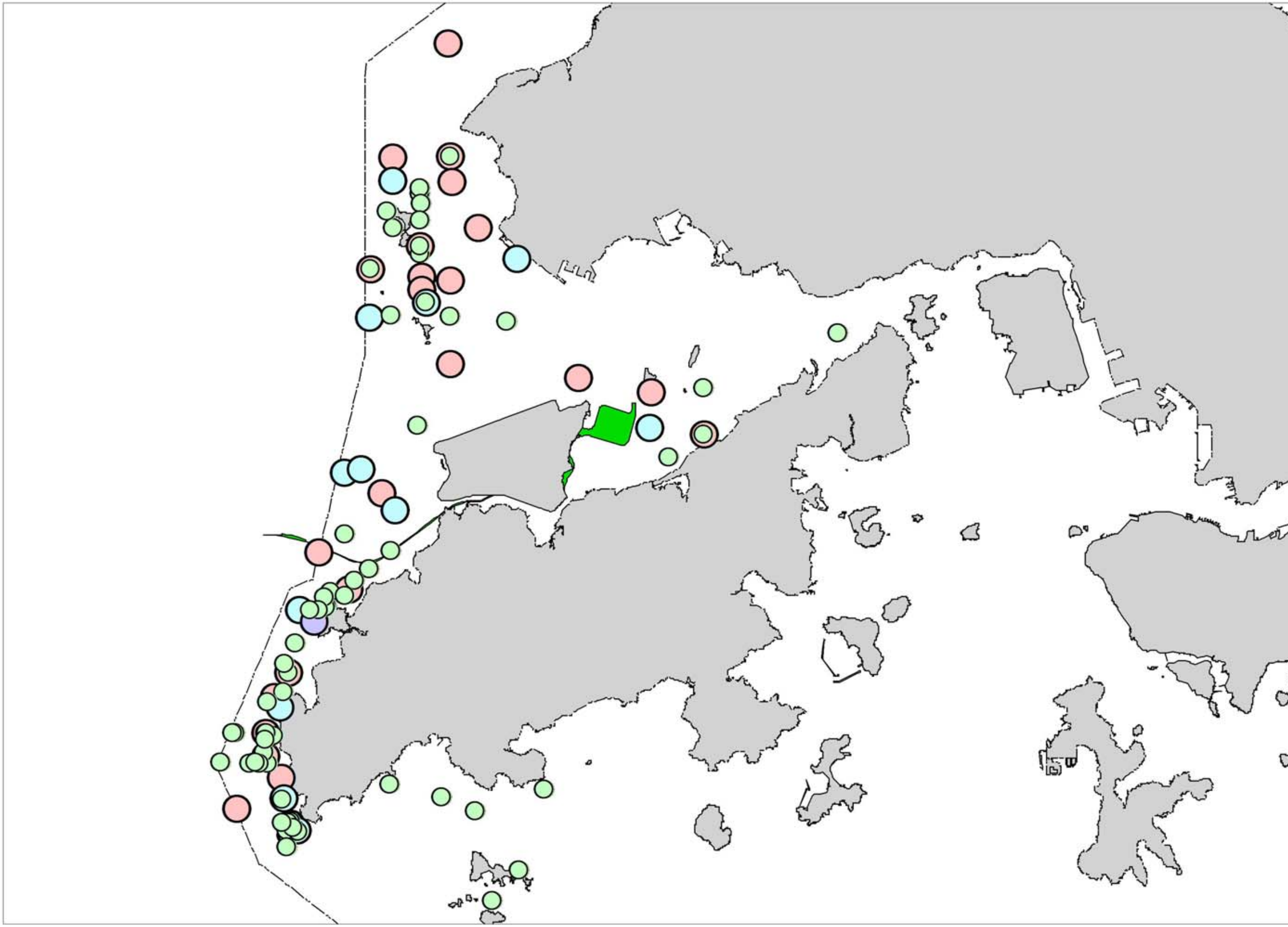


Figure 42. Distribution of Chinese white dolphins engaged in feeding (green dots), socializing (pink dots), traveling (blue dots) and milling (purple dots) activities in 2013

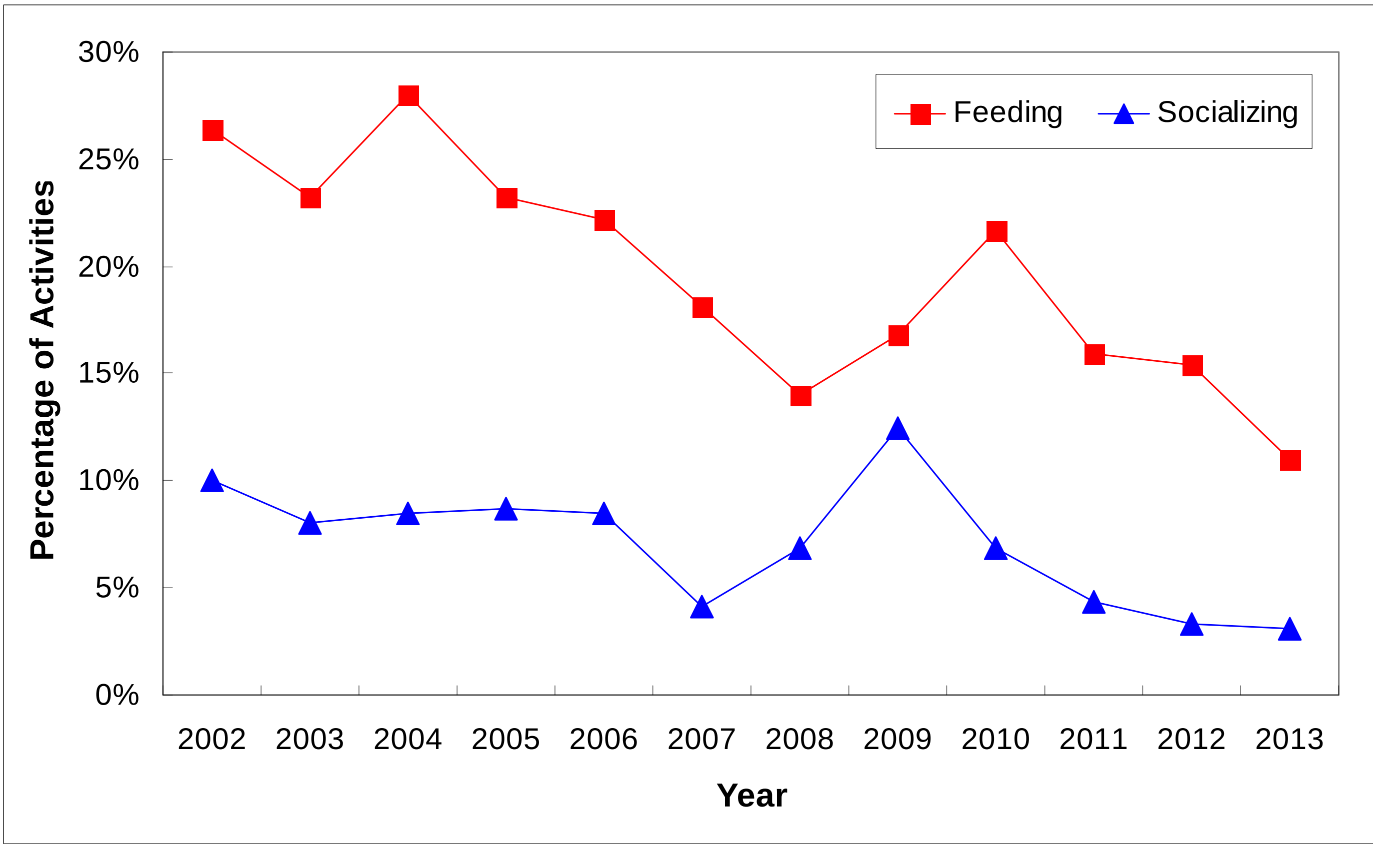


Figure 43. Percentages of feeding and socializing activities among all dolphin groups sighted in Hong Kong during 2002-13

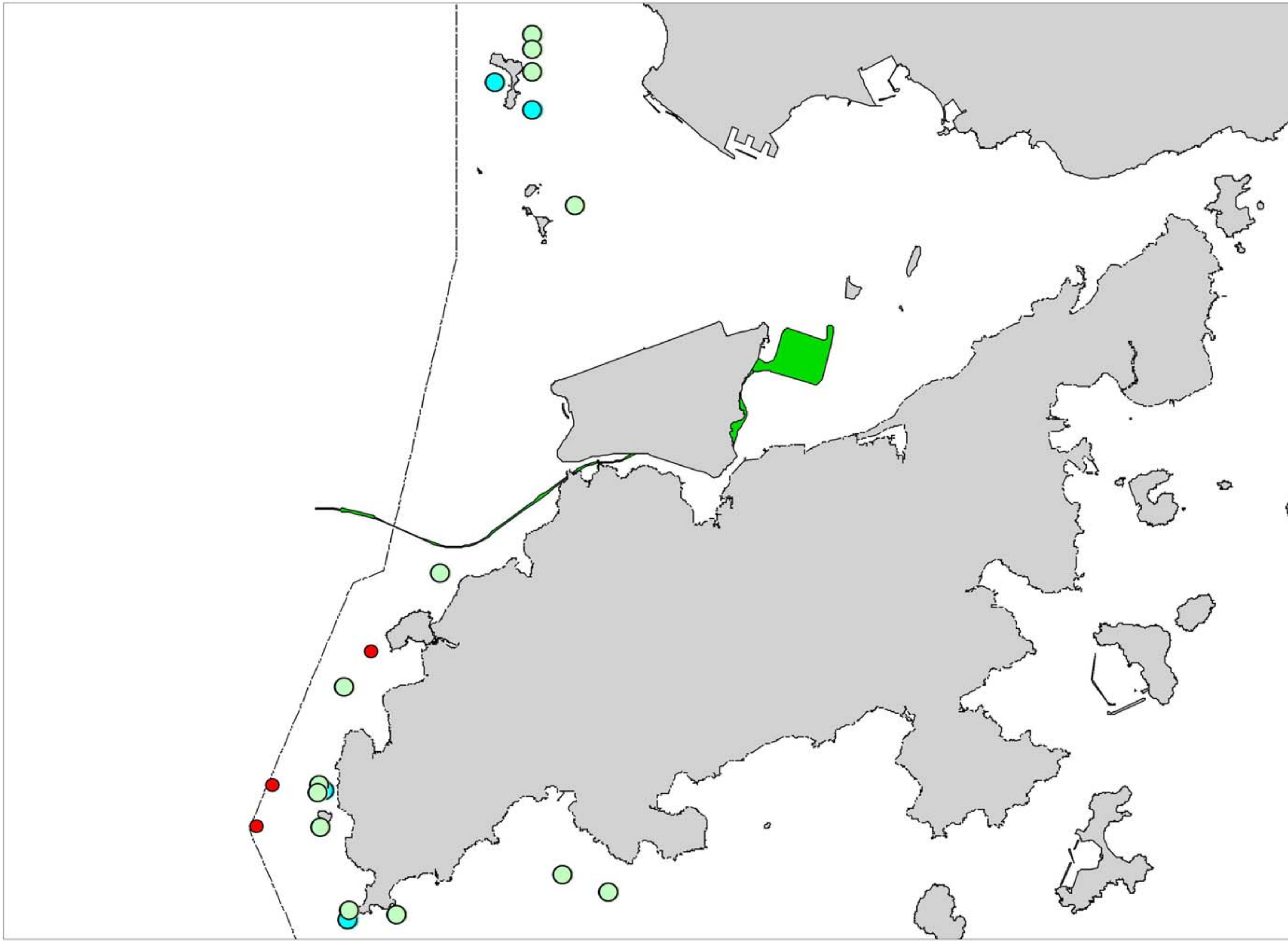


Figure 44. Distribution of dolphin sightings associated with fishing boats in 2013
(green dots: with purse-seiners, blue dots: with gill-netters; red dots: with bottom trawlers)

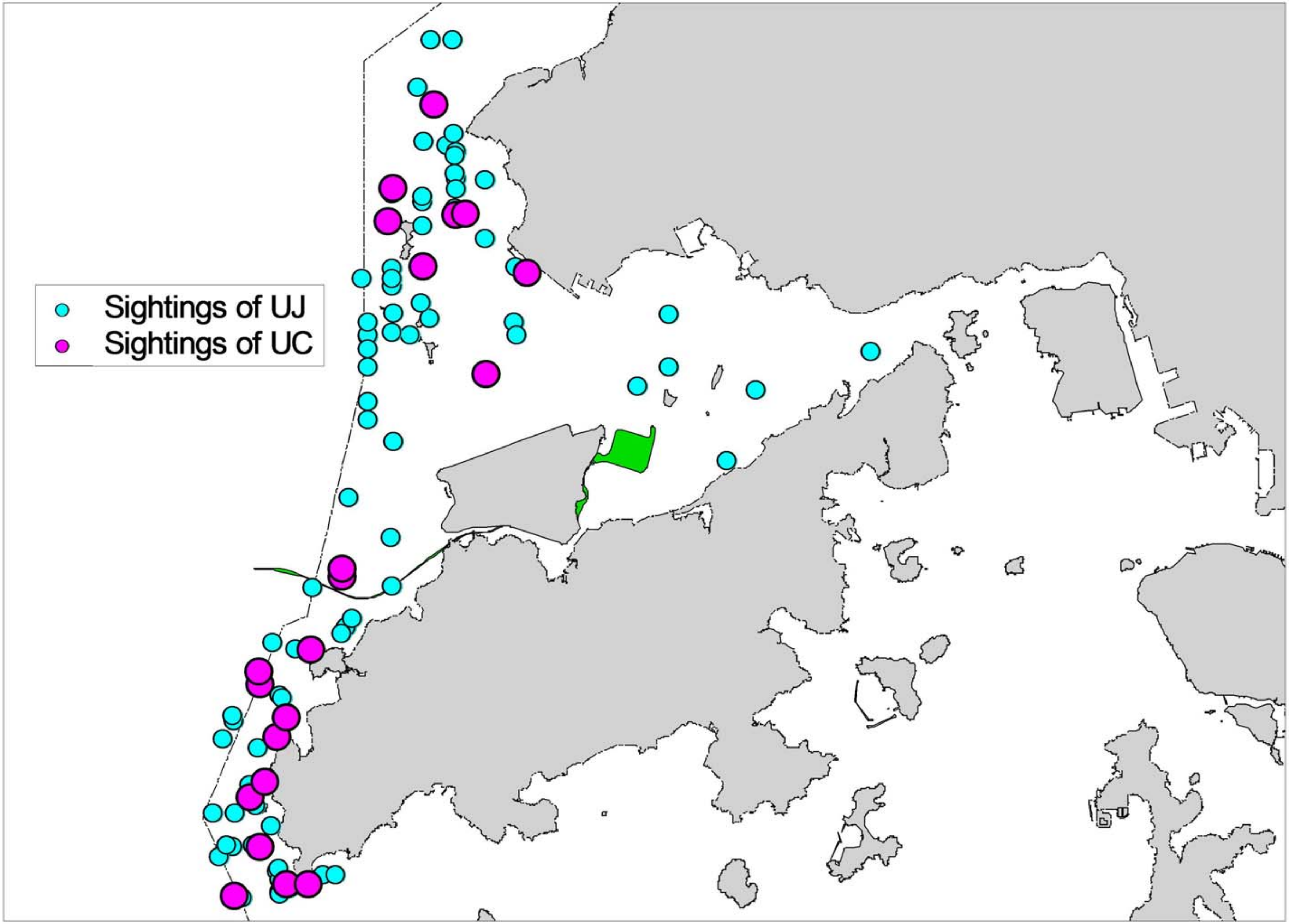


Figure 45. Distribution of Unspotted Calves (UC) & Unspotted Juveniles (UJ) during 2013 monitoring surveys

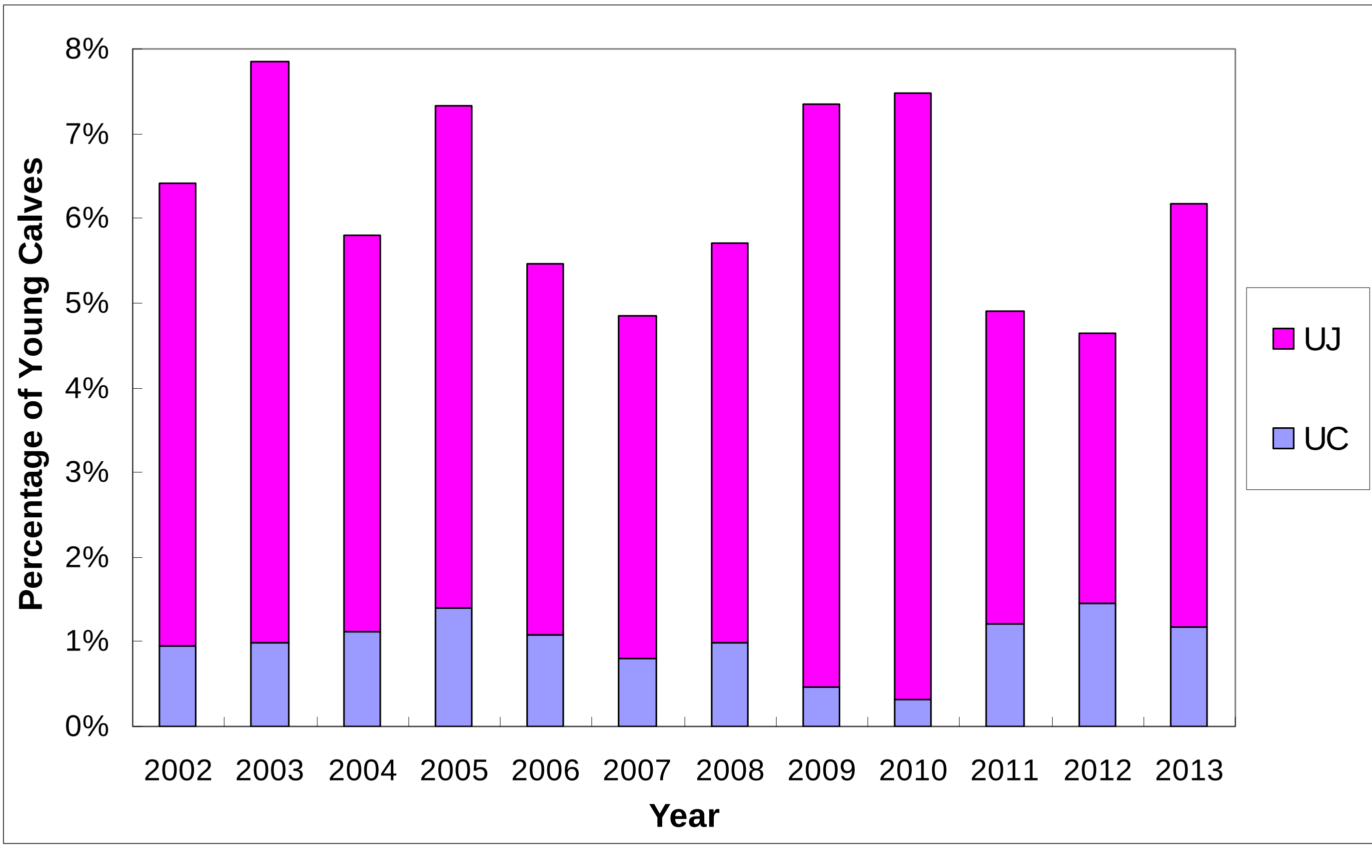


Figure 46. Percentages of young calves (i.e. unspotted calves (UC) and unspotted juveniles (UJ)) among all dolphin groups during 2002-13

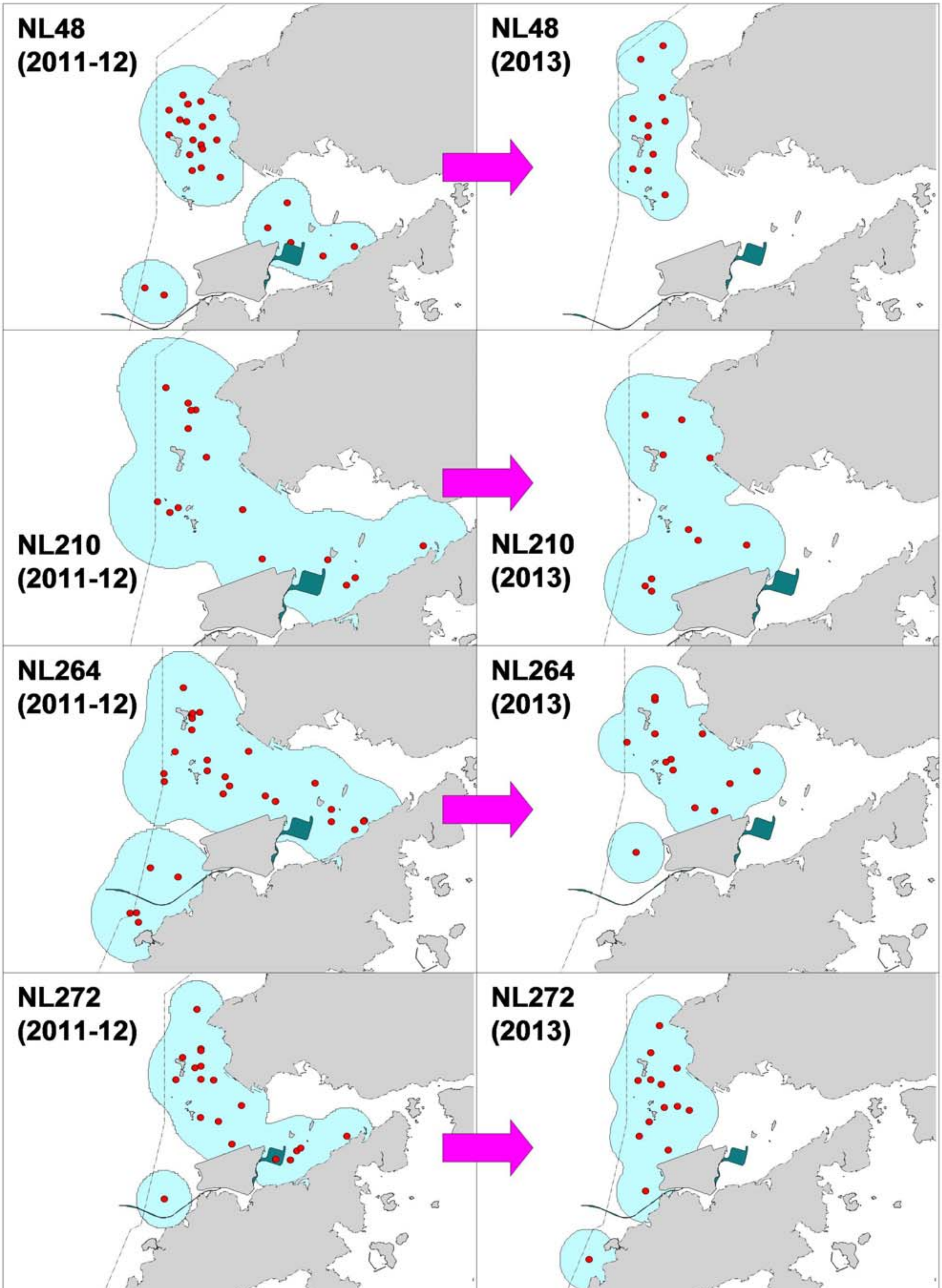


Figure 47. Examples of four individual dolphins with range shift away from the Brothers Islands between the two periods of 2011-12 and 2013

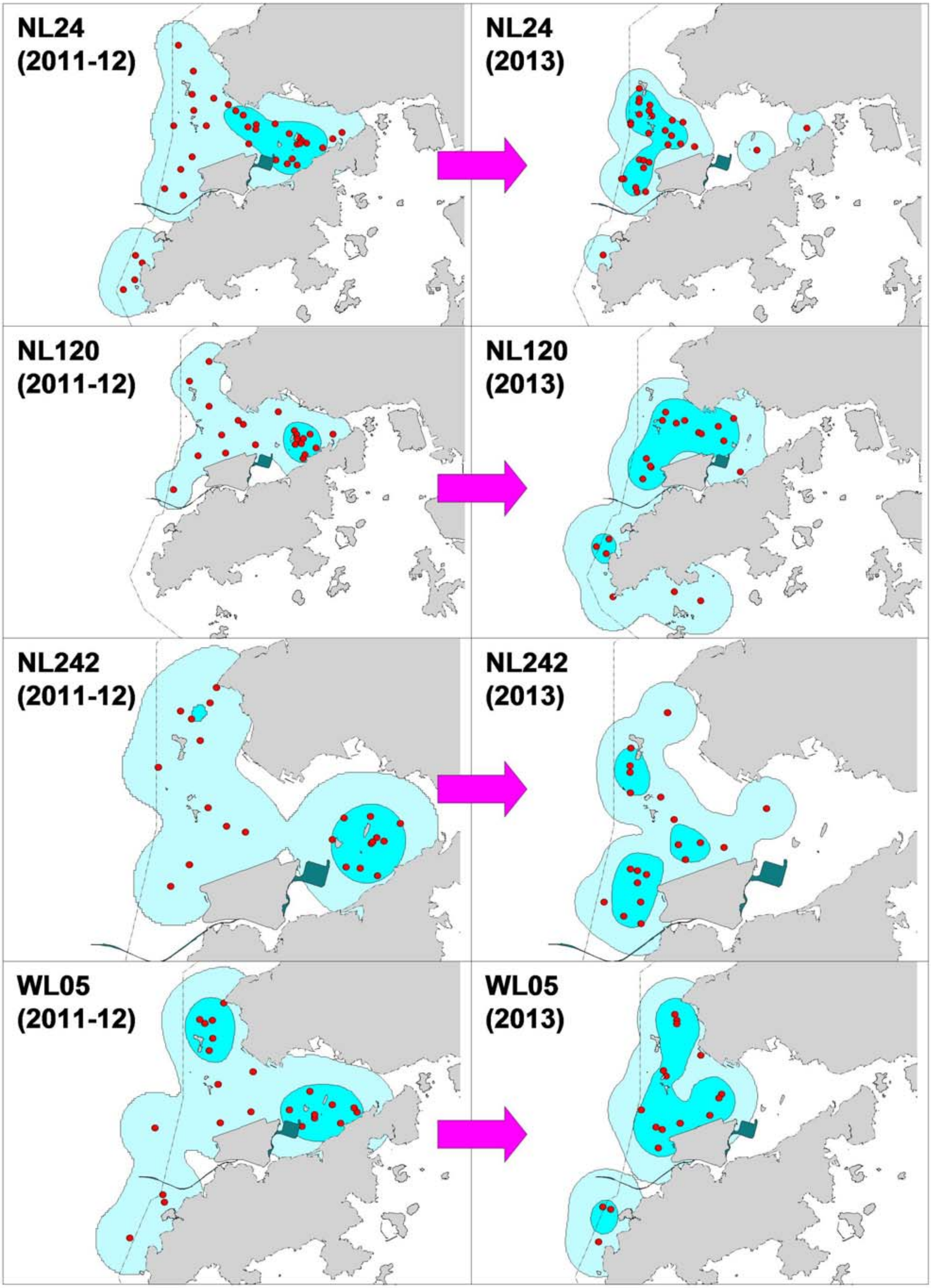


Figure 48. Examples of four individual dolphins with core area shift away from the Brothers Islands between the two periods of 2011-12 and 2013

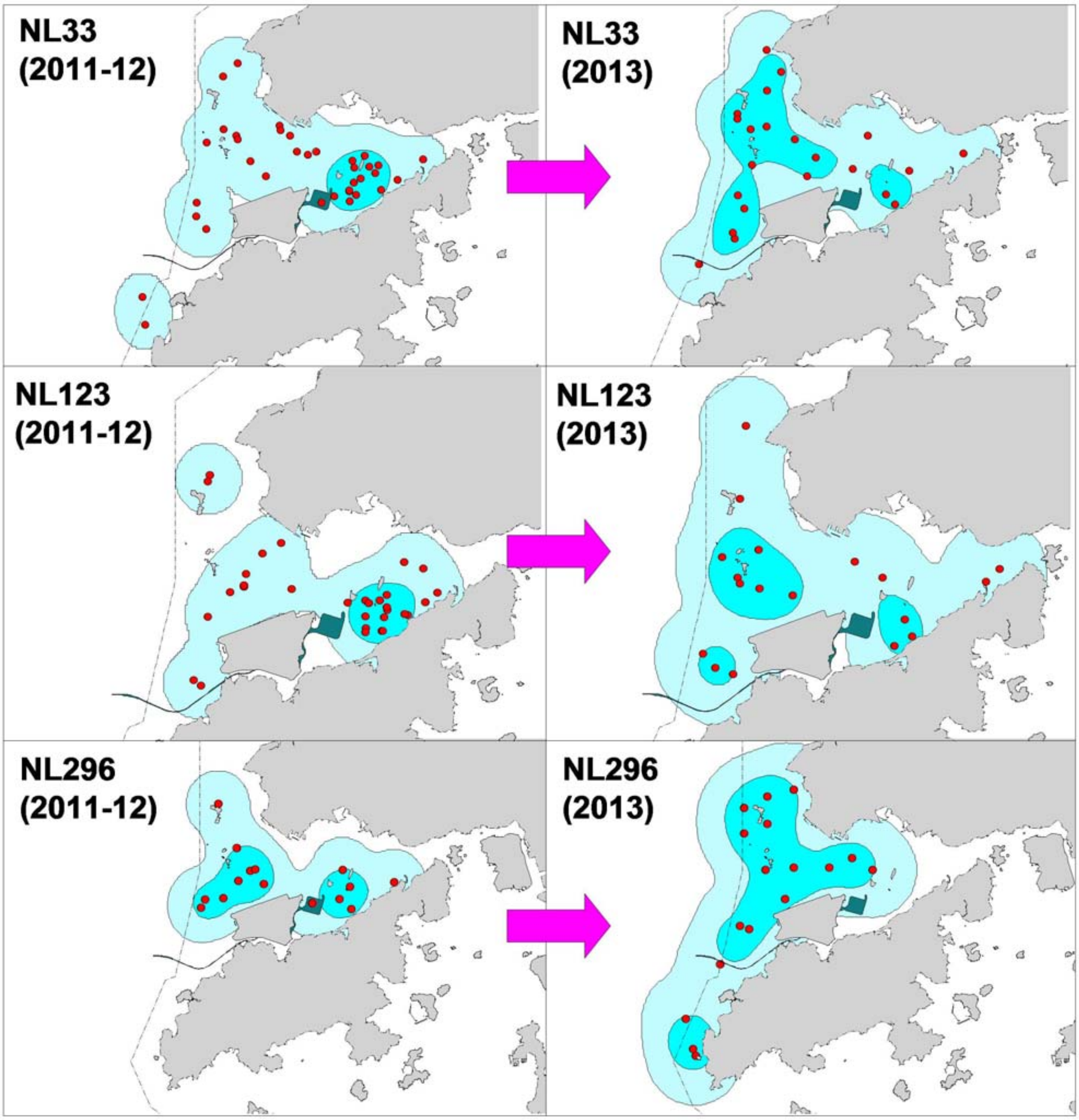


Figure 49. Examples of three individual dolphins with no apparent core area shift between the two periods of 2011-12 and 2013

Figure 50. Twenty-one focal follow tracks of individual or group of Chinese White Dolphins sighted in 2012-14

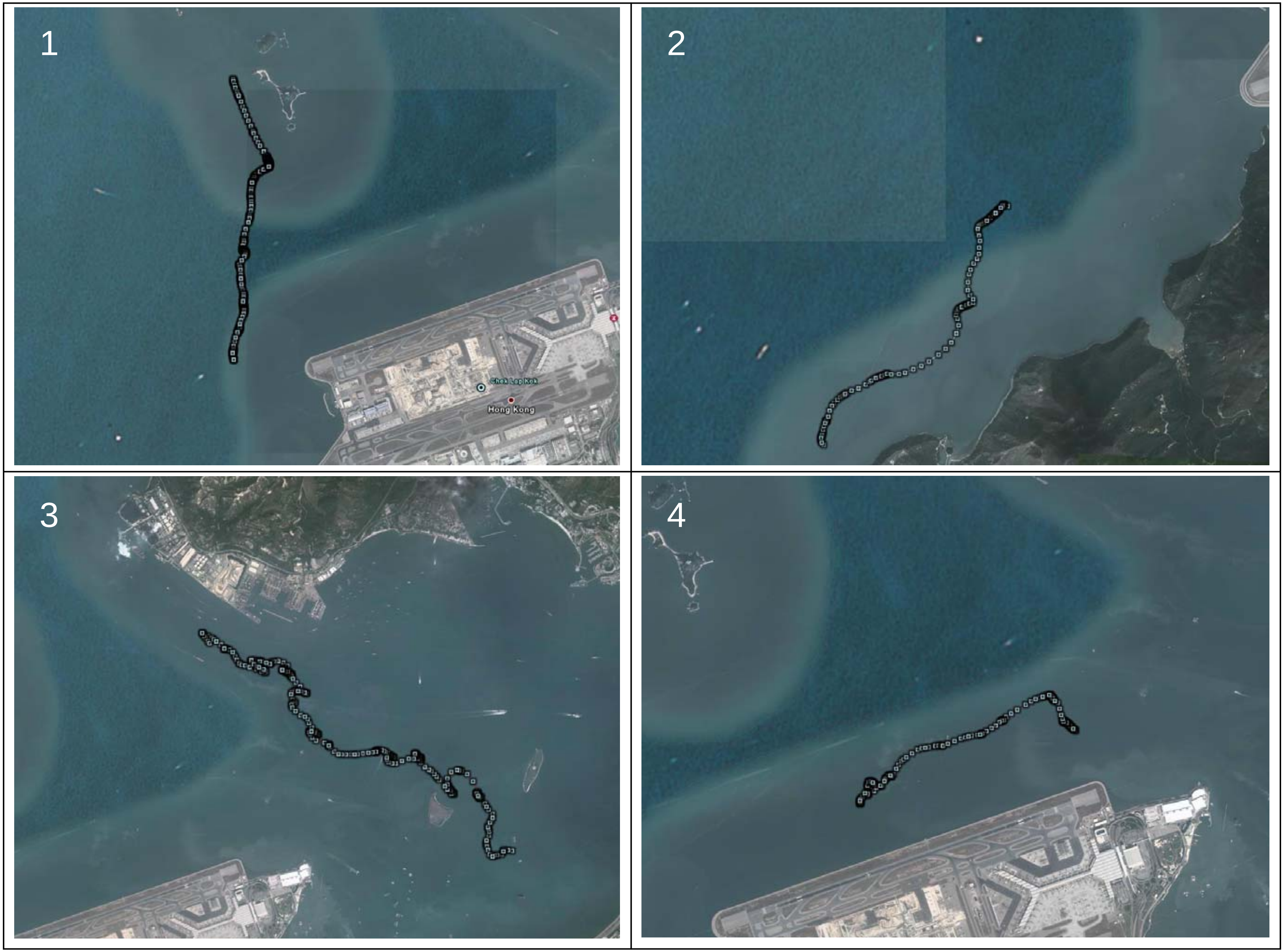


Figure 51. Four typical tracks indicating individual movement patterns between NWL, NEL and WL (1: along western boundary of North Lantau; 2: along the northwest shore of Lantau; 3: along the Urmston Road; 4: along the northern edge of airport platform)

Figure 52. Fifteen tracks of individual or group of Chinese White Dolphins observed during shore-based theodolite tracking sessions at Sham Wat in 2013 (figure on right: theodolite tracks overlapped with focal follow tracks from Figure 50)

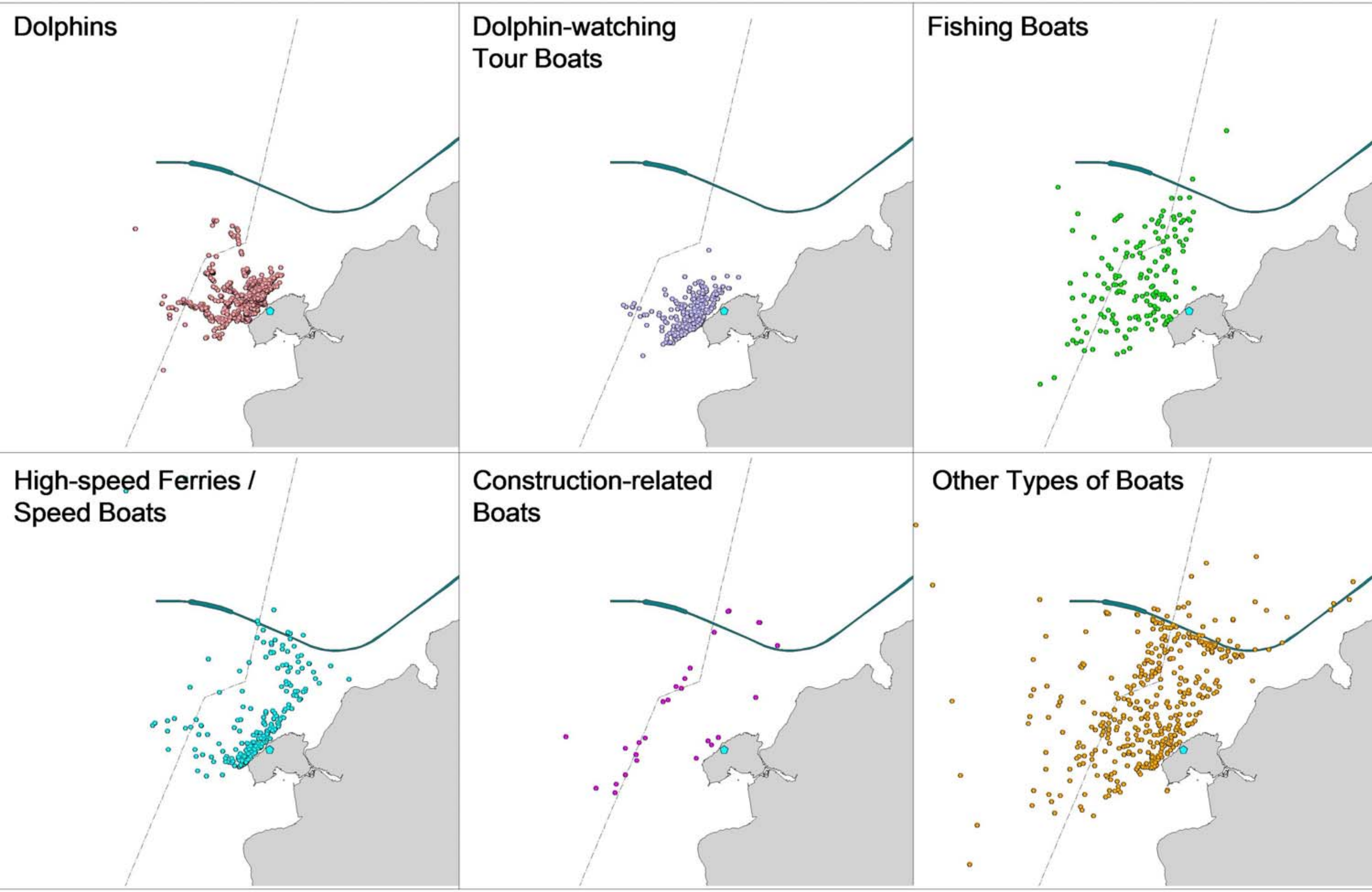


Figure 53. Fix positions under different categories during eight shore-based theodolite tracking sessions at Tai O

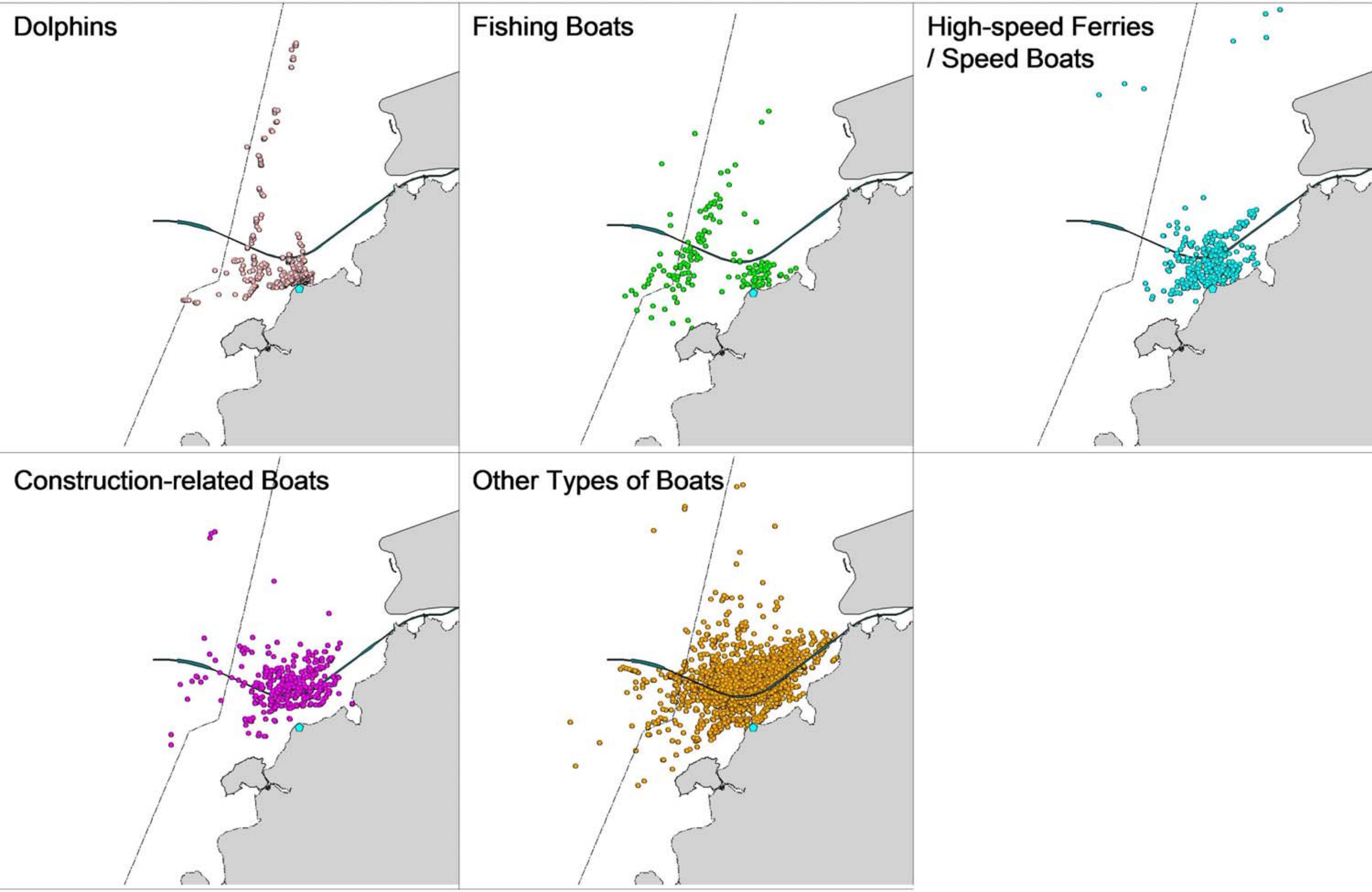


Figure 54. Fix positions under different categories during 13 shore-based theodolite tracking sessions at Sham Wat

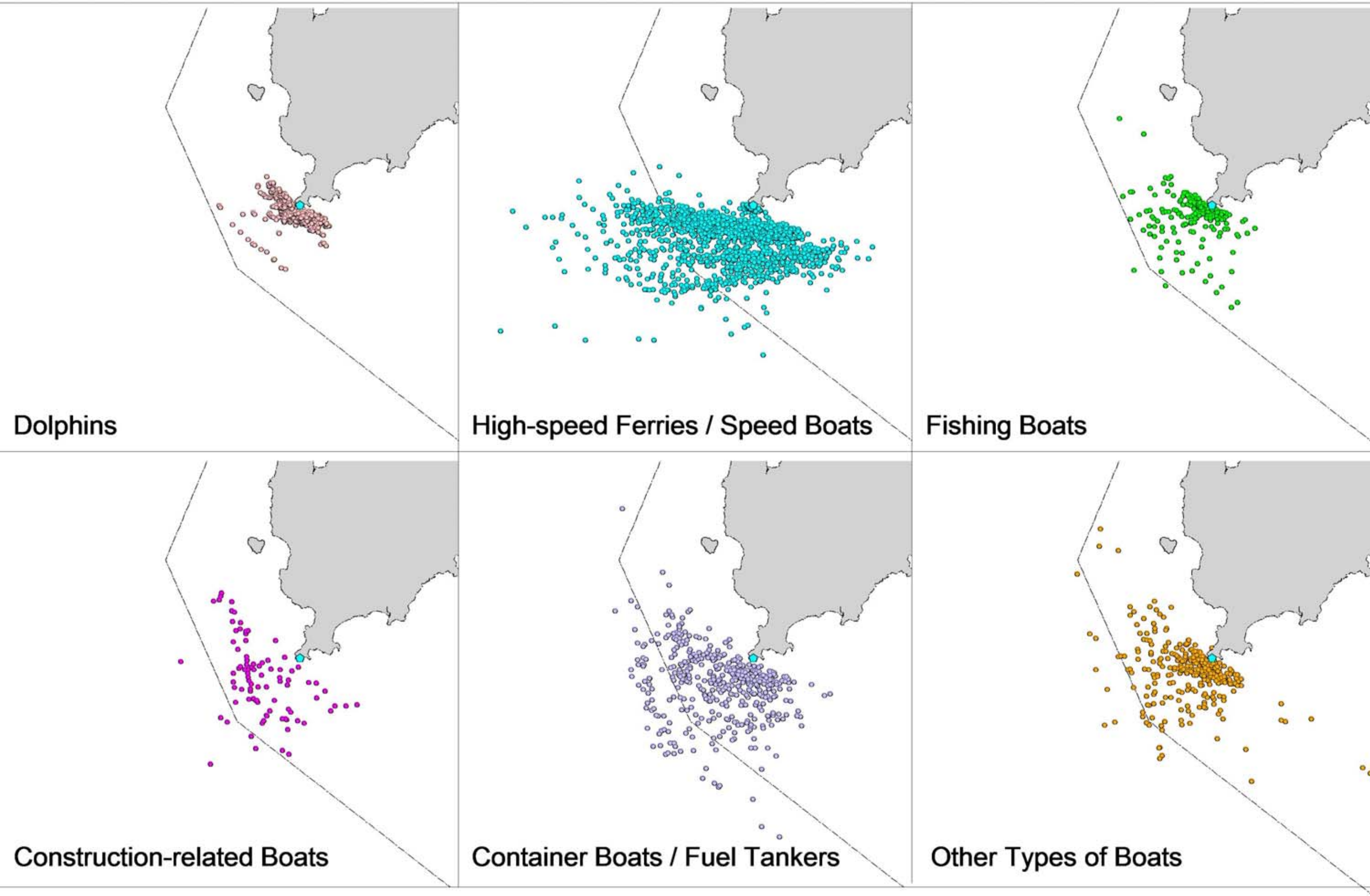


Figure 55. Fix positions under different categories during nine shore-based theodolite tracking sessions at Fan Lau

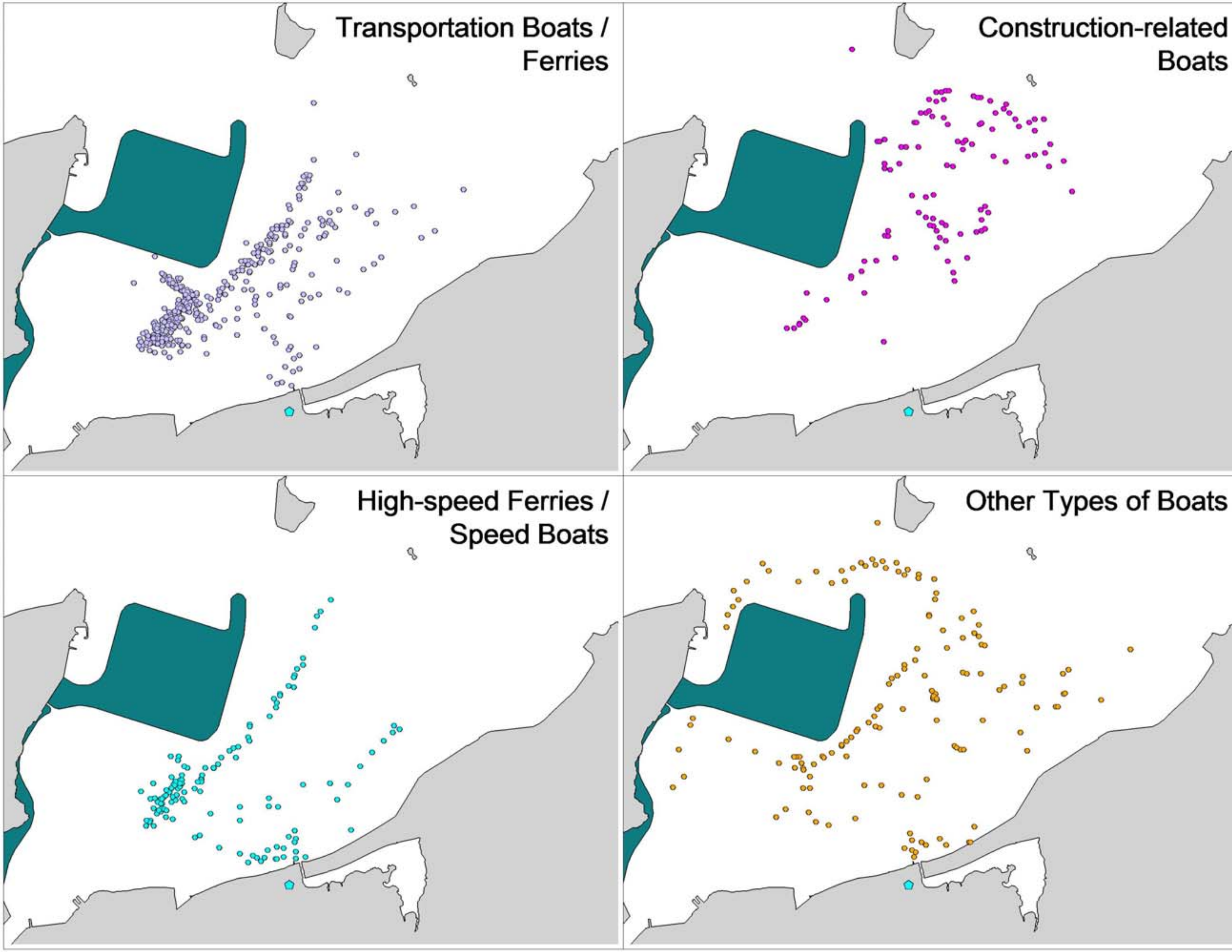


Figure 56. Fix positions under different categories during two shore-based theodolite tracking sessions at Tai Ho Wan

Figure 57. The four locations of C-POD deployments in western waters of Hong Kong in 2013

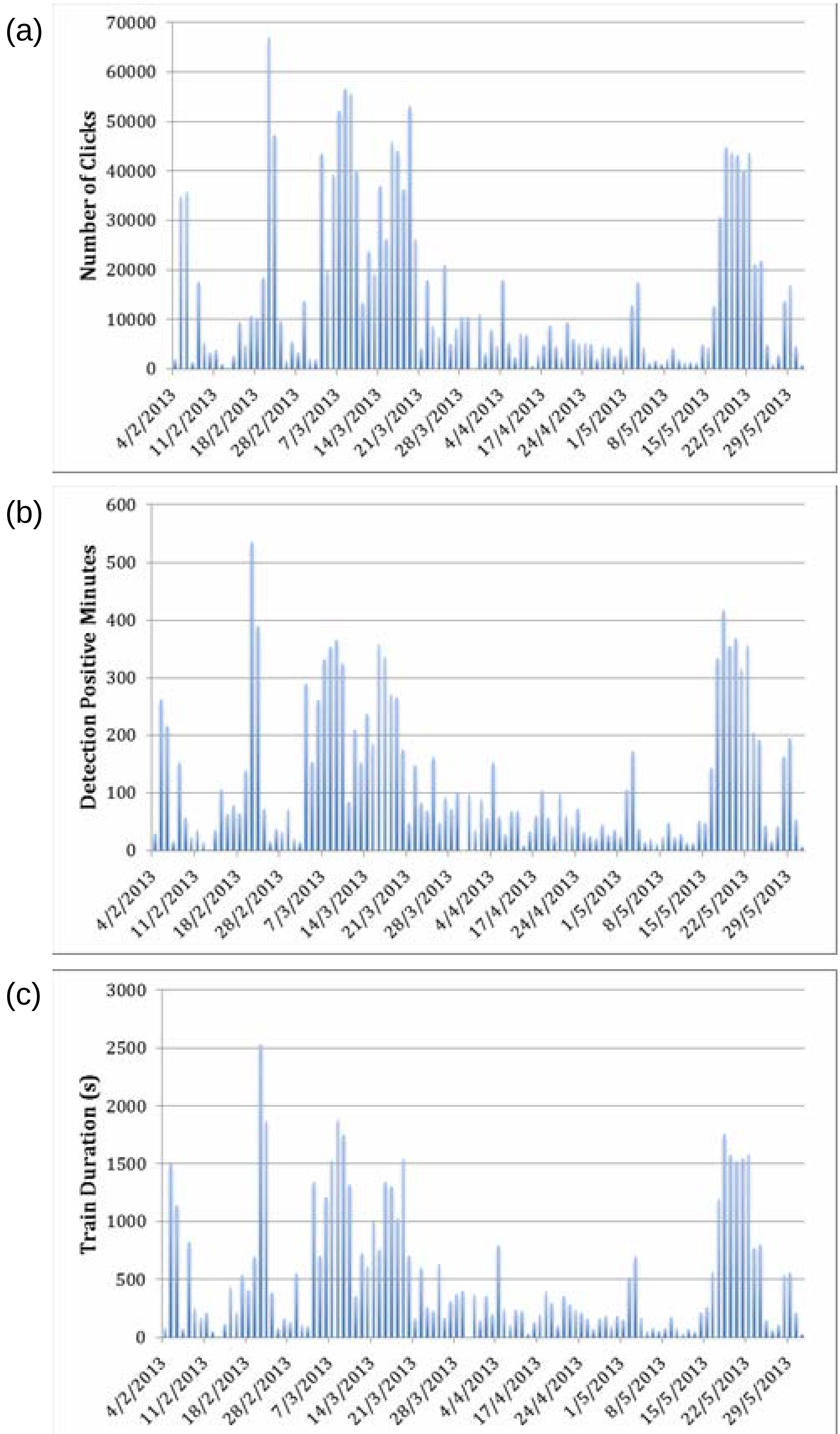


Figure 58. Daily number of dolphin clicks (a), daily detection positive minutes (b) and daily train duration (c) obtained from the C-POD deployment at Fan Lau

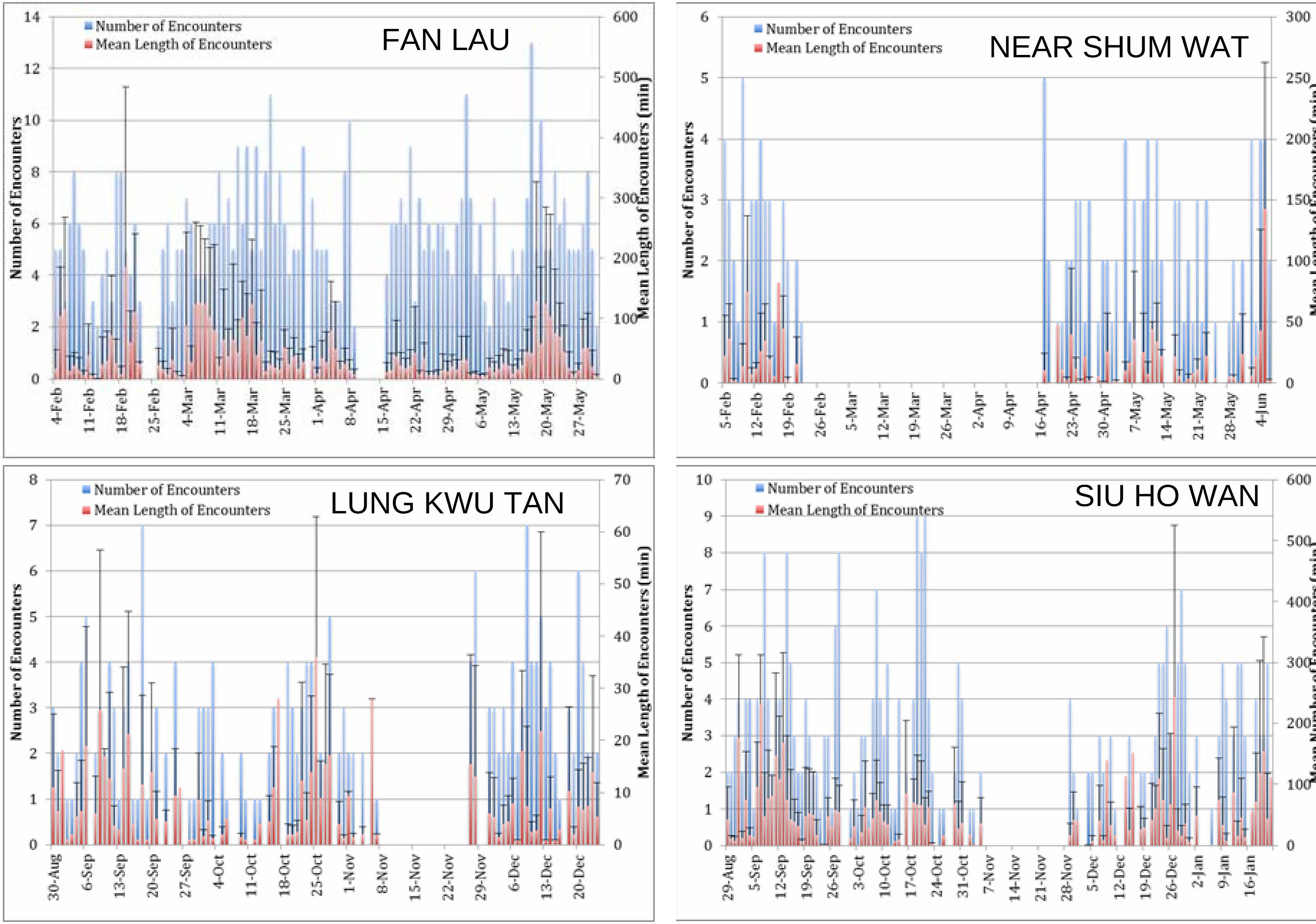


Figure 59. Number of encounters per day (blue bars) and the mean length of encounters per day (red bars) at the four sites where C-POD were deployed. Error bays represent standard deviation.

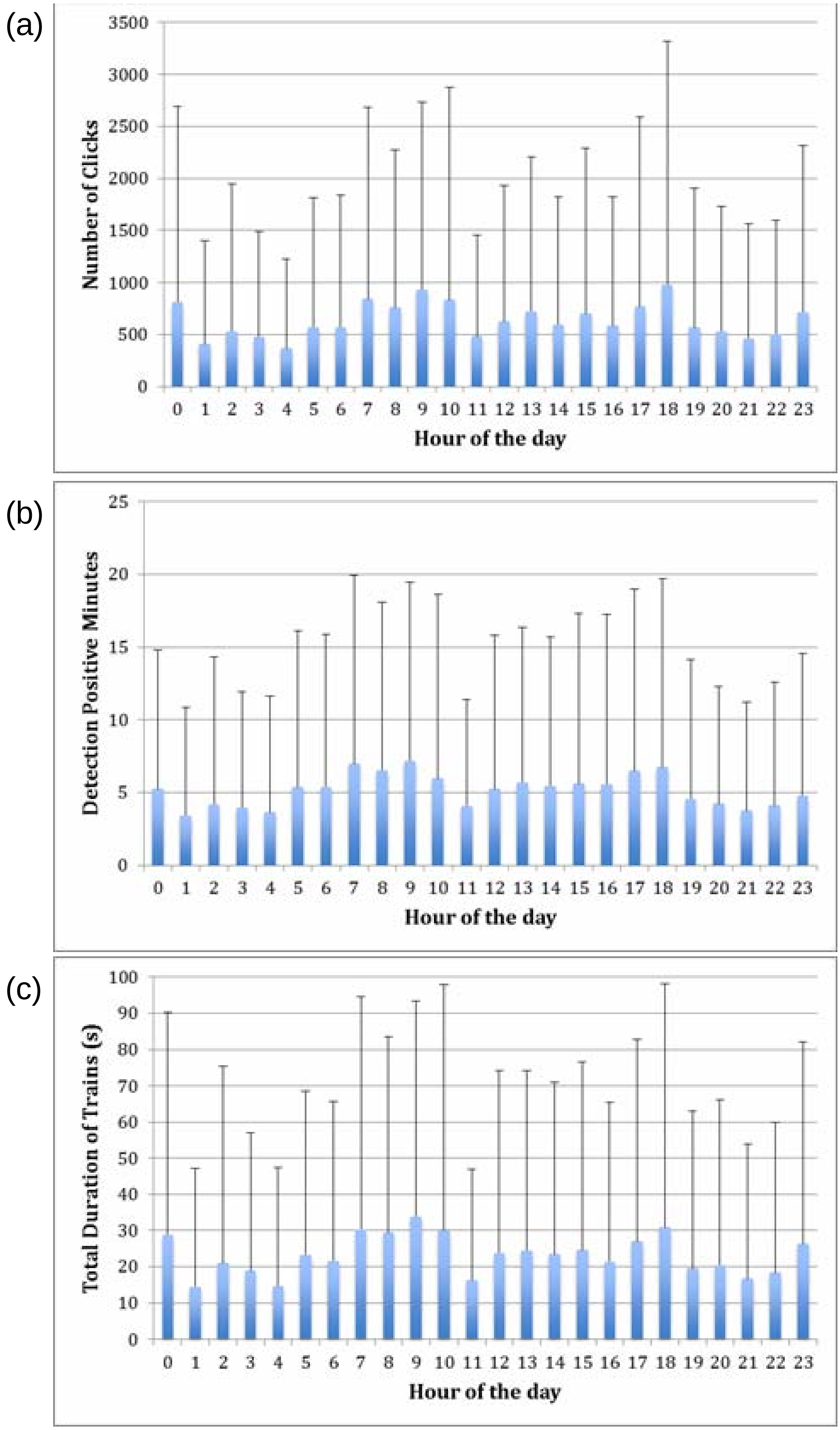


Figure 60. Number of dolphin clicks (a), detection positive minutes (b) and total duration of trains (c) as a function of time of day obtained from the C-POD deployment at Fan Lau. The day period is 06:00 to 17:59 and night period is 18:00 to 05:59. Error bars represent standard deviation.

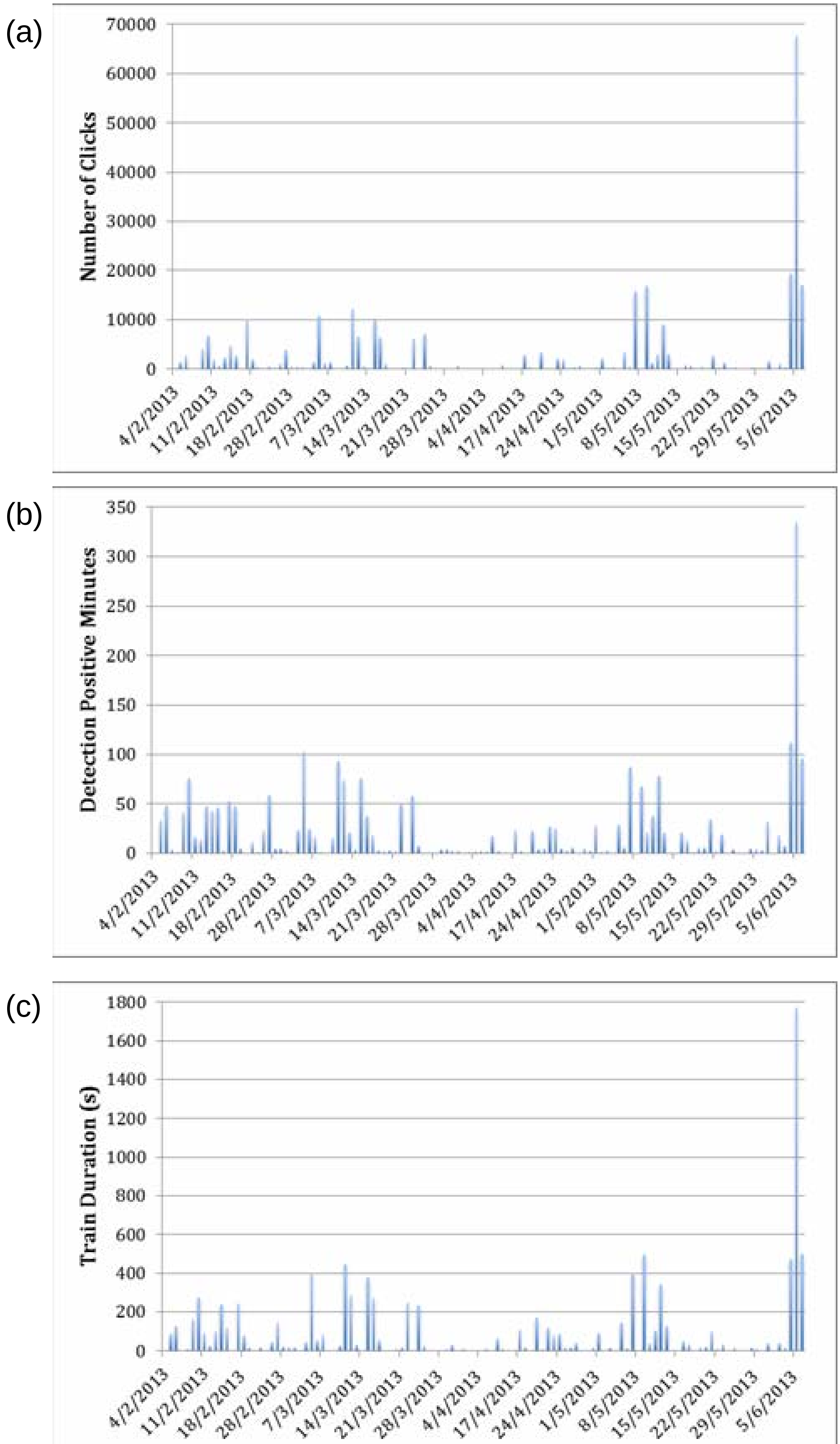


Figure 61. Daily number of dolphin clicks (a), daily detection positive minutes (b) and daily train duration (c) obtained from the C-POD deployment near Sham Wat

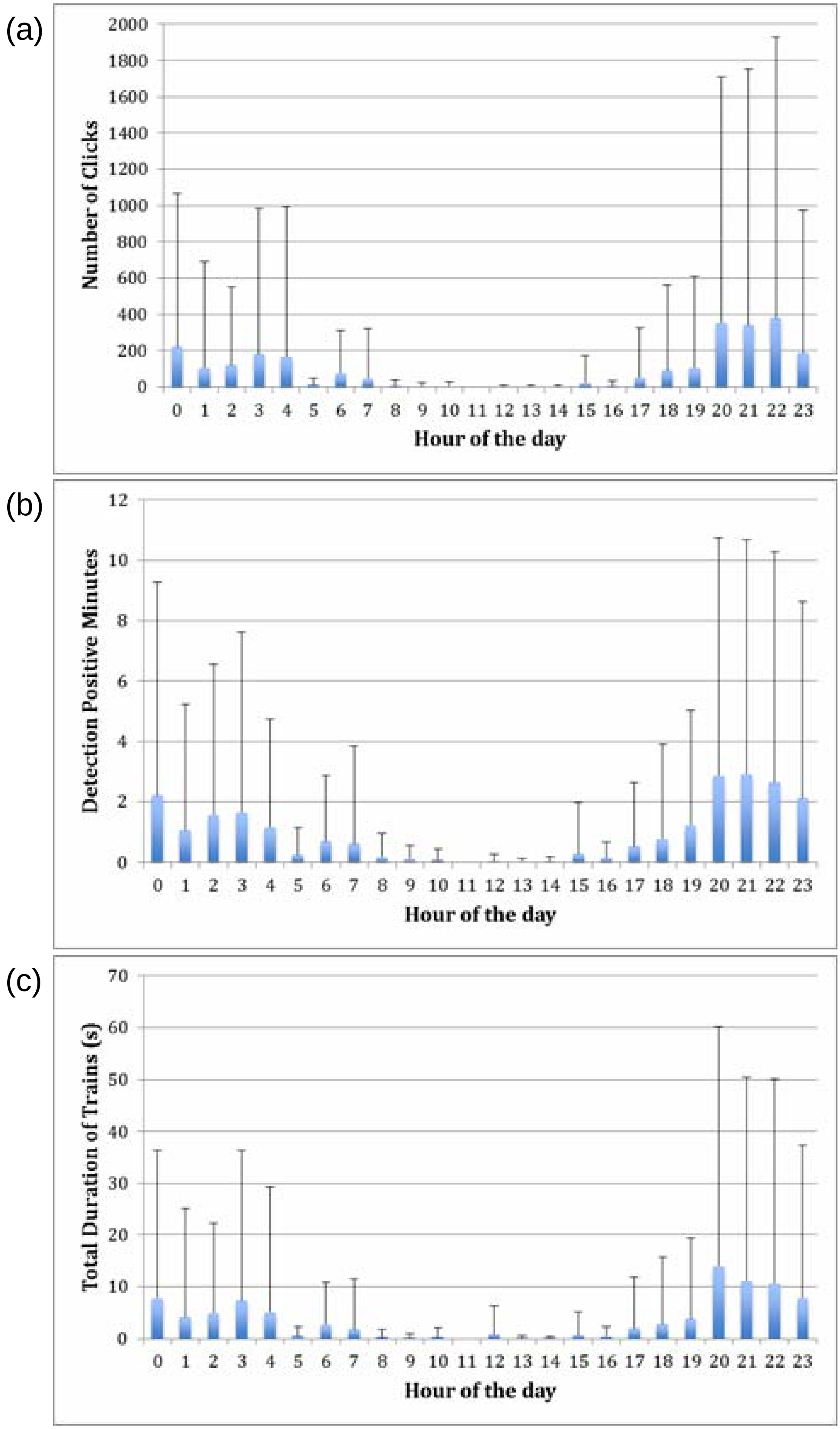


Figure 62. Number of dolphin clicks (a), detection positive minutes (b) and total duration of trains (c) as a function of time of day obtained from the C-POD deployment near Sham Wat. The day period is 06:00 to 17:59 and night period is 18:00 to 05:59. Error bars represent standard deviation.

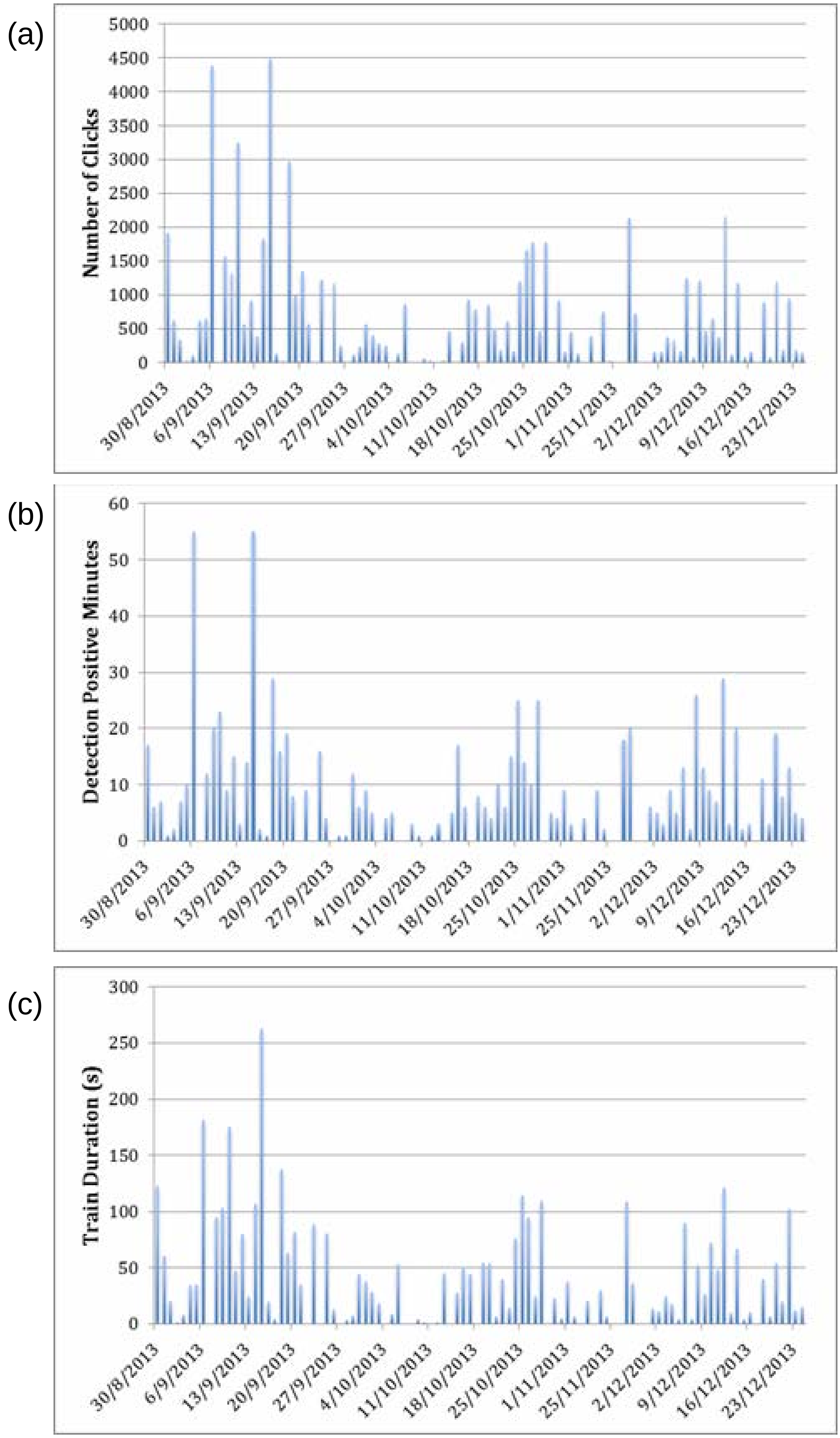


Figure 63. Daily number of dolphin clicks (a), daily detection positive minutes (b) and daily train duration (c) obtained from the C-POD deployment at Lung Kwu Tan

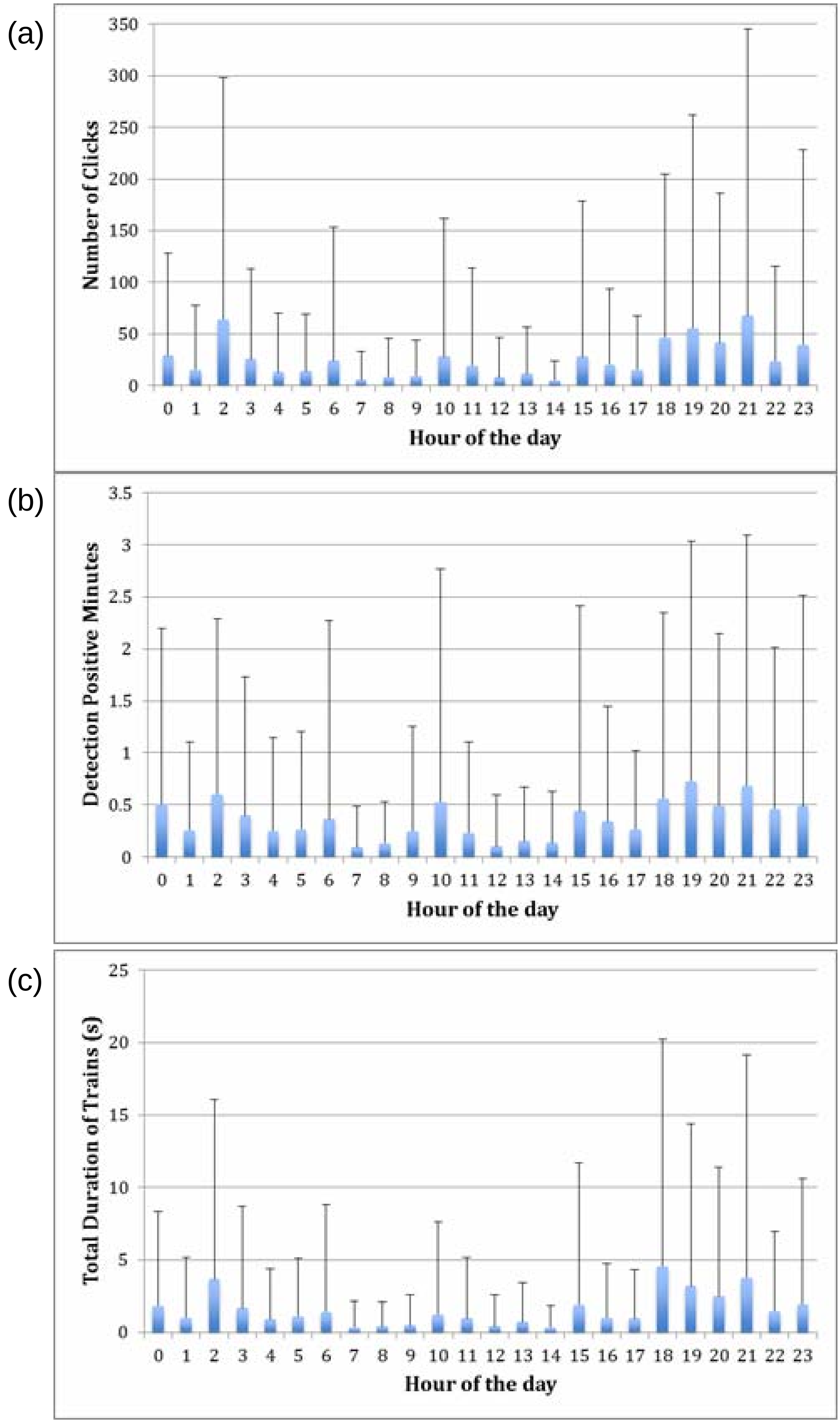


Figure 64. Number of dolphin clicks (a), detection positive minutes (b) and total duration of trains (c) as a function of time of day obtained from the C-POD deployment at Lung Kwu Tan. The day period is 06:00 to 17:59 and night period is 18:00 to 05:59. Error bars represent standard deviation.

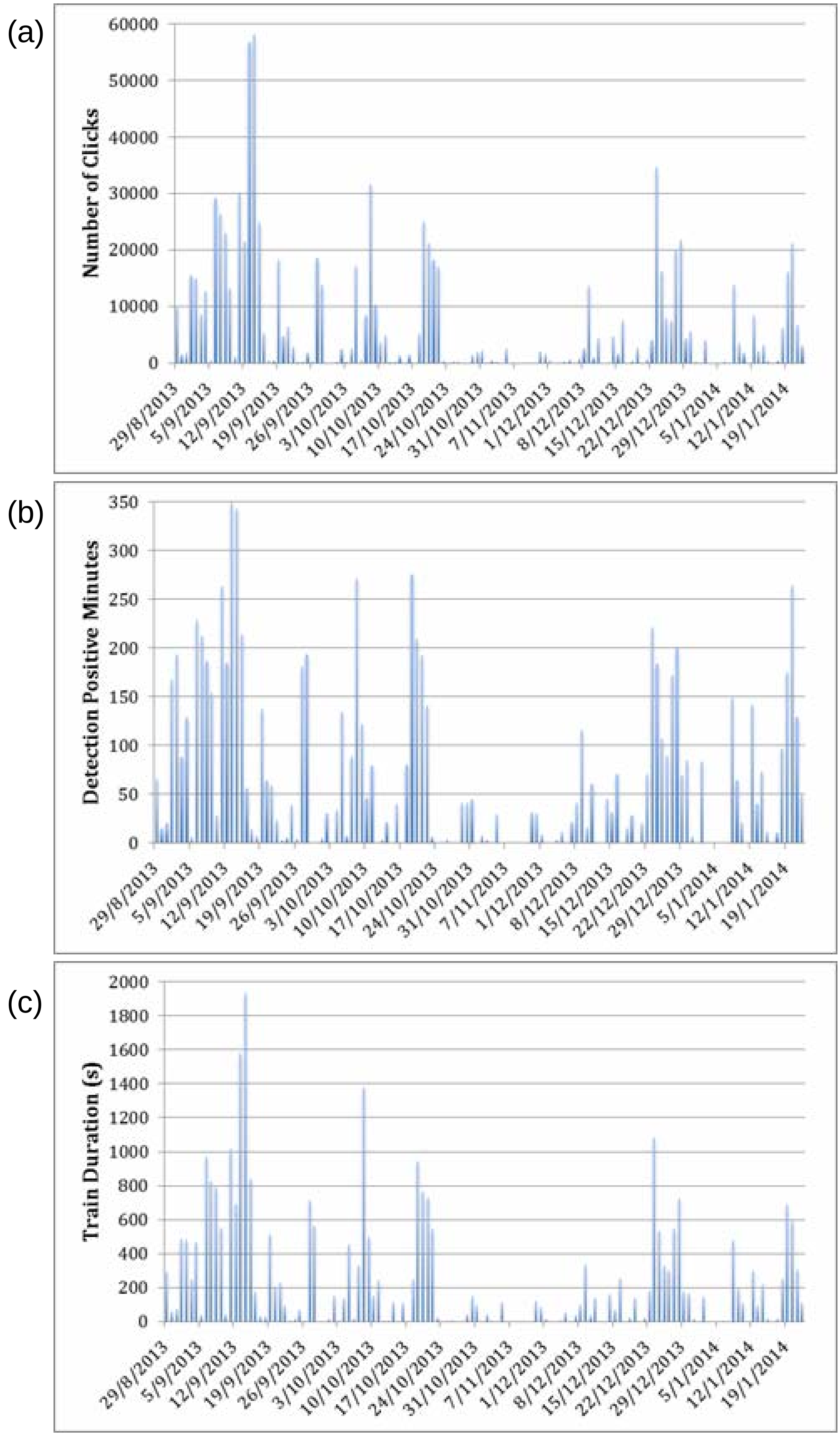


Figure 65. Daily number of dolphin clicks (a), daily detection positive minutes (b) and daily train duration (c) obtained from the C-POD deployment at Siu Ho Wan

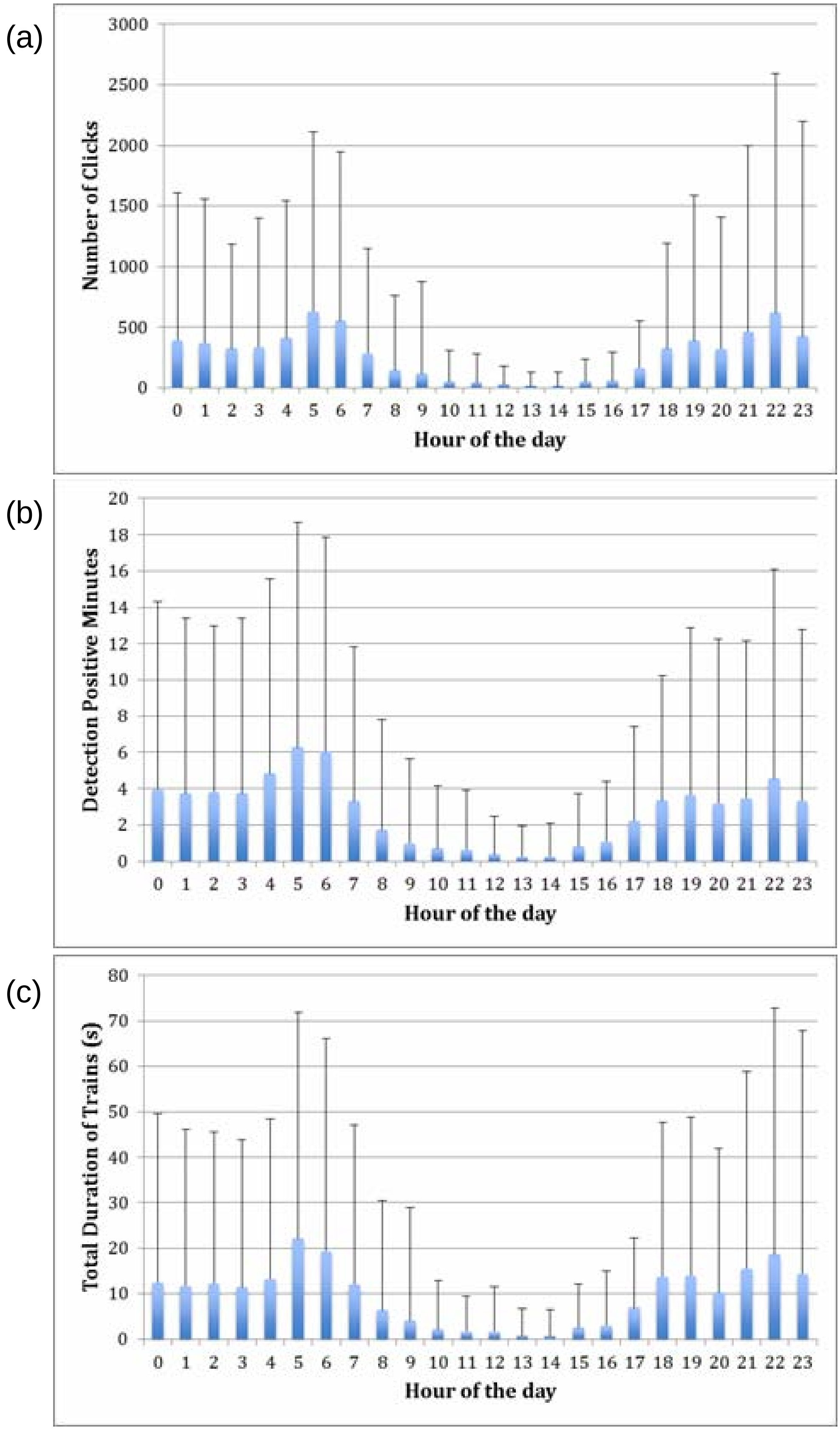


Figure 66. Number of dolphin clicks (a), detection positive minutes (b) and total duration of trains (c) as a function of time of day obtained from the C-POD deployment at Siu Ho Wan. The day period is 06:00 to 17:59 and night period is 18:00 to 05:59. Error bars represent standard deviation.

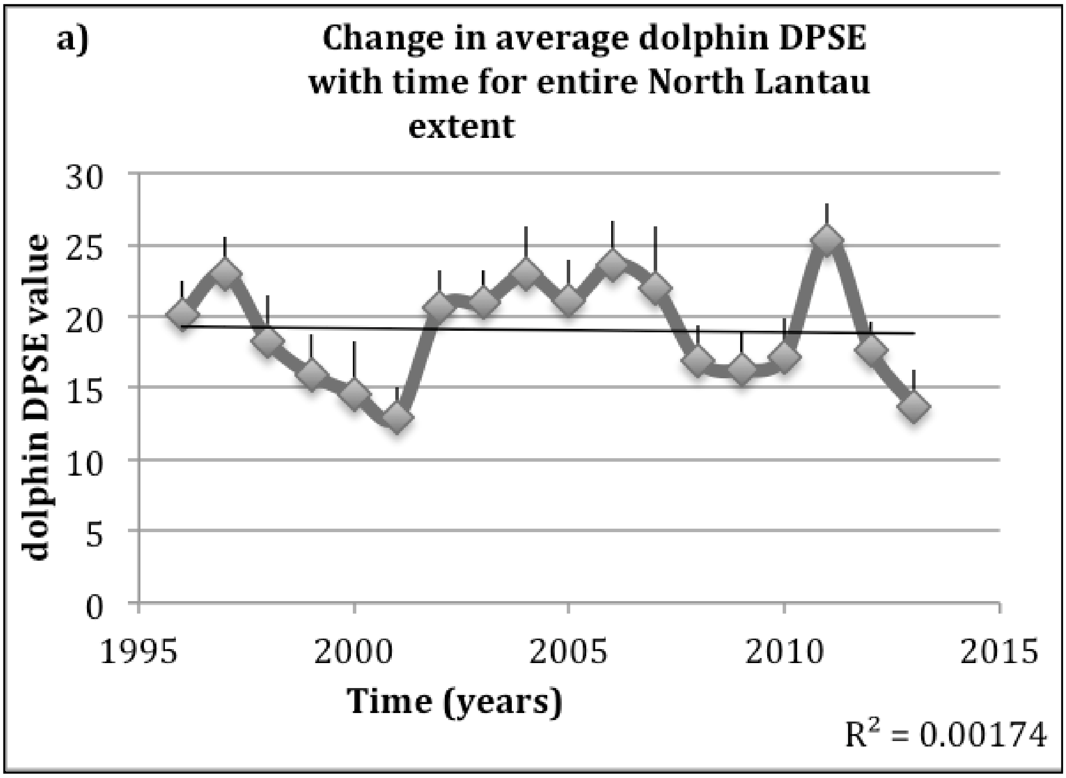


Figure 67a. Linear regression between time and average DPSE over entire North Lantau region (error bars display standard error)

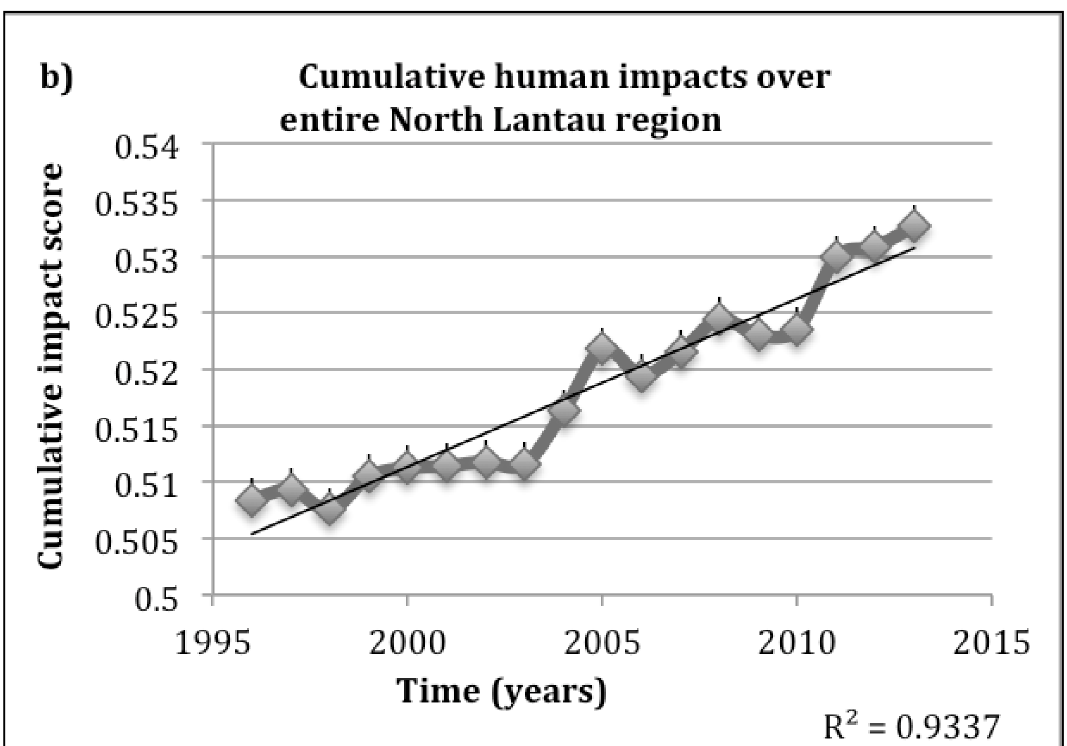


Figure 67b. Linear regression between time and cumulative impacts over entire North Lantau region (error bars display standard error)

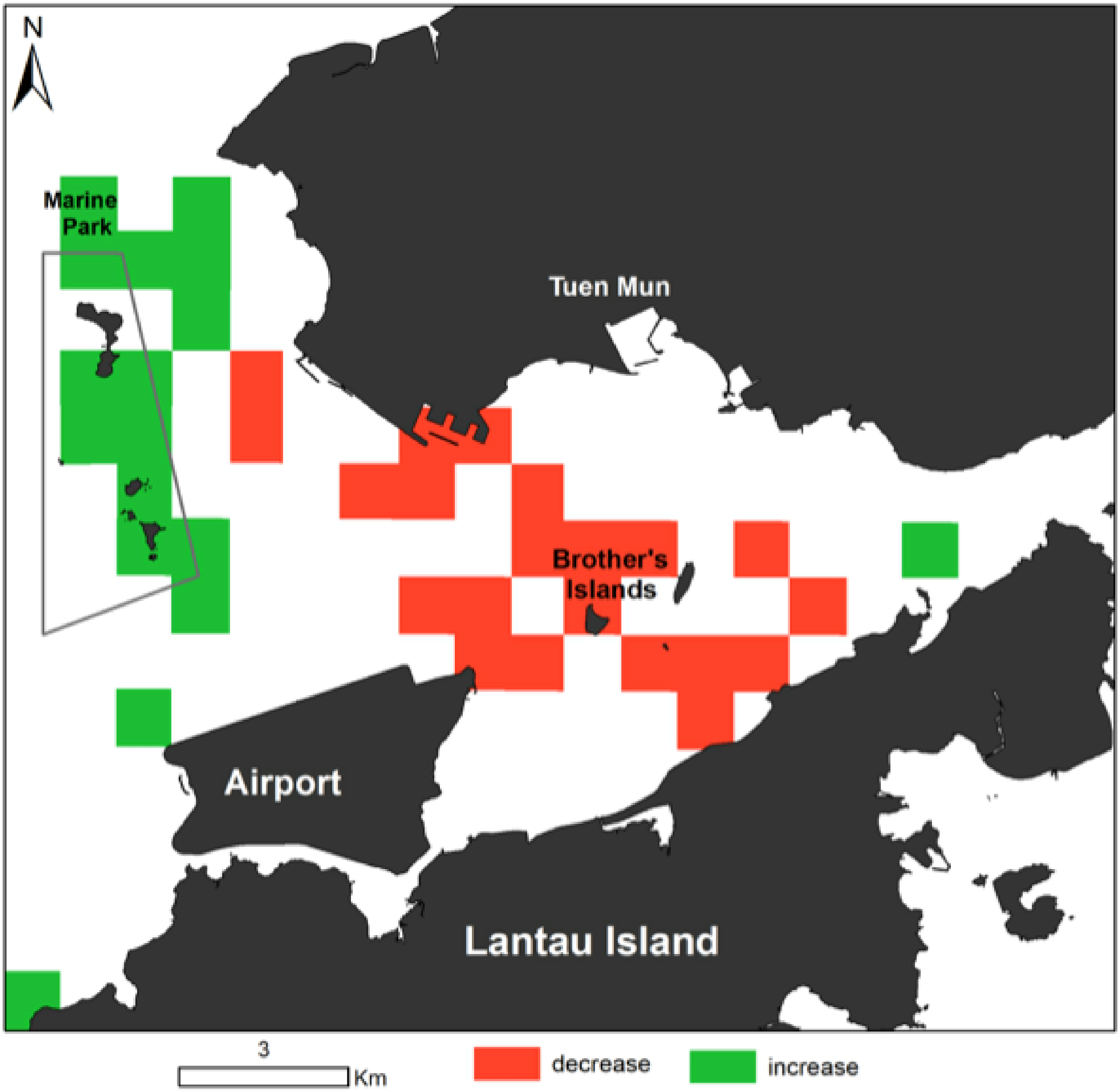


Figure 68. Study extent displaying areas of substantial dolphin density increase (green grids) and decrease (orange grids).

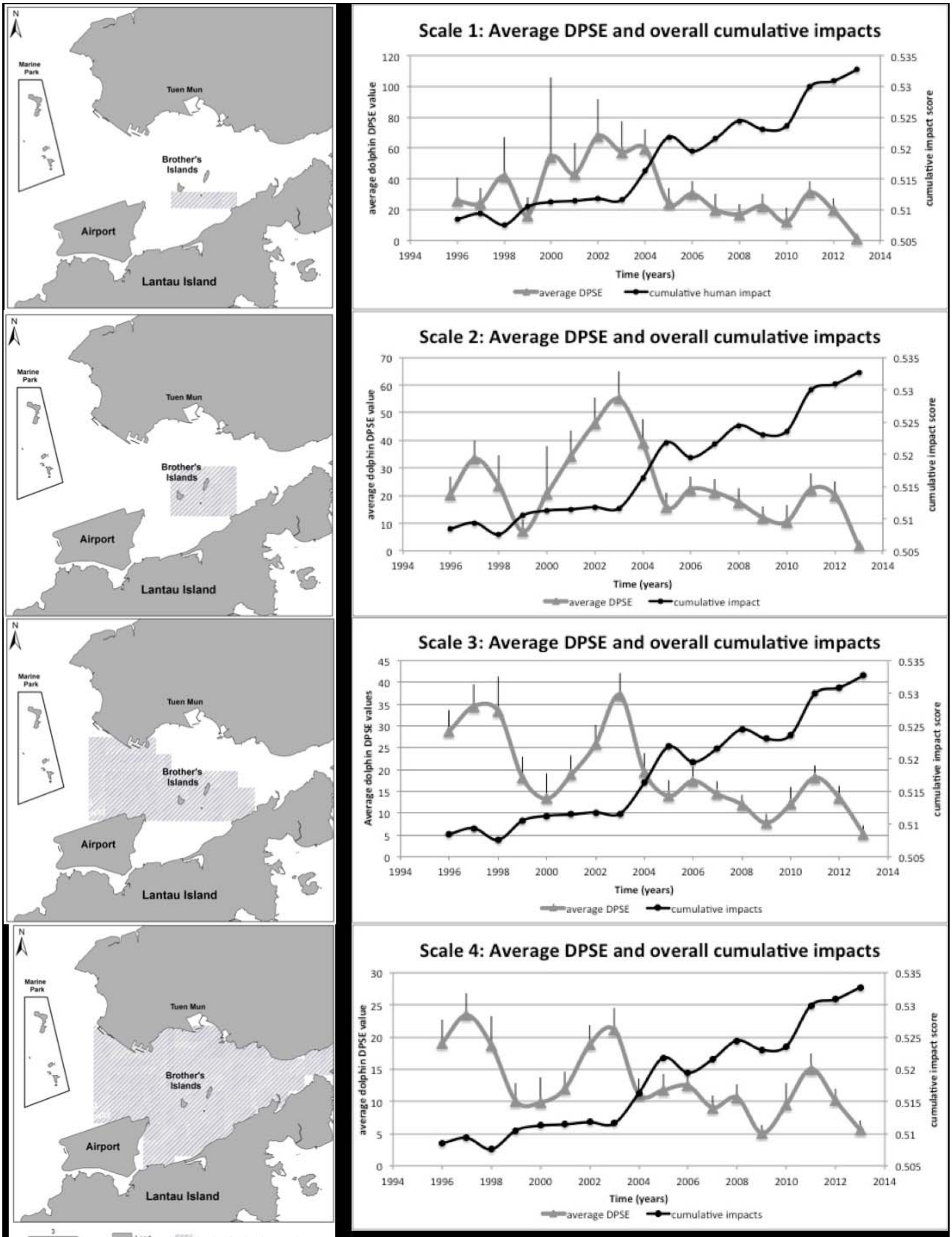


Figure 69. Four different spatial scales and their respective statistical analyses (error bars display standard error).

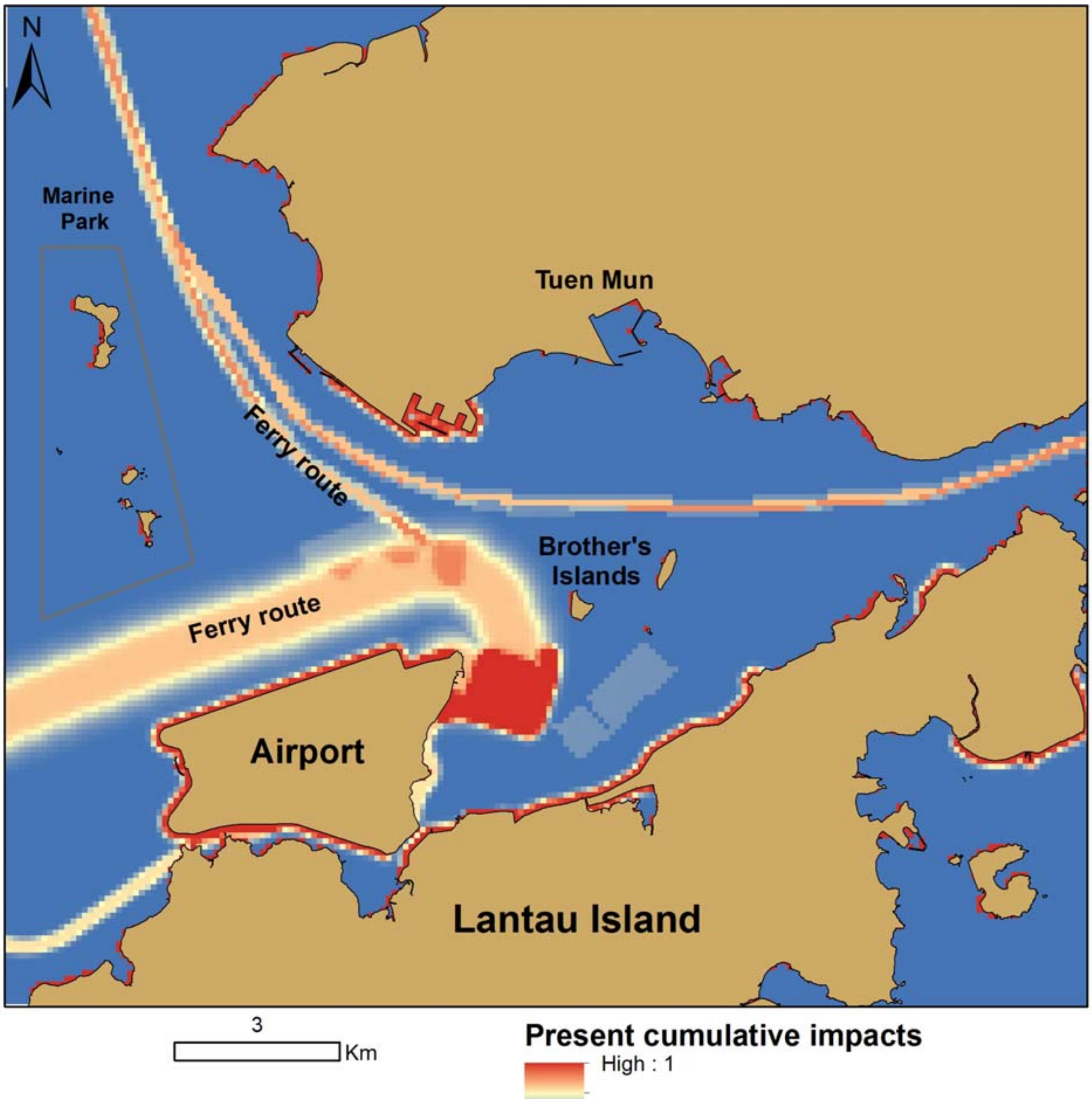


Figure 70. Present cumulative human impacts in North Lantau waters (note the ferry route between the marine park and the Brothers Islands.

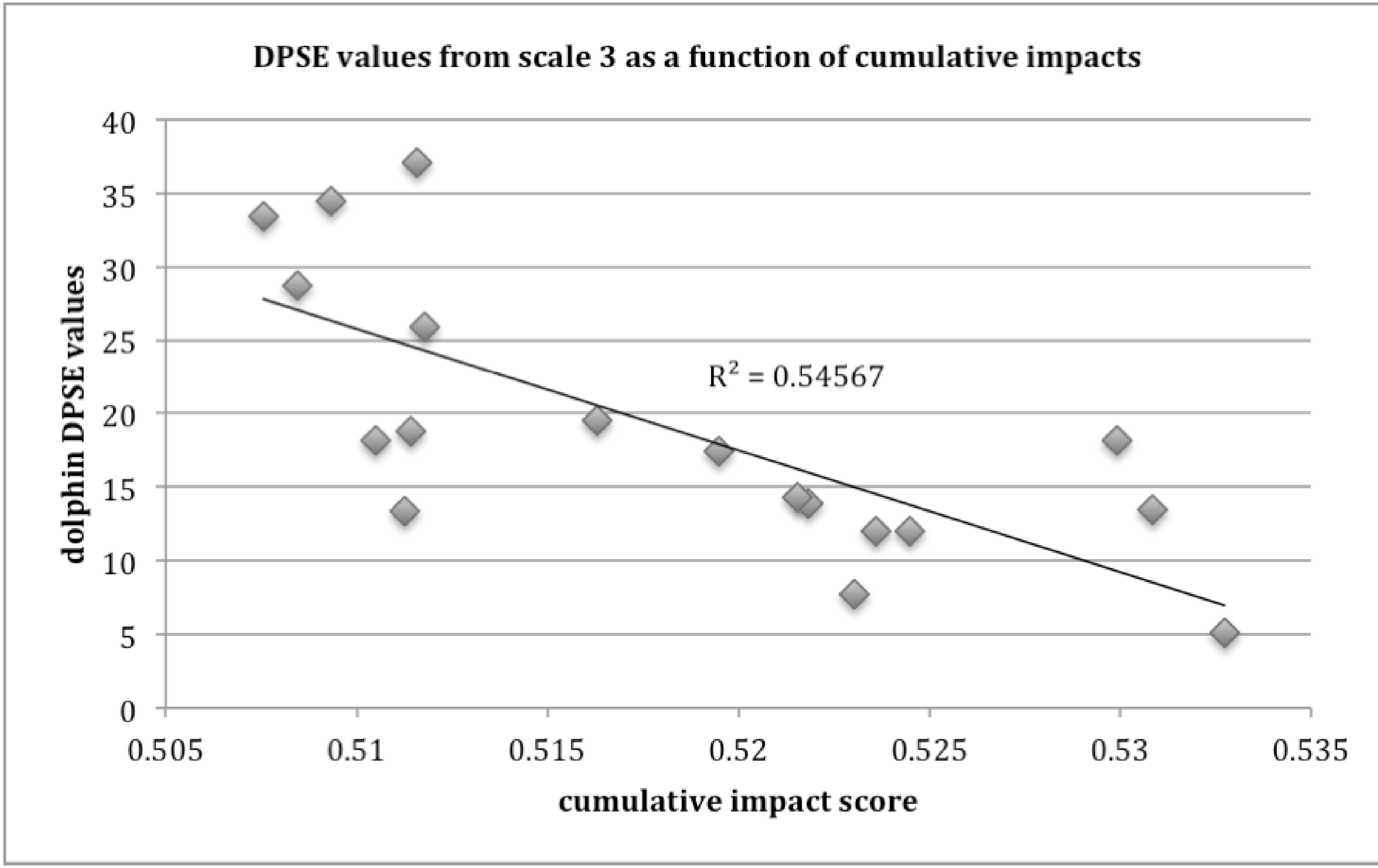


Figure 71. Regression between scale 3 dolphin DPSE and overall cumulative impacts

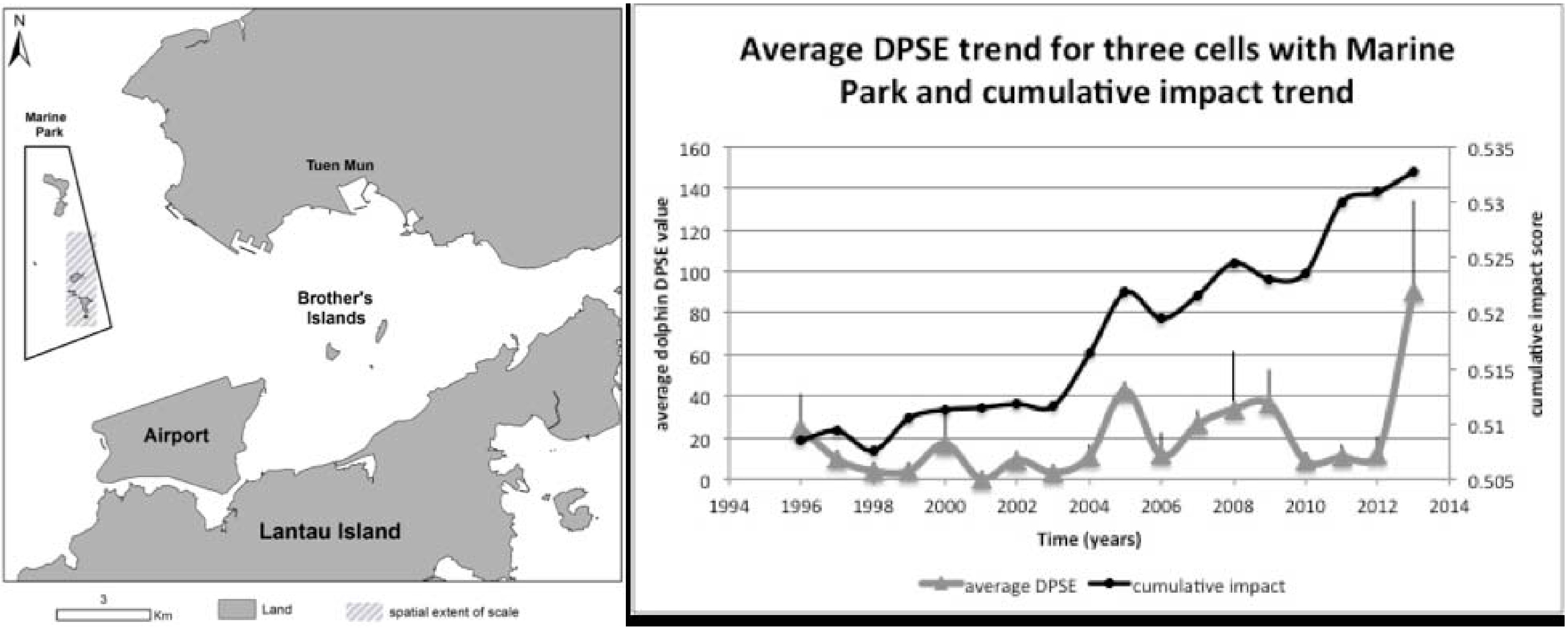


Figure 72. Western zone analysis (left: spatial extent; right: graphical assessment, with error bars displaying standard error

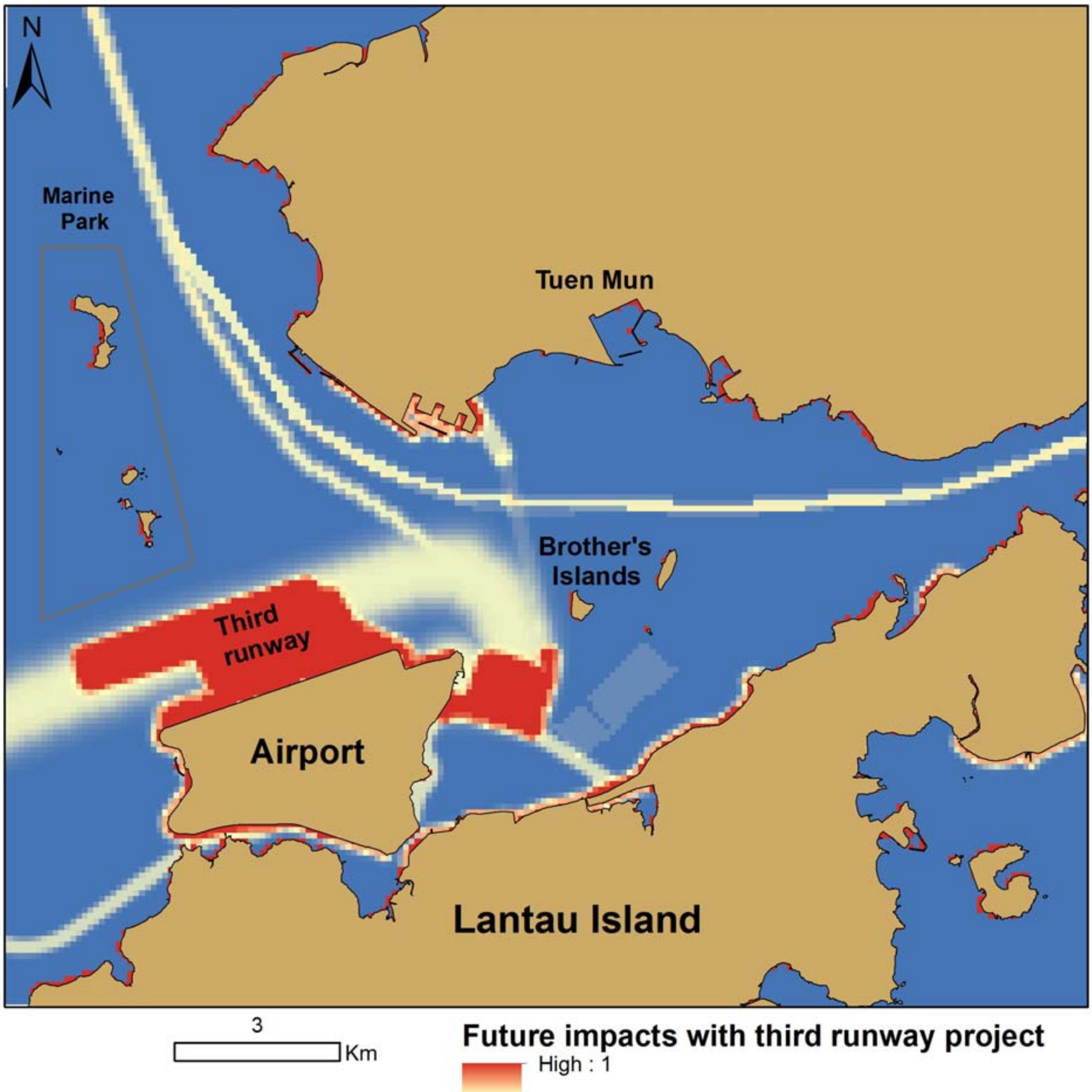


Figure 73. Future impacts with the Airport Third Runway project in North Lantau waters.

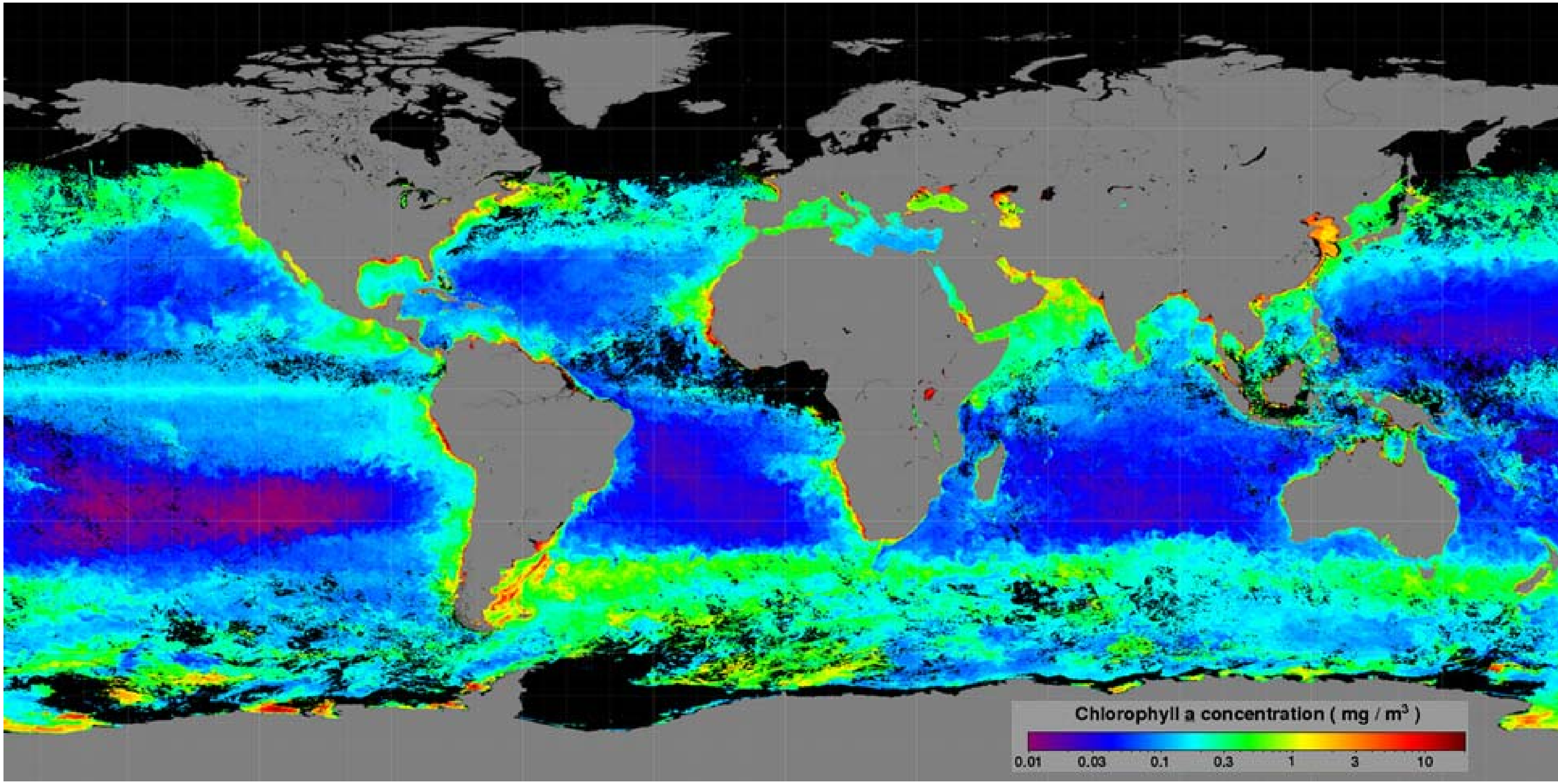


Figure 74. An example of worldwide monthly chlorophyll-a data (this image for January 2014) recorded by NASA's AquaMODIS satellite (downloaded from http://www.oceancolor.gsfc.nasa.gov). Each pixel in the image represents a single 4 km x 4 km grid cell.

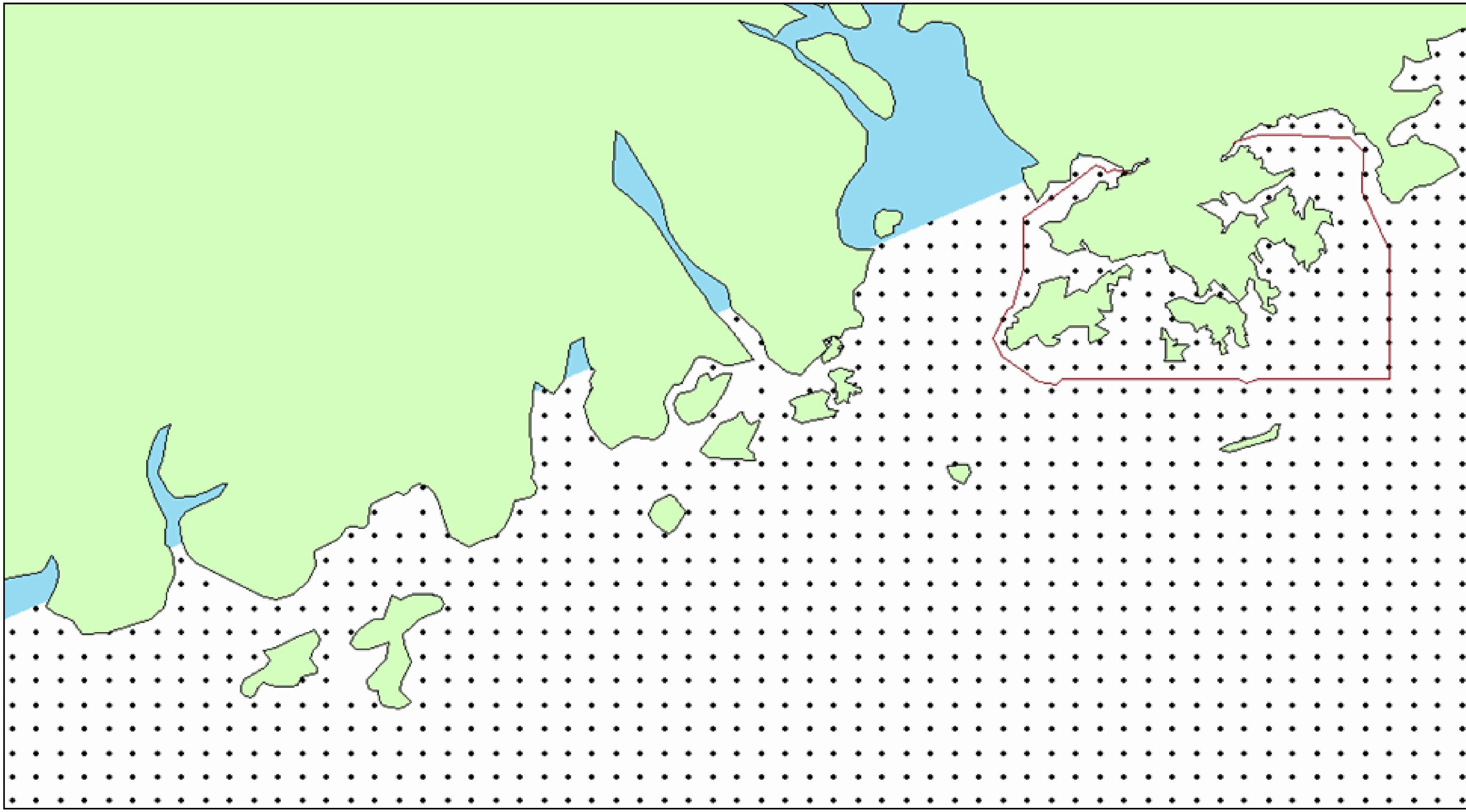


Figure 75. Sample sites used for extraction of chlorophyll-a, turbidity and sea surface temperature data from worldwide remotely sensed data files. Each point represents the corner of a 1 km x 1 km grid cell in which each environmental variable was measured. Note that data within the blue polygon has yet to be extracted, and thus areas further into the estuary were not included in this analysis.

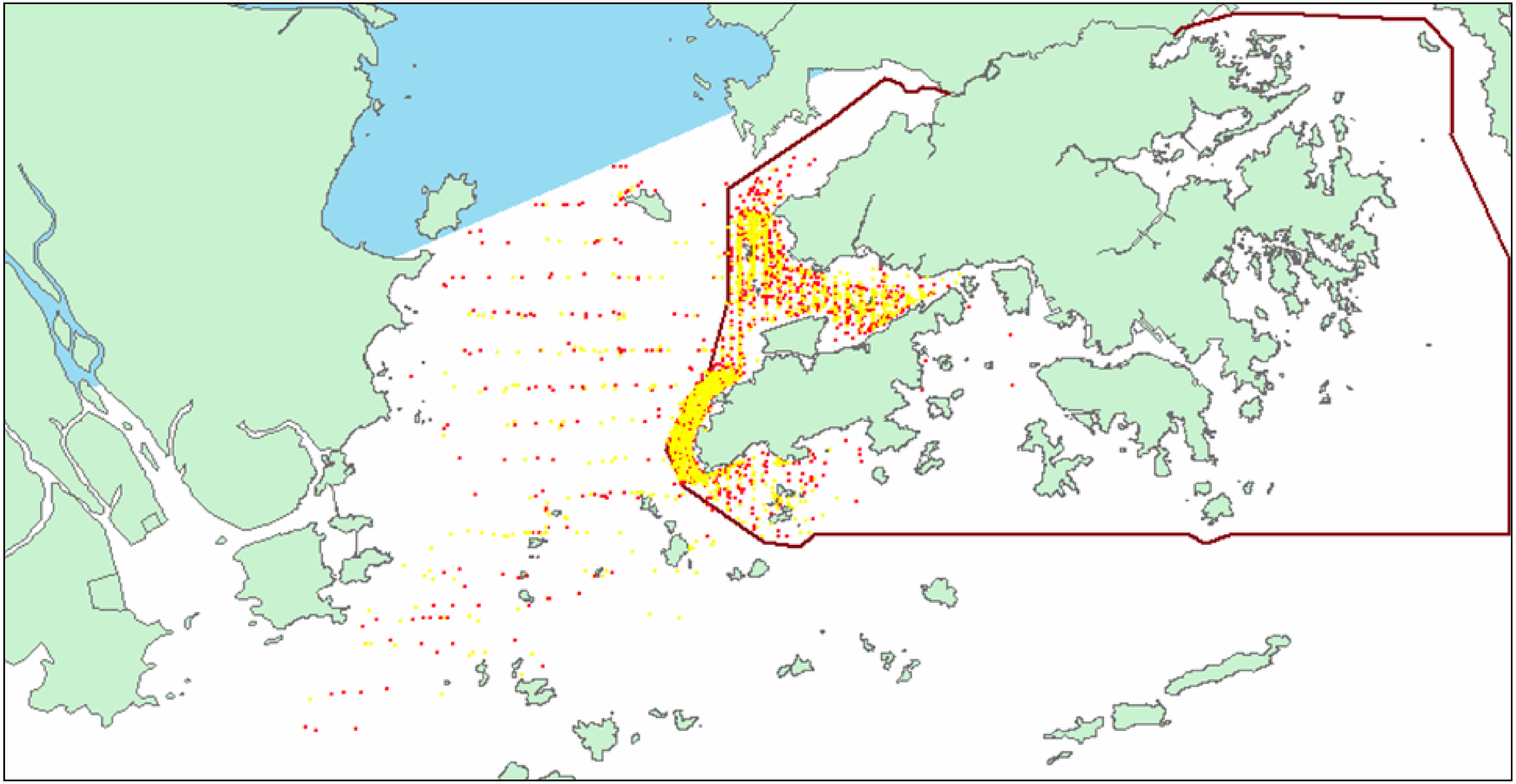


Figure 76. Sightings of Chinese White Dolphins in the Pearl River estuary between 2002 and 2011. Red indicates sightings made during the dry season (October-April), and yellow indicates sightings made during the wet season (May-September). Note that there was a disproportionate amount of survey effort between Hong Kong waters (outlined; surveyed regularly as part of HKCRP's long-term monitoring project throughout the study period) and waters of mainland China (two 12-month surveys conducted from 2005-2008; see Chen et al. 2010).

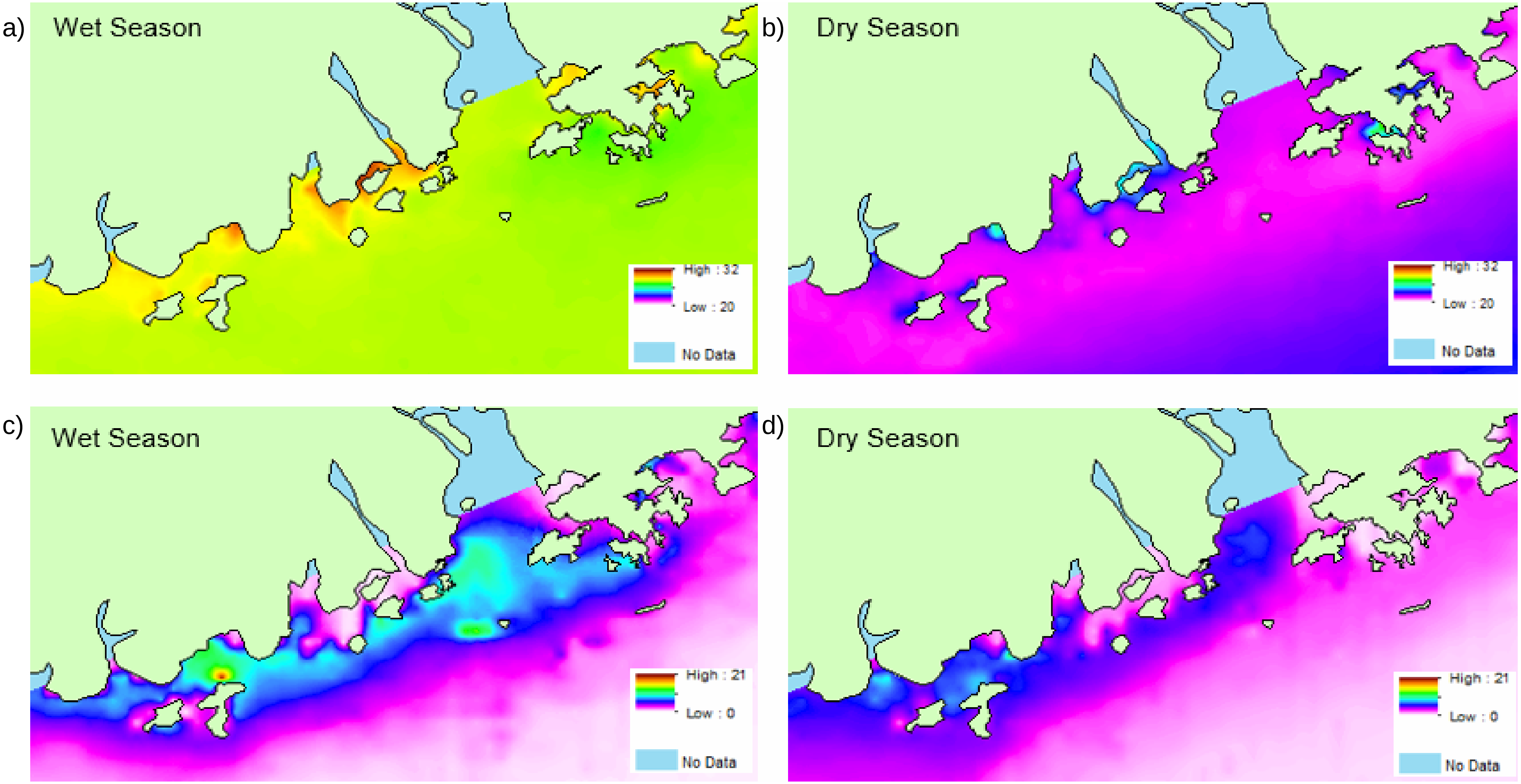


Figure 77. Interpolated surfaces for seasonal averages of sea surface temperature (a and b) and chlorophyll-a (c and d) measured from remote sensing reflectance for 2002-2011.

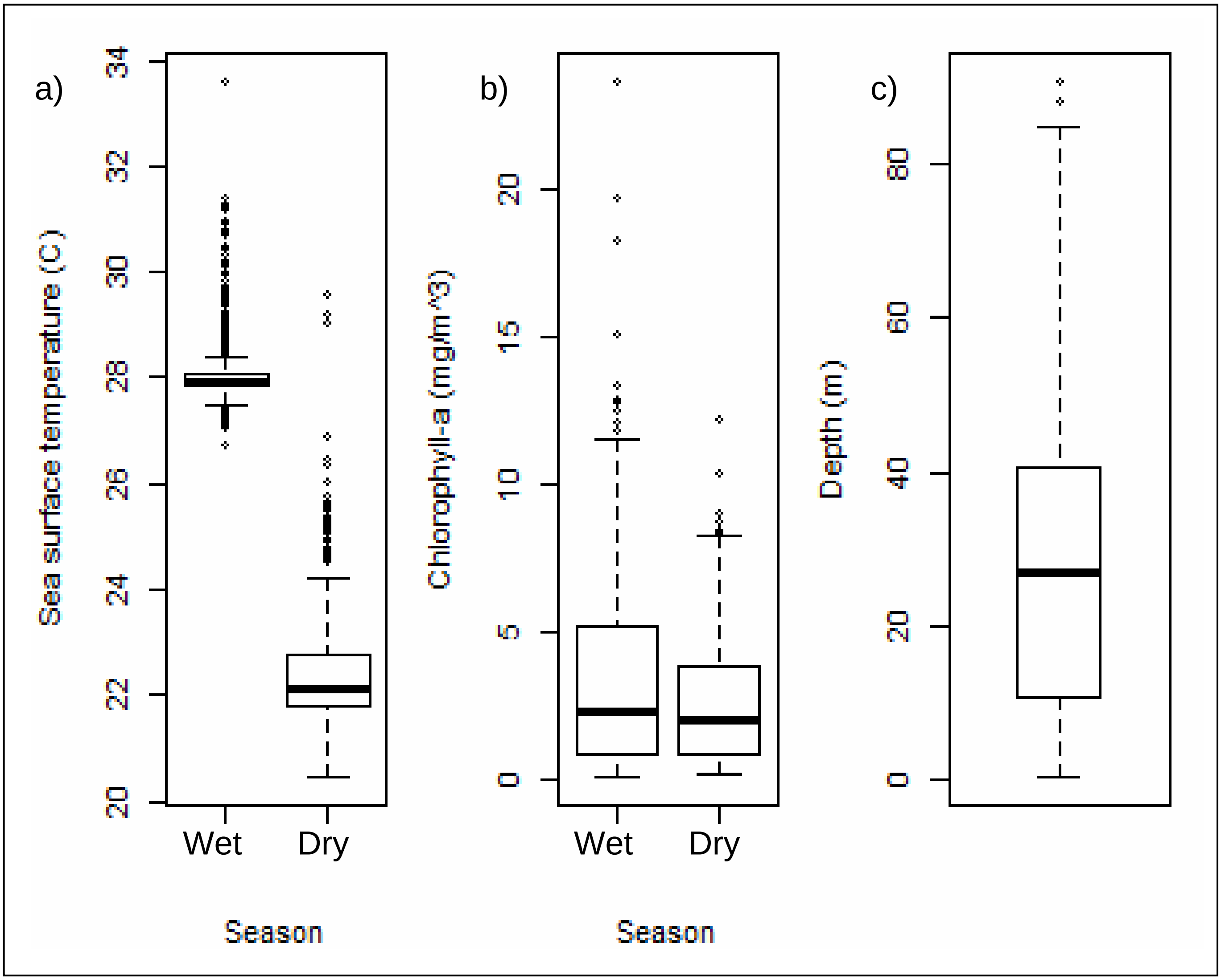


Figure 78. Medians, upper and lower quartiles and outliers in seasonal sea surface temperature (a), and chlorophyll-a (b) data. Depth (c) was considered to be a static variable that did not change seasonally.

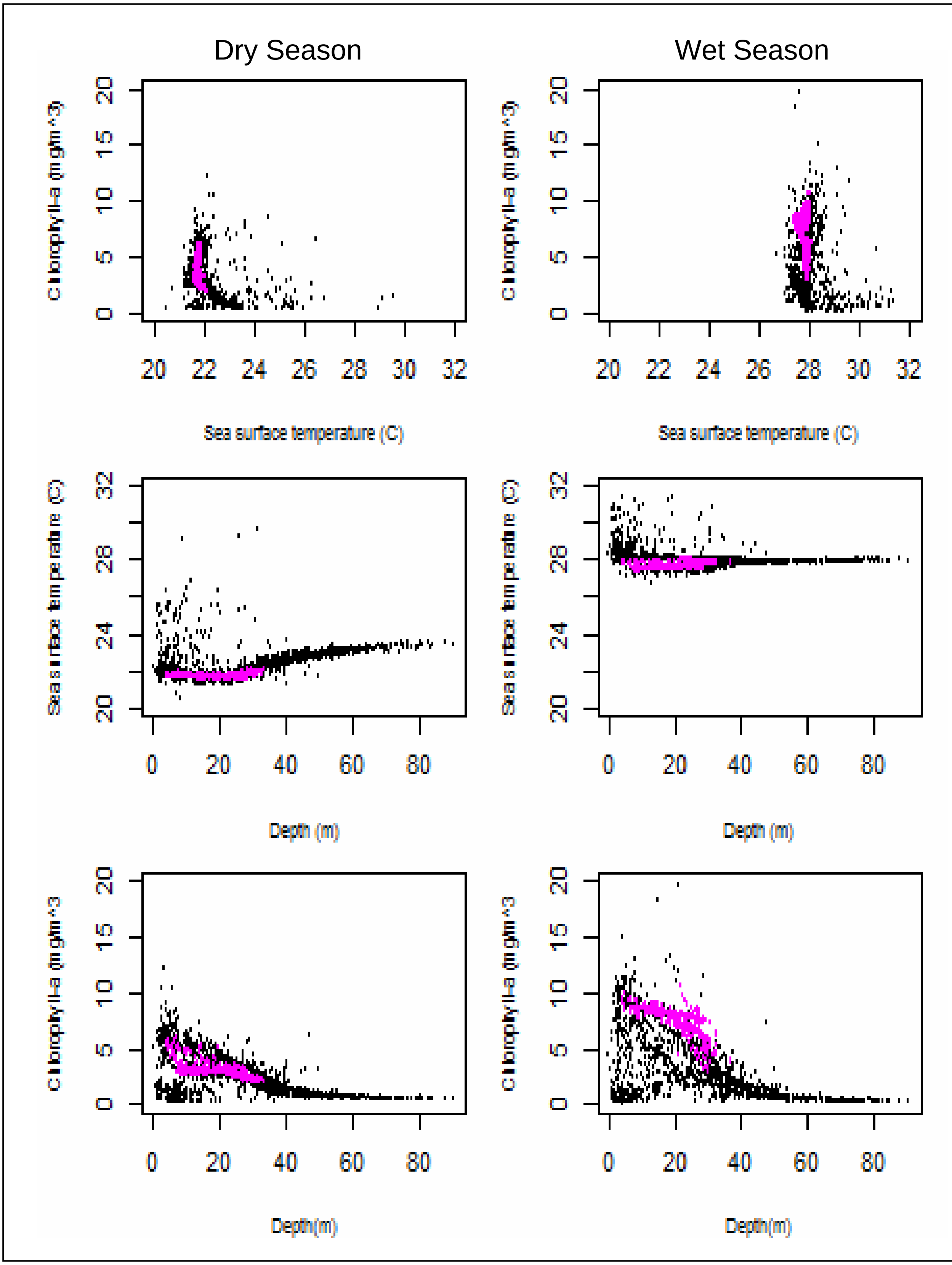


Figure 79. Chinese White Dolphin niche space (pink dots) in wet and dry seasons as defined by measurements of SST, ChA and water depth at sighting locations, compared to measurements of each environmental variable taken across the entire study area (black dots).

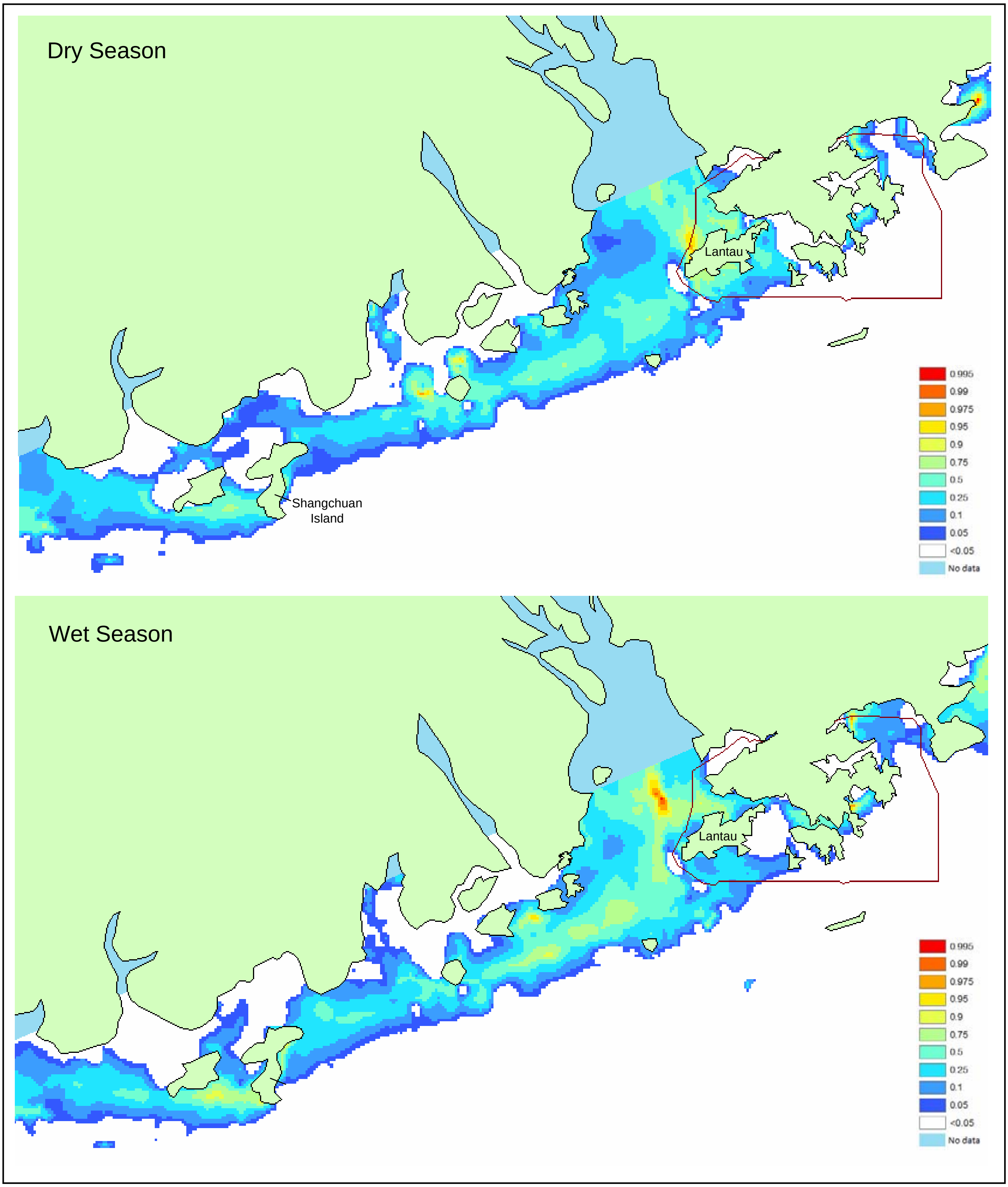


Figure 80. Habitat suitability maps coded by confidence level. Higher levels of confidence indicate higher reliability of the classification as suitable habitat. White space indicates areas with less than 5% confidence in being classified as suitable habitat, and thus is considered unsuitable.

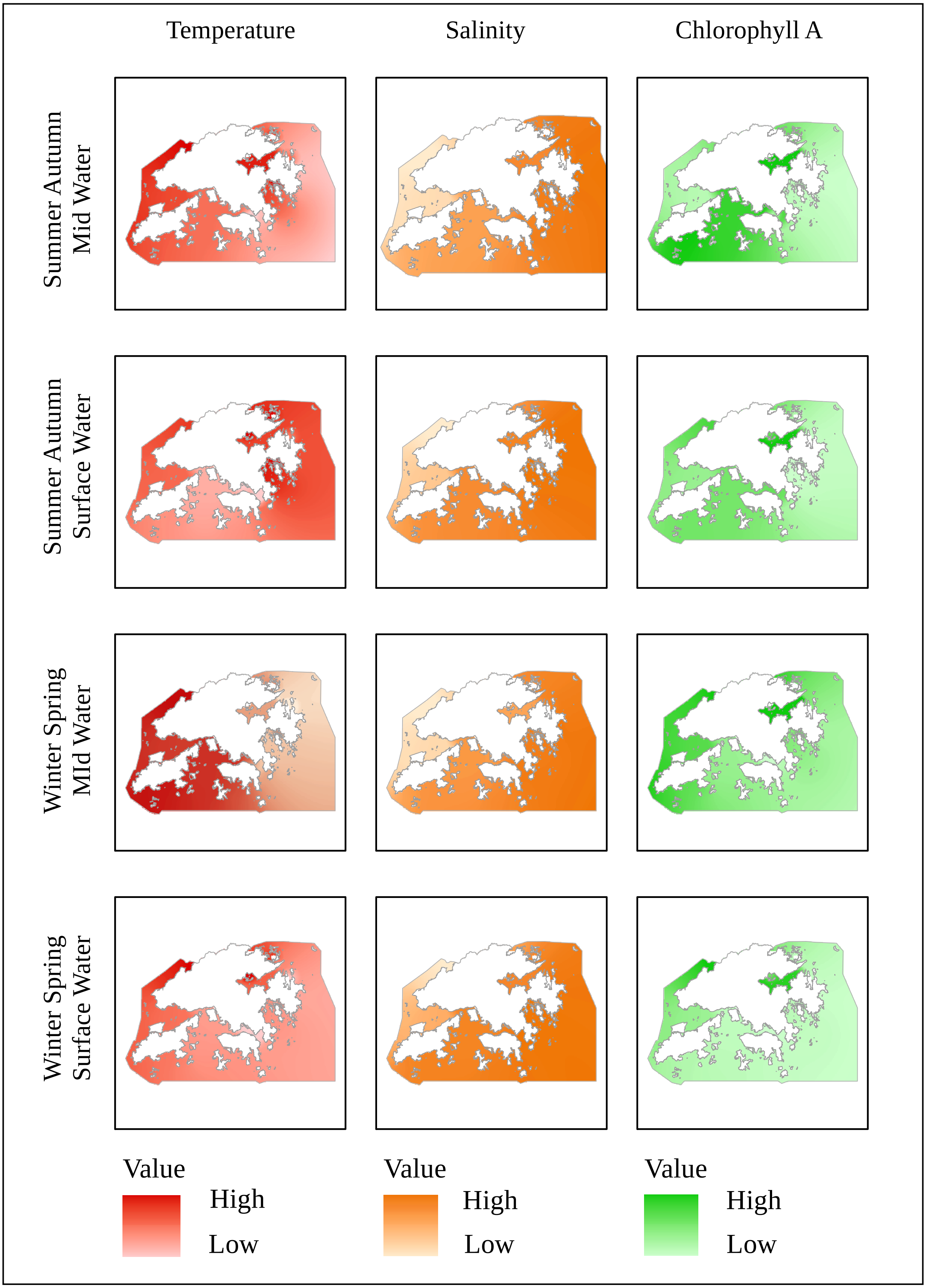


Figure 81. Layers of averaged interpolated environmental data showing values throughout the study area

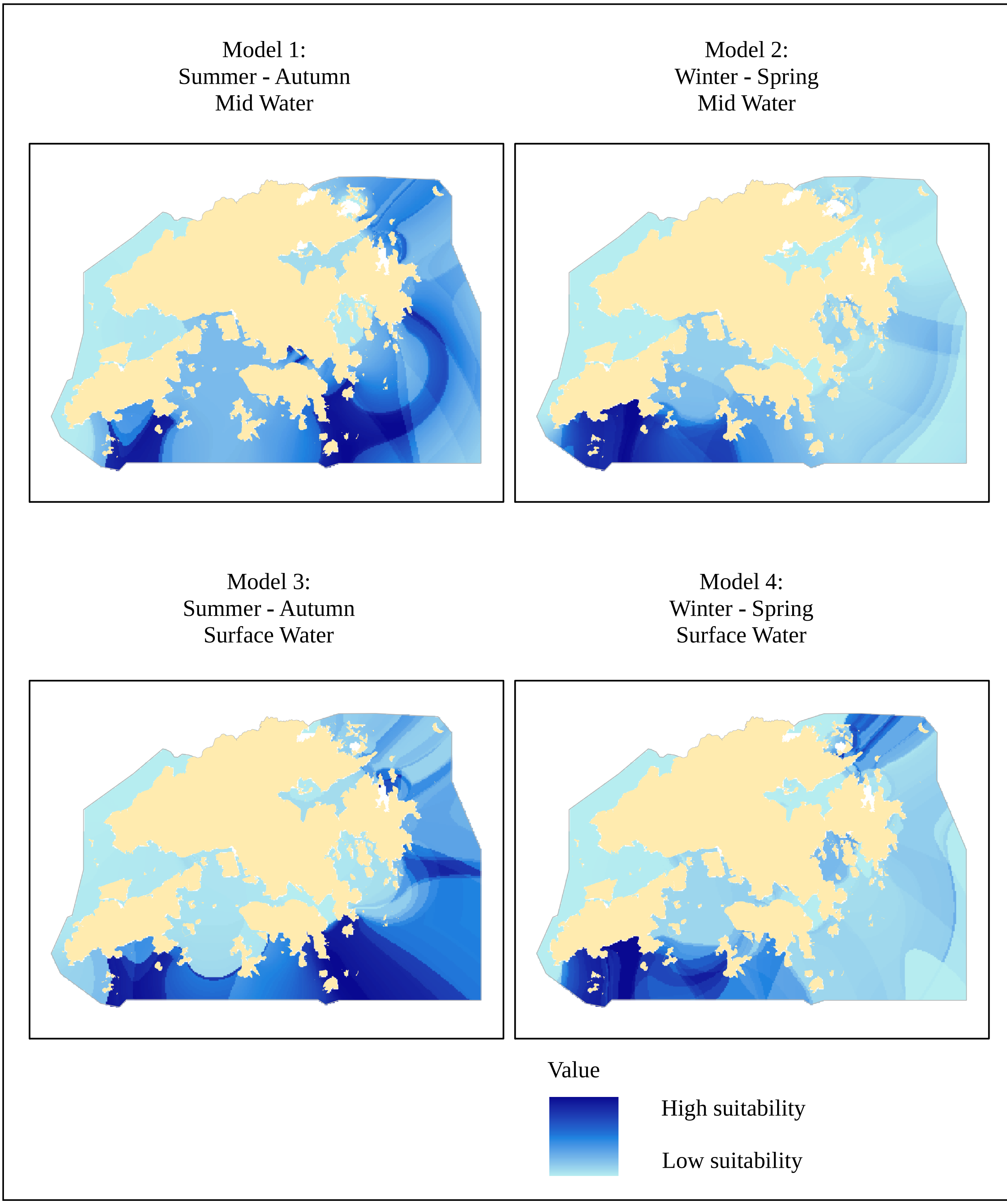


Figure 82. Predictive habitat suitability maps

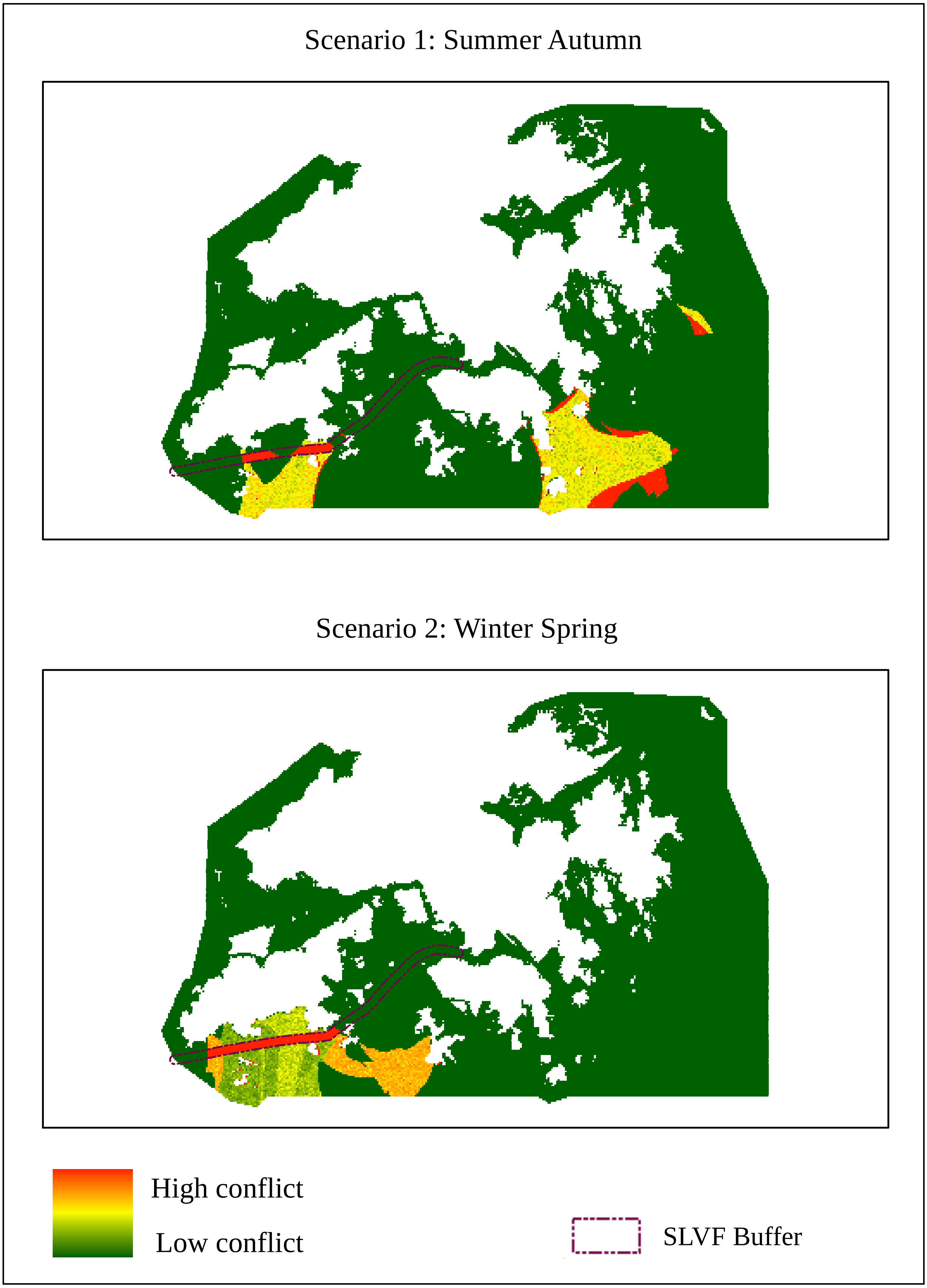


Figure 83. Impacts of South Lantau Vessel Fairway (SLVF) on suitable porpoise habitats

Appendix I. HKCRP-AFCD Survey Effort Database (April 2013 - March 2014)

(Note: P = Primary Line Effort; S = Secondary Line Effort)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
9-Apr-13	W LANTAU	2	10.30	SPRING	STANDARD31516	S
13-Apr-13	SE LANTAU	1	12.87	SPRING	STANDARD31516	P
13-Apr-13	SE LANTAU	2	11.10	SPRING	STANDARD31516	P
13-Apr-13	SE LANTAU	1	4.49	SPRING	STANDARD31516	S
13-Apr-13	SE LANTAU	2	1.20	SPRING	STANDARD31516	S
13-Apr-13	SE LANTAU	3	2.00	SPRING	STANDARD31516	S
13-Apr-13	SW LANTAU	1	3.15	SPRING	STANDARD31516	P
13-Apr-13	SW LANTAU	2	15.38	SPRING	STANDARD31516	P
13-Apr-13	SW LANTAU	3	6.20	SPRING	STANDARD31516	P
13-Apr-13	SW LANTAU	2	7.63	SPRING	STANDARD31516	S
13-Apr-13	SW LANTAU	3	2.20	SPRING	STANDARD31516	S
13-Apr-13	W LANTAU	2	5.37	SPRING	STANDARD31516	S
13-Apr-13	W LANTAU	3	4.47	SPRING	STANDARD31516	S
16-Apr-13	NE LANTAU	2	24.60	SPRING	STANDARD31516	P
16-Apr-13	NE LANTAU	3	2.10	SPRING	STANDARD31516	P
16-Apr-13	NE LANTAU	1	1.50	SPRING	STANDARD31516	S
16-Apr-13	NE LANTAU	2	6.70	SPRING	STANDARD31516	S
17-Apr-13	W LANTAU	1	0.50	SPRING	STANDARD31516	S
17-Apr-13	W LANTAU	2	4.70	SPRING	STANDARD31516	S
17-Apr-13	W LANTAU	3	7.20	SPRING	STANDARD31516	S
17-Apr-13	NW LANTAU	0	0.90	SPRING	STANDARD31516	P
17-Apr-13	NW LANTAU	1	16.60	SPRING	STANDARD31516	P
17-Apr-13	NW LANTAU	2	9.60	SPRING	STANDARD31516	P
17-Apr-13	NW LANTAU	1	4.20	SPRING	STANDARD31516	S
17-Apr-13	NW LANTAU	2	3.00	SPRING	STANDARD31516	S
18-Apr-13	NW LANTAU	1	0.90	SPRING	STANDARD31516	P
18-Apr-13	NW LANTAU	2	25.80	SPRING	STANDARD31516	P
18-Apr-13	NW LANTAU	3	13.40	SPRING	STANDARD31516	P
18-Apr-13	NW LANTAU	2	13.00	SPRING	STANDARD31516	S
18-Apr-13	NE LANTAU	1	8.20	SPRING	STANDARD31516	P
18-Apr-13	NE LANTAU	2	9.90	SPRING	STANDARD31516	P
18-Apr-13	NE LANTAU	1	2.80	SPRING	STANDARD31516	S
18-Apr-13	NE LANTAU	2	6.60	SPRING	STANDARD31516	S
30-Apr-13	LAMMA	1	8.02	SPRING	STANDARD31516	P
30-Apr-13	LAMMA	2	32.19	SPRING	STANDARD31516	P
30-Apr-13	LAMMA	3	1.70	SPRING	STANDARD31516	P
30-Apr-13	LAMMA	1	1.68	SPRING	STANDARD31516	S
30-Apr-13	LAMMA	2	6.45	SPRING	STANDARD31516	S
30-Apr-13	LAMMA	3	2.80	SPRING	STANDARD31516	S
3-May-13	NW LANTAU	1	0.66	SPRING	STANDARD31516	P
3-May-13	NW LANTAU	2	18.63	SPRING	STANDARD31516	P
3-May-13	NW LANTAU	3	16.45	SPRING	STANDARD31516	P
3-May-13	NW LANTAU	1	1.85	SPRING	STANDARD31516	S
3-May-13	NW LANTAU	2	2.35	SPRING	STANDARD31516	S
3-May-13	NW LANTAU	3	1.33	SPRING	STANDARD31516	S
6-May-13	W LANTAU	1	4.34	SPRING	STANDARD31516	S
6-May-13	W LANTAU	2	0.68	SPRING	STANDARD31516	S
6-May-13	W LANTAU	3	2.20	SPRING	STANDARD31516	S
6-May-13	NW LANTAU	2	9.49	SPRING	STANDARD31516	P
6-May-13	NW LANTAU	3	6.75	SPRING	STANDARD31516	P
6-May-13	NW LANTAU	2	3.06	SPRING	STANDARD31516	S
6-May-13	NW LANTAU	3	4.70	SPRING	STANDARD31516	S
7-May-13	NW LANTAU	2	4.82	SPRING	STANDARD31516	P
7-May-13	NW LANTAU	3	17.59	SPRING	STANDARD31516	P
7-May-13	NW LANTAU	1	1.16	SPRING	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
7-May-13	NW LANTAU	2	4.20	SPRING	STANDARD31516	S
7-May-13	NW LANTAU	3	3.12	SPRING	STANDARD31516	S
7-May-13	W LANTAU	2	11.59	SPRING	STANDARD31516	P
7-May-13	W LANTAU	3	3.26	SPRING	STANDARD31516	P
7-May-13	W LANTAU	4	0.41	SPRING	STANDARD31516	P
7-May-13	W LANTAU	5	1.88	SPRING	STANDARD31516	P
7-May-13	W LANTAU	1	0.64	SPRING	STANDARD31516	S
7-May-13	W LANTAU	2	9.78	SPRING	STANDARD31516	S
7-May-13	W LANTAU	3	3.27	SPRING	STANDARD31516	S
7-May-13	W LANTAU	4	0.94	SPRING	STANDARD31516	S
7-May-13	W LANTAU	5	1.97	SPRING	STANDARD31516	S
9-May-13	W LANTAU	2	8.25	SPRING	STANDARD31516	S
9-May-13	W LANTAU	3	5.90	SPRING	STANDARD31516	S
9-May-13	SW LANTAU	1	7.35	SPRING	STANDARD31516	P
9-May-13	SW LANTAU	2	21.04	SPRING	STANDARD31516	P
9-May-13	SW LANTAU	1	4.82	SPRING	STANDARD31516	S
9-May-13	SW LANTAU	2	5.13	SPRING	STANDARD31516	S
9-May-13	SW LANTAU	3	0.98	SPRING	STANDARD31516	S
9-May-13	SE LANTAU	2	1.55	SPRING	STANDARD31516	P
9-May-13	SE LANTAU	3	5.04	SPRING	STANDARD31516	P
9-May-13	SE LANTAU	2	3.15	SPRING	STANDARD31516	S
9-May-13	SE LANTAU	3	2.09	SPRING	STANDARD31516	S
24-May-13	LAMMA	1	5.08	SPRING	STANDARD31516	P
24-May-13	LAMMA	2	56.07	SPRING	STANDARD31516	P
24-May-13	LAMMA	3	5.39	SPRING	STANDARD31516	P
24-May-13	LAMMA	2	16.26	SPRING	STANDARD31516	S
29-May-13	W LANTAU	1	1.37	SPRING	STANDARD31516	P
29-May-13	W LANTAU	2	13.89	SPRING	STANDARD31516	P
29-May-13	W LANTAU	3	4.99	SPRING	STANDARD31516	P
29-May-13	W LANTAU	1	0.31	SPRING	STANDARD31516	S
29-May-13	W LANTAU	2	15.63	SPRING	STANDARD31516	S
29-May-13	W LANTAU	3	3.80	SPRING	STANDARD31516	S
29-May-13	NE LANTAU	2	2.74	SPRING	STANDARD31516	P
29-May-13	NE LANTAU	3	3.50	SPRING	STANDARD31516	P
29-May-13	NE LANTAU	2	6.56	SPRING	STANDARD31516	S
31-May-13	SE LANTAU	1	9.97	SPRING	STANDARD31516	P
31-May-13	SE LANTAU	2	13.89	SPRING	STANDARD31516	P
31-May-13	SE LANTAU	1	3.89	SPRING	STANDARD31516	S
31-May-13	SE LANTAU	2	4.32	SPRING	STANDARD31516	S
31-May-13	SW LANTAU	1	1.10	SPRING	STANDARD31516	P
31-May-13	SW LANTAU	2	20.18	SPRING	STANDARD31516	P
31-May-13	SW LANTAU	3	1.45	SPRING	STANDARD31516	P
31-May-13	SW LANTAU	2	4.22	SPRING	STANDARD31516	S
31-May-13	SW LANTAU	3	2.95	SPRING	STANDARD31516	S
3-Jun-13	PO TOI	1	13.26	SUMMER	STANDARD31516	P
3-Jun-13	PO TOI	2	34.54	SUMMER	STANDARD31516	P
3-Jun-13	PO TOI	3	25.50	SUMMER	STANDARD31516	P
3-Jun-13	PO TOI	4	6.90	SUMMER	STANDARD31516	P
3-Jun-13	PO TOI	2	3.40	SUMMER	STANDARD31516	S
3-Jun-13	PO TOI	3	7.20	SUMMER	STANDARD31516	S
4-Jun-13	NINEPINS	1	4.10	SUMMER	STANDARD31516	P
4-Jun-13	NINEPINS	2	59.60	SUMMER	STANDARD31516	P
4-Jun-13	NINEPINS	3	6.20	SUMMER	STANDARD31516	P
4-Jun-13	NINEPINS	2	5.50	SUMMER	STANDARD31516	S
4-Jun-13	NINEPINS	3	2.00	SUMMER	STANDARD31516	S
6-Jun-13	W LANTAU	1	6.31	SUMMER	STANDARD31516	S
6-Jun-13	W LANTAU	2	2.47	SUMMER	STANDARD31516	S
6-Jun-13	W LANTAU	3	2.64	SUMMER	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
6-Jun-13	NW LANTAU	2	4.94	SUMMER	STANDARD31516	P
6-Jun-13	NW LANTAU	3	3.71	SUMMER	STANDARD31516	P
6-Jun-13	NW LANTAU	4	0.91	SUMMER	STANDARD31516	P
6-Jun-13	NW LANTAU	1	1.77	SUMMER	STANDARD31516	S
6-Jun-13	NW LANTAU	2	4.76	SUMMER	STANDARD31516	S
6-Jun-13	NW LANTAU	3	1.18	SUMMER	STANDARD31516	S
10-Jun-13	NE LANTAU	2	12.02	SUMMER	STANDARD31516	P
10-Jun-13	NE LANTAU	3	7.42	SUMMER	STANDARD31516	P
10-Jun-13	NE LANTAU	2	8.48	SUMMER	STANDARD31516	S
10-Jun-13	NE LANTAU	3	2.38	SUMMER	STANDARD31516	S
10-Jun-13	NW LANTAU	1	11.48	SUMMER	STANDARD31516	P
10-Jun-13	NW LANTAU	2	10.05	SUMMER	STANDARD31516	P
10-Jun-13	NW LANTAU	1	0.79	SUMMER	STANDARD31516	S
10-Jun-13	NW LANTAU	2	2.13	SUMMER	STANDARD31516	S
10-Jun-13	NW LANTAU	3	2.31	SUMMER	STANDARD31516	S
10-Jun-13	DEEP BAY	0	2.81	SUMMER	STANDARD31516	P
10-Jun-13	DEEP BAY	1	6.14	SUMMER	STANDARD31516	P
10-Jun-13	DEEP BAY	2	6.73	SUMMER	STANDARD31516	P
10-Jun-13	DEEP BAY	0	0.94	SUMMER	STANDARD31516	S
10-Jun-13	DEEP BAY	1	5.36	SUMMER	STANDARD31516	S
10-Jun-13	DEEP BAY	2	1.96	SUMMER	STANDARD31516	S
11-Jun-13	W LANTAU	4	0.45	SUMMER	STANDARD31516	S
11-Jun-13	W LANTAU	5	1.37	SUMMER	STANDARD31516	S
11-Jun-13	SW LANTAU	2	4.04	SUMMER	STANDARD31516	P
11-Jun-13	SW LANTAU	4	6.33	SUMMER	STANDARD31516	P
11-Jun-13	SW LANTAU	5	1.81	SUMMER	STANDARD31516	P
11-Jun-13	SW LANTAU	2	1.21	SUMMER	STANDARD31516	S
11-Jun-13	SW LANTAU	3	1.92	SUMMER	STANDARD31516	S
11-Jun-13	SW LANTAU	4	5.10	SUMMER	STANDARD31516	S
11-Jun-13	SW LANTAU	5	1.96	SUMMER	STANDARD31516	S
11-Jun-13	SE LANTAU	2	8.48	SUMMER	STANDARD31516	P
11-Jun-13	SE LANTAU	3	4.87	SUMMER	STANDARD31516	P
11-Jun-13	SE LANTAU	2	2.00	SUMMER	STANDARD31516	S
11-Jun-13	SE LANTAU	3	2.05	SUMMER	STANDARD31516	S
17-Jun-13	W LANTAU	2	7.60	SUMMER	STANDARD31516	S
17-Jun-13	W LANTAU	3	6.30	SUMMER	STANDARD31516	S
17-Jun-13	NE LANTAU	2	10.30	SUMMER	STANDARD31516	P
17-Jun-13	NE LANTAU	2	6.80	SUMMER	STANDARD31516	S
20-Jun-13	SE LANTAU	2	21.20	SUMMER	STANDARD31516	P
20-Jun-13	SE LANTAU	2	4.10	SUMMER	STANDARD31516	S
20-Jun-13	SW LANTAU	1	1.40	SUMMER	STANDARD31516	P
20-Jun-13	SW LANTAU	2	24.50	SUMMER	STANDARD31516	P
20-Jun-13	SW LANTAU	1	2.30	SUMMER	STANDARD31516	S
20-Jun-13	SW LANTAU	2	7.10	SUMMER	STANDARD31516	S
20-Jun-13	W LANTAU	2	9.10	SUMMER	STANDARD31516	S
21-Jun-13	W LANTAU	1	1.20	SUMMER	STANDARD31516	P
21-Jun-13	W LANTAU	2	12.70	SUMMER	STANDARD31516	P
21-Jun-13	W LANTAU	3	4.30	SUMMER	STANDARD31516	P
21-Jun-13	W LANTAU	1	5.80	SUMMER	STANDARD31516	S
21-Jun-13	W LANTAU	2	8.50	SUMMER	STANDARD31516	S
21-Jun-13	W LANTAU	3	6.60	SUMMER	STANDARD31516	S
21-Jun-13	NE LANTAU	2	0.20	SUMMER	STANDARD31516	P
21-Jun-13	NE LANTAU	3	5.40	SUMMER	STANDARD31516	P
21-Jun-13	NE LANTAU	2	1.30	SUMMER	STANDARD31516	S
21-Jun-13	NE LANTAU	3	3.60	SUMMER	STANDARD31516	S
28-Jun-13	NE LANTAU	2	15.94	SUMMER	STANDARD31516	P

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
28-Jun-13	NE LANTAU	3	17.82	SUMMER	STANDARD31516	P
28-Jun-13	NE LANTAU	2	11.80	SUMMER	STANDARD31516	S
28-Jun-13	NE LANTAU	3	4.07	SUMMER	STANDARD31516	S
28-Jun-13	NW LANTAU	3	5.70	SUMMER	STANDARD31516	P
28-Jun-13	NW LANTAU	4	4.95	SUMMER	STANDARD31516	P
28-Jun-13	NW LANTAU	5	1.79	SUMMER	STANDARD31516	P
28-Jun-13	NW LANTAU	3	4.17	SUMMER	STANDARD31516	S
28-Jun-13	NW LANTAU	4	2.15	SUMMER	STANDARD31516	S
5-Jul-13	W LANTAU	2	6.25	SUMMER	STANDARD31516	S
5-Jul-13	W LANTAU	3	4.23	SUMMER	STANDARD31516	S
10-Jul-13	W LANTAU	1	3.89	SUMMER	STANDARD31516	S
10-Jul-13	W LANTAU	2	5.78	SUMMER	STANDARD31516	S
12-Jul-13	PO TOI	2	46.60	SUMMER	STANDARD31516	P
12-Jul-13	PO TOI	3	18.04	SUMMER	STANDARD31516	P
12-Jul-13	PO TOI	2	6.06	SUMMER	STANDARD31516	S
12-Jul-13	PO TOI	3	1.60	SUMMER	STANDARD31516	S
12-Jul-13	NINEPINS	2	9.32	SUMMER	STANDARD31516	P
17-Jul-13	SE LANTAU	2	14.62	SUMMER	STANDARD31516	P
17-Jul-13	SE LANTAU	2	1.08	SUMMER	STANDARD31516	S
17-Jul-13	SW LANTAU	2	17.06	SUMMER	STANDARD31516	P
17-Jul-13	SW LANTAU	3	11.37	SUMMER	STANDARD31516	P
17-Jul-13	SW LANTAU	4	1.30	SUMMER	STANDARD31516	P
17-Jul-13	SW LANTAU	5	1.00	SUMMER	STANDARD31516	P
17-Jul-13	SW LANTAU	2	3.30	SUMMER	STANDARD31516	S
17-Jul-13	SW LANTAU	3	9.17	SUMMER	STANDARD31516	S
17-Jul-13	SW LANTAU	4	5.80	SUMMER	STANDARD31516	S
17-Jul-13	W LANTAU	1	2.03	SUMMER	STANDARD31516	S
17-Jul-13	W LANTAU	2	7.82	SUMMER	STANDARD31516	S
18-Jul-13	W LANTAU	1	5.20	SUMMER	STANDARD31516	P
18-Jul-13	W LANTAU	2	14.10	SUMMER	STANDARD31516	P
18-Jul-13	W LANTAU	1	3.80	SUMMER	STANDARD31516	S
18-Jul-13	W LANTAU	2	12.30	SUMMER	STANDARD31516	S
18-Jul-13	NW LANTAU	2	8.50	SUMMER	STANDARD31516	P
18-Jul-13	NW LANTAU	3	5.50	SUMMER	STANDARD31516	P
18-Jul-13	NW LANTAU	2	2.80	SUMMER	STANDARD31516	S
23-Jul-13	SE LANTAU	2	9.30	SUMMER	STANDARD31516	P
23-Jul-13	SE LANTAU	3	5.70	SUMMER	STANDARD31516	P
23-Jul-13	SE LANTAU	3	1.00	SUMMER	STANDARD31516	S
23-Jul-13	SW LANTAU	2	9.10	SUMMER	STANDARD31516	P
23-Jul-13	SW LANTAU	3	15.70	SUMMER	STANDARD31516	P
23-Jul-13	SW LANTAU	4	7.20	SUMMER	STANDARD31516	P
23-Jul-13	SW LANTAU	5	0.60	SUMMER	STANDARD31516	P
23-Jul-13	SW LANTAU	2	4.80	SUMMER	STANDARD31516	S
23-Jul-13	SW LANTAU	3	2.30	SUMMER	STANDARD31516	S
23-Jul-13	SW LANTAU	4	2.10	SUMMER	STANDARD31516	S
23-Jul-13	W LANTAU	2	3.60	SUMMER	STANDARD31516	S
23-Jul-13	W LANTAU	3	4.20	SUMMER	STANDARD31516	S
24-Jul-13	NW LANTAU	2	7.04	SUMMER	STANDARD31516	P
24-Jul-13	NW LANTAU	3	4.67	SUMMER	STANDARD31516	P
24-Jul-13	NW LANTAU	2	3.27	SUMMER	STANDARD31516	S
24-Jul-13	DEEP BAY	1	5.69	SUMMER	STANDARD31516	P
24-Jul-13	DEEP BAY	2	8.55	SUMMER	STANDARD31516	P
24-Jul-13	DEEP BAY	3	3.50	SUMMER	STANDARD31516	P
24-Jul-13	DEEP BAY	1	2.17	SUMMER	STANDARD31516	S
24-Jul-13	DEEP BAY	2	8.36	SUMMER	STANDARD31516	S
24-Jul-13	NE LANTAU	1	4.60	SUMMER	STANDARD31516	P
24-Jul-13	NE LANTAU	2	3.60	SUMMER	STANDARD31516	P
24-Jul-13	NE LANTAU	3	6.36	SUMMER	STANDARD31516	P
24-Jul-13	NE LANTAU	1	4.70	SUMMER	STANDARD31516	S
24-Jul-13	NE LANTAU	2	1.00	SUMMER	STANDARD31516	S
24-Jul-13	NE LANTAU	3	1.94	SUMMER	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
30-Jul-13	SE LANTAU	1	9.60	SUMMER	STANDARD31516	P
30-Jul-13	SE LANTAU	2	17.60	SUMMER	STANDARD31516	P
30-Jul-13	SE LANTAU	1	3.60	SUMMER	STANDARD31516	S
30-Jul-13	SE LANTAU	2	3.20	SUMMER	STANDARD31516	S
30-Jul-13	SW LANTAU	1	1.40	SUMMER	STANDARD31516	P
30-Jul-13	SW LANTAU	2	23.60	SUMMER	STANDARD31516	P
30-Jul-13	SW LANTAU	2	6.40	SUMMER	STANDARD31516	S
30-Jul-13	W LANTAU	2	7.90	SUMMER	STANDARD31516	S
30-Jul-13	W LANTAU	3	2.70	SUMMER	STANDARD31516	S
31-Jul-13	W LANTAU	2	2.90	SUMMER	STANDARD31516	P
31-Jul-13	W LANTAU	3	15.80	SUMMER	STANDARD31516	P
31-Jul-13	W LANTAU	4	1.80	SUMMER	STANDARD31516	P
31-Jul-13	W LANTAU	1	2.40	SUMMER	STANDARD31516	S
31-Jul-13	W LANTAU	2	2.80	SUMMER	STANDARD31516	S
31-Jul-13	W LANTAU	3	12.50	SUMMER	STANDARD31516	S
31-Jul-13	W LANTAU	4	1.90	SUMMER	STANDARD31516	S
31-Jul-13	NW LANTAU	2	1.70	SUMMER	STANDARD31516	P
31-Jul-13	NW LANTAU	3	11.70	SUMMER	STANDARD31516	P
31-Jul-13	NW LANTAU	4	4.00	SUMMER	STANDARD31516	P
31-Jul-13	NW LANTAU	3	2.30	SUMMER	STANDARD31516	S
6-Aug-13	PO TOI	2	27.40	SUMMER	STANDARD31516	P
6-Aug-13	PO TOI	3	28.10	SUMMER	STANDARD31516	P
6-Aug-13	PO TOI	4	23.60	SUMMER	STANDARD31516	P
6-Aug-13	PO TOI	2	4.70	SUMMER	STANDARD31516	S
6-Aug-13	PO TOI	3	5.80	SUMMER	STANDARD31516	S
6-Aug-13	PO TOI	4	2.60	SUMMER	STANDARD31516	S
9-Aug-13	NINEPINS	2	23.10	SUMMER	STANDARD31516	P
9-Aug-13	NINEPINS	3	37.90	SUMMER	STANDARD31516	P
9-Aug-13	NINEPINS	4	11.20	SUMMER	STANDARD31516	P
9-Aug-13	NINEPINS	2	2.50	SUMMER	STANDARD31516	S
9-Aug-13	NINEPINS	3	5.70	SUMMER	STANDARD31516	S
9-Aug-13	NINEPINS	4	4.70	SUMMER	STANDARD31516	S
21-Aug-13	W LANTAU	2	10.00	SUMMER	STANDARD31516	S
21-Aug-13	W LANTAU	3	0.60	SUMMER	STANDARD31516	S
21-Aug-13	NW LANTAU	1	10.40	SUMMER	STANDARD31516	P
21-Aug-13	NW LANTAU	2	8.10	SUMMER	STANDARD31516	P
21-Aug-13	NW LANTAU	1	6.00	SUMMER	STANDARD31516	S
21-Aug-13	NW LANTAU	2	1.10	SUMMER	STANDARD31516	S
26-Aug-13	W LANTAU	2	6.86	SUMMER	STANDARD31516	S
26-Aug-13	W LANTAU	3	3.63	SUMMER	STANDARD31516	S
26-Aug-13	NE LANTAU	1	9.17	SUMMER	STANDARD31516	P
26-Aug-13	NE LANTAU	2	6.08	SUMMER	STANDARD31516	P
26-Aug-13	NE LANTAU	1	3.05	SUMMER	STANDARD31516	S
26-Aug-13	NE LANTAU	2	2.00	SUMMER	STANDARD31516	S
27-Aug-13	W LANTAU	1	4.91	SUMMER	STANDARD31516	S
27-Aug-13	W LANTAU	2	6.97	SUMMER	STANDARD31516	S
27-Aug-13	W LANTAU	3	0.58	SUMMER	STANDARD31516	S
27-Aug-13	SW LANTAU	1	2.75	SUMMER	STANDARD31516	P
27-Aug-13	SW LANTAU	2	22.93	SUMMER	STANDARD31516	P
27-Aug-13	SW LANTAU	3	1.67	SUMMER	STANDARD31516	P
27-Aug-13	SW LANTAU	1	2.09	SUMMER	STANDARD31516	S
27-Aug-13	SW LANTAU	2	6.50	SUMMER	STANDARD31516	S
27-Aug-13	SE LANTAU	2	14.59	SUMMER	STANDARD31516	P
27-Aug-13	SE LANTAU	2	5.71	SUMMER	STANDARD31516	S
28-Aug-13	PO TOI	1	33.76	SUMMER	STANDARD31516	P
28-Aug-13	PO TOI	2	33.32	SUMMER	STANDARD31516	P
28-Aug-13	PO TOI	1	3.84	SUMMER	STANDARD31516	S
28-Aug-13	PO TOI	2	5.88	SUMMER	STANDARD31516	S
28-Aug-13	NINEPINS	2	11.20	SUMMER	STANDARD31516	P
29-Aug-13	NINEPINS	1	18.69	SUMMER	STANDARD31516	P
29-Aug-13	NINEPINS	2	56.51	SUMMER	STANDARD31516	P

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
29-Aug-13	NINEPINS	1	4.20	SUMMER	STANDARD31516	S
29-Aug-13	NINEPINS	2	4.90	SUMMER	STANDARD31516	S
29-Aug-13	NINEPINS	3	0.80	SUMMER	STANDARD31516	S
30-Aug-13	NE LANTAU	1	3.03	SUMMER	STANDARD31516	P
30-Aug-13	NE LANTAU	2	24.09	SUMMER	STANDARD31516	P
30-Aug-13	NE LANTAU	1	6.04	SUMMER	STANDARD31516	S
30-Aug-13	NE LANTAU	2	8.34	SUMMER	STANDARD31516	S
30-Aug-13	NW LANTAU	0	2.00	SUMMER	STANDARD31516	P
30-Aug-13	NW LANTAU	1	17.23	SUMMER	STANDARD31516	P
30-Aug-13	NW LANTAU	2	11.66	SUMMER	STANDARD31516	P
30-Aug-13	NW LANTAU	1	0.47	SUMMER	STANDARD31516	S
30-Aug-13	NW LANTAU	2	6.12	SUMMER	STANDARD31516	S
4-Sep-13	W LANTAU	2	7.31	AUTUMN	STANDARD31516	P
4-Sep-13	W LANTAU	3	13.74	AUTUMN	STANDARD31516	P
4-Sep-13	W LANTAU	2	8.01	AUTUMN	STANDARD31516	S
4-Sep-13	W LANTAU	3	10.53	AUTUMN	STANDARD31516	S
4-Sep-13	W LANTAU	4	0.92	AUTUMN	STANDARD31516	S
4-Sep-13	NW LANTAU	2	4.05	AUTUMN	STANDARD31516	P
4-Sep-13	NW LANTAU	3	4.94	AUTUMN	STANDARD31516	P
4-Sep-13	NW LANTAU	3	2.44	AUTUMN	STANDARD31516	S
11-Sep-13	W LANTAU	2	9.50	AUTUMN	STANDARD31516	S
11-Sep-13	W LANTAU	3	2.43	AUTUMN	STANDARD31516	S
11-Sep-13	NW LANTAU	3	16.62	AUTUMN	STANDARD31516	P
11-Sep-13	NW LANTAU	4	2.84	AUTUMN	STANDARD31516	P
11-Sep-13	NW LANTAU	3	8.20	AUTUMN	STANDARD31516	S
12-Sep-13	NINEPINS	3	24.89	AUTUMN	STANDARD31516	P
12-Sep-13	NINEPINS	4	9.71	AUTUMN	STANDARD31516	P
12-Sep-13	NINEPINS	3	2.10	AUTUMN	STANDARD31516	S
12-Sep-13	PO TOI	2	3.50	AUTUMN	STANDARD31516	P
12-Sep-13	PO TOI	3	16.69	AUTUMN	STANDARD31516	P
12-Sep-13	PO TOI	4	3.91	AUTUMN	STANDARD31516	P
12-Sep-13	PO TOI	3	3.40	AUTUMN	STANDARD31516	S
19-Sep-13	W LANTAU	2	6.92	AUTUMN	STANDARD31516	S
19-Sep-13	W LANTAU	3	2.70	AUTUMN	STANDARD31516	S
19-Sep-13	W LANTAU	4	1.35	AUTUMN	STANDARD31516	S
19-Sep-13	W LANTAU	5	1.37	AUTUMN	STANDARD31516	S
26-Sep-13	NE LANTAU	2	18.66	AUTUMN	STANDARD31516	P
26-Sep-13	NE LANTAU	1	1.60	AUTUMN	STANDARD31516	S
26-Sep-13	NE LANTAU	2	6.62	AUTUMN	STANDARD31516	S
26-Sep-13	NE LANTAU	3	0.50	AUTUMN	STANDARD31516	S
26-Sep-13	NW LANTAU	2	15.02	AUTUMN	STANDARD31516	P
26-Sep-13	NW LANTAU	3	2.04	AUTUMN	STANDARD31516	P
26-Sep-13	NW LANTAU	2	2.91	AUTUMN	STANDARD31516	S
26-Sep-13	NW LANTAU	3	1.20	AUTUMN	STANDARD31516	S
26-Sep-13	DEEP BAY	2	11.69	AUTUMN	STANDARD31516	P
26-Sep-13	DEEP BAY	3	5.63	AUTUMN	STANDARD31516	P
26-Sep-13	DEEP BAY	2	8.71	AUTUMN	STANDARD31516	S
26-Sep-13	DEEP BAY	3	2.41	AUTUMN	STANDARD31516	S
27-Sep-13	W LANTAU	1	1.75	AUTUMN	STANDARD31516	P
27-Sep-13	W LANTAU	2	11.43	AUTUMN	STANDARD31516	P
27-Sep-13	W LANTAU	3	6.74	AUTUMN	STANDARD31516	P
27-Sep-13	W LANTAU	2	16.41	AUTUMN	STANDARD31516	S
27-Sep-13	W LANTAU	3	3.28	AUTUMN	STANDARD31516	S
27-Sep-13	NW LANTAU	1	1.20	AUTUMN	STANDARD31516	P
27-Sep-13	NW LANTAU	2	12.94	AUTUMN	STANDARD31516	P
27-Sep-13	NW LANTAU	1	2.16	AUTUMN	STANDARD31516	S
27-Sep-13	NW LANTAU	2	6.40	AUTUMN	STANDARD31516	S
9-Oct-13	SW LANTAU	3	12.39	AUTUMN	STANDARD31516	P
9-Oct-13	SW LANTAU	4	4.10	AUTUMN	STANDARD31516	P
9-Oct-13	SW LANTAU	2	2.60	AUTUMN	STANDARD31516	S
9-Oct-13	SW LANTAU	3	3.52	AUTUMN	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
9-Oct-13	SW LANTAU	4	5.44	AUTUMN	STANDARD31516	S
10-Oct-13	PO TOI	2	4.80	AUTUMN	STANDARD31516	P
10-Oct-13	PO TOI	3	19.89	AUTUMN	STANDARD31516	P
10-Oct-13	PO TOI	4	8.59	AUTUMN	STANDARD31516	P
10-Oct-13	PO TOI	5	10.02	AUTUMN	STANDARD31516	P
10-Oct-13	PO TOI	2	6.30	AUTUMN	STANDARD31516	S
10-Oct-13	PO TOI	3	11.80	AUTUMN	STANDARD31516	S
10-Oct-13	PO TOI	4	4.60	AUTUMN	STANDARD31516	S
10-Oct-13	PO TOI	5	2.20	AUTUMN	STANDARD31516	S
11-Oct-13	SE LANTAU	2	18.25	AUTUMN	STANDARD31516	P
11-Oct-13	SE LANTAU	3	7.9	AUTUMN	STANDARD31516	P
11-Oct-13	SE LANTAU	2	5.55	AUTUMN	STANDARD31516	S
11-Oct-13	SE LANTAU	3	3.1	AUTUMN	STANDARD31516	S
11-Oct-13	SW LANTAU	1	1.20	AUTUMN	STANDARD31516	P
11-Oct-13	SW LANTAU	2	16.65	AUTUMN	STANDARD31516	P
11-Oct-13	SW LANTAU	1	8.32	AUTUMN	STANDARD31516	S
11-Oct-13	SW LANTAU	2	4.31	AUTUMN	STANDARD31516	S
11-Oct-13	W LANTAU	1	9.64	AUTUMN	STANDARD31516	S
21-Oct-13	NE LANTAU	1	7.77	AUTUMN	STANDARD31516	P
21-Oct-13	NE LANTAU	2	13.06	AUTUMN	STANDARD31516	P
21-Oct-13	NE LANTAU	1	3.19	AUTUMN	STANDARD31516	S
21-Oct-13	NE LANTAU	2	7.32	AUTUMN	STANDARD31516	S
21-Oct-13	NW LANTAU	2	1.23	AUTUMN	STANDARD31516	P
21-Oct-13	NW LANTAU	3	14.22	AUTUMN	STANDARD31516	P
21-Oct-13	NW LANTAU	3	4.81	AUTUMN	STANDARD31516	S
21-Oct-13	DEEP BAY	2	5.93	AUTUMN	STANDARD31516	P
21-Oct-13	DEEP BAY	3	7.15	AUTUMN	STANDARD31516	P
21-Oct-13	DEEP BAY	2	5.35	AUTUMN	STANDARD31516	S
21-Oct-13	DEEP BAY	3	0.51	AUTUMN	STANDARD31516	S
31-Oct-13	SW LANTAU	1	3.65	AUTUMN	STANDARD31516	P
31-Oct-13	SW LANTAU	2	19.16	AUTUMN	STANDARD31516	P
31-Oct-13	SW LANTAU	3	1.95	AUTUMN	STANDARD31516	P
31-Oct-13	SW LANTAU	2	10.67	AUTUMN	STANDARD31516	S
31-Oct-13	SW LANTAU	3	1.96	AUTUMN	STANDARD31516	S
31-Oct-13	W LANTAU	1	0.28	AUTUMN	STANDARD31516	P
31-Oct-13	W LANTAU	2	2.96	AUTUMN	STANDARD31516	P
31-Oct-13	W LANTAU	1	1.08	AUTUMN	STANDARD31516	S
31-Oct-13	W LANTAU	2	6.54	AUTUMN	STANDARD31516	S
6-Nov-13	SE LANTAU	2	13.28	AUTUMN	STANDARD31516	P
6-Nov-13	SE LANTAU	3	2.01	AUTUMN	STANDARD31516	P
6-Nov-13	SE LANTAU	2	6.11	AUTUMN	STANDARD31516	S
7-Nov-13	NE LANTAU	2	12.73	AUTUMN	STANDARD31516	P
7-Nov-13	NE LANTAU	3	3.62	AUTUMN	STANDARD31516	P
7-Nov-13	NE LANTAU	1	1.30	AUTUMN	STANDARD31516	S
7-Nov-13	NE LANTAU	2	11.04	AUTUMN	STANDARD31516	S
7-Nov-13	NW LANTAU	2	12.08	AUTUMN	STANDARD31516	P
7-Nov-13	NW LANTAU	3	1.05	AUTUMN	STANDARD31516	P
7-Nov-13	NW LANTAU	2	10.88	AUTUMN	STANDARD31516	S
7-Nov-13	DEEP BAY	1	3.06	AUTUMN	STANDARD31516	P
7-Nov-13	DEEP BAY	2	13.64	AUTUMN	STANDARD31516	P
7-Nov-13	DEEP BAY	1	1.50	AUTUMN	STANDARD31516	S
7-Nov-13	DEEP BAY	2	8.86	AUTUMN	STANDARD31516	S
14-Nov-13	NW LANTAU	1	1.30	AUTUMN	STANDARD31516	P
14-Nov-13	NW LANTAU	2	18.75	AUTUMN	STANDARD31516	P
14-Nov-13	NW LANTAU	3	9.05	AUTUMN	STANDARD31516	P
14-Nov-13	NW LANTAU	2	3.94	AUTUMN	STANDARD31516	S
14-Nov-13	NW LANTAU	3	2.01	AUTUMN	STANDARD31516	S
14-Nov-13	W LANTAU	2	1.49	AUTUMN	STANDARD31516	P
14-Nov-13	W LANTAU	3	0.85	AUTUMN	STANDARD31516	P
14-Nov-13	W LANTAU	4	4.95	AUTUMN	STANDARD31516	P
14-Nov-13	W LANTAU	5	0.50	AUTUMN	STANDARD31516	P

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
14-Nov-13	W LANTAU	3	1.37	AUTUMN	STANDARD31516	S
14-Nov-13	W LANTAU	4	5.81	AUTUMN	STANDARD31516	S
14-Nov-13	W LANTAU	5	1.40	AUTUMN	STANDARD31516	S
15-Nov-13	SW LANTAU	2	10.51	AUTUMN	STANDARD31516	P
15-Nov-13	SW LANTAU	3	1.79	AUTUMN	STANDARD31516	P
15-Nov-13	SW LANTAU	2	0.70	AUTUMN	STANDARD31516	S
15-Nov-13	SW LANTAU	3	5.93	AUTUMN	STANDARD31516	S
22-Nov-13	NW LANTAU	0	2.04	AUTUMN	STANDARD31516	P
22-Nov-13	NW LANTAU	1	7.81	AUTUMN	STANDARD31516	P
22-Nov-13	NW LANTAU	2	12.65	AUTUMN	STANDARD31516	P
22-Nov-13	NW LANTAU	3	3.13	AUTUMN	STANDARD31516	P
22-Nov-13	NW LANTAU	1	0.47	AUTUMN	STANDARD31516	S
22-Nov-13	NW LANTAU	2	5.00	AUTUMN	STANDARD31516	S
22-Nov-13	NW LANTAU	3	0.78	AUTUMN	STANDARD31516	S
22-Nov-13	NE LANTAU	2	2.90	AUTUMN	STANDARD31516	P
22-Nov-13	NE LANTAU	3	13.07	AUTUMN	STANDARD31516	P
22-Nov-13	NE LANTAU	1	2.40	AUTUMN	STANDARD31516	S
22-Nov-13	NE LANTAU	2	2.40	AUTUMN	STANDARD31516	S
22-Nov-13	NE LANTAU	3	4.43	AUTUMN	STANDARD31516	S
25-Nov-13	SE LANTAU	2	7.53	AUTUMN	STANDARD31516	P
25-Nov-13	SE LANTAU	3	8.15	AUTUMN	STANDARD31516	P
25-Nov-13	SE LANTAU	4	7.86	AUTUMN	STANDARD31516	P
25-Nov-13	SE LANTAU	5	1.31	AUTUMN	STANDARD31516	P
25-Nov-13	SE LANTAU	2	2.00	AUTUMN	STANDARD31516	S
25-Nov-13	SE LANTAU	3	4.66	AUTUMN	STANDARD31516	S
25-Nov-13	SE LANTAU	4	3.08	AUTUMN	STANDARD31516	S
25-Nov-13	SW LANTAU	2	7.00	AUTUMN	STANDARD31516	P
25-Nov-13	SW LANTAU	3	10.57	AUTUMN	STANDARD31516	P
25-Nov-13	SW LANTAU	4	3.30	AUTUMN	STANDARD31516	P
25-Nov-13	SW LANTAU	2	2.82	AUTUMN	STANDARD31516	S
25-Nov-13	SW LANTAU	3	8.11	AUTUMN	STANDARD31516	S
25-Nov-13	SW LANTAU	4	0.80	AUTUMN	STANDARD31516	S
25-Nov-13	W LANTAU	3	6.94	AUTUMN	STANDARD31516	S
26-Nov-13	NW LANTAU	2	8.3	AUTUMN	STANDARD31516	S
26-Nov-13	W LANTAU	2	8.4	AUTUMN	STANDARD31516	P
26-Nov-13	W LANTAU	3	8.3	AUTUMN	STANDARD31516	P
26-Nov-13	W LANTAU	1	4.5	AUTUMN	STANDARD31516	S
26-Nov-13	W LANTAU	2	5.5	AUTUMN	STANDARD31516	S
26-Nov-13	W LANTAU	3	6.9	AUTUMN	STANDARD31516	S
26-Nov-13	NE LANTAU	2	2.5	AUTUMN	STANDARD31516	P
26-Nov-13	NE LANTAU	3	3.5	AUTUMN	STANDARD31516	P
26-Nov-13	NE LANTAU	3	7.1	AUTUMN	STANDARD31516	S
3-Dec-13	NW LANTAU	2	5.4	WINTER	STANDARD31516	S
3-Dec-13	NW LANTAU	3	1.9	WINTER	STANDARD31516	S
3-Dec-13	SW LANTAU	1	3.3	WINTER	STANDARD31516	S
3-Dec-13	SW LANTAU	2	3.7	WINTER	STANDARD31516	S
3-Dec-13	SW LANTAU	3	1.9	WINTER	STANDARD31516	S
6-Dec-13	W LANTAU	3	2.20	WINTER	STANDARD31516	S
6-Dec-13	W LANTAU	4	7.38	WINTER	STANDARD31516	S
6-Dec-13	SW LANTAU	2	3.96	WINTER	STANDARD31516	P
6-Dec-13	SW LANTAU	3	12.41	WINTER	STANDARD31516	P
6-Dec-13	SW LANTAU	4	5.56	WINTER	STANDARD31516	P
6-Dec-13	SW LANTAU	2	3.18	WINTER	STANDARD31516	S
6-Dec-13	SW LANTAU	3	7.48	WINTER	STANDARD31516	S
6-Dec-13	SW LANTAU	4	2.49	WINTER	STANDARD31516	S
6-Dec-13	SE LANTAU	2	5.32	WINTER	STANDARD31516	P
6-Dec-13	SE LANTAU	3	6.79	WINTER	STANDARD31516	P
6-Dec-13	SE LANTAU	2	5.91	WINTER	STANDARD31516	S
10-Dec-13	NW LANTAU	2	11.04	WINTER	STANDARD31516	P
10-Dec-13	NW LANTAU	3	9.03	WINTER	STANDARD31516	P
10-Dec-13	NW LANTAU	2	4.30	WINTER	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
10-Dec-13	DEEP BAY	2	12.81	WINTER	STANDARD31516	P
10-Dec-13	DEEP BAY	3	3.06	WINTER	STANDARD31516	P
10-Dec-13	DEEP BAY	1	1.66	WINTER	STANDARD31516	S
10-Dec-13	DEEP BAY	2	7.73	WINTER	STANDARD31516	S
10-Dec-13	DEEP BAY	3	0.52	WINTER	STANDARD31516	S
10-Dec-13	NE LANTAU	1	4.25	WINTER	STANDARD31516	P
10-Dec-13	NE LANTAU	2	8.71	WINTER	STANDARD31516	P
10-Dec-13	NE LANTAU	3	1.39	WINTER	STANDARD31516	P
10-Dec-13	NE LANTAU	2	4.36	WINTER	STANDARD31516	S
11-Dec-13	W LANTAU	2	3.14	WINTER	STANDARD31516	S
11-Dec-13	W LANTAU	3	8.10	WINTER	STANDARD31516	S
11-Dec-13	SW LANTAU	2	13.92	WINTER	STANDARD31516	P
11-Dec-13	SW LANTAU	3	4.31	WINTER	STANDARD31516	P
11-Dec-13	SW LANTAU	2	7.61	WINTER	STANDARD31516	S
11-Dec-13	SW LANTAU	3	2.38	WINTER	STANDARD31516	S
11-Dec-13	SE LANTAU	2	17.65	WINTER	STANDARD31516	P
11-Dec-13	SE LANTAU	2	6.11	WINTER	STANDARD31516	S
13-Dec-13	NW LANTAU	2	8.85	WINTER	STANDARD31516	P
13-Dec-13	NW LANTAU	3	4.44	WINTER	STANDARD31516	P
13-Dec-13	NW LANTAU	2	1.65	WINTER	STANDARD31516	S
13-Dec-13	NW LANTAU	3	1.34	WINTER	STANDARD31516	S
19-Dec-13	NW LANTAU	2	5.59	WINTER	STANDARD31516	P
19-Dec-13	NW LANTAU	3	4.41	WINTER	STANDARD31516	P
19-Dec-13	NW LANTAU	4	1.21	WINTER	STANDARD31516	P
19-Dec-13	NW LANTAU	2	4.99	WINTER	STANDARD31516	S
20-Dec-13	W LANTAU	3	6.71	WINTER	STANDARD31516	S
20-Dec-13	W LANTAU	4	2.35	WINTER	STANDARD31516	S
20-Dec-13	W LANTAU	5	2.37	WINTER	STANDARD31516	S
20-Dec-13	NE LANTAU	2	7.77	WINTER	STANDARD31516	P
20-Dec-13	NE LANTAU	3	2.68	WINTER	STANDARD31516	P
20-Dec-13	NE LANTAU	2	4.33	WINTER	STANDARD31516	S
30-Dec-13	NW LANTAU	2	8.76	WINTER	STANDARD31516	P
30-Dec-13	NW LANTAU	3	5.12	WINTER	STANDARD31516	P
30-Dec-13	NW LANTAU	2	3.57	WINTER	STANDARD31516	S
30-Dec-13	NW LANTAU	3	3.16	WINTER	STANDARD31516	S
30-Dec-13	DEEP BAY	2	5.70	WINTER	STANDARD31516	P
30-Dec-13	DEEP BAY	3	7.10	WINTER	STANDARD31516	P
30-Dec-13	DEEP BAY	2	1.62	WINTER	STANDARD31516	S
30-Dec-13	DEEP BAY	3	3.52	WINTER	STANDARD31516	S
30-Dec-13	NE LANTAU	2	6.38	WINTER	STANDARD31516	P
30-Dec-13	NE LANTAU	3	5.40	WINTER	STANDARD31516	P
30-Dec-13	NE LANTAU	2	6.79	WINTER	STANDARD31516	S
31-Dec-13	LAMMA	1	16.09	WINTER	STANDARD31516	P
31-Dec-13	LAMMA	2	50.54	WINTER	STANDARD31516	P
31-Dec-13	LAMMA	3	1.07	WINTER	STANDARD31516	P
31-Dec-13	LAMMA	1	4.70	WINTER	STANDARD31516	S
31-Dec-13	LAMMA	2	13.35	WINTER	STANDARD31516	S
8-Jan-14	W LANTAU	1	5.82	WINTER	STANDARD31516	S
8-Jan-14	W LANTAU	2	3.96	WINTER	STANDARD31516	S
8-Jan-14	SW LANTAU	1	8.96	WINTER	STANDARD31516	P
8-Jan-14	SW LANTAU	2	3.18	WINTER	STANDARD31516	P
8-Jan-14	SW LANTAU	0	2.71	WINTER	STANDARD31516	S
8-Jan-14	SW LANTAU	1	6.88	WINTER	STANDARD31516	S
8-Jan-14	SW LANTAU	2	2.57	WINTER	STANDARD31516	S
8-Jan-14	SE LANTAU	1	2.86	WINTER	STANDARD31516	P
8-Jan-14	SE LANTAU	2	6.65	WINTER	STANDARD31516	P
8-Jan-14	SE LANTAU	3	14.00	WINTER	STANDARD31516	P
8-Jan-14	SE LANTAU	4	2.89	WINTER	STANDARD31516	P
8-Jan-14	SE LANTAU	1	1.59	WINTER	STANDARD31516	S
8-Jan-14	SE LANTAU	2	3.83	WINTER	STANDARD31516	S
8-Jan-14	SE LANTAU	3	4.18	WINTER	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
8-Jan-14	SE LANTAU	4	0.70	WINTER	STANDARD31516	S
10-Jan-14	NW LANTAU	2	4.54	WINTER	STANDARD31516	P
10-Jan-14	NW LANTAU	3	15.45	WINTER	STANDARD31516	P
10-Jan-14	NW LANTAU	2	1.76	WINTER	STANDARD31516	S
10-Jan-14	NW LANTAU	3	1.20	WINTER	STANDARD31516	S
10-Jan-14	DEEP BAY	2	2.37	WINTER	STANDARD31516	P
10-Jan-14	DEEP BAY	3	10.42	WINTER	STANDARD31516	P
10-Jan-14	DEEP BAY	3	6.22	WINTER	STANDARD31516	S
10-Jan-14	NE LANTAU	2	11.22	WINTER	STANDARD31516	P
10-Jan-14	NE LANTAU	3	2.10	WINTER	STANDARD31516	P
10-Jan-14	NE LANTAU	2	6.42	WINTER	STANDARD31516	S
10-Jan-14	NE LANTAU	3	2.30	WINTER	STANDARD31516	S
22-Jan-14	NE LANTAU	2	31.03	WINTER	STANDARD31516	P
22-Jan-14	NE LANTAU	2	12.55	WINTER	STANDARD31516	S
22-Jan-14	NE LANTAU	3	2.27	WINTER	STANDARD31516	S
22-Jan-14	NW LANTAU	2	3.49	WINTER	STANDARD31516	P
22-Jan-14	NW LANTAU	3	13.40	WINTER	STANDARD31516	P
22-Jan-14	NW LANTAU	3	5.14	WINTER	STANDARD31516	S
22-Jan-14	NW LANTAU	4	2.87	WINTER	STANDARD31516	S
24-Jan-14	NW LANTAU	2	4.2	WINTER	STANDARD31516	P
24-Jan-14	NW LANTAU	3	4.4	WINTER	STANDARD31516	P
24-Jan-14	NW LANTAU	4	4.7	WINTER	STANDARD31516	P
24-Jan-14	NW LANTAU	3	9.1	WINTER	STANDARD31516	S
24-Jan-14	NW LANTAU	4	1.5	WINTER	STANDARD31516	S
24-Jan-14	W LANTAU	2	7.33	WINTER	STANDARD31516	S
24-Jan-14	W LANTAU	3	1.75	WINTER	STANDARD31516	S
24-Jan-14	W LANTAU	4	1.07	WINTER	STANDARD31516	S
27-Jan-14	NE LANTAU	2	10.3	WINTER	STANDARD31516	P
27-Jan-14	NE LANTAU	3	20.9	WINTER	STANDARD31516	P
27-Jan-14	NE LANTAU	2	8.7	WINTER	STANDARD31516	S
27-Jan-14	NE LANTAU	3	2.9	WINTER	STANDARD31516	S
27-Jan-14	NW LANTAU	2	6.7	WINTER	STANDARD31516	P
27-Jan-14	NW LANTAU	3	12.1	WINTER	STANDARD31516	P
27-Jan-14	NW LANTAU	2	4.1	WINTER	STANDARD31516	S
27-Jan-14	DEEP BAY	1	1.5	WINTER	STANDARD31516	P
27-Jan-14	DEEP BAY	2	8.9	WINTER	STANDARD31516	P
27-Jan-14	DEEP BAY	3	1.0	WINTER	STANDARD31516	P
27-Jan-14	DEEP BAY	1	1.1	WINTER	STANDARD31516	S
27-Jan-14	DEEP BAY	2	4.9	WINTER	STANDARD31516	S
28-Jan-14	NW LANTAU	2	15.83	WINTER	STANDARD31516	P
28-Jan-14	NW LANTAU	3	3.23	WINTER	STANDARD31516	P
28-Jan-14	NW LANTAU	2	8.83	WINTER	STANDARD31516	S
29-Jan-14	W LANTAU	0	1.89	WINTER	STANDARD31516	S
29-Jan-14	W LANTAU	1	3.60	WINTER	STANDARD31516	S
29-Jan-14	W LANTAU	2	5.91	WINTER	STANDARD31516	S
29-Jan-14	W LANTAU	3	0.98	WINTER	STANDARD31516	S
29-Jan-14	SW LANTAU	2	1.25	WINTER	STANDARD31516	P
29-Jan-14	SW LANTAU	3	7.36	WINTER	STANDARD31516	P
29-Jan-14	SW LANTAU	4	18.33	WINTER	STANDARD31516	P
29-Jan-14	SW LANTAU	4	9.05	WINTER	STANDARD31516	S
29-Jan-14	SE LANTAU	2	1.99	WINTER	STANDARD31516	P
29-Jan-14	SE LANTAU	3	9.42	WINTER	STANDARD31516	P
29-Jan-14	SE LANTAU	4	5.26	WINTER	STANDARD31516	P
29-Jan-14	SE LANTAU	2	1.38	WINTER	STANDARD31516	S
29-Jan-14	SE LANTAU	3	0.88	WINTER	STANDARD31516	S
29-Jan-14	SE LANTAU	4	3.82	WINTER	STANDARD31516	S
7-Feb-14	LAMMA	1	9.4	WINTER	STANDARD31516	P
7-Feb-14	LAMMA	2	64.3	WINTER	STANDARD31516	P
7-Feb-14	LAMMA	1	4.1	WINTER	STANDARD31516	S
7-Feb-14	LAMMA	2	18.6	WINTER	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
17-Feb-14	SE LANTAU	1	1.5	WINTER	STANDARD31516	P
17-Feb-14	SE LANTAU	2	16.8	WINTER	STANDARD31516	P
17-Feb-14	SE LANTAU	3	6.5	WINTER	STANDARD31516	P
17-Feb-14	SE LANTAU	2	4.2	WINTER	STANDARD31516	S
17-Feb-14	SE LANTAU	3	4.1	WINTER	STANDARD31516	S
17-Feb-14	SW LANTAU	2	13	WINTER	STANDARD31516	P
17-Feb-14	SW LANTAU	3	2.3	WINTER	STANDARD31516	P
17-Feb-14	SW LANTAU	2	10.1	WINTER	STANDARD31516	S
18-Feb-14	LAMMA	0	11	WINTER	STANDARD31516	P
18-Feb-14	LAMMA	1	17.5	WINTER	STANDARD31516	P
18-Feb-14	LAMMA	2	22.9	WINTER	STANDARD31516	P
18-Feb-14	LAMMA	3	1.3	WINTER	STANDARD31516	P
18-Feb-14	LAMMA	4	3.5	WINTER	STANDARD31516	P
18-Feb-14	LAMMA	1	7.4	WINTER	STANDARD31516	S
18-Feb-14	LAMMA	2	5.4	WINTER	STANDARD31516	S
18-Feb-14	LAMMA	4	2	WINTER	STANDARD31516	S
18-Feb-14	LAMMA	5	1.7	WINTER	STANDARD31516	S
24-Feb-14	W LANTAU	2	4.6	WINTER	STANDARD31516	S
24-Feb-14	W LANTAU	3	1.2	WINTER	STANDARD31516	S
24-Feb-14	W LANTAU	4	0.8	WINTER	STANDARD31516	S
24-Feb-14	W LANTAU	5	2.3	WINTER	STANDARD31516	S
25-Feb-14	NW LANTAU	2	13.4	WINTER	STANDARD31516	P
25-Feb-14	NW LANTAU	3	16.2	WINTER	STANDARD31516	P
25-Feb-14	NW LANTAU	4	0.5	WINTER	STANDARD31516	P
25-Feb-14	NW LANTAU	2	6.2	WINTER	STANDARD31516	S
25-Feb-14	NW LANTAU	3	2.4	WINTER	STANDARD31516	S
25-Feb-14	NE LANTAU	2	18.9	WINTER	STANDARD31516	P
25-Feb-14	NE LANTAU	2	4.6	WINTER	STANDARD31516	S
26-Feb-14	SE LANTAU	2	11.8	WINTER	STANDARD31516	P
26-Feb-14	SE LANTAU	2	7.3	WINTER	STANDARD31516	S
27-Feb-14	NE LANTAU	1	13.1	WINTER	STANDARD31516	P
27-Feb-14	NE LANTAU	2	8.2	WINTER	STANDARD31516	P
27-Feb-14	NE LANTAU	3	11	WINTER	STANDARD31516	P
27-Feb-14	NE LANTAU	4	4.4	WINTER	STANDARD31516	P
27-Feb-14	NE LANTAU	1	4.1	WINTER	STANDARD31516	S
27-Feb-14	NE LANTAU	2	3.8	WINTER	STANDARD31516	S
27-Feb-14	NE LANTAU	3	4.3	WINTER	STANDARD31516	S
27-Feb-14	NW LANTAU	2	5.2	WINTER	STANDARD31516	P
27-Feb-14	NW LANTAU	3	17.4	WINTER	STANDARD31516	P
27-Feb-14	NW LANTAU	4	4.4	WINTER	STANDARD31516	P
27-Feb-14	NW LANTAU	2	4	WINTER	STANDARD31516	S
27-Feb-14	NW LANTAU	3	4.5	WINTER	STANDARD31516	S
28-Feb-14	W LANTAU	3	9.6	WINTER	STANDARD31516	P
28-Feb-14	W LANTAU	4	3.2	WINTER	STANDARD31516	P
28-Feb-14	W LANTAU	5	2	WINTER	STANDARD31516	P
28-Feb-14	W LANTAU	3	8	WINTER	STANDARD31516	S
28-Feb-14	W LANTAU	4	4.3	WINTER	STANDARD31516	S
28-Feb-14	NW LANTAU	3	6.3	WINTER	STANDARD31516	P
28-Feb-14	NW LANTAU	4	2.6	WINTER	STANDARD31516	P
28-Feb-14	NW LANTAU	3	7.3	WINTER	STANDARD31516	S
28-Feb-14	DEEP BAY	2	8.6	WINTER	STANDARD31516	P
28-Feb-14	DEEP BAY	3	1.6	WINTER	STANDARD31516	P
28-Feb-14	DEEP BAY	2	4.1	WINTER	STANDARD31516	S
4-Mar-14	NE LANTAU	2	16.8	SPRING	STANDARD31516	P
4-Mar-14	NE LANTAU	2	11.5	SPRING	STANDARD31516	S
4-Mar-14	NW LANTAU	1	9.4	SPRING	STANDARD31516	P
4-Mar-14	NW LANTAU	2	30.4	SPRING	STANDARD31516	P
4-Mar-14	NW LANTAU	1	2.2	SPRING	STANDARD31516	S
4-Mar-14	NW LANTAU	2	11.4	SPRING	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
12-Mar-14	NW LANTAU	2	12.9	SPRING	STANDARD31516	P
12-Mar-14	NW LANTAU	3	5.5	SPRING	STANDARD31516	P
12-Mar-14	NW LANTAU	2	2.2	SPRING	STANDARD31516	S
12-Mar-14	NW LANTAU	3	4.1	SPRING	STANDARD31516	S
12-Mar-14	W LANTAU	2	10.3	SPRING	STANDARD31516	S
12-Mar-14	W LANTAU	3	2	SPRING	STANDARD31516	S
13-Mar-14	LAMMA	0	2.2	SPRING	STANDARD31516	P
13-Mar-14	LAMMA	1	18.3	SPRING	STANDARD31516	P
13-Mar-14	LAMMA	2	37.5	SPRING	STANDARD31516	P
13-Mar-14	LAMMA	3	9.1	SPRING	STANDARD31516	P
13-Mar-14	LAMMA	0	0.2	SPRING	STANDARD31516	S
13-Mar-14	LAMMA	1	6.5	SPRING	STANDARD31516	S
13-Mar-14	LAMMA	2	11	SPRING	STANDARD31516	S
13-Mar-14	LAMMA	3	3.1	SPRING	STANDARD31516	S
18-Mar-14	W LANTAU	1	6.5	SPRING	STANDARD31516	S
18-Mar-14	W LANTAU	2	2.5	SPRING	STANDARD31516	S
18-Mar-14	SW LANTAU	1	13	SPRING	STANDARD31516	P
18-Mar-14	SW LANTAU	2	7	SPRING	STANDARD31516	P
18-Mar-14	SW LANTAU	1	5.9	SPRING	STANDARD31516	S
18-Mar-14	SW LANTAU	2	5.9	SPRING	STANDARD31516	S
18-Mar-14	SE LANTAU	2	9	SPRING	STANDARD31516	P
18-Mar-14	SE LANTAU	1	1.8	SPRING	STANDARD31516	S
18-Mar-14	SE LANTAU	2	4.3	SPRING	STANDARD31516	S
20-Mar-14	LAMMA	0	8.9	SPRING	STANDARD31516	P
20-Mar-14	LAMMA	1	22.8	SPRING	STANDARD31516	P
20-Mar-14	LAMMA	2	5.3	SPRING	STANDARD31516	P
20-Mar-14	LAMMA	1	10.1	SPRING	STANDARD31516	S
20-Mar-14	SE LANTAU	1	13.2	SPRING	STANDARD31516	P
20-Mar-14	SE LANTAU	2	6.7	SPRING	STANDARD31516	P
20-Mar-14	SE LANTAU	1	5.8	SPRING	STANDARD31516	S
20-Mar-14	SE LANTAU	2	2.1	SPRING	STANDARD31516	S
26-Mar-14	W LANTAU	1	6.8	SPRING	STANDARD31516	S
26-Mar-14	W LANTAU	2	6.6	SPRING	STANDARD31516	S
26-Mar-14	NW LANTAU	1	9.1	SPRING	STANDARD31516	P
26-Mar-14	NW LANTAU	2	4.7	SPRING	STANDARD31516	P
26-Mar-14	NW LANTAU	1	2.7	SPRING	STANDARD31516	S
26-Mar-14	NW LANTAU	2	4.1	SPRING	STANDARD31516	S
27-Mar-14	W LANTAU	0	2.7	SPRING	STANDARD31516	S
27-Mar-14	W LANTAU	1	7.6	SPRING	STANDARD31516	S
27-Mar-14	SW LANTAU	0	3.4	SPRING	STANDARD31516	P
27-Mar-14	SW LANTAU	1	13.3	SPRING	STANDARD31516	P
27-Mar-14	SW LANTAU	2	7.5	SPRING	STANDARD31516	P
27-Mar-14	SW LANTAU	0	3.1	SPRING	STANDARD31516	S
27-Mar-14	SW LANTAU	1	4.2	SPRING	STANDARD31516	S
27-Mar-14	SW LANTAU	2	4.2	SPRING	STANDARD31516	S
27-Mar-14	SE LANTAU	0	0.9	SPRING	STANDARD31516	P
27-Mar-14	SE LANTAU	2	23	SPRING	STANDARD31516	P
27-Mar-14	SE LANTAU	1	0.8	SPRING	STANDARD31516	S
27-Mar-14	SE LANTAU	2	6.9	SPRING	STANDARD31516	S

Appendix II. HKCRP-AFCD Chinese White Dolphin Sighting Database (April 2013 - March 2014)

(Note: P = sightings made on primary lines; S = sightings made on secondary line

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
9-Apr-13	1	1523	1	W LANTAU	2	294	ON	HKCRP	811245	801787	SPRING	NONE	S
9-Apr-13	2	1531	3	W LANTAU	2	20	ON	HKCRP	812131	801747	SPRING	NONE	S
13-Apr-13	14	1643	4	W LANTAU	2	62	ON	HKCRP	811522	802066	SPRING	NONE	S
17-Apr-13	1	1529	2	NW LANTAU	1	106	ON	HKCRP	826637	807517	SPRING	NONE	P
25-Apr-13	1	901	3	W LANTAU	2	ND	OFF	THEO	806251	801971	SPRING	NONE	
25-Apr-13	2	936	1	W LANTAU	2	ND	OFF	THEO	806041	801796	SPRING	NONE	
25-Apr-13	3	1120	3	SW LANTAU	4	ND	OFF	THEO	806284	802157	SPRING	NONE	
25-Apr-13	4	1149	1	W LANTAU	4	ND	OFF	THEO	806217	802054	SPRING	NONE	
3-May-13	1	1212	3	NW LANTAU	3	69	ON	HKCRP	825355	806453	SPRING	NONE	P
6-May-13	1	1047	1	W LANTAU	3	100	ON	HKCRP	807782	800717	SPRING	NONE	S
7-May-13	1	1204	3	NW LANTAU	2	32	ON	HKCRP	829031	806461	SPRING	NONE	P
7-May-13	2	1311	5	W LANTAU	3	13	ON	HKCRP	818118	803770	SPRING	NONE	P
7-May-13	3	1401	1	W LANTAU	2	ND	OFF	HKCRP	813163	801162	SPRING	NONE	
7-May-13	4	1522	1	W LANTAU	5	172	ON	HKCRP	809667	799566	SPRING	NONE	S
9-May-13	1	1012	1	W LANTAU	2	350	ON	HKCRP	815159	804712	SPRING	NONE	S
9-May-13	2	1024	1	W LANTAU	2	25	ON	HKCRP	813889	803174	SPRING	NONE	S
9-May-13	3	1034	1	W LANTAU	2	131	ON	HKCRP	812817	802275	SPRING	NONE	S
9-May-13	4	1046	5	W LANTAU	2	ND	OFF	HKCRP	811202	801570	SPRING	NONE	
9-May-13	5	1109	2	SW LANTAU	2	ND	OFF	HKCRP	806228	802281	SPRING	NONE	
9-May-13	6	1114	4	SW LANTAU	2	252	ON	HKCRP	806205	802621	SPRING	NONE	P
9-May-13	7	1357	1	SW LANTAU	1	268	ON	HKCRP	803345	809814	SPRING	NONE	P
14-May-13	1	0927	1	W LANTAU	2	ND	OFF	THEO	806495	801859	SPRING	NONE	
14-May-13	2	1311	10	SW LANTAU	3	ND	OFF	THEO	806140	802105	SPRING	NONE	
16-May-13	1	1050	2	NW LANTAU	2	ND	OFF	HKCRP	826915	806899	SPRING	NONE	
29-May-13	1	1019	1	W LANTAU	2	360	ON	HKCRP	817564	803780	SPRING	NONE	P
29-May-13	2	1044	6	W LANTAU	1	15	ON	HKCRP	815462	802765	SPRING	NONE	S
29-May-13	3	1154	2	W LANTAU	2	ND	OFF	HKCRP	809432	800710	SPRING	NONE	
29-May-13	4	1233	5	W LANTAU	2	374	ON	HKCRP	805941	801734	SPRING	NONE	S
29-May-13	5	1258	2	W LANTAU	2	46	ON	HKCRP	805445	800835	SPRING	NONE	P
29-May-13	6	1322	4	W LANTAU	2	348	ON	HKCRP	806661	801663	SPRING	NONE	P
29-May-13	7	1343	1	W LANTAU	2	243	ON	HKCRP	807270	801613	SPRING	NONE	S
29-May-13	8	1412	2	W LANTAU	2	374	ON	HKCRP	809689	799566	SPRING	NONE	S
29-May-13	9	1518	1	W LANTAU	2	177	ON	HKCRP	814498	803392	SPRING	NONE	P

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
31-May-13	6	1439	1	SW LANTAU	2	532	ON	HKCRP	806812	809428	SPRING	NONE	P
31-May-13	1	933	10	W LANTAU	2	ND	OFF	THEO	806384	801951	SPRING	NONE	
31-May-13	2	1048	3	W LANTAU	2	ND	OFF	THEO	806373	801941	SPRING	NONE	
31-May-13	3	1227	4	W LANTAU	3	ND	OFF	THEO	806428	801786	SPRING	PURSE SEINE	
3-Jun-13	1	1607	3	W LANTAU	2	ND	OFF	HELI	806452	801291	SUMMER	NONE	
6-Jun-13	1	1038	6	W LANTAU	1	308	ON	HKCRP	814143	803298	SUMMER	NONE	S
6-Jun-13	2	1052	5	W LANTAU	1	103	ON	HKCRP	813547	802761	SUMMER	NONE	S
6-Jun-13	3	1104	1	W LANTAU	2	ND	OFF	HKCRP	811678	801602	SUMMER	NONE	
6-Jun-13	4	1106	3	W LANTAU	2	169	ON	HKCRP	811324	801436	SUMMER	NONE	S
6-Jun-13	5	1117	5	W LANTAU	2	219	ON	HKCRP	808967	800761	SUMMER	NONE	S
6-Jun-13	6	1135	1	W LANTAU	3	93	ON	HKCRP	806952	800509	SUMMER	NONE	S
6-Jun-13	7	1621	2	NW LANTAU	2	466	ON	HKCRP	825685	807288	SUMMER	NONE	S
6-Jun-13	8	1628	2	NW LANTAU	3	50	ON	HKCRP	825937	809163	SUMMER	NONE	S
6-Jun-13	9	1714	1	NW LANTAU	2	250	ON	HKCRP	821039	810834	SUMMER	NONE	S
10-Jun-13	1	1342	3	NW LANTAU	2	404	ON	HKCRP	826281	808515	SUMMER	NONE	P
10-Jun-13	2	1428	3	DEEP BAY	2	51	ON	HKCRP	831225	806156	SUMMER	NONE	S
11-Jun-13	1	1055	1	W LANTAU	5	72	ON	HKCRP	806473	801817	SUMMER	NONE	S
17-Jun-13	1	1351	1	W LANTAU	3	ND	OFF	HKCRP	807483	800489	SUMMER	NONE	
17-Jun-13	2	1356	1	W LANTAU	3	26	ON	HKCRP	808612	800760	SUMMER	NONE	S
17-Jun-13	3	1410	7	W LANTAU	2	47	ON	HKCRP	810825	801631	SUMMER	NONE	S
17-Jun-13	4	1448	1	W LANTAU	2	325	ON	HKCRP	813347	802863	SUMMER	NONE	S
18-Jun-13	1	956	1	NW LANTAU	2	ND	OFF	HKCRP	817059	807251	SUMMER	NONE	
19-Jun-13	1	830	2	W LANTAU	1	ND	OFF	THEO	806384	801869	SUMMER	NONE	
19-Jun-13	2	854	5	W LANTAU	1	ND	OFF	THEO	806340	801920	SUMMER	NONE	
19-Jun-13	3	922	6	W LANTAU	1	ND	OFF	THEO	806118	802023	SUMMER	NONE	
19-Jun-13	4	1022	4	W LANTAU	1	ND	OFF	THEO	806140	802126	SUMMER	NONE	
19-Jun-13	5	1101	10	W LANTAU	1	ND	OFF	THEO	806373	801765	SUMMER	NONE	
19-Jun-13	6	1223	5	W LANTAU	1	ND	OFF	THEO	806206	802105	SUMMER	NONE	
19-Jun-13	7	1310	4	W LANTAU	1	ND	OFF	THEO	806406	801889	SUMMER	NONE	
20-Jun-13	1	1307	1	SW LAMTAU	2	254	ON	HKCRP	807532	809481	SUMMER	NONE	S
20-Jun-13	2	1332	1	SW LAMTAU	2	820	ON	HKCRP	803845	809021	SUMMER	NONE	P
20-Jun-13	3	1546	2	SW LAMTAU	2	ND	OFF	HKCRP	805605	803424	SUMMER	NONE	
20-Jun-13	4	1551	2	SW LAMTAU	2	780	ON	HKCRP	806159	803405	SUMMER	NONE	P
20-Jun-13	5	1600	6	W LANTAU	2	ND	OFF	HKCRP	806284	801961	SUMMER	NONE	

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
20-Jun-13	6	1619	6	W LANTAU	2	269	ON	HKCRP	807204	801551	SUMMER	NONE	S
20-Jun-13	7	1635	2	W LANTAU	2	170	ON	HKCRP	808800	800946	SUMMER	NONE	S
20-Jun-13	8	1701	3	W LANTAU	2	217	ON	HKCRP	813126	802585	SUMMER	NONE	S
20-Jun-13	9	1713	1	W LANTAU	2	273	ON	HKCRP	814941	803300	SUMMER	NONE	S
21-Jun-13	1	1018	5	NW LANTAU	2	ND	OFF	HKCRP	818250	804028	SUMMER	NONE	
21-Jun-13	2	1030	5	W LANTAU	3	138	ON	HKCRP	818262	803791	SUMMER	NONE	P
21-Jun-13	3	1056	8	W LANTAU	3	ND	OFF	HKCRP	813789	803256	SUMMER	NONE	
21-Jun-13	4	1107	7	W LANTAU	2	192	ON	HKCRP	813749	801493	SUMMER	NONE	P
21-Jun-13	5	1231	2	W LANTAU	2	209	ON	HKCRP	805545	800485	SUMMER	NONE	S
21-Jun-13	6	1253	1	W LANTAU	2	103	ON	HKCRP	806244	800053	SUMMER	NONE	S
21-Jun-13	7	1307	3	W LANTAU	2	607	ON	HKCRP	806475	800621	SUMMER	NONE	P
21-Jun-13	8	1326	3	W LANTAU	1	295	ON	HKCRP	808424	800739	SUMMER	NONE	S
21-Jun-13	9	1353	2	W LANTAU	2	8	ON	HKCRP	808438	799553	SUMMER	NONE	P
21-Jun-13	10	1404	3	W LANTAU	1	120	ON	HKCRP	808670	799533	SUMMER	NONE	S
21-Jun-13	11	1429	1	W LANTAU	2	139	ON	HKCRP	810460	801496	SUMMER	NONE	P
21-Jun-13	12	1459	2	W LANTAU	2	408	ON	HKCRP	813461	801431	SUMMER	NONE	S
21-Jun-13	13	1514	4	W LANTAU	2	552	ON	HKCRP	814499	802876	SUMMER	NONE	P
28-Jun-13	1	1637	1	NW LANTAU	4	187	ON	HKCRP	827026	806807	SUMMER	NONE	S
5-Jul-13	1	1023	3	W LANTAU	2	ND	OFF	HKCRP	818227	804358	SUMMER	NONE	
5-Jul-13	2	1453	1	W LANTAU	2	33	ON	HKCRP	808601	800977	SUMMER	NONE	S
5-Jul-13	3	1502	1	W LANTAU	2	53	ON	HKCRP	810117	801392	SUMMER	NONE	S
10-Jul-13	1	1441	2	W LANTAU	1	395	ON	HKCRP	806995	800942	SUMMER	NONE	S
10-Jul-13	2	1449	1	W LANTAU	1	209	ON	HKCRP	808002	801429	SUMMER	NONE	S
10-Jul-13	3	1541	2	W LANTAU	1	124	ON	HKCRP	814220	803927	SUMMER	NONE	S
10-Jul-13	4	1640	4	W LANTAU	2	ND	OFF	HKCRP	814575	803649	SUMMER	NONE	
17-Jul-13	1	1602	4	SW LANTAU	2	48	ON	HKCRP	806295	802044	SUMMER	NONE	S
18-Jul-13	1	1034	2	W LANTAU	2	0	ON	HKCRP	814277	803010	SUMMER	NONE	S
18-Jul-13	2	1050	2	W LANTAU	2	682	ON	HKCRP	813547	802792	SUMMER	NONE	P
18-Jul-13	3	1117	1	W LANTAU	2	134	ON	HKCRP	811458	801004	SUMMER	NONE	P
18-Jul-13	4	1128	1	W LANTAU	2	400	ON	HKCRP	811445	801519	SUMMER	NONE	P
18-Jul-13	5	1133	6	W LANTAU	2	411	ON	HKCRP	811456	801932	SUMMER	NONE	P
18-Jul-13	6	1217	5	W LANTAU	1	114	ON	HKCRP	806728	801715	SUMMER	NONE	S
18-Jul-13	7	1251	2	W LANTAU	1	67	ON	HKCRP	806462	801776	SUMMER	NONE	P
18-Jul-13	8	1303	3	W LANTAU	1	124	ON	HKCRP	808457	801059	SUMMER	NONE	P

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
18-Jul-13	9	1314	1	W LANTAU	1	310	ON	HKCRP	808436	800461	SUMMER	NONE	P
18-Jul-13	10	1335	1	W LANTAU	2	515	ON	HKCRP	810463	800187	SUMMER	NONE	P
18-Jul-13	11	1348	1	W LANTAU	2	262	ON	HKCRP	810758	801703	SUMMER	NONE	S
18-Jul-13	12	1426	4	W LANTAU	2	735	ON	HKCRP	812875	801048	SUMMER	NONE	S
23-Jul-13	1	1336	2	SW LANTAU	2	102	ON	HKCRP	807578	808491	SUMMER	NONE	S
23-Jul-13	2	1638	4	W LANTAU	3	122	ON	HKCRP	812606	802388	SUMMER	NONE	S
24-Jul-13	1	1042	1	NW LANTAU	2	156	ON	HKCRP	823537	807511	SUMMER	NONE	P
24-Jul-13	2	1055	2	NW LANTAU	2	31	ON	HKCRP	824544	807513	SUMMER	NONE	P
24-Jul-13	3	1208	1	DEEP BAY	2	35	ON	HKCRP	831180	806053	SUMMER	NONE	S
24-Jul-13	4	1310	1	DEEP BAY	2	115	ON	HKCRP	834741	808675	SUMMER	NONE	S
24-Jul-13	5	1442	2	NW LANTAU	2	ND	OFF	HKCRP	825615	809379	SUMMER	NONE	
30-Jul-13	1	1423	1	SW LANTAU	2	143	ON	HKCRP	807299	809440	SUMMER	NONE	P
30-Jul-13	2	1442	1	SW LANTAU	2	79	ON	HKCRP	807945	807378	SUMMER	NONE	P
30-Jul-13	3	1611	2	SW LANTAU	2	ND	OFF	HKCRP	806492	803189	SUMMER	NONE	
30-Jul-13	4	1622	3	SW LANTAU	2	ND	OFF	HKCRP	806262	802095	SUMMER	NONE	
30-Jul-13	5	1640	3	W LANTAU	3	150	ON	HKCRP	809597	801092	SUMMER	NONE	S
30-Jul-13	6	1652	5	W LANTAU	3	438	ON	HKCRP	811633	801963	SUMMER	NONE	S
30-Jul-13	7	1704	2	W LANTAU	2	44	ON	HKCRP	812993	802564	SUMMER	NONE	S
31-Jul-13	1	1044	5	W LANTAU	2	590	ON	HKCRP	814155	803216	SUMMER	NONE	S
31-Jul-13	2	1107	4	W LANTAU	2	223	ON	HKCRP	813568	802988	SUMMER	NONE	S
31-Jul-13	3	1148	4	W LANTAU	3	477	ON	HKCRP	809398	800937	SUMMER	NONE	P
31-Jul-13	4	1241	1	W LANTAU	4	72	ON	HKCRP	805952	801703	SUMMER	NONE	S
31-Jul-13	5	1323	6	W LANTAU	3	133	ON	HKCRP	807869	801449	SUMMER	NONE	S
31-Jul-13	6	1403	5	W LANTAU	2	253	ON	HKCRP	810473	800744	SUMMER	NONE	P
31-Jul-13	7	1430	1	W LANTAU	3	14	ON	HKCRP	812441	802006	SUMMER	NONE	P
31-Jul-13	8	1458	2	W LANTAU	2	ND	OFF	HKCRP	814508	803567	SUMMER	NONE	
31-Jul-13	9	1546	2	NW LANTAU	3	353	ON	HKCRP	824781	805433	SUMMER	NONE	P
21-Aug-13	1	1026	2	W LANTAU	3	ND	OFF	HKCRP	812960	802533	SUMMER	NONE	
26-Aug-13	1	1415	1	W LANTAU	2	82	ON	HKCRP	810294	801465	SUMMER	NONE	S
26-Aug-13	2	1443	2	W LANTAU	3	118	ON	HKCRP	813181	802719	SUMMER	NONE	S
27-Aug-13	1	1006	4	W LANTAU	2	330	ON	HKCRP	815137	804857	SUMMER	NONE	S
27-Aug-13	2	1013	2	W LANTAU	1	153	ON	HKCRP	814408	804092	SUMMER	NONE	S
27-Aug-13	3	1021	1	W LANTAU	1	279	ON	HKCRP	813734	803184	SUMMER	NONE	S
27-Aug-13	4	1028	2	W LANTAU	2	40	ON	HKCRP	812994	802492	SUMMER	NONE	S

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
27-Aug-13	5	1037	2	W LANTAU	2	737	ON	HKCRP	812628	802336	SUMMER	SHRIMP	S
27-Aug-13	6	1050	8	W LANTAU	2	12	ON	HKCRP	810549	801486	SUMMER	NONE	S
27-Aug-13	7	1119	7	W LANTAU	2	357	ON	HKCRP	806517	801879	SUMMER	NONE	S
27-Aug-13	8	1212	2	SW LANTAU	2	10	ON	HKCRP	805225	805311	SUMMER	NONE	P
27-Aug-13	9	1344	1	SW LANTAU	2	243	ON	HKCRP	804851	809961	SUMMER	NONE	S
27-Aug-13	10	1402	1	SW LANTAU	2	332	ON	HKCRP	807155	809388	SUMMER	NONE	P
27-Aug-13	11	1415	1	SW LANTAU	2	114	ON	HKCRP	807454	809780	SUMMER	NONE	S
30-Aug-13	1	1400	1	NW LANTAU	2	104	ON	HKCRP	828775	807500	SUMMER	NONE	P
30-Aug-13	2	1428	2	NW LANTAU	1	134	ON	HKCRP	830350	805835	SUMMER	NONE	S
30-Aug-13	3	1734	6	NE LANTAU	1	234	ON	HKCRP	822078	820478	SUMMER	NONE	P
4-Sep-13	1	1153	3	W LANTAU	3	315	ON	HKCRP	813634	803132	AUTUMN	NONE	S
4-Sep-13	2	1233	2	W LANTAU	2	94	ON	HKCRP	810559	801527	AUTUMN	NONE	S
4-Sep-13	3	1331	1	W LANTAU	3	164	ON	HKCRP	806440	801559	AUTUMN	NONE	P
4-Sep-13	4	1450	1	W LANTAU	2	372	ON	HKCRP	812364	801810	AUTUMN	NONE	P
4-Sep-13	5	1612	1	NW LANTAU	3	24	ON	HKCRP	822289	805428	AUTUMN	NONE	P
11-Sep-13	1	1018	5	W LANTAU	2	120	ON	HKCRP	813392	802719	AUTUMN	NONE	S
11-Sep-13	2	1035	3	W LANTAU	2	18	ON	HKCRP	812032	801840	AUTUMN	NONE	S
11-Sep-13	3	1105	5	W LANTAU	3	191	ON	HKCRP	805833	800537	AUTUMN	NONE	S
11-Sep-13	4	1454	3	NW LANTAU	3	52	ON	HKCRP	819576	805453	AUTUMN	NONE	P
16-Sep-13	1	1554	1	W LANTAU	2	ND	OFF	HELI	813170	802678	AUTUMN	NONE	
19-Sep-13	1	1240	1	W LANTAU	5	ND	OFF	HKCRP	807283	800757	AUTUMN	NONE	
19-Sep-13	2	1303	3	W LANTAU	2	125	ON	HKCRP	810681	801610	AUTUMN	NONE	S
19-Sep-13	3	1322	3	W LANTAU	2	339	ON	HKCRP	813967	803050	AUTUMN	NONE	S
26-Sep-13	1	1238	1	NW LANTAU	2	253	ON	HKCRP	823666	809479	AUTUMN	NONE	P
27-Sep-13	1	1049	7	W LANTAU	2	566	ON	HKCRP	813745	803184	AUTUMN	NONE	S
27-Sep-13	2	1154	5	W LANTAU	2	ND	OFF	HKCRP	809310	800762	AUTUMN	NONE	
27-Sep-13	3	1211	4	W LANTAU	2	46	ON	HKCRP	808537	799605	AUTUMN	NONE	S
27-Sep-13	4	1223	2	W LANTAU	2	59	ON	HKCRP	807441	799798	AUTUMN	NONE	P
27-Sep-13	5	1301	2	W LANTAU	2	30	ON	HKCRP	806465	800270	AUTUMN	NONE	P
27-Sep-13	6	1320	1	W LANTAU	3	52	ON	HKCRP	806485	801446	AUTUMN	NONE	P
27-Sep-13	7	1326	1	W LANTAU	2	49	ON	HKCRP	806484	801714	AUTUMN	NONE	P
27-Sep-13	8	1358	4	W LANTAU	2	136	ON	HKCRP	809966	799670	AUTUMN	NONE	S
27-Sep-13	9	1433	1	W LANTAU	2	104	ON	HKCRP	812453	801490	AUTUMN	NONE	P
27-Sep-13	10	1456	2	W LANTAU	2	603	ON	HKCRP	814499	802907	AUTUMN	NONE	P

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DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
27-Sep-13	11	1606	1	NW LANTAU	1	64	ON	HKCRP	827082	806467	AUTUMN	PURSE SEINE	P
9-Oct-13	1	1424	3	SW LANTAU	3	255	ON	HKCRP	803214	803017	AUTUMN	NONE	S
11-Oct-13	1	1306	5	SW LANTAU	2	916	ON	HKCRP	806001	811149	AUTUMN	NONE	P
11-Oct-13	2	1429	5	SW LANTAU	1	134	ON	HKCRP	806847	808397	AUTUMN	PURSE SEINE	P
11-Oct-13	3	1502	4	SW LANTAU	2	257	ON	HKCRP	806795	806345	AUTUMN	NONE	P
11-Oct-13	5	1603	1	SW LANTAU	2	400	ON	HKCRP	806767	803891	AUTUMN	NONE	S
11-Oct-13	6	1609	8	SW LANTAU	2	176	ON	HKCRP	806536	803168	AUTUMN	NONE	S
11-Oct-13	7	1654	2	W LANTAU	1	258	ON	HKCRP	811500	801983	AUTUMN	NONE	S
11-Oct-13	8	1701	2	W LANTAU	1	384	ON	HKCRP	812606	802439	AUTUMN	NONE	S
11-Oct-13	9	1706	1	W LANTAU	1	260	ON	HKCRP	813535	803080	AUTUMN	NONE	S
18-Oct-13	1	1434	4	SW LANTAU	2	ND	OFF	HKCRP	805973	802208	AUTUMN	NONE	
18-Oct-13	2	1445	2	SW LANTAU	2	ND	OFF	HKCRP	806249	802662	AUTUMN	NONE	
18-Oct-13	3	1452	5	SW LANTAU	2	ND	OFF	HKCRP	806369	803426	AUTUMN	NONE	
18-Oct-13	4	1502	3	SW LANTAU	2	ND	OFF	HKCRP	806722	804509	AUTUMN	NONE	
18-Oct-13	5	1520	1	SW LANTAU	3	ND	OFF	HKCRP	807224	808089	AUTUMN	NONE	
18-Oct-13	6	1527	1	SW LANTAU	3	ND	OFF	HKCRP	807344	809316	AUTUMN	NONE	
21-Oct-13	1	1043	2	NE LANTAU	2	ND	OFF	HKCRP	821572	817439	AUTUMN	NONE	
21-Oct-13	2	1054	1	NE LANTAU	2	122	ON	HKCRP	821827	817532	AUTUMN	NONE	P
21-Oct-13	3	1257	4	NW LANTAU	3	233	ON	HKCRP	821340	809475	AUTUMN	NONE	P
21-Oct-13	4	1415	5	NW LANTAU	3	170	ON	HKCRP	828564	807397	AUTUMN	NONE	P
21-Oct-13	5	1459	4	DEEP BAY	3	148	ON	HKCRP	830970	806300	AUTUMN	NONE	S
31-Oct-13	3	1451	9	W LANTAU	2	394	ON	HKCRP	805900	800238	AUTUMN	NONE	S
31-Oct-13	4	1540	2	W LANTAU	2	664	ON	HKCRP	809043	801142	AUTUMN	NONE	S
31-Oct-13	5	1558	4	W LANTAU	2	133	ON	HKCRP	811268	801591	AUTUMN	NONE	S
31-Oct-13	6	1620	6	W LANTAU	2	329	ON	HKCRP	817971	805089	AUTUMN	NONE	S
6-Nov-13	1	1029	7	NW LANTAU	3	ND	OFF	HKCRP	819696	806370	AUTUMN	NONE	
6-Nov-13	2	1416	1	SW LANTAU	2	ND	OFF	HKCRP	807281	807212	AUTUMN	PURSE SEINE	
6-Nov-13	3	1423	3	SW LANTAU	2	ND	OFF	HKCRP	807036	808037	AUTUMN	NONE	
6-Nov-13	4	1435	6	SW LANTAU	2	ND	OFF	HKCRP	807540	810863	AUTUMN	NONE	
7-Nov-13	1	1115	2	NE LANTAU	2	430	ON	HKCRP	822582	815534	AUTUMN	NONE	P
7-Nov-13	2	1330	7	DEEP BAY	2	386	ON	HKCRP	830437	806793	AUTUMN	NONE	P
7-Nov-13	3	1607	3	NW LANTAU	2	212	ON	HKCRP	826540	806456	AUTUMN	PURSE SEINE	P
7-Nov-13	4	1629	10	NW LANTAU	2	297	ON	HKCRP	824303	806400	AUTUMN	NONE	P
14-Nov-13	1	1127	2	NW LANTAU	2	18	ON	HKCRP	825873	807505	AUTUMN	NONE	P

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DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
14-Nov-13	2	1203	5	NW LANTAU	2	98	ON	HKCRP	829306	807378	AUTUMN	NONE	S
14-Nov-13	3	1255	1	NW LANTAU	2	386	ON	HKCRP	826099	805456	AUTUMN	NONE	P
14-Nov-13	4	1311	4	NW LANTAU	2	208	ON	HKCRP	823375	805440	AUTUMN	NONE	P
15-Nov-13	1	1356	5	SW LANTAU	3	270	ON	HKCRP	807727	805388	AUTUMN	NONE	S
15-Nov-13	2	1422	1	SW LANTAU	2	183	ON	HKCRP	805336	805321	AUTUMN	NONE	P
15-Nov-13	3	1433	2	SW LANTAU	2	215	ON	HKCRP	803509	805307	AUTUMN	NONE	P
15-Nov-13	4	1453	2	SW LANTAU	3	134	ON	HKCRP	801435	806634	AUTUMN	NONE	S
15-Nov-13	5	1531	3	SW LANTAU	3	137	ON	HKCRP	807735	807378	AUTUMN	NONE	P
15-Nov-13	6	1542	2	SW LANTAU	3	273	ON	HKCRP	807500	808759	AUTUMN	NONE	S
22-Nov-13	1	1033	1	NW LANTAU	2	295	ON	HKCRP	824938	810264	AUTUMN	NONE	S
22-Nov-13	2	1044	1	NW LANTAU	2	35	ON	HKCRP	824962	809460	AUTUMN	NONE	P
22-Nov-13	3	1130	8	NW LANTAU	2	90	ON	HKCRP	823348	807531	AUTUMN	PURSE SEINE	P
22-Nov-13	4	1212	3	NW LANTAU	2	105	ON	HKCRP	827579	807529	AUTUMN	NONE	P
22-Nov-13	5	1246	3	NW LANTAU	3	30	ON	HKCRP	827992	805460	AUTUMN	NONE	P
25-Nov-13	2	1322	4	SW LANTAU	2	73	ON	HKCRP	807628	811142	AUTUMN	NONE	P
25-Nov-13	3	1532	3	SW LANTAU	4	205	ON	HKCRP	803597	805297	AUTUMN	NONE	P
25-Nov-13	4	1603	1	SW LANTAU	3	555	ON	HKCRP	806511	804591	AUTUMN	NONE	S
25-Nov-13	5	1611	3	SW LANTAU	3	343	ON	HKCRP	806535	803601	AUTUMN	NONE	S
25-Nov-13	6	1632	1	W LANTAU	3	ND	OFF	HKCRP	808579	800956	AUTUMN	NONE	
25-Nov-13	7	1639	4	W LANTAU	3	103	ON	HKCRP	809774	801227	AUTUMN	NONE	S
26-Nov-13	1	1110	6	W LANTAU	3	88	ON	HKCRP	813558	802565	AUTUMN	NONE	P
26-Nov-13	2	1149	4	W LANTAU	3	112	ON	HKCRP	811458	801004	AUTUMN	NONE	P
26-Nov-13	3	1213	5	W LANTAU	2	304	ON	HKCRP	809431	801030	AUTUMN	PURSE SEINE	P
26-Nov-13	4	1227	2	W LANTAU	2	2	ON	HKCRP	809476	800628	AUTUMN	NONE	P
26-Nov-13	5	1247	7	W LANTAU	3	264	ON	HKCRP	807451	800005	AUTUMN	NONE	P
26-Nov-13	6	1310	1	W LANTAU	2	188	ON	HKCRP	806108	801682	AUTUMN	NONE	S
26-Nov-13	7	1326	3	W LANTAU	3	445	ON	HKCRP	806045	800146	AUTUMN	NONE	S
26-Nov-13	8	1332	1	W LANTAU	3	86	ON	HKCRP	806464	800538	AUTUMN	NONE	P
26-Nov-13	9	1347	3	W LANTAU	2	315	ON	HKCRP	806463	800961	AUTUMN	NONE	P
26-Nov-13	10	1421	2	W LANTAU	2	156	ON	HKCRP	810473	800537	AUTUMN	NONE	P
26-Nov-13	11	1449	2	W LANTAU	2	212	ON	HKCRP	812464	801779	AUTUMN	NONE	P
26-Nov-13	12	1505	6	W LANTAU	2	ND	OFF	HKCRP	814507	804123	AUTUMN	PURSE SEINE	
3-Dec-13	1	1413	2	SW LANTAU	1	67	ON	HKCRP	806304	802992	WINTER	PURSE SEINE	S
6-Dec-13	1	1015	5	W LANTAU	4	18	ON	HKCRP	814309	803649	WINTER	NONE	S

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DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
6-Dec-13	2	1103	4	W LANTAU	4	5	ON	HKCRP	806284	802002	WINTER	NONE	S
6-Dec-13	3	1114	4	SW LANTAU	3	80	ON	HKCRP	805928	802559	WINTER	NONE	P
6-Dec-13	4	1153	4	SW LANTAU	4	104	ON	HKCRP	804319	804267	WINTER	NONE	P
6-Dec-13	5	1204	3	SW LANTAU	4	59	ON	HKCRP	805692	804270	WINTER	NONE	P
6-Dec-13	6	1213	2	SW LANTAU	3	20	ON	HKCRP	806866	804427	WINTER	NONE	S
6-Dec-13	7	1403	2	SW LANTAU	2	128	ON	HKCRP	807297	810481	WINTER	NONE	P
10-Dec-13	1	1440	3	DEEP BAY	2	312	ON	HKCRP	833447	807952	WINTER	NONE	P
10-Dec-13	2	1513	1	DEEP BAY	2	296	ON	HKCRP	831441	808648	WINTER	NONE	P
10-Dec-13	3	1550	5	NW LANTAU	2	442	ON	HKCRP	827682	805439	WINTER	NONE	P
11-Dec-13	1	1037	9	W LANTAU	3	86	ON	HKCRP	809232	800988	WINTER	PURSE SEINE	S
11-Dec-13	2	1057	2	W LANTAU	3	564	ON	HKCRP	806938	801664	WINTER	NONE	S
11-Dec-13	3	1104	1	W LANTAU	3	132	ON	HKCRP	806339	801941	WINTER	NONE	S
11-Dec-13	4	1111	5	SW LANTAU	3	ND	OFF	HKCRP	806250	802343	WINTER	NONE	
11-Dec-13	5	1127	1	SW LANTAU	2	20	ON	HKCRP	806106	802528	WINTER	NONE	S
11-Dec-13	6	1148	1	SW LANTAU	2	209	ON	HKCRP	807008	805304	WINTER	NONE	P
11-Dec-13	7	1249	1	SW LANTAU	2	96	ON	HKCRP	807347	807377	WINTER	NONE	P
20-Dec-13	1	1016	4	W LANTAU	3	295	ON	HKCRP	814010	803782	WINTER	NONE	S
20-Dec-13	2	1026	1	W LANTAU	4	140	ON	HKCRP	813447	802915	WINTER	NONE	S
20-Dec-13	3	1053	1	W LANTAU	4	ND	OFF	HKCRP	808690	800874	WINTER	NONE	
20-Dec-13	4	1512	1	NE LANTAU	3	153	ON	HKCRP	820953	816500	WINTER	NONE	P
20-Dec-13	5	1531	4	NE LANTAU	3	86	ON	HKCRP	822393	816585	WINTER	NONE	P
30-Dec-13	1	1124	6	NW LANTAU	2	290	ON	HKCRP	826662	806456	WINTER	NONE	P
30-Dec-13	2	1225	3	DEEP BAY	2	245	ON	HKCRP	831868	805612	WINTER	NONE	S
30-Dec-13	3	1241	12	DEEP BAY	2	270	ON	HKCRP	832453	806715	WINTER	NONE	P
30-Dec-13	4	1351	5	DEEP BAY	3	376	ON	HKCRP	832552	806756	WINTER	NONE	S
3-Jan-14	1	1032	1	NW LANTAU	2	ND	OFF	HKCRP	819874	806175	WINTER	NONE	
3-Jan-14	2	1423	6	W LANTAU	2	ND	OFF	HKCRP	806040	802105	WINTER	NONE	
3-Jan-14	3	1442	2	SW LANTAU	2	390	ON	HKCRP	805317	803424	WINTER	NONE	P
3-Jan-14	4	1447	10	SW LANTAU	2	0	ON	HKCRP	804443	803442	WINTER	NONE	P
8-Jan-14	1	1031	1	W LANTAU	2	308	ON	HKCRP	810383	801187	WINTER	NONE	S
8-Jan-14	2	1119	7	SW LANTAU	1	273	ON	HKCRP	806774	806180	WINTER	GILLNET	S
8-Jan-14	1	854	6	SW LANTAU	1	ND	OFF	THEO	806206	802013	WINTER	NONE	
8-Jan-14	2	1315	4	SW LANTAU	3	ND	OFF	THEO	806306	802054	WINTER	NONE	
10-Jan-14	1	1305	4	NW LANTAU	2	ND	OFF	HKCRP	830038	806978	WINTER	SINGLE	

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
22-Jan-14	1	1340	6	NW LANTAU	3	41	ON	HKCRP	820390	808638	WINTER	NONE	S
22-Jan-14	2	1430	6	NW LANTAU	2	ND	OFF	HKCRP	821505	810670	WINTER	NONE	
22-Jan-14	3	1658	6	NW LANTAU	2	ND	OFF	HKCRP	821193	811576	WINTER	NONE	
24-Jan-14	1	1436	5	W LANTAU	3	694	ON	HKCRP	811690	801221	WINTER	NONE	S
24-Jan-14	2	1538	1	NW LANTAU	3	696	ON	HKCRP	823340	805965	WINTER	NONE	P
24-Jan-14	3	1601	3	NW LANTAU	2	105	ON	HKCRP	826775	805323	WINTER	NONE	P
27-Jan-14	1	1453	4	DEEP BAY	3	317	ON	HKCRP	832409	806416	WINTER	NONE	P
28-Jan-14	1	1123	6	NW LANTAU	2	702	ON	HKCRP	825985	806867	WINTER	NONE	P
28-Jan-14	2	1205	4	NW LANTAU	2	ND	OFF	HKCRP	825233	806515	WINTER	NONE	
28-Jan-14	3	1617	8	NW LANTAU	2	931	ON	HKCRP	821138	805436	WINTER	NONE	S
29-Jan-14	1	1040	1	W LANTAU	1	ND	OFF	HKCRP	810040	801114	WINTER	NONE	
29-Jan-14	2	1100	7	W LANTAU	2	ND	OFF	HKCRP	806217	802209	WINTER	NONE	
29-Jan-14	3	1114	7	SW LANTAU	3	324	ON	HKCRP	805762	802558	WINTER	NONE	P
29-Jan-14	4	1308	2	SW LANTAU	4	399	ON	HKCRP	807310	809450	WINTER	NONE	S
29-Jan-14	5	1346	2	SW LANTAU	4	98	ON	HKCRP	804196	811198	WINTER	NONE	P
24-Feb-14	1	1002	4	NW LANTAU	3	ND	OFF	HKCRP	816718	806292	WINTER	NONE	
24-Feb-14	2	1018	3	W LANTAU	2	36	ON	HKCRP	814287	803608	WINTER	PURSE SEINE	S
24-Feb-14	3	1026	10	W LANTAU	3	92	ON	HKCRP	813348	802544	WINTER	PURSE SEINE	S
24-Feb-14	4	1045	1	W LANTAU	2	ND	OFF	HKCRP	812176	801820	WINTER	NONE	
24-Feb-14	5	1053	21	W LANTAU	2	306	ON	HKCRP	810096	800743	WINTER	NONE	S
24-Feb-14	6	1113	5	W LANTAU	3	46	ON	HKCRP	809078	800679	WINTER	NONE	S
24-Feb-14	7	1117	1	W LANTAU	3	230	ON	HKCRP	808590	800750	WINTER	NONE	S
25-Feb-14	1	1049	1	NW LANTAU	2	0	ON	HKCRP	823440	806079	WINTER	NONE	S
25-Feb-14	2	1104	5	NW LANTAU	3	7	ON	HKCRP	825532	806444	WINTER	PURSE SEINE	P
27-Feb-14	1	1618	5	NW LANTAU	2	272	ON	HKCRP	822544	805449	WINTER	NONE	P
28-Feb-14	1	1048	7	W LANTAU	3	231	ON	HKCRP	812452	801923	WINTER	NONE	P
28-Feb-14	2	1108	9	W LANTAU	3	ND	OFF	HKCRP	812673	802037	WINTER	NONE	
28-Feb-14	3	1226	8	W LANTAU	3	19	ON	HKCRP	812676	800914	WINTER	NONE	S
28-Feb-14	4	1244	6	W LANTAU	3	126	ON	HKCRP	813548	802245	WINTER	PURSE SEINE	P
12-Mar-14	1	1018	3	NW LANTAU	2	13	ON	HKCRP	828932	806131	SPRING	NONE	S
12-Mar-14	2	1507	1	W LANTAU	2	103	ON	HKCRP	813988	803576	SPRING	NONE	S
18-Mar-14	1	1023	15	W LANTAU	1	95	ON	HKCRP	813889	803359	SPRING	PURSE SEINE	S
18-Mar-14	2	1106	4	W LANTAU	2	567	ON	HKCRP	808568	800945	SPRING	NONE	S

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
18-Mar-14	3	1116	4	W LANTAU	2	387	ON	HKCRP	806983	801592	SPRING	NONE	S
18-Mar-14	4	1120	3	W LANTAU	2	86	ON	HKCRP	806484	801838	SPRING	NONE	S
18-Mar-14	5	1131	3	SW LANTAU	2	139	ON	HKCRP	806349	802786	SPRING	NONE	S
18-Mar-14	7	1250	1	SW LANTAU	1	160	ON	HKCRP	807416	806336	SPRING	NONE	P
18-Mar-14	16	1503	1	SW LANTAU	1	55	ON	HKCRP	806378	810480	SPRING	NONE	P
26-Mar-14	1	1032	3	W LANTAU	2	549	ON	HKCRP	811699	801922	SPRING	NONE	S
26-Mar-14	2	1059	5	W LANTAU	2	364	ON	HKCRP	809133	800844	SPRING	NONE	S
26-Mar-14	3	1118	7	W LANTAU	1	ND	OFF	HKCRP	807340	800118	SPRING	NONE	
26-Mar-14	4	1146	1	W LANTAU	2	25	ON	HKCRP	806422	799930	SPRING	NONE	S
26-Mar-14	5	1607	1	NW LANTAU	2	ND	OFF	HKCRP	827502	807137	SPRING	NONE	
26-Mar-14	6	1708	5	NW LANTAU	2	ND	OFF	HKCRP	821623	812432	SPRING	NONE	
24-Mar-14	3	1638	9	W LANTAU	2	ND	OFF	HELI	812928	801945	SPRING	NONE	
27-Mar-14	1	1001	4	W LANTAU	1	76	ON	HKCRP	811976	801912	SPRING	NONE	S

Appendix III. HKCRP-AFCD Finless Porpoise Sighting Database (April 2013 - March 2014)

(Note: P = sightings made on primary lines; S = sightings made on secondary lines)

DATE	STG #	TIME	HRD SZ	NORTHING	EASTING	AREA	BEAU	PSD	EFFORT	SEASON	P/S
13-Apr-13	1	1017	3	805757	819399	SE LANTAU	2	169	ON	SPRING	P
13-Apr-13	2	1107	1	806523	817502	SE LANTAU	2	73	ON	SPRING	S
13-Apr-13	3	1140	2	806293	815285	SE LANTAU	1	217	ON	SPRING	P
13-Apr-13	4	1147	2	805607	815284	SE LANTAU	1	57	ON	SPRING	P
13-Apr-13	5	1154	1	804909	815283	SE LANTAU	1	116	ON	SPRING	P
13-Apr-13	6	1200	5	804511	815272	SE LANTAU	2	15	ON	SPRING	P
13-Apr-13	7	1228	2	802498	813206	SE LANTAU	1	275	ON	SPRING	P
13-Apr-13	8	1232	2	802952	813217	SE LANTAU	1	67	ON	SPRING	P
13-Apr-13	9	1240	1	803605	813218	SE LANTAU	1	307	ON	SPRING	P
13-Apr-13	10	1248	2	805001	813210	SE LANTAU	1	194	ON	SPRING	P
13-Apr-13	11	1332	4	804251	811167	SW LANTAU	2	15	ON	SPRING	P
13-Apr-13	12	1347	2	802069	811163	SW LANTAU	2	144	ON	SPRING	P
13-Apr-13	13	1356	1	801373	810461	SW LANTAU	1	45	ON	SPRING	S
30-Apr-13	1	1154	6	806489	837209	LAMMA	2	58	ON	SPRING	P
30-Apr-13	2	1228	1	805459	836993	LAMMA	2	ND	OFF	SPRING	
30-Apr-13	3	1232	3	805448	836869	LAMMA	2	11	ON	SPRING	P
9-May-13	8	1428	1	800775	810563	SW LANTAU	2	148	ON	SPRING	S
9-May-13	9	1434	3	801305	811152	SW LANTAU	2	83	ON	SPRING	P
9-May-13	10	1443	2	802280	811153	SW LANTAU	2	128	ON	SPRING	P
9-May-13	11	1456	1	804583	811147	SW LANTAU	1	119	ON	SPRING	P
9-May-13	12	1504	1	805901	811159	SW LANTAU	2	23	ON	SPRING	P
9-May-13	13	1508	2	806377	811150	SW LANTAU	2	20	ON	SPRING	P
9-May-13	14	1513	1	807119	811161	SW LANTAU	2	166	ON	SPRING	P
9-May-13	15	1530	1	805621	813211	SE LANTAU	2	52	ON	SPRING	P
31-May-13	1	1034	1	805923	819410	SE LANTAU	1	178	ON	SPRING	P
31-May-13	2	1116	2	804895	817335	SE LANTAU	1	182	ON	SPRING	P
31-May-13	3	1224	2	802043	814010	SE LANTAU	2	3	ON	SPRING	S
31-May-13	4	1253	2	806507	813213	SE LANTAU	2	237	ON	SPRING	P
31-May-13	5	1310	1	808555	813216	SE LANTAU	2	122	ON	SPRING	P
19-Jun-13	1	1016	4	804109	833630	LAMMA	2	ND	OFF	SUMMER	
9-Aug-13	1	1050	2	808462	856862	NINEPINS	2	212	ON	SUMMER	P
9-Aug-13	2	1115	1	808468	860945	NINEPINS	2	81	ON	SUMMER	P
28-Aug-13	1	1555	1	808489	851077	NINEPINS	2	89	ON	SUMMER	P
29-Aug-13	1	1111	1	809441	860273	NINEPINS	2	11	ON	SUMMER	P
11-Oct-13	4	1531	1	802687	806337	SW LANTAU	2	50	ON	AUTUMN	P
31-Oct-13	1	1043	1	802841	813692	SE LANTAU	2	ND	OFF	AUTUMN	
31-Oct-13	2	1253	2	800857	808056	SW LANTAU	3	20	ON	AUTUMN	S
25-Nov-13	1	1041	3	805059	819409	SE LANTAU	4	21	ON	AUTUMN	P
6-Dec-13	8	1549	1	807056	816235	SE LANTAU	2	130	ON	WINTER	P
11-Dec-13	8	1519	1	805186	815253	SE LANTAU	2	5	ON	WINTER	P
11-Dec-13	9	1558	2	804696	817345	SE LANTAU	2	226	ON	WINTER	P
31-Dec-13	1	1008	2	807408	838426	LAMMA	1	208	ON	WINTER	P
31-Dec-13	2	1028	1	807430	834807	LAMMA	2	16	ON	WINTER	P
31-Dec-13	3	1048	2	806489	834848	LAMMA	2	104	ON	WINTER	P
2-Jan-14	1	916	2	809678	834714	LAMMA	2	ND	OFF	WINTER	
3-Jan-14	5	1639	1	804952	816201	SE LANTAU	2	ND	OFF	WINTER	
3-Jan-14	6	1645	3	805305	817563	SE LANTAU	2	ND	OFF	WINTER	
3-Jan-14	7	1655	1	806044	819668	SE LANTAU	0	ND	OFF	WINTER	
3-Jan-14	8	1658	2	806243	820039	SE LANTAU	0	ND	OFF	WINTER	
3-Jan-14	9	1711	2	807304	822907	LAMMA	1	ND	OFF	WINTER	
8-Jan-14	3	1339	1	803140	813218	SE LANTAU	1	245	ON	WINTER	P
8-Jan-14	4	1457	2	806791	815884	SE LANTAU	3	79	ON	WINTER	S
29-Jan-14	6	1453	4	803814	814725	SE LANTAU	4	118	ON	WINTER	S
29-Jan-14	7	1458	1	803791	815220	SE LANTAU	4	145	ON	WINTER	S
29-Jan-14	8	1502	1	804411	815272	SE LANTAU	3	12	ON	WINTER	P
29-Jan-14	9	1554	1	804208	817665	SE LANTAU	4	153	ON	WINTER	S
29-Jan-14	10	1604	1	804207	819325	SE LANTAU	4	110	ON	WINTER	S
29-Jan-14	11	1608	1	805103	819388	SE LANTAU	4	15	ON	WINTER	P

Appendix III. (cont'd)

DATE	STG #	TIME	HRD SZ	NORTHING	EASTING	AREA	BEAU	PSD	EFFORT	SEASON	P/S
17-Feb-14	1	1106	1	804742	816294	SE LANTAU	2	110	ON	WINTER	P
17-Feb-14	2	1149	2	809008	814258	SE LANTAU	2	156	ON	WINTER	P
17-Feb-14	3	1257	1	805600	812180	SE LANTAU	2	53	ON	WINTER	P
17-Feb-14	4	1336	1	805149	810477	SW LANTAU	2	52	ON	WINTER	P
17-Feb-14	5	1345	2	803776	810465	SW LANTAU	2	ND	OFF	WINTER	
17-Feb-14	6	1614	2	804776	815365	SE LANTAU	2	ND	OFF	WINTER	
17-Feb-14	7	1616	1	804887	815675	SE LANTAU	2	ND	OFF	WINTER	
17-Feb-14	8	1625	1	805239	817501	SE LANTAU	2	ND	OFF	WINTER	
17-Feb-14	9	1631	3	805735	819007	SE LANTAU	2	ND	OFF	WINTER	
17-Feb-14	10	1644	2	806663	821566	LAMMA	2	ND	OFF	WINTER	
18-Feb-14	1	1126	5	803488	838612	LAMMA	1	84	ON	WINTER	P
18-Feb-14	2	1140	3	803477	836559	LAMMA	1	211	ON	WINTER	P
18-Feb-14	3	1234	1	803492	825977	LAMMA	0	98	ON	WINTER	P
18-Feb-14	4	1315	2	805500	821472	LAMMA	2	174	ON	WINTER	P
26-Feb-14	1	1443	8	802155	806780	SW LANTAU	1	ND	OFF	WINTER	
26-Feb-14	2	1450	3	801677	807439	SW LANTAU	2	ND	OFF	WINTER	
26-Feb-14	3	1508	4	801749	810802	SW LANTAU	2	ND	OFF	WINTER	
26-Feb-14	4	1525	4	803995	812177	SE LANTAU	2	129	ON	WINTER	P
26-Feb-14	5	1552	3	808023	813833	SE LANTAU	2	ND	OFF	WINTER	
26-Feb-14	6	1607	3	805132	814252	SE LANTAU	2	14	ON	WINTER	P
13-Mar-14	1	1049	2	806497	821132	LAMMA	2	151	ON	SPRING	P
13-Mar-14	2	1142	3	804531	829907	LAMMA	1	188	ON	SPRING	P
13-Mar-14	3	1241	1	802488	821716	LAMMA	2	54	ON	SPRING	P
13-Mar-14	4	1433	1	804518	835177	LAMMA	2	83	ON	SPRING	P
13-Mar-14	5	1444	1	804518	833775	LAMMA	2	109	ON	SPRING	P
13-Mar-14	6	1448	4	804518	833197	LAMMA	2	13	ON	SPRING	P
13-Mar-14	7	1528	6	806500	837601	LAMMA	2	148	ON	SPRING	P
18-Mar-14	6	1218	1	802809	806337	SW LANTAU	2	196	ON	SPRING	P
18-Mar-14	8	1318	5	805208	808188	SW LANTAU	2	27	ON	SPRING	S
18-Mar-14	9	1343	8	801909	808141	SW LANTAU	2	10	ON	SPRING	S
18-Mar-14	10	1411	3	801144	808408	SW LANTAU	2	6	ON	SPRING	P
18-Mar-14	11	1427	1	800941	810460	SW LANTAU	2	152	ON	SPRING	P
18-Mar-14	12	1434	2	802048	810452	SW LANTAU	2	183	ON	SPRING	P
18-Mar-14	13	1442	2	803134	810464	SW LANTAU	1	91	ON	SPRING	P
18-Mar-14	14	1450	2	804296	810528	SW LANTAU	1	ND	OFF	SPRING	
18-Mar-14	15	1455	1	804916	810487	SW LANTAU	1	70	ON	SPRING	P
18-Mar-14	17	1608	1	803867	816303	SE LANTAU	2	70	ON	SPRING	P
18-Mar-14	18	1616	3	804963	816304	SE LANTAU	2	52	ON	SPRING	P
18-Mar-14	19	1624	2	806038	816068	SE LANTAU	2	183	ON	SPRING	S
20-Mar-14	1	1448	3	808176	815288	SE LANTAU	1	183	ON	SPRING	P
20-Mar-14	2	1458	4	806891	815286	SE LANTAU	1	145	ON	SPRING	P
20-Mar-14	3	1513	1	804466	815282	SE LANTAU	1	213	ON	SPRING	P
20-Mar-14	4	1545	5	804120	817345	SE LANTAU	1	167	ON	SPRING	P
20-Mar-14	5	1621	2	807152	819401	SE LANTAU	1	113	ON	SPRING	P
27-Mar-14	2	1214	18	803799	809877	SW LANTAU	1	409	ON	SPRING	S
27-Mar-14	3	1245	1	800888	809428	SW LANTAU	2	311	ON	SPRING	P
27-Mar-14	4	1256	2	801339	811152	SW LANTAU	2	456	ON	SPRING	S
27-Mar-14	5	1302	2	801715	811142	SW LANTAU	2	157	ON	SPRING	P
27-Mar-14	6	1308	2	802690	811154	SW LANTAU	1	266	ON	SPRING	P
27-Mar-14	7	1314	4	803321	811145	SW LANTAU	1	196	ON	SPRING	P
27-Mar-14	8	1322	1	804317	811146	SW LANTAU	1	143	ON	SPRING	P
27-Mar-14	9	1329	2	805170	811148	SW LANTAU	1	16	ON	SPRING	P
27-Mar-14	10	1457	2	805485	815284	SE LANTAU	2	102	ON	SPRING	P
27-Mar-14	11	1504	2	806072	815285	SE LANTAU	2	51	ON	SPRING	P
27-Mar-14	12	1628	2	806521	819400	SE LANTAU	2	16	ON	SPRING	P

Appendix IV. Individual dolphins identified during AFCD surveys (Apr 2013 to March 2014)

(in black: vessel survey sightings; in blue: sightings made from land or helicopter)

DOLPHIN ID	DATE	STG#	AREA
CH12	19/06/13	2	SWL
	06/12/13	1	WL
	11/12/13	1	WL
	29/01/14	2	WL
CH34	30/08/13	3	NEL
	21/10/13	4	NWL
	06/11/13	1	NWL
	22/11/13	4	NWL
	28/01/14	1	NWL
CH38	11/12/13	1	WL
	29/01/14	2	WL
	24/02/14	5	WL
	28/02/14	2	WL
	28/02/14	3	WL
CH84	30/12/13	3	DB
CH98	30/08/13	2	NWL
	14/11/13	2	NWL
	27/01/14	1	DB
CH105	26/11/13	12	WL
CH108	31/10/13	3	WL
	18/03/14	1	WL
CH113	06/06/13	1	WL
	21/06/13	4	WL
CH153	10/07/13	4	WL
DB03	30/12/13	3	DB
EL01	19/06/13	6	SWL
	19/06/13	7	SWL
	22/11/13	3	NWL
	26/03/14	6	NWL
NL11	10/01/14	1	NWL
NL24	13/04/13	14	WL
	21/06/13	1	NWL
	21/06/13	2	WL
	06/11/13	1	NWL
	07/11/13	4	NWL
	22/01/14	2	NWL
	22/01/14	3	NWL
	27/02/14	1	NWL
	26/03/14	6	NWL
NL33	29/05/13	2	WL
	21/10/13	1	NEL
	07/11/13	4	NWL
	22/01/14	2	NWL
	12/03/14	1	NWL
	18/03/14	1	WL
	27/03/14	1	WL
NL46	24/01/14	3	NWL
	25/02/14	2	NWL
NL48	14/11/13	2	NWL
	22/11/13	3	NWL
	22/11/13	5	NWL
	10/01/14	1	NWL
	28/01/14	1	NWL
NL49	19/06/13	2	SWL
	06/11/13	1	NWL
	10/12/13	3	NWL
NL80	30/12/13	1	NWL
NL98	09/04/13	2	WL
	21/06/13	1	NWL
	07/11/13	4	NWL
	14/11/13	4	NWL
	22/01/14	1	NWL
	22/01/14	3	NWL
	27/02/14	1	NWL

DOLPHIN ID	DATE	STG#	AREA
NL103	17/06/13	3	WL
	20/06/13	7	WL
NL104	10/06/13	1	NWL
	21/06/13	3	WL
	07/11/13	4	NWL
	27/01/14	1	DB
	28/01/14	1	NWL
NL105	06/11/13	1	NWL
	22/11/13	4	NWL
NL120	31/05/13	1	SWL
	11/10/13	1	SWL
	11/10/13	2	SWL
	31/10/13	6	WL
	26/03/14	6	NWL
NL123	05/07/13	1	WL
	30/08/13	3	NEL
	21/10/13	3	NWL
	07/11/13	2	DB
	07/11/13	3	NWL
	14/11/13	4	NWL
NL128	19/06/13	7	SWL
	06/11/13	2	SWL
	08/01/14	2	SWL
	24/02/14	5	WL
NL136	06/06/13	8	NWL
	30/07/13	6	WL
	11/10/13	6	WL
	22/11/13	3	NWL
	10/01/14	1	NWL
	27/02/14	1	NWL
NL139	20/06/13	5	WL
	30/07/13	6	WL
	22/01/14	2	NWL
	22/01/14	3	NWL
NL145	25/02/14	2	NWL
NL156	17/06/13	3	WL
	18/10/13	4	SWL
	06/11/13	1	NWL
	11/12/13	1	WL
	20/12/13	1	WL
NL165	31/05/13	1	SWL
	27/08/13	6	WL
	16/09/13	1	WL
	31/10/13	6	WL
NL182	10/06/13	2	DB
	30/08/13	2	NWL
	10/01/14	1	NWL
	28/02/14	4	WL
NL188	29/05/13	2	WL
	19/06/13	5	SWL
	27/09/13	2	WL
	31/10/13	6	WL
	20/12/13	1	WL
	22/01/14	1	NWL
	18/03/14	1	WL
	27/03/14	1	WL
NL191	28/01/14	1	NWL
	25/02/14	1	NWL
NL203	10/12/13	1	DB
NL206	29/05/13	4	WL
	27/09/13	4	WL
	27/09/13	5	WL
	06/12/13	4	SWL
	24/02/14	6	WL

DOLPHIN ID	DATE	STG#	AREA
NL210	11/09/13	4	NWL
	07/11/13	3	NWL
NL212	27/08/13	7	WL
NL213	14/11/13	2	NWL
	27/01/14	1	DB
NL214	22/11/13	3	NWL
NL220	13/04/13	14	WL
	21/06/13	13	WL
	07/11/13	4	NWL
	22/11/13	3	NWL
NL221	10/12/13	3	NWL
NL226	29/05/13	2	WL
	27/02/14	1	NWL
NL233	21/10/13	5	DB
	07/11/13	2	DB
NL242	21/06/13	1	NWL
	06/11/13	1	NWL
	22/01/14	2	NWL
	22/01/14	3	NWL
NL244	03/05/13	1	NWL
	06/06/13	8	NWL
	21/06/13	1	NWL
	20/12/13	4	NEL
NL255	30/12/13	3	DB
NL256	07/11/13	2	DB
	30/12/13	1	NWL
NL259	10/12/13	3	NWL
NL260	17/04/13	1	NWL
	31/10/13	6	WL
	06/11/13	1	NWL
NL261	21/10/13	3	NWL
	20/12/13	5	NEL
	26/03/14	6	NWL
NL262	10/06/13	2	DB
	24/07/13	5	NWL
	22/11/13	3	NWL
	25/02/14	2	NWL
NL264	22/01/14	1	NWL
	24/02/14	3	WL
NL269	20/06/13	6	WL
NL272	10/06/13	1	NWL
	22/11/13	3	NWL
	28/01/14	1	NWL
	25/02/14	2	NWL
NL278	31/07/13	1	WL
	31/07/13	6	WL
NL279	11/09/13	1	WL
NL283	30/12/13	3	DB
NL284	30/08/13	3	NEL
	21/10/13	3	NWL
	07/11/13	4	NWL
	20/12/13	5	NEL
	26/03/14	6	NWL
NL285	05/07/13	1	WL
	30/08/13	3	NEL
	07/11/13	2	DB
	07/11/13	3	NWL
	14/11/13	4	NWL
NL287	07/05/13	1	NWL
	25/02/14	2	NWL
NL288	22/01/14	1	NWL
	24/02/14	3	WL
NL293	20/06/13	6	WL
NL295	24/01/14	2	NWL

Appendix IV. (cont'd)

(in black: vessel survey sightings; in blue: sightings made from land or helicopter)

DOLPHIN ID	DATE	STG#	AREA
NL296	20/06/13	7	WL
	05/07/13	1	WL
	27/09/13	2	WL
	31/10/13	6	WL
	22/01/14	2	NWL
NL299	31/07/13	5	WL
	31/07/13	6	WL
	27/08/13	6	WL
	11/09/13	1	WL
	07/11/13	2	DB
	30/12/13	1	NWL
NL301	30/12/13	1	NWL
NL304	24/01/14	1	WL
NL309	20/12/13	3	WL
SL05	11/10/13	1	SWL
	11/10/13	2	SWL
	28/02/14	1	WL
	28/02/14	2	WL
	28/02/14	3	WL
	18/03/14	4	WL
	26/03/14	3	WL
SL27	14/05/13	1	SWL
	31/05/13	6	SWL
	03/06/13	1	WL
	19/06/13	7	SWL
	06/11/13	4	SWL
	06/12/13	6	SWL
	24/02/14	5	WL
SL35	18/10/13	6	SWL
	26/11/13	3	WL
	20/12/13	3	WL
	28/02/14	4	WL
SL40	06/06/13	5	WL
SL44	31/10/13	3	WL
	24/02/14	3	WL
SL47	21/06/13	5	WL
SL49	21/06/13	5	WL
	06/11/13	3	SWL
SL50	09/05/13	5	SWL
	09/05/13	6	SWL
	09/05/13	7	SWL
SL51	03/12/13	1	SWL
SL52	11/12/13	5	SWL
WL04	18/07/13	2	WL
	06/12/13	2	WL
WL05	21/06/13	4	WL
	21/10/13	4	NWL
	06/11/13	1	NWL
WL11	29/05/13	2	WL
WL15	19/06/13	5	SWL
	11/12/13	7	SWL
	03/01/14	1	NWL
WL17	27/08/13	9	SWL
	27/08/13	11	SWL
WL21	20/06/13	6	WL
	21/06/13	4	WL
	18/07/13	5	WL
	18/07/13	8	WL
	23/07/13	2	WL
	30/07/13	5	WL
	31/07/13	5	WL

DOLPHIN ID	DATE	STG#	AREA
WL25	29/05/13	7	WL
	18/07/13	6	WL
	09/10/13	1	WL
	11/10/13	3	SWL
	06/12/13	1	WL
	11/12/13	1	WL
	20/12/13	1	WL
	29/01/14	1	WL
	24/02/14	5	WL
	28/02/14	1	WL
WL29	24/02/14	5	WL
WL30	30/12/13	3	DB
WL42	29/05/13	6	WL
	18/07/13	2	WL
	24/02/14	5	WL
	28/02/14	2	WL
	28/02/14	3	WL
WL44	14/05/13	2	SWL
WL46	31/05/13	2	SWL
	11/09/13	1	WL
WL47	24/02/14	5	WL
WL50	11/10/13	3	SWL
WL58	11/10/13	6	WL
WL61	31/05/13	2	SWL
	19/06/13	5	SWL
	18/03/14	1	WL
WL62	30/07/13	3	SWL
	06/12/13	5	SWL
	24/02/14	5	WL
	28/02/14	4	WL
WL66	11/09/13	1	WL
WL68	31/05/13	1	SWL
	28/02/14	2	WL
	28/02/14	3	WL
WL69	29/05/13	4	WL
	19/06/13	3	SWL
	19/06/13	4	SWL
	27/08/13	10	SWL
	11/12/13	4	SWL
	08/01/14	2	SWL
	28/02/14	4	WL
	18/03/14	16	SWL
WL72	11/10/13	6	WL
	31/10/13	3	WL
	03/01/14	2	WL
	12/03/14	1	NWL
WL73	29/01/14	2	WL
	28/02/14	2	WL
	28/02/14	3	WL
WL74	17/06/13	3	WL
	19/06/13	5	SWL
	19/06/13	7	SWL
	06/12/13	4	SWL
WL79	19/09/13	3	WL
WL84	26/03/14	2	WL
WL86	14/05/13	2	SWL
	19/06/13	5	SWL
	25/11/13	3	SWL
	08/01/14	2	SWL
	24/02/14	3	WL

DOLPHIN ID	DATE	STG#	AREA
WL91	29/05/13	4	WL
	29/05/13	6	WL
	19/06/13	4	SWL
	11/10/13	1	SWL
	11/10/13	2	SWL
	06/12/13	7	SWL
	24/02/14	5	WL
WL92	26/03/14	1	WL
WL93	23/07/13	1	SWL
	06/11/13	4	SWL
	25/11/13	5	SWL
	03/12/13	1	SWL
	24/02/14	5	WL
WL94	19/06/13	4	SWL
WL97	27/09/13	1	WL
WL100	18/10/13	2	SWL
WL109	06/06/13	2	WL
	26/11/13	2	WL
	03/01/14	2	WL
	29/01/14	2	WL
	24/02/14	5	WL
	28/02/14	1	WL
	28/02/14	3	WL
WL114	31/05/13	3	SWL
	24/02/14	6	WL
WL116	31/05/13	3	SWL
	24/02/14	5	WL
	26/03/14	2	WL
WL118	09/05/13	6	SWL
	19/06/13	5	SWL
WL122	26/11/13	1	WL
WL123	20/06/13	5	WL
	09/10/13	1	WL
	11/10/13	1	SWL
	11/10/13	2	SWL
	18/10/13	2	SWL
	06/12/13	4	SWL
	03/01/14	4	SWL
	08/01/14	1	SWL
	29/01/14	2	WL
	28/02/14	1	WL
	28/02/14	2	WL
	28/02/14	4	WL
WL124	06/06/13	5	WL
	20/06/13	6	WL
	10/07/13	3	WL
	11/09/13	2	WL
WL128	18/10/13	3	SWL
WL130	14/05/13	2	SWL
	29/05/13	4	WL
	31/05/13	3	SWL
	11/10/13	3	SWL
	18/03/14	1	WL
WL131	11/12/13	1	WL
	24/02/14	5	WL
	28/02/14	1	WL
	28/02/14	2	WL
	18/03/14	1	WL
WL132	31/05/13	1	SWL
	09/10/13	1	WL
	15/11/13	3	SWL
	11/12/13	4	SWL
	03/01/14	4	SWL
	28/02/14	4	WL

Appendix IV. (cont'd)
(in black: vessel survey sightings; in blue: sightings made from land or helicopter)

DOLPHIN ID	DATE	STG#	AREA
WL137	21/06/13	8	WL
	18/10/13	1	SWL
	15/11/13	1	SWL
	06/12/13	1	WL
	11/12/13	4	SWL
	18/03/14	1	WL
WL142	29/05/13	4	WL
	31/05/13	2	SWL
	19/06/13	2	SWL
	06/12/13	4	SWL
	26/03/14	1	WL
WL144	31/10/13	3	WL
	26/03/14	2	WL
WL145	27/09/13	10	WL
	26/11/13	12	WL
WL152	17/07/13	1	SWL
	06/12/13	1	WL
	11/12/13	1	WL
	03/01/14	4	SWL
	08/01/14	1	SWL
	29/01/14	2	WL
WL153	18/07/13	5	WL
	23/07/13	2	WL
	30/07/13	5	WL
	31/07/13	5	WL
	04/09/13	1	WL
WL157	06/11/13	4	SWL
WL159	06/06/13	2	WL
	21/06/13	13	WL
	18/07/13	5	WL
	18/07/13	12	WL
WL164	31/10/13	3	WL
WL165	14/05/13	2	SWL
	29/05/13	6	WL
	19/06/13	3	SWL
	19/06/13	5	SWL
	11/09/13	3	WL
	11/10/13	6	WL
	25/11/13	3	SWL
	08/01/14	2	SWL
	24/02/14	3	WL
WL168	28/02/14	3	WL
	26/03/14	1	WL
WL170	20/06/13	2	SWL
	06/11/13	4	SWL
	06/12/13	6	SWL
	24/02/14	5	WL
WL173	11/10/13	1	SWL
	11/10/13	2	SWL
	11/12/13	1	WL
	24/02/14	5	WL
	28/02/14	2	WL
	28/02/14	3	WL
WL176	29/05/13	1	WL
WL180	11/10/13	1	SWL
	11/10/13	2	SWL
	15/11/13	4	SWL
	06/12/13	4	SWL
	03/01/14	4	SWL
	29/01/14	2	WL
	24/02/14	5	WL
	18/03/14	4	WL
WL182	26/11/13	3	WL
WL183	31/10/13	5	WL

DOLPHIN ID	DATE	STG#	AREA
WL186	11/09/13	3	WL
WL188	26/08/13	1	WL
WL191	24/02/14	5	WL
WL193	09/05/13	3	SWL
	06/06/13	1	WL
	21/06/13	4	WL
	18/07/13	5	WL
	31/07/13	5	WL
	19/09/13	3	WL
WL197	20/06/13	5	WL
WL199	17/06/13	3	WL
	20/06/13	5	WL
	27/08/13	7	WL
WL200	06/06/13	5	WL
	17/06/13	3	WL
WL201	14/05/13	2	SWL
	19/06/13	5	SWL
	18/07/13	6	WL
WL207	31/07/13	1	WL
	31/07/13	6	WL
WL208	31/05/13	1	SWL
	19/06/13	6	SWL
WL210	31/05/13	1	SWL
	24/02/14	2	WL
WL212	09/05/13	2	WL
	29/05/13	9	WL
WL213	27/09/13	2	WL
WL214	20/06/13	5	WL
WL215	21/06/13	8	WL
	15/11/13	1	SWL
	06/12/13	1	WL
	11/12/13	4	SWL
	18/03/14	1	WL
WL217	06/06/13	1	WL
WL218	05/07/13	3	WL
WL220	03/12/13	1	WL
	03/01/14	4	SWL
	29/01/14	2	WL
	24/02/14	5	WL
	18/03/14	4	WL
WL221	24/02/14	5	WL
	28/02/14	1	WL
WL222	19/06/13	1	SWL
WL223	26/11/13	6	WL
	24/02/14	5	WL
WL224	09/05/13	6	SWL
	14/05/13	2	SWL
	31/05/13	1	SWL
	19/06/13	3	SWL
	18/07/13	6	WL
	27/09/13	4	WL
	11/10/13	6	WL
	26/03/14	3	WL
WL225	26/11/13	3	WL
WL228	27/08/13	4	WL
	11/09/13	1	WL

Appendix V. HKCRP-AFCD Underwater Acoustic Database (April 2013 - March 2014)

Date	File #	Begin Time	End Time	Location Latitude	Location Longitude	Area	Event	Beau	Hp	Hp Depth	HPF	ICP Gain	Note(s)
3-May-13	1	11:09:58	11:13:10	22.3503	113.8778	NW LANTAU	NWL#1	2	CR1	5.5	N	10x	Snapping shrimp sounds
3-May-13	2	15:40:56	15:43:55	22.3300	113.9810	NE LANTAU	NEL#2	1	CR1	7	N	10x	Yellow croaker sounds
7-May-13	1	11:40:31	11:46:08	22.3845	113.9076	NW LANTAU	NWL Station#3	3	CR1	7	N	10x	Snapping shrimp sounds
7-May-13	2	12:28:53	12:32:05	22.3845	113.8875	NW LANTAU	NWL Station#2	3	CR1	7	N	10x	Snapping shrimp sound
7-May-13	3	13:37:33	13:42:42	22.2787	113.8617	W LANTAU	WL Station#1	2	CR1	7	N	10x	Yellow croaker sound
7-May-13	4	14:40:33	14:43:36	22.2228	113.8323	W LANTAU	WL Station#2	3	CR1	7	N	10x	Snapping shrimp sound sound, yellow croaker sound
9-May-13	1	12:23:35	12:27:53	22.1971	113.8771	SW LANTAU	SWL#3	2	CR1	7	N	10x	
9-May-13	2	13:02:05	13:05:35	22.1507	113.8976	SW LANTAU	SWL#1	2	CR1	7	N	10x	
9-May-13	4	16:10:42	16:14:23	22.2150	113.9733	SE LANTAU	SEL#2	2	CR1	7	N	10x	Yellow croaker sounds
27-Jun-13	1	12:06:23	12:09:47	22.3633	113.9699	NE LANTAU	Off shore to Tuen Mun	4	CR1	7	N	10x	
28-Jun-13	2	10:07:56	10:12:59	22.3264	113.9668	NE LANTAU	NEL Station#1	2	CR1	7	N	10x	Snapping shrimp sound
28-Jun-13	3	10:43:46	10:46:49	22.3631	113.9837	NE LANTAU	NEL Station#3	3	CR1	7	N	10x	
28-Jun-13	4	11:11:24	11:15:31	22.3305	113.9851	NE LANTAU	NEL Station#2	2	CR1	7	N	10x	
28-Jun-13	5	12:08:15	12:12:01	22.3507	114.0225	NE LANTAU	NEL Station#4	3	CR1	7	N	10x	
28-Jun-13	6	15:07:32	15:11:49	22.3596	113.9257	NW LANTAU	NWL Station#4	4	CR1	7	N	10x	Snapping shrimp sound
28-Jun-13	7	15:29:37	15:32:37	22.3393	113.9282	NW LANTAU	NWL Station#5	3	CR1	7	N	10x	Snapping shrimp sound
28-Jun-13	8	16:28:53	16:32:21	22.3794	113.9074	NW LANTAU	NWL Station#3	5	CR1	7	N	10x	
28-Jun-13	9	16:47:43	16:53:31	22.3817	113.8913	NW LANTAU	NWL Station#2	4	CR1	7	N	10x	Near stg. #1; has backgroud noise, snapping shrimp sound
30-Jul-13	1	11:55:17	11:58:17	22.1904	113.9739	SE LANTAU	SEL Station#1	1	CR1	7	N	10x	
30-Jul-13	3	14:04:54	14:07:54	22.1724	113.9210	SW LANTAU	SWL Station#2	1	CR1	7	N	10x	
30-Jul-13	5	15:25:55	15:28:55	22.1523	113.8976	SW LANTAU	SWL Station#1	2	CR1	7	N	10x	cargo boat >1700m@01:38
31-Jul-13	6	10:31:07	10:34:41	22.2778	113.8581	W LANTAU	WL Station#1	2	CR1	7	N	10x	
31-Jul-13	7	11:51:28	11:52:25	22.2225	113.8341	W LANTAU	WL Station#2	3	CR1	7	N	10x	Snapping shrimp sound
31-Jul-13	8	11:55:12	12:00:12	22.2210	113.8339	W LANTAU	WL Station#2	3	CR1	7	N	10x	Near Stg. #3; Dolphin at bow ~100m
31-Jul-13	9	13:06:09	13:09:39	22.1965	113.8305	W LANTAU	WL Station#3	4	CR1	7	N	10x	
26-Sep-13	1	11:17:54	11:22:54	22.3233	113.9709	NE LANTAU	NEL Station#1	2	CR1	4	N	10x	Construction noise throughout near HKBCF
26-Sep-13	2	12:26:46	12:30:06	22.3672	113.9189	NW LANTAU	NWL Station#4	3	CR1	4	N	10x	
26-Sep-13	3	12:53:59	12:56:59	22.3409	113.9166	NW LANTAU	NWL Station#5	2	CR1	4	N	10x	
26-Sep-13	4	13:52:06	13:55:36	22.3886	113.8978	NW LANTAU	NWL Station#3	2	CR1	4	N	10x	
26-Sep-13	6	14:48:48	14:51:50	22.4316	113.9194	DEEP BAY	DB Station#1	3	CR1	4	N	10x	
27-Sep-13	1	10:30:15	10:34:20	22.2851	113.8618	W LANTAU	WL Station#1	3	CR1	7	N	10x	Stationary piling platform nearby (624m)
27-Sep-13	2	11:49:09	11:52:12	22.2230	113.8325	W LANTAU	WL Station#2	2	CR1	7	N	10x	
27-Sep-13	3	11:55:48	11:58:54	22.2213	113.8325	W LANTAU	CWD recording	2	CR1	7	N	10x	Dolphin nearby 70-200m
27-Sep-13	4	13:14:12	13:17:12	22.1963	113.8335	W LANTAU	WL Station #3	2	CR1	7	N	10x	
21-Oct-13	1	13:10:33	13:14:03	22.3277	113.9205	NW LANTAU	STG#3	3	CR1	5.5	N	10x	dolphins swim farther away
21-Oct-13	2	14:05:47	14:08:44	22.3858	113.8975	NW LANTAU	NWL Station#3	3	CR1	7	N	10x	
31-Oct-13	2	12:20:52	12:23:52	22.1738	113.9088	SW LANTAU	SWL Station#2	2	CR1	7	N	10x	
31-Oct-13	3	12:45:08	12:47:35	22.1505	113.9073	SW LANTAU	SWL Station#1	2	CR1	7	N	10x	
31-Oct-13	5	13:30:48	13:36:48	22.1934	113.8870	SW LANTAU	SWL Station#3	1	CR1	7	N	10x	abnormal sound recorded
7-Nov-13	1	10:59:58	11:05:16	22.3626	113.9762	NE LANTAU	NEL Station#3	1	CR1	7	N	10x	
7-Nov-13	2	13:00:18	13:03:19	22.3880	113.9074	NW LANTAU	NWL Station#3	2	CR1	7	N	10x	
7-Nov-13	3	13:24:49	13:27:49	22.4136	113.8955	DEEP BAY	DB Station#1	2	CR1	7	N	10x	
7-Nov-13	4	16:02:08	16:05:08	22.3835	113.8878	NW LANTAU	NWL Station#2	2	CR1	7	N	10x	
7-Nov-13	5	16:47:06	16:52:00	22.3544	113.8912	SHA CHAU N	STG#4	2	CR1	7	N	10x	2 mother & calf pairs ~150m

Appendix V. (cont'd)

Date	File #	Begin Time	End Time	Location Latitude	Location Longitude	Area	Event	Beau	Hp	Hp Depth	HPF	ICP Gain	Note(s)
14-Nov-13	1	11:44:47	11:47:47	22.3841	113.8976	NW LANTAU	NWLStation#3	2	CR1	7	N	10x	
14-Nov-13	2	12:46:32	12:49:30	22.3855	113.8771	NW LANTAU	NWLStation#2	2	CR1	5.5	N	10x	
14-Nov-13	3	15:15:31	15:18:31	22.2120	113.8379	W LANTAU	WL Station#2	4	CR1	2.5	N	10x	
25-Nov-13	1	11:47:00	11:50:02	22.2198	113.9726	SE LANTAU	SEL Station#2	2	CR1	5.5	N	10x	Snapping shrimp sound
25-Nov-13	2	12:30:44	12:33:47	22.1567	113.9562	SE LANTAU	SEL Station#3	3	CR1	7	N	10x	Interference noise recorded
25-Nov-13	3	15:55:40	15:59:13	22.1985	113.8759	SW LANTAU	SWL Station#3	3	CR1	5.5	N	10x	
26-Nov-13	4	13:35:23	13:40:23	22.1973	113.8299	W LANTAU	WL Station#3	3	CR1	7	N	10x	02:04 Gain Change from 0x
26-Nov-13	5	16:22:05	16:25:07	22.3302	113.9754	NE LANTAU	NEL Station#2	3	CR1	7	N	10x	
26-Nov-13	6	16:42:25	16:47:25	22.3626	113.9755	NE LANTAU	NEL Station#3	3	CR1	7	N	10x	
6-Dec-13	1	13:08:02	13:11:12	22.1467	113.8998	SW LANTAU	SWL Station#1	2	CR1	7	N	10x	Interference noise recorded
6-Dec-13	2	14:50:56	14:53:56	22.1582	113.9429	SE LANTAU	SEL Station#3	2	CR1	7	N	10x	Interference noise recorded
10-Dec-13	1	10:30:57	10:34:00	22.3315	113.9758	NE LANTAU	NEL Station#2	2	CR1	5.5	N	10x	
10-Dec-13	2	13:07:25	13:10:48	22.4132	113.8986	DEEP BAY	DB Station#1	2	CR1	7	N	10x	
10-Dec-13	4	16:00:51	16:03:53	22.3864	113.8835	NW LANTAU	STG#3	2	CR1	7	N	10x	
11-Dec-13	2	13:35:41	13:38:44	22.1746	113.9184	SW LANTAU	SWL Station#2	2	CR1	7	N	10x	
11-Dec-13	3	15:22:35	15:25:35	22.1851	113.9726	SE LANTAU	SEL Station#2	2	CR1	7	N	10x	
30-Dec-13	1	11:01:13	11:04:14	22.3470	113.8835	NW LANTAU	NWL Station#1	3	CR1	5.5	N	10x	Interference noise recorded
30-Dec-13	2	12:08:29	12:11:31	22.4135	113.8963	DEEP BAY	DB Station#1	2	CR1	7	N	10x	
30-Dec-13	3	15:47:49	15:50:49	22.3610	113.9845	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	
30-Dec-13	4	16:09:02	16:12:02	22.3304	113.9853	NE LANTAU	NEL Station#2	2	CR1	7	N	10x	
30-Dec-13	5	17:00:53	17:03:54	22.3531	114.0231	NE LANTAU	NEL Station#4	2	CR1	7	N	10x	
7-Jan-14	1	11:09:35	11:13:40	22.3272	113.9845	NE LANTAU	NEL Station#2	3	CR1	7	N	10x	
7-Jan-14	2	11:38:30	11:43:48	22.3144	113.9663	NE LANTAU	NEL Station#1	3	CR1	7	N	10x	
7-Jan-14	3	15:01:13	15:06:13	22.3816	113.8884	NW LANTAU	NWL Station#2	3	CR1	7	N	10x	
8-Jan-14	1	13:44:26	13:49:26	22.1663	113.9532	SE LANTAU	STG#3	0	CR1	7	Y	10x	Noise interference
8-Jan-14	2	14:40:58	14:46:01	22.2166	113.9778	SE LANTAU	SEL Station#2	4	CR1	7	N	10x	Noise interference
8-Jan-14	3	15:09:38	15:11:38	22.1868	113.9835	SE LANTAU	SEL Station#1	3	CR1	7	N	10x	
8-Jan-14	4	15:13:08	15:18:08	22.1863	113.9839	SE LANTAU	SEL Station#1	3	CR1	7	N	10x	
9-Jan-14	1	9:58:05	10:02:05	22.3528	114.0331	NE LANTAU	NEL Station #4	2	CR1	7	N	10x	
9-Jan-14	2	11:37:30	11:41:30	22.3633	113.9752	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	
9-Jan-14	3	12:27:53	12:32:53	22.3575	113.9365	NW LANTAU	NWL Station#4	1	CR1	7	N	10x	
9-Jan-14	4	13:01:00	13:06:00	22.3384	113.9164	NW LANTAU	NWL Station#5	2	CR1	4	N	10x	
9-Jan-14	5	14:52:03	14:57:03	22.3866	113.8974	NW LANTAU	NWL Station#3	2	CR1	7	N	10x	
9-Jan-14	6	16:07:16	16:11:16	22.3510	113.8773	NW LANTAU	NWL Station#1	2	CR1	4	N	10x	
10-Jan-14	1	10:56:56	11:01:59	22.3846	113.9073	NW LANTAU	NWL Station#3	2	CR1	7	N	10x	
10-Jan-14	2	11:25:50	11:30:51	22.4136	113.8977	DEEP BAY	DB Station#1	3	CR1	7	N	10x	
10-Jan-14	3	15:15:26	15:20:36	22.3128	113.9659	NE LANTAU	NEL Station#1	2	CR1	4	N	10x	
10-Jan-14	4	16:58:26	17:03:26	22.3533	114.0268	NE LANTAU	NEL Station#4	3	CR1	7	N	10x	
21-Jan-14	1	11:51:08	11:56:08	22.3301	113.9594	NE LANTAU	NEL Station#1	4	CR1	7	N	10x	
21-Jan-14	2	12:21:07	12:26:07	22.3568	113.9364	NW LANTAU	NWL Station#4	3	CR1	7	N	10x	
21-Jan-14	3	12:55:00	13:00:00	22.3398	113.9170	NW LANTAU	NWL Station#5	3	CR1	7	N	10x	
21-Jan-14	4	13:55:09	14:00:09	22.3942	113.8974	NW LANTAU	NWL Station#3	3	CR1	7	N	10x	
21-Jan-14	5	15:39:18	15:44:24	22.3465	113.8777	NW LANTAU	NWL Station#1	2	CR1	7	N	10x	

Appendix V. (cont'd)

Date	File #	Begin Time	End Time	Location Latitude	Longitude	Area	Event	Beau	Hp	Hp Depth	HPF	ICP Gain	Note(s)
12-Feb-14	6	9:54:36	9:59:40	22.3544	114.0334	NE LANTAU	NEL Station#4	2	CR1	7	N	10X	
12-Feb-14	8	11:50:52	11:55:08	22.3634	113.9756	NE LANTAU	NEL Station#3	3	CR1	7	N	10x	
12-Feb-14	9	12:45:18	12:50:26	22.3577	113.9366	NW LANTAU	NWL Station#4	2	CR1	7	N	10x	
12-Feb-14	10	12:51:36	12:52:36	22.3574	113.9371	NW LANTAU	NWL Station#4	2	CR1	7	N	10x	
12-Feb-14	11	14:13:12	14:17:14	22.3880	113.8975	NW LANTAU	NWL Station#3	2	CR1	7	N	10x	
12-Feb-14	12	14:58:42	15:02:44	22.3868	113.8776	NW LANTAU	NWL Station#2	3	CR1	7	N	10x	Radio interference
12-Feb-14	13	15:24:52	15:30:00	22.3489	113.8776	NW LANTAU	NWL Station#1	3	CR1	7	N	10x	
13-Feb-14	15	12:40:34	12:46:50	22.4135	113.8973	DEEP BAY	DB Station#1	2	CR1	7	N	10x	
13-Feb-14	16	14:22:06	14:28:36	22.3373	113.9164	NW LANTAU	NWL Station#4	3	CR1	5.5	N	10x	
13-Feb-14	17	16:02:50	16:08:06	22.3326	113.9755	NE LANTAU	NEL Station#4	3	CR1	5.5	N	10x	
17-Feb-14	18	11:38:50	11:43:50	22.2255	113.9657	SE LANTAU	SEL Station#2	2	CR1	7	N	10x	Radio interference
17-Feb-14	19	12:39:04	12:43:18	22.1644	113.9435	SE LANTAU	SEL Station#3	2	CR1	7	N	10x	
17-Feb-14	20	14:30:52	14:36:40	22.1746	113.9119	SW LANTAU	SWL Station#2	2	CR1	7	N	10x	
20-Feb-14	21	10:53:38	10:58:54	22.3438	113.8735	NW LANTAU	NWL Station#1	3	CR1	7	N	10x	Radio interference; STG#1 (~100m in first minute)
20-Feb-14	23	11:24:08	11:29:08	22.3851	113.8778	NW LANTAU	NWL Station#2	3	CR1	7	N	10x	
20-Feb-14	24	13:49:56	13:55:10	22.3404	113.9370	NW LANTAU	NWL Station#5	3	CR1	7	N	10x	
20-Feb-14	25	14:35:08	14:40:08	22.3628	113.9740	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	
20-Feb-14	26	14:58:12	15:03:14	22.3319	113.9755	NE LANTAU	NEL Station#2	2	CR1	7	N	10x	Snapping shrimp
20-Feb-14	27	16:23:38	16:28:42	22.3538	114.0337	NE LANTAU	NEL Station#4	2	CR1	7	N	10x	
25-Feb-14	28	12:59:12	13:04:12	22.3342	113.9165	NW LANTAU	NWL Station#5	3	CR1	7	N	10x	Interference noise@~3:25
25-Feb-14	29	14:33:36	14:38:42	22.3110	113.9661	NE LANTAU	NEL Station#1	2	CR1	4	N	10x	stationary sand barges
25-Feb-14	30	16:29:00	16:33:30	22.3302	113.9846	NE LANTAU	NEL Station#2	2	CR1	7	N	10x	radio interference
26-Feb-14	32	12:34:06	12:38:56	22.2268	113.8368	W LANTAU	STG#3	1	CR1	7	N	10x	Dolphin whistle
26-Feb-14	33	12:40:44	12:45:50	22.2252	113.8357	W LANTAU	STG#3	1	CR1	7	N	10x	Dolphin whistle and clicks
27-Feb-14	34	11:57:02	12:02:18	22.3614	113.9851	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	radio interference
27-Feb-14	35	15:46:48	15:52:04	22.3857	113.8776	NW LANTAU	NWLStation#2	3	CR1	5.5	N	10x	croaker sound recorded
4-Mar-14	36	10:47:38	10:52:50	22.3580	113.9856	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	
4-Mar-14	37	11:10:20	11:14:20	22.3301	113.9851	NE LANTAU	NEL Station#2	2	CR1	7	N	10x	radio interference
4-Mar-14	38	14:46:22	14:50:56	22.3841	113.8873	NW LANTAU	NWL Station#2	2	CR1	7	N	10x	radio interference
4-Mar-14	39	15:53:36	15:57:40	22.3488	113.8700	NW LANTAU	NWL Station#1	2	CR1	5.5	N	10x	
5-Mar-14	40	13:15:26	13:20:28	22.3894	113.8985	NW LANTAU	NWL Station#3	2	CR1	7	N	10x	
5-Mar-14	41	14:22:00	14:27:02	22.3348	113.9168	NW LANTAU	NWL Station#5	3	CR1	7	N	10x	
18-Mar-14	43	12:41:24	12:46:28	22.1985	113.8867	SW LANTAU	SWL Station#3	2	CR1	7	N	10x	Yellow croaker sounds
18-Mar-14	44	13:51:50	13:56:50	22.1557	113.9066	SW LANTAU	STG#9	1	CR1	7	Y	10x	Research vessel surrounded by porpoises; porpoise sounds heard
18-Mar-14	46	13:59:42	14:04:44	22.1557	113.9068	SW LANTAU	STG#9	1	CR1	7	Y	10x	Yellow croaker sounds; porpoises 150m from boat

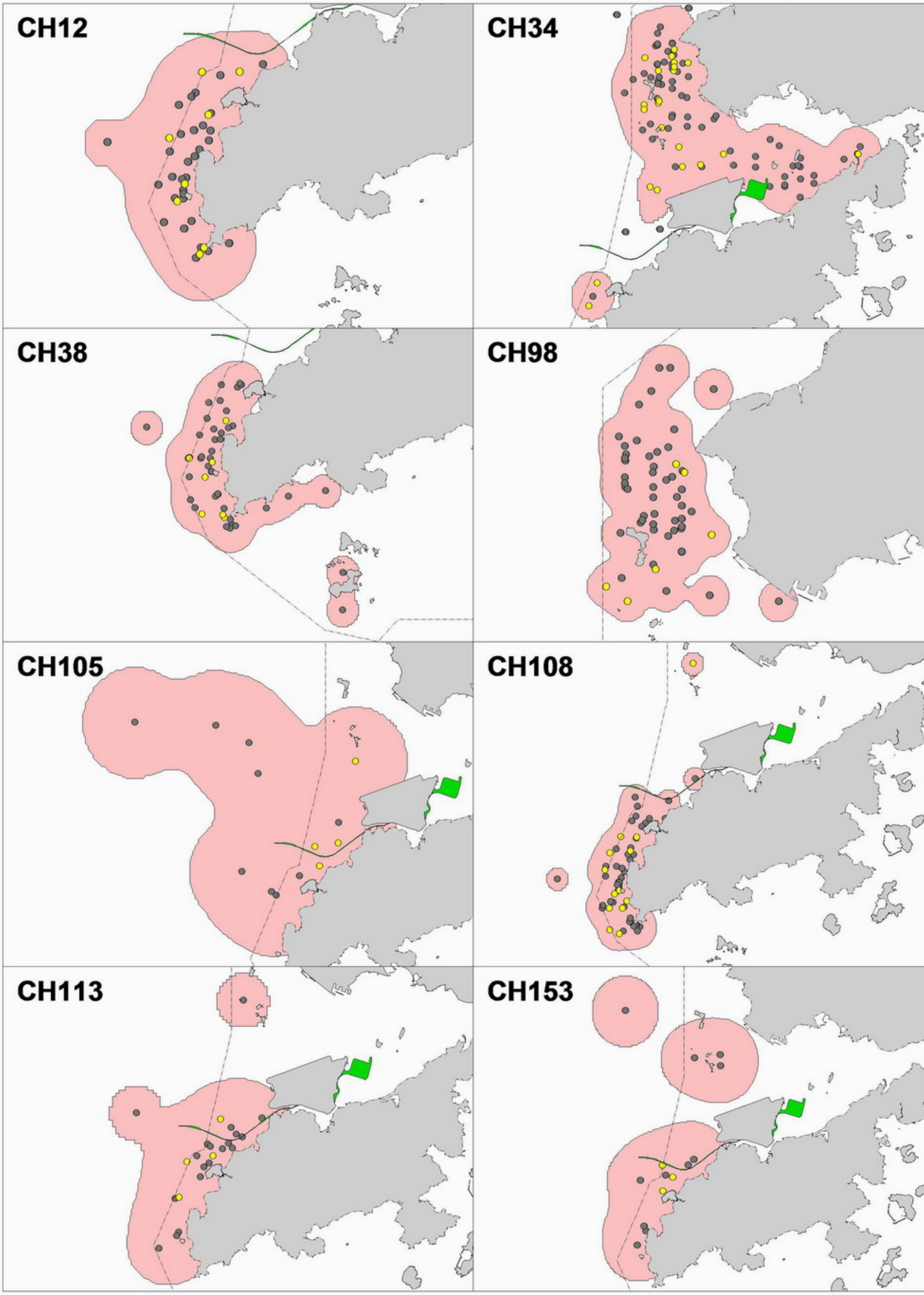
Appendix VI. Land-based Theodolite Tracking Database (April 2013 - March 2014)

Date	Station	Start Time	End Time	Duration	Beaufort	Visibility	Number of Dolphin Groups	Total No. of Fixes	No. of fix (dolphin)	No. of fix (dolphin-tour boat)	No. of fix (fishing boat)	No. of fix (high-speed ferry)	No. of fix (other vessels)	Note
03/04/13	Tai O	8:43	12:44	4:01	3-6	2.5-3	0	123	0	20	29	15	56	Occasional stop due to rain
22/04/13	Tai O	8:46	13:19	4:33	2-3	2-2.5	6	281	169	26	31	8	46	
23/04/13	Shum Wat	9:36	14:25	4:49	2-3	1.5-3	0	203	0	0	34	11	157	
25/04/13	Fan Lau	8:48	14:46	5:58	1-2	2.5	8	544	227	0	2	212	99	
28/04/13	Shum Wat	9:03	13:28	4:25	2-3	2.5-3	2	227	60	0	11	12	142	
08/05/13	Shum Wat	9:03	13:30	4:27	3-4	2.5	0	183	0	0	12	10	160	
12/05/13	Tai O	8:46	13:07	4:21	1	3	3	295	109	42	43	12	88	
14/05/13	Fan Lau	8:51	14:55	6:04	2-3	2.5-3	4	477	164	0	11	206	93	Stopped from 10:55-11:58 due to rain
15/05/13	Shum Wat	9:12	13:28	4:16	1-3	1.5	1	193	1	0	21	13	157	
30/05/13	Shum Wat	10:14	14:16	4:02	1-3	1	4	333	214	0	0	3	115	
31/05/13	Fan Lau	9:19	14:28	5:09	2-3	1	8	533	244	0	20	86	182	
07/06/13	Tai O	8:46	15:00	6:14	2-4	1	11	660	473	92	0	11	82	
13/06/13	Shum Wat	9:06	13:36	4:30	3	2.5	4	230	107	0	19	8	95	
19/06/13	Fan Lau	8:50	14:37	5:47	1	1	19	626	382	0	0	147	95	
26/06/13	Shum Wat	9:04	13:31	4:27	3-5	1	5	271	73	0	9	7	181	
27/06/13	Tai O	8:54	13:25	4:31	2-4	1-2	4	235	118	13	4	6	90	Swap to Tai O North from 1003-1116
07/08/13	Tai O	9:23	14:01	4:38	2	1	6	324	175	85	32	11	20	
12/08/13	Tai Ho Wan	12:02	16:09	4:07	2	1.5	1	322	13	0	24	4	278	
19/08/13	Tai Ho Wan	8:17	13:24	5:07	1		0	412	0	0	8	19	384	
21/08/13	Fan Lau	9:17	13:44	4:27	2	4	7	426	144	0	15	176	89	
26/08/13	Shum Wat	9:06	14:10	5:04	2	1.5-2.5	4	456	167	0	9	16	262	
27/08/13	Tai Ho Wan	8:07	13:27	5:20	2	2	1	361	1	0	0	19	340	
29/08/13	Shum Wat	9:11	13:15	4:04	1-2	1	3	215	59	0	10	9	135	
25/10/13	Shum Wat	9:06	14:00	4:54	3-4	3	0	325	0	0	15	10	299	
30/10/13	Fan Lau	9:07	14:59	5:52	3-5	3	4	535	30	0	75	238	190	
31/10/13	Tai O	9:06	14:00	4:54	2	2	2	431	215	81	5	12	117	
29/11/13	Shum Wat	11:00	15:27	4:27	2-5	1.5	1	353	9	0	0	5	337	

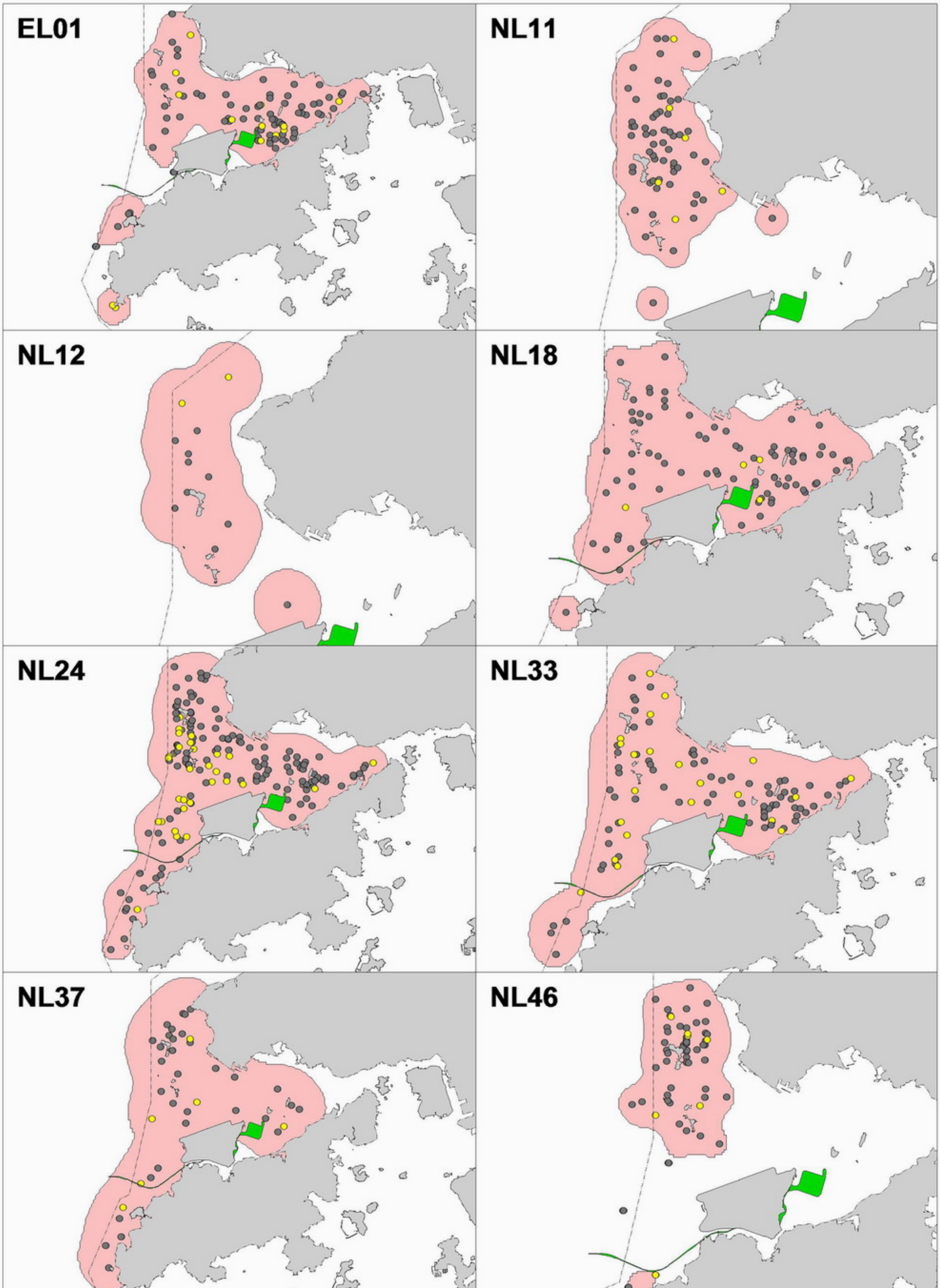
Appendix VI. (cont'd)

Date	Station	Start Time	End Time	Duration	Beaufort	Visibility	Number of Dolphin Groups	Total No. of Fixes	No. of fix (dolphin)	No. of fix (dolphin-tour boat)	No. of fix (fishing boat)	No. of fix (high-speed ferry)	No. of fix (other vessels)	Note
02/12/13	Fan Lau	10:16	15:01	4:45	3	2	5	449	118	0	28	187	115	
04/12/13	Shum Wat	8:58	13:01	4:03	2-3	3-3.5	1	385	1	0	20	7	355	
12/12/13	Tai O	8:58	13:30	4:32	2-3	3.5	0	147	0	31	36	8	71	
19/12/13	Shum Wat	9:03	13:33	4:30	3-4	2-2.5	2	320	20	0	0	5	293	
08/01/14	Fan Lau	8:53	14:23	5:30	1-4	4	8	335	70	0	30	125	179	Hazy
16/01/14	Shum Wat	9:03	13:38	4:35	2	3	0	385	0	0	4	11	367	
17/01/14	Fan Lau	8:49	14:32	5:43	2-4	2.5	9	519	188	0	19	164	146	
06/02/13	Shum Wat	9:19	14:18	4:59	2	1.5	0	308	0	0	23	12	271	
07/02/14	Siu Ho Wan	8:16	13:52	5:36	2	2	2	307	103	9	15	4	174	
12/02/14	Lung Kwu Tan	9:52	14:07	4:15	1	3-3.5	0	348	0	0	5	93	249	
14/02/14	Siu Ho Wan	8:19	13:48	5:29	2	2.5-3	0	370	0	0	43	15	311	
17/02/14	Shum Wat	9:21	13:24	4:03	2	2-3.5	1	276	55	0	2	9	209	
18/02/14	Fan Lau	8:51	13:55	5:04	2-4	3.5-4	1	197	11	0	43	78	64	Very misty; Visibility below 500m
20/02/14	Siu Ho Wan	8:09	13:23	5:14	2	1.5	0	419	0	0	0	15	403	
25/02/14	Lung Kwu Tan	8:55	14:37	5:42	2	1.5	1	602	3	0	25	156	414	

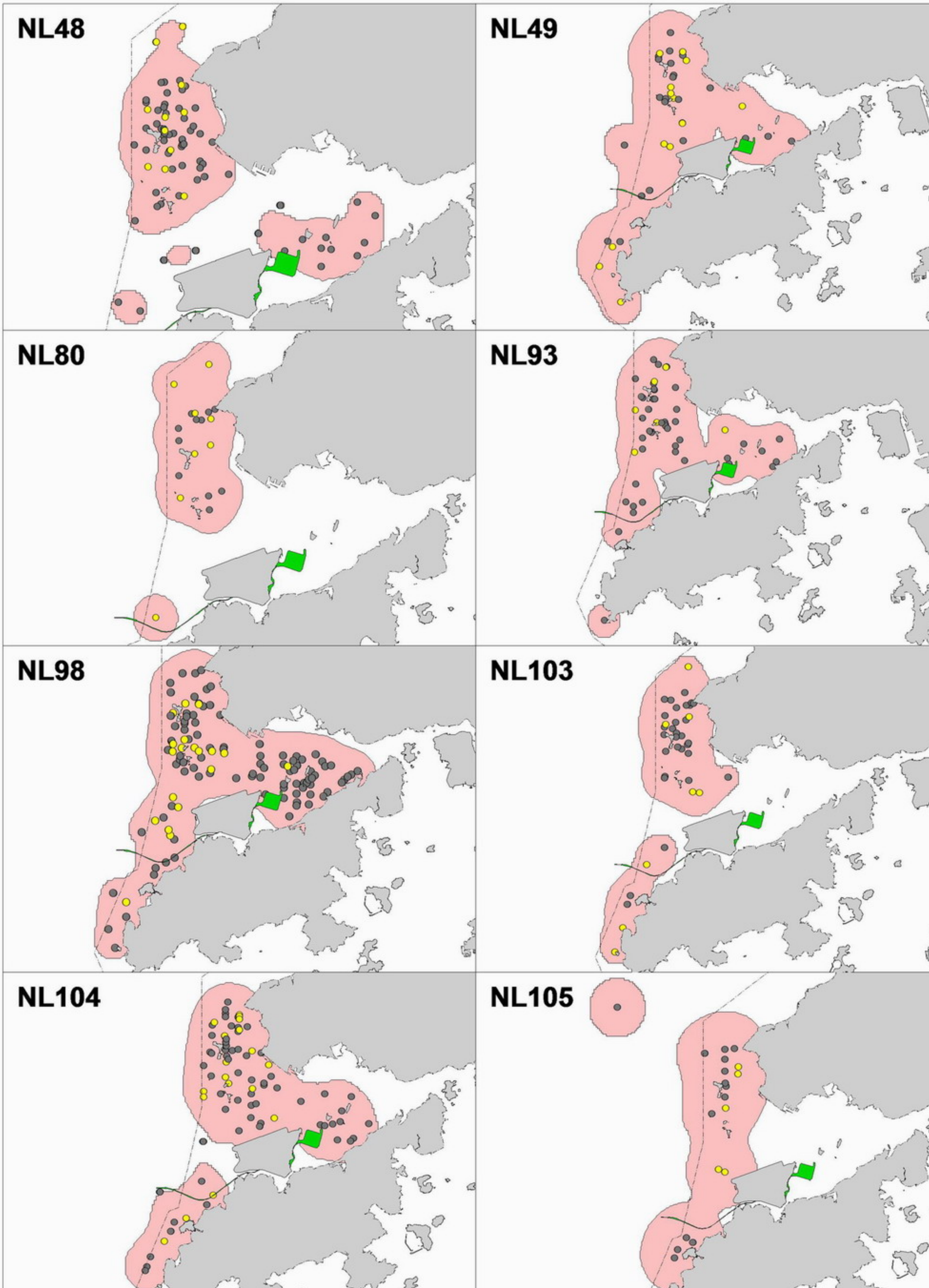
Appendix VII. Ranging patterns (95% kernel ranges) of 141 individual dolphins with 10+ re-sightings that were sighted during 2013-14 monitoring period (note: yellow dots indicates sightings made in 2013)



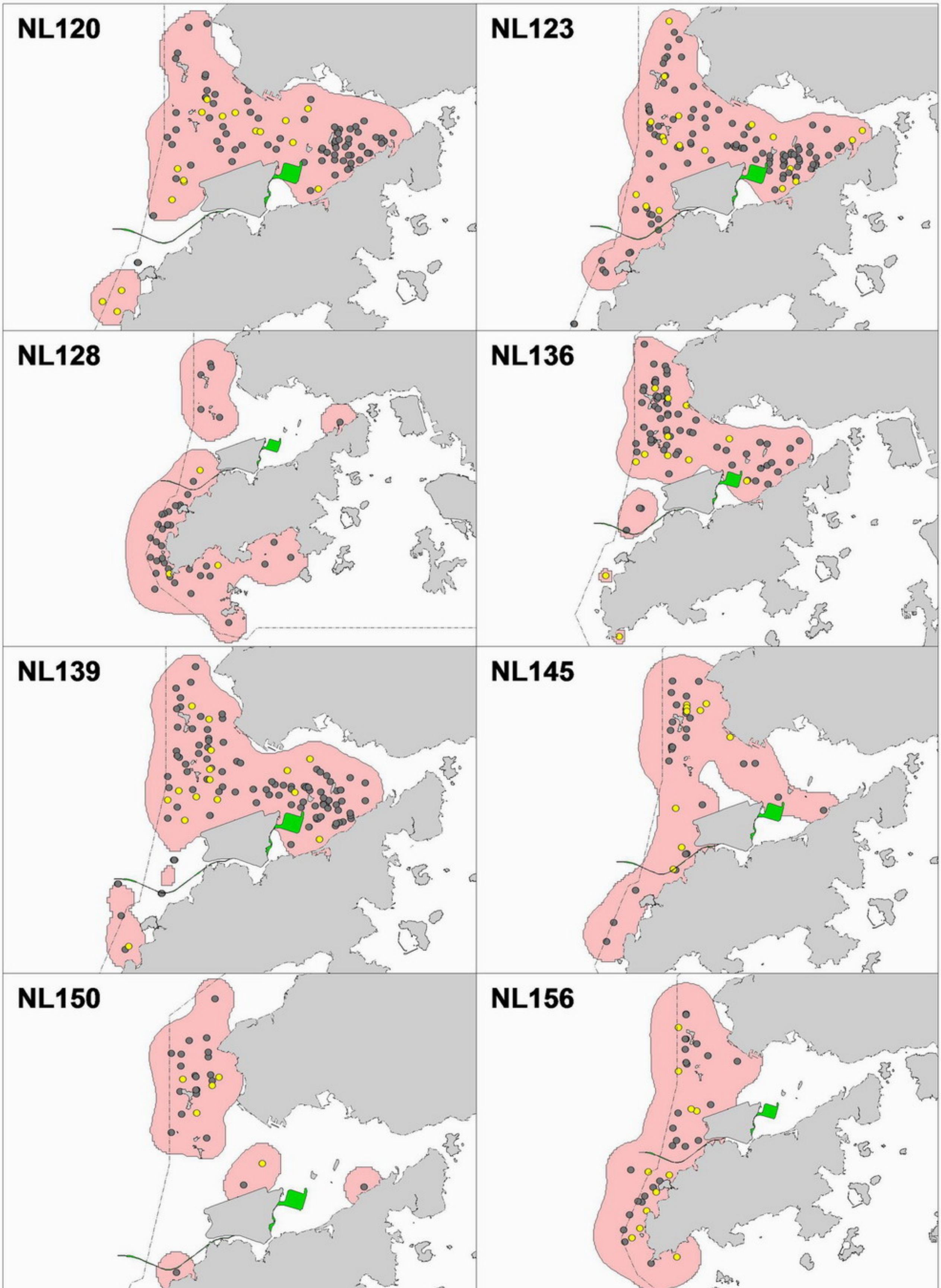
Appendix VII (cont'd).



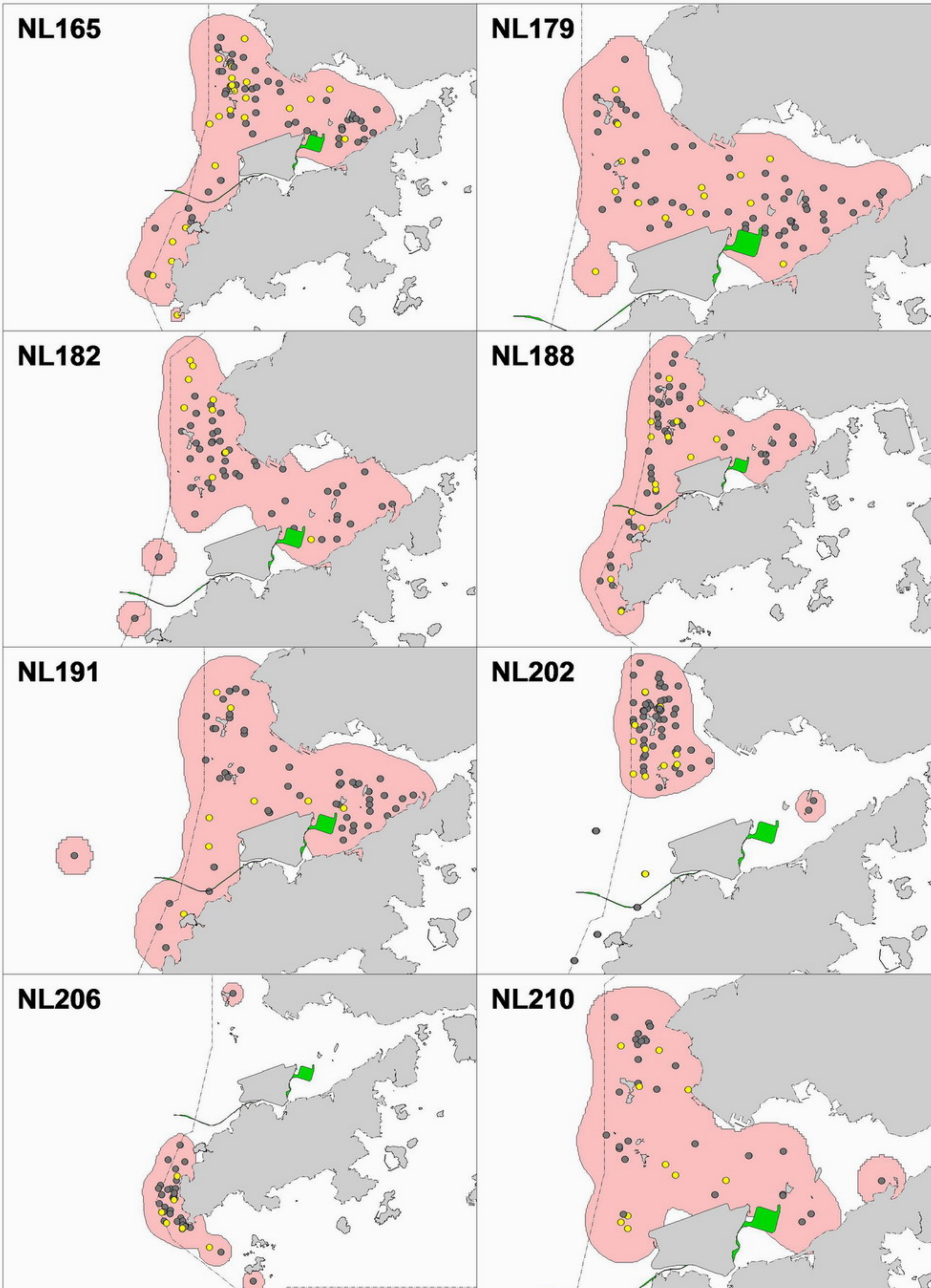
Appendix VII (cont'd).



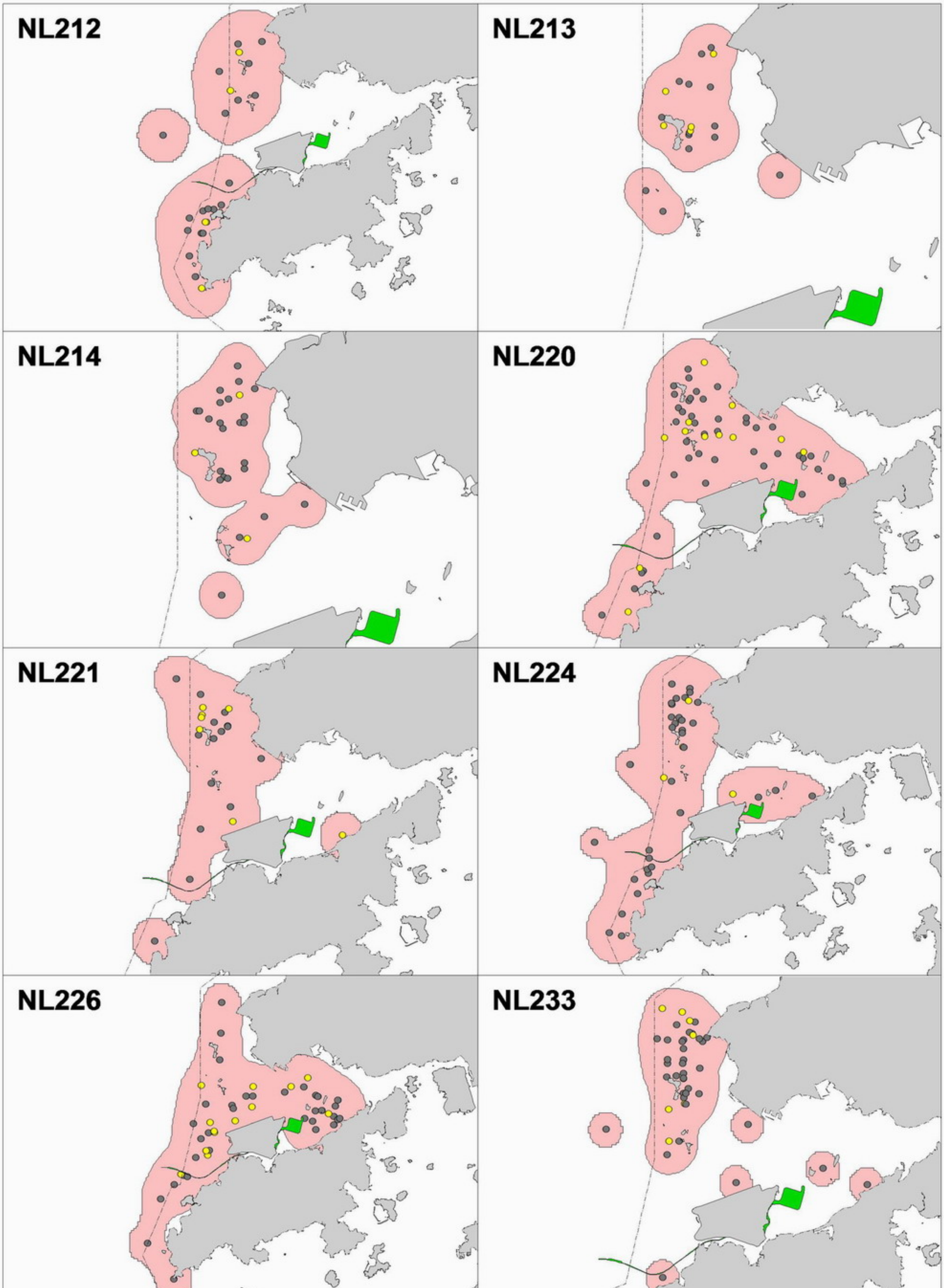
Appendix VII (cont'd).



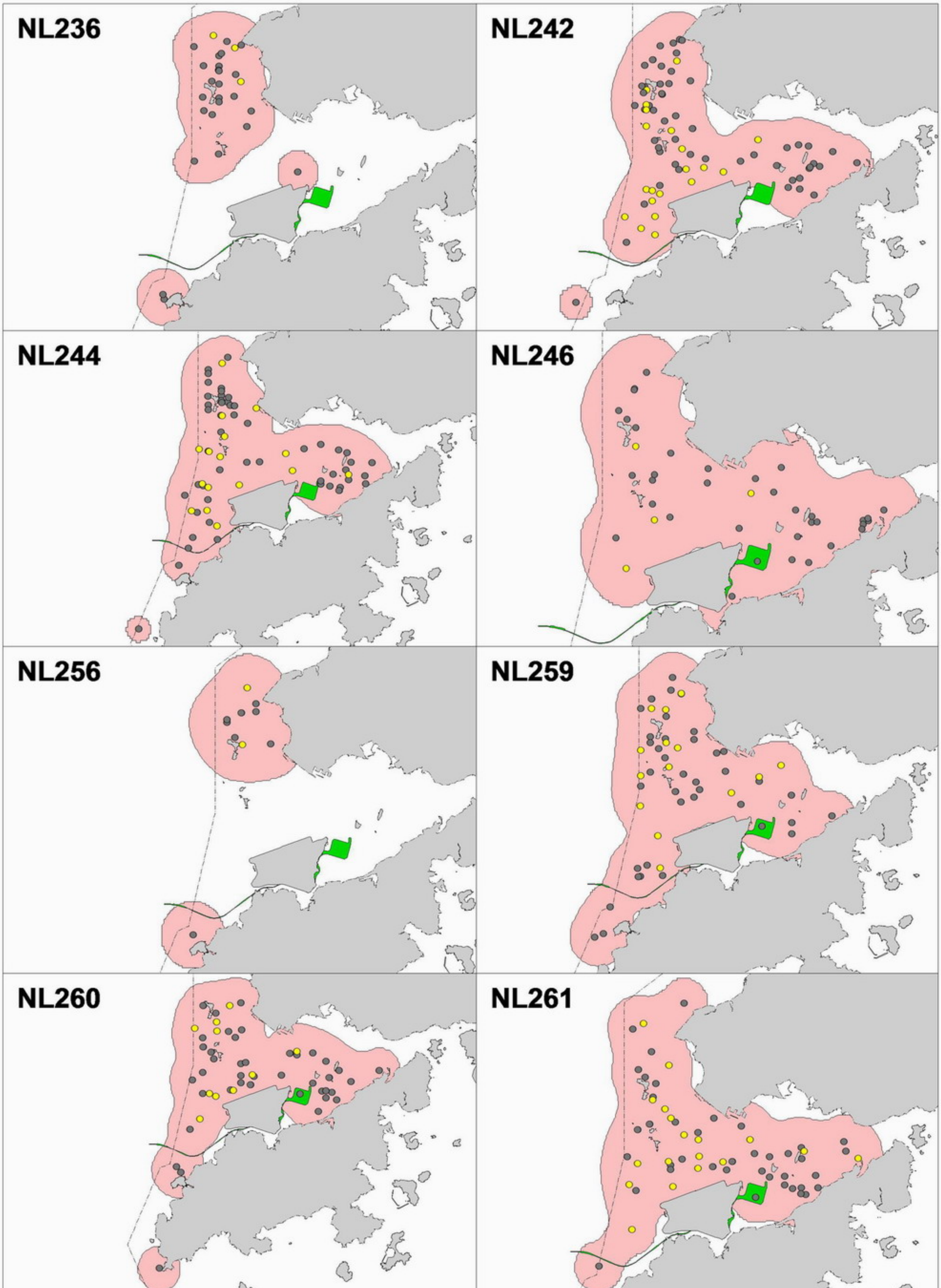
Appendix VII (cont'd).



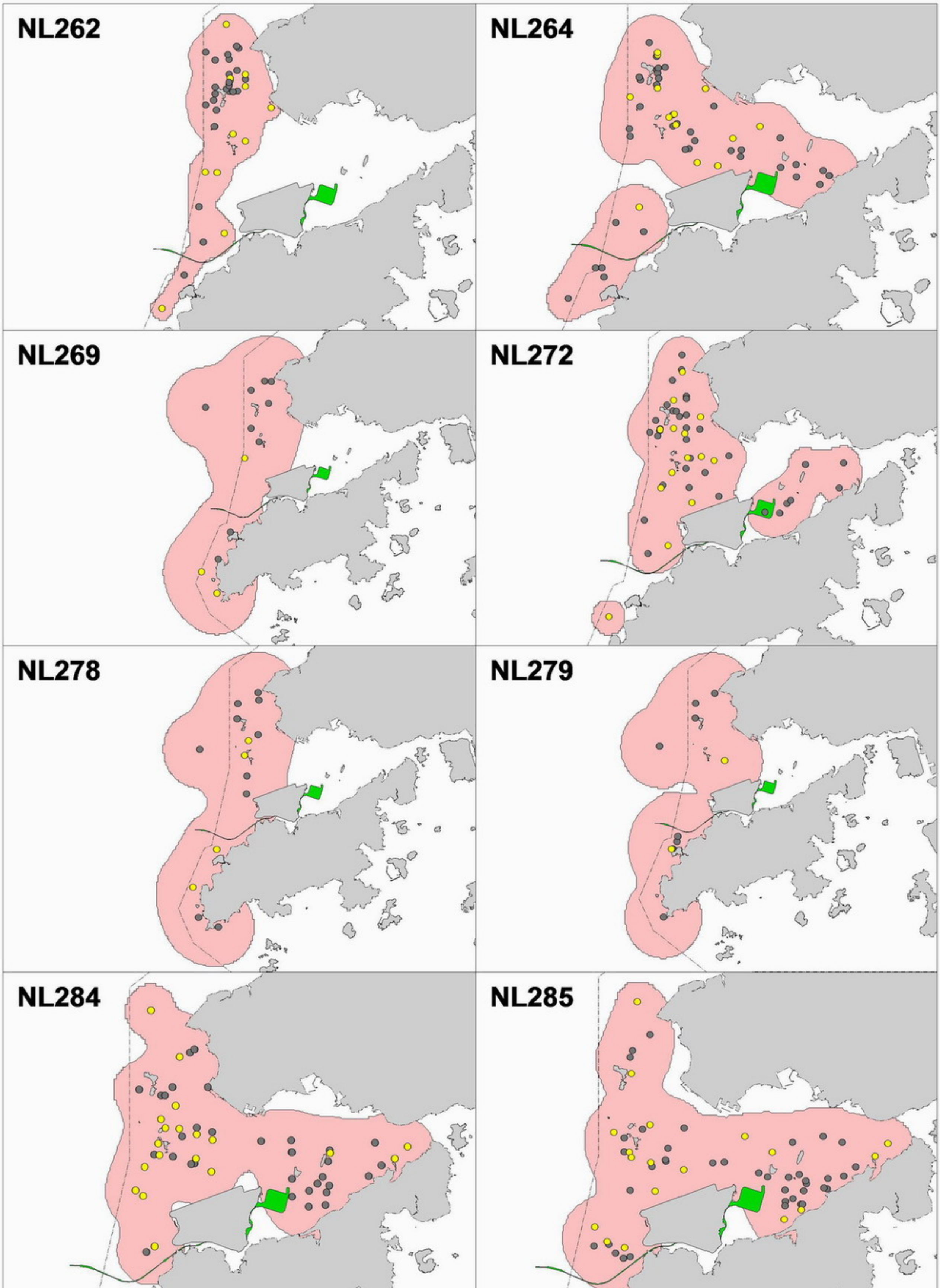
Appendix VII (cont'd).



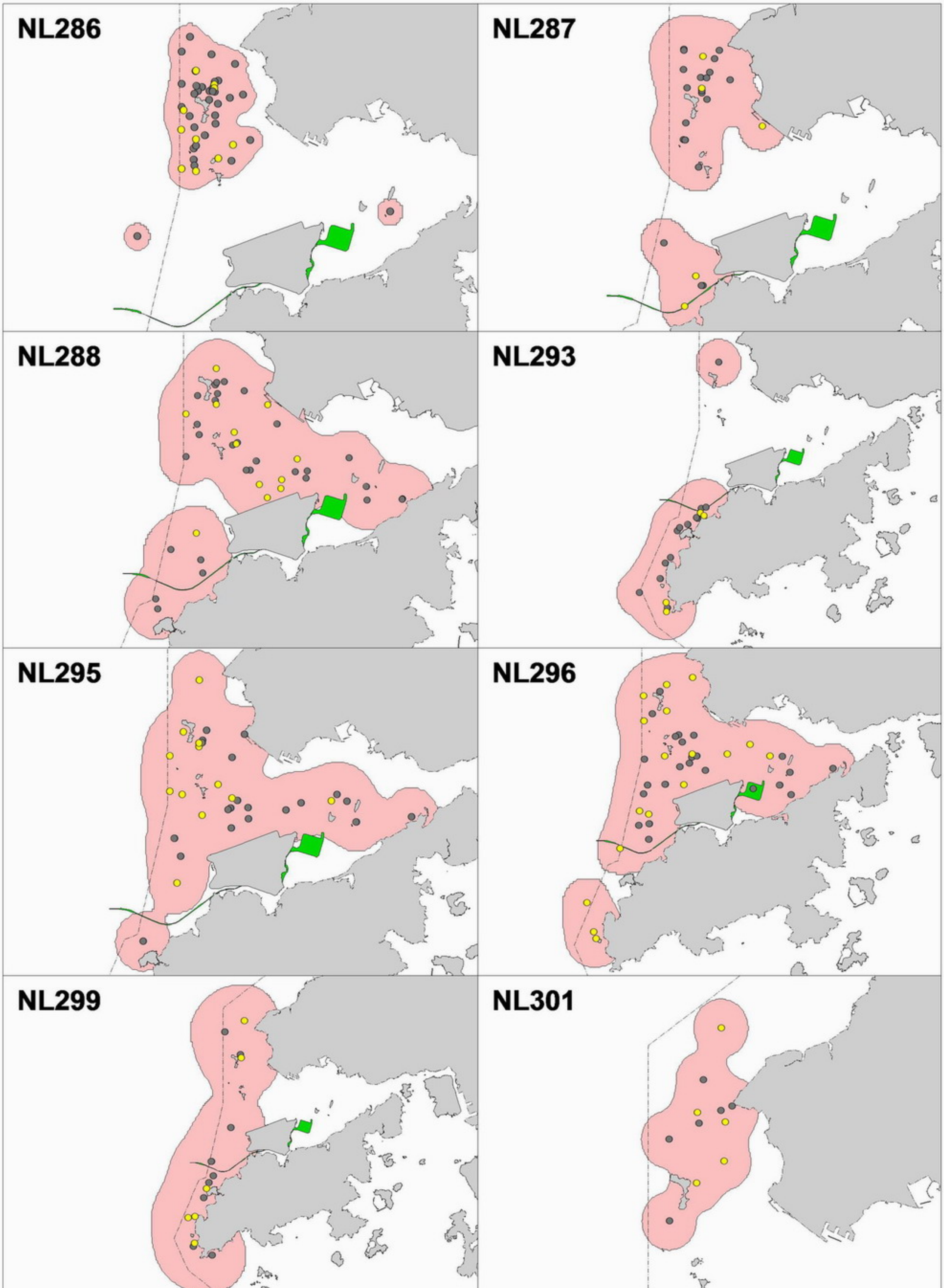
Appendix VII (cont'd).



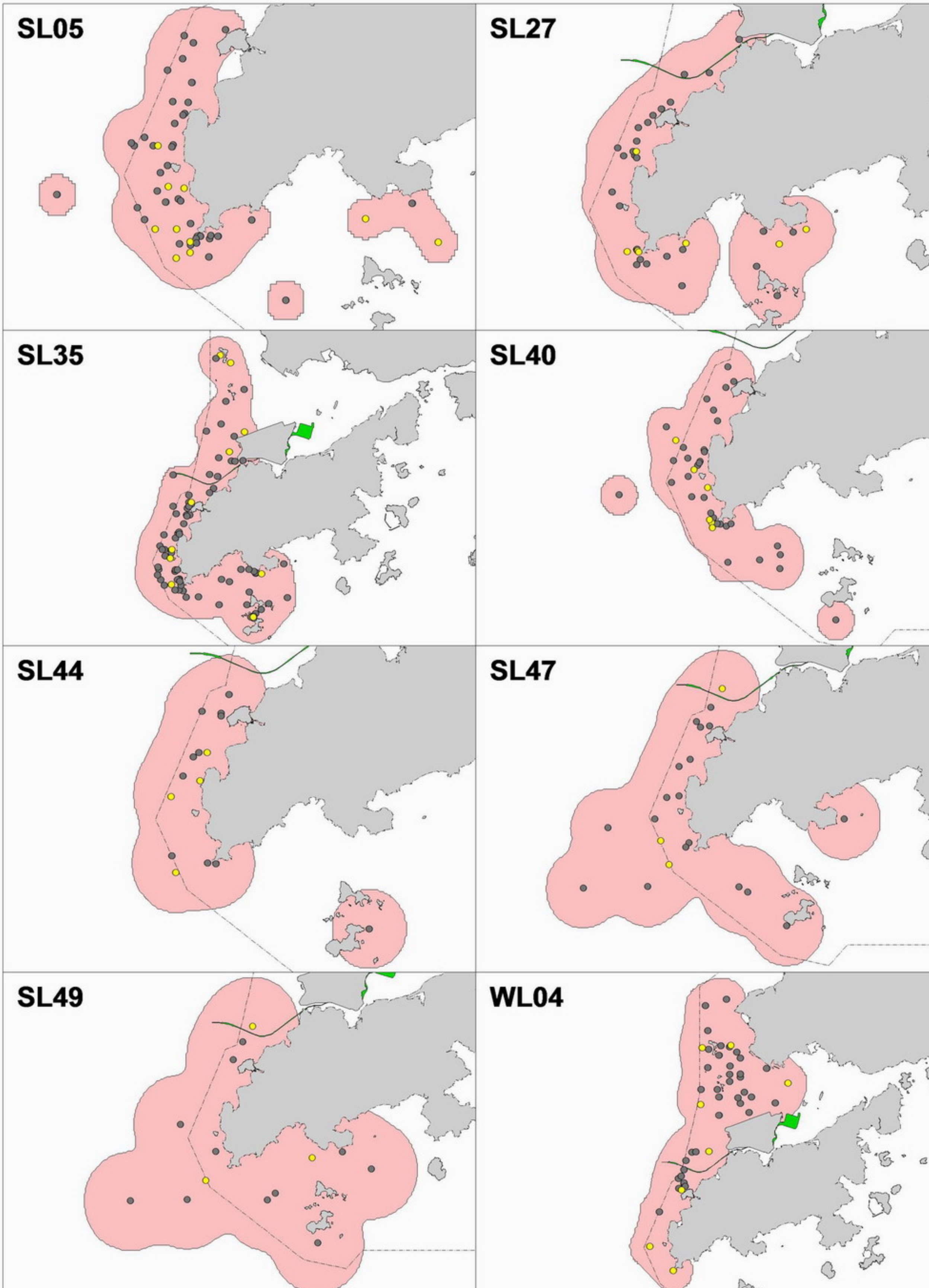
Appendix VII (cont'd).



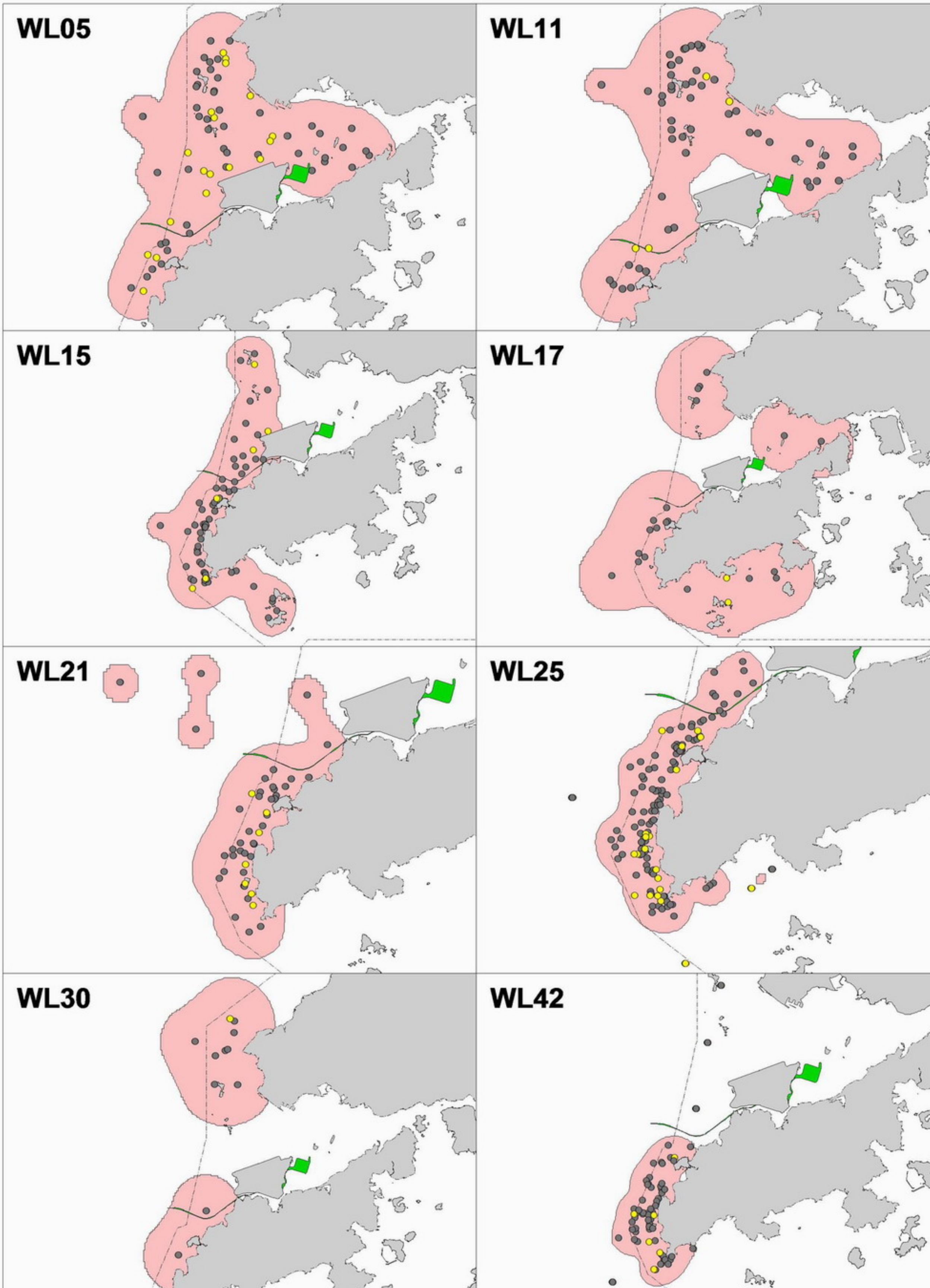
Appendix VII (cont'd).



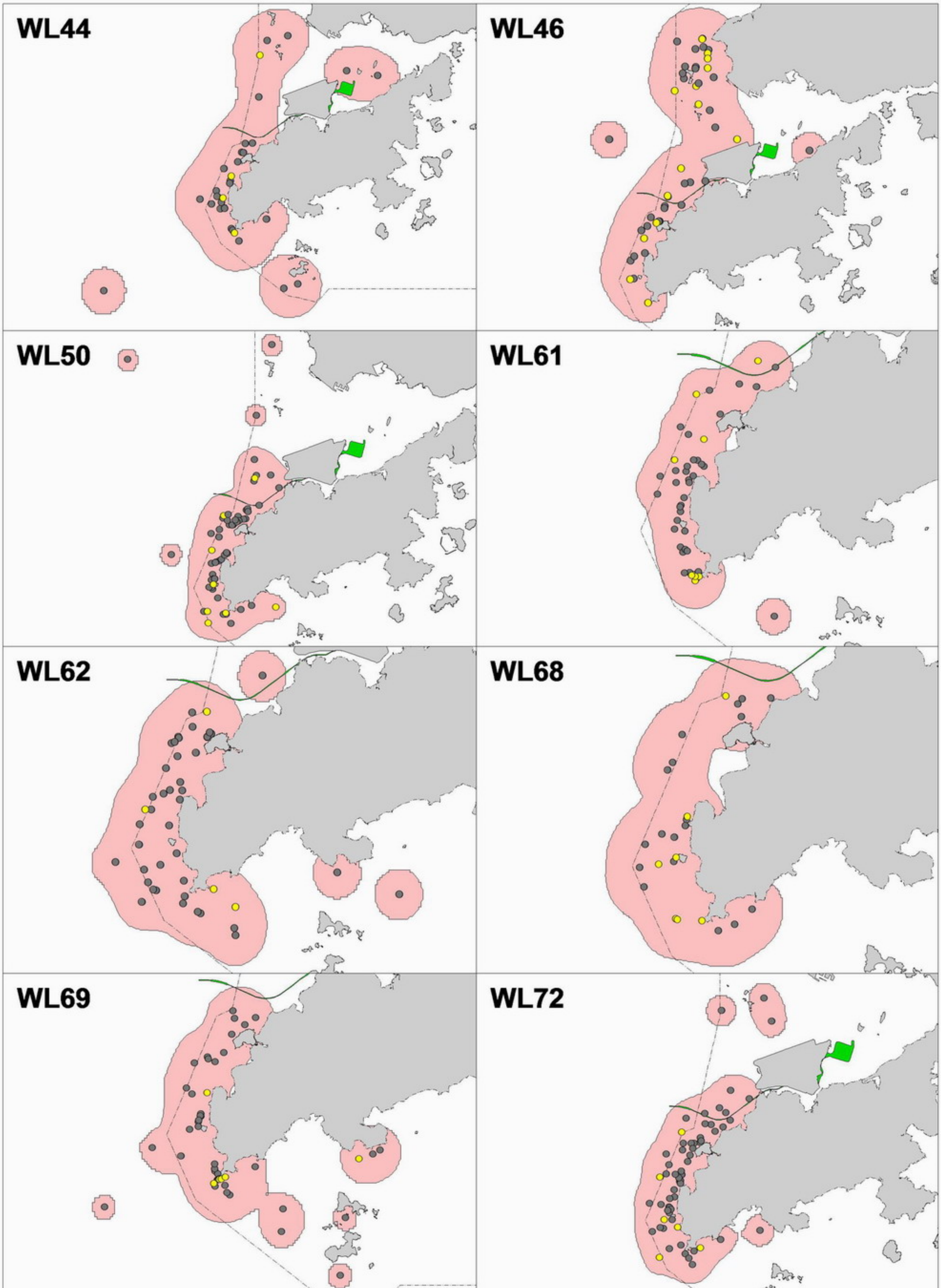
Appendix VII (cont'd).



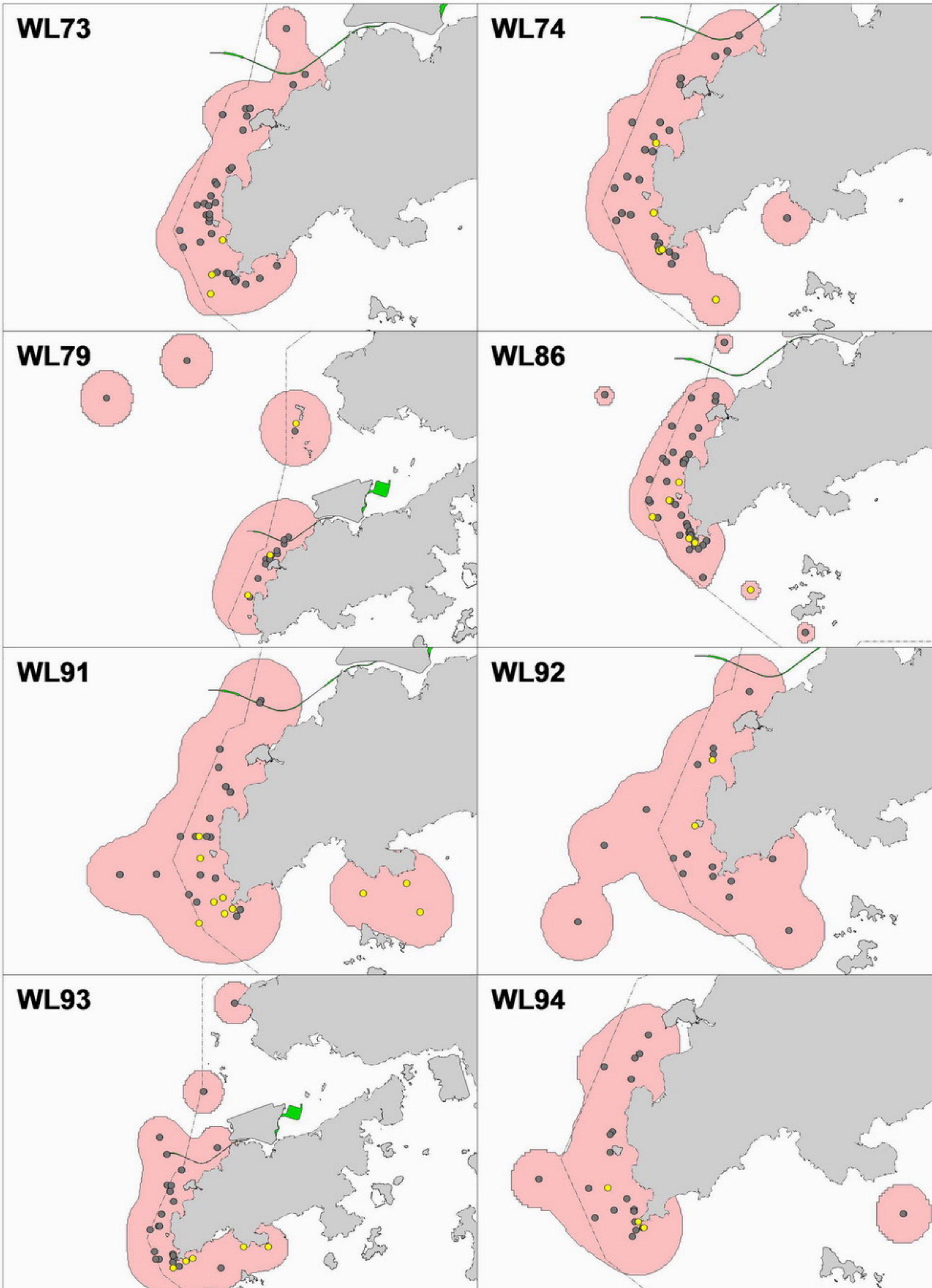
Appendix VII (cont'd).



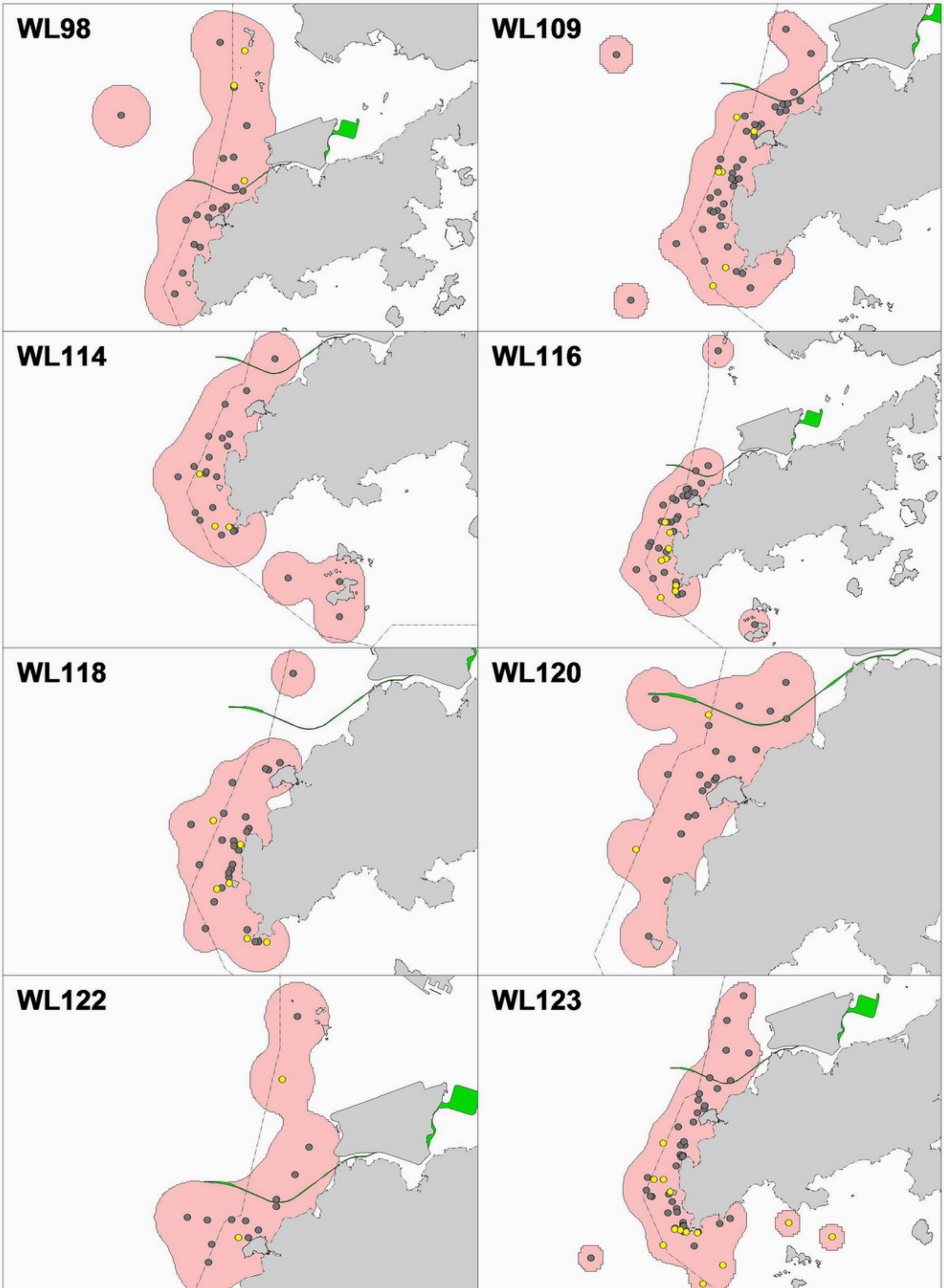
Appendix VII (cont'd).



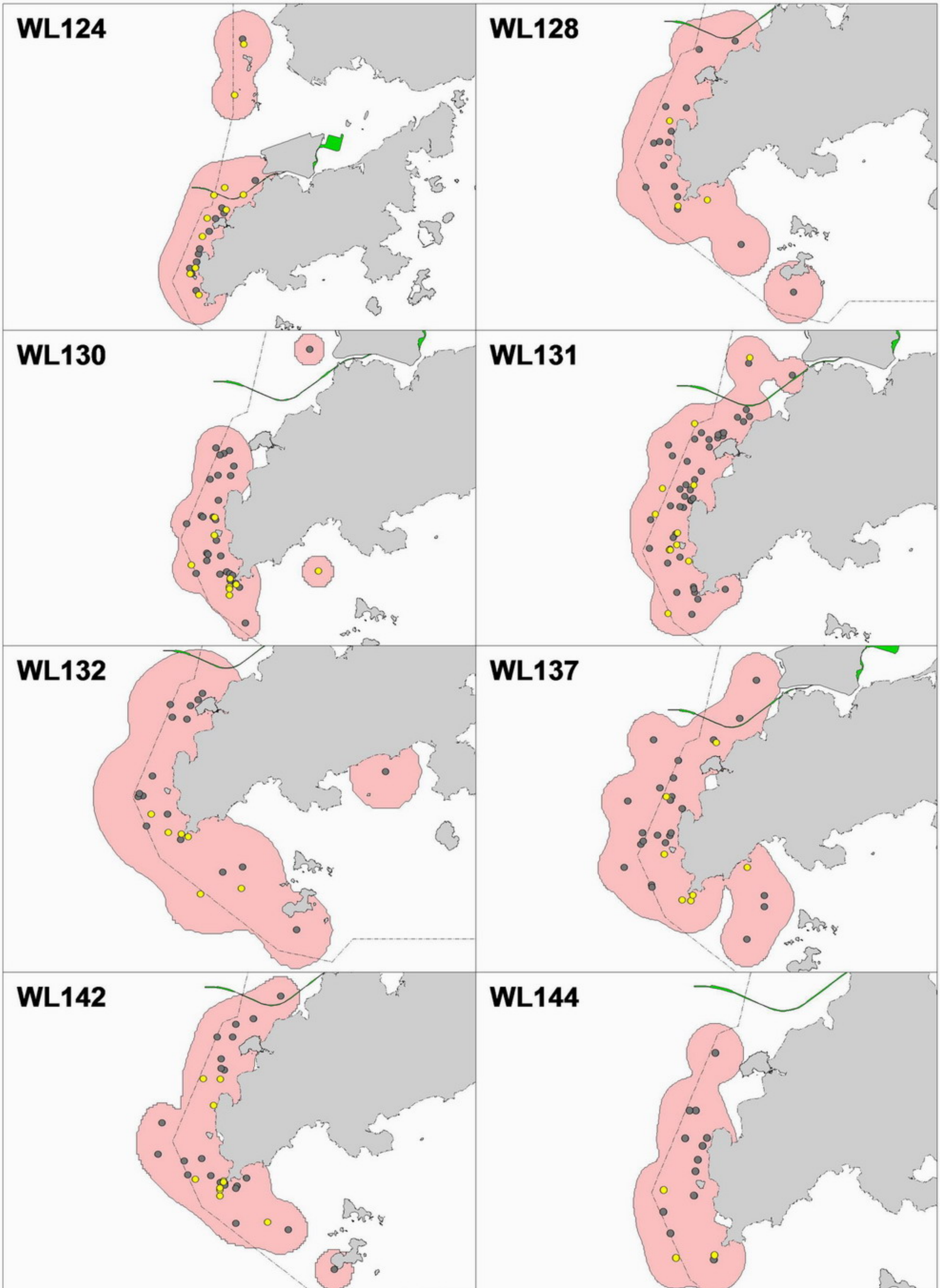
Appendix VII (cont'd).



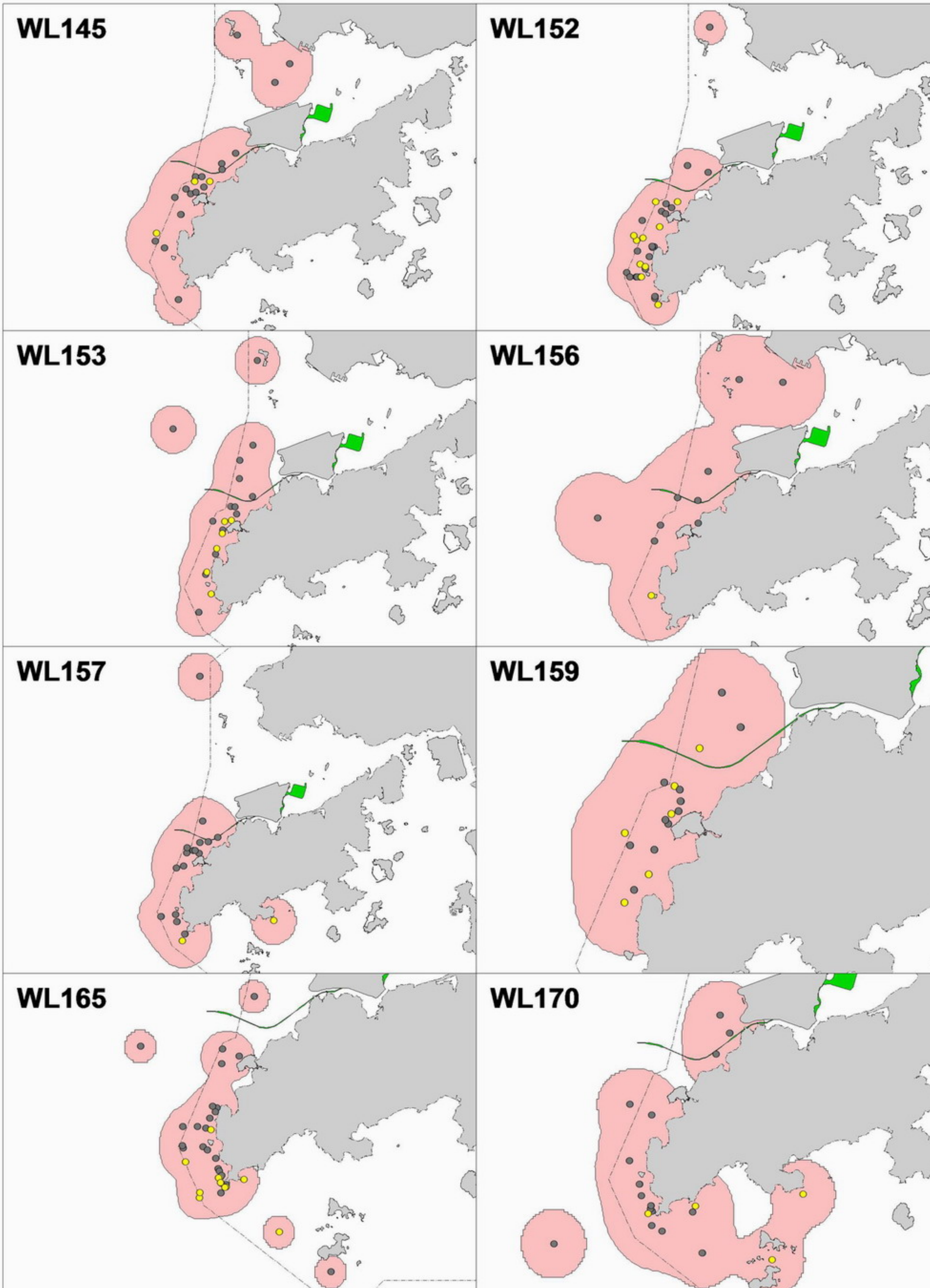
Appendix VII (cont'd).



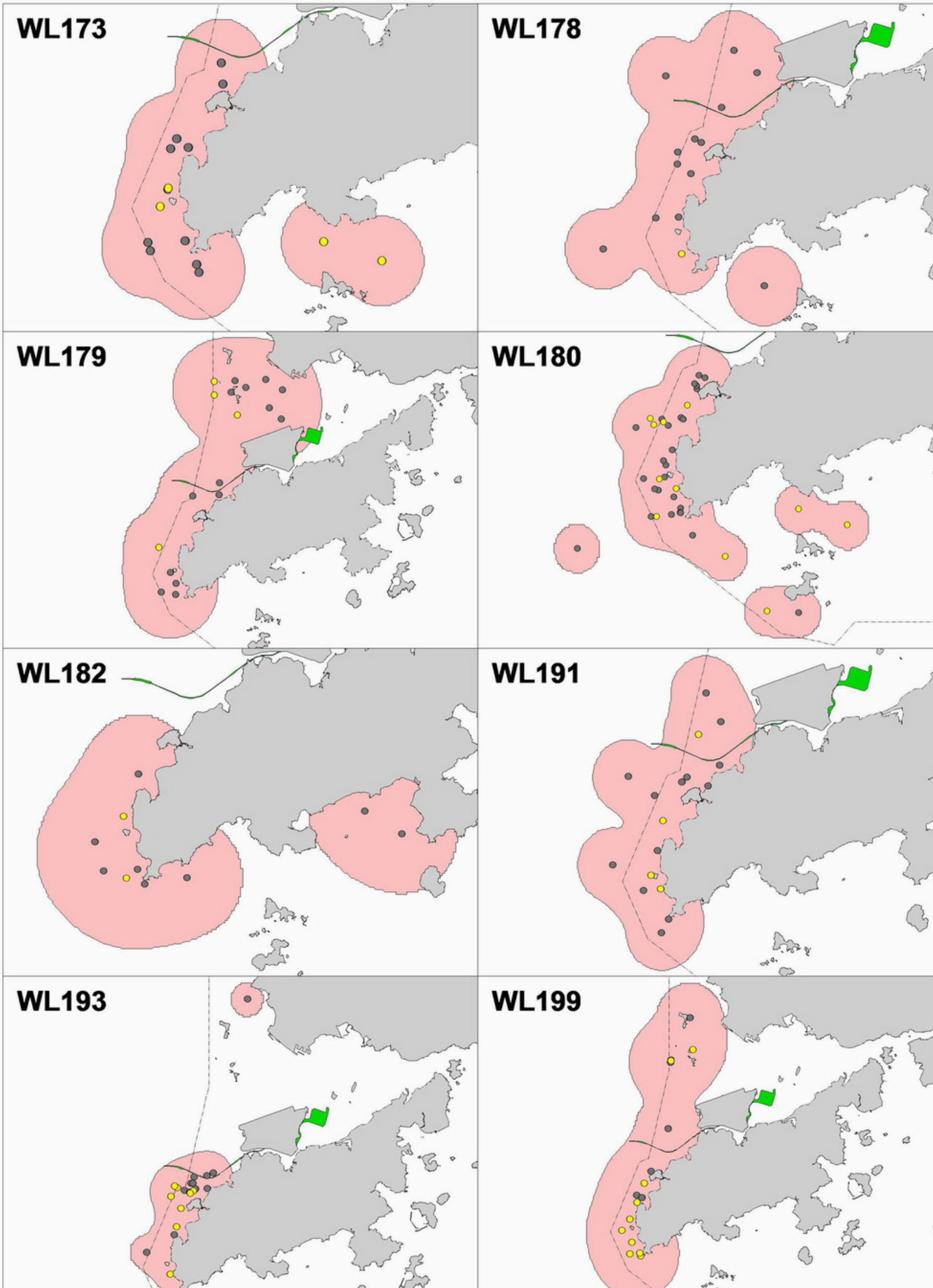
Appendix VII (cont'd).



Appendix VII (cont'd).



Appendix VII (cont'd).



Appendix VII (cont'd).