MONITORING OF MARINE MAMMALS IN HONG KONG WATERS (2014-15)

FINAL REPORT
(1 April 2014 to 31 March 2015)

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WL212, the seriously injured dolphin © HKCRP

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Since 1995, a longitudinal study on Chinese White Dolphins and Indo-Pacific finless porpoises has been conducted in Hong Kong. The present monitoring study represents a continuation of this long-term research study with the funding support from the Agriculture, Fisheries and Conservation Department, covering the period of April 2014 to March 2015. During the one-year study period, 173 line-transect vessel surveys with 4,626 km of survey effort were conducted among ten survey areas in Hong Kong. In total, 258 groups of 1,075 Chinese White Dolphins and 106 groups of 288 finless porpoises were sighted during vessel and helicopter surveys. Most dolphin sightings were made in West Lantau (WL) and Southwest Lantau (SWL) survey areas, but they rarely occurred in Northeast Lantau (NEL), including the various construction sites of the Hong Kong-Zhuhai-Macau Bridge (HZMB). There were declining usage of dolphins in both NEL and Northwest Lantau (NWL) waters, while a continuous increase of dolphin usage occurred in SWL in recent years. The majority of finless porpoise sightings were concentrated between the Soko Islands and Shek Kwu Chau in 2014-15.

There was a marked decline in dolphin encounter rate in North Lantau region since 2011 to an exceptionally low level in 2014, but the combined one in WL and SWL remained at a higher level in 2013 and 2014. The commencement of five HZMB-related construction works in different quarters of 2012-14 all coincided with a further drop in dolphin encounter rates in the respective quarter in NEL and NWL waters. The combined estimate of dolphin abundance in WL, NWL and NEL survey areas in 2014 was 61 dolphins, which was similar to 2012 and 2013 estimates, but the estimates in NWL and NEL reached the lowest in 2014 since 2001. 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 and NWL waters was likely related to the HZMB construction works. Several recommendations in management strategies have been made to address this serious issue, including proper management of high-speed ferry traffic from the Sky Pier, and avoidance of further reclamation around Lantau waters until a thorough assessment of cumulative impacts from different construction works is completed.

Important dolphin habitats in 2014 were identified along the west coast of Lantau as well as near Lung Kwu Chau in NWL. Habitat use patterns of Chinese White Dolphins revealed a noticeable decline in dolphin densities from 2011-2014, including the waters between Pillar Point and the airport platform as well as around the Brothers

Islands. During 2005-14, the important porpoise habitats were located to the south of Tai A Chau, southwest of Shek Kwu Chau, south of Cheung Chau, and the waters between Shek Kwu Chau and Soko Islands in the dry season, while their habitats around Po Toi Islands and at the juncture of Po Toi and Ninepins survey areas were identified as important during the wet season.

In 2014-15, 197 individual dolphins with 589 re-sightings were identified, with most of these made in WL and NWL. Temporal trend in individual movements across different survey areas revealed that the ones between NEL and NWL have greatly diminished in recent monitoring periods, while there was an emerging intensity of individual movements between WL and SWL in the past five monitoring periods. Range use of individual dolphins indicated a progressive increase in number of shifts of individual range use away from NEL waters, and expansions of range use to WL waters have also intensified for some individuals in 2014.

From the examination of 220 individual dolphins on some of their life history parameters, 70% of them were estimated to be at least 12 years old, which should all be sexually mature adults. The minimum period of 68 female calf associations ranged from 2-107 months, while the maximum calving intervals between 34 births ranged from 3-120 months. The events during three weeks of at-sea observations of a seriously injured dolphin (WL212) as well as a summary of 12 focal follow sessions with 33 hours and 46 minutes of observations of this dolphin were presented.

Analysis of 453 recordings during 2010-13 revealed that the sound levels at South Lantau Vessel Fairway were higher through most of the frequency range than in other areas of Lantau waters. The sounds of solitary high-speed ferry, small dolphin-watching boat, shrimp trawler and shipping container vessel were all much louder than the ambient sound levels. The study concluded that vessels contribute considerable sound levels over a wide range of frequencies to the ambient acoustic environment in western Hong Kong.

During the study period, HKCRP researchers delivered nine 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)

自 1995 年開始，一項有關本地中華白海豚及印度太平洋江豚的長期研究經已展開。此項為期一年 (由 2014 年 4 月至 2015 年 3 月)、獲香港特別行區政府漁農自然護理署資助的研究工作，正是這長期監察的延伸。在為期十二個月的研究期間，研究員共進行了 173 次樣條線船上調查，在全港十個調查區共航行了 4,626 公里，並觀察到共 258 群中華白海豚 (總數達 1,075 隻) 及 106 群江豚 (總數達 288 隻)。大部份中華白海豚均在大嶼山西面及西南面水域出沒，但卻甚少在大嶼山東北面水域 (包括港珠澳大橋多個施工範圍附近水域) 發現牠們的蹤影。在過往數年，白海豚在大嶼山東北面及西北面水域的使用量持續減少，但同時間在大嶼山西南面水域的使用量卻逐漸提升。另一方面，在 2014-15 年間江豚主要出沒於石鼓洲與索罟群島之間一帶水域。

中華白海豚於北大嶼山區域的目擊率，自 2011 年起不斷下降至 2014 年之最低水平；而大嶼山西面及西南面水域之合併目擊率，於 2013 及 2014 年仍維持在較高的水平。於 2012-14 年間，港珠澳大橋相關共五項工程所開展的時間，均與同一季度於東北及西北大嶼的海豚目擊率之明顯下降的時間相當吻合。

在 2014 年度裡，中華白海豚在三個主要出沒區域的整體數目估計為 61 隻，此數字與 2012 及 2013 年的估計相近，但西北及東北大嶼山水域之海豚數目均為自 2001 年所估計的最低數目。此三個區域的估計數目均呈現明顯的下降趨勢。海豚目擊率及數目均於過去近年雙雙下降，應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，包括妥善管理來往海天碼頭之高速船隻 (如調整數量及減速)，並在未完全掌握不同工程對白海豚的累積影響之前，應避免在大嶼山水域進行額外的基建工程。

中華白海豚在 2014 年的重要棲身地，主要集中在大嶼山西面整片水域及西北大嶼山的龍鼓洲一帶水域。2011-2014 期間，中華白海豚於踏石角與機場島之間水域、及大小磨刀洲一帶水域的使用率明顯下降。此外，在 2005-14 年期間，在枯水期被確認為重要的江豚生境包括大鴉洲以南、石鼓洲西南面、長洲以南、及大鴉洲與石鼓洲之間水域；另一方面，江豚在豐水期間使用量較高的生境，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。

研究員於 2014-15 年間辨認出 197 隻個別海豚、共 589 次的目擊紀錄，其中大部分均出現在大嶼山西面及西北面水域。個別海豚來往不同調查區之年度趨勢變化顯示，中華白海豚來往西北及東北大嶼山水域的頻密程度已大不如前，但在過去五個年度來往大嶼山西面及西南面水域之移動卻漸趨頻繁。將其活動範圍自大嶼山東北水域轉移至其他地方的個別海豚數目亦正陸續增加，而部份更於

2014 年將其活動範圍擴展至大嶼山西面水域一帶。

利用長期相片辨認的數據，研究員分析了220條中華白海豚的數項生命史參數，發現多達七成的海豚壽命已屆十二歲或以上，均是已達至性成熟的成年個體。此外，有關68條雌性海豚的產幼間隔及母豚與幼豚聯繫的研究發現，海豚母子的最短聯繫時間由兩個月至107個月不等，而雌性海豚產幼間隔的最長時間由三個月至120個月不等。在本年度於大嶼山水域發現一條嚴重受傷海豚(WL212)，有關於海中針對此個體進行為期三個星期之觀察，包括12次、共33小時46分鐘之目標追蹤，亦於此報告作總結匯報。

透過分析於2010-13年間搜集的453個水底聲音檔案，發現於大嶼山南面水域的一條高速船航道之水底聲浪水平，於大部份頻率範圍均高於大嶼山周邊水域不同的地點。此外，單一出現的高速船、觀豚小艇、蝦拖漁船、及貨櫃輪船所發出的水底聲浪亦全部高於背景噪音水平。研究顯示，航行船隻所發出的聲浪於不同的頻率範圍內，均令香港西部水域的水底聲音環境更為嘈雜。

在本年度，研究員為本地中小學主持了共九場講座，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 2013, 2014).

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 2005, 2008, 2013, 2014; 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 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 2014 to 31 March 2015, 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, eight 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 ten survey areas (i.e. Northwest (NWL), Northeast (NEL), West (WL), Southwest (SWL) and Southeast Lantau (SEL), Deep Bay (DB), Lamma (LM), Po Toi (PT), Ninepins (NP) and Sai Kung (SK)) (Figure 1).

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 board 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 are 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

When a group of Chinese White Dolphins were sighted during the line-transect vessel 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 850 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.

4.4 Dolphin-related Acoustic Works

4.4.1. Calibrated hydrophone

For acoustic data collection, a calibrated hydrophone was 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 and porpoises 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). A feasibility study on theodolite tracking of Indo-Pacific finless porpoises was also conducted for the first time during the present monitoring period.

Shore-based theodolite tracking sessions were conducted from six different stations at Siu Ho Wan, Tai O, Sham Wat and Fan Lau (for Chinese White Dolphins) as well as Shek Kwu Chau and Cheung Chau (for finless porpoises) during the present study period (Figure 4). To conduct theodolite tracking from one of these stations, on each survey day observers searched systematically throughout the study area for Chinese White Dolphins or finless porpoises using the unaided eye and 7x50 handheld binoculars. A theodolite tracking session was initiated when an individual or group of dolphins/porpoises was located, and focal follow methods were used to track the dolphins or porpoises. 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/porpoise 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/porpoises 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 activities nearby such as bored piling works. 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/porpoises, 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/porpoise was recorded at every surfacing with use of *Pythagoras*. The position, type, and activity of all vessels within 5 km of the focal individual 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 their 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:

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

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

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

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

A strategy of selective pooling and stratification was used in order to minimize bias and maximize precision in making the estimates of density and abundance (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 2014, 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 (see Hung 2008), positions of on-effort sightings of Chinese White Dolphins and finless porpoises were retrieved from their 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:

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

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

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 2014, and in recent years of monitoring (2004-15 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 was 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 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 2000-2014, 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.

5. RESULTS AND DISCUSSIONS

5.1. Summary of Data Collection

5.1.1. Survey effort

During the 12-month monitoring period in April 2014 to March 2015, a total of 173 line-transect vessel surveys were conducted among ten survey areas in Hong Kong waters. These included 19 surveys in NEL, 28 surveys in NWL, 38 surveys in WL, 29 surveys in SWL, 21 surveys in SEL, 16 surveys in DB, eight surveys in LM, five surveys in PT, seven surveys in NP and two surveys in Sai Kung. The details of these survey effort data shown in Appendix I. In addition, five focal follow surveys were conducted on the seriously injured dolphin WL212 in late January to early February 2015 (see Section 5.10).

As in the previous monitoring year, more survey effort were allocated to survey areas outside of North and West Lantau waters during the present monitoring period, as additional surveys have been conducted by HKCRP research team in NWL, NEL and WL survey areas concurrently 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, HKCRP 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, seven helicopter surveys were conducted with the Government Flying Services through the arrangement of AFCD on April 7th, May 26th, June 9th, July 2nd, August 4th, September 17th of 2014 and February 9th of 2015. 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.

Among the ten survey areas, 611.5 hours were spent to collect 4,625.8 km of survey effort. The majority of these effort (73.1% of total) was conducted in six areas where dolphins regularly occur, in which 28.0% of total effort were spent in NEL/NWL, 11.7% in WL, 26.9% in SWL/SEL and 6.4% in DB. In addition, 53.8% of total survey effort was allocated to survey areas in southern and eastern waters of Hong Kong (i.e. SWL, SEL, LM, PT, NP and SK) where porpoise occurrences were more frequent. Notably, 94.2% of all 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 their encounter rates, habitat use, and estimations of density and abundance.

During the same 12-month monitoring period, a total of 4,315.4 km of survey effort was conducted in NEL, NWL and WL under the HKLR03 (the section between Scenic Hill and Hong Kong Boundary Crossing Facilities (HKBCF)) and HKLR09 (the section between HKSAR Boundary and Scenic Hill) EM&A dolphin monitoring surveys respectively. This brings the total survey effort to 6,155.0 km for the combined dataset from AFCD and HKLR surveys within these three survey areas. Over 94% of the survey effort of HKLR surveys was also 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 159,356 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 53.0% of the effort funded by AFCD. The survey effort in 2014 alone comprised 5.9% of the total survey effort collected since 1996.

5.1.2. Marine Mammal Sightings

Chinese White Dolphin - From AFCD surveys alone, 258 groups of 1,075 Chinese White Dolphins were sighted during April 2014 to March 2015 (see Appendix II). With the additional sightings from HKLR surveys, a total of 461 groups of 1,897 individuals were sighted during the same 12-month period. Among these 461 dolphin groups, 381 were sighted during on-effort line-transect vessel surveys, while the rest were made during off-effort search. Most dolphin sightings were made in WL (262 sightings) and NWL (114 sightings), comprising 81.6% of the total. On the other hand, dolphins occurred in a lesser extent in SWL (71 sightings), and infrequently in DB (8 sightings), NEL (3 sightings) and SEL (3 sightings) despite extensive survey effort being conducted in these three areas. As in the previous monitoring periods, no dolphin was sighted in LM, PT, NP or SK survey areas.

Finless porpoise - During the 12-month study period, 106 groups of 288 finless porpoises were sighted during vessel and helicopter surveys (see Appendix III). Eighty-one 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), SWL (18 groups) and LM (15 groups) survey areas. Eight groups each were sighted in PT and NP survey areas, while only three groups were sighted in SK survey areas. 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 2014 to March 2015, over 26,000 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 individual dolphins, were incorporated into the photo-identification catalogue. Significant amount of photo-identification data were also contributed from the HKLR surveys during the same period.

Up to January 2015, a total of 874 individual Chinese White Dolphins have been identified by HKCRP researchers in Hong Kong waters and the rest of the Pearl River Estuary. These included 35 new individuals being added to the catalogue during 2014, all of which were identified in Hong Kong waters. In the current catalogue, 507 individuals were first identified within Hong Kong territorial waters, while the rest were first identified in Guangdong waters of the Pearl River Estuary. Moreover, 234 individuals have been seen 10 times or more; 182 individuals have been seen 15 times or more; 100 individuals have been seen 30 times or more; and 64 individuals have been seen 50 times or more. On the contrary, nearly half of the identified individuals (49.2%) have only been seen once or twice, with most of these being first identified in Guangdong waters (300 out of 367 individuals). Temporal trends in the 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 significant progress in photo-identification work has been made in the 2014-15 monitoring period (Figure 5).

During the present 12-month monitoring period from April 2014 to March 2015, a total of 197 individuals, sighted 589 times altogether, were identified during AFCD regular vessel surveys and shore-based theodolite tracking works (Appendix IV). In addition, 173 individuals were also identified 451 times during HKLR monitoring surveys in NEL, NWL and WL during the same period. More than half of the re-sightings of individual dolphins made during AFCD/HKLR surveys were in WL survey area, comprising 58.1% of the total, while many re-sightings were also made in NWL (22.4%) and SWL (16.4%) survey areas. On the contrary, only 23 and 7 re-sightings were made in DB and NEL survey areas, and just two individuals (SL35 and WL69) were re-sighted in SEL survey area.

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, 22 individuals were sighted more than 10 times from the combined dataset, with one of them (NL48) sighted 16 times during the relatively short study period. Most of these repeatedly-sighted individuals are considered year-round residents (see Section 5.8.1), and centered their range use in WL and SWL waters. This is in contrast to past monitoring periods that most frequently sighted individuals centered their range use in North Lantau waters.

Moreover, many year-round residents (e.g. NL24, NL33, NL120, NL123, NL139,

WL25) that were frequently sighted in HK waters in the past have only occurred occasionally during the present monitoring period. For example, with similar amount of survey effort during the past three monitoring periods, NL24 was sighted 16 and 22 times in 2012-13 and 2013-14 respectively, but it was only sighted twice in 2014-15. Similarly, NL139 was sighted 13 and 11 times in 2012-13 and 2013-14 respectively, but it was sighted only four times in 2014-15. Their rare occurrence during the present monitoring period raises serious concerns on whether these once-residents might have greatly diminished their reliance of Hong Kong waters with significant shift in their range use to elsewhere. This would be further investigated in Section 5.8.3.

5.1.4. Dolphin-related Acoustic Studies

For the long-term acoustic monitoring work, a total of 6 hours and 51 minutes of recordings in 100 sound samples were collected from different acoustic monitoring stations around Lantau Island and in Deep Bay during the 12-month monitoring period (see Appendix V). Opportunistic recordings of dolphin and porpoise 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 (such as the results presented in Section 5.11), and to improve the overall understanding of the natural sound habitat and anthropogenic noises within dolphin habitats around Lantau Island.

5.1.5. Shore-based Theodolite Tracking

During the 12-month study period, a total of 22 sessions with 107.0 hours of theodolite tracking were conducted from Tai O (ten sessions), Fan Lau (three sessions), Sham Wat (one session), Siu Ho Wan (one session), Shek Kwu Chau (four sessions) and Cheung Chau (three sessions) shore-based stations (Appendix VI). The effort spent at the Sham Wat station was significantly reduced as there has been on-going monitoring effort by HKCRP team for the HKLR09 project to determine the impact of bridge construction on the north-south movement of dolphins in that area. On the other hand, the tracking effort at Shek Kwu Chau and Cheung Chau was conducted as a feasibility study in the application of theodolite tracking technique on finless porpoises to study their behaviours and movements in southern waters of Hong Kong. Several stations have been successfully set up on Shek Kwu Chau and Cheung Chau, and the feasibility study would be continued during and after the present monitoring period to assess whether the porpoises can be reliably tracked from land-based stations.

From these sessions, 64 groups of Chinese White Dolphins with 1,710 fixes of their positions were collected (Figure 6). For the tracking effort on Cheung Chau and Shek Kwu Chau, 14 groups of finless porpoises with 168 fixes of their positions were collected (Figure 7). In total, another 3,961 fixes were also made from locations of dolphin-watching boats, fishing boats, high-speed ferries and other types of vessels from the six tracking stations (Figures 6-7).

5.2. Distribution

5.2.1 Distribution of Chinese White Dolphins

During the 12-month monitoring period in 2014-15, Chinese White Dolphins were regularly sighted to the west and south of Lantau Island, but to a lesser extent in North Lantau waters during AFCD surveys (Figure 8). In 2014, with the combined effort from AFCD and HKLR surveys, the dolphin sightings were mainly concentrated along the west coast of Lantau, extending from Tai O Peninsula to Fan Lau (Figures 9-10). They were often sighted in SWL waters with a somewhat even distribution, while a few sightings were also made in SEL waters (Figure 10). On the other hand, their occurrence in North Lantau waters mainly clustered to the northwestern portion, including the waters around Lung Kwu Chau and Sha Chau as well as at the mouth of Deep Bay (i.e. the juncture of NWL and DB survey areas) (Figure 11). Notably, they rarely occurred in NEL waters in 2014, with only a handful of sightings being made there, while some sightings were also made to the north of the airport platform where the proposed reclamation for the third runway expansion would occur (Figure 11).

In 2013, dolphin occurrence near HZMB-related works was generally low (Hung 2014), and this was also the case in 2014 (Figures 10-11). Dolphins were rarely sighted near the HKBCF reclamation site and along the alignment of HKLR to the west of the airport, and they also generally avoided the northern landfall and southern viaduct of the Tuen Mun-Chek Lap Kok Link (TMCLKL) construction works (Figure 11).

<u>Temporal change in annual distribution records (2009-14)</u>

Using AFCD survey data alone, dolphin distribution records in the previous five years (2009-13) was compared with the one in 2014 to examine any temporal change in dolphin usage around Lantau waters (Figure 12). Several notable differences were observed. First, dolphin occurrence in NEL has reached a low point in 2014, with dolphins largely vacated from this area, where it was used to be an important dolphin habitat in the past (Figure 12). The significant decline in usage of the NEL

waters, especially around the Brothers Islands, has raised serious concerns on whether the on-going construction works of HZMB since 2012 has been seriously affecting dolphin usage in this area. Such situation undoubtedly has further worsened in 2014, and this will be further discussed in various sections of the present report.

In addition to the noticeable declining usage of NEL waters, such decline has also been extended to NWL waters in 2014 (Figure 12). In the past, the waters within and around Sha Chau and Lung Kwu Chau Marine Park, as well as the adjacent waters between Pillar Point and the airport platform (including the Urmston Road) have served as important dolphin habitats with their frequent occurrence. However, their occurrence in NWL in 2014 was largely limited to the waters around Lung Kwu Chau, and they were rarely found around Sha Chau as well as the central portion of North Lantau waters (Figure 12). With the HZMB construction activities further intensified in 2014 with the additional works of the TMCLKL construction, the cumulative impacts of HZMB-related works may have extended further westward to NWL waters, which was further compounded by the on-going disturbance of vessel movements in North Lantau waters, such as the increasing amount of high-speed ferry traffic from the Sky Pier.

Moreover, the paucity of dolphin sightings made to the west of airport platform was also observed in 2013 and 2014 (Figure 12), where dolphins were frequently found in the earlier years. This area at the juncture of NWL and WL survey areas has been important habitat for dolphins where individual dolphins from both northern and southern social clusters in Hong Kong come into contact (Dungan et al. 2012). Through focal follow study and shored-based theodolite tracking study, this area has also been proved to be a traveling corridor for dolphins to move between West Lantau waters and the Sha Chau and Lung Kwu Chau Marine Park (Hung 2014). The rare occurrence of dolphins from the coastal waters between Sham Wat and the western end of airport platform coincided well with the construction period of HKLR09 with works commencement in early 2013, and it is likely that dolphin occurrence in this important habitat has been affected by these construction works (including intensive bored piling activities) and associated vessel movements in this area (see Hung 2014; Section 5.3.1). As the spacing between the bridge piers will become narrower progressively, the overall dolphin usage over the bridge alignment as well as the north-south movement pattern of individual dolphins would become a major concern, and therefore should be closely examined.

On the contrary, there has been a continuous increase of dolphin usage of SWL

waters in recent years as compared to the earlier years, especially along the coastal waters between Fan Lau and Shui Hau Peninsula (Figure 12). As the dolphin usage has progressively declined in North Lantau waters and increased in West and Southwest Lantau waters, it is possible that some individual dolphins from the northern social cluster may have shifted their range use to WL and SWL. Such potential range shift would be further examined in Section 5.8.3.

Finally, it should be emphasized that the coastal waters of West Lantau was the only area in Hong Kong where consistent and frequent occurrence of dolphins was recorded (Figure 12). This highlights the urgent needs for the protection of this remaining important dolphin habitat in Hong Kong, in light of the continuous development pressure and anthropogenic activities seriously affecting dolphin occurrence in other parts of their local range.

5.2.2. Distribution of finless porpoises

During the 12-month period in 2014-15, the majority of finless porpoise sightings were clustered between the Soko Islands and Shek Kwu Chau (Figure 13). They were also sighted to the south of Soko Islands, around Shek Kwu Chau, to the south and southeast of Cheung Chau, around the Po Toi Islands, to the east and south of Ninepins Islands and the offshore waters of Sai Kung Peninsula (Figure 13). On the contrary, the porpoises rarely occurred in the western portion of South Lantau waters or around Lamma Island in 2014-15 (Figure 13). The rare occurrence of porpoises near Lamma Island was rather surprising, as the eastern and southwestern sides of the island were used to be important porpoise habitat (Hung 2012, 2013).

Due to the line-transect survey effort allocation in eastern waters, all porpoise sightings were only made there in summer and autumn months (Figure 13), even though some effort from helicopter survey was also spent in these waters in winter and spring months. On the other hand, the survey effort has been consistent year-round in South Lantau waters, and distinct seasonal occurrence of porpoises was found there. Fewer porpoise sightings were made in the offshore areas of South Lantau waters during summer and autumn months, while most sightings made in winter and spring months were concentrated between Shek Kwu Chau and the Soko Islands (Figure 13).

Comparison of annual porpoise distribution patterns from 2011-2014 revealed that porpoise occurrence was a lot more frequent in South Lantau waters in 2013-2014 than in 2011-2012 (Figure 14) However, very few porpoises were found

along the coastal waters of South Lantau in 2014, which was very different from their distribution in the previous year. Moreover, another notable difference was their rare occurrence on both sides of Lamma Island in 2014, where porpoises were frequently found in previous years (Figure 14). This may be partly related to the lower amount of survey effort conducted in this survey area in 2014. On the other hand, more porpoises were sighted in the eastern waters in 2014, which was in stark contrast to their rare occurrence there in 2012 and 2013 (Figure 14), even though the amount of survey effort was similar across these years. Notably, the most consistently used areas by the porpoises in the past four years were located around the Soko Islands and in the waters between Shek Kwu Chau and the Soko Islands (Figure 14). These areas have been proposed to be established as marine parks in coming years, which would certainly offer some protection for these important porpoise habitats.

5.3. Encounter Rate

5.3.1. Encounter rates of Chinese White Dolphins

For the calculations of dolphin encounter rates, only survey data collected in Beaufort 0-3 conditions was included in the analysis, since dolphin encounter rate was considerably lower in Beaufort 4-5 conditions (4.1 sightings per 100 km of survey effort) than in Beaufort 0-3 conditions (5.5) during the 12-month monitoring period.

From April 2014 to March 2015, the combined encounter rates of dolphins from NEL, NWL, WL and SWL was 5.5, which was the lowest among all monitoring periods since 2002 (the previous low was 6.3 in 2009-10; Figure 15). In fact, there has been a steady decline of dolphin encounter rates in the past four monitoring periods. Among the four survey areas around Lantau, the encounter rate was the highest in WL (18.4), which was 3-5 times higher than in SWL and NWL. The encounter rate in NEL was only 0.1 (two sightings out of 1,816 km of survey effort), which was a tiny fraction of all other survey areas. It should be noted that for the second consecutive monitoring periods, dolphin encounter rate in SWL (5.7) was higher than the one in NWL (3.7) in 2014-15.

Temporal trend in annual encounter rate

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 rate among the four survey areas of NEL, NWL, WL and SWL reached the lowest in 2014 since 2002, but it was fairly similar to the ones in 2009, 2010 and 2012 (Figure 16).

In North Lantau region (i.e. NEL and NWL combined), there was a marked decline in dolphin encounter rate since 2011 to an exceptionally low level in 2014 (Figure 16). The 2014 figure was nearly half of the one in previous year, signaling a greatly diminished usage of dolphins in North Lantau region in 2014 (Figure 16). In contrast, the combined dolphin encounter rate in WL/SWL region remained at a higher level in 2014 (similar to the one in 2013), after a noticeable decline from the highest in 2003 to the lowest in 2011. Potential range shift of individuals form the northern social cluster to the WL/SWL region would be further examined in Section 5.8.3 to investigate the reason behind the opposite trend of dolphin occurrence in 2013 and 2014 among the two main regions of dolphin occurrence in Hong Kong.

Temporal change in encounter rate in relation to HZMB construction

In the past monitoring period of 2013-14, the examination of temporal changes in quarterly encounter rates of dolphins in NEL and NWL in the past few years revealed that the noticeable drops in NEL coincided with the commencement of reclamation works of HKBCF and HKLR in association with HZMB construction commenced in 2012 (Hung 2014). For the present report, such temporal trends in each quarter of the four-year period of 2011-14 were again examined independently.

In NEL, after experiencing noticeable drops in dolphin encounter rates in all four quarters between 2012 and 2013, it further dropped to a very low level in all four quarters in 2014 (Figure 17). In fact, the dolphin encounter rates of the first three quarters of 2014 were only 0.2 sightings per 100 km of survey effort respectively (only one sighting in 500+ km of survey effort among each quarter), and such rate dropped to zero during the fourth quarter when no dolphin was sighted at all during 523 km of survey effort (Figure 17). On the other hand, steady decline in dolphin encounter rates also occurred during the second and fourth quarters in NWL in the past four years, while there was also a marked decline between 2013 and 2014 in the first quarter and between 2012 and 2013/14 in the third quarter (Figure 17). It appeared that the declines in quarterly dolphin occurrence were not limited to NEL, but have been extended to NWL waters as well. In fact, the entire North Lantau region (NEL and NWL combined) showed consistent declines in dolphin encounter rates throughout all four quarters in the past four years (Figure 17).

It should be noted that in NEL region, the HKBCF and HKLR03 reclamation works commenced in the second and fourth quarters of 2012 respectively, while the reclamation works of TMCLKL northern landfall and bored piling works of TMCLKL southern viaduct commenced in the fourth quarter of 2013 and first quarter

of 2014 respectively. The commencement of these construction works all coincided with a further drop in dolphin encounter rates in the respective quarter in NEL waters (Figure 17). The commencement of HKLR09 piling works at the juncture of NWL and WL survey areas in the second quarter of 2013 also corresponded to a decline in dolphin encounter rate in NWL during the same period (Figure 17). It is uncertain whether the impact of a single project commencement or the cumulative impacts of several concurrent projects have resulted in continuous drop in dolphin encounter rates. Nevertheless, it is evident that the HZMB-related construction works have played a pivotal role in marked decline in dolphin usage of North Lantau region in recent years, which included the near abandonment of their important habitat around the Brothers Islands. During the first two years of HZMB construction, several studies have been conducted by HKCRP through the Environmental Teams and project contractors for the Highways Department, specifically on the potential impacts of bored piling activities on Chinese White Dolphins as part of the EM&A requirements. As these studies would shed light on the impacts of construction activities associated with HZMB works, some of the results of these unpublished reports are summarized here as reference.

For the HKLR section between HKSAR boundary and airport channel, two studies were conducted on dolphin acoustic behaviour as well as overall behaviour and movement through theodolite tracking at the juncture of NWL and WL survey areas. From the acoustic monitoring study, the calibrated hydrophone results revealed a significantly lower sighting rate during construction period (March-April, and July 2013) than in the pre-construction period (January to February 2013). Moreover, the daily whistling rate of dolphins was significantly lower during construction phase, while the daily clicking rate of dolphins was also significantly lower at the beginning of construction phase (March-April 2013) but not in July 2013. The lower clicking and whistling rates of dolphins could be indicative of a stress response to construction activities. But the lower clicking rate was probably only a short-term response and the dolphins may later become habituated by returning acoustic activity levels of click production, while the whistling rate could be a more sustained shift in behavioural patterns by spending less time socializing in favour of more foraging after habituation occurred. A significant decrease in both dolphin whistling and clicking rates was also observed during construction in the afternoon (between 13:00-14:59), when there was also a sharp increase in ambient noise levels recorded by a PAM (i.e. Ecological Acoustic Recorder) nearby. This acoustic behavioural change was likely a response to noise level increase, attributed by anthropogenic disturbance in relation to the bridge construction. As part of the same

study, a PAM (Ecological Acoustic Recorder) was deployed near the construction site and at a control site at Fan Lau, which also recorded lower occurrence of recordings with dolphin clicks and whistles during construction phase at both sites, implying the likely effects of strong behavioural response to construction activities could reach as far as to Fan Lau. There was also significant increase in ambient noise levels measured by PAM at both sites during construction phase, which was also likely attributed by the construction noise associated with HZMB works.

As another part of the bored piling monitoring programme on HKLR, the shore-based theodolite tracking was conducted from Sham Wat to examine dolphin behaviour and movement in response to construction activities of HKLR09. The study revealed some mild effects during construction on dolphin behaviour and movement, as dolphins swam slower, made more turns and breathed more frequently. These are the same effects observed when the total number and variety of vessels encountered during a dolphin group increase, suggesting that construction activity may elicit the same response as total vessel presence. It is also possible that a group of construction-related vessels further than 500 metres away creates sufficient background noise to elicit the same response as individual vessels sequentially approaching the dolphin within 500 metres. Moreover, dolphin spent a significantly greater proportion of time feeding and significantly lesser proportion of time resting when construction activity was occurring. The results implied that construction activity may affect dolphins to spend more time searching for food, as such disturbance may reduce their ability to locate their prey.

Another bored piling monitoring programme conducted for the southern connection viaduct section of TMCLKL in NEL waters revealed that there was an 88% increase in vessel traffic during construction phase (5,725 vessels in 30 days from September- October 2013) when compared to baseline phase (3,053 vessels in 30 days from March-April 2014), mostly attributable to construction traffic (such traffic also involved work boats from HKBCF and HKLR03 projects). It was expected that the presence of additional vessel traffic would affect dolphin movement and behaviour as in HKLR09 project as described above. Moreover, the noise measurements before and during bored piling works of TMCLKL revealed that the average bandlevels in the general area of NEL were ~5-6 dB greater than those measured during baseline phase. Such increase was likely attributable to increase in vessel traffic that was mostly construction-related. Moreover, in the vicinity of the bored piling site of TMCLKL, mean bandlevels of recordings measured concurrently with construction-related activities was 11dB higher in construction phase than in

baseline phase. Such increase was likely attributed to both bored piling construction noise as well as transient vessel noise (e.g. working boats involved in bored piling).

From the supplementary information of bored piling monitoring programme of HKLR09 and TMCLKL, it was noted that there has been elevated noise levels in the underwater environment in relation to construction works, and dolphin behaviours and movements have also shown to be affected as a result. This provided further proof that the decline in dolphin encounter rate in North Lantau waters was at least partly related to HZMB construction works, and such decline has worsened progressively in 2013 and 2014. It should be noted that under the Event and Action Plans for HZMB-associated projects, 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 quarterly periods. In fact, both Action and Limit Levels have been triggered repeatedly under these monitoring works since the Event and Action Plan was implemented. In light of the dramatic decline of dolphin usage in NEL and NWL since the commencement of HZMB construction works, follow-up actions should be taken urgently to reverse such worrisome trend, and to ensure the integrity of NEL waters as one of the major dolphin habitats in Hong Kong.

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 much lower in Beaufort 3-5 conditions (1.4 sightings per 100 km of survey effort) than in Beaufort 0-2 conditions (4.2). In 2014-15, the combined encounter rate of SWL, SEL, LM and PT was 4.2 porpoise sightings per 100 km of survey effort, which was similar to the ones in previous monitoring periods. Among the five survey areas, porpoise encounter rate was much higher in SEL (8.7). On the contrary, the ones in SWL (2.6), LM (2.9), PT (2.2) and PT (3.3) were all lower than the overall encounter rate.

The temporal trend of annual porpoise encounter rates indicated that porpoise usage of Hong Kong waters fluctuated across different years since 2002, but was relatively stable in the past three years of 2012-14 (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). 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 collectively for examination of such temporal trend in the past decade. In 2014, porpoise usage in the southern waters of Hong Kong was similar to the ones in 2012 and 2013, and the porpoise encounter rates for this three-year period were at relatively high level since 2002, with the exception of 2007 when there was an unusually high porpoise encounter rate (Figure 18b).

Such annual trend on porpoise usage, especially in southern waters of Hong Kong, should be continuously monitored, as several pending 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) as well as the on-going threat of high-speed ferry traffic may affect the porpoise usage in these waters.

5.4. Density and Abundance

5.4.1. Estimates of dolphin density and abundance in 2014

The density and abundance of Chinese White Dolphins were estimated in NEL, NWL and WL survey areas using the line-transect analysis method, following similar approach as in previous years of dolphin monitoring in Hong Kong (e.g. Hung 2013, 2014). The annual estimates in 2014 can be used to assess the long-term temporal trend in dolphin occurrence in Hong Kong since 2003. Only effort and sighting data collected under conditions of Beaufort 0-3 were used in the analysis, which included 6,127.7 km of survey effort and 314 dolphin groups for the density and abundance estimation in 2014.

Among the three survey areas, WL recorded the highest dolphin densities in 2014, with 130.9 individuals/100 km^2. This was the highest estimate since 2010, but was still considerably lower than the ones in the earlier years. On the contrary, in 2014, both NWL and NEL recorded the lowest estimates of dolphin densities since 2001, with only 27.2 and 1.0 individuals/100 km^2 respectively. These estimates were only a small fraction of the dolphin densities estimated in these two areas in previous years.

In 2014, the abundance estimates of Chinese White Dolphins were 36, 24 and 1 dolphins respectively in WL, NWL and NEL survey areas, with a combined estimate of 61 dolphins from the three areas (Figure 20). The 2014 estimate was similar to both 2012 (61 dolphins) and 2013 (62 dolphins) estimates. It should be noted that even though the coefficient of variations (CVs) remained fairly low in WL (12%) and NWL (21%), it was exceptionally high in NEL (82%), likely due to the very small

size in number of dolphin sightings (three only in 2014) and their rare occurrence in this area. Nevertheless, the 95% confidence interval for the NEL estimate was 0-3 dolphins and the combined estimate would not be affected much even if the upper estimate of 3 dolphins in NEL was adopted.

5.4.2. Temporal trend in dolphin abundance

Temporal trends of annual dolphin abundance in NWL and NEL (2001-14) as well as WL (2003-14) were further examined for each survey area and collectively, where consistent amount of survey effort (at least 500 km of annual survey effort) has been conducted in these three areas of major dolphin occurrence. In WL, individual abundance has steadily decreased from 54 dolphins in 2007 to only 17 dolphins in 2012 (Figure 21). Since then the abundance estimate has rebounded to 23 dolphins in 2013 and 36 dolphins in 2014, with the latter being the highest estimate since 2010 (Figure 21). However, the 2014 estimate was still considerably lower than the abundance estimates during the earlier years of 2003-09.

On the contrary, dolphin abundance showed noticeable declining trends in both NWL and NEL (Figure 21). In NWL, dolphin abundance steadily dropped from the highest in 2003 (84 dolphins) to the lowest in 2014 (24 dolphins), with a 71% decline in 12 years. Such decline has intensified in 2013 and 2014, dropping form 40 dolphins in 2012 to 24 dolphins in 2014, with a 40% decline within two years (Figure 21). In NEL, the decline was even more alarming, dropping from the highest in 2001 (20 dolphins) to the lowest in 2014 (one dolphin). The most noticeable decline occurred between 2011 and 2014, with a 91% drop in just three years (Figure 21). When combining NEL and NWL estimates to examine the trend in dolphin abundance for the entire North Lantau region, it has decreased from an estimate of 102 dolphins in 2003 to only 25 dolphins in 2014, with a 75% drop during 2003-14, or 50% drop during 2011-14.

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 (2003-14): the test statistic for the hypotheses was -4.5009 whose *p*-value was 0.0006 <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.

- NWL (2001-14): the test statistic for the hypotheses was -8.7639 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.

- NEL (2001-14): the test statistic for they hypotheses was -5.5402 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 NEL was also concluded to possess a significant downward sloping trend.

- Combined estimates from WL, NWL and NEL (2003-14): the test statistic for the hypotheses was -8.2350 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.

As there has been a resurgence of dolphin occurrence in SWL waters in recent years coincided with the dramatic decline in dolphin occurrence in North Lantau waters during the same period (Section 5.3.1), an attempt was also made to estimate dolphin abundance in SWL to examine the associated temporal trend for the first time. It should be noted that the reason why annual abundance of SWL has not been estimated before was mainly due to the inconsistent amount of survey effort allocated to this area in the earlier years. The low number of dolphin sightings made in each year in SWL could also affect the accuracy of annual abundance estimates using the line-transect analysis. Therefore, the annual estimates in SWL were only deduced for the past five years (2010-14) when consistent survey effort (500+ km of survey effort each year) was collected annually. To examine the temporal trend for a longer study period including the earlier years, biennial estimates were deduced instead for 2002-2013 to examine the overall temporal trend in dolphin abundance in SWL in the past decade.

The temporal trend in biennial abundance estimates showed a marked decline from 30 dolphins in 2002/03 to only six dolphins in 2006/07 (Figure 22a). Since then, the dolphin numbers have rebound slightly, and become stabilized at around 11-12 dolphins for the following biennial periods of 2008/09, 2010/11 and 2012/13 (Figure 22a). The CVs of the six biennial periods were in the range of 17-45% with

considerable effort per period, and therefore the biennial abundance estimates and the associated trend should be quite reliable. For the annual abundance estimates during 2010-14, the numbers fluctuated during the first four years, but have significantly increased to 26 dolphins in 2014 (Figure 22b). Notably, the CVs were fairly high in 2010 (67%) and 2012 (54%), while the estimates should be more reliable for the years of 2011 (CV=40%), 2013 (29%) and 2014 (28%). If the annual dolphin estimates in SWL were added onto the combined annual estimates in NEL, NWL and WL, the temporal trend indicated a decline of dolphin numbers in Hong Kong waters from 88 dolphins in 2011 to only 73 dolphins in 2013, with a rebound to 87 dolphins in 2014.

In summary, when the abundance estimates of SWL were also considered for the overall number of dolphins occurred in western waters of Hong Kong, there was also a marked decline in abundance to the lowest point in 2013, but the abundance have rebounded in 2014 with the increased number of dolphins in WL and SWL despite the exceptionally low numbers in NWL and NEL.

Mitigation for decline in dolphin abundance in North Lantau

The declining trend in NWL and disappearance of dolphins from NEL are particularly worrisome, as the North Lantau region has long been the prime habitat for Chinese White Dolphins in Hong Kong until recent years (Hung 2008, 2012). As discussed in previous and present reports, such decline was linked to the increased amount of high-speed ferry traffic from the Sky Pier since 2003 (Hung 2013, 2014), and then further attributed by the on-going HZMB-related construction works since 2012 (Hung 2013, 2014). The impacts of HZMB-related construction works was discussed in Section 5.3.1 in details. Besides previous information on impacts of high-speed ferries on the local dolphin population (Hung 2012, 2013; Sims et al. 2012a; Marcotte et al. 2014), a recent EIA study of the third runway system expansion further contributed to our knowledge on the negative impacts of high-speed ferries in general, and specifically on the ferry traffic originated from the Sky Pier (AAHK 2014).

From their shored-based survey and boat survey data, the analyzed results of the third runway EIA study revealed that dolphins avoided the areas with lowered occurrence where high-speed ferry traffic to the north of airport was high (AAHK 2014). Moreover, the theodolite tracking study showed that dolphins swam faster, changed direction more and move in a less linear fashion when vessels were present, and such responses were similar to other studies on the disturbance of high-speed vessels (Hung 2013; Piwetz et al. 2012). Several Ecological Acoustic Recorders

(EARs) deployed for the study also provided further information on the noise of high-speed ferries leaving from Sky Pier that at an average distance of 500 m from the EAR, sound pressure levels within the frequency of dolphin whistle communication (4-8 kHz octave band) were about 97 dB at speeds 6-8 knots, 99 dB at speed 11-15 and 16-20 knots, 100 dB at speeds of 21-25 knots and 103 dB at speeds of 26-30 knots (AAHK 2014). This was a 4-fold increase in loudness from less than 10 knots to a 26-30 knot vessel speed at about 500 m from the vessel, and the noise levels would be much higher at closer distances. As the ferry traffic volume from the Sky Pier continues to increase and maintain at a high level, such vessel activities would seriously impact the dolphins, and affect their movements between NEL and NWL survey areas, since the area to the north of the airport was confirmed as an important traveling corridor in AAHK study (AAHK 2014) as well as in previous studies (e.g. Hung 2014).

Certainly there is an urgent need to safeguard the dolphin habitat throughout the North Lantau region as a whole, and such responsibility falls on the project proponent of HZMB (i.e. Highways Department), the Airport Authority and the Marine Department (to control high-speed vessel traffic), and the Hong Kong Government as a whole. It is critical that the Administration should give a high priority in ensuring 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. The presumption against reclamation could only be relaxed when the declining trend of dolphin usage in North Lantau waters 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.

In addition, the high-speed ferry traffic in North Lantau should be properly managed to reduce the continuous acoustic disturbance to the dolphins as well as the risk of vessel collision (Marcotte et al. 2015). As suggested in previous monitoring reports, the high-speed ferry traffic should be re-aligned and diverted away from important dolphin habitats and traveling corridors (Hung 2012, 2014; Marcotte et al. 2015). Since there are now solid proofs on the serious impacts of high-speed ferry traffic originated from the Sky Pier by their own study (see AAHK 2014), the Airport Authority should implement some immediate measures regardless of the expansion of

third runway system, and such measures should include reducing the marine traffic volume in the middle of North Lantau region and imposing a speed limit within the Sky Pier vessel traffic route that connects to Urmston Road (see Hung 2014; Marcotte et al. 2015). This would alleviate the restriction on dolphin movements between NWL and NEL waters through the traveling corridors to the north of the airport, and ensure their continuous usage of the soon-to-be established Brothers Islands Marine Park.

As importantly, additional protected areas should be established in the dolphins' priority habitats (see Hung 2014) as soon as possible. The Brothers Islands Marine Park is scheduled to be established in 2016, while the Administration is also committed to establish the Southwest Lantau Marine Park and Soko Islands Marine Park by 2017. These initiatives would certainly provide critical protective measures in some important habitats of local dolphins. However, these proposed areas still have not covered most important and critical habitats of dolphins according to the habitat index (Hung 2014), and should be further expanded progressively to offer better protection to the local dolphins 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 2014, which was also compared to the annual patterns in the past three years.

In 2014, the important habitats of Chinese White Dolphins in WL and SWL waters that recorded high dolphin densities were identified near Tai O Peninsula, Kai Kung Shan, Peaked Hill, around Fan Lau and Kau Ling Chung (Figure 23). In North Lantau waters, the high dolphin density grids were only concentrated around Lung Kwu Chau, while the rest of the region recorded low to very low densities of dolphins (Figure 23). Notably, only three grids in NEL recorded dolphin occurrence with very low density, despite a considerable amount of survey effort being conducted there in 2014. Dolphin densities were also high among some grids in SWL (e.g. around Shui Hau Peninsula) as well as a few grids at the mouth of Deep Bay (Figure 23), but those results should be treated with some cautions as the grids with high dolphin densities could be potentially biased with relatively lower amount of survey effort collected within the one-year study period.

Temporal changes in dolphin habitat use patterns (2011-14)

A comparison was made among the habitat use patterns in the past four years to examine whether there was any recent temporal change in densities at various important dolphin habitats (Figure 24). Dolphin habitat use patterns in WL waters were similar across the four years, although their densities were generally lower among some WL grids in 2012 while more WL grids recorded very high densities in 2014 (Figure 24). It was also noted that the usage of SWL waters have greatly increased in 2014 when compared to earlier years, with many grids recorded moderate to high densities, especially around the Soko Islands (Figure 24).

In NWL, the waters around Lung Kwu Chau were consistently used by dolphins to a high extent throughout the four-year period, but dolphin densities were declining progressively for the rest of this area, especially in the waters between Pillar Point and the airport platform (Figure 24). In NEL waters, there was a dramatic decline in dolphin densities during the four-year period, from high to very high usage around the Brothers Islands and Sham Shui Kok in 2011, to very rare usage in the same area in 2014 (Figure 24). In fact, only three grids recorded very low densities in NEL during 2014, while there were 33 and 25 grids that recorded dolphin occurrence in NEL during 2011 and 2012 respectively. This general area has been identified as important dolphin habitat in the past (Hung 2008, 2014), and since the construction of HZMB-related projects commenced in mid-2012, dolphin usage has diminished dramatically to an exceptionally low level in 2014.

Temporal changes in habitat use patterns at six key habitats (2004-14)

The temporal trends in dolphin usage at six key habitats were also examined between 2004-14, which included an 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 the Soko Islands, and two “dolphin hot spots” (Tai O and Black Point) where they regularly occurred in the past decade (Figure 25). 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 11-year study period of 2004-14 for examination of their temporal trends.

Among the existing marine park and three proposed marine parks, the Southwest Lantau Marine Park (12 grids) recorded the highest level of dolphin usage during the 11-year period (Figure 26). After an apparent decline in dolphin usage from 2004-2009, the DPSE values rose back to a higher level there in recent years, with a

noticeable increase between 2012 and 2014. As 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 26). But since then, there was another noticeable increasing trend from 2010 to 2013 before another drop in 2014. 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).

Within the proposed Brothers Islands Marie Park (12 grids), there was a consistent declining trend from the highest in 2004 to the relatively low level in 2010, which coincided well with the temporal trend within the Sha Chau and Lung Kwu Chau Marine Park during the same period (Figure 26). After a significant rebound to a higher level in 2011, dolphin usage at the proposed Brothers Island Marine Park plummeted to a very low level in 2014 (Figure 26). In fact, dolphin usage was the lowest in this proposed marine park among all six key dolphin habitats in 2014. As this area will soon 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, and any protective measure should be implemented as soon as possible to reverse the alarming trend in dolphin usage.

Throughout the eleven-year period, dolphin densities at the proposed Soko Islands Marine Park (20 grids) remained at a low level with no consistent trend. However, after experienced the exceptionally low densities in 2012 and 2013, dolphin usage was exceptionally high in this area in 2014 (Figure 26). That was partly due to a large group of 25 dolphins being sighted to the west of Siu A Chau in 2014 (see Section 5.6.1). Both dolphin and porpoise usage should be continuously monitored around the Soko Islands, as a proposed marine park is aimed to be established in 2017 in this area with regular occurrence of 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 26). 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, before rising to a relatively higher level in 2014

(Figure 26). The diminished usage of dolphins in this important habitat in recent years could be related to the dolphin-watching activities originated from Tai O fishing village as well as the nearby HZMB construction in both Hong Kong and Guangdong waters. On the other hand, dolphin usage at Black Point (four grids) has greatly fluctuated with no apparent trend (Figure 26). As this area is situated at the border of a proposed large-scale reclamation site at Lung Kwu Tan, special attention should be paid on dolphin occurrence in this general area.

5.5.2. Habitat use patterns of finless porpoises

The habitat use patterns of finless porpoises were examined by calculating SPSE and DPSE values in grids across the five areas where they regularly occurred (i.e. SWL, SEL, LM, PT and NP) for the entire year of 2014 as well as the 10-year period of 2005-14. The spatial pattern of porpoise habitat use revealed that their most heavily utilized habitats in 2014 included the waters to the south of Tai A Chau, between Soko Islands and Shek Kwu Chau, and to the south of Cheung Chau (Figure 27). A number of grids in LM, PT and SK survey areas also recorded high to very high porpoise densities (Figure 27), but the results there could be seriously biased by the relatively low amount of survey effort conducted during the one-year period. Therefore, survey effort and porpoise data collected from the monitoring periods in the past decade should be pooled and analyzed for a longer period with sufficient amount of data, in order to present a better picture of porpoise habitat use in eastern waters of Hong Kong.

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 2005-14 with a much 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 further 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 respectively.

For the examination of porpoise habitat use patterns during the dry season (winter and spring months) in 2005-14, in which the majority of survey effort was allocated to SWL, SEL and LM survey areas, the grids with high porpoise densities were mostly located in South Lantau waters (Figure 28). In particular, important porpoise habitats during the dry season were located to the south of Tai A Chau, southwest of Shek Kwu Chau, south of Cheung Chau, and the waters between Shek

Kwu Chau and the Soko Islands (Figure 28). Moreover, 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 28). 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 also generally avoided the northern end of Lamma Island, and the offshore area at the juncture of SEL and LM survey areas (Figure 28).

During the wet season (summer and autumn months), more survey effort were allocated to the eastern survey areas (i.e. PT and NP), while the survey effort remained the same in SWL and SEL year-round. Relatively fewer surveys were conducted in LM waters during the wet seasons of 2005-14. In summer and autumn months, porpoise densities were higher around the Po Toi Islands, and at the juncture of PT and NP survey areas (Figure 29). 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 (less than 10 units of survey effort in total per grid). 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 29), indicating their infrequent visits across the southern territorial boundary of Hong Kong during the wet seasons.

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 27 animals, with an overall mean of 4.1 ± 3.43. Among the six areas where dolphins occurred in 2014-15, the mean group size was the lowest in SEL (1.0) and NEL (2.7) but the highest in WL (4.4). In fact, 28 out of the 32 large dolphin groups (i.e. with 10+ dolphins per group) were found in WL. Among the four seasons, mean group sizes were similar across spring, summer and autumn months with a range of 4.1-4.3 dolphins per group, but the one during winter months (3.8) was slightly lower than the overall mean.

The majority of dolphin groups sighted during the 2014-15 monitoring period were relatively small, with 39.4% of the groups composed of 1-2 animals, and 68.1% of the groups with fewer than five animals (Figure 30). Only 23 out of the 461

groups contained more than ten animals per group. In 2014, the smaller groups were found throughout the distribution range of dolphins, but in particular most dolphin groups in the peripheral distribution range in NEL and SEL were dominated by these smaller groups (Figure 31). On the other hand, the larger groups mainly concentrated around Lung Kwu Chau and along the coastal waters of WL (Figure 31). Three particularly large dolphin groups were sighted near Kai Kung Shan with 21 and 27 dolphins each, and another one near Siu A Chau of Soko Islands with 25 dolphins. These large aggregations could possibly be related to good feeding opportunities in the respective areas.

Long-term trend in annual mean dolphin group sizes since 2002 revealed that the one in 2014 (4.2 dolphins per group) was the second highest during the 13-year period, and the highest in the past decade (Figure 32). Such significant change in group dynamics in 2014 could possibly be related to different foraging strategies adopted by the dolphins in midst of disturbance as discussed in previous sections, or it could also be a response to changes in prey distribution and overall prey resources in western waters of Hong Kong, especially after the trawl ban has been implemented for two full years. Such temporal trend in dolphin group size should therefore be continuously monitored in the future.

In 2014-15, porpoise group sizes ranged from singles to 18 animals, with an overall mean of 2.7 ± 2.57. This mean group size was similar to the ones in previous monitoring periods, but was slightly higher than the one in 2013-14. Most of the porpoise groups sighted in 2014-15 were very small, with 65.1% of porpoises groups composed of 1-2 animals, and all except 13 groups had less than five animals per group (Figure 33). The mean group sizes in SWL (3.5) and LM (3.1) were relatively higher than the overall mean, while the ones in PT (1.9) and SK (1.3) were lower than the overall mean. Distinct seasonal variations in mean group sizes were found, with lower mean group size in summer months but higher means in spring and autumn months.

5.6.2. Activities of dolphins

A total of 53 and 20 groups of dolphins were observed to be engaged in feeding and socializing activities during 2014-15 monitoring period, comprising of 12.0% and 4.5% of the total dolphin groups respectively. In addition, there were ten other groups engaged in traveling and three groups engaged in resting or milling activities.

Temporal trend in annual percentages of feeding and socializing activities

revealed that both activities in 2014 have slightly rebound from the previous lows in 2013, but still remained at a relatively low level when compared to the rest of the 2002-14 study period (Figure 34). In 2014, most of the feeding activities occurred along the west coast of Lantau, with higher concentrations near Tai O Peninsula, Kai Kung Shan and Fan Lau (Figure 35). Some feeding activities also occurred around Lung Kwu Chau in NWL as well as between Shui Hau Peninsula and Siu A Chau in SWL. On the other hand, dolphin sightings associated with socializing activities were more randomly distributed, with slightly higher concentration near Tai O Peninsula and Kai Kung Shan in WL and to the north of Lung Kwu Chau in NWL (Figure 35). Dolphin groups engaged in traveling activities were mostly found around Lung Kwu Chau as well as between Tai O Peninsula and Kai Kung Shan, while the few engaged in resting and milling activities could be found between Peaked Hill and Fan Lau (Figure 35).

5.6.3. Dolphin associations with fishing boats

Among the 461 groups of dolphins sighted in 2014-15, only 14 were associated with operating purse-seiners (the only type of fishing boat with dolphin associations), or 3.0% of all dolphin groups. The percentage in 2014 was the second lowest since 1996, and the decline in fishing boat association in recent years was partly related to the fishing ban implemented in December 2012. Although illegal trawling activities were often observed near the western and southern borders of Hong Kong, dolphins rarely associated with them but mostly with purse-seiners. It is possible that the implementation of trawl ban has increased the fishery resources and resulted in less reliance of fishing boat associations by the dolphins, while the operation of purse-seiners would concentrate the fisheries resources better for dolphins to find more benefits in association with them.

Spatial distribution of dolphin groups associated with different types of fishing boats in 2014 revealed that these associations occurred predominantly along the west coast of Lantau, especially the ones with purse-seiners (Figure 36). Association with a single trawler and a hang trawler also occurred near Black Point and to the west of Sha Chau in NWL, but such associations have been extremely rare in 2014. A few other associations occurred along the coast in SWL and SEL as well (Figure 36).

5.7. Calf occurrence

Of the 1,897 dolphins sighted during the study period in 2014-15, 53.1% of them were categorized into six age classes. Similar to previous monitoring periods, the spotted juveniles (21.5%) and spotted adults (12.3%) dominated the proportion of

dolphins being identified with their age classes. Moreover, a total of 14 unspotted calves (UC) and 37 unspotted juveniles (UJ) were sighted, with these young calves comprised of only 2.8% of the total.

Temporal trend in annual occurrence of young calves revealed that the percentage of UJs in 2014 was the lowest during the 13-year period of 2002-14, while the percentage of UCs in 2014 was also relatively low among recent years (Figure 37). As mother-calf pairs are more susceptible to anthropogenic disturbances, the low percentages of young calves in 2014 raised grave concerns on their survival as well as the suitability of Hong Kong waters for nursing activities for mother-calf pairs, in light of the impacts of HZMB construction works and high level of vessel activities within their habitats.

Distribution of young calves in 2014 was similar to the overall dolphin distribution. They mainly occurred near Tai O Peninsula, Kai Kung Shan and around Lung Kwu Chau, but were mostly absent in NEL, South Lantau waters and Deep Bay (Figure 38). Notably, all except one UCs occur in West Lantau waters, showing the importance of this area for nursing activities of the newborns by their mothers.

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 139 individuals that occurred in 2014 through photo-identification works were deduced using the fixed kernel method, and their ranging patterns are shown in Appendix VII.

In addition, 161 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 (93.2%), NWL (79.5%) and SWL (50.9%), and to a smaller extent in NEL (35.4%) and DB (18.0%). On the contrary, only a handful of individual dolphins have been sighted in EL or SEL survey areas as part of their ranges in the past. Moreover, 44.1% of these 161 individuals occupied range that spanned from Hong Kong across the border to Guangdong waters, indicating the frequent cross-boundary movements of individual dolphins identified in Hong Kong waters.

The residency patterns of 150 individuals were assessed by examining their annual and monthly occurrences. The other eleven individuals were identified and

re-sighted only in the past few years, and therefore their annual occurrence cannot be properly and reliably assessed. Almost all 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. However, the proportion of visitors that utilized Hong Kong waters could be seriously 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 required for this analysis. Based on their monthly occurrences, 41.6% of individuals only occurred in Hong Kong during certain months of the year, while the rest occurred here year-round (Table 1). Overall, 83 and 66 individuals were identified as year-round and seasonal residents respectively.

In addition to residency pattern, the 161 individuals were classified into the two social clusters that occurred regularly in Hong Kong (see Dungan et al. 2012), based on their overall range use at 95% UD level as well as core area use at 50% UD and 25% UD levels. Results indicated that 62 individuals (38.5%) and 87 individuals (54.0%) belonged to the northern and western social clusters respectively, while another eleven individuals spanned their range use evenly across North and West Lantau waters with frequent occurrence in both waters (Table 1).

In examination of the range use of the 161 individual dolphins, their major core areas of activities were located around the Brothers Islands in NEL, Lung Kwu Chau in NWL and along the west coast of Lantau, and the latter can be further subdivided into Tai O, Peaked Hill (including Kai Kung Shan) and Fan Lau (Table 1). In summary, 72 and 62 individuals occupied Lung Kwu Chau as their 50% and 25% UD core areas respectively, with 51 of these individuals belonged to the northern social cluster. Moreover, 22 and 16 individuals occupied the Brothers Islands as their 50% and 25% UD core areas respectively, and all of them were members of the northern social cluster. In comparison, 100 and 95 individuals occupied the west coast of Lantau as their 50% and 25% UD core areas respectively, with 87% of them belonged to the southern social clusters. Among the 95 individuals that occupied WL waters as their 25% UD core areas, 43%, 52% and 41% of them primarily utilized Tai O, Peaked Hill and Fan Lau respectively (Table 1). Notably, only seventeen of the 161 individuals had their core areas in both Lung Kwu Chau and WL waters, while only one individual (NL260) utilized its core area use across the Brothers Islands, Lung Kwu Chau and WL waters.

5.8.2. Individual movement pattern

Combining all photo-identification data collected through the present monitoring

study and other studies, movement patterns of individual dolphins within Hong Kong territorial waters in 2014-15 were broadly examined. During the 12-month period, 227 individuals were re-sighted a total of 1,170 times, with 191 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 121 individuals moved extensively across different survey areas around Lantau Island in 2014-15. For example, 72 individuals were re-sighted in both SWL and WL survey areas, while 62 individuals occurred across NWL and WL survey areas. Fourteen individuals occurred in NWL, WL and SWL survey areas, while another five individuals were re-sighted across NEL, NWL and WL survey areas, covering extensive ranges during the 12-month monitoring period. On the other hand, only six individuals were re-sighted both in NWL and NEL survey areas, coincided with the extremely low occurrence of dolphins in NEL waters during the monitoring period.

It should also be noted that despite a large sample size of photo-identification data collected in 2014-15, a significant portion of dolphins were only sighted repeatedly within just a single survey area, but did not range into neighbouring areas. For example, 49 individuals occurred exclusively in WL survey area, while another 13 individuals were only re-sighted in NWL waters during the 12-month study period. Undoubtedly, some of these animals likely 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 of movements as a result of human activities (e.g. vessel traffic) or infrastructure project (e.g. reclamation, bridge construction).

For the first time, an attempt to examine temporal trend in individual movement patterns across different survey areas was made to provide insight on whether their intensity of movements has increased or declined due to anthropogenic factors. In the past, dolphins moved regularly and frequently between NEL and NWL by utilizing the Sha Chau and Lung Kwu Chau Marine Park as well as the Brothers Islands as their core areas (see Hung 2008, 2012). However, such movements have greatly diminished in the past four monitoring periods, with 50 individual dolphins engaged in such movement in 2011-12 to only six dolphins in 2014-15 (Figure 39). This coincided with the dramatic decline in dolphin abundance and overall usage in North Lantau waters during the same period (see Sections 5.4.2 and 5.5.1). As such movements between the two areas was facilitated by an important traveling corridor

to the north of the airport based on results from focal follow study and theodolite tracking works (Hung 2014), these movements have likely been disrupted by the increased amount of vessel traffic originated from the Sky Pier, as well as the commencement of HKBCF reclamation works since spring 2012 with significant habitat loss and increased amount of construction boats to the northeast of the airport platform. Such situation has further worsened in 2014-15 monitoring period as shown in the very low level of movement between the two survey areas.

On the other hand, after a slight decline in movements between NWL and WL survey areas from 66 dolphins involved in 2011-12 to only 50 and 52 dolphins in 2012-13 and 2013-14 respectively, the intensity of movements between these two important areas have apparently increased in 2014-15 (Figure 39). Dolphin movements between these two areas are also facilitated by an important traveling corridor to the west of the airport and near Sham Wat based on focal follow study and shore-based theodolite tracking works (Hung 2014). There has been a concern that the north-south movement between the two areas of NWL and WL would be hampered by the HKLR09 construction works as part of the HZMB construction. In fact, dolphins have avoided the alignment in the past few years since works commenced in early 2013, and individual movements across the alignment were apparently less intense during that period. The somewhat restricted movement could be related to the increasing amount of work vessels in the areas, the acoustic disturbance from the associated bored piling works (see Section 5.3.1), and the progressively reduced spacing between bridge piers. Such potential restriction of movements should be continuously monitored through focal follows from boat or shored-based theodolite tracking at Sham Wat Station, as the unrestricted movements of individual dolphins between NWL and WL survey areas are vital to the interaction between the two social clusters of dolphins in Hong Kong (Dungan et al. 2012). Continuous monitoring on the intensity of individual movements across NWL and WL waters would shed light on whether the impacts of bridge construction in high density area of dolphins with frequent movements would result in temporary restriction or more permanent impacts by restricting movements between bridge piers.

Another notable trend is the emerging intensity of movements between WL and SWL survey areas in the past five monitoring periods (Figure 39). During the 2010-11 monitoring period, there were only 14 individual dolphins moving across these two areas. Since then, the intensity of such movements have increased significantly to the highest in 2014-15 period involving 72 dolphins (Figure 39). The frequent movements of individuals between these two areas in 2014-15

corresponded well with the significant increase in dolphin occurrence in SWL waters (see Sections 5.2.1 and 5.5.1). Notably, some individuals (e.g. NL98, NL165, NL224) from the northern social cluster were involved in movements extending to SWL waters in 2014, which could also contribute to the increase in dolphin abundance in WL and SWL waters and the decline in North Lantau waters as shown in Section 5.4.2. Such trend should be continuously monitored as it would shed light on whether the range shifts of some individuals have occurred as a response to anthropogenic impacts.

5.8.3. Temporal shift in range use of individual dolphins

As some apparent shifts in range use of individual dolphins was documented in 2013 (Hung 2014), the ranging pattern of 36 individuals (including the core area use of some individuals with adequate sample size) with past regular occurrence around the Brothers Islands were examined again to assess any further changes in their range use in 2014 as compared to the ones in 2011-12 and 2013.

For these 36 individuals that occurred regularly in both Lung Kwu Chau and the Brothers Islands in 2011-12, nine of them have completely shifted their ranges away from the Brothers Islands in 2013, and another 19 individuals only occurred around the Brothers Islands once or twice in 2013. In 2014, four of the 36 individuals have not occurred in Hong Kong waters at all, while 29 of the remaining 32 individuals have either completely shifted away form the Brothers Islands (18 individuals) or only occurred there once or twice (11 individuals) (see examples in Figure 40). It is apparent that the vast majority of individuals that used to occur around the Brothers Islands as a major part of their home ranges have shifted away from this habitat, coincided with the dramatic decline in dolphin occurrence in NEL. Notably, half of these individuals with apparent range shifts away from the Brothers Islands have also increased their range use in WL waters (see examples in Figure 40), while the rest have only occurred primarily in NWL waters, with some individuals reducing their usage of Hong Kong waters. In comparison, while 23 individuals showed apparent range shifts away from NEL waters in 2013, only six of them showed increased usage in WL during the same year. This progressive change implied both the range shifts of individuals as well as the expansion of range use to WL for some individuals have intensified in 2014.

Moreover, 18 of 36 individuals were sighted at least 10 times among the three periods of 2011-12, 2013 and 2014, and their 50% UD core areas across the three periods were also examined to determine whether any core area shift may have

occurred. The results revealed that 14 individuals had their core areas centered around the Brothers Islands in 2011-12, but 11 of them had abandoned this area as their core areas in 2013 with apparent shift in core area use. In 2014, only one individual (EL01) remained to utilize the Brothers Islands as its 50% UD core area, but this individual has also expanded its range use to utilize WL as its core area as well. In fact, none of these 14 individuals utilized WL as their core areas in 2011-12, but three of them did so in 2013, and that number increased to seven in 2014 (see examples in Figure 40). Similar to the overall range shift as discussed above, progressively more individuals have expanded or shifted their core area use to WL waters in 2014.

To further understand the correlation between the extent of range shift of individual dolphins in Hong Kong and the trends in dolphin abundance among different survey areas, the level of utilization among different areas were broadly examined for individuals that has occurred regularly in Lantau waters in the past decade. The candidates for such examination included 66 individuals that were re-sighted at least 30 times during on-effort surveys since 2003, which included 42 members from the northern social cluster and 24 members from the western social cluster. Notably, only individual re-sightings made during on-effort survey effort were included in this analysis, as such re-sightings can be further normalized by the amount of survey effort collected in the respective year and survey area, since varied amount of effort across years and survey areas could affect the frequency of individual being re-sighted through photo-identification works during on-effort surveys.

To calculate the individual re-sighting rate, the number of on-effort re-sightings of each individual was counted for each year of 2007-2014 among each of the four main survey areas (i.e. NEL, NWL, WL and SWL). Then these numbers of all 66 individuals included in the analysis were summed up for a total of re-sightings for each area per year, which were then further divided by the amount of survey effort for the corresponding area and year. The combined individual re-sighting rate, or the total number of re-sightings per 1,000 km of survey effort, can then be compared across different survey areas for each year, and across different years for the same survey area to examine any temporal changes in individual usage among different areas of Lantau waters.

For the 66 individuals, the combined individual re-sighting rate in NEL remained at a lower level of 27-40 (or 13-18% of the combined total from all four areas) in

2007-10, but such value increased markedly to 87 in 2011 (Figure 41). Since then, there was a dramatic decline in the re-sighting rate from 87 (or 26% of combined total) in 2011 to only 6 (or 2%) in 2014. For individual occurrence in NWL, there was a declining trend of individual re-sighting rate from 81 (39%) in 2007 to 50 (or 24%) in 2010 (Figure 41). Then a noticeable increase to the highest re-sighting rate of 115 (or 34%) occurred in 2011, followed by another decline to 60 (or 22%) in 2014. On the contrary, individual occurrence in WL started with a declining trend of individual re-sighting rate from 116 (or 52%) in 2008 to 91 in 2011 (or 27%). Thereafter, there was a marked increase to the highest level in 2014 (re-sighting rate of 151, or 54% of the combined total) (Figure 41). Finally, there was a steady increase in individual re-sighting rate in SWL waters, from 14 (or 6%) in 2008 to 61 (or 22%) in 2014. The margin of individual re-sighting rates in NWL: SWL also narrowed dramatically from 81:16 in 2007 to 60:61 in 2014 (Figure 41). The above trends of individual occurrence among NEL, NWL, WL and SWL were similar to the trends in dolphin abundance as examined in Section 5.4.2.

Since the primary range use of members from the northern social cluster centered around NEL and NWL, while the ones from the western social cluster center in WL and SWL waters, it would be insightful to look at the temporal trends in individual re-sighting rates among different survey areas separately for the two social clusters, with an attempt to understand the opposite trends in dolphin abundance in NEL/NWL and WL/SWL as observed in Section 5.4.2. For the 42 individuals from the northern cluster, the proportion of combined individual re-sighting rates in NWL remained relatively stable (51%-64% of the total from the four areas) in the past six years of 2009-14 (Figure 42). However, there was a gradual increase in individual sighting rate in NEL from 23% in 2007 to the 40% in 2011, followed by a rapid decline to only 6% in 2014 (Figure 42). The greatly diminished occurrence of northern cluster individuals in NEL in recent years was opposite to the trend in WL, where the proportion of individual re-sightings rates has increased evidently from 9% in 2011 and 2012 to 36% in 2014 (Figure 42). Such opposite trends implied that many individuals from the northern social cluster have diminished their usage in NEL and have started to utilize WL waters (or even SWL to a low extent) more in the past two years. This corresponded well with the results from the examination of temporal range shifts of 36 individuals as examined above, with increasing number of individuals shifting their range use away from NEL and some of them starting to utilize WL waters more. This also coincided with the decreasing trend in dolphin movements between NEL and NWL, and increasing trend in movements between NWL-WL as described in Section 5.8.2.

For the 24 individuals from the western social cluster, there were opposite trends in proportion of individual re-sightings rates in WL and SWL, with more individuals utilizing WL in earlier years (2007-09) and less in recent years (2011-14), while less individual utilizing SWL in earlier years (2007-09) and more in recent years (2011-14) (Figure 43). This reflected the increasingly higher usage of SWL by individual dolphins from the western cluster in recent years, and such trend also corresponded well with the increasing trend of dolphin movements between WL and SWL (see Section 5.8.2) as well as the increase in dolphin abundance in both WL and SWL in the past few years (see Section 5.4.2).

It should be acknowledged that the limitation of this analysis is still restricted to 66 individuals that frequently occurred in Hong Kong waters, and may not reflect fully on the overall usage of the 200+ individuals that occurred in Hong Kong annually at various degrees (in which the abundance estimates from line-transect analysis would take account for). However, this analysis would still provide some quantitative measurements on the overall level of range utilization of individual dolphins and how that would affect the temporal trends in dolphin abundance across different survey areas. It could also examine whether the range utilization would differ between the two social clusters as a result of different levels of pressure from anthropogenic disturbance that they experienced in their respective ranges.

5.9. Update on Life History Parameters of Individual Dolphins

In the past, information on life history parameters of Chinese White Dolphins in Hong Kong were mostly obtained from stranded specimens. However, these dolphin stranding events are opportunistic, and may have biases toward certain sex and age classes, or even ailing individuals. Therefore, several life history parameters of Chinese White Dolphins occurred in Hong Kong were preliminarily examined five years ago using the long-term photo-identification data, with a fairly limited sample size for various analyses (Hung 2010). In this report, another updates on their life span, female-calf association as well as calf survival are provided, which are supplemented by a wealth of photo-identification data collected since then.

5.9.1. Individual life span

The sighting history of 220 individuals from the photo-ID catalogue were examined for the present analysis, and they either have long sighting histories (more than five years) or were frequently sighted (10+ re-sightings) in Hong Kong waters since 1995. The ages of 18 individual dolphins were directly deduced from their sighting histories without the need of estimation, since they have been observed with

their mothers since their birth during the study period. On the other hand, the ages of the other 202 individuals were estimated from their sighting histories and by making some assumptions of their ages when they were first seen (see Hung 2010). The assumed minimum age of each age class is as follow: mottled or SJ (at least three years old), speckled or SS (at least eight years old), SA (at least 10 years old), and UA (at least 15 years old). These assumed minimum ages in relation to their colour pattern were based on available information on their growth curve (age/length relationship) (see Jefferson 2007; Jefferson et al. 2012) and theory of their colour pattern development established in Hung 2010. The estimated age of identified individuals were then calculated by summing up the length of sighting history (number of years between the first and last sightings of that individual) and the minimum age of the individual based on its age class when it was first seen.

For these 220 individuals, four individuals (CH34, EL01, NL06 and SL05) were estimated to be over 30 years old, while another 19 individuals were estimated to be 27-30 years old. Nearly 70% of the examined individuals were estimated to be at least 12 years old, which should all be sexually mature adults (see Jefferson 2000; Jefferson et al. 2012). Moreover, the mean estimated age of females (19.8, n=83) was very similar to the one of males (19.7, n=9).

It should be cautioned that since many young animals in the photo-ID catalogue (including all unspotted calves, unspotted juveniles and most mottled animals with no distinct features for photo-identification) are not included in the analysis, the results presented here do not reflect the age structure of all dolphins occurred in Hong Kong. Nevertheless, it is noted that many individual dolphins in the photo-ID catalogue are sexually mature (i.e. more than 12 years old) with a good proportion of them having survived well into their twenties or even thirties. These sexually mature adults are vital to the sustainability of a healthy population, and their continued survival with a relatively long life span would give the population a fighting chance against various threats faced in their habitats as described throughout the present report.

5.9.2. Female-calf association

Among the 220 individual examined, 83 were identified as females through confirmation from their calving histories (with repeated calf associations) or through biopsy results. Another 12 individuals were listed as probable females, as they were only seen with their calves in a single incident but those calves disappeared shortly after (presumably dead). In total, 49 of these females were seen with one calf before, while 30 and 7 individuals had record of two and three calves respectively in the past.

Most of these are considered residents of Hong Kong with regular occurrence and relatively long sighting history.

Notably, at least 56 of the 130 confirmed births of newborns were observed only once with their mothers before, including 13 that were probably dead shortly after birth (i.e. newborn calves disappeared quickly in subsequent sightings of their mothers within a few weeks), and another four dead ones that were supported by their mothers at the time of discovery (a type of epimeletic behaviour as detailed in Hung 2014). For the other 39 calves, it was possible that their mothers do not occur in Hong Kong waters frequently enough to be re-sighted again during the period of female-calf association, or they were also dead within the first few months after birth. The observed low survival rate of calves was further supported by the stranding data, with a high proportion of stranded animals being dead calves (Hung 2006). This is a serious concern for the continuous survival of dolphins in Hong Kong waters, in light of the worrisome declining trend in their abundance the past decade. As the pressure of anthropogenic disturbances including vessel traffic and construction activities associated with coastal development continue to mount in the foreseeable future, the survival of calves can be seriously hampered by these negative impacts, which was reflected in the low occurrence of calves in recent years as examined in Section 5.7.

For the 68 calves that were sighted repeatedly, the minimum periods of female-calf associations were estimated between their first and last re-sightings. It should be cautioned that the estimated periods of female-calf associations were likely underestimates, as some calves were already unspotted calves (i.e. older calves) when first seen, or they might still be associated with their mothers for a period of time after their last re-sightings. Such minimum periods of female-calf associations ranged from 2-107 months, with an average of 30.8 ± 23.17 months (median = 28 months). About half of the calves were associated with their mothers for fewer than 24 months, but there were also 13 calves associated with their mothers for at least four years or more. NL18 and NL202 were two notable exceptions. NL18 was first sighted with her calf in March 2000, and the calf was associated with her until January 2009, which has become a spotted juvenile at the time with its own identity as NL259. Since then, NL259 and NL18 were sighted together occasionally in the same group, until NL18 disappeared from Hong Kong waters since March 2013. On the other hand, NL202 was first sighted with her newborn in October 2006; since then the mother-calf pair has been frequently sighted together around the Lung Kwu Chau area. Such association of this mother-calf pair still persists at present (i.e. at least eight years of association), and the calf has been identified as NL286, a distinctively

recognizable individual which has suffered from an injury of net entanglement at its early age.

For the females with records of two or three births since 1996, their calving intervals between giving births were estimated. Thirty-seven calving intervals from 34 females were examined in details. It should be cautioned that the estimated calving intervals are likely overestimates, as the first calves may still be associated with their mothers after the last re-sightings, while the second calves may have already associated with the same females well before their first re-sightings made. Moreover, there were also possibilities that some females might have given another birth(s) during the calving interval but have gone unnoticed (or the calf was dead quickly as mentioned above). Nevertheless, the maximum calving intervals between births ranged from 3-120 months, with an average of 37.8 ± 27.30 (median = 28 months). For those females with short calving interval recorded (e.g. NL98, WL86, NL46), the associations of their first calves were relatively long, which may have overlapped with their subsequent pregnancy and resulted in seemingly short calving intervals. On the other hand, seven individuals recorded calving intervals of more than five years, and again they might have given another birth(s) but were not observed in between their re-sightings. Overall, most of the calving intervals were estimated to be about 2-3 years, and occasionally up to 4-6 years.

5.10. Case Study of a Seriously Injured Dolphin WL212

In mid-January 2015, a seriously injured Chinese White Dolphin was spotted off Tai O, spurring much concern of its condition in the public domain. This case study is presented here with the chronicle of events during the three weeks of monitoring at sea, including information collected during the focal follow sessions of this individual dolphin.

5.10.1. Background

The dolphin was first sighted off Tai O Peninsula in the afternoon of January 16th, by graduate students from the Cetacean Ecology Lab of the Swire Institute of Marine Science. The dolphin was reported to be seriously injured, and a team of AFCD and Ocean Park staff was dispatched to search for the dolphin in the evening, but the dolphin was not found. On the next day (January 17th), Hong Kong Dolphin Conservation Society (HKDCS) received another sighting report of this injured dolphin in the afternoon; the author (S. Hung) and his research assistant searched along the west coast of Lantau and found the dolphin near Tai O Pier at around 16:30. The dolphin was observed continuously for its injury and engaged behaviour until

sunset at around 18:00.

During the brief observation, the animal was confirmed to be seriously injured, and multiple deep lacerations were found between its tail fluke and dorsal fin. The last cut near the tail fluke appeared to be the most serious, with half of the tail being cut through. The dolphin was confirmed later in the day as WL212, an identified individual appeared in the HKCRP photo-ID catalogue before. WL212 was first identified in February 2012, and has been sighted 12 times subsequently before its injury. During 2012-14, the spotted juvenile mainly occurred along the west coast of Lantau (from airport platform in the north to Fan Lau in the south), with only one occurrence in North Lantau waters (see its ranging pattern in Appendix VII). Notably, WL212 was sighted alone four times, and with one other dolphin twice, during its brief sighting history in Hong Kong.

Despite its serious injury, WL212 was able to swim slowly on its own, with frequent surfacing near water surface followed by shallow dives. During the 80 minutes of observation on the 17th, it was also observed actively chasing and catching fishes on waters surface at times, and lifting its tail fluke up several times for deeper dives. Its body was covered with mud after such longer dives, apparently foraging on the seafloor. It should also be noted that the dolphin was situated just off Tai O harbour, and several small motorized boats were encircling the dolphin for observation, but the dolphin was able to evade those boats. The author (S. Hung) informed AFCD on its condition, and has decided to continue monitoring this dolphin with established focal follow protocol before any further plan was made by AFCD.

5.10.2. Brief chronicle of events during three weeks of at-sea observations

After the initial observation on January 17th, below is a brief chronicle of events (with some general observations) leading up to the rescue of WL212 for rehabilitation at Ocean Park on February 6th and subsequent death on the 10th:

- *January 18th* (Day 3 of discovery): WL212 was found by Hong Kong Dolphinwatch in the morning near General Rock at Tai O. AFCD marine park patrol boat was dispatched to guard the dolphin from dolphin-watching vessels, and the dolphin slowly moved toward Peaked Hill in the afternoon.

- *January 19th* (Day 4): HKDCS researchers found WL212 near Kau Ling Chung in SWL at 14:50, and the animal was swimming slowly near water surface, at times engaged in logging behaviour. The animal stayed in the same area

throughout the focal follow observation session.

- *January 20th* (Day 5): WL212 was sighed off Fan Lau and a rescue attempt was made by Ocean Park team with a modified noose on a long pole in the morning. The attempt was unsuccessful as the dolphin was able to evade the boat during close approaches. The operation was halted around noon when the animal moved to deeper water, and HKDCS researchers took over to observe the dolphin since then.

- *January 21st* (Day 6): No search was conducted by HKCRP or HKDCS, but the dolphin was reported to swim near the high-speed ferry lane in SWL.

- *January 22nd* (Day 7): HKCRP researchers found WL212 near Fan Lau at 12:54, and it was apparently moving faster and behaved closer to a normal dolphin with quick surfacings for a few times at water surface followed by longer dives. The animal eventually moved eastward, heading toward the west side of Soko Islands, and was in open water most of the time. It ended up staying in the high-speed ferry lane, and AFCD alerted the Marine Department to advise high-speed ferries keeping a distance from the dolphin.

- *January 23rd* (Day 8): HKDCS team located WL212 near Shek Pik at 14:00, and its behaviour was similar to the previous day, with fewer shallow dives and more longer dives while moving quickly across the high-speed ferry lane to the east side of Siu A Chau. The dolphin was found actively foraging with fish found in its mouth on one occasion, while its body was covered with soft mud on several occasions. Fluke-up behaviour with deeper dives was also observed several times during the observation.

- *January 24th* (Day 9): HKDCS team conducted a search of WL212 with windy condition in WL and SWL waters, but the animal was not located.

- *January 25th* (Day 10): A search was conducted by AFCD but the animal was not located.

- *January 26th* (Day 11): HKCRP researchers found WL212 near Shek Pik in the morning and observed the dolphin for more than five hours. It moved slowly westward to Kau Ling Chung with some active feeding activities near a purse-seiner, and fluked up several times for extended deep dives. It went fairly

inactive and rested on water surface for a while before becoming active once again and starting to move eastward.

- *January 27th* (Day 12): A joint-effort was conducted by HKDCS, AFCD, Ocean Park and HKU to search for WL212 with an attempt for rescue, but the dolphin was not found on the day.

- *January 28th/29th* (Day 13-14): No search was conducted due to windy condition.

- *January 30th* (Day 15): Another capture attempt by Ocean Park was made, when WL212 was first observed near the coastline at Shek Pik. During the approach, WL212 was moving actively in parallel to the coastline, and later reached the Shui Hau Peninsula near an area of multiple gill-netters with their nets set in the water. Ocean Park and AFCD purchased some fishes from the gill-net fishermen to feed WL212, with an attempt to lure it closer to the capture boat. WL212 responded by picking up some fishes immediately, and Ocean Park team used the modified noose to get close to WL212 for capture. WL212 was able to evade three attempts of capture, and the environmental condition was very calm with little current. Rescue attempt was called off around noon, and the dolphin started to swim slowly toward Shek Pik, staying closer to shore. HKCRP researchers observed the animal for a few hours while it was drifting slowly eastward with some logging behaviour.

- *January 31st/February 1st* (Day 16-17): No search was conducted due to windy condition. The dolphin was reportedly fed by fishermen, but such report was unconfirmed.

- February 2nd (Day 18): The fourth capture attempt was made by Ocean Park team on the day, with WL212 first found in the shipping channel in the morning. It was first fed with 7 kg of fishes, and an attempt was made to capture WL212 with a hoop-net but was unsuccessful. Later, WL212 was more alert to discarded fishes after the capture attempt, and stayed at a distance from the capture boat.

- February 3rd (Day 19): A search in the early afternoon was conducted by HKDCS team in West and South Lantau waters, but WL212 was not found in fairly windy condition at sea.

- February 4th (Day 20): The fifth capture attempt was conducted by Ocean Park team with a modified hoop-net, with the additional assistance of a purse-seiner hired by AFCD. WL212 was first found to the west of Soko Islands, and then moved slowly toward the southern coast of Lantau. The purse-seiner set its nets four times to try surrounding and trapping the dolphin during the course of capture attempt, but each time WL212 was able to escape from the encircling net. The capture attempt halted around 14:30.

- February 5th (Day 21): No search was conducted.

- February 6th (Day 22): The sixth and final capture attempt was conducted by Ocean Park team with the modified hoop-net. After being found very close to shore of Shek Pik in the morning, WL212 was fed with fishes stuffed with sedatives to calm the dolphin and make it less resistant to capture. After sedative was applied, WL212 slowed down its activity considerably, and was logging on the surface for extended period. The capture team attempted to scoop up the dolphin with the hoop-net, but the dolphin was still able to evade the approaching vessel. After two hours, the dolphin seemed to have resumed its normal activity and the capture operation was halted by noon. HKCRP researchers continued the focal follow observation with Ocean Park team on board. The dolphin was followed for a few more hours, and then its activity started to slow down again with some logging behaviour while becoming closer to shore. Ocean Park team decided to capture the dolphin again, and during one close approach, WL212 laid motionlessly on water surface when Ocean Park veterinarian was able to trap it into the hoop-net. Immediately after the capture, several divers went into the water to constrain WL212 which showed signs of struggle. The animal was quickly lifted onto HKCRP research boat, and transported back to Aberdeen in two hours before another transfer to Ocean Park's medical pool for rehabilitation in the evening.

- February 10th (Day 26): A decision was made by Ocean Park and AFCD in the early morning to euthanize WL212, as its health condition seriously deteriorated overnight, reaching a humane endpoint according to the assessment by the Park's veterinary team.

5.10.3. Summary of focal follow observations

As briefly mentioned in the chronicle of events, focal follow observation was conducted whenever possible during the encounter of WL212, to collect vital

information on this seriously injured dolphin for evaluation of its latest condition. A summary of these observations is provided in Table 2.

Focal follow observation of WL212 was conducted with the aim to provide in-depth information on its movement patterns and behaviour in greater detail, and the observation followed the same protocol established in previous monitoring period as detailed in Hung (2014). During focal follows, the research vessel was driven parallel to the dolphin, matching its 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 its movement. In addition, information including diving pattern, the environmental condition, the dolphin's reaction to research vessel, boat association, sub-group size and composition, behavioural state of the dolphin, as well as the occurrence of moving vessels around the targeted individual 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. Moreover, a number of additional parameters were noted during the focal follows to evaluate its latest condition, such as the duration of logging behaviour on water surface, its direction of movement (whether it was swimming with or against with current flow), ability to evade boats and other dangers, the robustness of the animal (whether the animal was getting thinner), the location of where it has traveled through, and any sign of interaction with other dolphins.

A total of 12 focal follow sessions were conducted during the ten days of observation of WL212, with two separate sessions conducted on the same day on January 20th and February 6th. The initial position of each focal follow observation is presented in Figure 44, while the focal follow tracks of each session are presented altogether in Figures 45-46. In summary, a total of 33 hours and 46 minutes of focal follow observations were conducted on WL212, and the distance traveled by the dolphin varied from 2.0-11.3 km from sessions that lasted for 96-310 minutes. The average swimming speed ranged from 1.25 km per hour (when the animal was under sedatives on February 6th), to 2.77 km per hour (when the dolphin was actively foraging in the shipping channel on January 23rd). In comparison, the average swimming speed from six focal follow tracks of five individual dolphins recorded in Hung (2013) ranged from 2.22-4.83 km per hour, with a mean of 3.4 km per hour (note: the highest speed was recorded when dolphin was actively traveling). The swimming speed of WL212 was considerably lower than a normal dolphin on the first few days as well as the final days leading up to the successful capture when it was fed

with fishes (<2 km per hour), but it was also moving within the normal range of speed on some days when it was observed actively foraging (January 22nd, 23rd and 26th) (Table 2).

5.11. Dolphin-related Acoustic Studies (in collaboration with Ms. Michelle Klein, Trent University)

5.11.1. Overview of acoustic monitoring data collection in 2010-14

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 49 hours and 3 minutes of recordings in 661 sound samples were collected from 19 acoustic monitoring stations and opportunistic recordings around Lantau Island and in Deep Bay from 19 April 2010 to 30 December 2014 (Figure 3). A summary of these acoustic monitoring data collected in different areas among different monitoring periods is also provided in Figure 47.

Of the 661 sound samples that were collected from 19 acoustic monitoring stations and opportunistic recordings around Lantau Island and in Deep Bay from 19 April 2010 to 30 December 2014, 440 sound samples (66% of the recordings) contained vessel noise (from vessels that were observed to within 2 km of calibrated hydrophone). Of the 440 sounds samples with vessel noise, 201 sound samples (30% of all recordings) contained noise from a single vessel within 2 km of the calibrated hydrophone, while the other 239 sound samples (36%) contained two or more vessels within 2 km of the hydrophone.

The acoustic data collected since 2010 were all integrated into a long-term acoustics database, which can serve as useful baseline information for future studies. For instance, an on-going study by Ms. Michelle Klein, a graduate student from Trent University supervised by Professor Bradley White and Dr. John Wang, 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 vessel traffic and underwater ambient underwater noise levels. Characterization of the sound profiles of all sound sources and ambient noise levels within the dolphin habitat is in progress to determine how different sources of noise contribute to the overall soundscape of the waters within dolphin habitats. Here some preliminary results from those analyses are presented in this report.

5.11.2. Vessel noises in western HK waters in relation to Chinese White Dolphins

Introduction

Marine mammals with near-shore distributions are susceptible to human-related recreation and commercial disturbances, particularly near densely populated and industrialized coastal communities (Würsig 1989; Jefferson et al. 2009). A Chinese White Dolphin population of over 2,500 individual resides in the Pearl River Estuary (PRE) (Chen et al., 2010), and a part of this population uses Hong Kong waters off of Lantau Island, where they are subjected to a number of anthropogenic effects, including vessel disturbance, fisheries interactions, and boat-based tourism. This is an important foraging area for Chinese White Dolphins (herein referred to as dolphins) where these generalist feeders consume a variety of demersal and mid-water shoaling fishes supported by the PRE (Barros et al. 2004). While the dolphins also engage in other biologically important activities in these waters, including socializing and resting, feeding appears to dominate daytime behavior (Hung 2008). Increasing levels of vessel traffic and other anthropogenic activity off Lantau Island, including associated underwater noises that overlap with the dolphins' vocalizations (Sims et al. 2012b), are of concern to the welfare of the animals in Hong Kong waters (Reeves et al. 2008; Jefferson et al. 2009).

Previous research (Ng and Leung 2003; Hung et al. 2007) focused on anthropogenic disturbances that affected Hong Kong's dolphins and porpoises, but only a few researchers have studied the effects of noise pollution on these species (Würsig et al. 2000; Würsig and Greene 2002; Sims et al. 2012a). Würsig and Greene (2002) documented sound pressure level (SPL) relationships to different frequencies associated with tankers and tugs either offloading, approaching, or departing the Aviation Fuel Receiving Facility (AFRF, Figure 48). Their findings showed waters north of Lantau Island are relatively noisy, but the vessels in question still meet airport authority requirements. However, they also noted that the effects of these sound disturbances to the cetaceans (almost exclusively Chinese White Dolphins in North Lantau waters) inhabiting the area are yet to be documented. Sims et al. (2012a) later found large differences in sound pressure levels between high traffic and no traffic areas, suggesting that vessels are the main contributors to these discrepancies. They documented the relative sound contributions of various high-speed vessels to nearby ambient and dolphin social sounds and found that the vessel sounds were well within the audible range of *Sousa chinensis*, with sounds from 315-45,000 Hz. Additionally, Sims et al. (2012a) found that vessel sounds at distances ≥100 m exceeded those of dolphin sounds at closer distances and may be inducing masking effects of dolphin sounds at close distances.

The objectives of this study were to broaden the scope of Würsig and Greene's (2002) and Sims et al.'s (2012a) research by examining the sound contributions of other vessel types including a high-speed vessel, a dolphin watching tour boat, a shrimp trawler, and a shipping container vessel in western Hong Kong waters, and better quantify their various contributions to the nearby background ambient noise levels. Recent dolphin abundance data indicate that the various activities of these vessels may be partially related to recent declines of Chinese White Dolphins in Hong Kong waters (Hung 2014; Section 5.4.2 of this report). Thus, a summary of selected vessel sounds relative to ambient background sound levels and dolphin hearing thresholds are provided. An understanding of the various sounds generated by these vessels will be useful in determining their contributions to the underwater soundscape and their effects on marine mammals in the area, as well as providing data for potential mitigation measures.

Methods

Field methods - Vessel and ambient sounds (i.e. sounds recorded both in the presence and absence of vessels, and in the absence of dolphins; see Greene's (1995b) definition) were recorded at various monitoring stations (Figure 48) in the waters surrounding Lantau Island in Hong Kong (latitude 22°15'00", longitude 113°55'00"), from May 2010 to July 2013. Samples were taken in conjunction with a long-term sound monitoring program conducted by HKCRP. This program annually conducts line transect surveys throughout the Hong Kong Special Administrative Region. Vessel and ambient sounds were recorded from the stern of a 15-m diesel vessel, with the vessel's engine and power off and the vessel drifting. A Cetacean Research Technology spot-calibrated hydrophone (model: CR1; sensitivity: 197.69 dB, re. V/µPa; linear frequency range listed as: 0.0002 kHz–48 kHz ± 3 dB; usable frequency range listed as: 0.00004 kHz–68kHz ± 3/−20 dB, only analyzing sounds up to 48 kHz due to our linear frequency range) was used to record sounds, and a Fostex digital recorder (model: FR-2; frequency response: 20 Hz–80 kHz ± 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 ± 0.25 dB) was used to prevent overloading. The hydrophone, suspended by a 2 m spar buoy, was lowered into the water at 3 to 7 m depths and recorded (sampling rate: 24-bit at 192 kHz) various durations in Broadcast Wave Format, ranging from 3 min and 1 s to 5 min and 2 s. The spar buoy acted to prevent excessive hydrophone movement from wave and boat motion.

During each sampling event, vessel type, distance from the recording vessel at cue time, vessel activity, and dolphin presence were recorded. The distance to vessels was noted using Bushnell laser range-finding binoculars (distance accuracy ±0.5 m up to 700–800 m). The date, start and end times, hydrophone and water depths, Beaufort sea state, area, start and end location, gain, event, and any additional notes for each sampling event was also recorded for each sampling. A total of 453 recordings were taken between May 2010 - July 2013 both with and without the presence of various vessel types; however, many recordings took place in the presence of multiple vessels.

Acoustic data analysis - Recordings of a high-speed ferry, a small motorized dolphin watching tour boat (locally referred to as "wala walas"), a shrimp trawler, a shipping container vessel, and the ambient noise at various locations in western Hong Kong waters were analyzed using SpectraLAB software (version 4.32) on a Lenovo ThinkPad T400 7174-PLU notebook PC. Following the methods outlined in Sims et al. (2012a), vessel selections were divided into two categories of solitary and multiple vessels present during the recording. Vessels were defined as solitary if there were no other vessels present within 2 km from the recording vessel throughout the duration of the recording. Recordings in which there were two or more vessels within 2 km of each other in the study area were classified as having multiple vessels. Solitary vessel selections were analyzed at specific cue times that described the vessel distance and direction. These selections were analyzed over 5-second segments, ±2.5 seconds of the cue time to accurately capture their sound pressure level without averaging out their sounds. One third octave band sound pressure levels were computed using SpectraLAB's "compute average spectrum" analysis for solitary vessel selections. A 1/3 octave bandwidth was used because of its general approximation to cetacean auditory bands (Greene 1995a). The 1/3 octave band sound pressure levels describe the sound pressure levels of the individual vessel at specific distances, relative to the hearing range of *S. chinensis* and nearby ambient noise levels.

For ambient noise measurements, 10-second non-overlapping section measurements were made throughout the recording starting at the beginning. Most recording times were not a multiple of 10, so only full 10-second clips were measured for these. To avoid sound selection bias, measurements were repeated starting from the end of the recording. Furthermore, 18 of these selections (for a total of 3 minutes) were randomly selected and averaged for each ambient sound recording to compute 1/3 octave band ambient sound pressure levels. To reduce geographic or nearby

traffic differences between ambient sites and individual recordings, sites were selected near the individual vessel recording for ambient sound comparisons when recordings of the site with no vessels present were unavailable. These ambient sounds were used to assess individual vessel sound contributions relative to the natural background sounds (i.e. without vessel present within 2 km).

While only one audiogram is available for *Sousa chinensis* at present (Li et al. 2012), several exist for common bottlenose dolphins (*Tursiops truncatus*, hereafter simply "bottlenose dolphins") (Johnson 1967; Popov et al. 2007). Popov et al. (2007) observed variation amongst individual bottlenose dolphin audiograms; as such, the single audiogram available for *Sousa chinensis* may not accurately represent the mean hearing sensitivity of the species. Past research on communication frequencies of *Sousa chinensis* (Sims et al. 2012b; Van Parijs and Corkeron 2001a) indicates that they share similarities in repertoire and frequency range to bottlenose dolphins, suggesting that these two species may also share similar audiograms. Therefore, the published audiograms of both bottlenose dolphins and the single audiogram of a *Sousa chinensis* were used for comparison with the received sound pressure levels (see Figure 49). For the bottlenose dolphin audiograms, the average sound pressure level for each frequency band was used since both audiograms gave multiple sound pressure level thresholds per frequency unit. For the Johnson (1967) audiogram, dB re 1 μbar was converted to dB re 1 μPa by adding 100 to the recorded sound pressure level (Greene 1995a).

Results

Of the 453 recordings taken between May 2010 and July 2013, four recordings were used for analysis of solitary vessels. Specifically, recordings of an unclassified high-speed ferry (HSF), a small speed boat ("wala-wala") escorting tourists to watch dolphins in isolation, a shrimp trawler and a shipping container vessel were examined. Ambient sounds of the seven areas were also analyzed, including NEL #1, NWL #2, NWL #1, WL #2, WL #3, SWL #2, and South Lantau Vessel Fairway (SLVF) (see Table 3 for site details). NEL #1, NWL #1, NWL #2, WL #2, and SWL #2 were used for comparisons to natural ambient sounds, while WL #3 was used as a comparison to a usually busy traffic area with only one HSF present. Lastly, SLVF near Fan Lau (the southwest tip of Lantau Island; Figure 48) was used for an ambient sound recording of a generally busy traffic area with moderate vessel traffic (i.e. the presence of a sand barge and two high-speed ferries; Table 3).

Ambient Noise - A comparison of the ambient noise levels between the seven sites revealed several differences. The South Lantau Vessel Fairway (SLVF) ambient sound levels were higher through most of the frequency range of NEL #1, NWL #2, NWL #1, WL #2, and SWL #2 (i.e., 50-10,000 Hz; Figure 50). SLVF ambient sound levels were also higher than parts of and WL #3's, frequency ranges, particularly frequencies between 800-25,000 Hz. However, the differences in ambient sound levels between SLVF and WL#3 were less pronounced below 500 Hz and above 10,000 Hz. The relatively high sound pressure levels associated with SLVF corresponded with the presence of several ships, a sand barge and two high-speed ferries; as such, it is considered a busy traffic area. In contrast, WL #3, also considered a busy traffic area, only had one vessel present (a high-speed ferry) during the recording. Similar to SLVF, WL #3's sound pressure levels were higher through most of the frequency range of NEL #1, NWL #2, NWL #1, WL #2, and SWL #2 (i.e. 50-10,000 Hz; Figure 50). However, NWL #1 had increasingly higher sound pressure levels compared to WL #3 above 20,000 Hz (Figure 50).

Located near the northeast corner of the Hong Kong International Airport and adjacent to the Sky Pier high-speed ferry lane, NEL#1 had sound pressure levels between 90 and 100 dB re 1 µPa through the entire frequency range measured (50-48,000 Hz; Figure 50). Despite being near (~2 km) a high-traffic area, NEL #1 maintained relatively low sound pressure levels throughout the range of frequencies measured. However, this area had higher sound pressure levels below 700 Hz (between 90-100 dB re 1 µPa) than SWL #2, WL #2, and NWL #2 (Figure 50).

Located just to the north of Lung Kwu Chau within the Sha Chau and Lung Kwu Chau Marine Park, NWL#2 had the lowest sound pressure levels among all of the recordings between 250 and 1000 Hz, around 80-85 dB re 1 µPa (Figure 50). NWL #1 is located to the west of Sha Chau within the Sha Chau and Lung Kwu Chau Marine Park and also experiences very little boat traffic. NWL #1 had the lowest sound pressure levels below 250 Hz (Figure 50), and its sound pressure levels between 800 and 5,000 Hz were ~5-10 dB re 1 µPa lower than the one in SLVF.

Located in an area considered relatively pristine with a natural coastline and rare boat traffic, WL#2 had the lowest sound pressure levels of the seven ambient noise recordings below 250Hz, at around 75 dB re 1 µPa. Sound pressure levels increased rapidly between 200 and 315 Hz by almost 20 dB re 1 µPa to a peak of 106 dB re 1 µPa at 1,600 Hz, and then gradually declined to equilibrium around 8,000 Hz at 100 dB re 1 µPa (Figure 50). This area is located about 3 km from the busy SLVF.

Lastly, SWL#2, also considered to be a quiet area, was consistently in the relatively lower range of sound pressure levels to about 6,300 Hz, where it slightly exceeded the sound pressure levels of all of the other acoustic sampling locations except SLVF and NWL#1. At frequencies greater than 6,300 Hz, the sound pressure level at SWL#2 declines to an equilibrium around 10,000 Hz at 100 dB re 1 µP.

The dolphin audiograms were also compared to the ambient sounds of the seven aforementioned areas to describe the audibility of the average background sound levels. The Johnson (1967) bottlenose dolphin audiogram extended above all ambient sound levels to around 200 Hz, where it dropped below the ambient sounds of WL #2 (Figure 49). All audiograms for the dolphins (both *Sousa* and *Tursiops*) followed a declining pattern as frequency increased, thereby supplementing the difference between dolphin hearing thresholds and the various ambient sounds. There appeared to be intraspecific variation in the magnitude of the difference between dolphin hearing thresholds and sound pressure level. Notably, the difference between the *Sousa* audiogram and the SLVF sound pressure level was smaller as compared to the Johnson (1967) bottlenose dolphin audiogram and the SLVF sound pressure level. For example, near 5,600 Hz the difference for *Sousa* was ~13 dB re 1 µPa compared to ~33 dB re 1 µPa for bottlenose dolphins. This corresponds to the same ~20 dB re 1 µPa difference between the two audiograms observed by Sims et al. (2012a). However, this interspecific difference between audiograms and SLVF rapidly decreased with frequencies increased, with the two species converging around 32,000 Hz.

While this study did not extend to frequencies above 48,000 Hz, it should be noted that the *Sousa* audiogram diverged from the bottlenose dolphin audiogram and increased in sound pressure levels at frequencies above 48,000 Hz. We also observed intraspecific variation in hearing thresholds between the bottlenose audiograms. The Popov et al. (2007) audiogram declined at a slower rate as compared to the Johnson (1967) audiogram. Additionally, the Popov et al. (2007) audiogram was an average of 13 bottlenose dolphin subjects and may be a more accurate representation of a bottlenose audiogram. We were limited by the existence of only one available audiogram from a single *Sousa chinensis*, and individual variation may potentially bias our observed differences. While both bottlenose audiograms show a clear continuing trend of decline, the Popov et al. (2007) audiogram appeared to begin leveling out around 48,000 Hz. The data from Johnson (1967) audiogram did not extend beyond an upper frequency limit of 45,000 Hz; likewise, Popov et al. (2007) did not record responses to frequencies below 8,000 Hz.

Because of these data gaps, both bottlenose dolphin audiograms are shown for better clarity in frequency and sound pressure auditory thresholds.

Vessel sounds - At most distances, the high-speed ferry (Figure 51), a small motorized dolphin-watching tour boat off Tai O (Figure 52), a shrimp trawler (Figure 53), and shipping container vessel (Figure 54) sounds were much louder when compared to the corresponding natural ambient sound levels from either NEL #1, WL #2, or SWL #2. These higher sound pressure levels were consistent throughout the range of frequencies analyzed, though for all vessel types except the high-speed ferry, they usually declined to levels similar to those of the natural ambient sound in the upper frequencies (e.g. ≥4,000 Hz). On the other hand, the sound pressure levels of the high-speed ferry were consistently higher throughout the range of frequencies measured than the natural ambient sound pressure levels at the sampling location nearest to where to ferry was recorded (NEL#1; Figure 51).

Sound pressure levels tended to peak between 200-1000 Hz for the high-speed ferry, 2,000-5,000 Hz for the Wala wala, 50-100 Hz for the shrimp trawler, and 250-500 Hz for the shipping container vessel (Figures 51-54). The highest sound pressure level was 131 dB re 1 µPa at 500 Hz, and was associated with the shipping container vessel. These peaks were associated with a range of distances from 126-376 m. The direction of the vessel (i.e. approaching or away) may have affected some of the received sounds. In one case, received sounds from a shipping container vessel were higher from distances away than from approaching (Figure 54, away at 243 m from 200-500 Hz).

There were differences between vessel-generated sounds and the dolphin audiograms similar to those described for ambient sounds. However, most vessel sounds exceeded the ambient sound levels, increasing the differences in sound levels between vessels and dolphin audiograms. The increased difference was apparent from frequencies of 50-45,000 Hz for the high-speed ferry (Figure 51), from frequencies of 2,000-5,000 Hz for the small tour boat (Figure 52), from frequencies of 50-800 Hz for the shrimp trawler (Figure 53), and from frequencies of 50-4,000 Hz for the shipping container vessel (Figure 54). While ambient sounds did not appear to be audible to bottlenose dolphin around frequencies ≤300 Hz, some vessel sound pressure levels reached or exceeded the dolphin auditory threshold at lower frequencies, from 200-800 Hz (Figures 51, 53, and 54). The *Sousa* audiogram did not extend below 5,600 Hz (Li et al. 2012), so we were unable to determine if *Sousa*

chinensis show similar decreases in hearing sensitivity to bottlenose dolphins in the lower frequencies.

Discussion

Vessels contribute considerable sound levels over a wide range of frequencies to the ambient environment in western Hong Kong. Echoing the previous findings of Sims et al. (2012a), greater vessel traffic appeared to be associated with higher sound pressure levels. The South Lantau Vessel Fairway had the highest sound pressure levels across most of the frequency range analyzed, and the greatest number of vessels present (three). Though other sites also had relatively high sound level peaks, none were maintained across the majority of the frequency band. The other site that maintained relatively high sound pressure levels, though over a smaller frequency range, was WL#3, in which a single HSF was present during the recording.

Differences in sound pressure level may be partially attributed to Beaufort sea state (BSS), as SLVF had a BSS of 4, and the other sites had BSS ranging from 2 to 4. However, despite the high BSS at SLVF, the measured SPLs there were similar to those presented by Sims et al. (2012a), particularly in the lower frequencies (i.e., <1000 Hz). Because the ambient noise recordings were taken over several years, seasonal differences may be responsible for the observed differences in sound pressure levels. However, there were not enough ambient recordings (i.e. with no vessels present within a 2 km radius of the hydrophone) for each of the monitoring stations to determine if there were any seasonal differences in SPLs at the same site. No recordings were available for WL#3 or SLVF in which vessels were absent, so we are unable to eliminate the possibility that those sites with vessel traffic are louder due to factors other than vessel traffic. Nevertheless, our results concurred with the findings of Sims et al. (2012a), and it seems likely that vessels are important contributors to the underwater ambient sound environment in both SLVF and WL#3, particularly when examined in conjunction with the individual sound pressure level data from the other vessel types.

Three audiograms (two bottlenose and one *Sousa*) were used to compare vessel sound outputs to dolphin hearing. Only one audiogram exists for *Sousa chinensis* (Li et al. 2012), and recent research indicates that they share similar communication frequencies and repertoire as bottlenose dolphins (Sims et al. 2012b; Van Parijs and Corkeron 2001a), thus the Johnson (1967) bottlenose dolphin audiogram was used as a proxy for humpback hearing sensitivity in frequencies below those in the *Sousa* audiogram. The sound pressure levels for SLVF peaked at around 115 dB from

around 1,250–2,500 Hz at the hydrophone (with unknown levels at a standard 1 m distance from the sound source), well within the lower audible range of bottlenose dolphins and partially so for *Sousa*. Extrapolation of the bottlenose dolphin audiogram to the *Sousa* one in lower frequencies may be questionable based on some of the observed differences where *Sousa* hearing threshold data overlap with those of bottlenose dolphins. However, individual variation in audiograms exists in bottlenose dolphins, and *Sousa* likely exhibit similar differences as well. Thus, any conclusions of species differences or similarities in hearing thresholds should be taken cautiously until more data are available on variability in *Sousa* hearing thresholds.

It is unknown if ambient noise of the level that we observed may cause physiological damage, induced stress, or behavioural changes since long-term data are not available for these traits in the Hong Kong dolphin population. However, Chinese White Dolphin in Hong Kong exhibited behavioural changes in response to high levels of traffic, with greater occurrences of longer dives associated with the presence of some oncoming vessels, particularly those at high speeds (Ng and Leung 2003). Increasing diving duration in response to oncoming and high levels of vessel traffic may result in elevated stress levels. Furthermore, *Sousa* increase their whistling rates after a vessel (<1.5 km) has passed, which is hypothesized to function as reestablishing group cohesion (Van Parijs and Corkeron 2001b). Thus, these dolphins may experience increased stress and both physical and communicative behavioral changes in busy traffic environments such as SLVF.

The ambient noise level of SLVF may be a conservatively low estimate because the data were collected in the presence of multiple vessels, all of which changed in proximity to the hydrophone during the recording. No vessels were present during the recordings for NEL#1, NWL#1, NWL#2 and WL#2, so this issue does not pertain to them. Due to the random nature of our selections, it is likely that the represented noise levels are a mixture of both near and far vessel distances. Vessels closer in proximity will generate higher sound pressure levels, thus our estimated ambient noise level is likely more representative of the average sound levels recorded from the average distance of vessels during our recording. This is potentially problematic in determining the effects of noise on the local dolphins, since it is presently unknown at what distances dolphins maintain (or attempt to maintain) from vessels. Ng and Leung (2003) documented differences in their responses to vessel type and distance; however, they did not describe dolphin responses to specific vessel types at varying distances. They reported higher rates of vessel avoidance by the local dolphins in

response to high-speed vessels, but it is unknown at what distances these behavioural changes were documented.

Piwetz et al. (2012) found behavioural changes, such as mean leg speed and reorientation rate, in response to small tour boats and trawlers within 1 km. Additionally, many of the vessels present in SLVF are high-speed ferries, which are fast moving vessels, known to make abrupt entrances and departures at high speeds (Piwetz et al. 2012). These HSFs could quickly increase their proximity to dolphins, and sound pressure levels can elevate rapidly, potentially startling the dolphins or causing other reactions. Some research indicated increased unpredictability in vessel movement can have stronger effects on dolphin behaviour (Constantine et al., 2004; Lusseau, 2003). The potential magnitude of ambient noise levels for SLVF is dependent upon the assumption that the local dolphins maintain distances similar to the average distances between the hydrophone and ships recorded in our analyzed selections. This highlights a need for further research on their proximity and behavior in the presence of various ships to determine potential differences in behavior at varying distances and vessel types.

In conclusion, it appears that the high speed ferries, small tour boats, fishing vessels, and shipping container vessels all make important contributions to the local sound environment, although the influence of factors such as local topography and vessel sound propagation and attenuation have yet to be studied. Trawling vessels (including pair, stern, shrimp and hang trawlers) have been banned in Hong Kong's waters since December 2012, so they are likely not to have a significant impact on future dolphin distribution. However, high-speed ferries, tour boats and shipping container vessels are numerous in western Hong Kong, and management of their speeds and distribution are important in mitigating potential effects on the local dolphin population. Data from the Hong Kong Marine Department shows that there has been significant increases in vessel traffic, particularly high-speed ferries, over the past decade (see http://www.mardep.gov.hk/en/publication/portstat.html#2). This increase in high-speed ferry traffic inversely correlated with the observed decrease (Hung 2013) in dolphin densities in parts of western Hong Kong. However, it is unclear if increased noise relating to the increase in vessel traffic is the cause of this observed decline in dolphin abundance. It will be important to determine how yearly resident and seasonally sighted dolphins in Hong Kong have responded to the increased vessel traffic and high levels of noise in particular areas; the upkeep of the HKCRP's photo-identification catalogue and sightings database will help answer these questions. Future research also should focus on understanding how

individually identified dolphins distribute themselves spatially relative to different types of vessels. The uncertainty in interspecific differences and/or similarities in audiogram hearing thresholds highlights a need for more *Sousa* audiograms to help determine which sound pressure levels at various frequencies are audible to the dolphins. As an ultimate goal, determination of both the acute and chronic effects of different sound pressure levels on *Sousa* physiology, behavior, and communication throughout their range will help to assess and manage anthropogenic ship disturbances to these animals.

5.12. Assessing Short-term Impacts of Vessel Activity and Coastal Development on Chinese White Dolphins in HK waters (in collaboration with Ms. Shiva Javdan and Lauren Dares, Trent University)

Background

Chinese White Dolphins in Hong Kong have been monitored since 1995. Long-term impacts of coastal development and vessel activity on these local dolphins have been assessed through changes in their abundance, encounter rate and density (see Hung 2014). However, little has been done to understand the short-term responses of individual dolphins to disturbances in their habitat. Immediate changes in cetacean behaviour in response to stressors like vessel activity are known to include tighter group formation (Bejder et al. 1999), differences in dive duration (Janik and Thompson 1996), abrupt changes in swimming orientation (Mattson et al. 2005) and decreases in resting, socializing and feeding behaviours (Steckenreuter et al. 2012). An evaluation of short-term responses can help complement long-term studies of these dolphins.

Hong Kong is one of the busiest ports in the world, and continues to face habitat loss and degradation as a result of coastal development projects, thus it is important to conduct a comprehensive evaluation of human impact on the local dolphins. Ng and Leung (2003) provide the only assessment of this kind for the dolphins in Hong Kong waters; however, Hong Kong waters have changed dramatically over the past decade with increases in boat traffic and coastal development projects. The trajectory of human impact does not appear to be slowing down in the near future, thus the purpose of this study is to assess the short-term impacts of vessel activity and coastal development on the dive behaviour of Chinese White Dolphins in Hong Kong.

Methodology

Data were collected between June 2012 and October 2013, inclusive, through land based observations from four vantage points:Tai O, Sham Wat, Fan Lau, and Sha

Chau. These sites provided relatively unobstructed views of Hong Kong waters north, west and south of Lantau Island. When a dolphin was identified as a candidate for dive data collection (i.e. alone or easy to distinguish from other dolphins due to a prominent mark or unique colour pattern), the dive duration of the focal dolphin was recorded. Additional data were collected on group sizes when more than one dolphin was present, as well as the presence and type of vessels within 1km of the focal dolphin. Vessel types included hang trawler, single trawler, pair trawler, shrimp trawler, high speed ferry, police vessel, research vessel (15m yacht), speed boat, and other boats.

Dive recordings were grouped by individual. A new grouping was started when there was doubt about whether a new animal was being observed, and if more than a few minutes had elapsed since the last recorded dive. Each dive time was assigned a "dive sequence" number, used to group together dives performed by the same animal during observation. Dolphin dive times were compared between study areas, which represented varying levels of local disturbance. For example, Sha Chau is situated within the Sha Chau and Lung Kwu Chau Marine Park (SCLKCMP), and thus had little to no impact from vessels or construction; Fan Lau exhibited significant vessel impact due to the high speed ferry route that was approximately 1-2 km from the coastline; Tai O had intense vessel impact from a variety of boat types, as well as a coastal development site about 2 km away; and Sham Wat experienced coastal development impact within 1 km of the coast. The level of vessel impact in each area was quantified by a density calculation of boats in each area (total number of boats divided by the total number of dives recorded). Dolphin dive times were also analyzed with respect to boat presence, boat proximity and boat type. Proximity of any transiting vessels to the focal dolphin were estimated during observation, and later classed as $\leq$ or $\geq$ 500 m. The type of vessel was also assigned to one of five categories: trawler, yacht, police vessel, vessel with an outboard motor, or other. An additional assessment was done on the impact of *wala walas*, which are small motorized tour boats found in Tai O that specifically target the dolphin for observation for extended period. All data analyses were conducted in R (R Core Team 2013) using a linear mixed effects model (package lme4) and Tukey's HSD tests (package multcomp) for post-hoc assessments of significance.

Results

A total of 2,686 dives were recorded for Chinese White Dolphins in Hong Kong during the study period (Table 4). Most dives were under 30 sec (mean 27 $\pm$ 26 sec) in duration, and the longest dive was 316 sec (Table 4; Figure 55). There was a

significant difference in dive times between Sham Wat and Sha Chau (p=0.003), in addition to marginally significant differences in dive times between Fan Lau and Sha Chau (p=0.065), and between Tai O and Sha Chau (p=0.058) (Figure 56). Boat density differed among the four areas, with the highest density in Tai O (1.55) and the lowest density in Sha Chau (1.00) (Table 4). Boat presence (Figure 57), proximity (Figure 58) and boat type (Figure 59) did not significantly affect the dive times of the focal dolphin (p>0.05). The presence of wala walas and their proximity to the focal dolphin were also not found to significantly impact dolphin dive times (p>0.05).

Discussion

The majority of dives in this study fell below 30 seconds, which coincides with previous estimates for *Sousa chinensis* in Hong Kong (Ng and Leung 2003) and also in South Africa (Karczmarski et al. 1997). However, the longest dive (316 seconds) in this study is almost double that of Ng and Leung (2003). The longest dive in this study was observed in Tai O where dolphins were viewed at a steep angle and with little obstruction and so following dolphins was relatively easy for experienced observers. The two areas of observation in the Ng and Leung (2003) study were in close proximity to vessel fairways with larger boats and deeper waters where environmental conditions can change quickly and limit the ability to observe dolphins. There are two other published reports of dolphin dives for Hong Kong. One study by Yang and Chen (1996) reported a longest dive of 4-5 minutes, which coincides with the longest dive presented in this study, while Parsons (1997) presented a dive of over 7 minutes, which remains the longest known dive for the genus.

Several studies have suggested that longer dives in cetaceans are an avoidance tactic and potential sign of a negative response to a human induced stressor (see Baker et al. 1988; Janik and Thompson 1996; Lusseau 2003). Significant differences in dive times among study areas may be due to localized disturbances as each area represented different levels of coastal development and vessel intensity. Longer dives at Sham Wat may be a response to the ongoing HZMB construction, even though data were not collected at Sham Wat during times when pile driving occurred. An overall increase in boat traffic and noise pollution in this area compared to conditions prior to construction could contribute to differences in dive times with Sha Chau, which experiences less vessel traffic (lowest boat density) and other disturbances due to regulations within the SCLKCMP. Within the marine park, boat speeds are restricted to under 10 knots, and fishing is not allowed without a permit. Longer dives were also observed in Tai O and Fan Lau in comparison to Sha Chau. The vessel activities at both Tai O and Fan Lau were more disruptive in comparison

to Sha Chau because they had the highest boat density among the four study areas. Tai O was also exposed to a HZMB construction site (reclamation for an artificial island) about 2 km from its coastline. However, the difference in dives times between Sha Chau and these two study areas were marginally significant. There were only seven dive sequences in Fan Lau (64 dives), and only six dive sequences at Sha Chau (83 dives) compared to 156 and 33 in Tai O and Sham Wat, respectively. The samples taken in Fan Lau and Sha Chau are likely not representative of the true distribution of dive times, thus more data needs to be collected at both study sites for conclusive results.

Sousa chinensis typically behave evasively towards boats (see Jefferson 2000; Karczmarski et al. 1997); however, there was no significant difference in dolphin dive times with respect to vessel presence, proximity or boat type (including the Tai O *wala walas*) in this study. This may be due to small sample sizes or a product of the data collection method. At times when dolphins were engaged in a long dive, fast-moving (and more likely to be disruptive) boats could have passed within proximity of where the dolphin was sighted prior to a dive and then out of the 1 km buffer zone used in this study before the dolphin surfaced again. Thus it was difficult to quantify the exact moment when the boat was present during a dive. As a result, our boat and dolphin dive data may not have accurately captured this interaction. Also, studies have found that the orientation of the boat significantly impacts the response of the dolphin (e.g. Constantine 2001). This information was not recorded during this study, and thus future data collection should incorporate boat direction with respect to the focal dolphin.

In conclusion, this study showed that dive duration can be a valuable indicator of a short-term response to stressors in Hong Kong waters. Dolphins that avoid areas of heavy vessel traffic or costal development may be displaced to low quality habitat where food availability is scarce, and there may be abrupt ends to socializing and resting behaviours in avoidance events, which can have serious negative impacts on dolphin health and subsequently the viability of the population. We recommend that such monitoring continue during HZMB construction period, so that future development projects can implement informed mitigation action aimed at reducing short-term impacts on humpback dolphins in Hong Kong.

6. 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 nine 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.

7. KEY FINDINGS

Summary of Data Collection (April 2014-March 2015)

- 173 line-transect vessel surveys were conducted among ten survey areas.
  - 611.5 hours were spent to collect 4,625.8 km of survey effort.
  - 258 groups of 1,075 Chinese White Dolphins were sighted.
  - 106 groups of 288 Indo-Pacific finless porpoises were sighted.
- 197 individual dolphins, sighted 589 times altogether, were identified.
- 6 hours and 51 minutes of recordings in 100 sounds samples were collected.
- 22 sessions with over 107.0 hours of theodolite tracking were conducted.
  - 64 dolphins groups with 1,710 fixes of their positions were collected.
  - 14 porpoise groups with 168 fixes of their positions were collected
  - Another 3,961 fixes were made from locations of moving vessels.

Distribution

- In 2014, dolphin sightings were mainly concentrated along the west coast of Lantau, and dolphins were often sighted in SWL waters. Their occurrence in NWL mainly clustered around Lung Kwu Chau and Sha Chau as well as the mouth of Deep Bay. Rare occurrence of dolphins was found in NEL waters. They were seldom sighted near the HZMB-related construction sites.
- There has been a significant decline in usage of the NEL in recent years and such

decline worsened in 2014. Similar declining usage also occurred in NWL waters in 2014. Both declines were likely linked to the disturbance of HZMB construction activities. On the contrary, there has been a continuous increase of dolphin usage of SWL waters in recent years. The coastal water of WL was the only area where consistent and frequent occurrence of dolphins was recorded in 2009-14.

- In 2014-15, the majority of finless porpoise sightings were concentrated between the Soko Islands and Shek Kwu Chau, but they were also sighted to the south of Soko Islands, around Shek Kwu Chau, to the south and southeast of Cheung Chau, around the Po Toi Islands, to the east and south of Ninepins Islands and at the offshore waters of Sai Kung Peninsula. In the past four years, the most consistently used areas by porpoises were located around the Soko Islands as well as in the waters between Shek Kwu Chau and the Soko Islands.

Encounter Rate

- There was a marked decline in dolphin encounter rate in North Lantau region since 2011 to an exceptionally low level in 2014. In contrast, the combined dolphin encounter rate of WL and SWL remained at a higher level in 2013 and 2014 after a noticeable decline from the highest in 2003 to the lowest in 2011.
- The commencement of five HZMB-related construction works in different quarters of 2012-14 all coincided with a further drop in dolphin encounter rates in the respective quarter in NEL and NWL waters. With additional evidence from the HKLR and TMCLKL bored piling monitoring programme, the HZMB construction works have played a significant role in the marked decline in dolphin usage in North Lantau region, including the near abandonment of their important habitat around the Brothers Islands.

Abundance

- The combined estimate of dolphin abundance in 2014 was 61 dolphins from WL, NWL and NEL, which was very similar to the 2012 and 2013 estimates. Both NWL and NEL estimates were the lowest in 2014 since 2001, while there was a steady rebound in WL estimates from 17 dolphins in 2012 (the lowest since 2003) to 36 dolphins in 2014.
- Significant downward sloping trends were detected in all three areas individually and collectively during the past decade.
- Temporal trend of dolphin abundance in SWL was also examined for the first time. When abundance estimates of SWL were also added to the combined estimate of WL, NWL and NEL, there was also a marked decline in dolphin

abundance in Hong Kong from 2010-13, but such combined estimate rebounded noticeably in 2014 with the increased number of dolphins in WL and SWL despite the exceptionally low numbers in NWL and NEL.

Habitat Use

- The important dolphin habitats recorded in 2014 were identified near Tai O Peninsula, Kai Kung Shan, Peaked Hill, Fan Lau and Kau Ling Chung in WL and SWL waters, as well as near Lung Kwu Chau in NWL waters.
- There was a noticeable decline in dolphin densities in North Lantau region from 2011 to 2014, including the waters between Pillar Point and the airport platform in NWL, and around the Brothers Islands and Sham Shui Kok in NEL.
- Important porpoise habitats during the dry seasons of 2005-14 were located to the south of Tai A Chau, southwest of Shek Kwu Chau, south of Cheung Chau, and the waters between Shek Kwu Chau and the Soko Islands. Porpoise densities were higher around Po Toi Islands, and at the juncture between PT and NP survey areas during the wet seasons of 2005-14.

Group Size, Activities, Associations with Fishing Boats and Calf Occurrence

- Mean dolphin group size in 2014 (4.2 dolphins per group) was the second highest since 2002, and could possibly related to different foraging strategies adopted by the dolphins in midst of disturbance.
- Mean porpoise group size in 2014-15 (2.7 porpoises per group) was similar to the ones in previous monitoring periods. All except 13 groups were with less than five animals per group, while 65.1% of porpoises groups composed of 1-2 animals per group.
- Both feeding and socializing activities in 2014 remained at a low level during the past 13-year period.
- In 2014-15 monitoring period, all 14 fishing boat associated sightings were with operating purse-seiners. The percentage of dolphin sightings associated with fishing boats in 2014 was the second lowest since 1996, which was partly related to the fishing trawl ban implemented in 2013.
- The percentage of unspotted juveniles in 2014 was the lowest during the past 13 year period, while the percentage of unspotted calves remained at a low level in recent years. This raised grave concerns on calf survival as well as the suitability of Hong Kong waters for nursing activities.

Range Use, Residency and Movement Patterns

- By examining the movement patterns between re-sightings of 191 individuals,

121 of them moved extensively across different survey areas around Lantau in 2014-15, with most of these movements occurred between SWL/WL and NWL/WL.

- Temporal trend in individual movement revealed that the movements between NEL and NWL have greatly diminished in recent monitoring periods, while there was an emerging intensity of individual movements between WL and SWL in the past five monitoring periods.
- Range use of 36 individual dolphins indicated a progressive increase in number of shifts of individual range use away from NEL waters, and expansions of range use to WL waters have intensified for some individuals in 2014.
- Another examination of re-sighting rate of 66 individuals also revealed that many individuals from the northern social cluster have diminished their usage in NEL and have started to utilize WL waters more in the past two years.

Update on Life History Parameters of Individual Dolphins

- Nearly 70% of the 220 examined individuals from the photo-ID catalogue were estimated to be at least 12 years old, which should be sexually mature adults.
- The minimum period of 68 female-calf associations ranged from 2-107 months, with an average of 30.8 months. Two individuals (NL18 and NL202) were associated with their calves (NL259 and NL286) for more than eight years.
- The maximum calving intervals between 34 births ranged from 3-120 months, with an average of 37.8 months. Most of the calving intervals were estimated to be about 2-3 years, and occasionally up to 4-6 years.

Case Study of a Seriously Injured Dolphin WL212

- A brief chronicle of events during the three weeks of at-sea observations of a seriously injured dolphin was presented. The individual was identified as WL212, which occurred in WL waters 12 times since 2012.
- A total of 12 focal follow sessions with 33 hours of 46 minutes of observations were conducted on WL212. The distance traveled by this dolphin varied from 2.0-11.3 km from sessions that lasted for 96-310 minutes. Its average swimming speed ranged from 1.25 km per hour (recorded when it was under sedatives) to 2.77 km per hour (when it was actively foraging).

Dolphin-related Acoustic Studies

- Analysis of the 453 recordings during 2010-13 revealed that the sound levels at South Lantau Vessel Fairway were higher through most of the frequency range than in other areas of Lantau waters.

- The sounds of solitary high-speed ferry, small motorized dolphin-watching boat off Tai O, shrimp trawler and shipping container vessel were all much louder than the ambient sound levels in the respective region of recordings.
- Vessels contribute considerable sound levels over a wide range of frequencies to the ambient environment in western Hong Kong.

Assessing Short-term Impacts of Vessel Activity and Coastal Development

- An analysis of 2,686 dives of Chinese White Dolphins in HK showed that most dives were under 30 seconds in duration, and the longest dive was 316 seconds.
- There was a significant difference in dive times recorded between Sham Wat and Sha Chau, but the boat presence, proximity and boat type did not significantly affect the dive times of the focal dolphins.

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Table 1. Range use (50%/25% UD core areas and sighting coverage) and residency pattern of 161 individuals with 15+ sightings from the PRE humpback dolphin photo-ID catalogue during 1995-2014.

(abbreviations: SR=Seasonal Resident; YR=Year-round Resident; SV=Seasonal Visitor; UD= Utilization Distribution; LKC = Lung Kwu C 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				Primary	Occurrence in Survey Areas								50% UD Core Area					25% UD Core Area				
ID#	Sighted	# STG	Gender	Residency	Range	DB	EL	NEL	NWL	WL	SWL	SEL	CH	LKC	BR	TO	PH	FL	LKC	BR	TO	PH	FL
CH12	30/12/14	53	F?	YR	WL					√	√		√				√	√				√	
CH25	06/05/11	16	F	SR	WL				√	√			√			√	√	√			√	√	
CH34	18/11/14	113	F	YR	NL	√		√	√	√			√	√					√				
CH37	08/02/13	19	?	SR	WL					√	√		√				√	√				√	
CH38	03/12/14	65	?	YR	WL					√	√		√				√	√				√	
CH98	29/04/14	68	?	YR	NL	√			√	√				√					√				
CH105	22/08/14	17	F	SR	WL				√	√			√			√					√		
CH108	10/12/14	70	F	YR	WL				√	√	√		√				√	√				√	√
CH113	30/07/14	29	F	SR	WL				√	√			√			√					√		
CH153	22/09/14	17		SR	WL				√	√			√			√					√		
EL01	10/09/14	117	M*	YR	NL		√	√	√	√	√				√					√			
NL06	03/08/12	21	?	YR	NL			√	√					√	√				√				
NL12	09/07/14	26	F	SR	NL	√		√	√		√		√	√					√				
NL18	24/03/13	107	F	YR	NL			√	√	√			√	√	√					√			
NL24	14/04/14	237	F	YR	NL			√	√	√			√	√	√				√	√			
NL33	09/07/14	121	F*	YR	NL			√	√	√					√					√			
NL37	04/07/14	65	?	SR	NL		√	√	√	√				√					√				
NL46	04/11/14	75	F*	YR	NL				√	√			√	√					√				
NL48	23/12/14	105	?	YR	NL	√		√	√	√				√					√				
NL49	03/12/14	50	F*	SR	NL			√	√	√				√					√				
NL80	11/09/14	28	F	SR	NL	√			√	√				√					√				
NL93	05/08/14	60	F	YR	NL			√	√	√				√					√				
NL98	30/10/14	149	F*	YR	NL			√	√	√	√		√	√	√				√	√			
NL103	08/10/14	53	?	SR	NL	√			√	√	√			√					√				
NL104	19/12/14	109	F	YR	NL	√		√	√	√			√	√					√				
NL105	03/12/14	27	?	SR	NL/WL				√	√			√	√		√			√		√		
NL112	18/02/13	22	M*	SR	NL	√		√	√	√				√					√				
NL120	17/06/14	107	F*	YR	NL			√	√	√					√					√			
NL123	30/10/14	136	F	YR	NL	√		√	√	√			√		√					√			
NL128	20/05/14	53	M*	SR	WL			√	√	√	√	√	√			√	√	√				√	√
NL136	19/12/14	98	F*	SR	NL	√		√	√	√				√					√				
NL139	04/07/14	134	F	YR	NL			√	√	√			√	√	√					√			
NL145	14/07/14	41	F	SR	NL			√	√	√				√					√				
NL150	10/12/14	35	F	SR	NL	√		√	√	√	√			√					√				
NL153	29/04/14	20	F	SR	NL	√			√				√	√					√				
NL156	30/12/14	45	?	SR	NL/WL				√	√	√			√		√	√				√	√	
NL165	01/08/14	81	?	SR	NL			√	√	√	√			√	√				√				
NL179	02/10/13	73	?	YR	NL			√	√					√	√				√	√			
NL182	18/11/14	68	F	YR	NL	√		√	√	√				√					√				
NL188	03/12/14	74	F	YR	NL/WL			√	√	√	√			√		√	√		√				
NL191	24/06/14	67	?	YR	NL			√	√	√			√	√	√					√			
NL202	19/12/14	81	F	YR	NL	√		√	√	√				√					√				
NL206	03/12/14	46	F*	YR	WL				√	√	√						√	√				√	√
NL210	12/11/14	44	?	YR	NL			√	√	√				√					√				
NL212	22/08/14	27	F	SR	WL				√	√			√			√	√				√		
NL213	13/10/14	26	?	SR	NL	√			√	√				√					√				
NL214	09/12/14	35	F?	SR	NL	√			√					√					√				
NL215	19/02/12	19	F	SR	NL			√	√	√					√								
NL219	26/02/12	20	?	SR	NL				√					√					√				
NL220	19/12/14	68	F	YR	NL	√		√	√	√				√					√				
NL221	21/01/14	24	F	SR	NL				√	√			√	√					√				

Table 1. (cont'd)

ID#	Last Sighted	# STG	Gender	Residency	Primary Range	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
NL224	23/09/14	49	?	YR	NL/WL	√		√	√	√	√		√	√		√			√				
NL226	30/12/14	52	?	YR	NL	√		√	√	√	√				√					√			
NL233	07/10/14	48	F	YR	NL	√		√	√	√				√					√				
NL236	22/09/14	32	?	YR	NL				√	√				√					√				
NL241	13/09/12	21	?	SR	NL				√					√					√				
NL242	30/10/14	80	F*	YR	NL			√	√	√				√	√				√				
NL244	20/12/13	68	F	YR	NL			√	√	√				√	√				√				
NL246	01/02/13	41	?	YR	NL			√	√					√	√				√	√			
NL258	04/07/12	18	?	SR	NL/WL				√	√	√			√				√	√				
NL259	10/12/14	67	?	YR	NL			√	√	√				√					√				
NL260	30/12/14	59	?	YR	NL			√	√	√				√	√	√			√	√			
NL261	03/07/14	72	M?	YR	NL	√		√	√	√				√	√					√			
NL262	08/08/14	44	?	YR	NL	√			√	√				√					√				
NL264	04/06/14	56	F	YR	NL			√	√	√				√					√				
NL269	08/10/14	21	?	SR	NL/WL				√	√			√	√		√	√				√	√	
NL272	12/11/14	61	?	YR	NL	√		√	√	√	√			√					√				
NL278	07/10/14	20	?	SR	NL/WL				√	√	√		√	√		√			√		√		
NL279	10/09/14	15	?	SR	WL				√	√			√			√					√		
NL280	17/02/13	17	?	N.D.	NL	√			√					√					√				
NL284	15/08/14	63	?	YR	NL			√	√	√				√	√				√	√			
NL285	03/12/14	64	?	YR	NL			√	√	√				√	√					√			
NL286	19/12/14	55	?	YR	NL	√		√	√					√					√				
NL287	15/08/14	31	?	SR	NL				√	√				√					√				
NL288	15/04/14	46	?	YR	NL			√	√	√				√					√				
NL293	23/09/14	22	?	SR	WL				√	√						√					√		
NL295	07/10/14	40	?	YR	NL			√	√	√				√	√				√				
NL296	30/12/14	53	F?	YR	NL			√	√	√				√					√				
NL299	08/08/14	19	?	YR	WL	√			√	√	√			√		√	√				√	√	
NL300	30/10/14	17	?	SR	NL			√	√	√				√		√			√				
NL301	11/09/14	18	?	SR		√			√					√					√				
SL05	29/11/14	69	F	YR	WL					√	√						√	√					√
SL27	24/12/14	45	M	YR	WL				√	√	√					√		√			√		√
SL35	28/07/14	90	M	YR	WL				√	√	√	√	√			√	√	√				√	√
SL40	10/12/14	47	F	YR	WL					√	√		√				√	√					√
SL44	24/11/14	25	?	SR	WL					√	√					√	√					√	
SL47	18/08/14	23	?	YR	WL					√	√		√			√	√	√			√		√
WL04	25/11/14	51	F?	YR	NL/WL	√		√	√	√				√		√			√		√		
WL05	12/11/14	76	F?	YR	NL			√	√	√			√	√		√			√		√		
WL09	26/11/10	20	?	SR	WL				√	√	√		√			√	√					√	
WL11	05/03/14	59	F*	YR	NL			√	√	√			√	√					√				
WL15	25/11/14	78	M*	YR	WL			√	√	√	√					√	√	√			√		√
WL17	18/08/14	27	?	SR	WL			√	√	√	√	√	√	√		√	√	√	√		√	√	√
WL21	10/09/14	55	F	SR	WL				√	√	√		√			√	√				√		
WL25	04/06/14	153	F	YR	WL				√	√	√		√			√	√	√			√	√	√
WL28	08/10/14	20	F	SR	WL				√	√			√			√	√				√		
WL29	17/06/14	27	F	SR	WL					√	√		√			√	√					√	
WL37	15/08/12	20	?	SR	WL					√	√		√			√	√	√			√	√	
WL40	14/05/11	18	F*	SV	NL/WL				√	√			√	√					√				
WL42	30/12/14	83	?	YR	WL				√	√	√		√				√	√				√	
WL44	09/07/13	31	?	SR	WL			√	√	√	√		√	√		√	√	√				√	
WL46	22/08/14	62	?	YR	NL/WL			√	√	√	√			√		√					√		
WL47	21/11/14	25	?	YR	WL	√			√	√	√	√	√			√	√	√				√	√
WL48	11/02/12	15	F	SR	WL			√	√	√			√	√		√	√		√		√		
WL50	30/12/14	73	F*	YR	WL				√	√	√		√			√	√	√			√	√	√
WL55	04/07/12	28	?	SR	WL				√	√	√					√		√			√		√
WL61	10/12/14	61	?	YR	WL				√	√	√						√	√					√
WL62	24/11/14	59	F	YR	WL					√	√	√	√			√	√	√			√		√
WL68	03/12/14	35	F*	YR	WL					√	√						√	√				√	
WL69	10/12/14	64	F?	YR	WL					√	√	√	√				√	√					√
WL72	10/12/14	78	F	YR	WL				√	√	√					√	√	√				√	
WL73	08/10/14	41	?	SR	WL					√	√					√	√	√				√	√

Table 1. (cont'd)

ID#	Last Sighted	# STG	Gender	Residency	Primary Range	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
WL74	24/11/14	36	?	YR	WL					√	√						√	√				√	√
WL79	10/09/14	23	?	SR	WL				√	√			√			√					√		
WL87	22/03/13	36	?	YR	WL					√	√	√	√				√	√					√
WL88	29/11/11	31	F	YR	WL				√	√	√	√				√	√	√			√	√	√
WL91	10/12/14	41	?	SR	WL					√	√		√				√	√				√	
WL92	24/11/14	23	?	SR	WL					√	√		√				√	√					√
WL93	25/11/14	39	?	YR	WL				√	√	√						√	√					√
WL94	17/11/14	27	F	SR	WL					√	√		√					√					√
WL98	04/06/14	24	F	YR	WL				√	√			√			√	√				√		
WL108	18/05/10	21	M*	N.D.	WL					√	√							√					√
WL109	25/11/14	64	?	YR	WL				√	√	√		√			√	√					√	
WL111	13/11/12	18	F*	SR	NL			√	√	√				√					√				
WL114	24/11/14	40	F?	YR	WL				√	√	√		√				√	√				√	√
WL116	24/11/14	50	?	YR	WL				√	√	√		√			√	√	√				√	
WL118	03/12/14	39	F	YR	WL					√	√						√	√				√	
WL120	29/07/14	26	?	SR	WL				√	√						√					√		
WL122	08/10/14	16	?	SR	WL				√	√	√		√			√					√		
WL123	30/12/14	69	F?	YR	WL				√	√	√		√				√	√					√
WL124	23/09/14	38	F	SR	WL				√	√	√					√	√				√		
WL128	03/12/14	27	?	SR	WL					√	√						√	√				√	√
WL130	29/11/14	54	?	YR	WL				√	√	√						√	√					√
WL131	25/11/14	71	?	YR	WL				√	√	√					√	√	√				√	
WL132	24/11/14	36	F?	N.D.	WL					√	√	√	√			√	√	√				√	√
WL137	10/12/14	42	F	YR	WL				√	√	√		√				√					√	
WL138	20/02/12	21	?	SR	WL				√	√							√					√	
WL142	24/11/14	44	?	YR	WL					√	√		√					√					√
WL144	03/12/14	19	?	SR	WL					√							√					√	
WL145	08/10/14	21	F	SR	WL				√	√						√					√		
WL152	30/12/14	42	?	SR	WL				√	√	√						√	√				√	
WL153	08/10/14	23	?	YR	WL				√	√			√			√	√				√		
WL157	06/11/13	18	?	N.D.	WL					√	√		√			√					√		
WL159	04/07/14	22	F	SR	WL				√	√			√			√					√		
WL165	24/11/14	48	?	YR	WL					√	√						√	√					√
WL170	10/12/14	26	?	SR	WL				√	√	√		√					√					√
WL173	10/12/14	26	?	SR	WL					√	√						√	√				√	
WL178	10/10/14	15	?	SR	WL				√	√	√		√			√	√				√		
WL179	23/09/14	21	F	SR	NL/WL				√	√				√			√	√	√			√	
WL180	30/12/14	50	F	SR	WL					√	√		√			√	√	√				√	√
WL191	23/09/14	20	?	N.D.	WL				√	√			√			√	√	√				√	
WL193	08/10/14	26	?	N.D.	WL				√	√						√					√		
WL199	24/11/14	22	?	N.D.	WL				√	√	√					√	√	√				√	
WL201	18/10/13	28	?	N.D.	WL					√	√		√				√	√				√	√
WL208	11/11/14	16	?	N.D.	WL				√	√	√					√	√	√			√	√	
WL210	03/12/14	16	?	SR	WL					√	√		√			√	√					√	
WL215	10/12/14	25	?	YR	WL				√	√	√		√				√	√				√	√
WL220	30/12/14	23	?	N.D.	WL					√	√					√	√	√				√	√
WL221	08/10/14	27	?	N.D.	WL				√	√	√					√		√			√		

Table 2. Summary of monitoring effort of a seriously injured dolphin (WL212) in January-February 2015

(* conducted by HKDCS; ** conducted by HKCRP under AFCD monitoring program)

Date	Start Time	End Time	Total Time	Start Latitude	Start Longitude	End Latitude	End Longitude	Dist (km) Covered	Area (km^2) Covered	Speed (km/hr)	Engaged Behaviours and Other Notes
17/01/15*	16:32	17:52	1:20	22.2519	113.8530	22.2411	113.8471	2.4	0.30	1.80	Milling and Feeding (with several fluke up)
19/01/15*	14:51	16:33	1:42	22.1995	113.8700	22.1999	113.8725	2.6	0.07	1.53	Resting (with some logging)
20/01/15*	11:24	13:20	1:56	22.1949	113.8427	22.1967	113.8680	4.5	1.10	2.33	Resting after capture attempt
20/01/15*	14:23	15:39	1:16	22.2025	113.8868	22.1990	113.8938	2.3	0.20	1.82	Resting and Milling
22/01/15**	12:54	15:38	2:44	22.1901	113.8424	22.1919	113.8884	6.1	1.00	2.23	Milling and Feeding
23/01/15*	14:04	16:27	2:23	22.2051	113.8875	22.1916	113.9369	6.6	0.20	2.77	Milling and Feeding (with several fluke up)
26/01/15**	11:10	16:20	5:10	22.2002	113.9033	22.2011	113.8975	11.3	0.90	2.19	Feeding (around purse-seiner at times) and Milling
30/01/15**	10:31	16:00	5:29	22.2023	113.9166	22.2041	113.8812	9.6	1.60	1.75	Feeding (fed with fishes) and Milling; capture attempt at 11:53 and 12:06; Resting in pm
02/02/15**	11:11	15:02	3:51	22.1907	113.8796	22.2043	113.8793	7.6	2.00	1.97	Feeding (fed with fishes) and Milling; repeated fluke-up; capture attempt at 11:47
04/02/15**	10:14	14:35	4:21	22.1873	113.8799	22.1907	113.9030	7.7	3.20	1.77	Feeding (fed with fishes) and Milling; seine-net trap attempts at 10:25, 11:49, 12:59 & 14:23
06/02/15**	10:02	11:38	1:36	22.2072	113.8828	22.2019	113.8699	2.0	0.20	1.25	Milling and Resting (with some logging); sedative applied beforehand; capture attempts failed
06/02/15**	12:22	14:20	1:58	22.1980	113.8690	22.1920	113.8861	3.2	0.30	1.63	Milling and Logging; capture succeed at 14:20-14:23

Table 3. Site descriptions of ambient noise recordings

Location	Site description	Beaufort sea state	Vessel(s) present	Recording date
West Lantau #3 (WL #3)	Within the very busy shipping route at South Lantau Vessel Fairway (SLVF)	4	High-speed ferry	7-Feb-11
West Lantau #2 (WL #2)	Located in a relatively pristine area with natural coastline and little vessel traffic	4	None	30-Jun-10
Northwest Lantau #1 (NWL #1)	Within the Sha Chau and Lung Kwu Chau Marine Park with very little vessel traffic	3	None	13-Aug-10
Northwest Lantau #2 (NWL #2)	Located to the north of Lung Kwu Chau; adjacent to the North Lantau Vessel Fairway (NLVF)	2	None	8-Feb-11
Northeast Lantau #1 (NEL #1)	Located near the northeast corner of the Hong Kong International Airport	2	None	2-Mar-11
Southwest Lantau #2 (SWL #2)	Located between the Soko Islands with very little vessel traffic	2	None	18-Apr-11
South Lantau Vessel Fairway (SLVF)	A busy area which experiences much traffic, particularly from ferries	4	Sand barge, two high speed ferries	31-Jul-13

Table 4. Summary of dive times of Chinese White Dolphins in Hong Kong waters

	Tai O	Fan Lau	Sham Wat	Sha Chau	All Areas
Boat Density	1.55	1.13	1.02	1.00	1.50
Number of dives	2160	64	379	83	2686
Number of dive sequences	156	7	33	6	202
Min (sec)	1	3	3	3	1
Max (sec)	316	178	170	77	316
Mean ± SD (sec)	27 ± 26	36 ± 37	29 ± 25	21 ± 18	27 ± 26

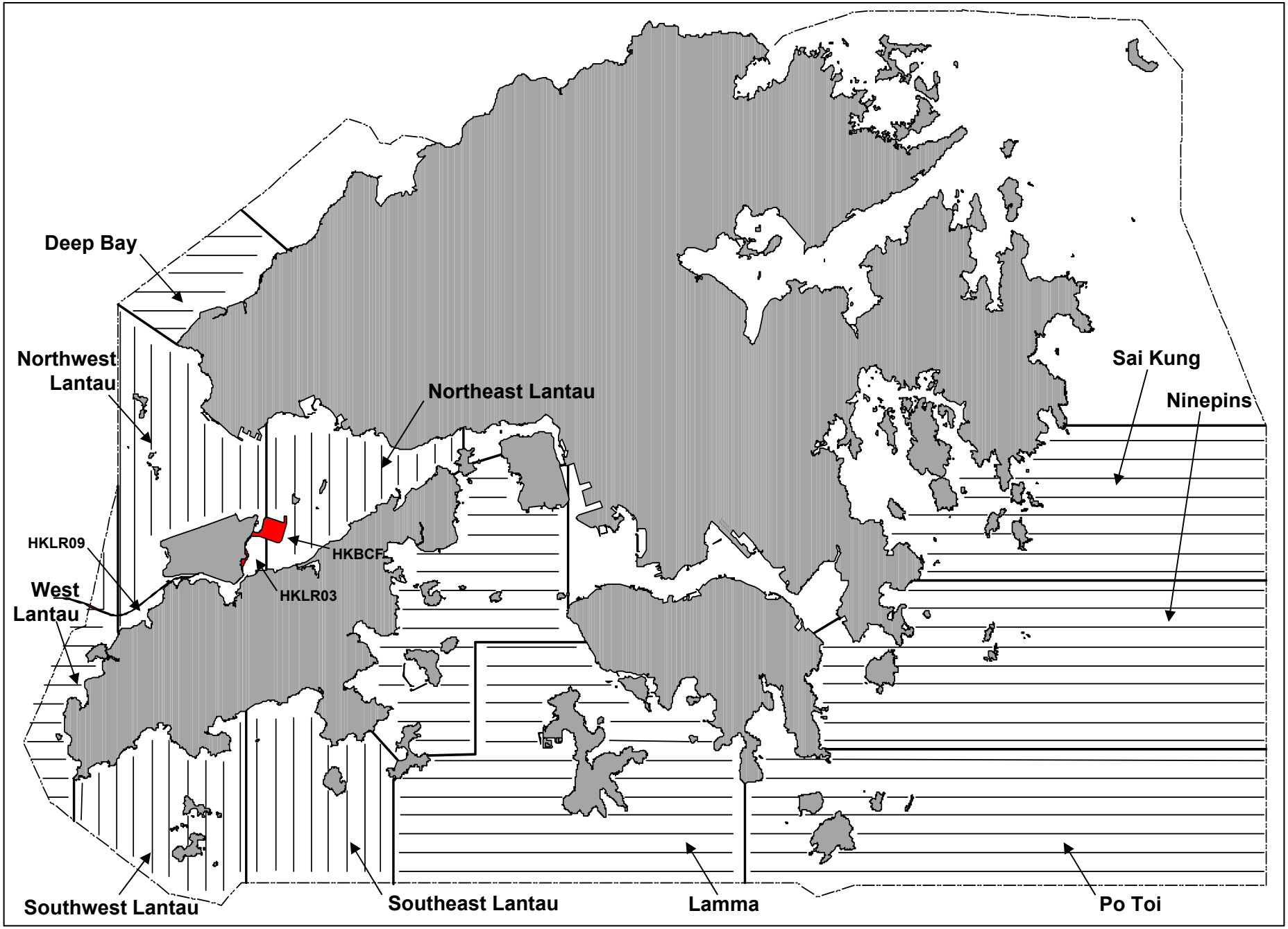


Figure 1. Ten Line-Transect Survey Areas within the Study Area chosen for the Present Monitoring Study (2014-15)

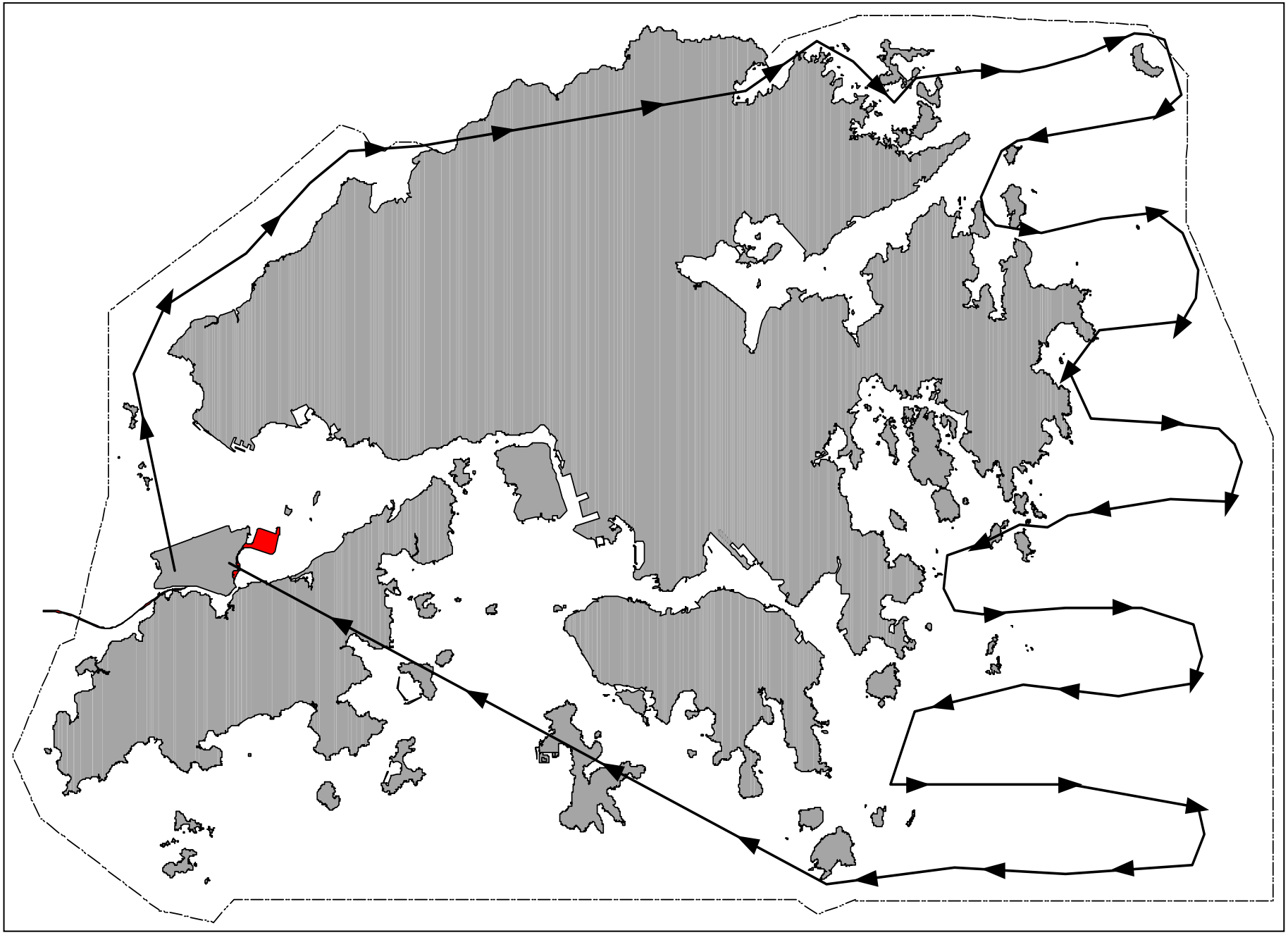


Figure 2. Survey Route for Helicopter Surveys in Eastern and Southern Waters of Hong Kong

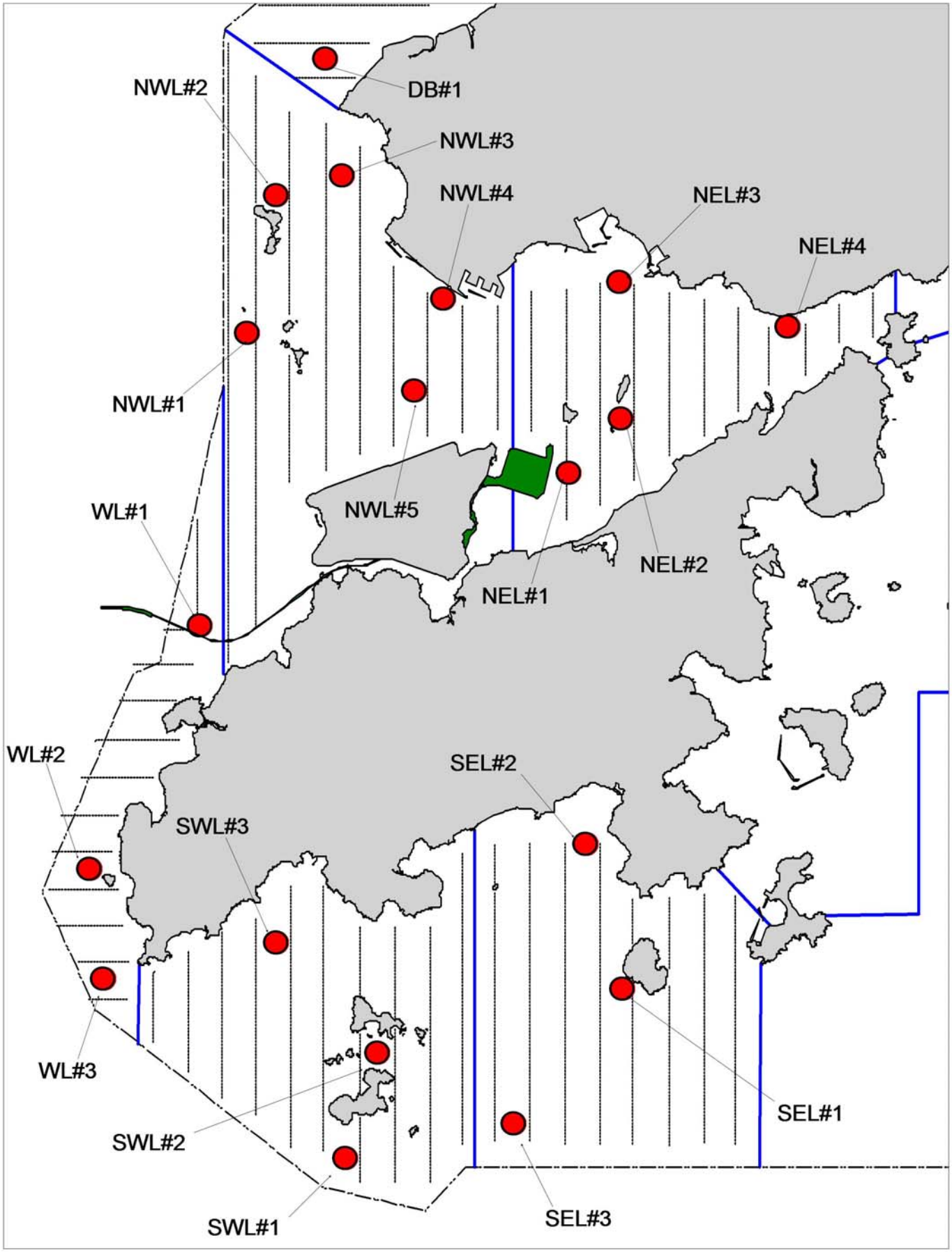


Figure 3. Locations of acoustic monitoring stations around Lantau waters

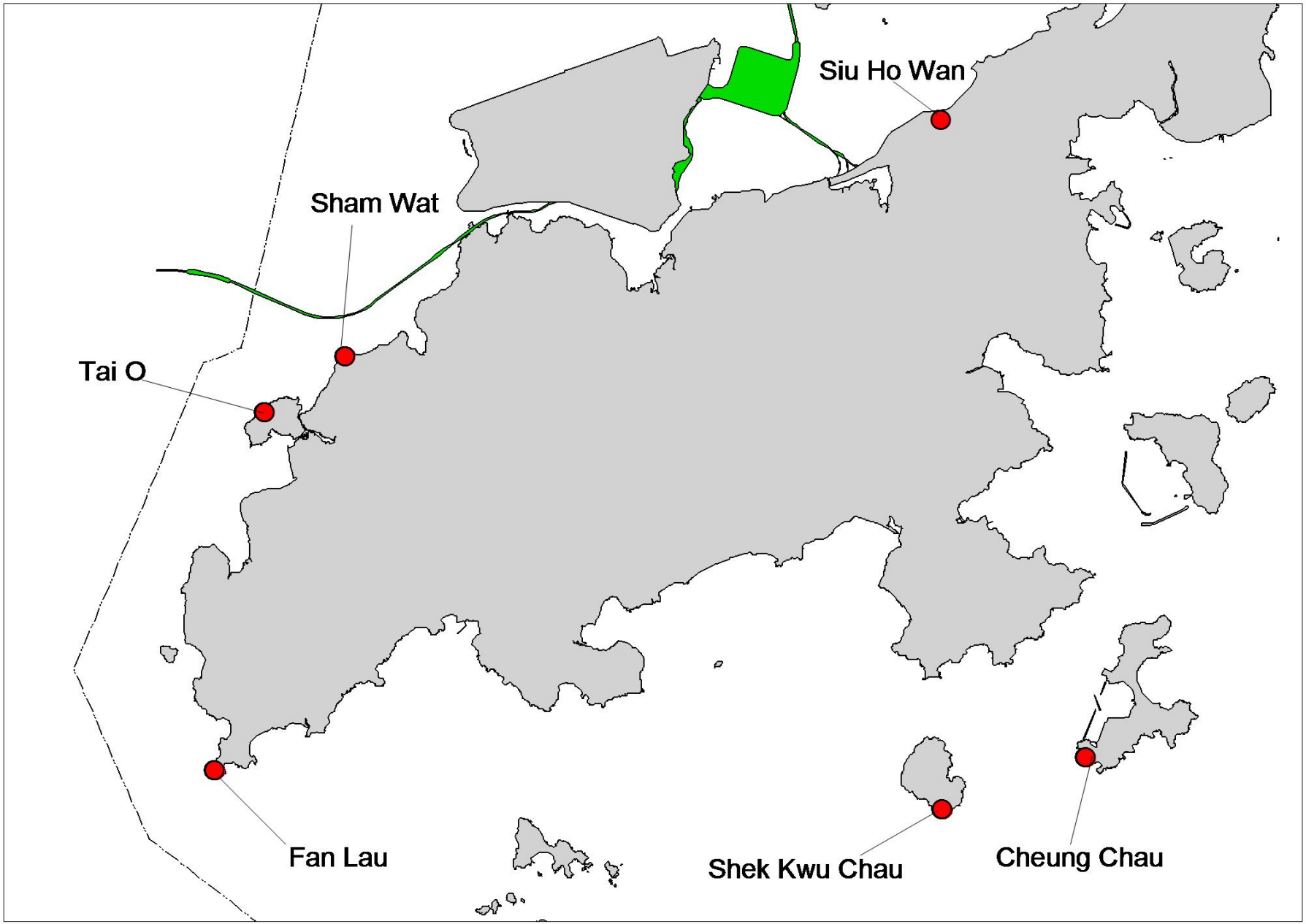


Figure 4. Locations of shore-based theodolite tracking stations around Lantau waters used in 2014-15

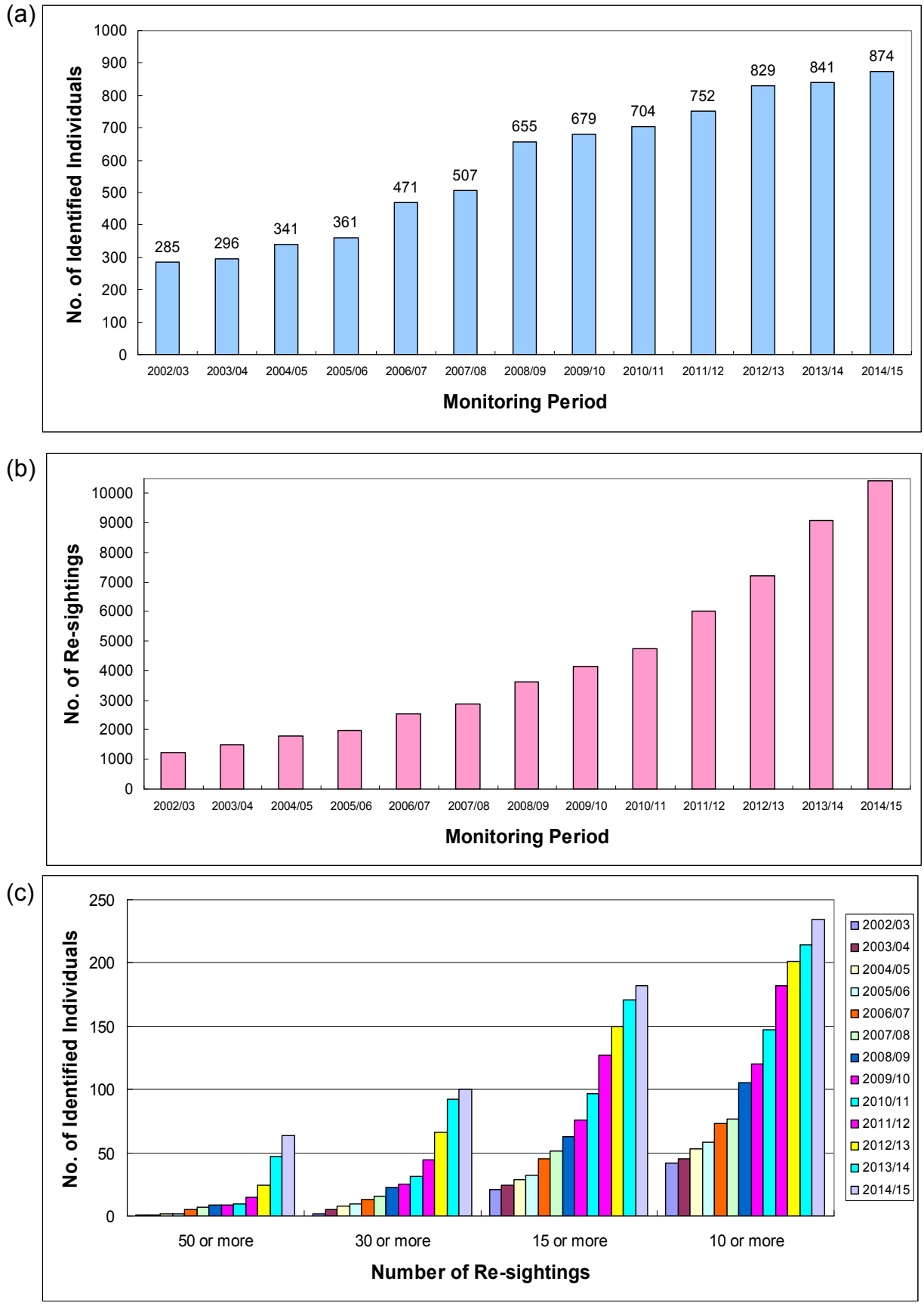


Figure 5. Temporal trends of (a) total number of identified individuals; (b) total number of re-sightings made; and (c) number of identified individuals within several categories of number of re-sightings in the past 13 monitoring periods since 2002

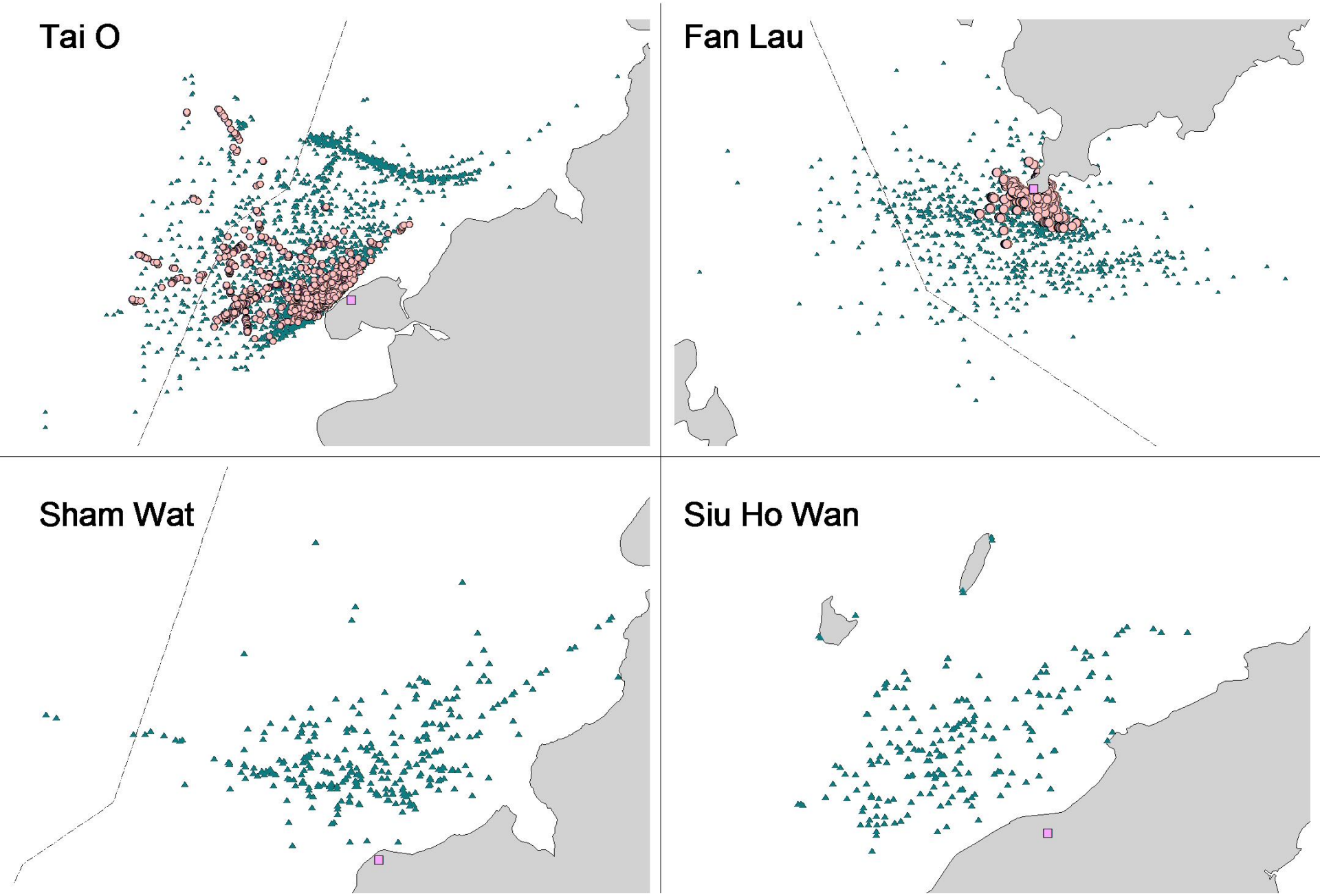


Figure 6. Positions of dolphins (pink circles) and vessels (green triangles) tracked from four different shore-based theodolite tracking stations (purple squares) in 2014-15

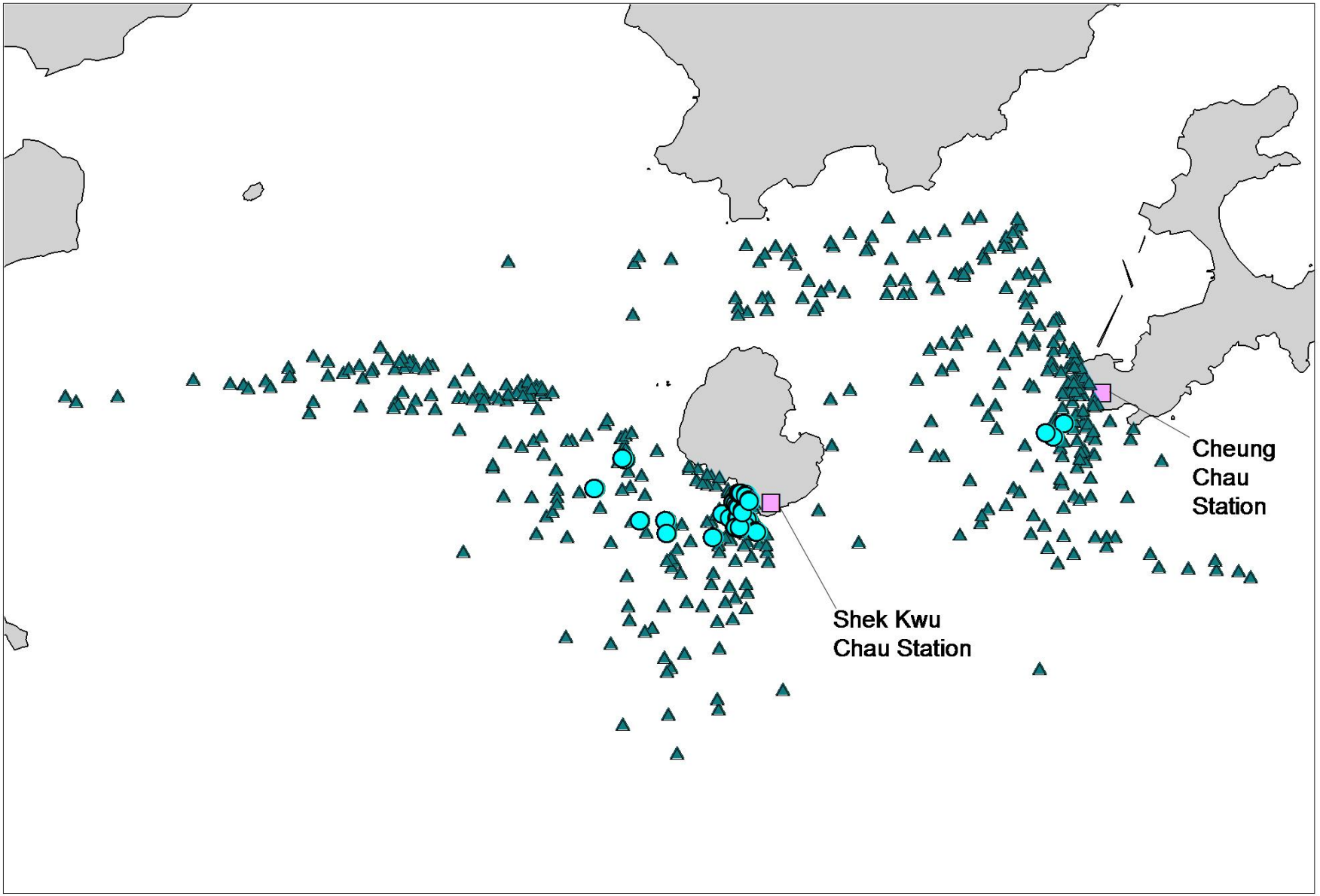


Figure 7. Positions of porpoises (blue circles) and vessels (green triangles) tracked from two shore-based theodolite tracking stations (purple squares) in 2014-15

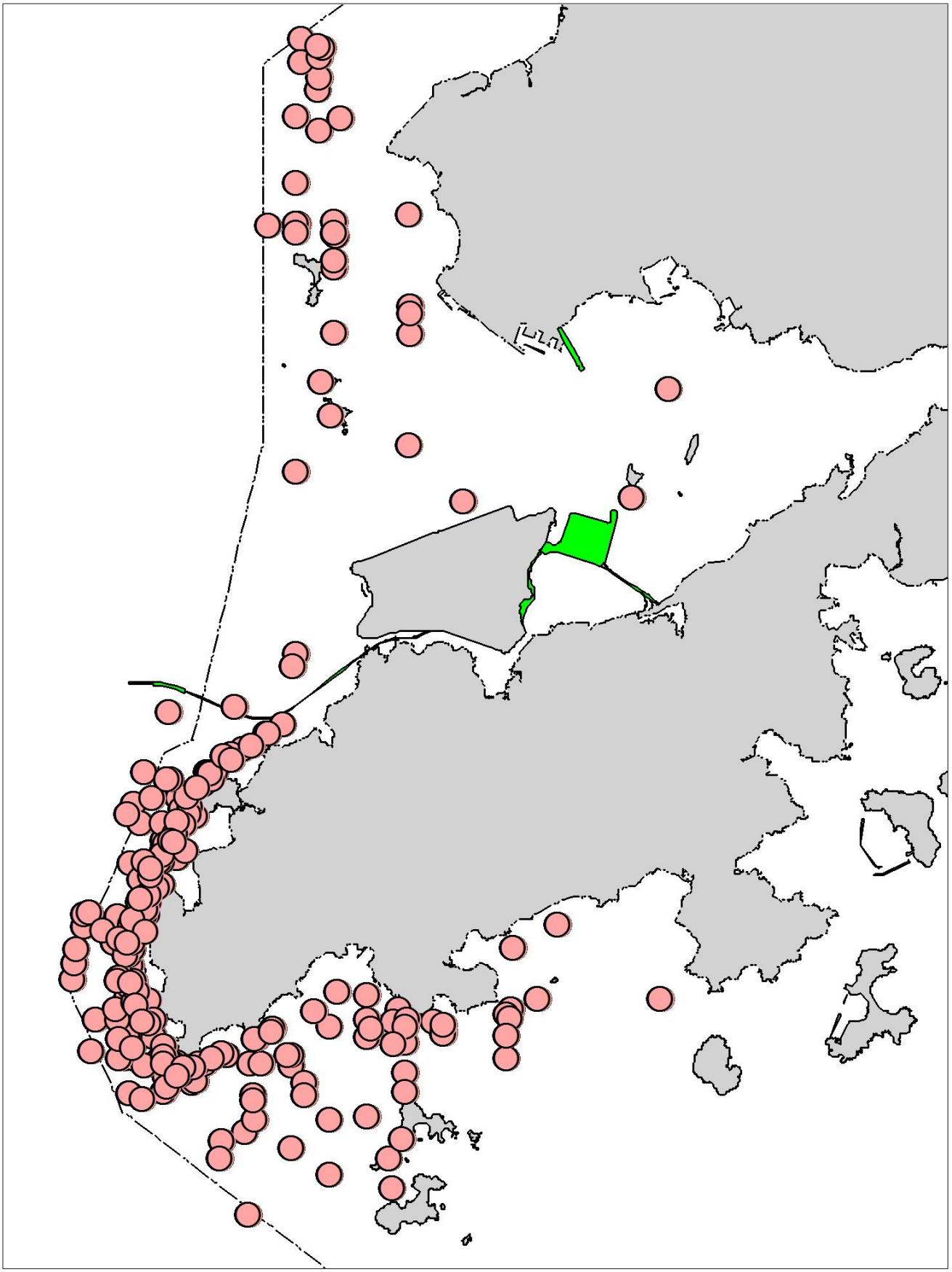


Figure 8. Distribution of CWD sightings in Hong Kong waters during AFCD monitoring surveys (April 2014 – March 2015)

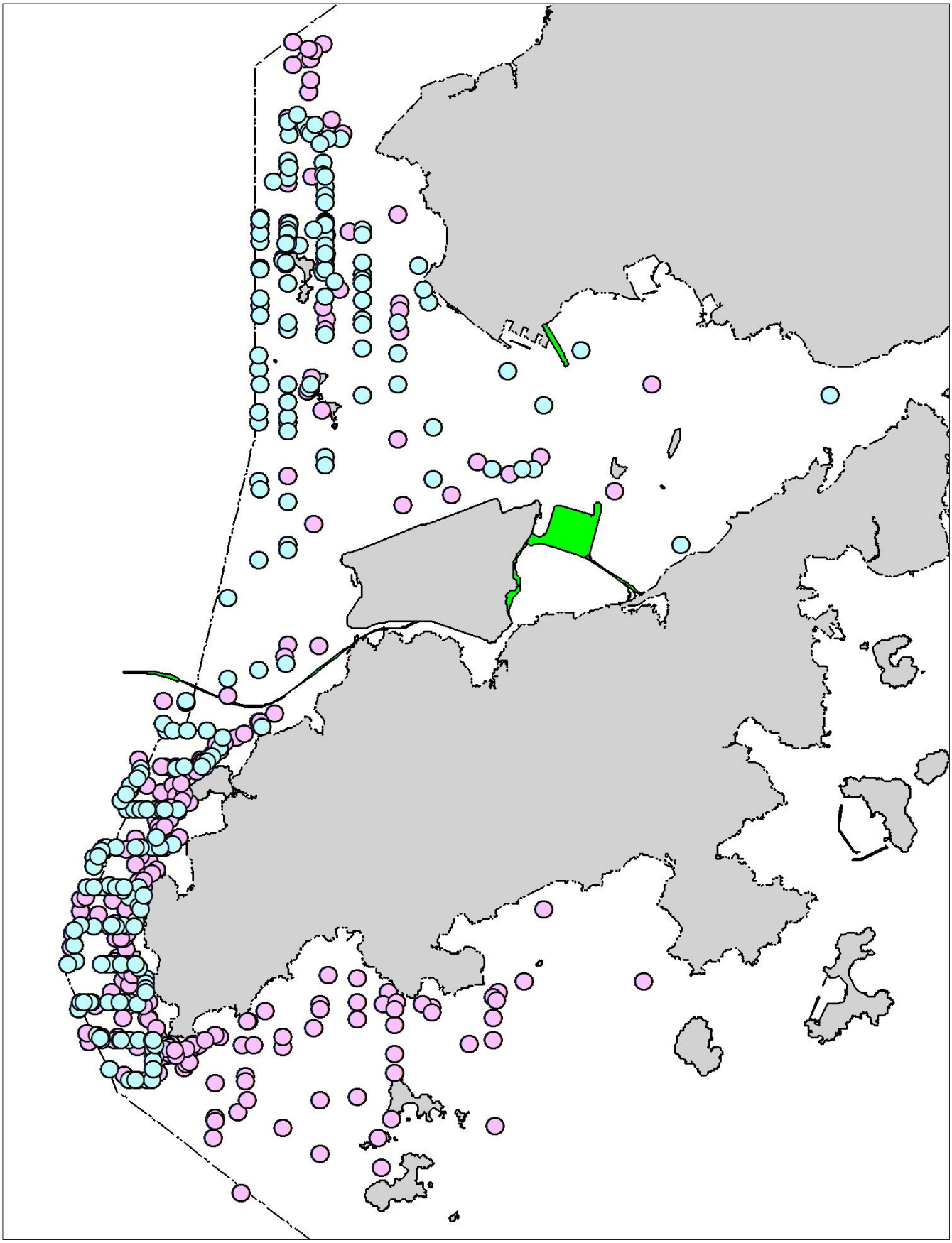


Figure 9. Distribution of all CWD sightings in Hong Kong waters in 2014
(pink dots: AFCD survey sightings; blue dots: HKLR survey sightings)

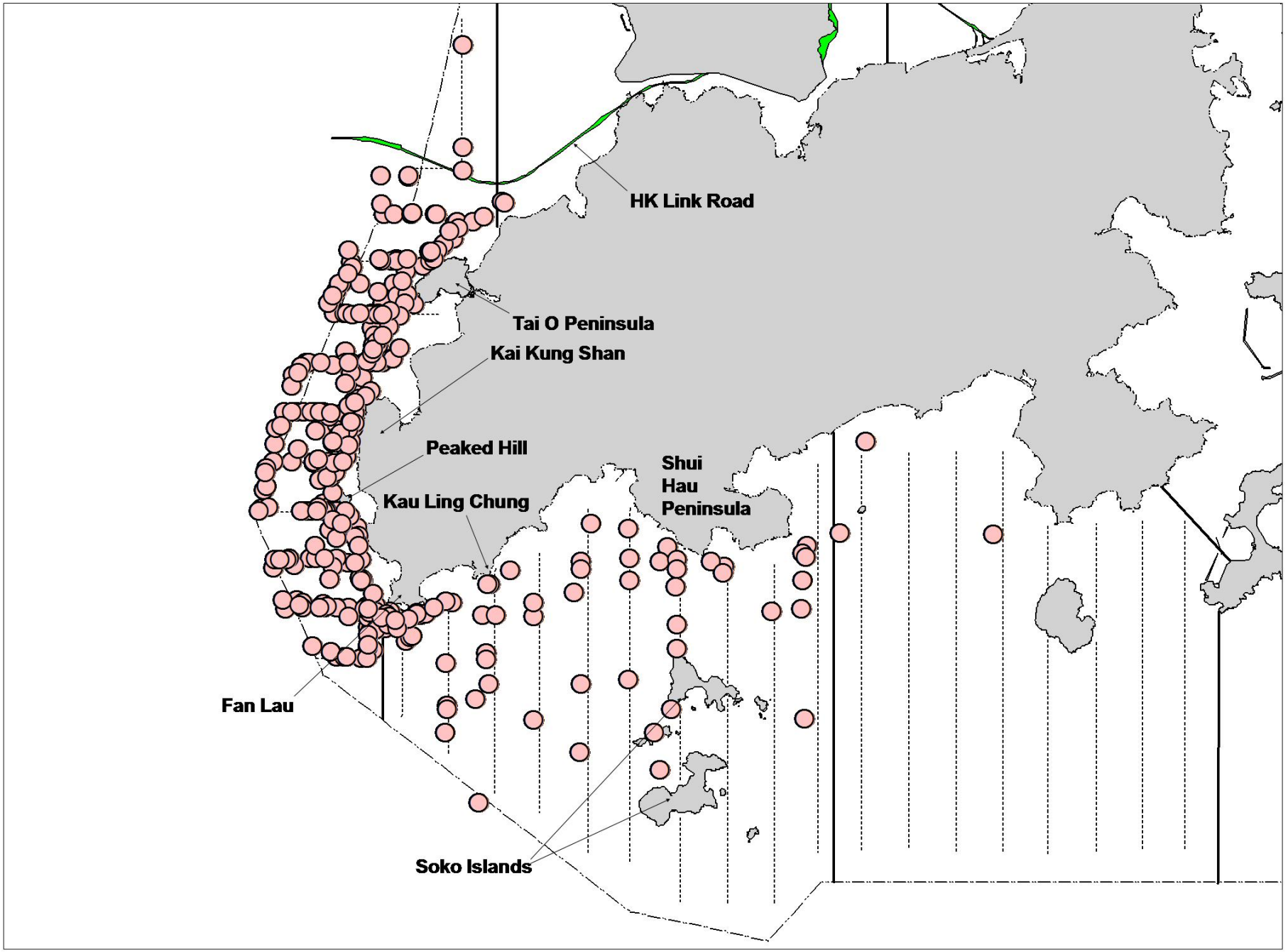


Figure 10. Distribution of Chinese white dolphin sightings in West and Southwest Lantau waters (2014)

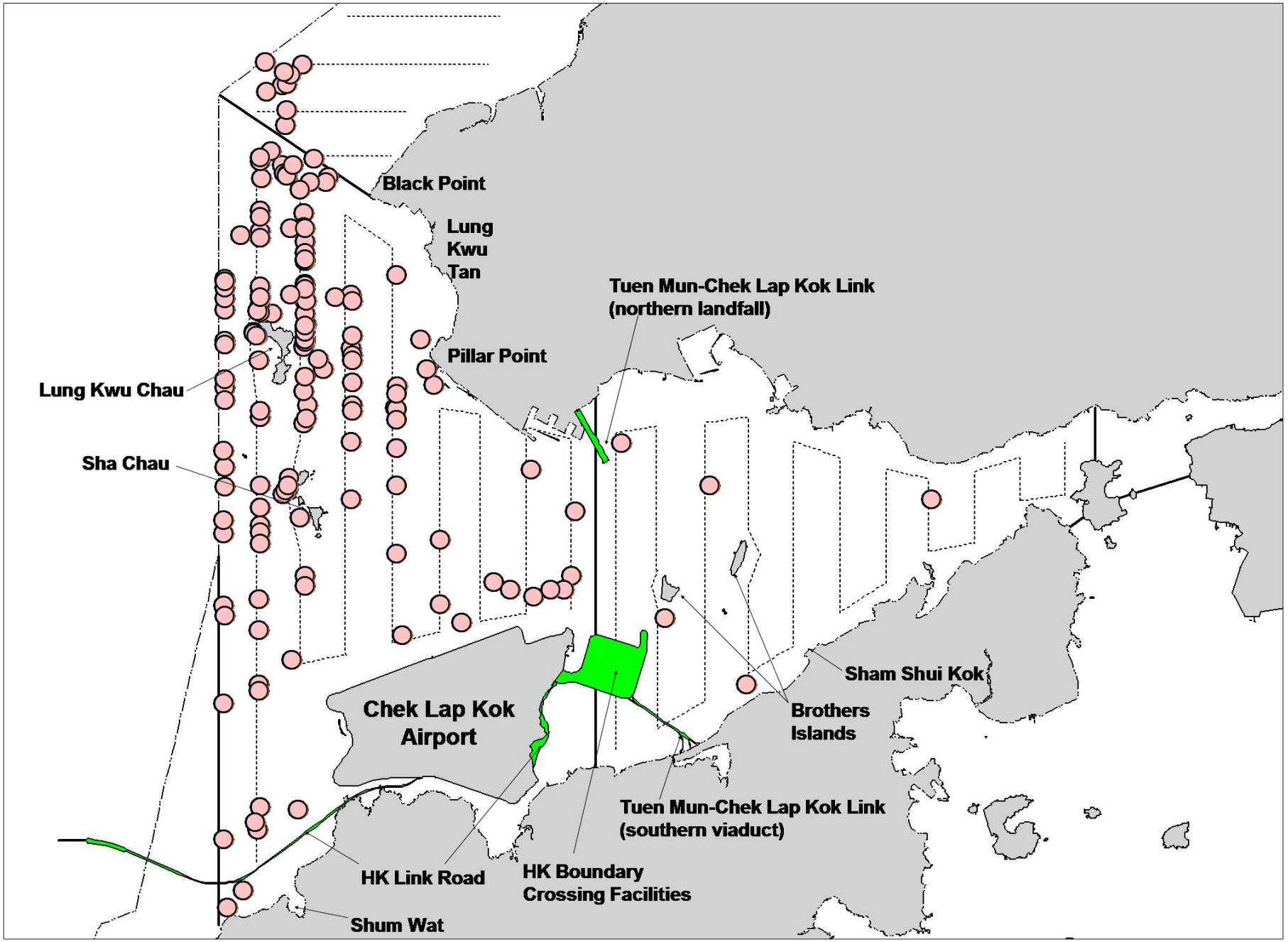


Figure 11. Distribution of Chinese white dolphin sightings in North Lantau and Deep Bay (2014)

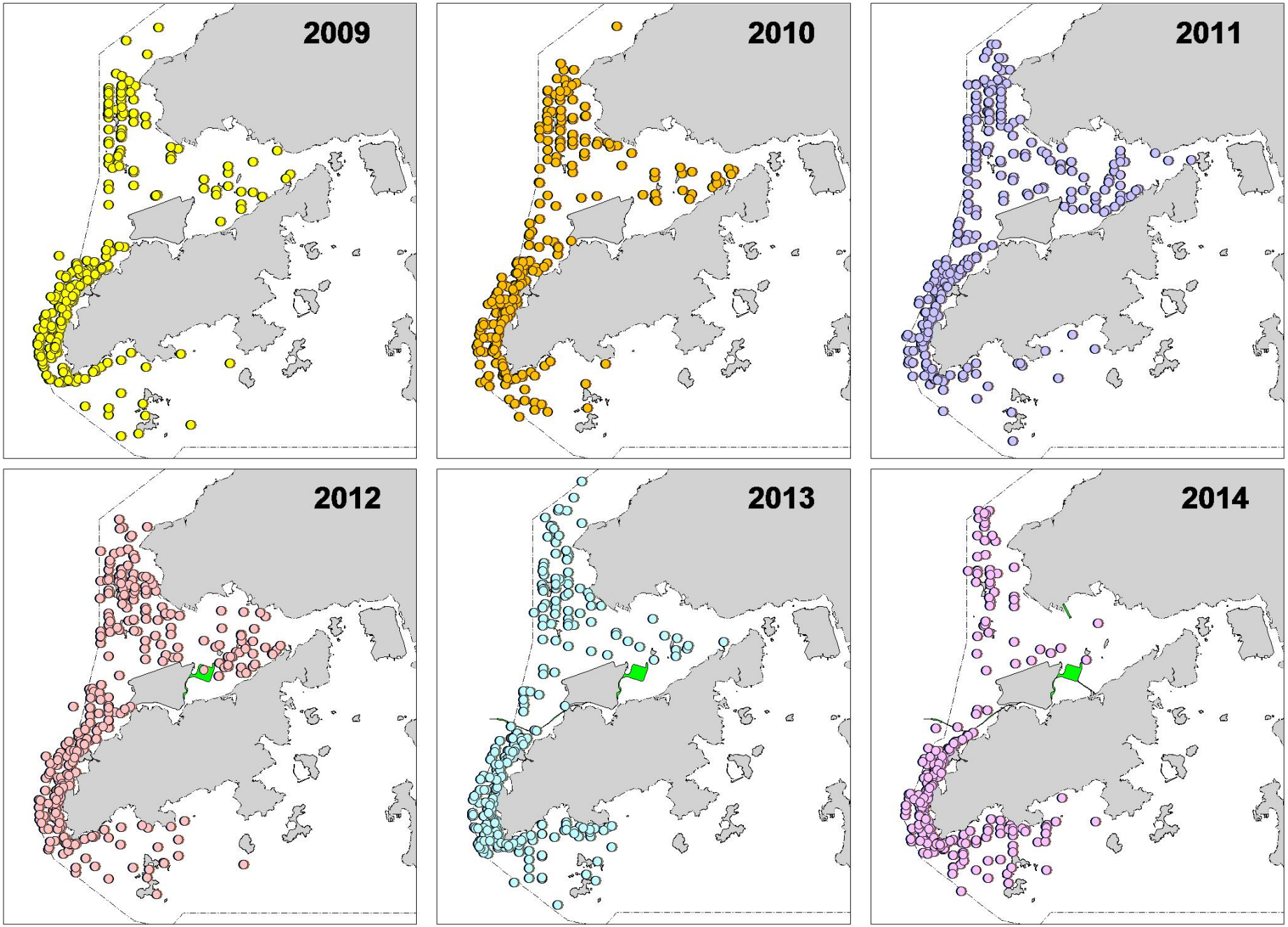


Figure 12. Comparison of dolphin distribution patterns from the past six years (2009-14)

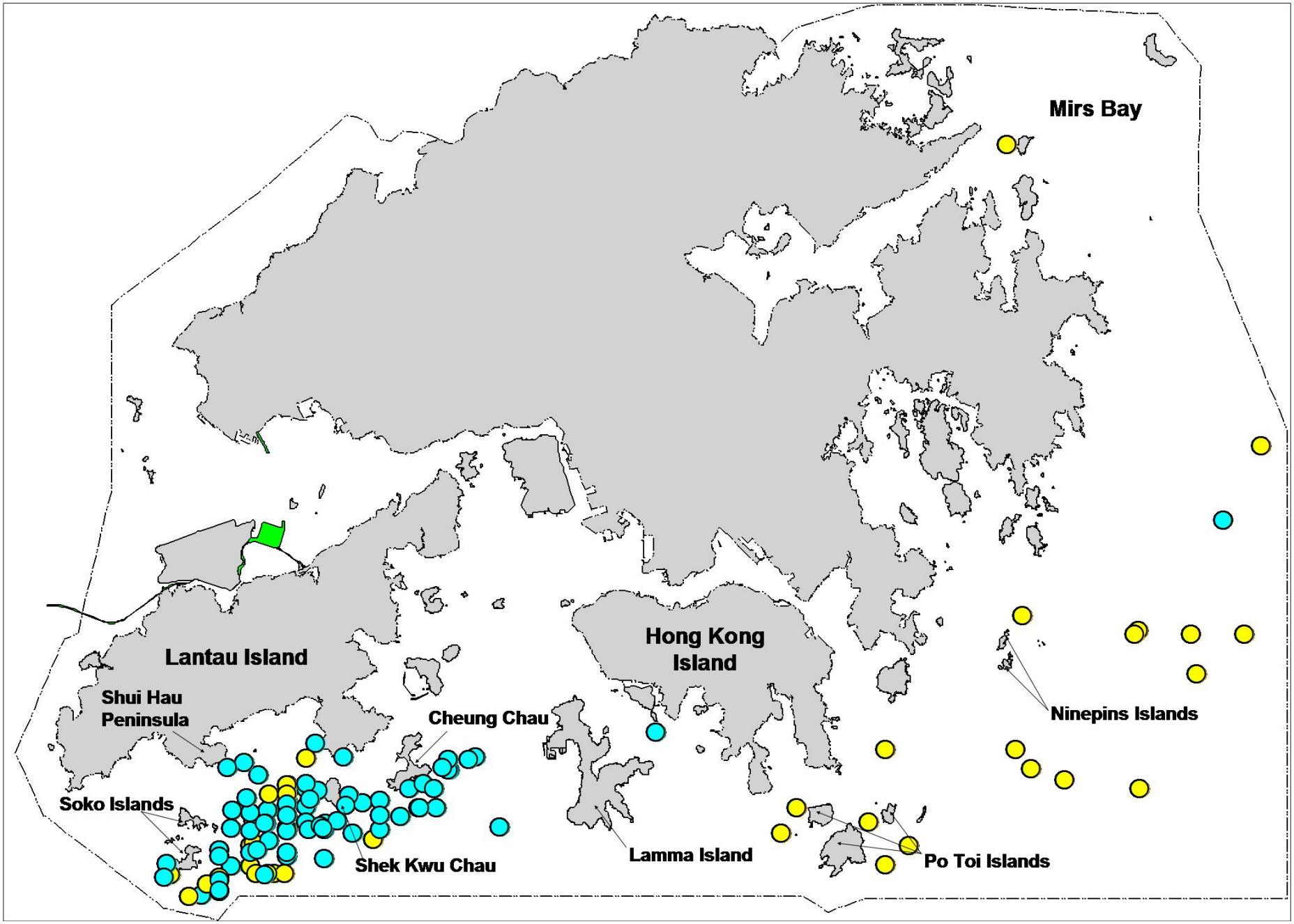


Figure 13. Distribution of finless porpoise sightings made during AFCD surveys (April 2014 – March 2015)
(yellow dots: sightings made during summer/autumn months)

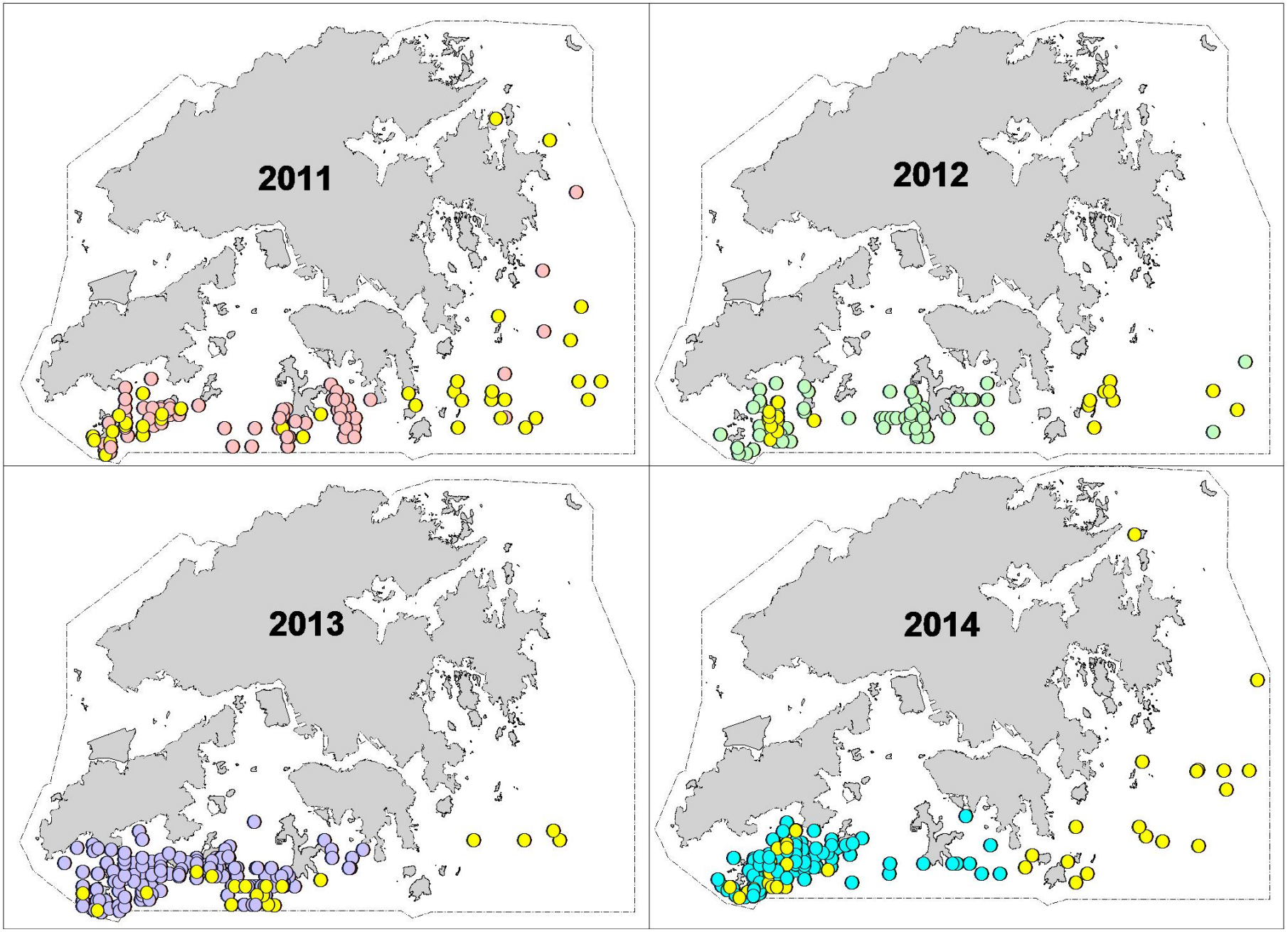


Figure 14. Comparison of annual porpoise distribution patterns from the past four years
(yellow dots: sightings made during summer/autumn months)

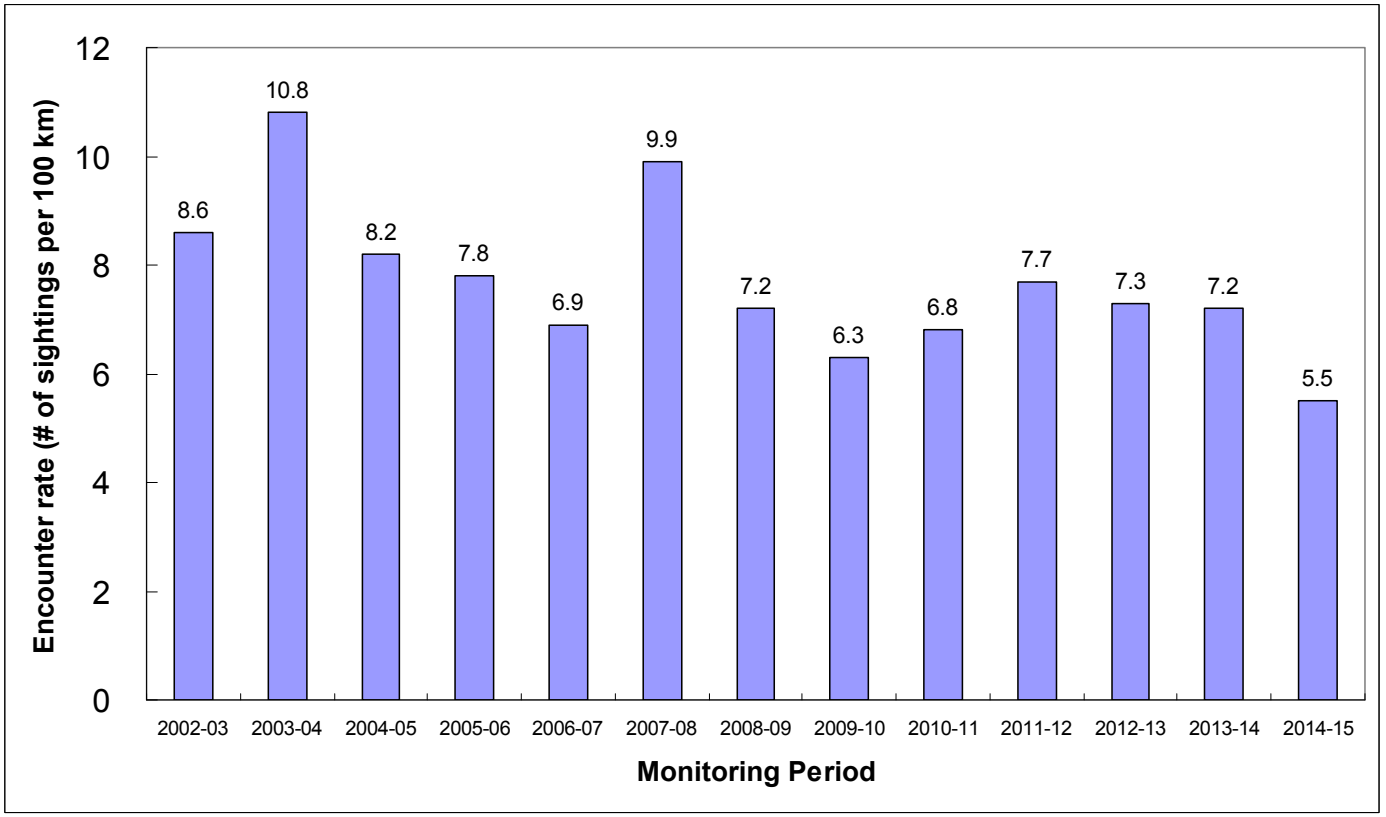
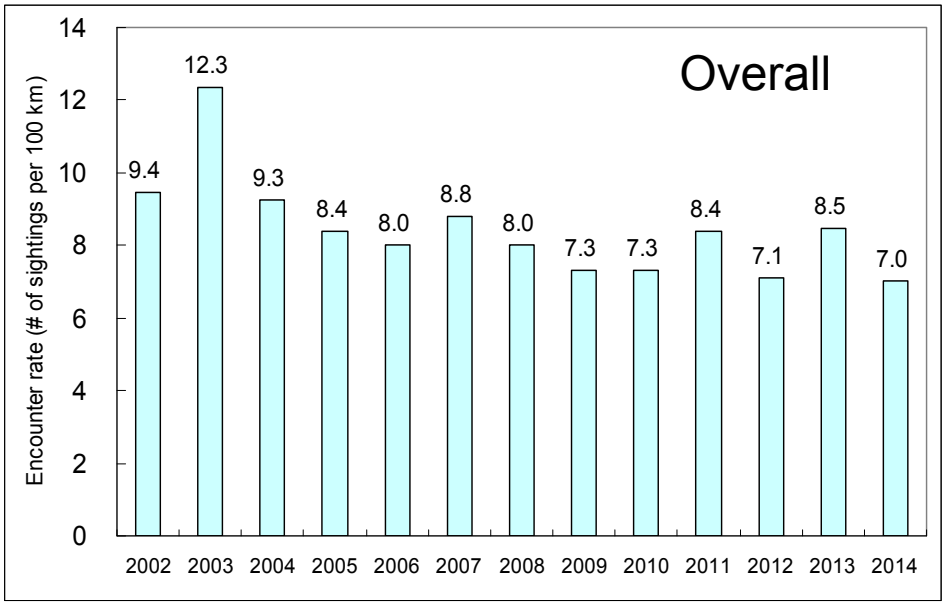
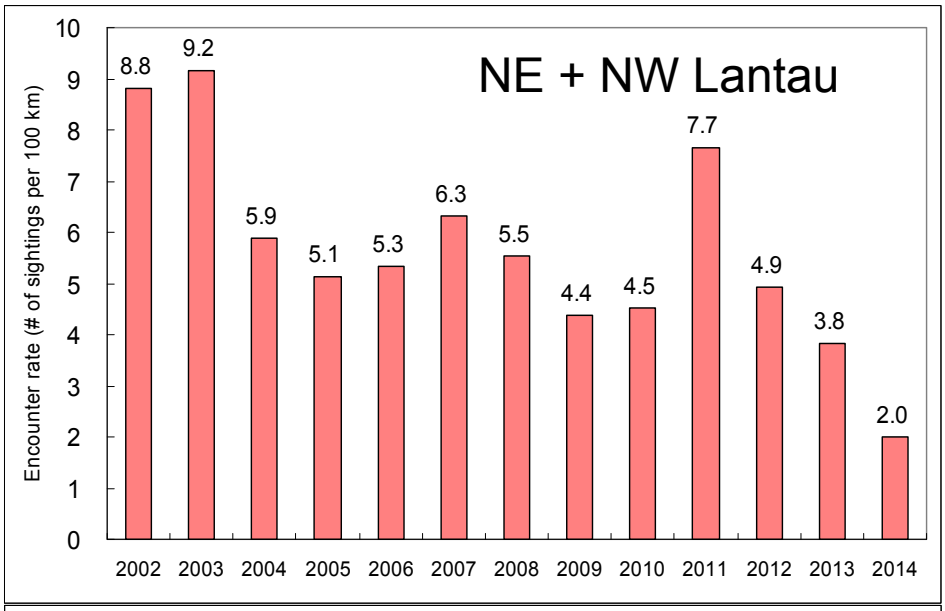


Figure 15. Temporal trend in encounter rates of Chinese white dolphins (combined from WL, NWL, NEL and SWL survey areas) in the past twelve monitoring periods from 2002-15





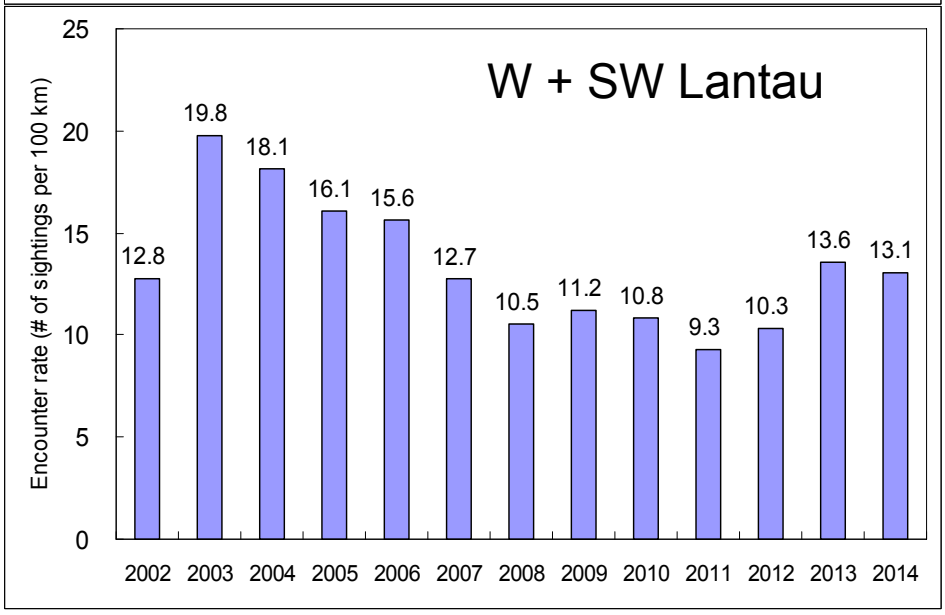


Figure 16. Long-term trends in annual dolphin encounter rates in different survey areas

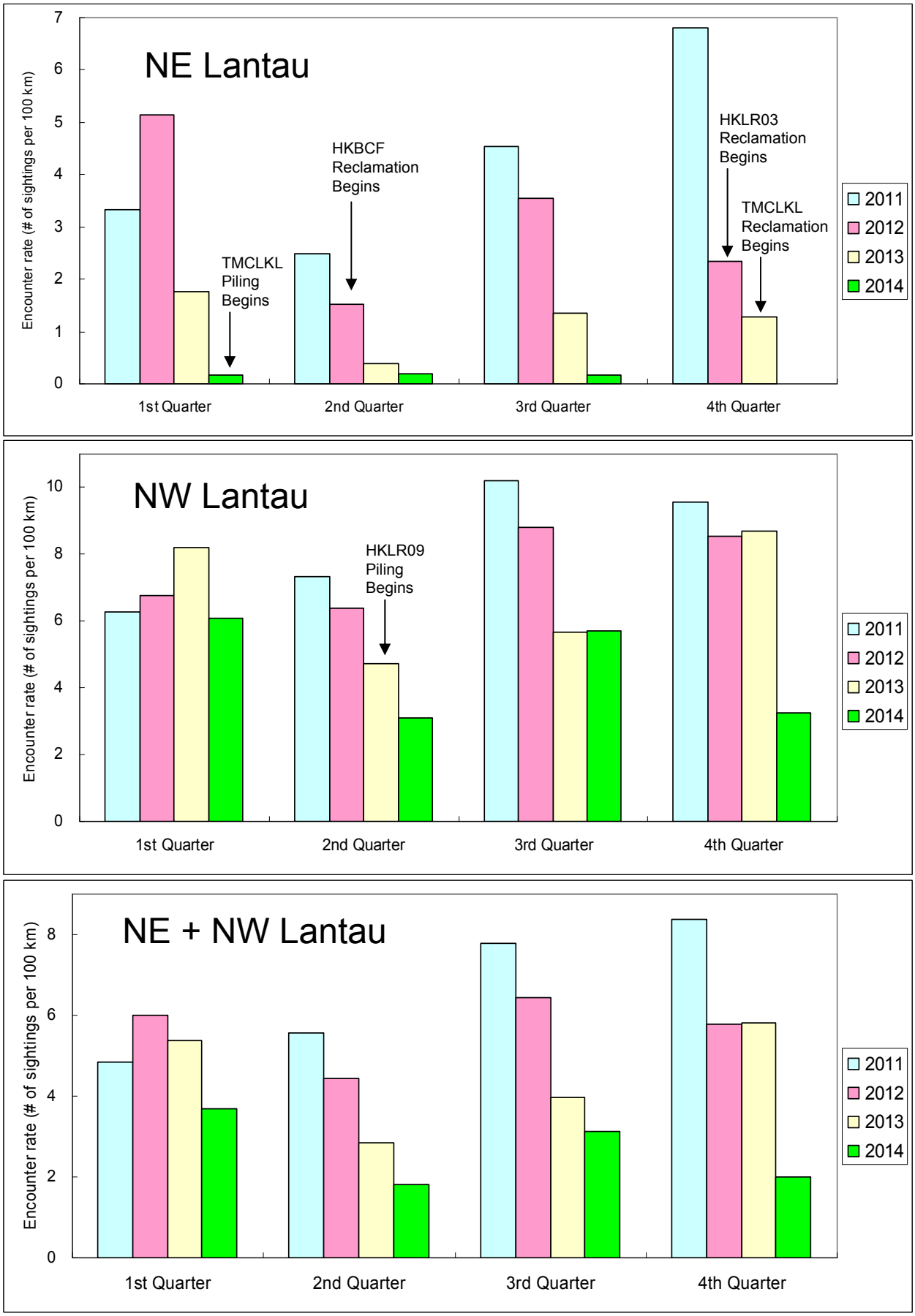


Figure 17. Temporal trends in quarterly dolphin encounter rates in North Lantau region from 2011-14 in association with schedules of HZMB works in NEL waters

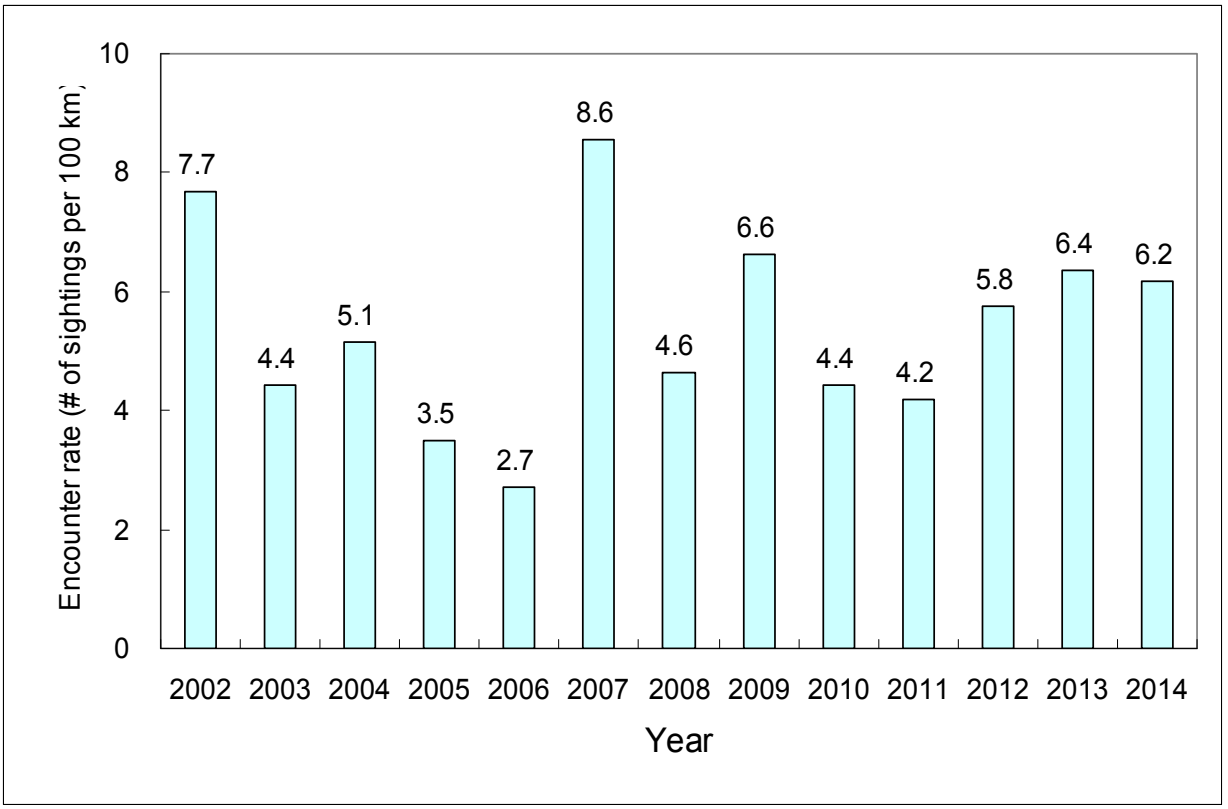


Figure 18a. Temporal trend of annual encounter rates of finless porpoises (combined from SWL, SEL, LM and PT survey areas) from 2002-14

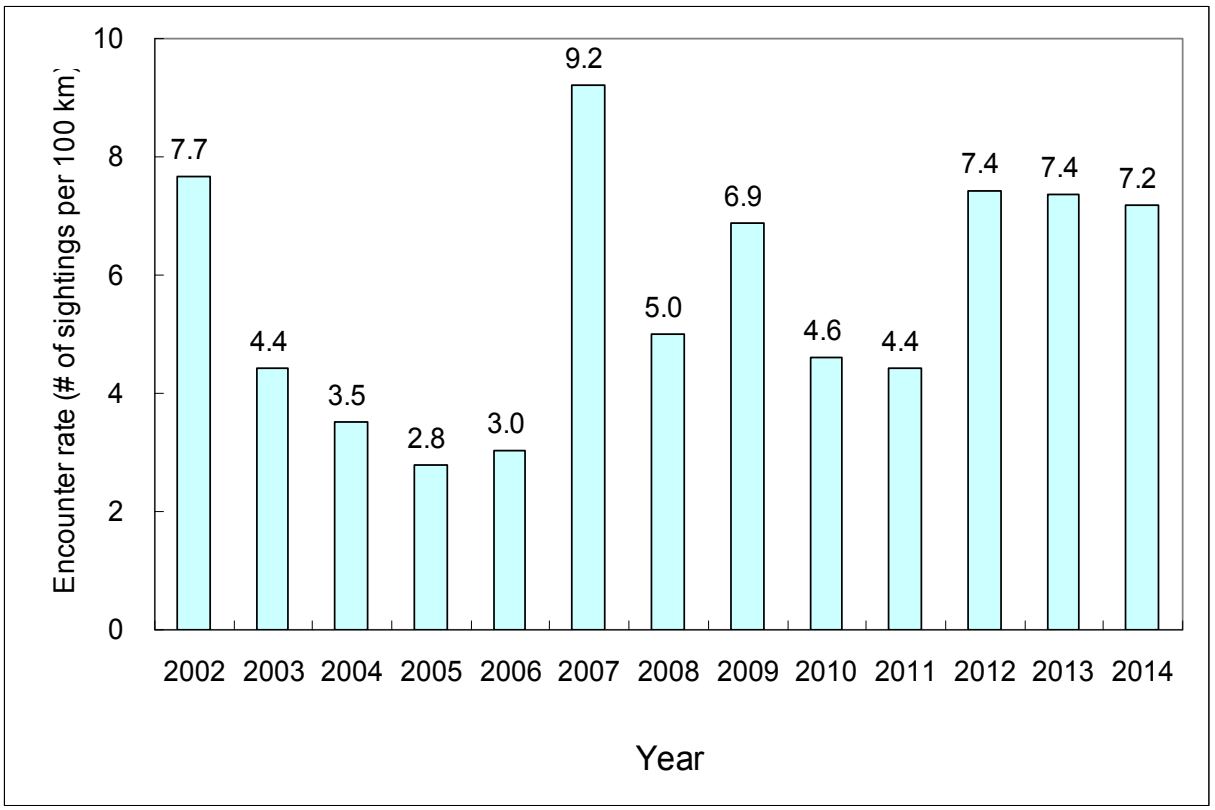
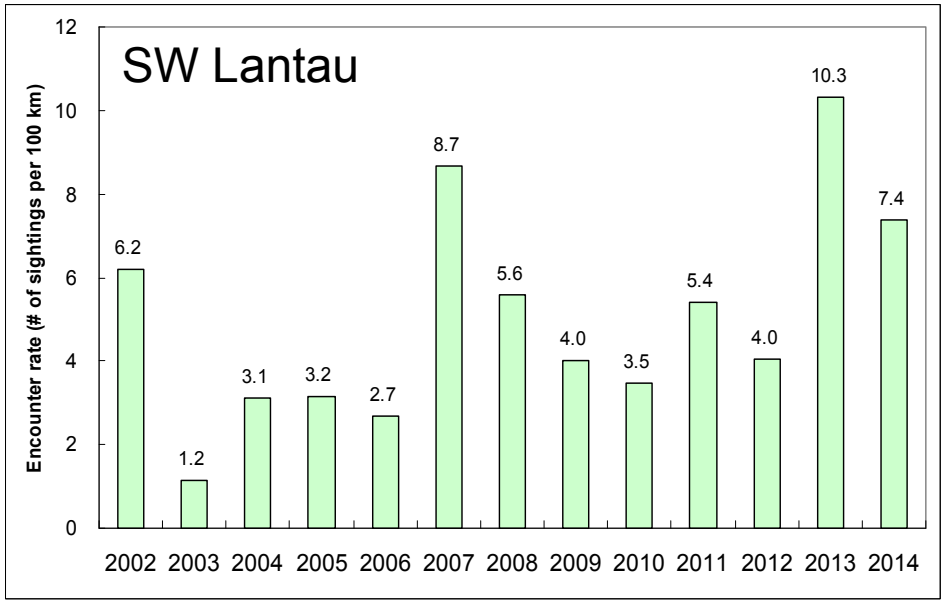
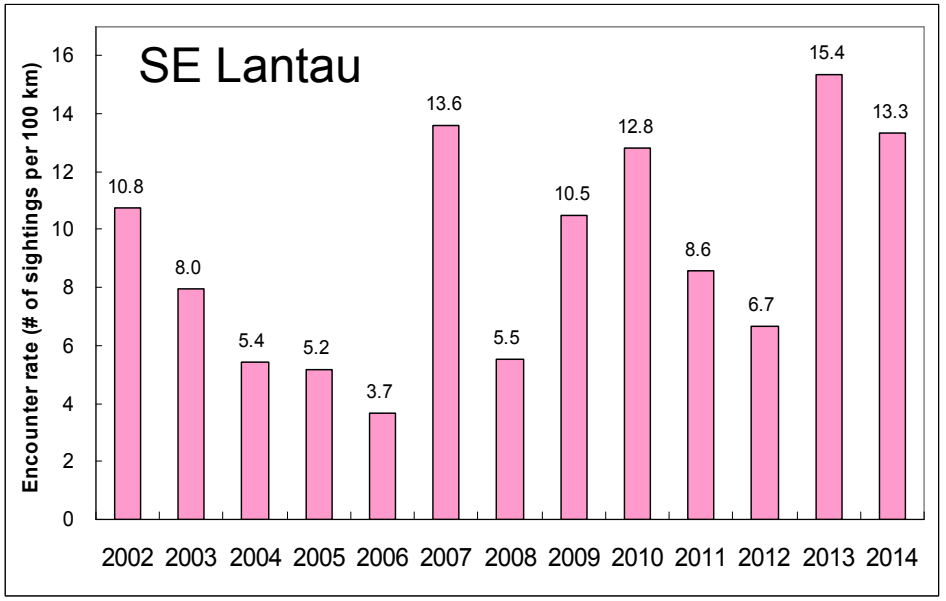
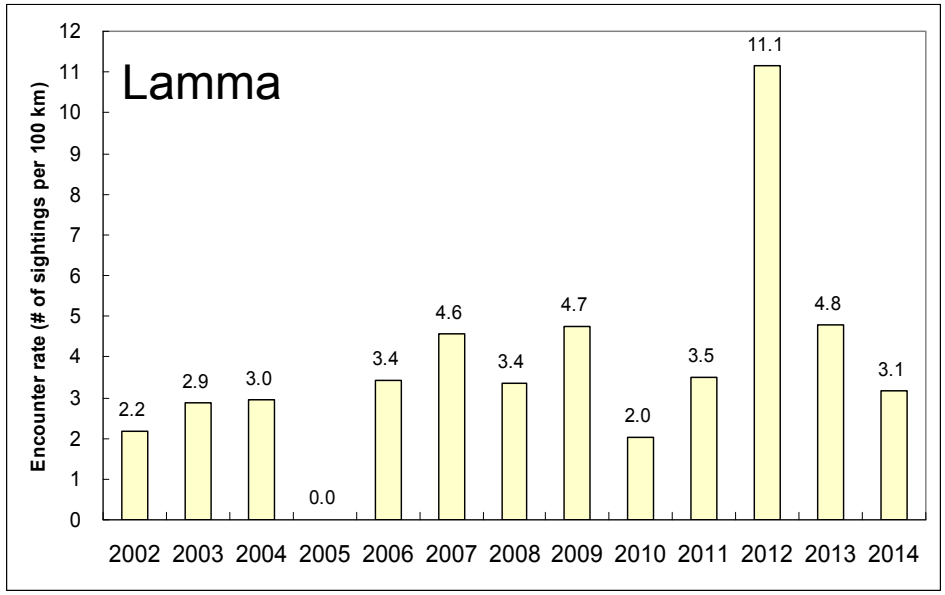


Figure 18b. Temporal trend of porpoise encounter rates in South Lantau and Lamma waters combined from winter/spring months of 2002-14







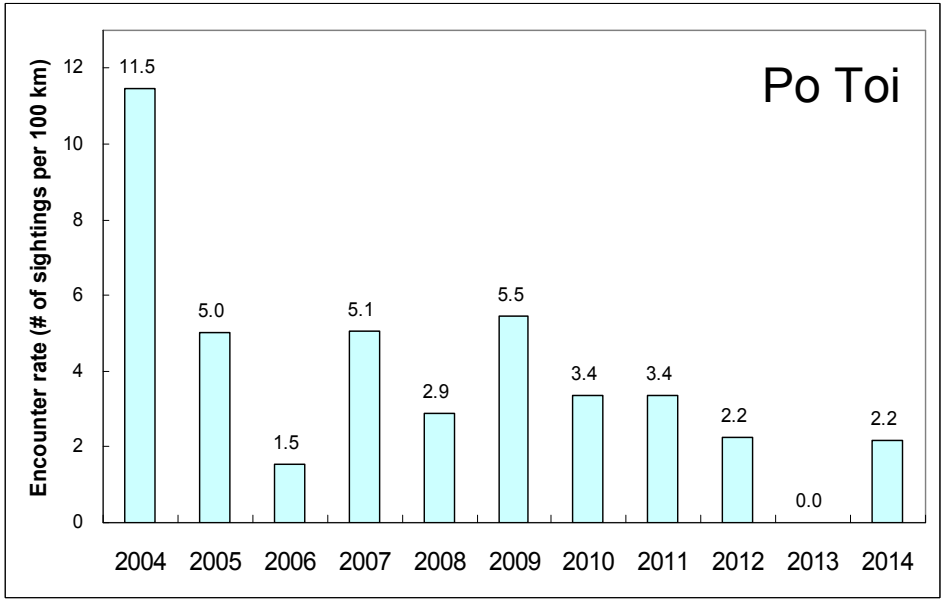


Figure 19. Temporal trends in annual encounter rates of finless porpoises among different survey areas

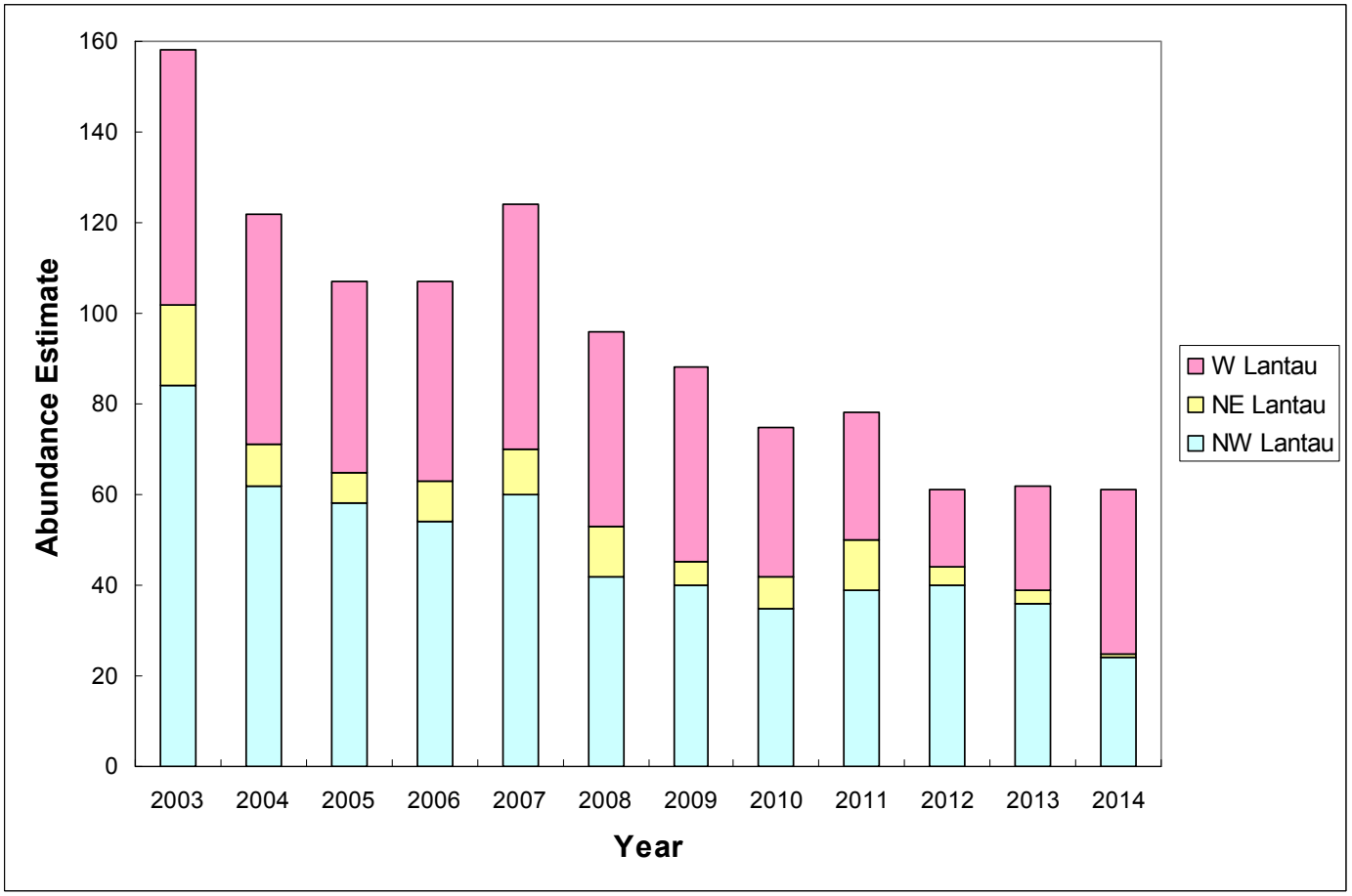
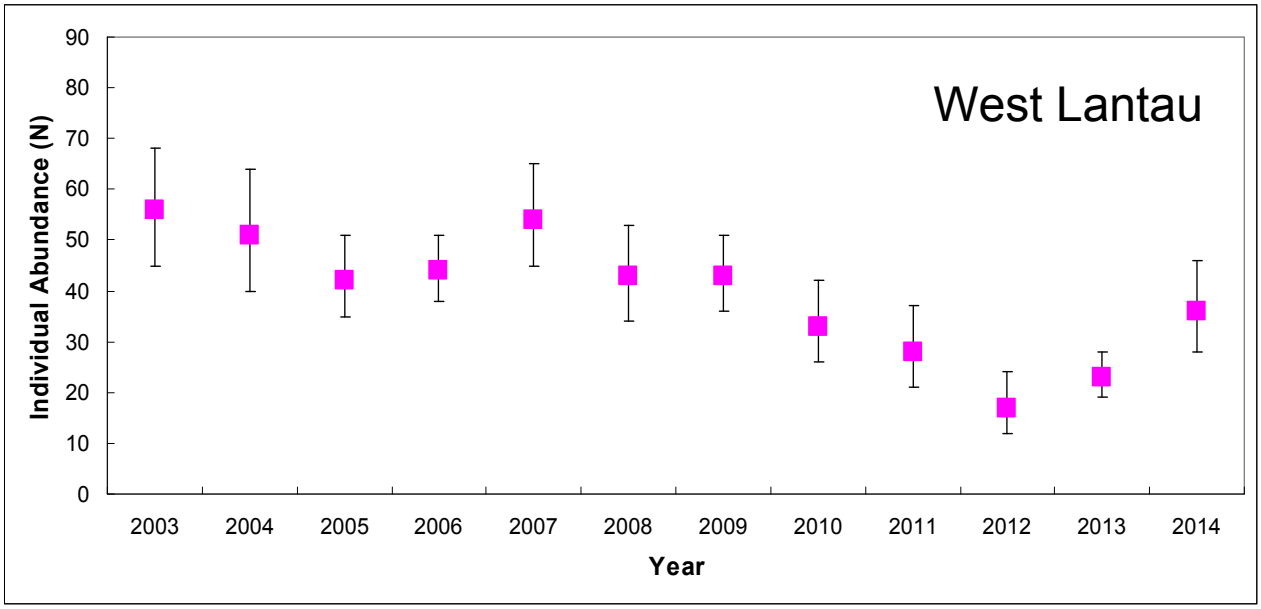
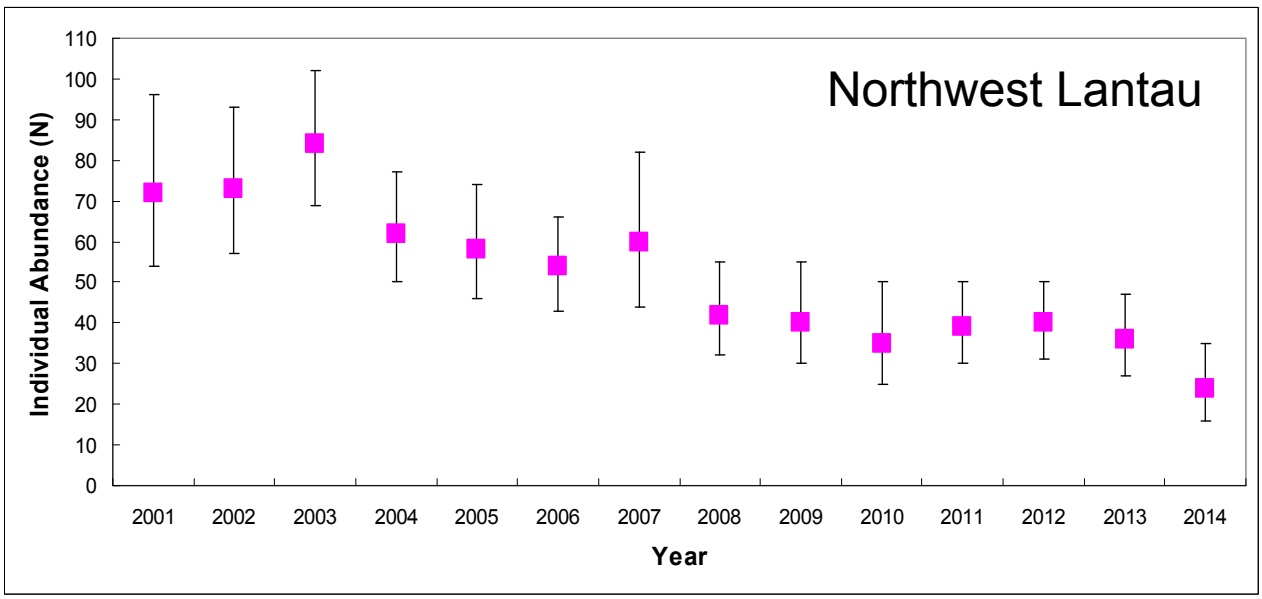


Figure 20. Temporal trends in combined abundance estimates of Chinese white dolphins in West, Northwest & Northeast Lantau from 2003-14





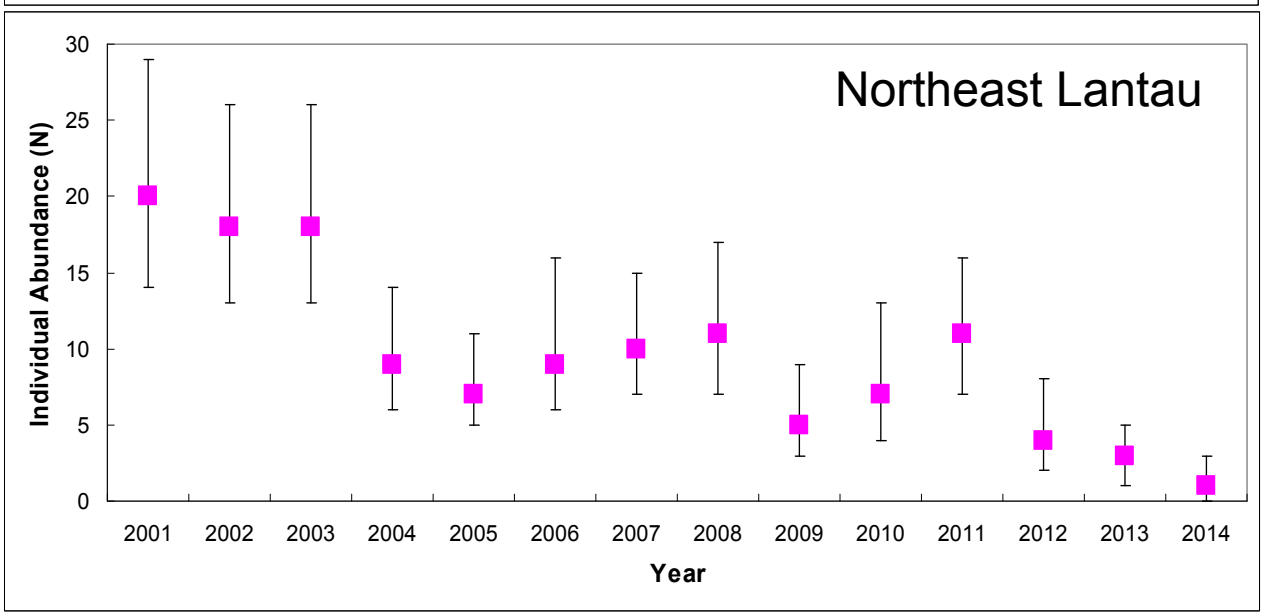


Figure 21. Temporal trends in abundance estimates of Chinese white dolphins in WL, NWL & NEL from 2001-14 (error bars: 95% confidence interval of abundance estimates)

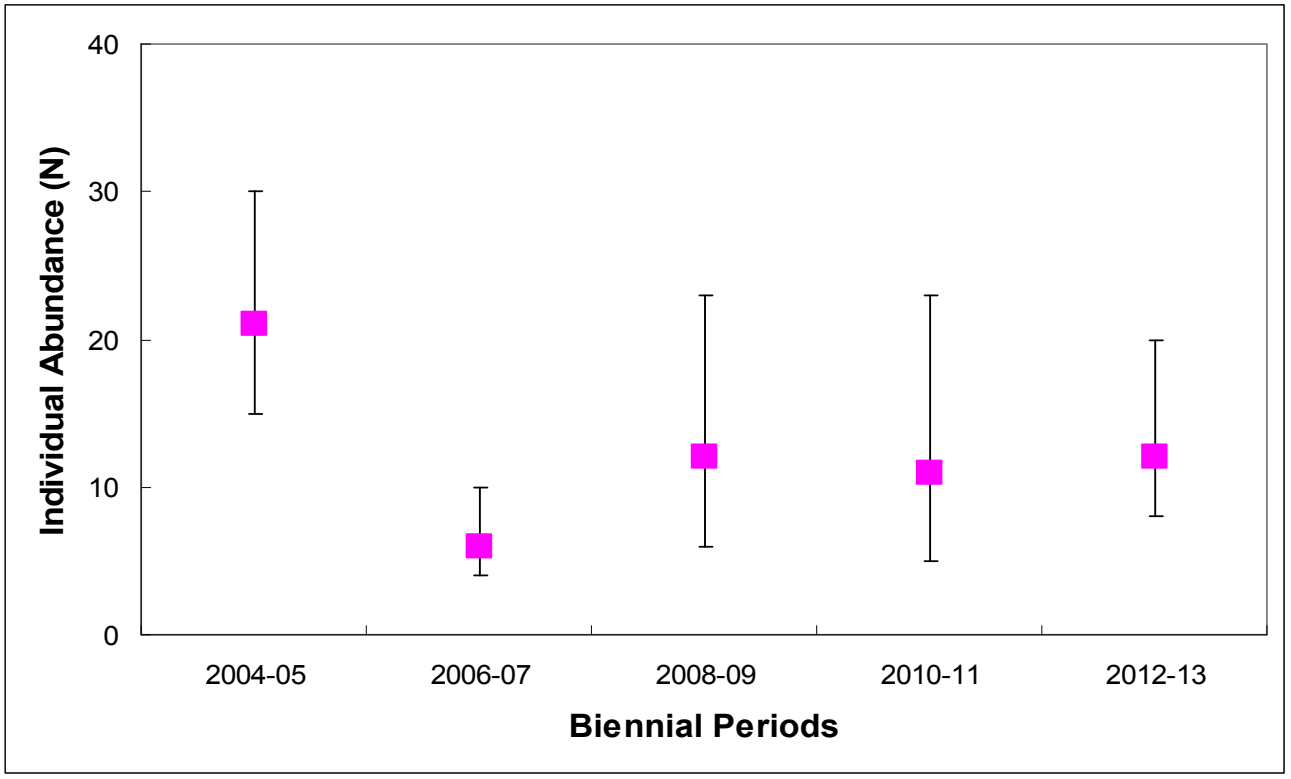


Figure 22a. Temporal trend in biennial abundance estimates of Chinese white dolphins in Southwest Lantau during 2004-13 (error bars: 95% confidence interval of abundance estimates)

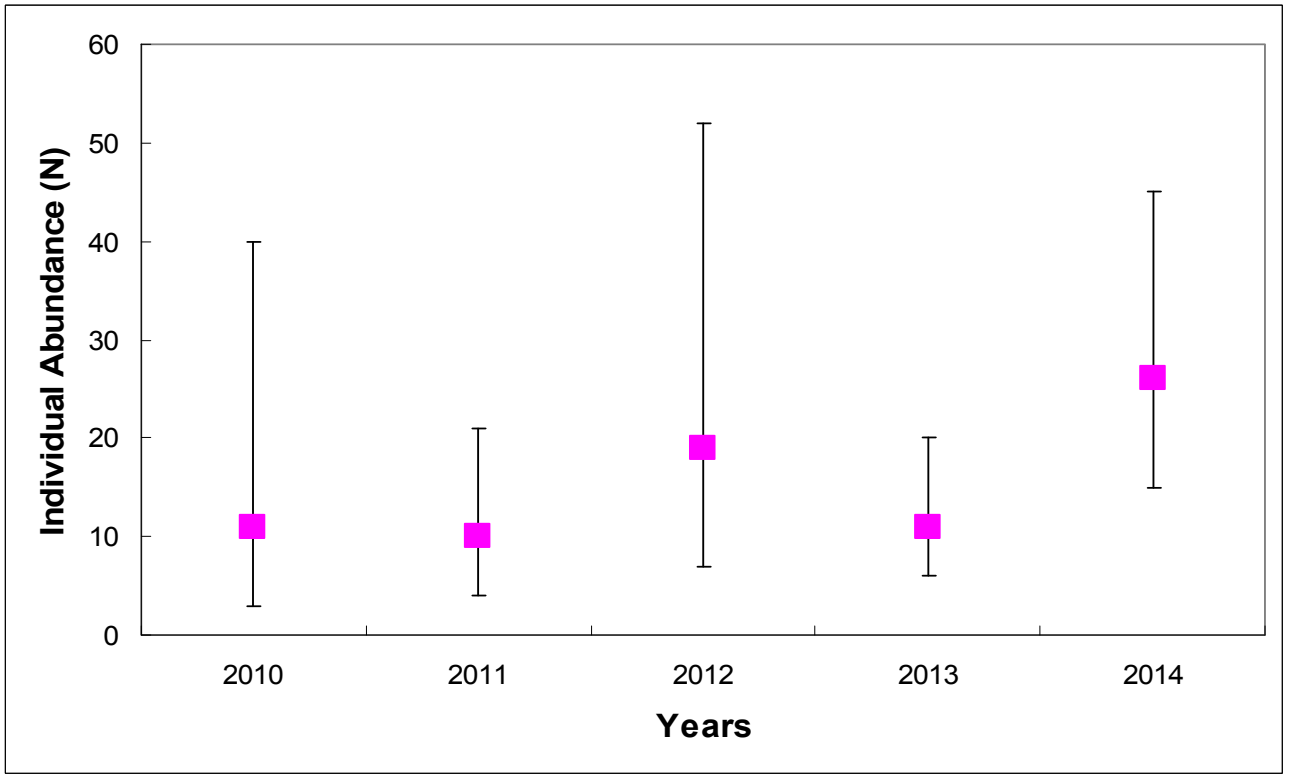
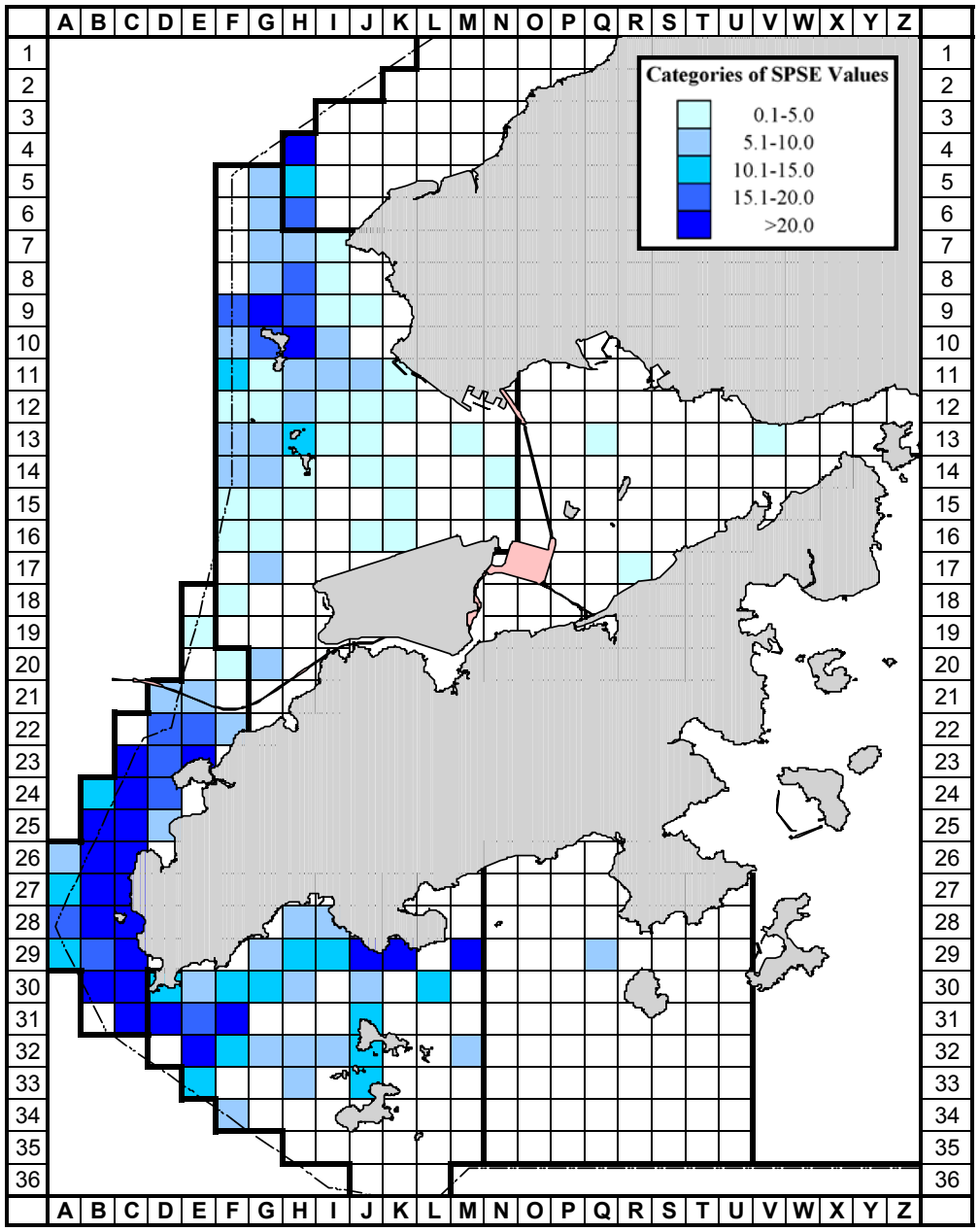


Figure 22b. Temporal trend in annual abundance estimates of Chinese white dolphins in Southwest Lantau from 2010-14 (error bars: 95% confidence interval of abundance estimates)



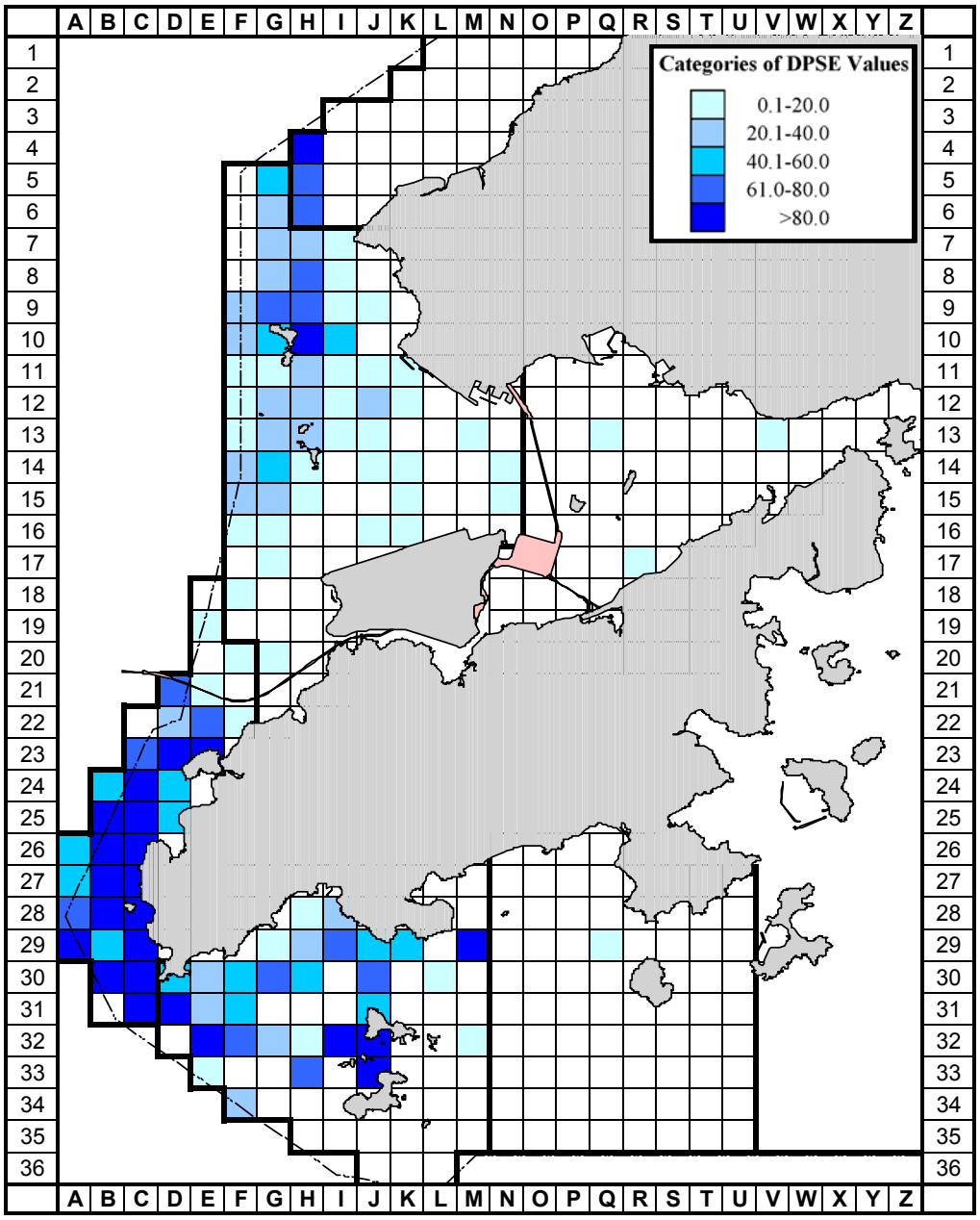


Figure 23. (left) Sighting density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau Island (number within grids represent "SPSE" = no. of on-effort dolphin sightings per 100 units of survey effort) (using data from January - December 2014)

(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 2014)

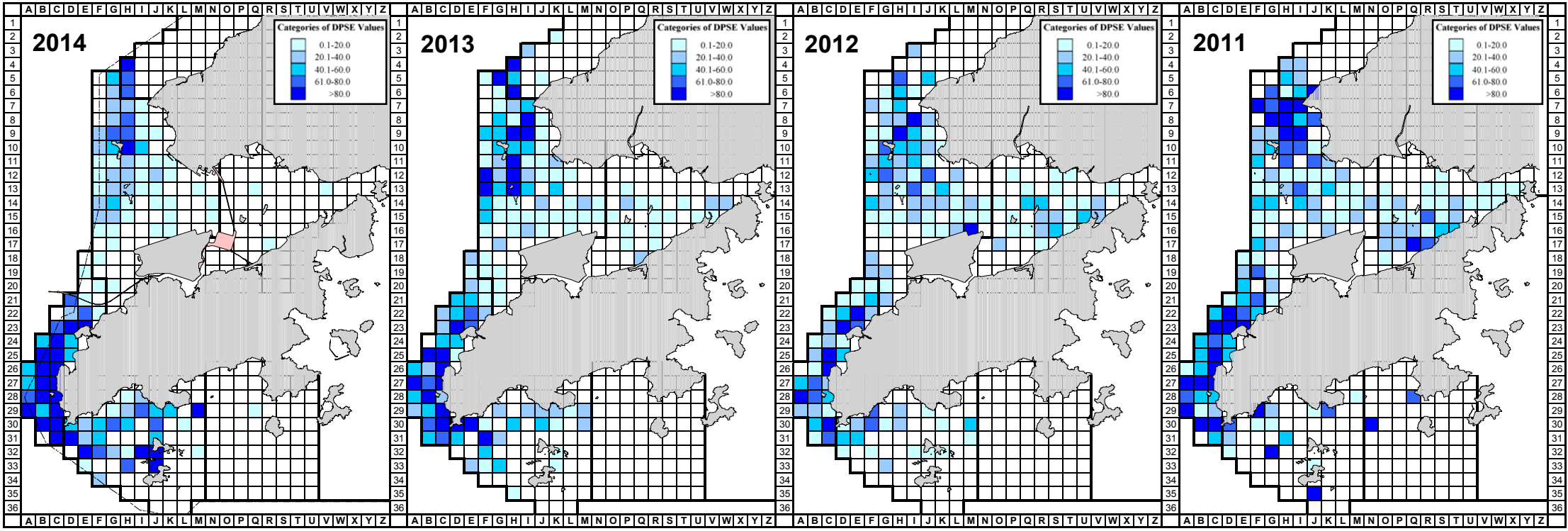
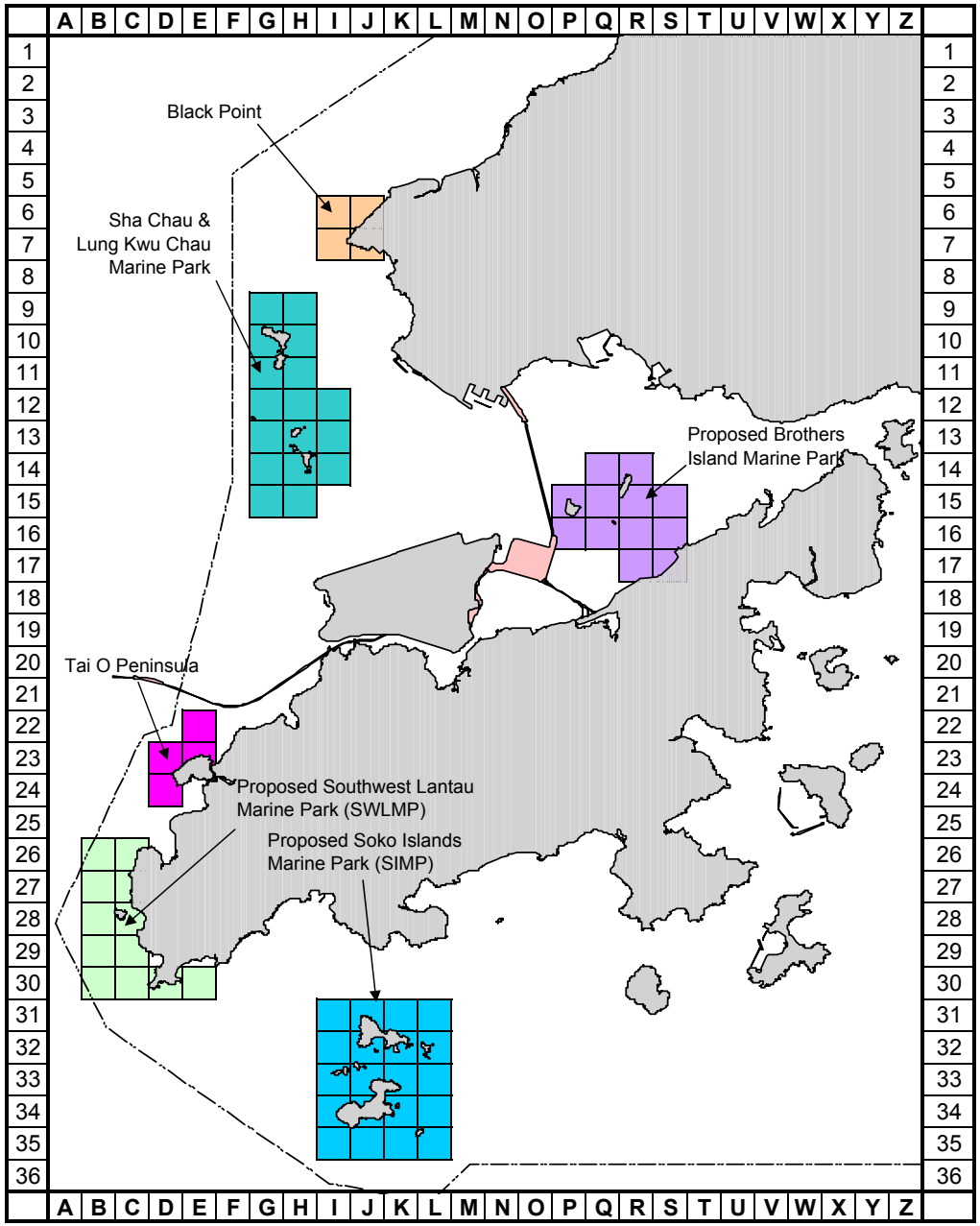


Figure 24. Comparison of Chinese white dolphin densities with corrected survey effort per km^2 in waters around Lantau Island in 2011-14
(number within grids represent "DPSE" = no. of dolphins per 100 units of survey effort)



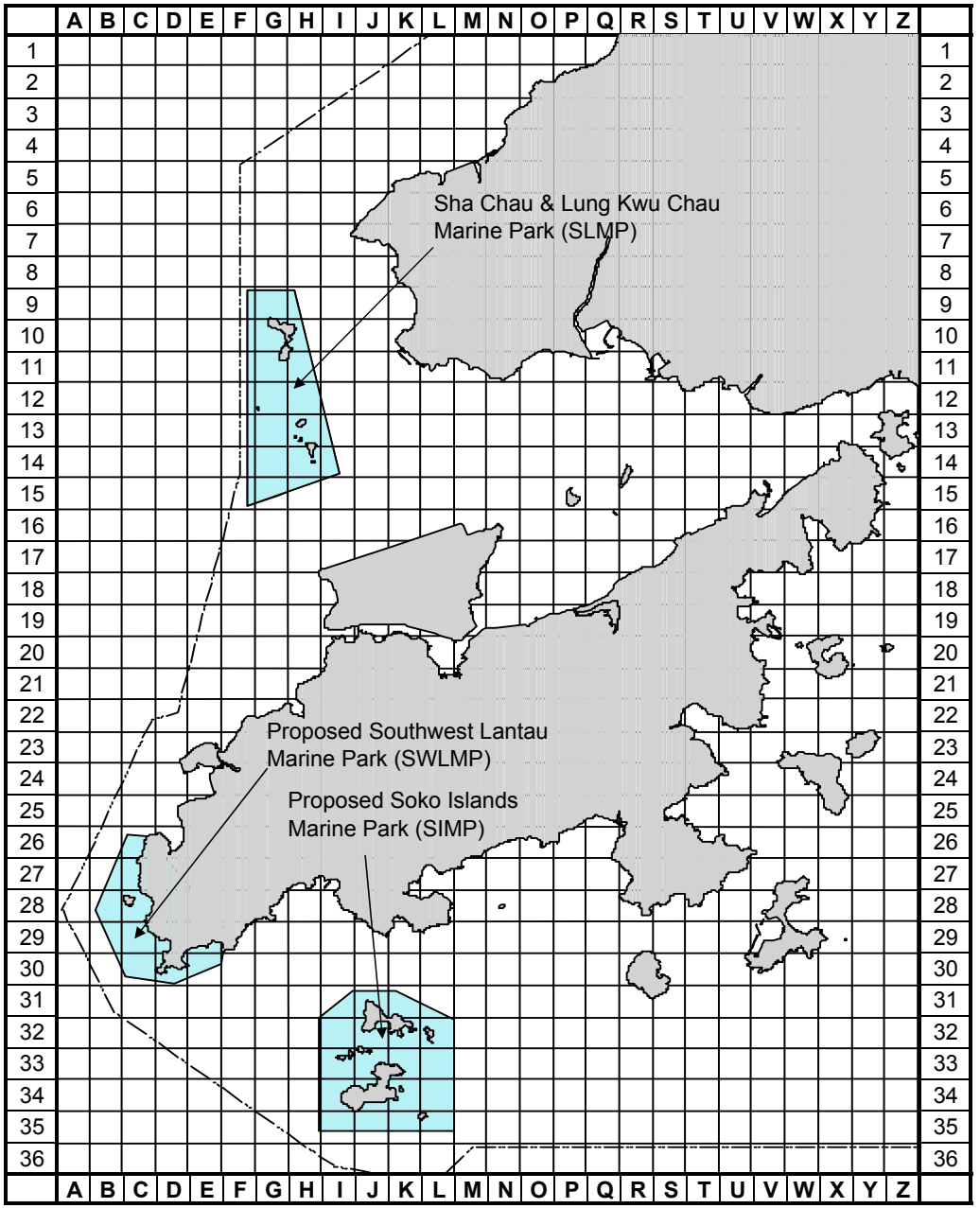


Figure 25. Grids of six key dolphin habitats that were examined for temporal trend in dolphin densities

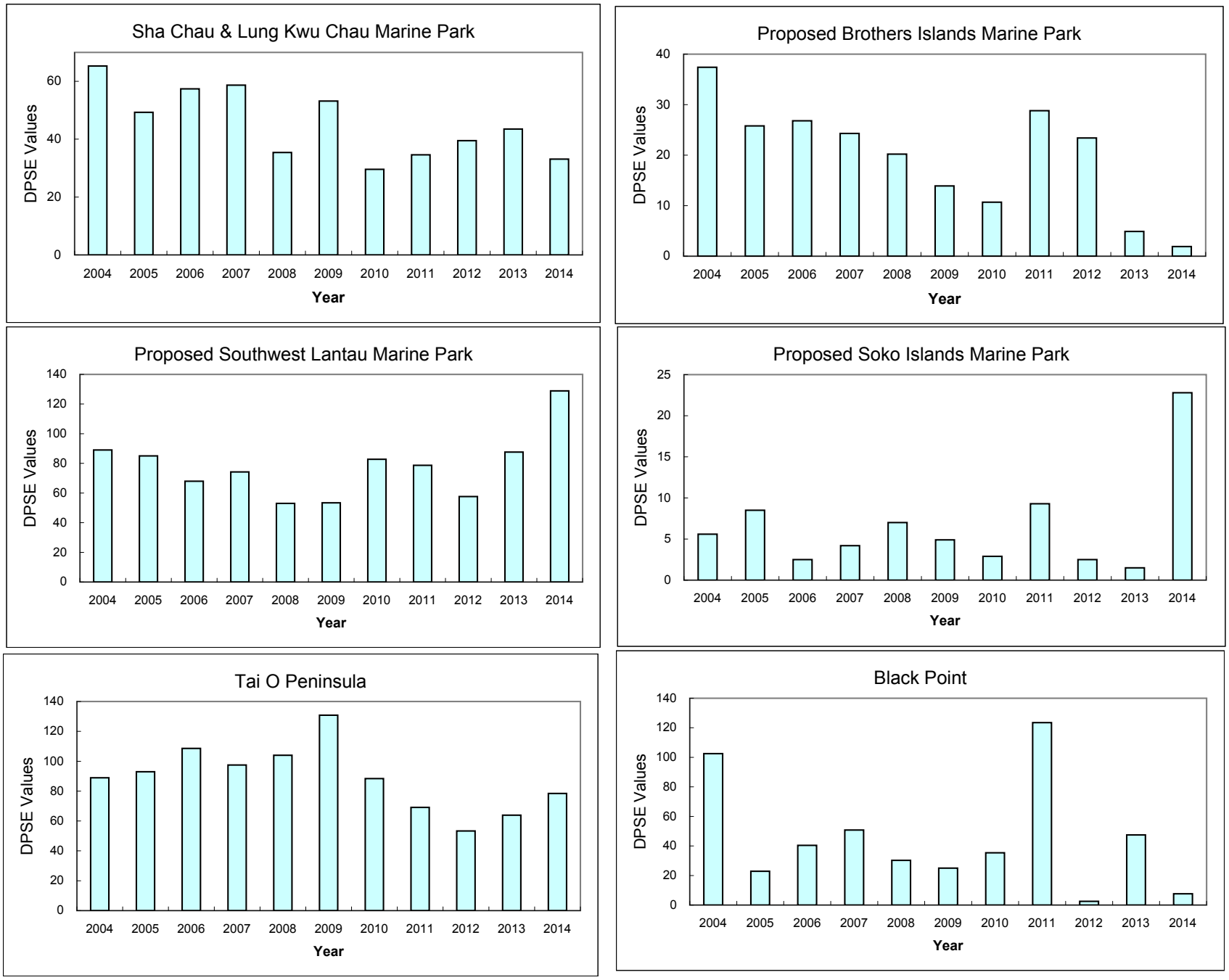


Figure 26. Temporal trend of dolphin densities (DPSE Values) at six key dolphin habitats in Lantau waters

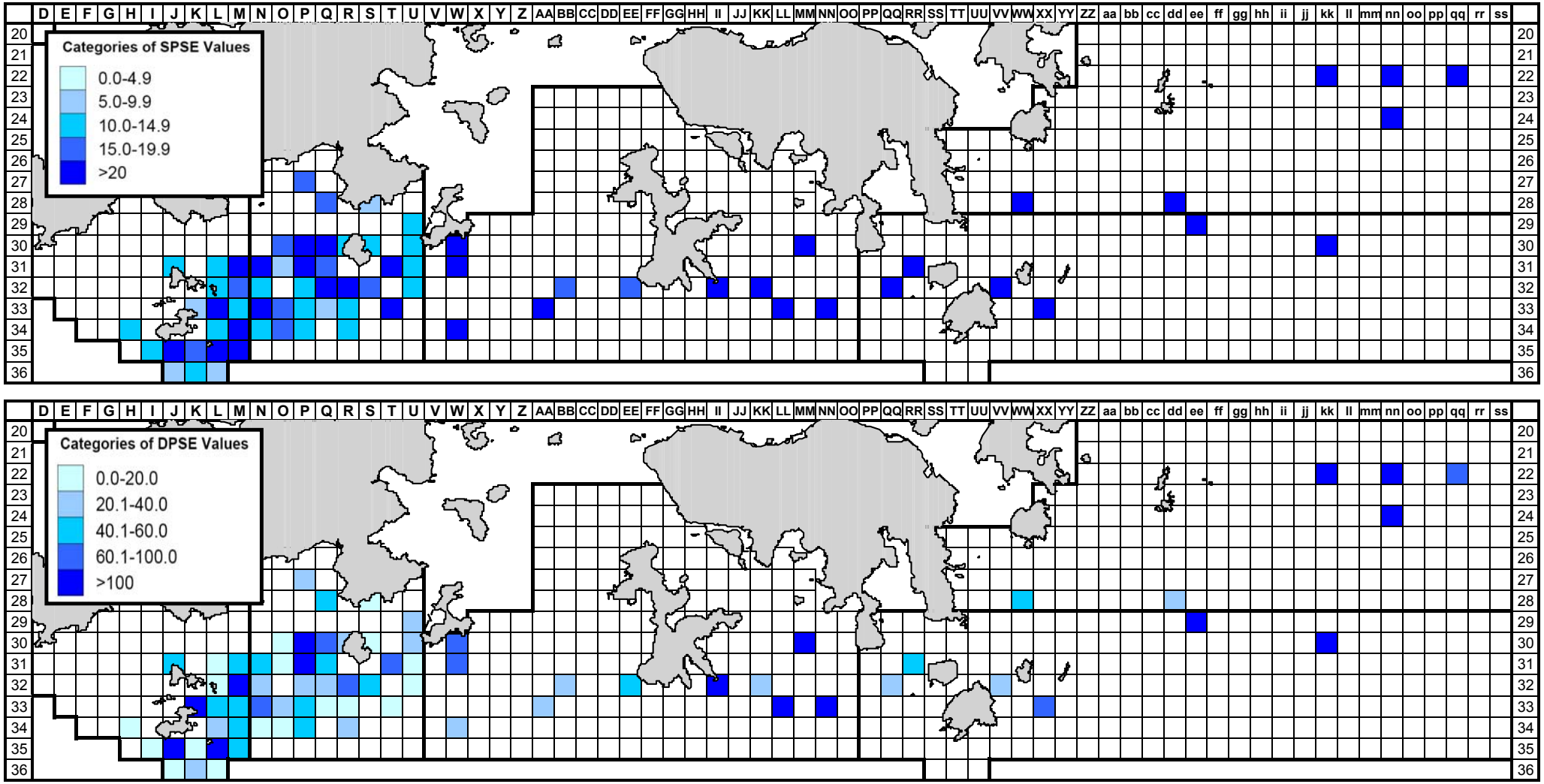


Figure 27. (top) Sighting density of finless porpoises with corrected survey effort per km^2 in southern waters of Hong Kong (number within grids represent "SPSE" = no. of on-effort porpoise sightings per 100 units of survey effort) (using data from January - December 2014)

(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 2014)

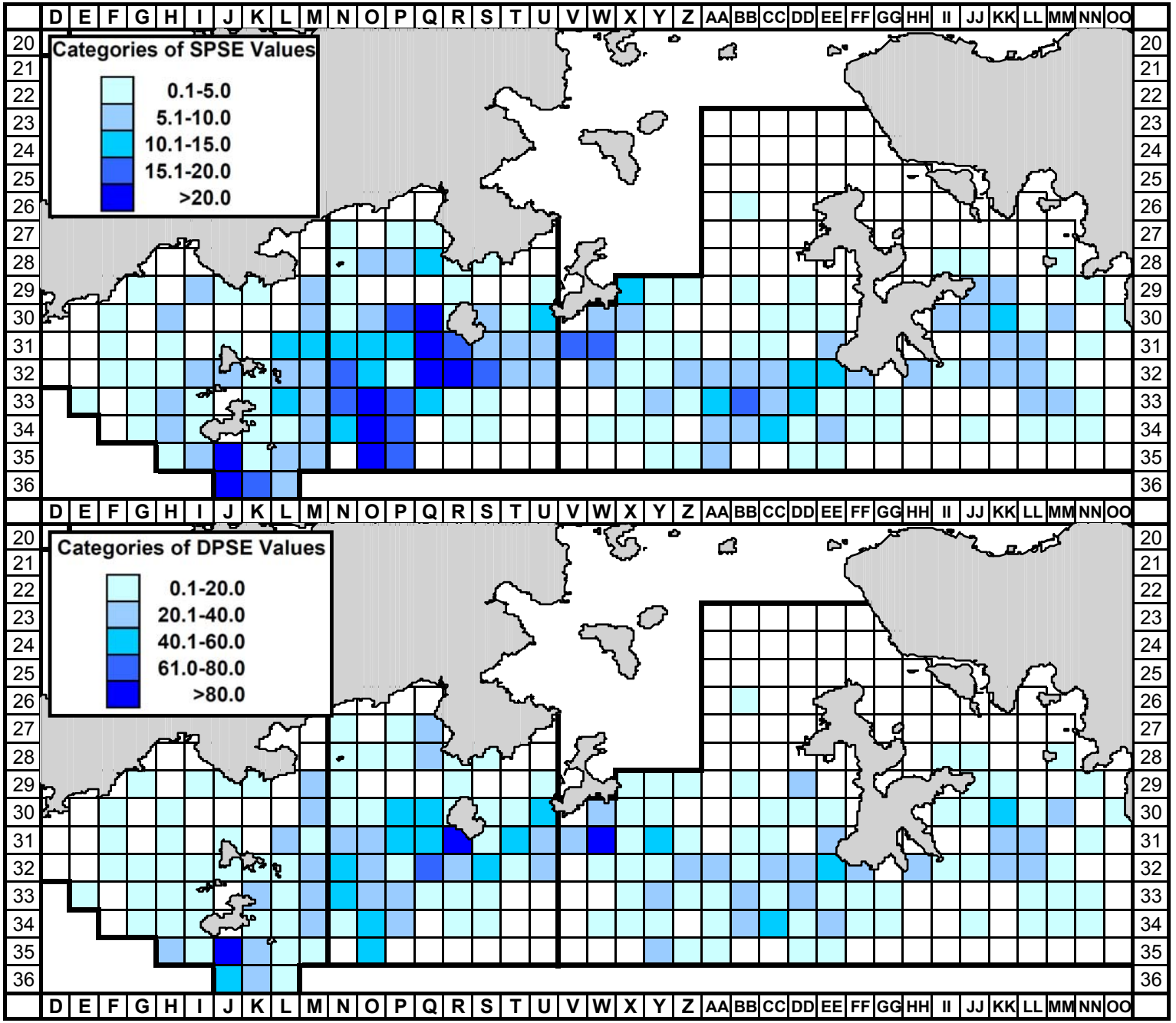


Figure 28. Density of finless porpoises with corrected survey effort per km^2 in southern waters of Hong Kong during dry season (December to May), using data collected during 2005-14 (SPSE = no. of on-effort porpoise sightings per 100 units of survey effort; DPSE = no. of porpoises per 100 units of survey effor

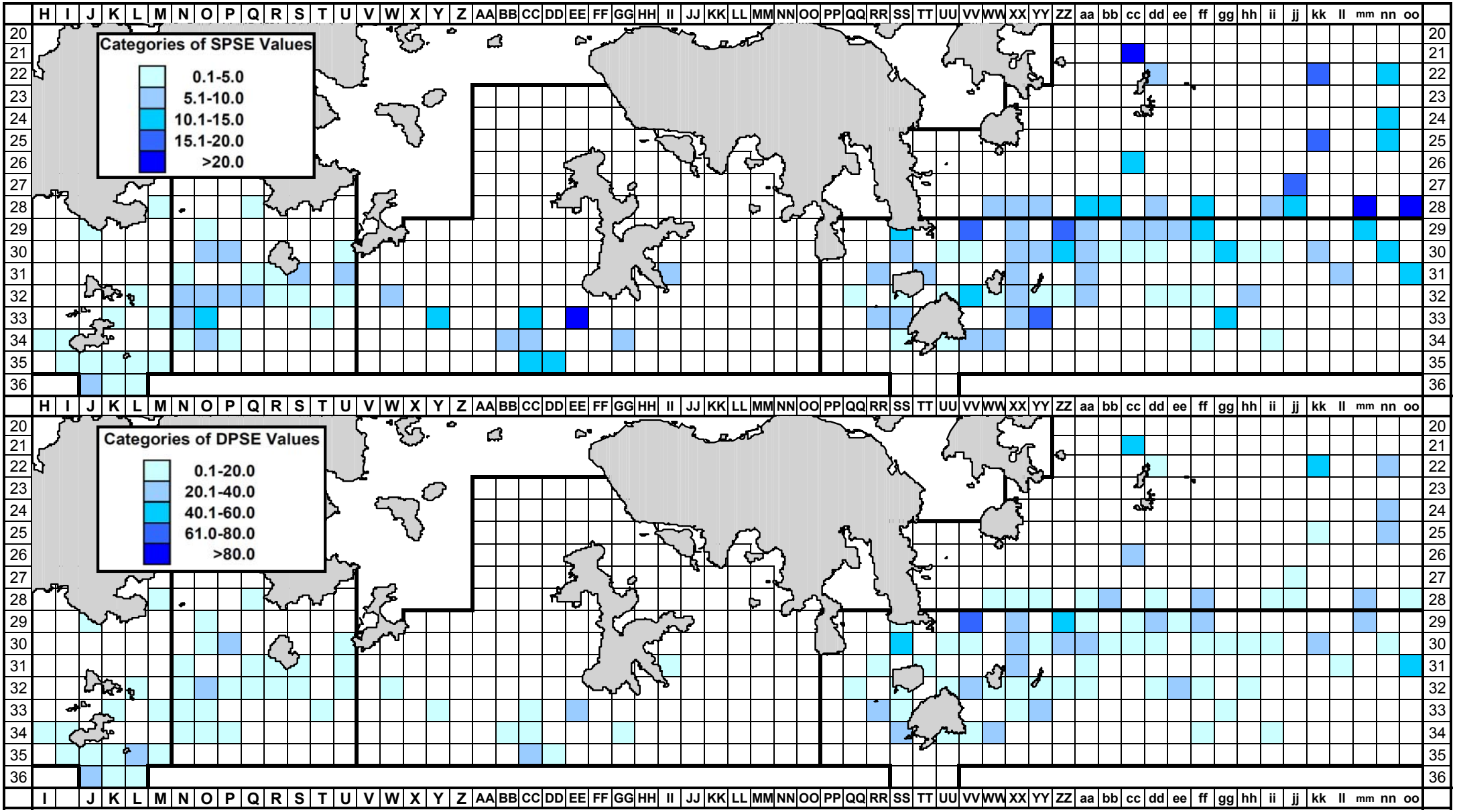


Figure 29. Density of finless porpoises with corrected survey effort per km^2 in southern waters of Hong Kong during wet season (June to November), using data collected during 2005-14 (SPSE = no. of on-effort porpoise sightings per 100 units of survey effort; DPSE = no. of porpoises per 100 units of survey effort

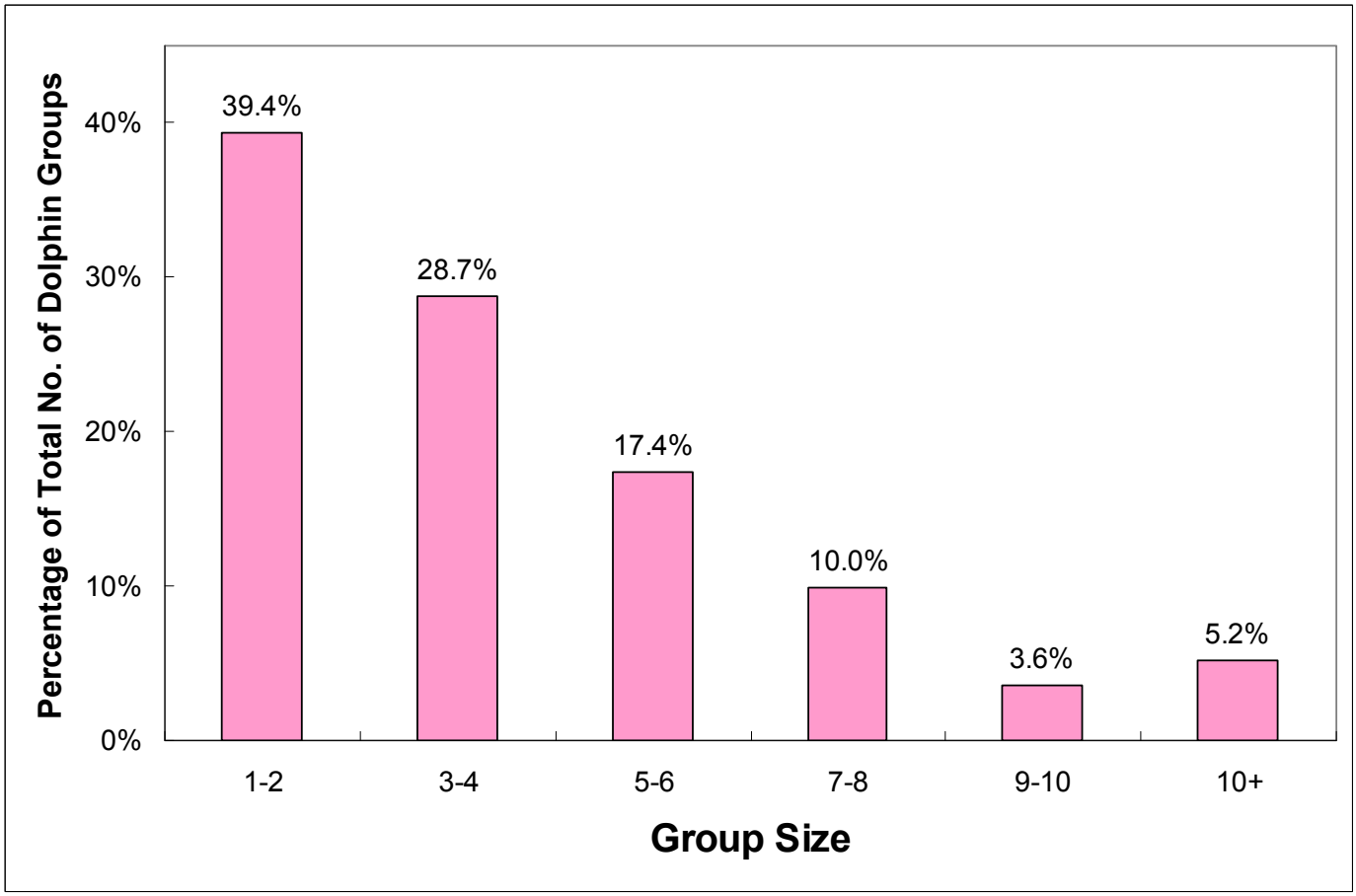


Figure 30. Percentages of different group sizes of Chinese white dolphins in Hong Kong during April 2014 to March 2015

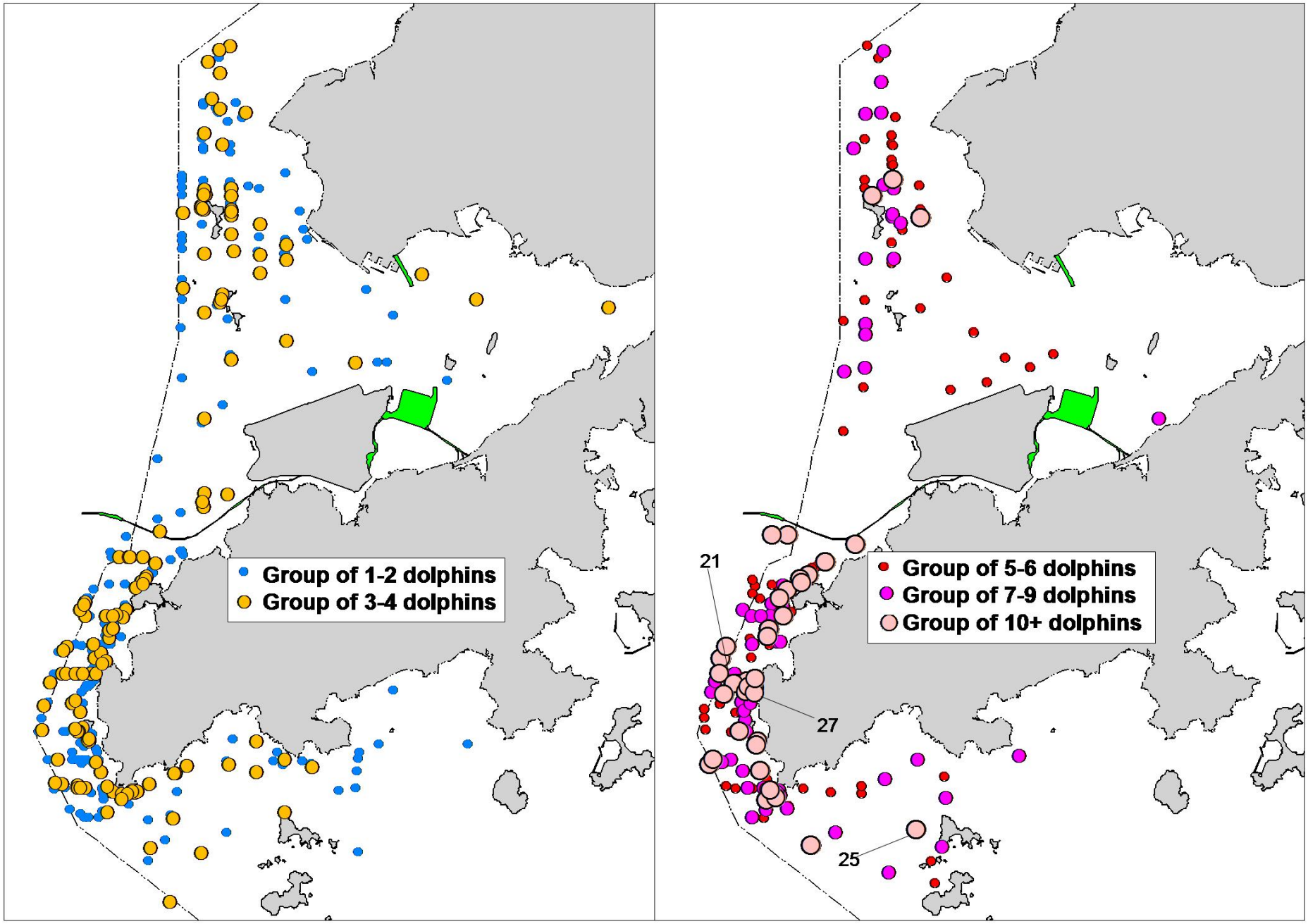


Figure 31. Distribution of Chinese white dolphins with different group sizes in 2014 (groups with 20+ dolphins highlighted)

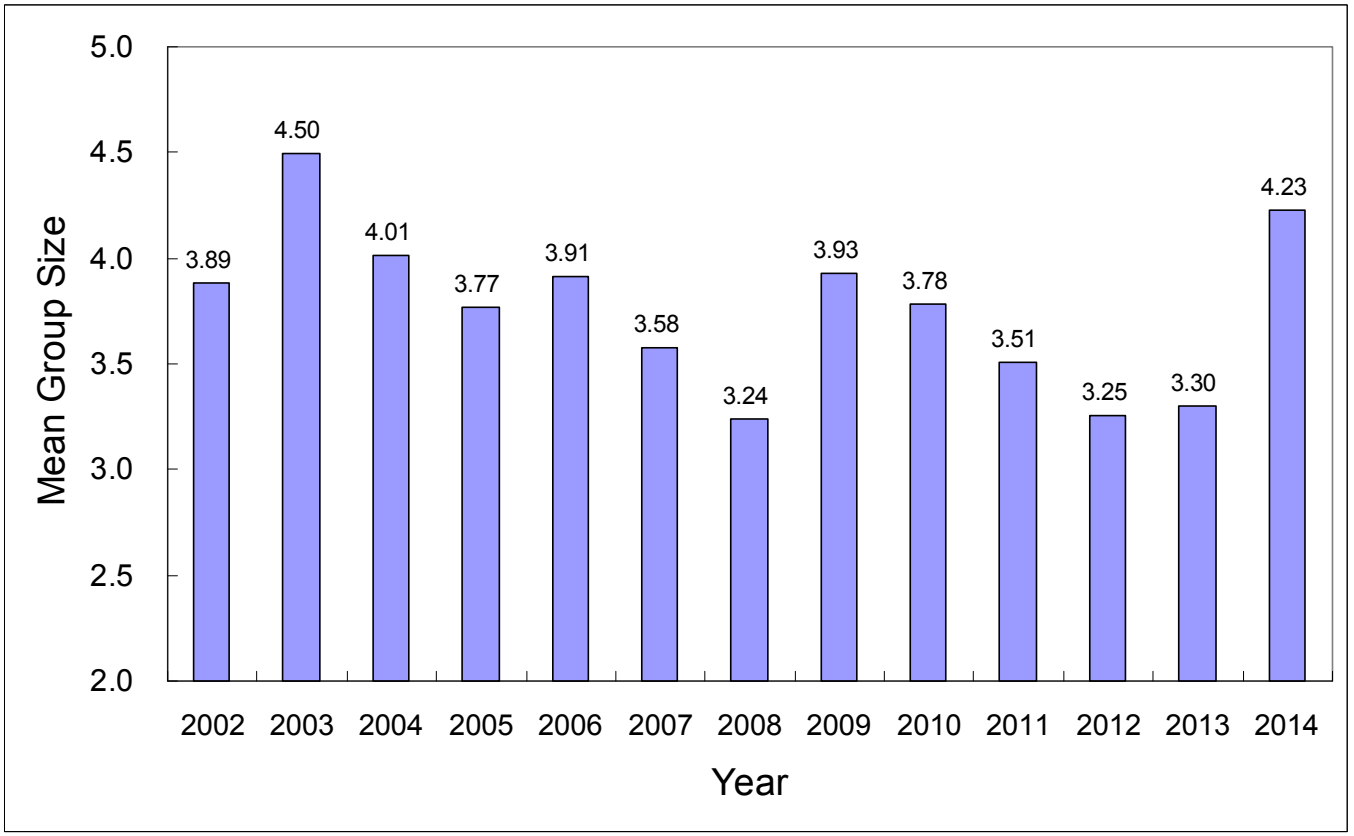


Figure 32. Temporal trend of mean dolphin group size in 2002-14

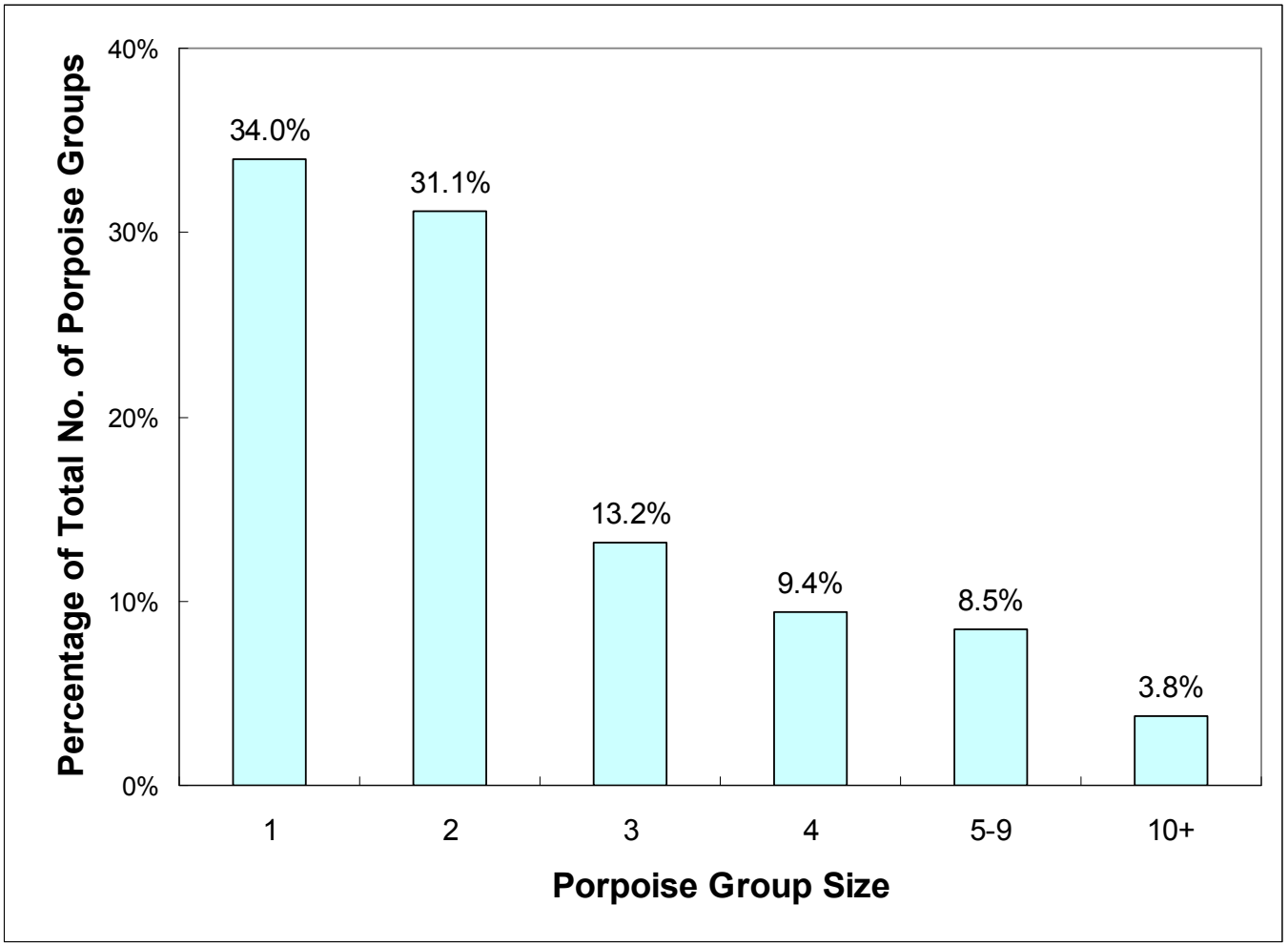


Figure 33. Percentages of different group sizes of finless porpoises in Hong Kong during April 2014 to March 2015

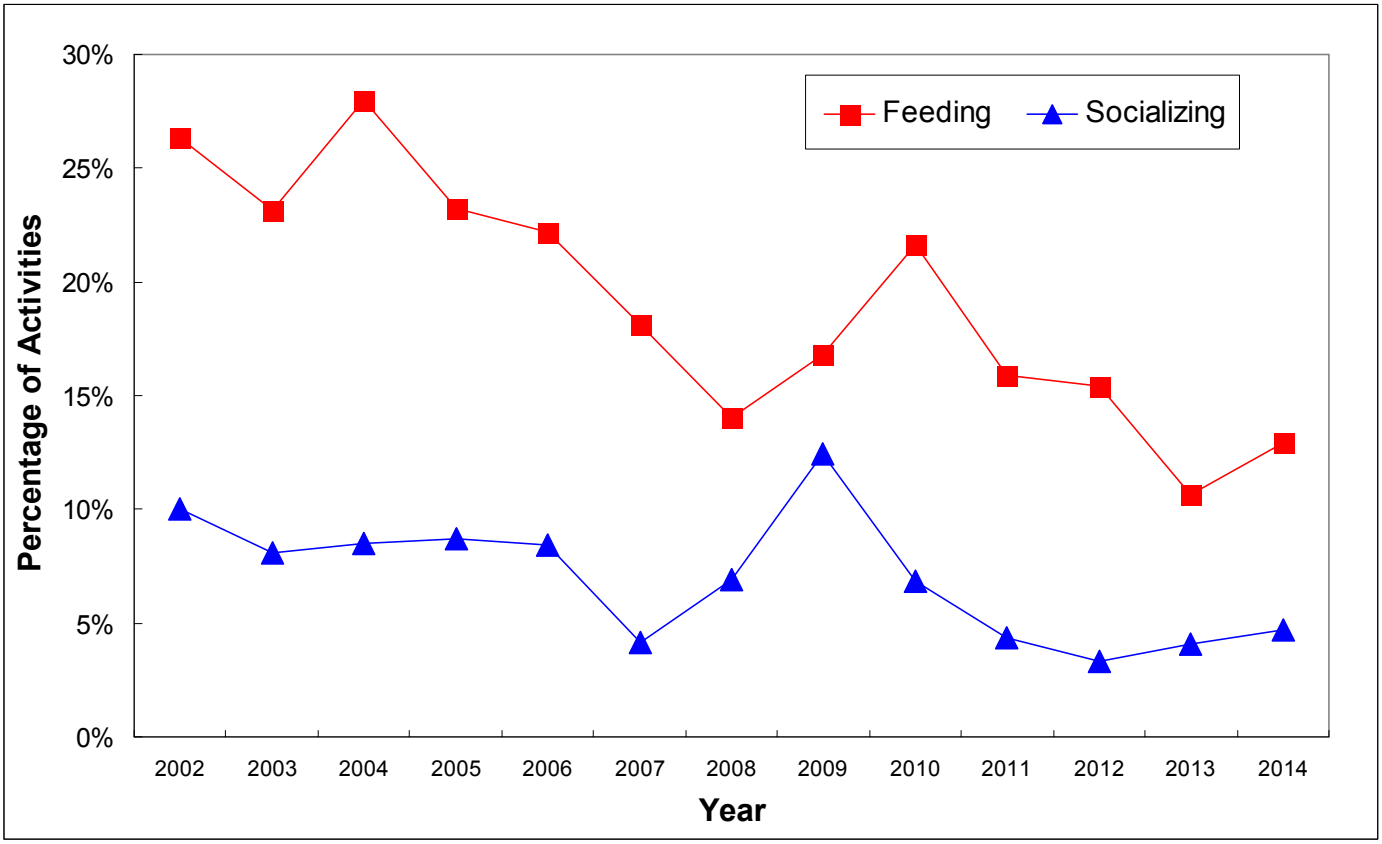


Figure 34. Percentages of feeding and socializing activities among all dolphin groups sighted in Hong Kong during 2002-14

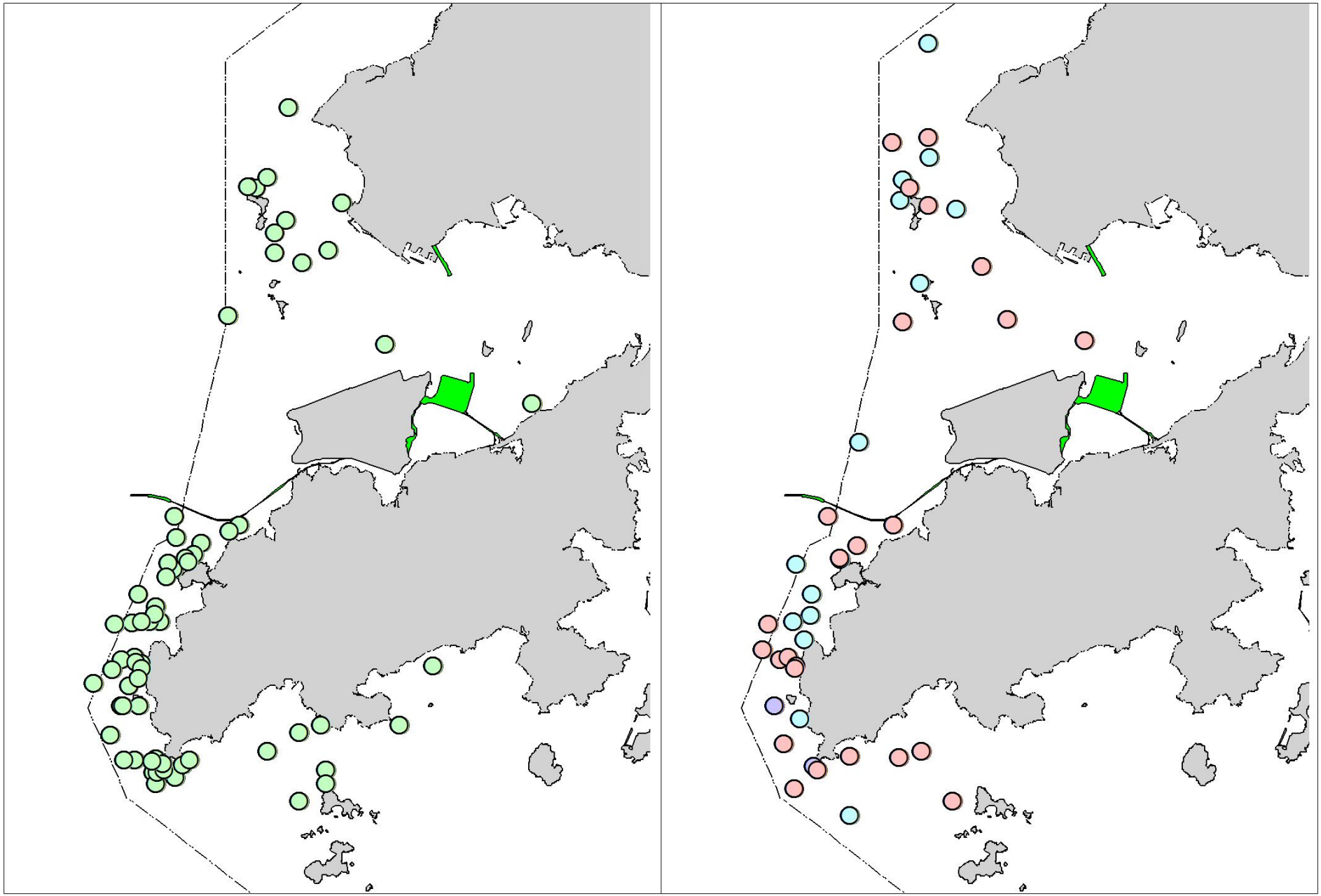


Figure 35. Distribution of Chinese white dolphins engaged in feeding (green dots), socializing (pink dots), traveling (blue dots) and milling (purple dots) activities in 2014

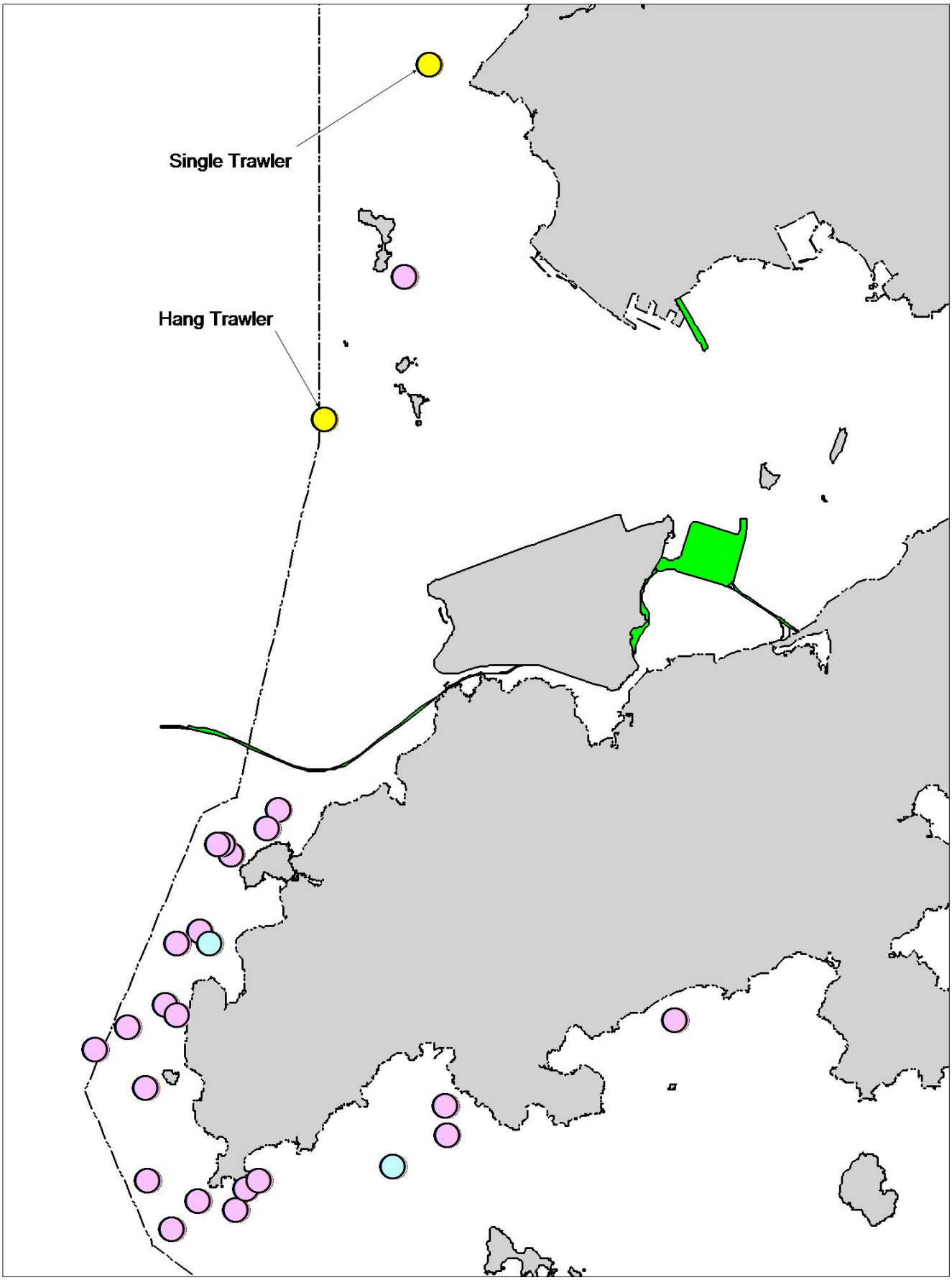


Figure 36. Distribution of dolphin sightings associated with fishing boats in 2014
(purple dots: with purse-seiners, blue dots: with gill-netters; yellow dots: with bottom trawlers)

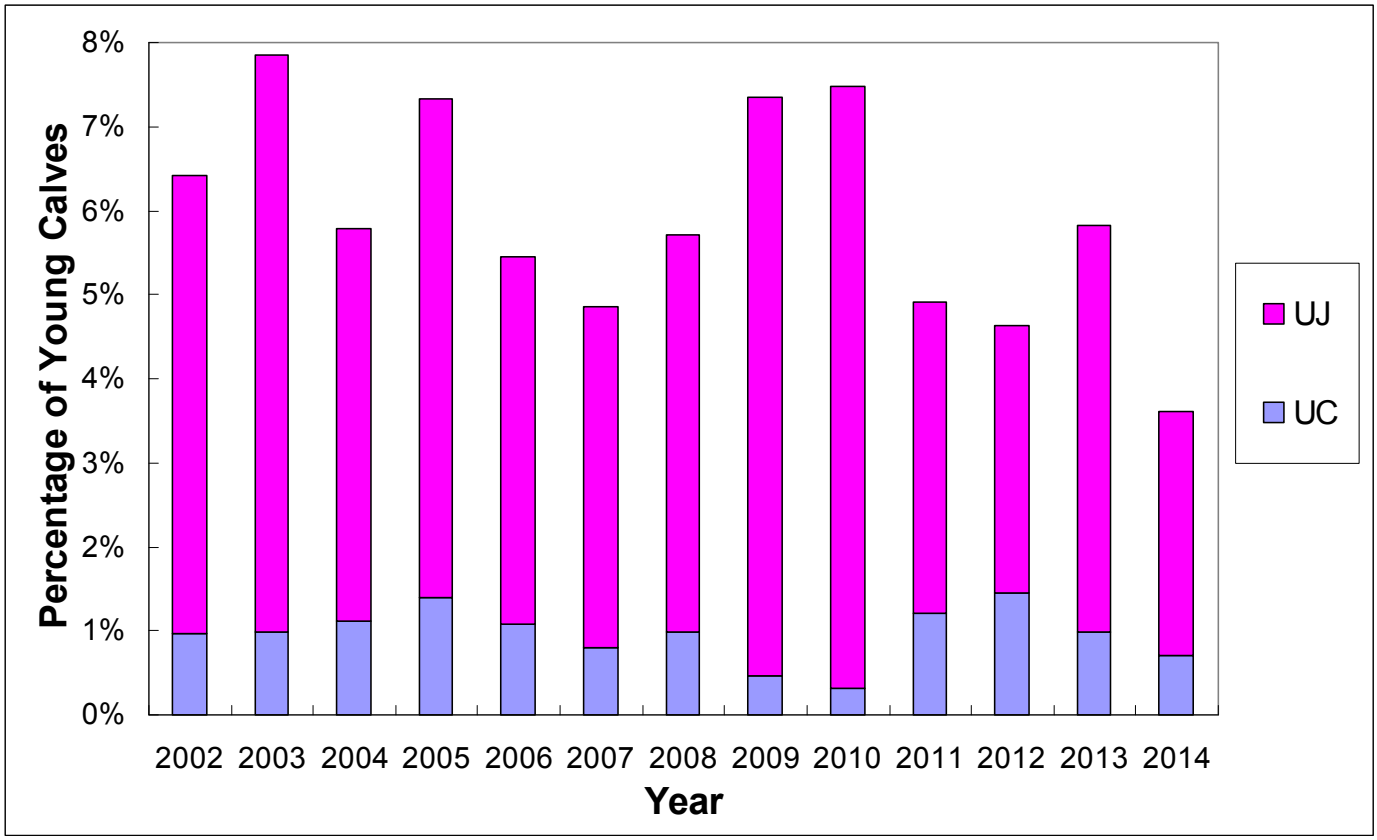


Figure 37. Percentages of young calves (i.e. unspotted calves (UC) and unspotted juveniles (UJ)) among all dolphin groups during 2002-14

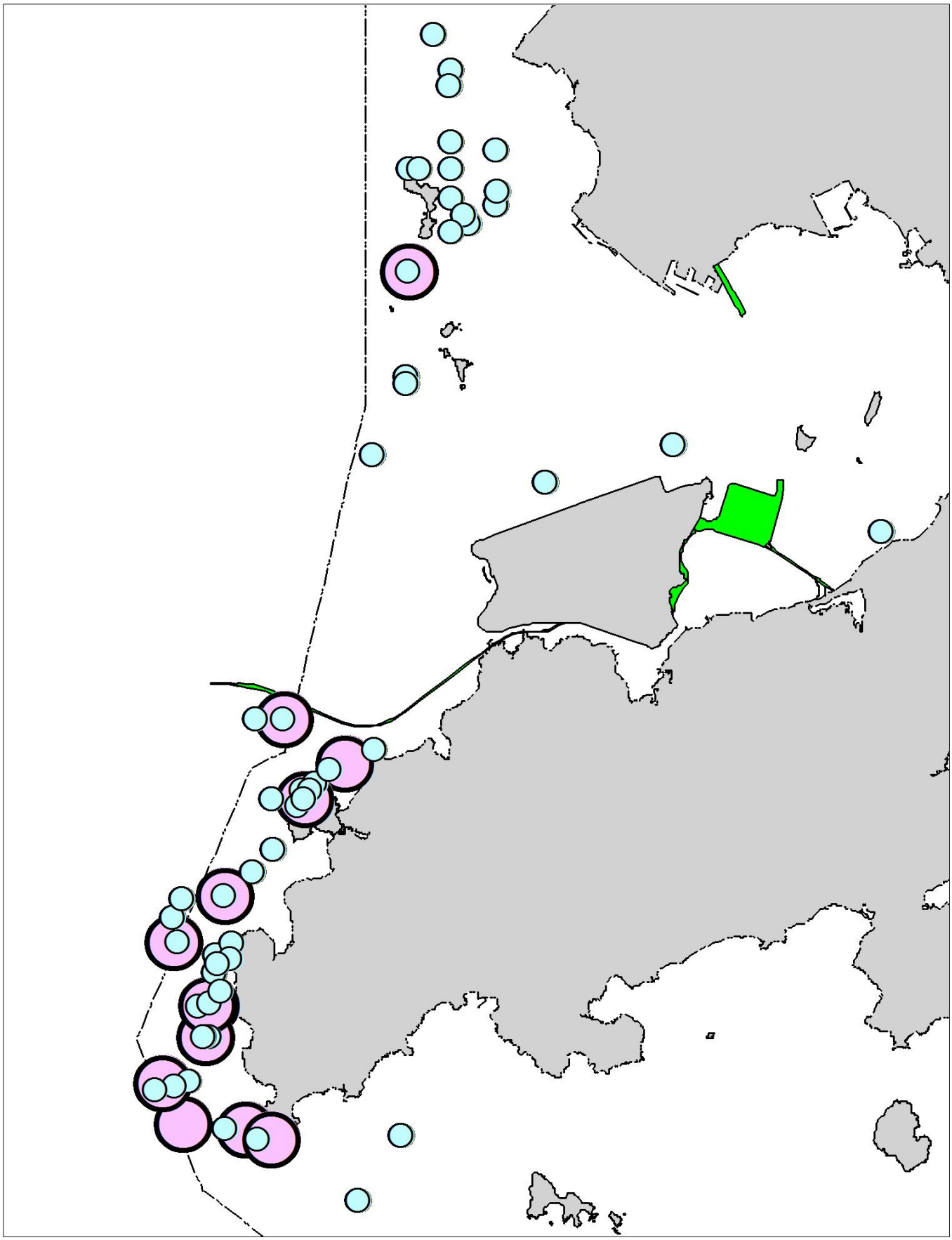


Figure 38. Distribution of Unspotted Calves (purple dots) & Unspotted Juveniles (blue dots) in 2014

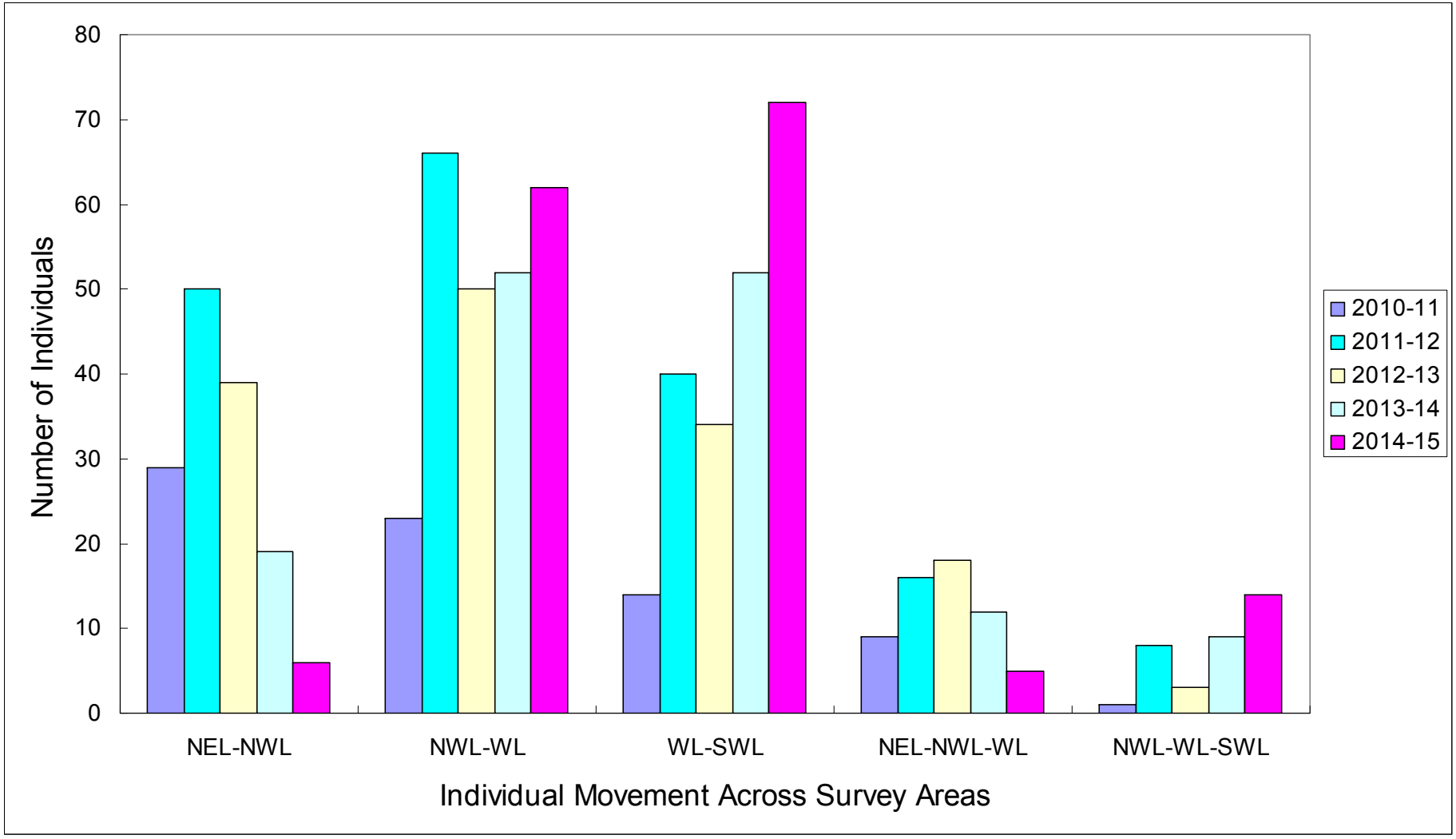


Figure 39. Temporal trends in number of individual dolphins involved in movements across different survey areas around Lantau in the past five monitoring periods

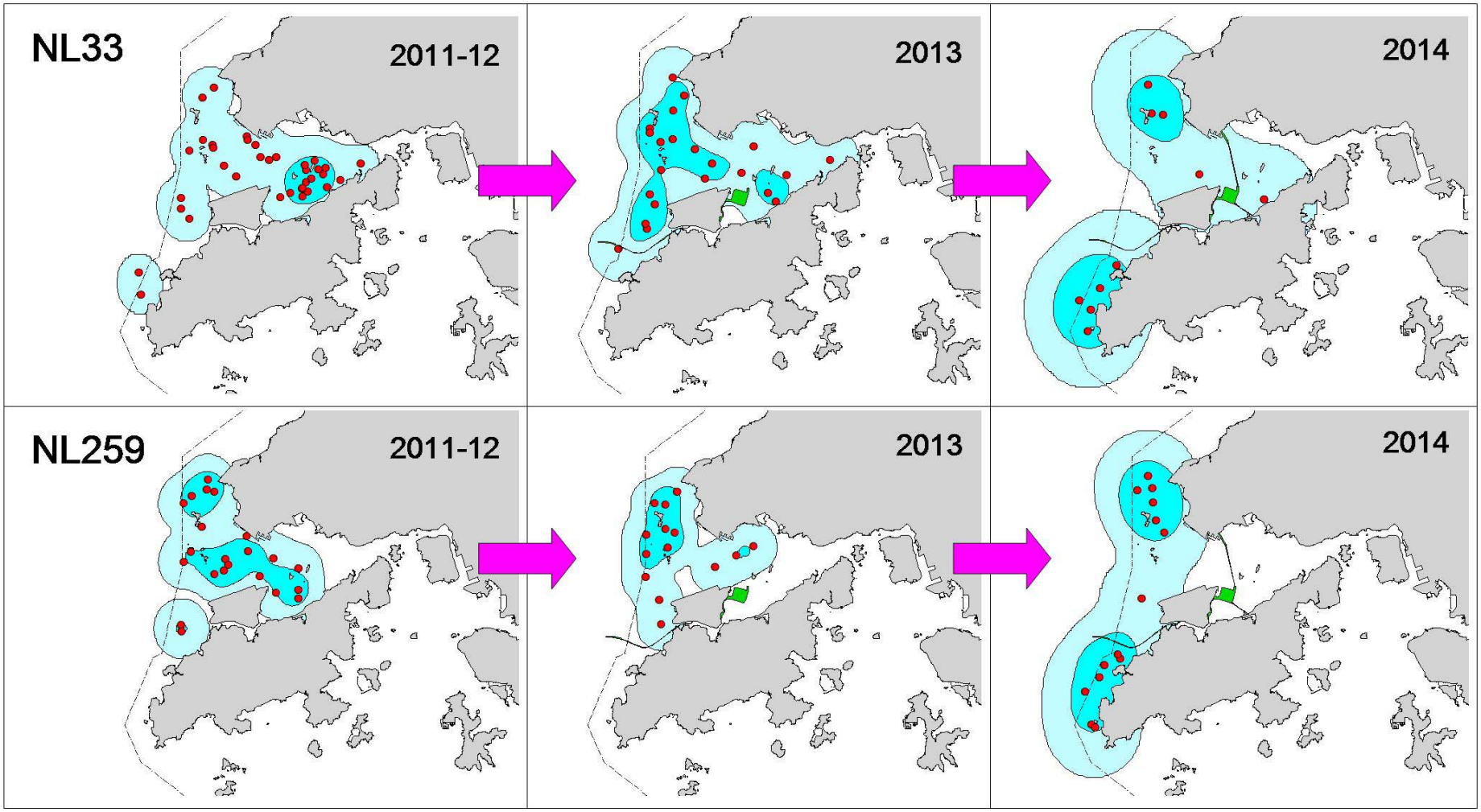


Figure 40. Examples of two individual dolphins with obvious range shift and core are shift between the three periods of 2011-12, 2013 and 2014

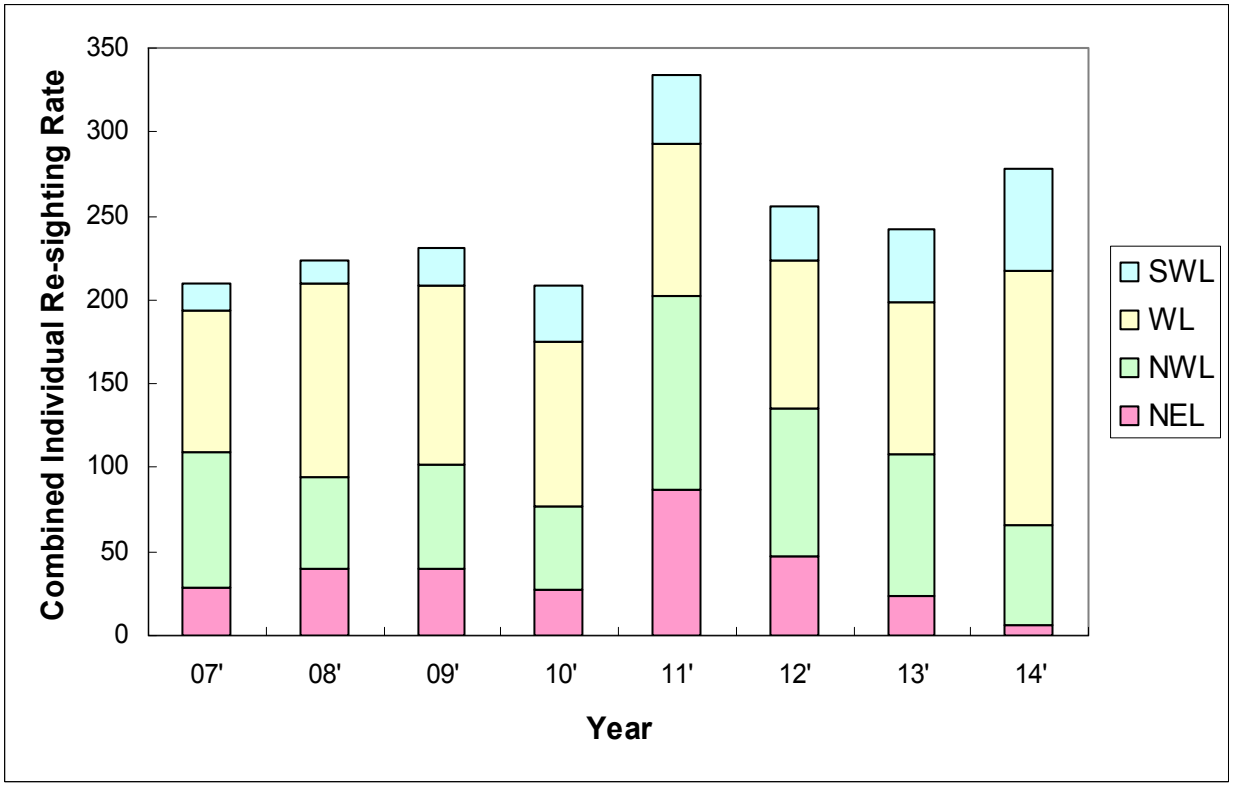


Figure 41a. Combined Individual Re-sighting Rate (total no. of individual re-sightings per 1,000 km of survey effort) of 66 individual dolphins (with 30+ re-sightings) among four survey areas during 2007-2014

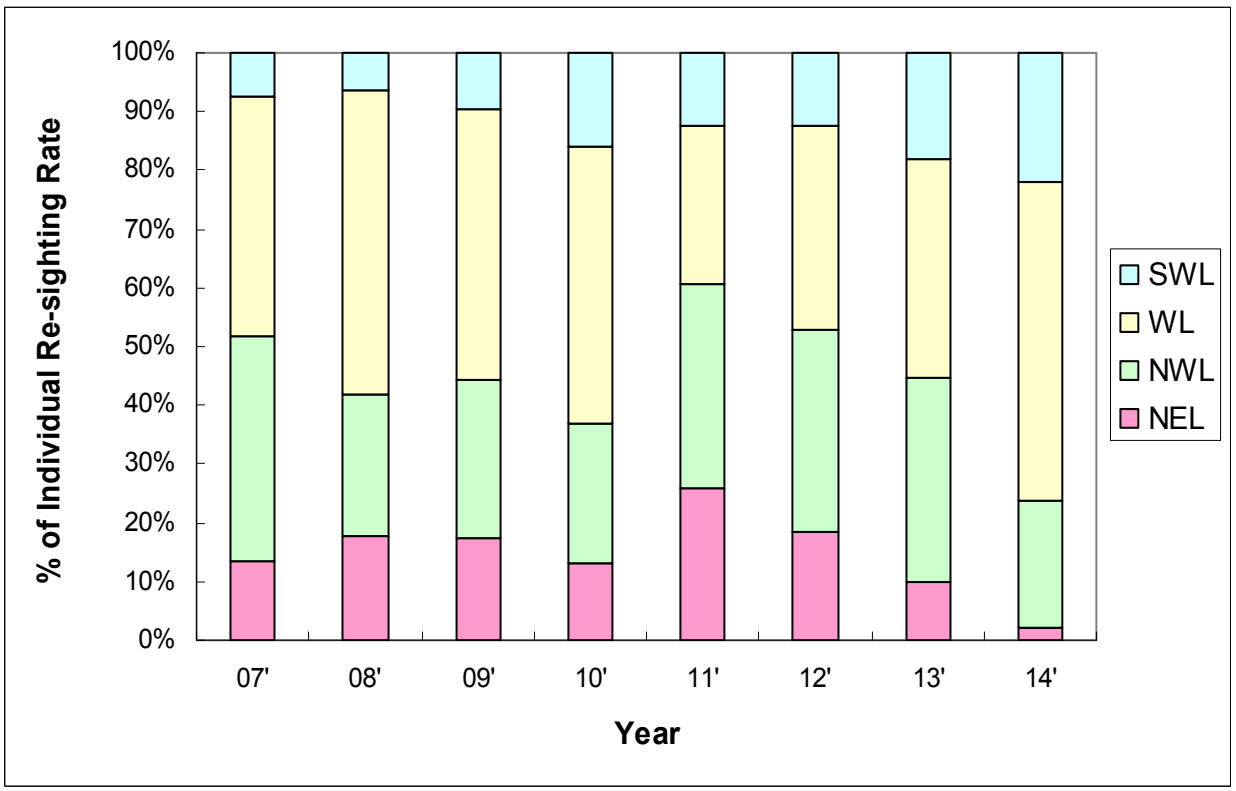


Figure 41b. Proportion of Combined Individual Re-sighting Rate of the total among four survey areas during 2007-2014 based on 66 individual dolphins with 30+ re-sightings

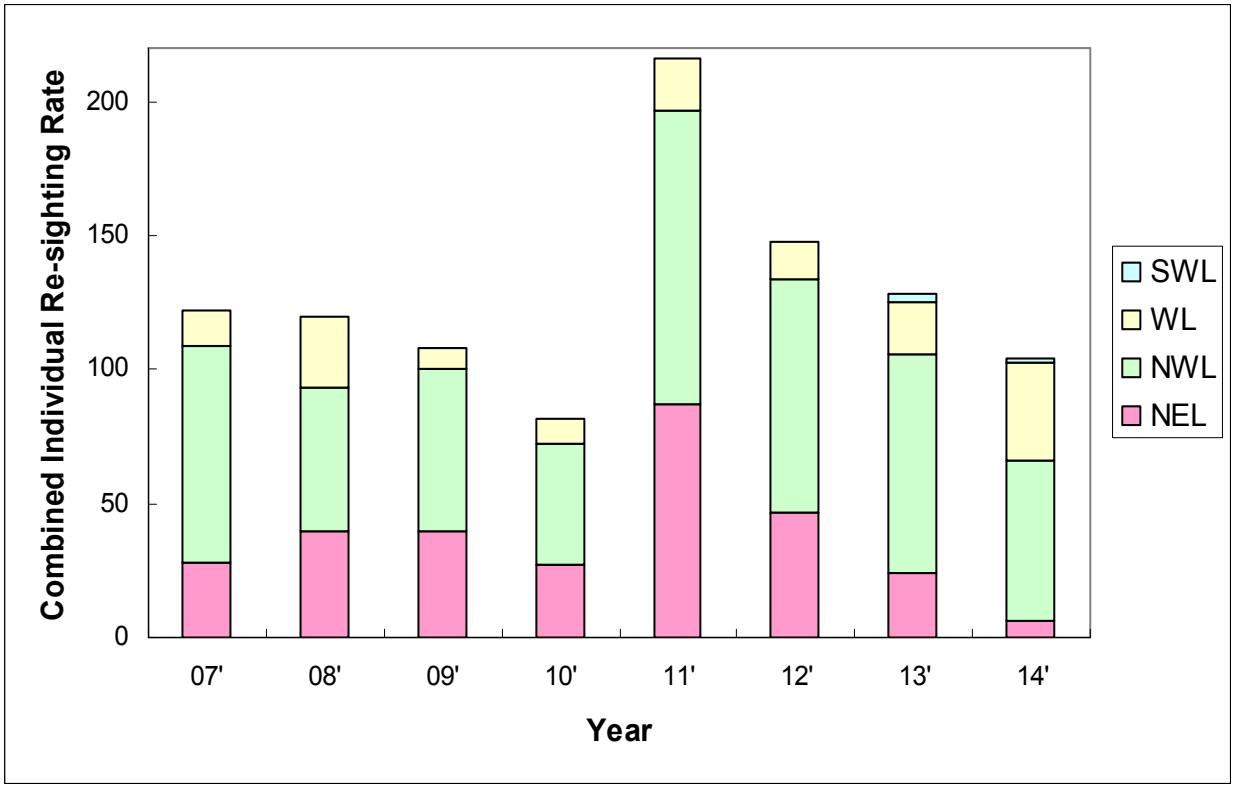


Figure 42a. Combined Individual Re-sighting Rate (total no. of individual re-sightings per 1,000 km of survey effort) of 42 individual dolphins (from northern social cluster) among four survey areas during 2007-2014

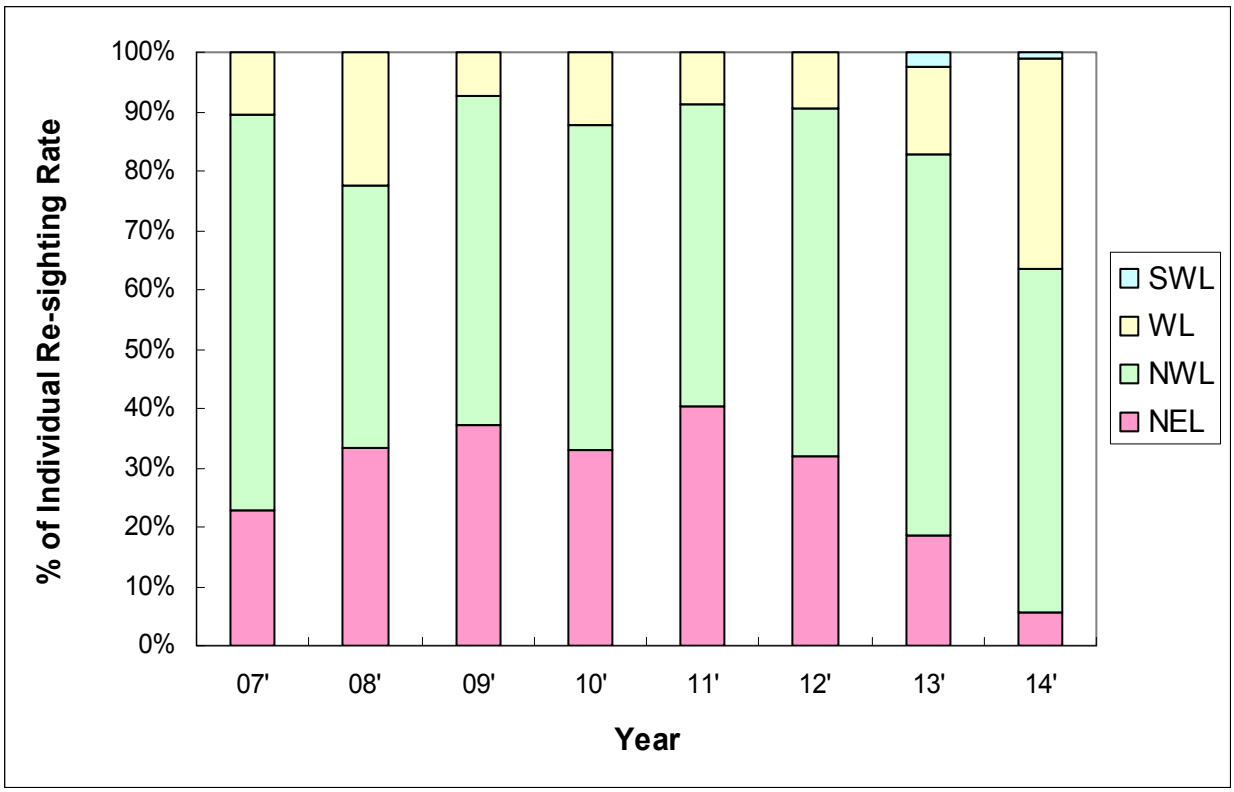


Figure 42a. Proportion of Combined Individual Re-sighting Rate of the total among four survey areas during 2007-2014 based on 42 individual dolphins from northern social cluster

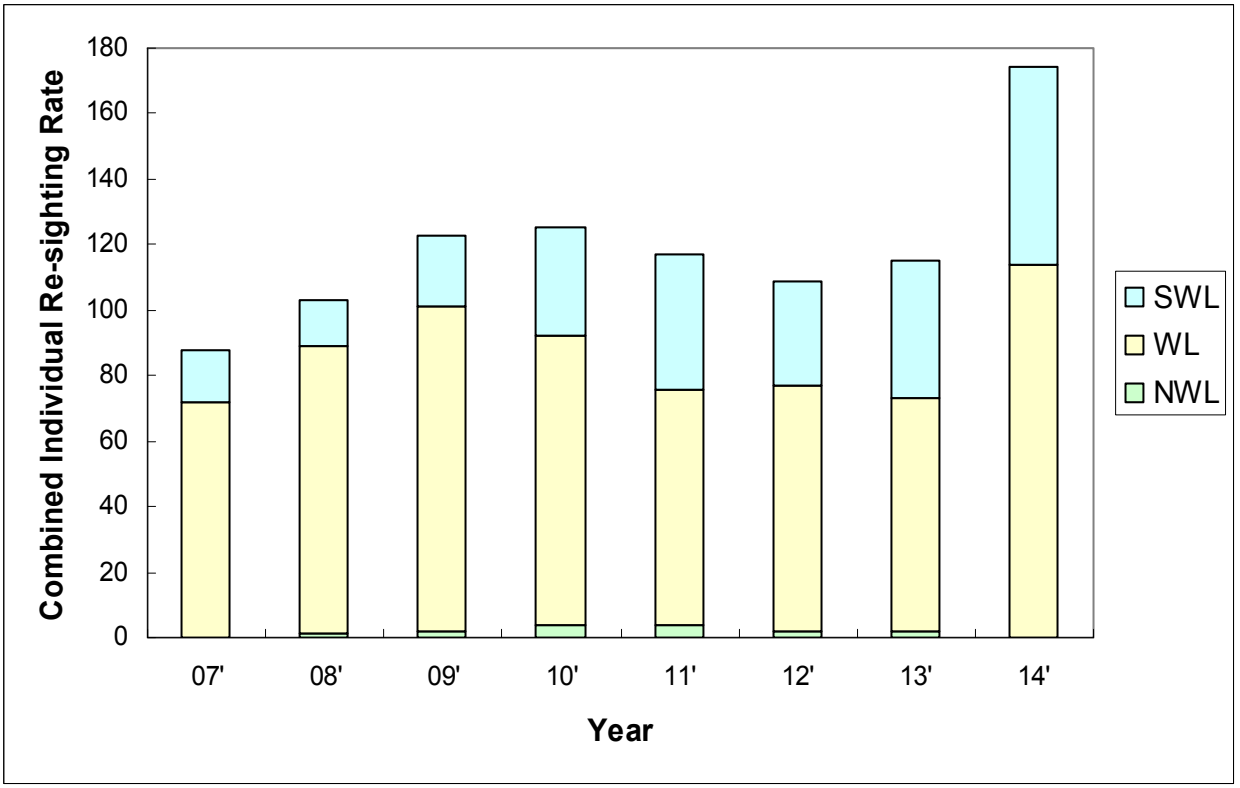


Figure 43a. Combined Individual Re-sighting Rate (total no. of individual re-sightings per 1,000 km of survey effort) of 24 individual dolphins (from western social cluster) among four survey areas during 2007-2014

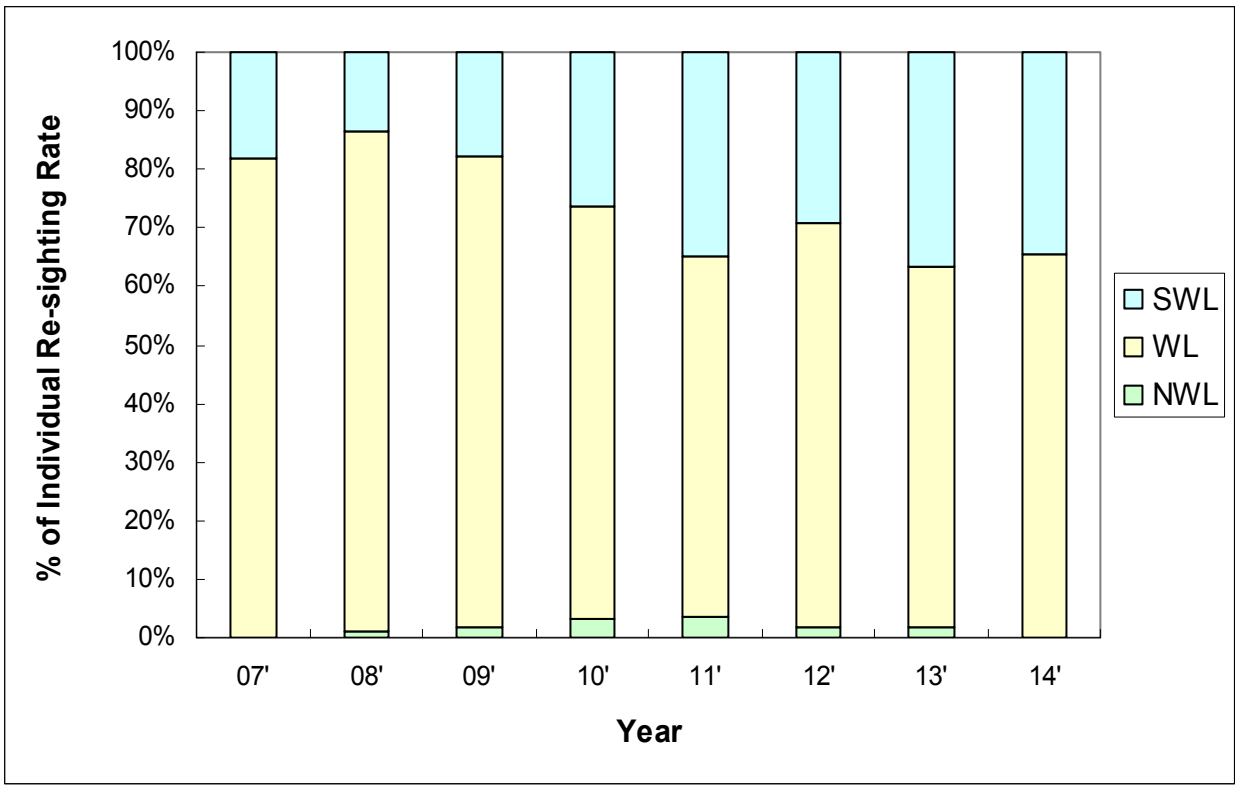


Figure 43b. Proportion of Combined Individual Re-sighting Rate of the total among four survey areas during 2007-2014 based on 24 individual dolphins from western social cluster

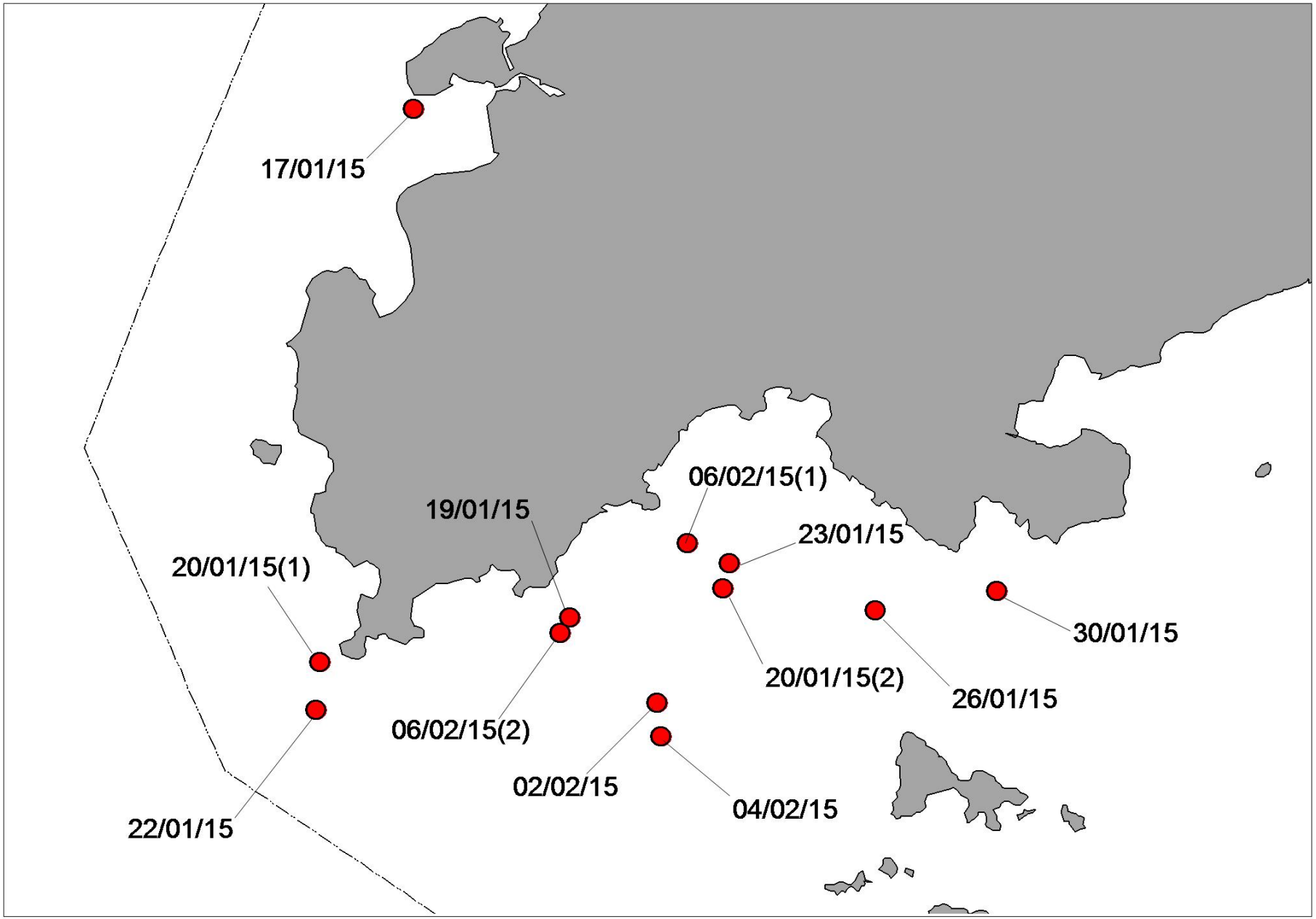


Figure 44. Initial positions of 12 focal-follow sessions of WL212 from January 17th to February 6th, 2015

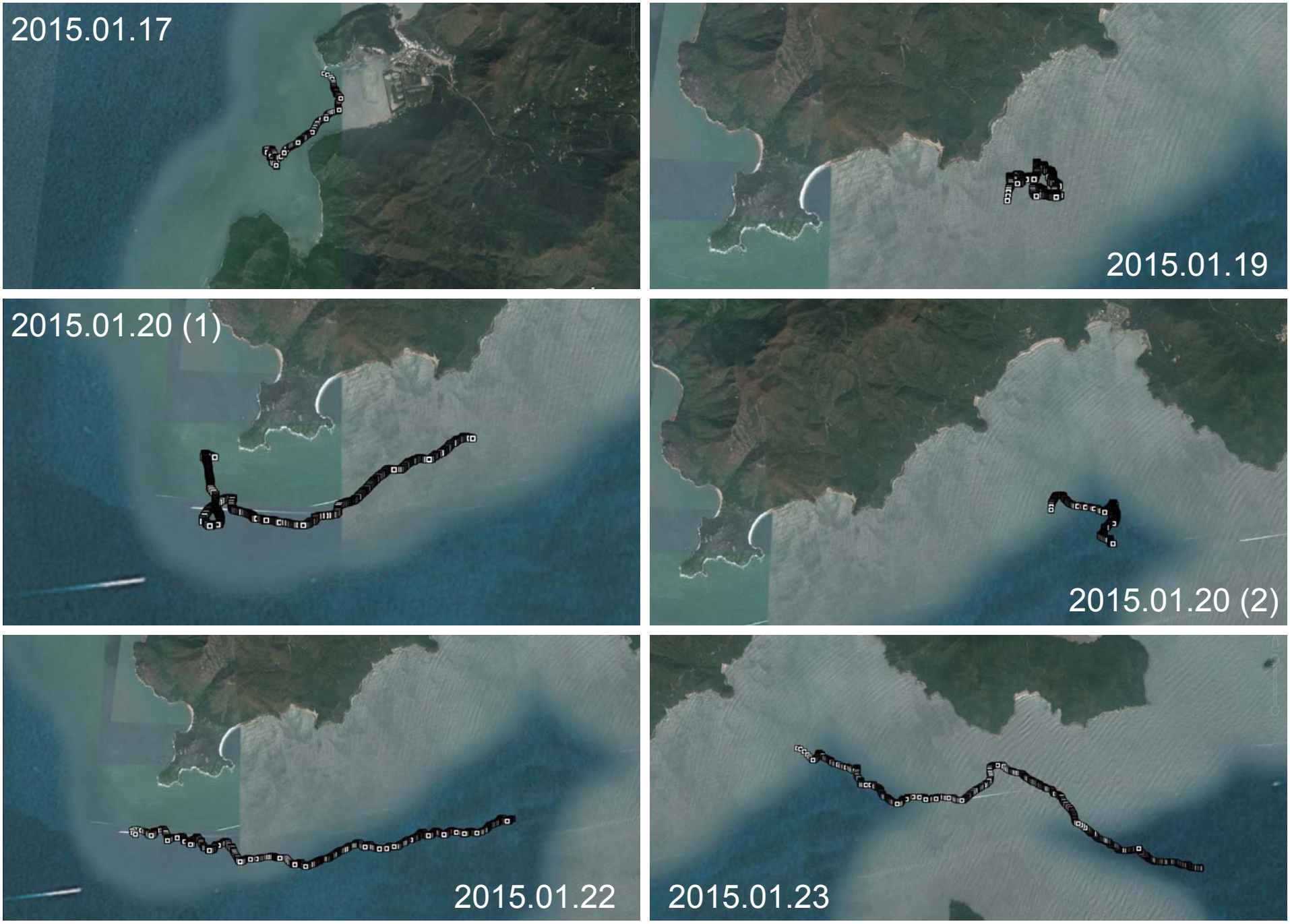


Figure 45. Focal follow tracks of WL212 from January 17th to 23rd , 2015

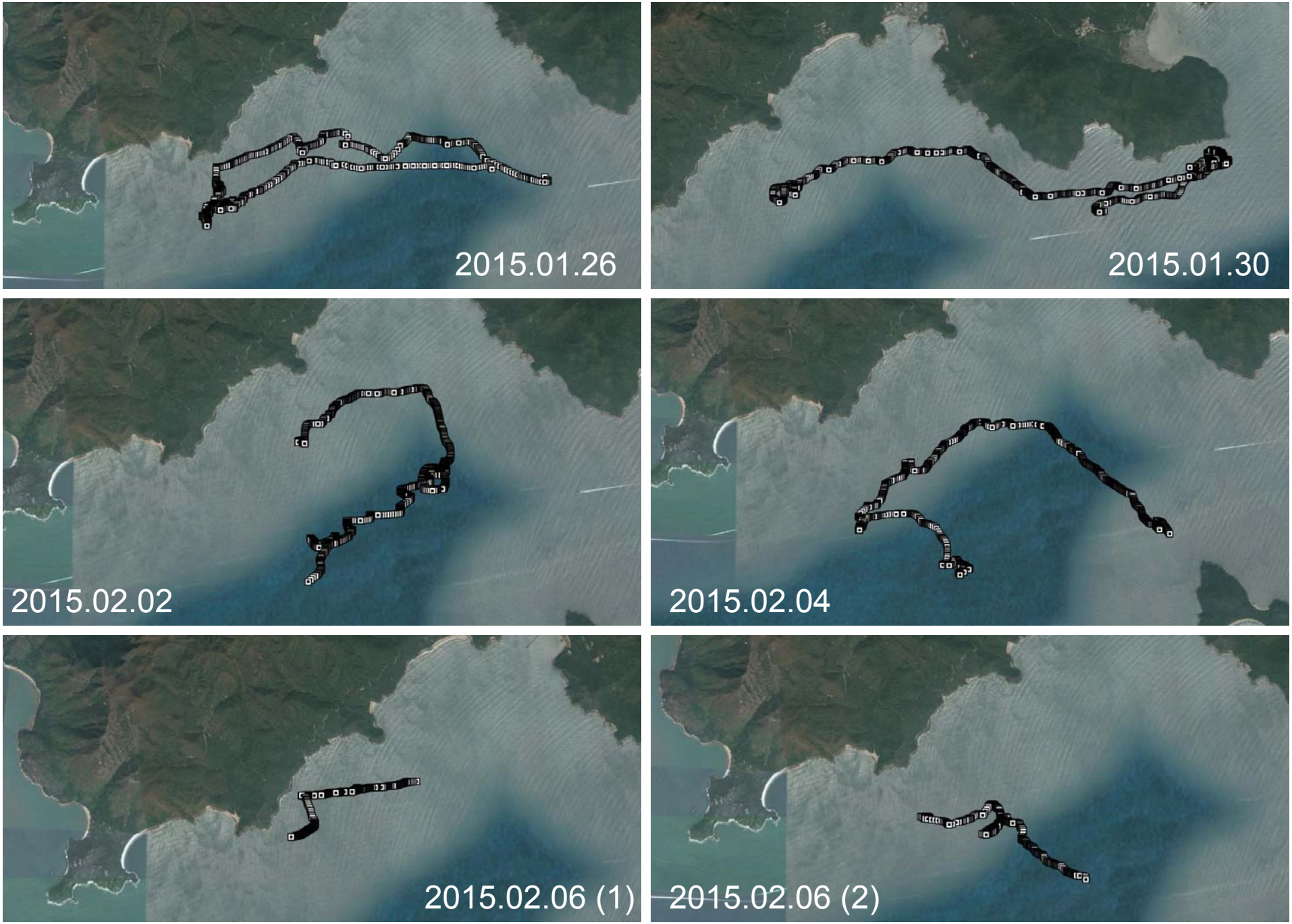


Figure 46. Focal follow tracks of WL212 from January 26th to February 6th, 2015

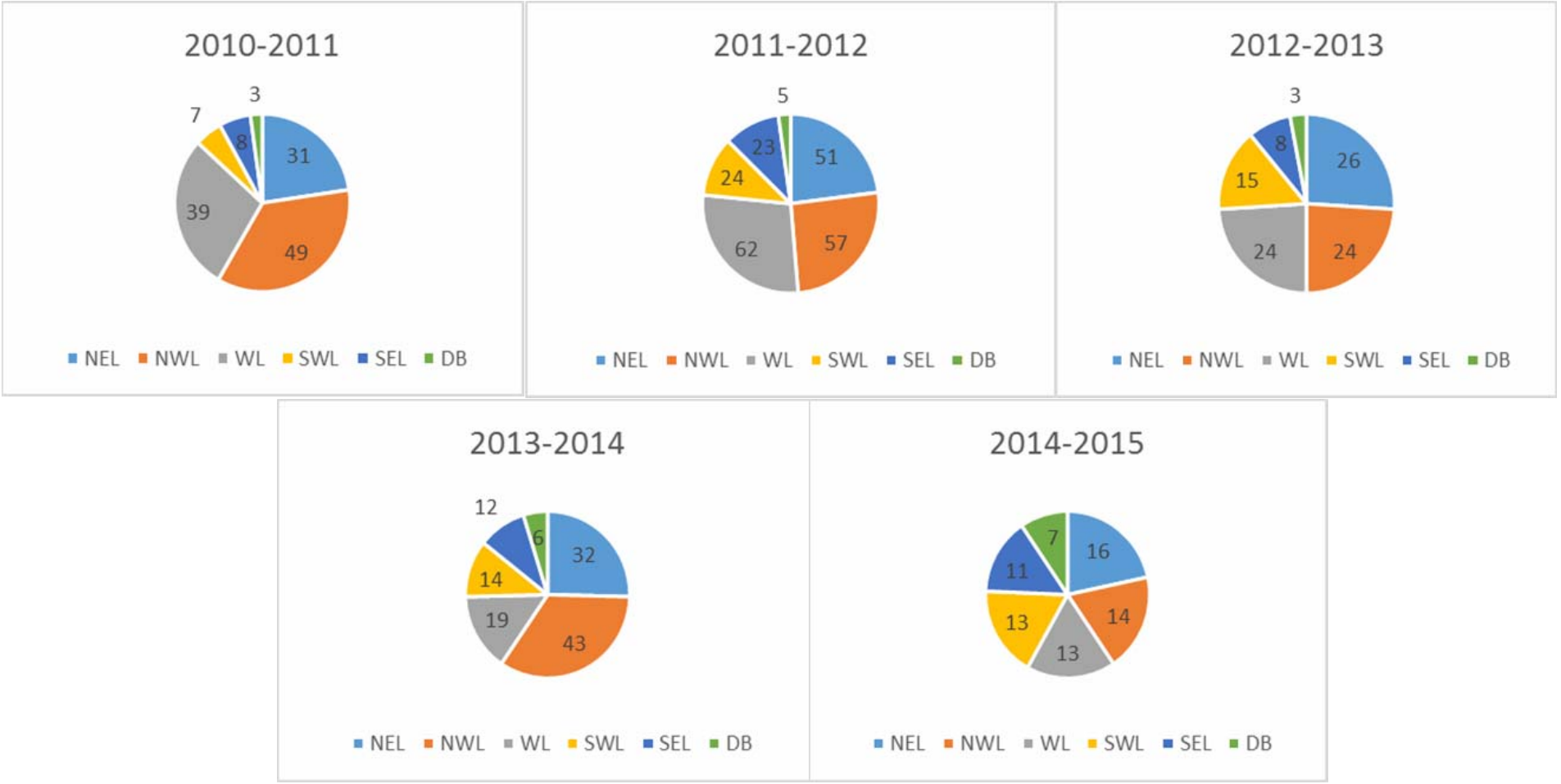


Figure 47. Summary of acoustic monitoring data collection from 19 April 2010 to 30 December 2014. Each pie chart shows the number of recordings taken in each of the six survey areas in western Hong Kong for each year.

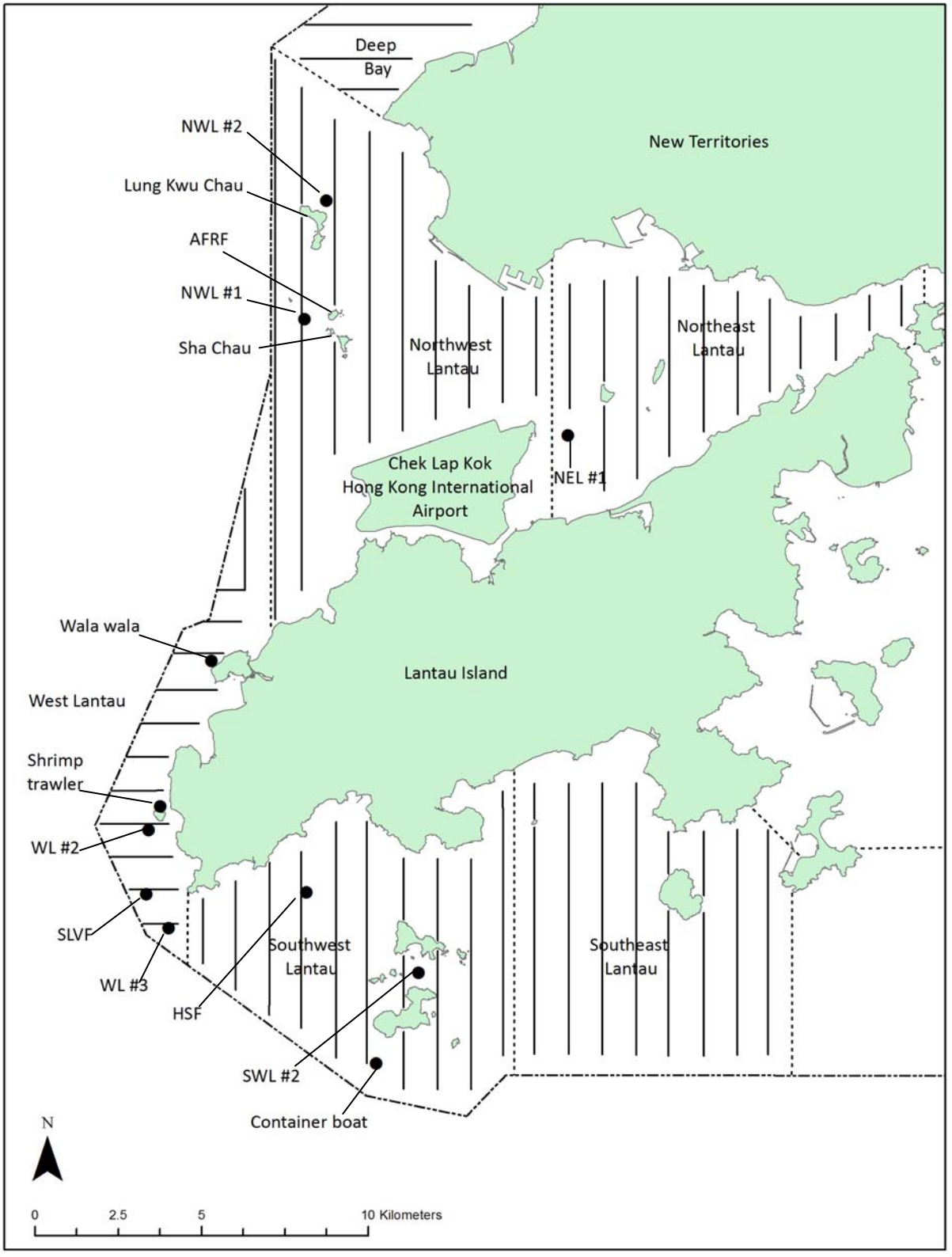


Figure 48. A map of Lantau Island in Hong Kong with recording stations, recording locations and survey transect lines. “HSF” stands for an unidentified high-speed ferry and “Wala wala” is an arbitrary name associated with the small dolphin-watching tour boats in the area. The “SLVF” is the South Lantau Vessel Fairway and the “AFRF” is the retired Aviation Fuel Receiving Facility.

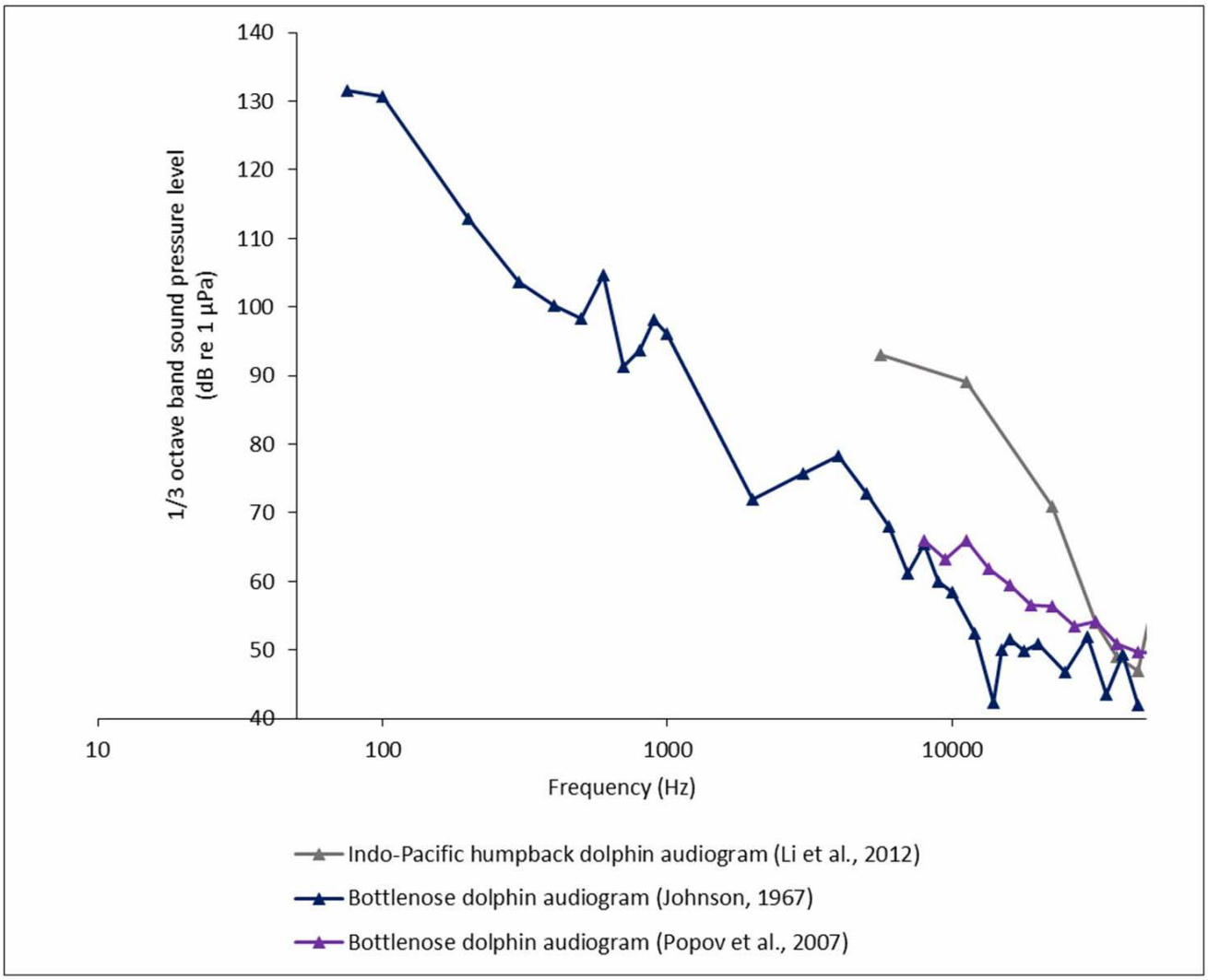


Figure 49. Audiograms of a Indo-Pacific humpback dolphin and two bottlenose dolphin (adapted from Li et al. 2012; Johnson 1967; and Popov et al. 2007)

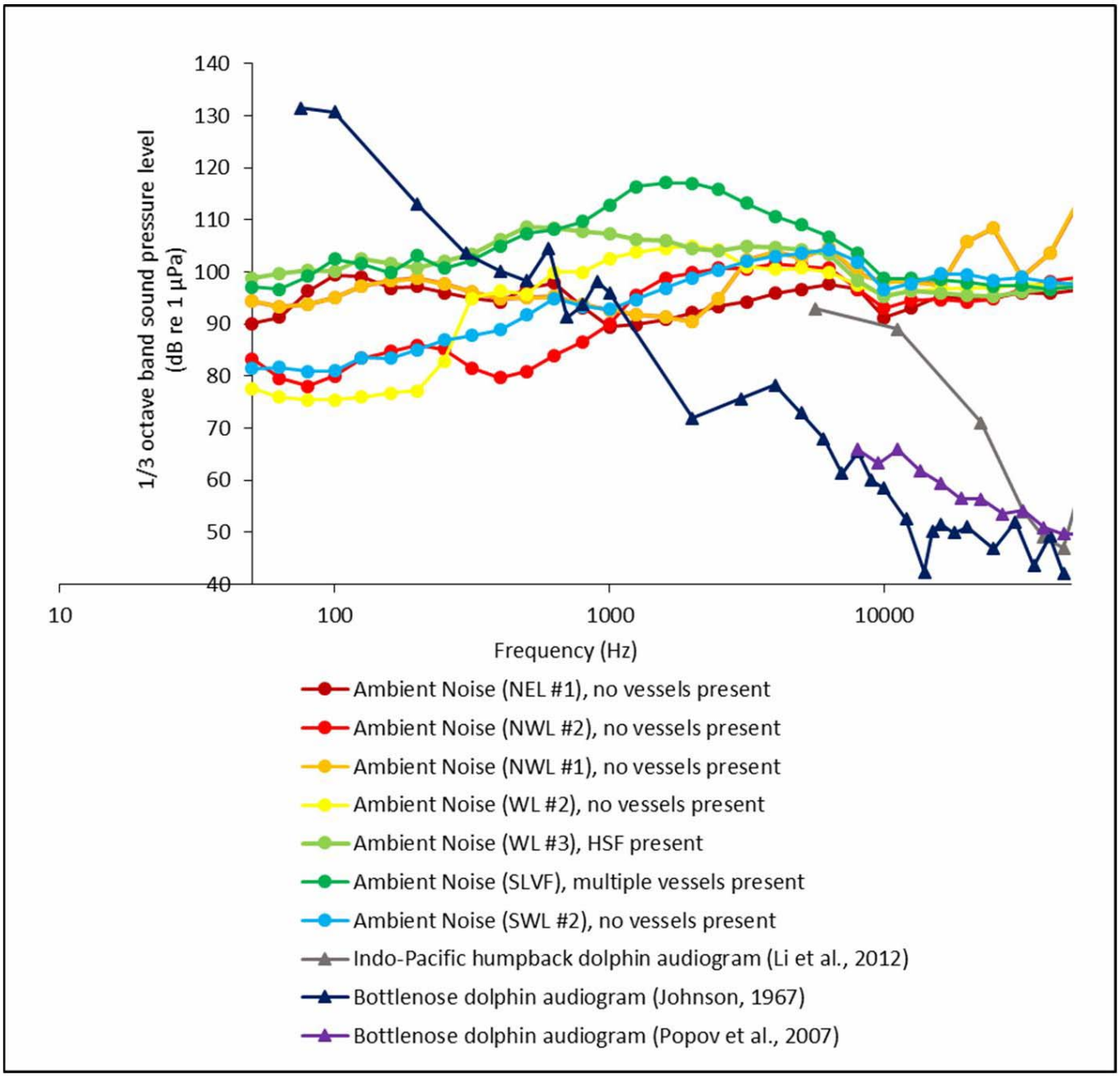


Figure 50. Ambient sounds of seven areas varying in amount of vessel traffic and types of vessels present (see Table 3). Bottlenose and humpback dolphin audiograms show the difference between ambient noise levels and minimum audible levels for the dolphins.

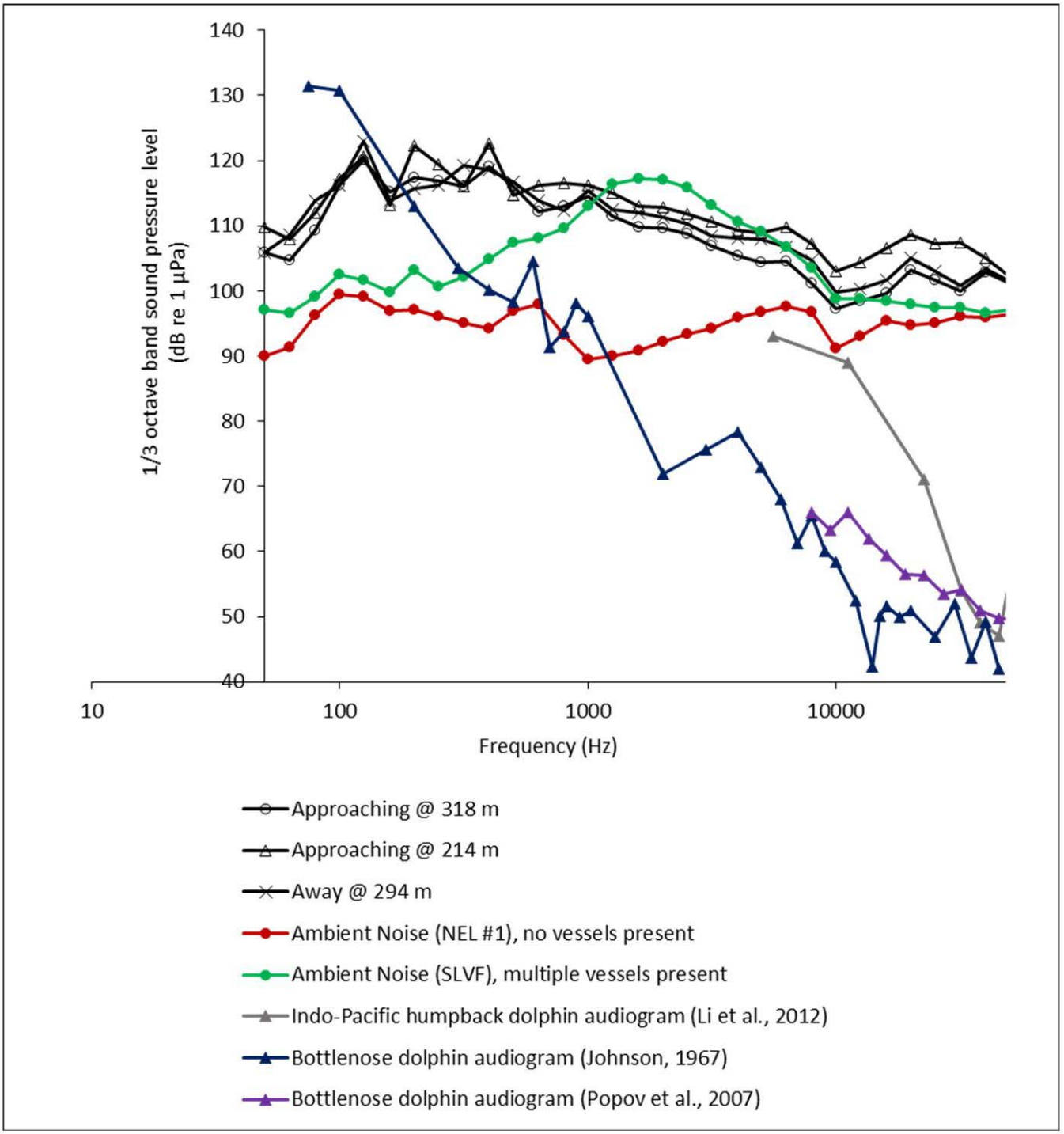


Figure 51. 1/3 octave band sound pressure levels for a high-speed ferry at Southwest Lantau #2 (SWL #2); Beaufort sea state 2. The dark red line represents the ambient sounds of NEL #1, and the dark green line represents SLVF (see their site details in Table 3).

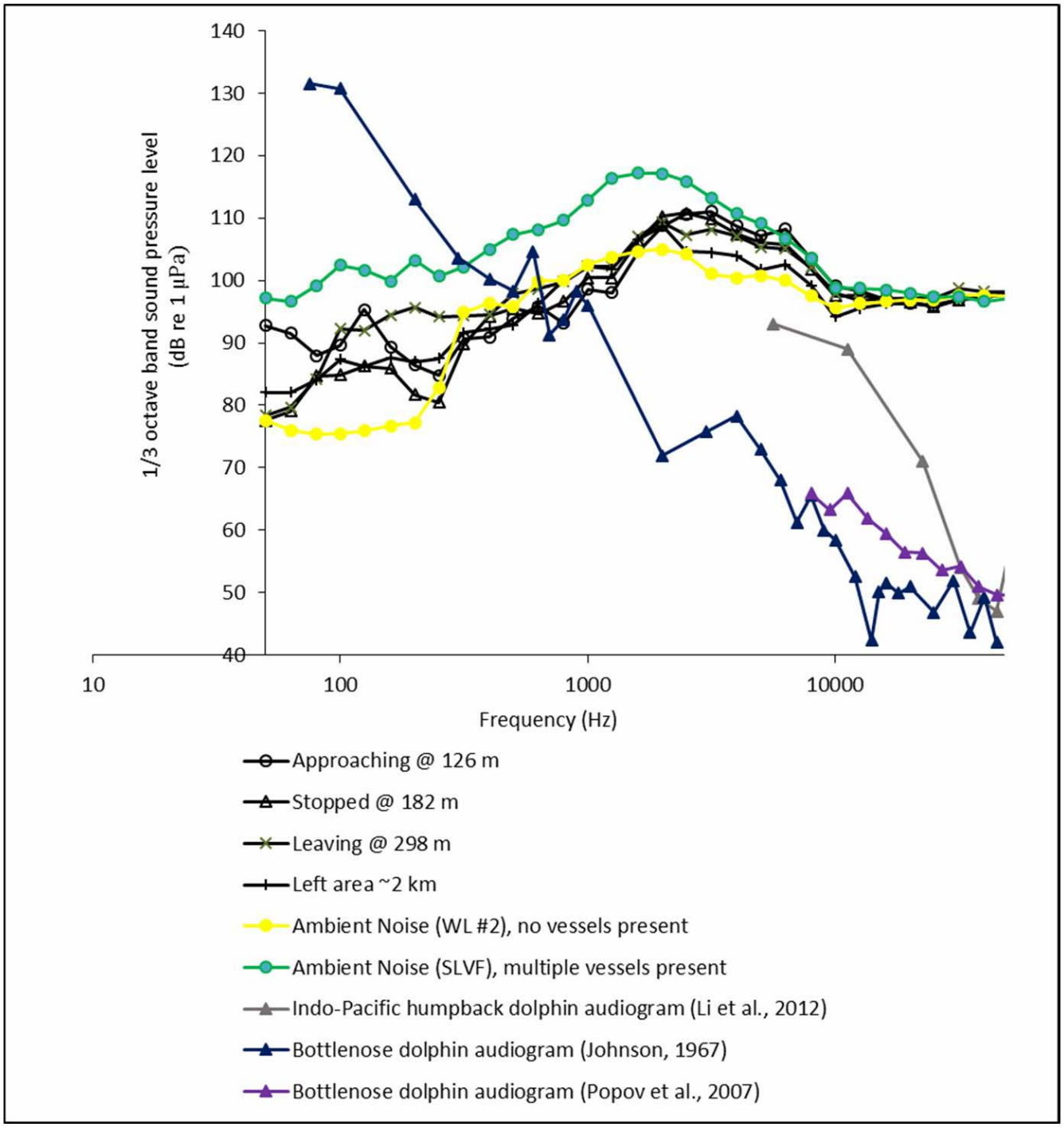


Figure 52. 1/3 octave band sound pressure levels for a small motorized dolphin watching tour boat (wala wala) off Tai O in West Lantau; Beaufort sea state 1. The yellow line represents the ambient sounds of WL #2, and the dark green line represents SLVF (see their site details in Table 3).

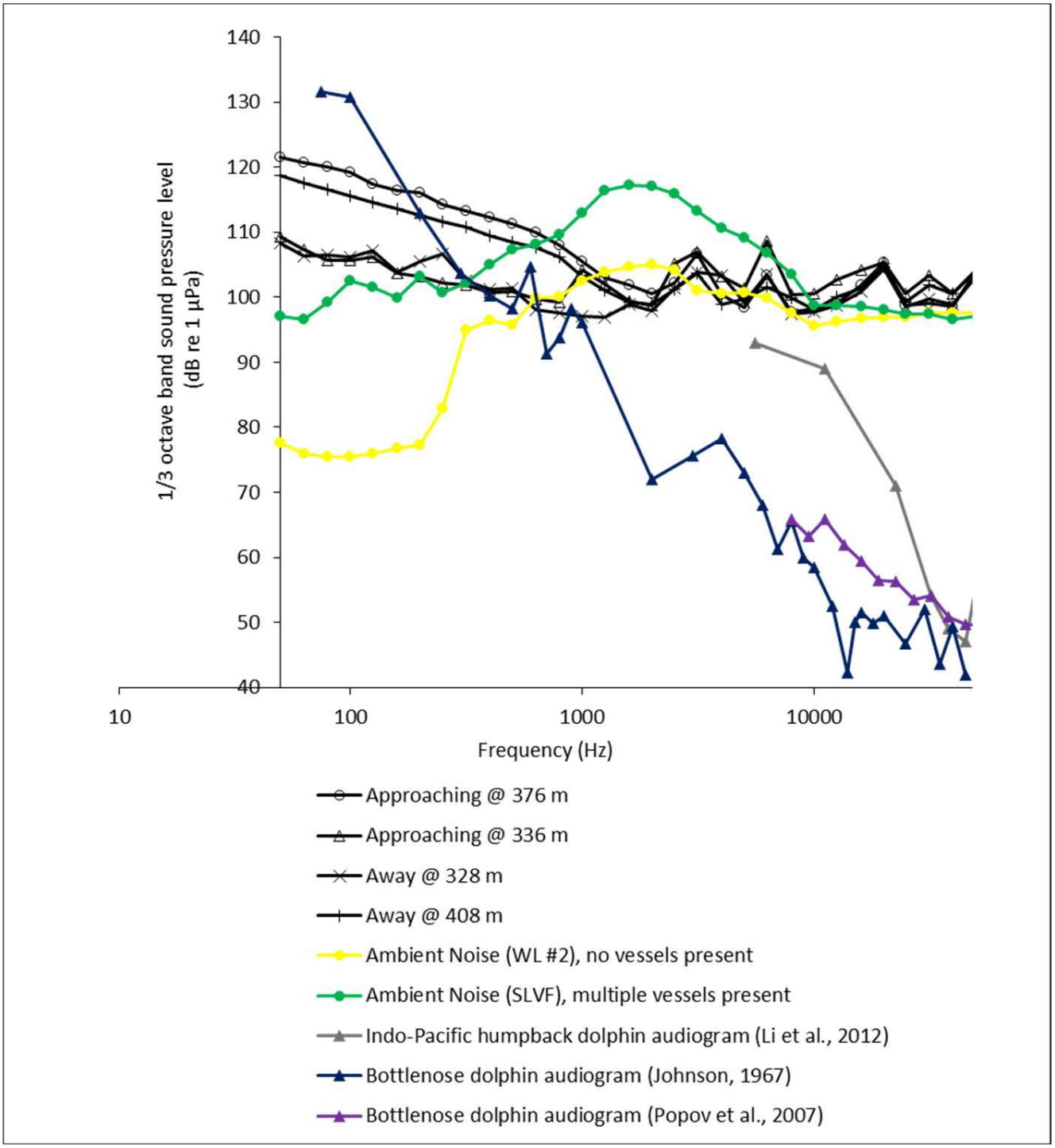


Figure 53. 1/3 octave band sound pressure levels for a shrimp trawling vessel at West Lantau #2 (WL #2); Beaufort sea state 3. The yellow line represents the ambient sounds of WL #2 , and the dark green line represents SLVF (see their site details in Table 3).

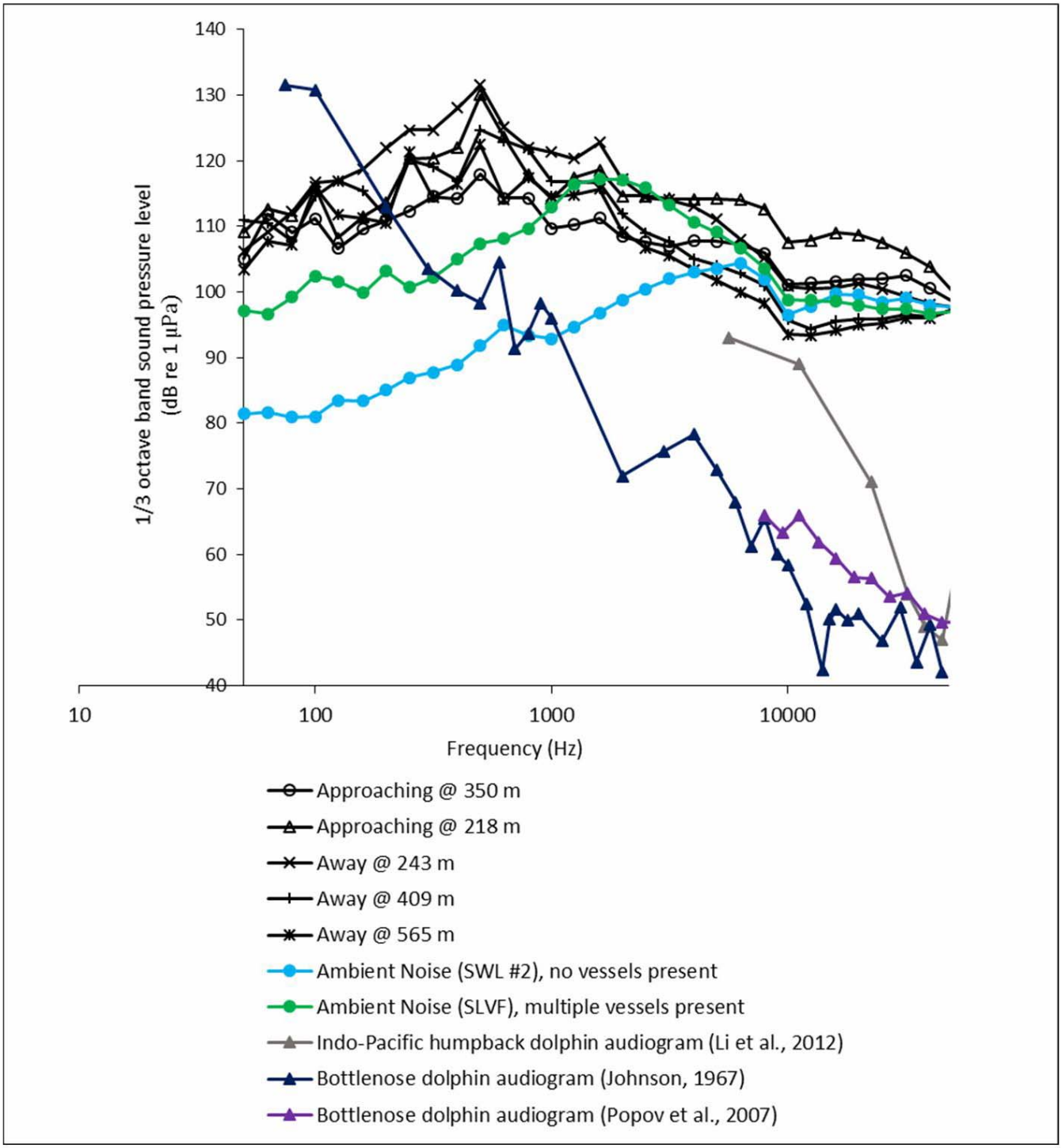


Figure 54. 1/3 octave band sound pressure levels for a large shipping container vessel at Southwest Lantau #1 (SWL #1); Beaufort sea state 2. The dark green line represents the ambient sounds of nearby SWL #2, and the light blue line represents ambient sounds at WL #3 (see their site details in Table 3).

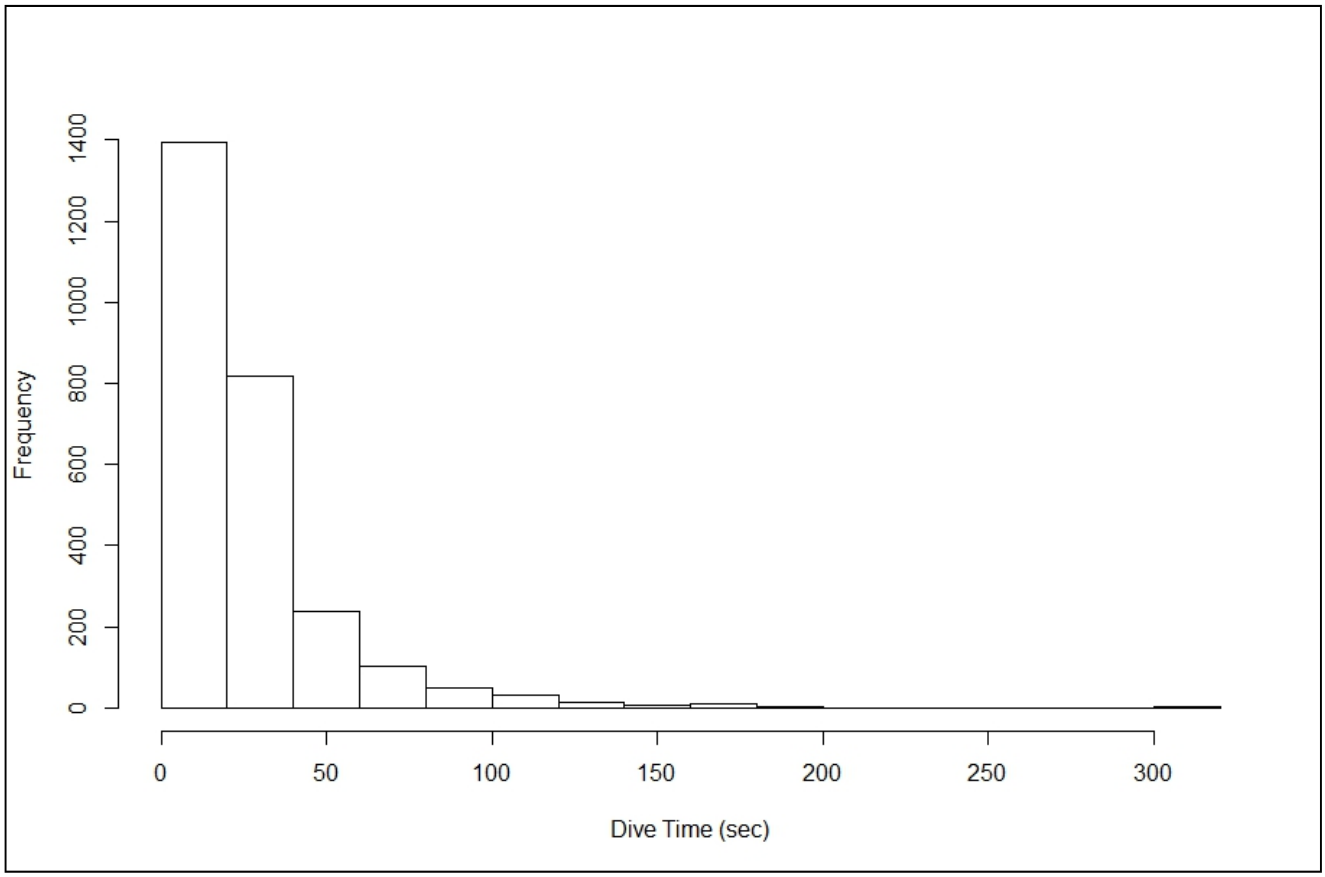


Figure 55. Frequency distribution for dive times of Chinese White Dolphins observed across all study areas in Hong Kong

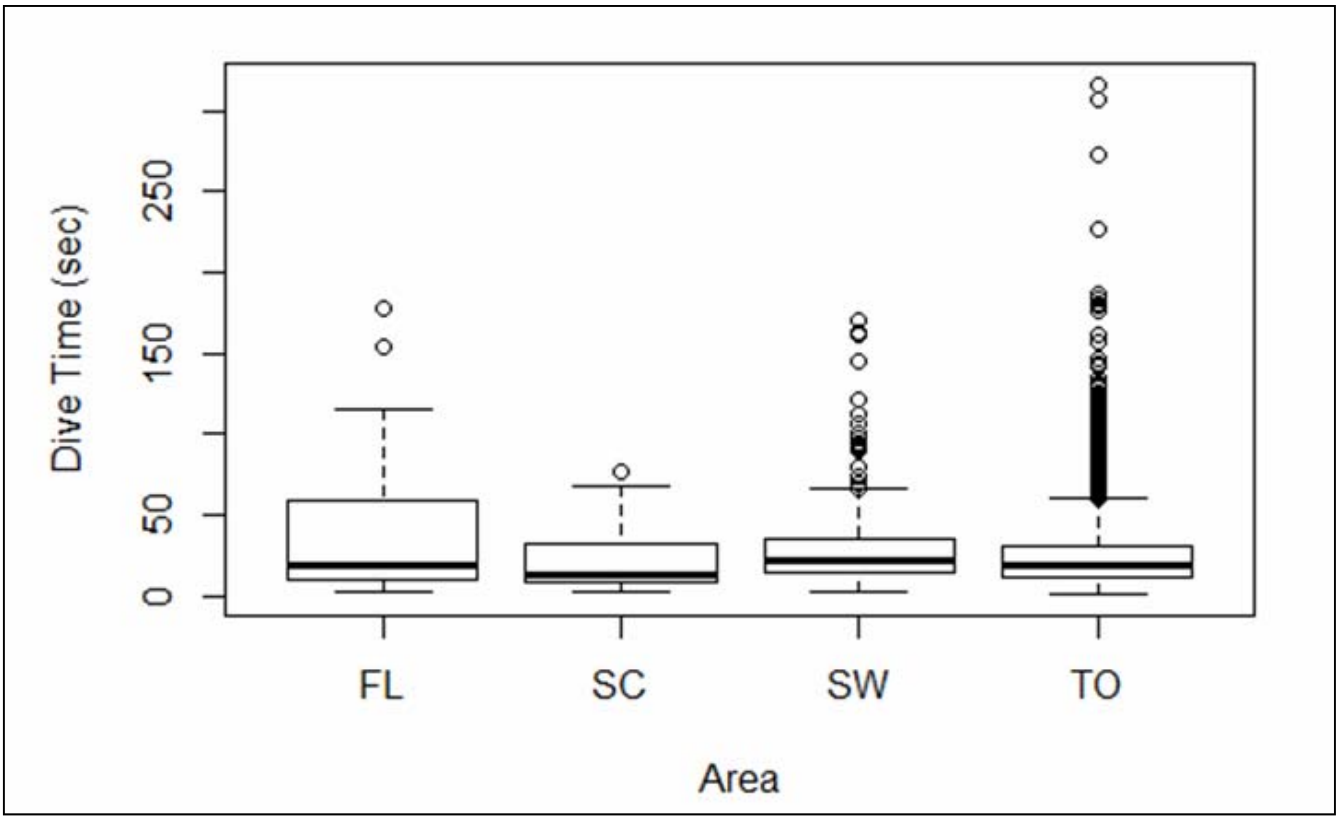


Figure 56. Medium, upper and lower quartiles and outliers of dolphin dives observed at each study area (FL: Fan Lau, SC: Sha Chau, SW: Sham Wat, TO: Tai O)

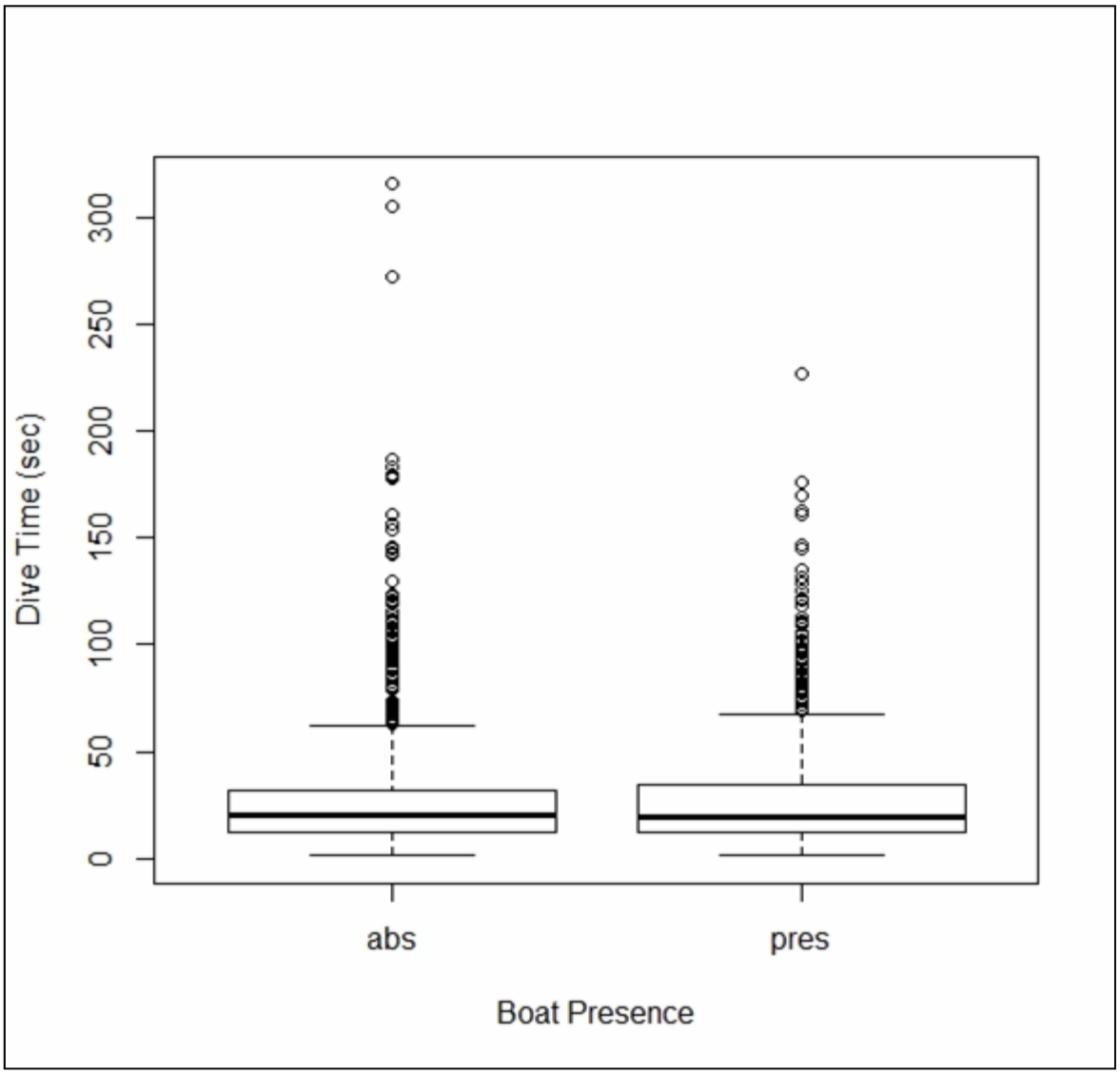


Figure 57. Medium, upper and lower quartiles and outliers of dolphin dives observed in the presence (pres) and absence (abs) of boats

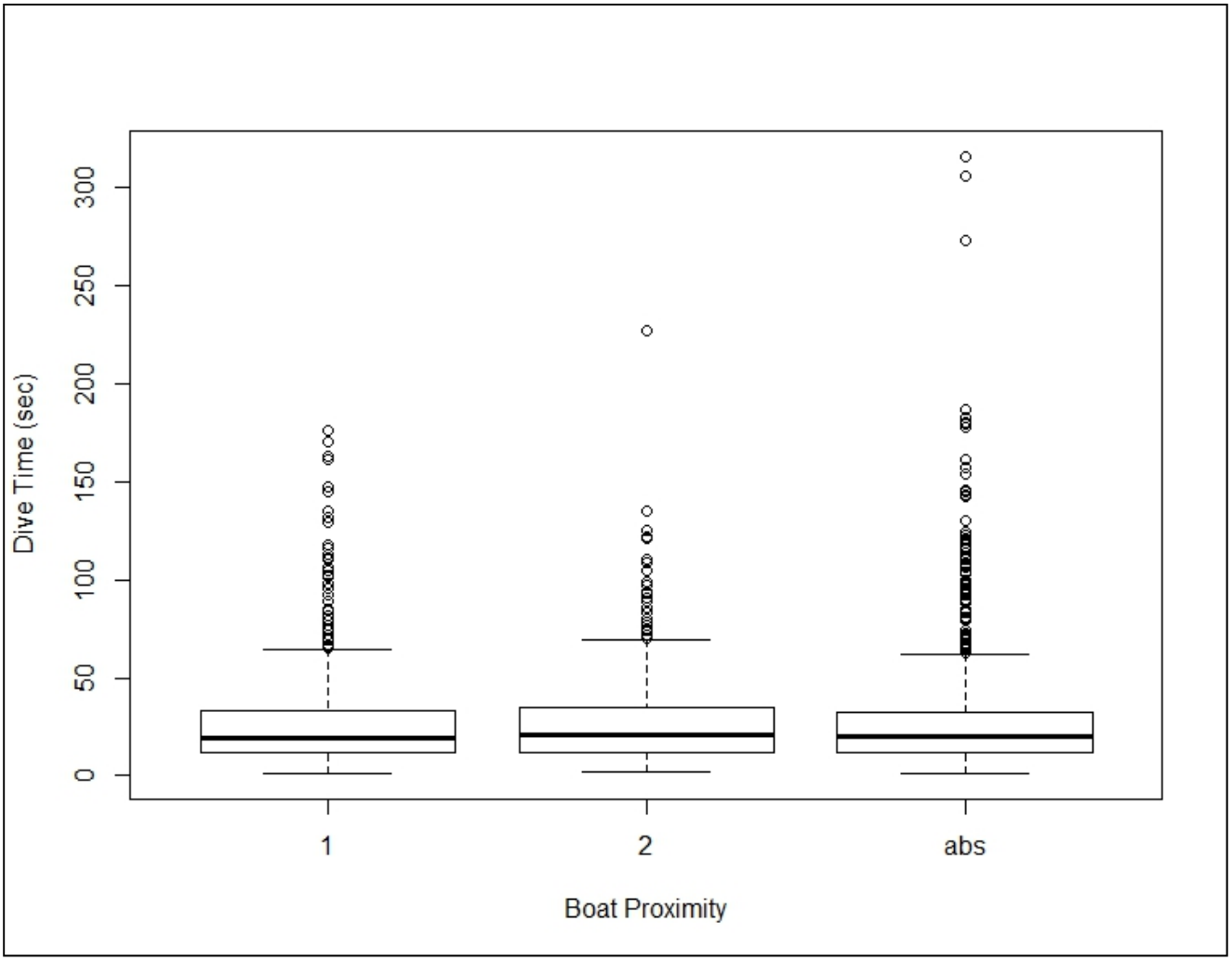


Figure 58. Medium, upper and lower quartiles and outliers of dolphin dives observed when boats were ≤ 500m from the focal dolphin (1), ≥ 500m from the focal dolphin (2) or absent from the area (abs)

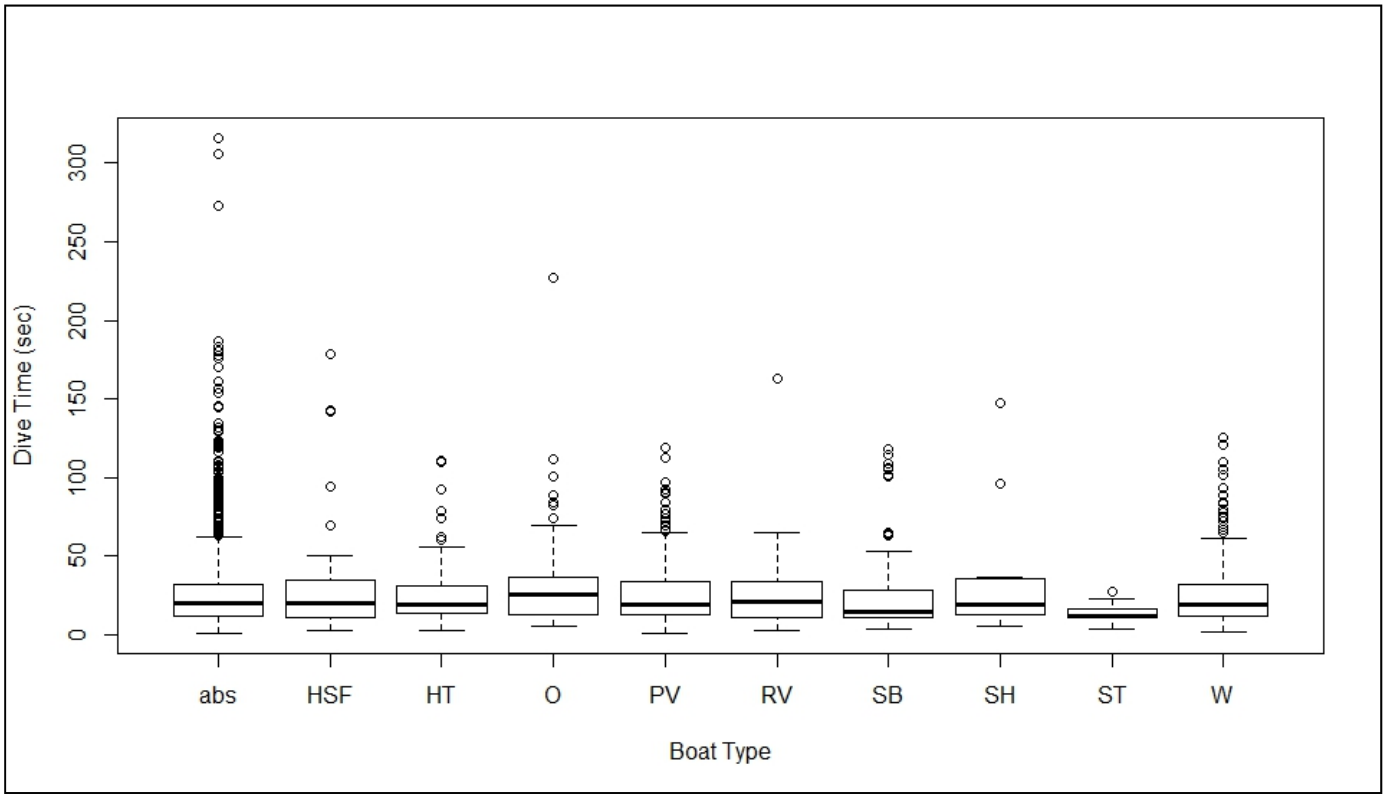


Figure 59. Medium, upper and lower quartiles and outliers of dolphin dives observed at each type of boat type category (abs: absent, HSF: high speed ferry, HT: hang trawler, O: other, PV; pair trawler, RV: research vessel, SB: speed boat, SH: shrimp trawler, ST: single trawler, W: *wala wala*).

Appendix I. HKCRP-AFCD Survey Effort Database (April 2014 - March 2015)

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

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
9-Apr-14	SE LANTAU	2	14.79	SPRING	STANDARD31516	P
9-Apr-14	SE LANTAU	3	5.33	SPRING	STANDARD31516	P
9-Apr-14	SE LANTAU	2	4.51	SPRING	STANDARD31516	S
9-Apr-14	SE LANTAU	3	1.97	SPRING	STANDARD31516	S
9-Apr-14	SW LANTAU	2	15.37	SPRING	STANDARD31516	P
9-Apr-14	SW LANTAU	3	6.79	SPRING	STANDARD31516	P
9-Apr-14	SW LANTAU	2	10.40	SPRING	STANDARD31516	S
9-Apr-14	SW LANTAU	3	2.63	SPRING	STANDARD31516	S
9-Apr-14	W LANTAU	2	4.36	SPRING	STANDARD31516	S
9-Apr-14	W LANTAU	3	8.40	SPRING	STANDARD31516	S
10-Apr-14	NW LANTAU	2	11.56	SPRING	STANDARD31516	P
10-Apr-14	NW LANTAU	3	17.56	SPRING	STANDARD31516	P
10-Apr-14	NW LANTAU	4	1.24	SPRING	STANDARD31516	P
10-Apr-14	NW LANTAU	2	0.71	SPRING	STANDARD31516	S
10-Apr-14	NW LANTAU	3	4.26	SPRING	STANDARD31516	S
10-Apr-14	DEEP BAY	2	5.57	SPRING	STANDARD31516	P
10-Apr-14	DEEP BAY	3	7.27	SPRING	STANDARD31516	P
10-Apr-14	DEEP BAY	4	0.66	SPRING	STANDARD31516	P
10-Apr-14	DEEP BAY	2	3.76	SPRING	STANDARD31516	S
10-Apr-14	DEEP BAY	3	2.30	SPRING	STANDARD31516	S
10-Apr-14	NE LANTAU	2	6.57	SPRING	STANDARD31516	P
10-Apr-14	NE LANTAU	3	5.91	SPRING	STANDARD31516	P
10-Apr-14	NE LANTAU	2	3.61	SPRING	STANDARD31516	S
10-Apr-14	NE LANTAU	3	6.62	SPRING	STANDARD31516	S
15-Apr-14	NW LANTAU	3	7.49	SPRING	STANDARD31516	P
15-Apr-14	NW LANTAU	4	13.39	SPRING	STANDARD31516	P
15-Apr-14	NW LANTAU	5	5.82	SPRING	STANDARD31516	P
15-Apr-14	NW LANTAU	3	1.56	SPRING	STANDARD31516	S
15-Apr-14	NW LANTAU	5	1.14	SPRING	STANDARD31516	S
15-Apr-14	W LANTAU	2	3.22	SPRING	STANDARD31516	S
15-Apr-14	W LANTAU	3	4.78	SPRING	STANDARD31516	S
15-Apr-14	W LANTAU	4	2.38	SPRING	STANDARD31516	S
17-Apr-14	LAMMA	2	48.01	SPRING	STANDARD31516	P
17-Apr-14	LAMMA	3	21.24	SPRING	STANDARD31516	P
17-Apr-14	LAMMA	2	20.97	SPRING	STANDARD31516	S
17-Apr-14	LAMMA	3	6.68	SPRING	STANDARD31516	S
23-Apr-14	W LANTAU	3	7.29	SPRING	STANDARD31516	S
23-Apr-14	W LANTAU	4	4.11	SPRING	STANDARD31516	S
23-Apr-14	NW LANTAU	3	5.73	SPRING	STANDARD31516	P
23-Apr-14	NW LANTAU	4	10.77	SPRING	STANDARD31516	P
23-Apr-14	NW LANTAU	5	4.50	SPRING	STANDARD31516	P
23-Apr-14	NW LANTAU	2	1.80	SPRING	STANDARD31516	S
23-Apr-14	NW LANTAU	3	2.70	SPRING	STANDARD31516	S
23-Apr-14	NW LANTAU	4	1.00	SPRING	STANDARD31516	S
28-Apr-14	SW LANTAU	1	9.43	SPRING	STANDARD31516	P
28-Apr-14	SW LANTAU	2	7.85	SPRING	STANDARD31516	P
28-Apr-14	SW LANTAU	1	4.65	SPRING	STANDARD31516	S
28-Apr-14	SW LANTAU	2	6.06	SPRING	STANDARD31516	S
28-Apr-14	SE LANTAU	1	1.68	SPRING	STANDARD31516	P
28-Apr-14	SE LANTAU	2	10.92	SPRING	STANDARD31516	P
28-Apr-14	SE LANTAU	3	6.58	SPRING	STANDARD31516	P
28-Apr-14	SE LANTAU	1	5.41	SPRING	STANDARD31516	S
28-Apr-14	SE LANTAU	2	3.77	SPRING	STANDARD31516	S
28-Apr-14	W LANTAU	2	8.02	SPRING	STANDARD31516	S
28-Apr-14	W LANTAU	3	2.78	SPRING	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
29-Apr-14	NW LANTAU	0	2.10	SPRING	STANDARD31516	P
29-Apr-14	NW LANTAU	1	6.73	SPRING	STANDARD31516	P
29-Apr-14	NW LANTAU	2	8.27	SPRING	STANDARD31516	P
29-Apr-14	NW LANTAU	3	14.08	SPRING	STANDARD31516	P
29-Apr-14	NW LANTAU	3	4.13	SPRING	STANDARD31516	S
29-Apr-14	DEEP BAY	2	7.90	SPRING	STANDARD31516	P
29-Apr-14	DEEP BAY	3	3.16	SPRING	STANDARD31516	P
29-Apr-14	DEEP BAY	4	1.36	SPRING	STANDARD31516	P
29-Apr-14	DEEP BAY	2	3.31	SPRING	STANDARD31516	S
29-Apr-14	DEEP BAY	3	2.48	SPRING	STANDARD31516	S
29-Apr-14	DEEP BAY	4	0.30	SPRING	STANDARD31516	S
29-Apr-14	NE LANTAU	3	7.20	SPRING	STANDARD31516	P
29-Apr-14	NE LANTAU	2	0.94	SPRING	STANDARD31516	S
29-Apr-14	NE LANTAU	3	5.11	SPRING	STANDARD31516	S
7-May-14	W LANTAU	2	11.00	SPRING	STANDARD31516	S
7-May-14	SW LANTAU	2	11.04	SPRING	STANDARD31516	P
7-May-14	SW LANTAU	3	2.30	SPRING	STANDARD31516	P
7-May-14	SW LANTAU	2	9.06	SPRING	STANDARD31516	S
8-May-14	NW LANTAU	1	3.60	SPRING	STANDARD31516	P
8-May-14	NW LANTAU	2	8.57	SPRING	STANDARD31516	P
8-May-14	NW LANTAU	3	10.21	SPRING	STANDARD31516	P
8-May-14	NW LANTAU	1	0.50	SPRING	STANDARD31516	S
8-May-14	DEEP BAY	1	3.49	SPRING	STANDARD31516	P
8-May-14	DEEP BAY	2	9.93	SPRING	STANDARD31516	P
8-May-14	DEEP BAY	1	2.17	SPRING	STANDARD31516	S
8-May-14	DEEP BAY	2	3.89	SPRING	STANDARD31516	S
8-May-14	NE LANTAU	2	3.60	SPRING	STANDARD31516	P
8-May-14	NE LANTAU	3	4.87	SPRING	STANDARD31516	P
8-May-14	NE LANTAU	3	0.95	SPRING	STANDARD31516	S
12-May-14	W LANTAU	1	5.41	SPRING	STANDARD31516	P
12-May-14	W LANTAU	2	9.33	SPRING	STANDARD31516	P
12-May-14	W LANTAU	3	4.40	SPRING	STANDARD31516	P
12-May-14	W LANTAU	1	7.17	SPRING	STANDARD31516	S
12-May-14	W LANTAU	2	7.80	SPRING	STANDARD31516	S
12-May-14	W LANTAU	3	2.82	SPRING	STANDARD31516	S
14-May-14	NW LANTAU	2	1.90	SPRING	STANDARD31516	P
14-May-14	NW LANTAU	3	7.41	SPRING	STANDARD31516	P
14-May-14	NW LANTAU	4	12.88	SPRING	STANDARD31516	P
14-May-14	NW LANTAU	2	2.00	SPRING	STANDARD31516	S
14-May-14	NW LANTAU	3	3.57	SPRING	STANDARD31516	S
14-May-14	NW LANTAU	4	2.03	SPRING	STANDARD31516	S
14-May-14	NE LANTAU	2	4.29	SPRING	STANDARD31516	P
14-May-14	NE LANTAU	3	6.24	SPRING	STANDARD31516	P
14-May-14	NE LANTAU	2	0.30	SPRING	STANDARD31516	S
14-May-14	NE LANTAU	3	3.97	SPRING	STANDARD31516	S
15-May-14	W LANTAU	2	2.72	SPRING	STANDARD31516	S
15-May-14	W LANTAU	3	7.85	SPRING	STANDARD31516	S
15-May-14	SW LANTAU	1	7.55	SPRING	STANDARD31516	P
15-May-14	SW LANTAU	2	13.76	SPRING	STANDARD31516	P
15-May-14	SW LANTAU	1	0.30	SPRING	STANDARD31516	S
15-May-14	SW LANTAU	2	10.82	SPRING	STANDARD31516	S
15-May-14	SW LANTAU	3	0.91	SPRING	STANDARD31516	S
15-May-14	SE LANTAU	2	6.38	SPRING	STANDARD31516	P
15-May-14	SE LANTAU	1	1.69	SPRING	STANDARD31516	S
15-May-14	SE LANTAU	2	2.69	SPRING	STANDARD31516	S
15-May-14	SE LANTAU	3	2.44	SPRING	STANDARD31516	S
20-May-14	SW LANTAU	2	3.38	SPRING	STANDARD31516	P
20-May-14	SW LANTAU	3	5.90	SPRING	STANDARD31516	P

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
20-May-14	SW LANTAU	2	2.85	SPRING	STANDARD31516	S
20-May-14	SW LANTAU	3	7.29	SPRING	STANDARD31516	S
20-May-14	W LANTAU	2	2.79	SPRING	STANDARD31516	S
20-May-14	W LANTAU	3	3.65	SPRING	STANDARD31516	S
20-May-14	W LANTAU	4	3.42	SPRING	STANDARD31516	S
28-May-14	LAMMA	2	21.59	SPRING	STANDARD31516	P
28-May-14	LAMMA	3	29.30	SPRING	STANDARD31516	P
28-May-14	LAMMA	4	6.80	SPRING	STANDARD31516	P
28-May-14	LAMMA	2	7.21	SPRING	STANDARD31516	S
28-May-14	LAMMA	3	8.30	SPRING	STANDARD31516	S
28-May-14	LAMMA	4	1.40	SPRING	STANDARD31516	S
4-Jun-14	W LANTAU	2	5.17	SUMMER	STANDARD31516	S
4-Jun-14	SW LANTAU	2	15.60	SUMMER	STANDARD31516	P
4-Jun-14	SW LANTAU	3	5.17	SUMMER	STANDARD31516	P
4-Jun-14	SW LANTAU	2	7.71	SUMMER	STANDARD31516	S
4-Jun-14	SW LANTAU	3	3.21	SUMMER	STANDARD31516	S
4-Jun-14	SE LANTAU	2	6.42	SUMMER	STANDARD31516	P
4-Jun-14	SE LANTAU	3	6.56	SUMMER	STANDARD31516	P
4-Jun-14	SE LANTAU	2	5.59	SUMMER	STANDARD31516	S
4-Jun-14	SE LANTAU	3	2.10	SUMMER	STANDARD31516	S
6-Jun-14	SW LANTAU	2	5.20	SUMMER	STANDARD31516	S
6-Jun-14	SW LANTAU	3	3.70	SUMMER	STANDARD31516	S
6-Jun-14	SE LANTAU	2	11.72	SUMMER	STANDARD31516	P
6-Jun-14	SE LANTAU	3	1.59	SUMMER	STANDARD31516	P
6-Jun-14	SE LANTAU	2	6.24	SUMMER	STANDARD31516	S
9-Jun-14	W LANTAU	2	4.83	SUMMER	STANDARD31516	S
9-Jun-14	W LANTAU	3	1.28	SUMMER	STANDARD31516	S
9-Jun-14	W LANTAU	4	1.65	SUMMER	STANDARD31516	S
9-Jun-14	NW LANTAU	3	11.54	SUMMER	STANDARD31516	P
9-Jun-14	NW LANTAU	4	4.81	SUMMER	STANDARD31516	P
9-Jun-14	NW LANTAU	5	0.70	SUMMER	STANDARD31516	P
9-Jun-14	NW LANTAU	2	1.32	SUMMER	STANDARD31516	S
9-Jun-14	NW LANTAU	3	7.03	SUMMER	STANDARD31516	S
12-Jun-14	NE LANTAU	2	14.27	SUMMER	STANDARD31516	P
12-Jun-14	NE LANTAU	3	1.50	SUMMER	STANDARD31516	P
12-Jun-14	NE LANTAU	2	7.23	SUMMER	STANDARD31516	S
12-Jun-14	NW LANTAU	2	2.22	SUMMER	STANDARD31516	P
12-Jun-14	NW LANTAU	3	0.84	SUMMER	STANDARD31516	P
12-Jun-14	NW LANTAU	1	1.64	SUMMER	STANDARD31516	S
12-Jun-14	NW LANTAU	2	3.03	SUMMER	STANDARD31516	S
12-Jun-14	DEEP BAY	2	1.81	SUMMER	STANDARD31516	P
12-Jun-14	DEEP BAY	3	4.53	SUMMER	STANDARD31516	P
12-Jun-14	DEEP BAY	2	1.41	SUMMER	STANDARD31516	S
12-Jun-14	DEEP BAY	3	0.85	SUMMER	STANDARD31516	S
13-Jun-14	W LANTAU	1	5.95	SUMMER	STANDARD31516	P
13-Jun-14	W LANTAU	2	11.33	SUMMER	STANDARD31516	P
13-Jun-14	W LANTAU	3	4.50	SUMMER	STANDARD31516	P
13-Jun-14	W LANTAU	1	4.77	SUMMER	STANDARD31516	S
13-Jun-14	W LANTAU	2	3.63	SUMMER	STANDARD31516	S
13-Jun-14	W LANTAU	3	1.18	SUMMER	STANDARD31516	S
13-Jun-14	W LANTAU	4	0.94	SUMMER	STANDARD31516	S
13-Jun-14	SW LANTAU	1	3.03	SUMMER	STANDARD31516	P
13-Jun-14	SW LANTAU	2	5.82	SUMMER	STANDARD31516	P
13-Jun-14	SW LANTAU	3	2.78	SUMMER	STANDARD31516	P
13-Jun-14	SW LANTAU	1	1.77	SUMMER	STANDARD31516	S
13-Jun-14	SW LANTAU	2	3.34	SUMMER	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
13-Jun-14	SW LANTAU	3	1.16	SUMMER	STANDARD31516	S
17-Jun-14	W LANTAU	2	2.35	SUMMER	STANDARD31516	S
17-Jun-14	W LANTAU	3	7.58	SUMMER	STANDARD31516	S
17-Jun-14	W LANTAU	4	0.90	SUMMER	STANDARD31516	S
17-Jun-14	SW LANTAU	2	3.86	SUMMER	STANDARD31516	P
17-Jun-14	SW LANTAU	3	19.00	SUMMER	STANDARD31516	P
17-Jun-14	SW LANTAU	4	6.04	SUMMER	STANDARD31516	P
17-Jun-14	SW LANTAU	3	7.59	SUMMER	STANDARD31516	S
17-Jun-14	SE LANTAU	2	1.14	SUMMER	STANDARD31516	P
17-Jun-14	SE LANTAU	3	10.24	SUMMER	STANDARD31516	P
17-Jun-14	SE LANTAU	4	1.45	SUMMER	STANDARD31516	P
17-Jun-14	SE LANTAU	2	2.07	SUMMER	STANDARD31516	S
25-Jun-14	NW LANTAU	2	15.98	SUMMER	STANDARD31516	P
25-Jun-14	NW LANTAU	3	15.09	SUMMER	STANDARD31516	P
25-Jun-14	NW LANTAU	1	1.09	SUMMER	STANDARD31516	S
25-Jun-14	NW LANTAU	3	4.24	SUMMER	STANDARD31516	S
25-Jun-14	DEEP BAY	2	5.33	SUMMER	STANDARD31516	P
25-Jun-14	DEEP BAY	3	6.63	SUMMER	STANDARD31516	P
25-Jun-14	DEEP BAY	4	1.90	SUMMER	STANDARD31516	P
25-Jun-14	DEEP BAY	2	1.86	SUMMER	STANDARD31516	S
25-Jun-14	DEEP BAY	3	3.26	SUMMER	STANDARD31516	S
25-Jun-14	DEEP BAY	4	0.80	SUMMER	STANDARD31516	S
4-Jul-14	NW LANTAU	3	7.07	SUMMER	STANDARD31516	S
4-Jul-14	W LANTAU	2	5.46	SUMMER	STANDARD31516	S
4-Jul-14	W LANTAU	3	2.94	SUMMER	STANDARD31516	S
7-Jul-14	PO TOI	1	36.35	SUMMER	STANDARD31516	P
7-Jul-14	PO TOI	2	31.00	SUMMER	STANDARD31516	P
7-Jul-14	PO TOI	3	3.03	SUMMER	STANDARD31516	P
7-Jul-14	PO TOI	1	5.82	SUMMER	STANDARD31516	S
7-Jul-14	PO TOI	2	10.69	SUMMER	STANDARD31516	S
8-Jul-14	NINEPINS	0	1.80	SUMMER	STANDARD31516	P
8-Jul-14	NINEPINS	1	33.45	SUMMER	STANDARD31516	P
8-Jul-14	NINEPINS	2	19.45	SUMMER	STANDARD31516	P
8-Jul-14	NINEPINS	3	13.60	SUMMER	STANDARD31516	P
8-Jul-14	NINEPINS	1	6.21	SUMMER	STANDARD31516	S
8-Jul-14	NINEPINS	2	3.50	SUMMER	STANDARD31516	S
8-Jul-14	NINEPINS	3	1.90	SUMMER	STANDARD31516	S
9-Jul-14	W LANTAU	1	5.00	SUMMER	STANDARD31516	S
9-Jul-14	W LANTAU	2	0.94	SUMMER	STANDARD31516	S
23-Jul-14	NE LANTAU	2	4.16	SUMMER	STANDARD31516	P
23-Jul-14	NE LANTAU	3	16.11	SUMMER	STANDARD31516	P
23-Jul-14	NE LANTAU	2	4.70	SUMMER	STANDARD31516	S
23-Jul-14	NE LANTAU	3	5.73	SUMMER	STANDARD31516	S
23-Jul-14	NW LANTAU	3	11.75	SUMMER	STANDARD31516	P
23-Jul-14	NW LANTAU	4	19.11	SUMMER	STANDARD31516	P
23-Jul-14	NW LANTAU	3	4.84	SUMMER	STANDARD31516	S
23-Jul-14	NW LANTAU	4	3.50	SUMMER	STANDARD31516	S
24-Jul-14	NW LANTAU	3	11.47	SUMMER	STANDARD31516	P
24-Jul-14	NW LANTAU	4	12.59	SUMMER	STANDARD31516	P
24-Jul-14	NW LANTAU	3	9.44	SUMMER	STANDARD31516	S
24-Jul-14	DEEP BAY	3	0.67	SUMMER	STANDARD31516	P
24-Jul-14	DEEP BAY	4	9.16	SUMMER	STANDARD31516	P
24-Jul-14	DEEP BAY	5	3.30	SUMMER	STANDARD31516	P
24-Jul-14	DEEP BAY	3	1.10	SUMMER	STANDARD31516	S
24-Jul-14	DEEP BAY	4	3.57	SUMMER	STANDARD31516	S
24-Jul-14	DEEP BAY	5	1.70	SUMMER	STANDARD31516	S
24-Jul-14	NE LANTAU	1	1.83	SUMMER	STANDARD31516	P
24-Jul-14	NE LANTAU	2	20.61	SUMMER	STANDARD31516	P
24-Jul-14	NE LANTAU	1	0.40	SUMMER	STANDARD31516	S
24-Jul-14	NE LANTAU	2	8.06	SUMMER	STANDARD31516	S
28-Jul-14	SE LANTAU	1	2.47	SUMMER	STANDARD31516	P

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
28-Jul-14	SE LANTAU	2	16.68	SUMMER	STANDARD31516	P
28-Jul-14	SE LANTAU	3	6.48	SUMMER	STANDARD31516	P
28-Jul-14	SE LANTAU	2	4.57	SUMMER	STANDARD31516	S
28-Jul-14	SE LANTAU	3	3.10	SUMMER	STANDARD31516	S
28-Jul-14	SW LANTAU	2	8.49	SUMMER	STANDARD31516	P
28-Jul-14	SW LANTAU	3	6.19	SUMMER	STANDARD31516	P
28-Jul-14	SW LANTAU	4	0.73	SUMMER	STANDARD31516	P
28-Jul-14	SW LANTAU	2	5.42	SUMMER	STANDARD31516	S
28-Jul-14	SW LANTAU	3	4.37	SUMMER	STANDARD31516	S
28-Jul-14	W LANTAU	2	4.34	SUMMER	STANDARD31516	S
28-Jul-14	W LANTAU	3	5.21	SUMMER	STANDARD31516	S
29-Jul-14	W LANTAU	1	1.22	SUMMER	STANDARD31516	P
29-Jul-14	W LANTAU	2	17.91	SUMMER	STANDARD31516	P
29-Jul-14	W LANTAU	3	2.39	SUMMER	STANDARD31516	P
29-Jul-14	W LANTAU	1	1.96	SUMMER	STANDARD31516	S
29-Jul-14	W LANTAU	2	7.56	SUMMER	STANDARD31516	S
29-Jul-14	W LANTAU	3	0.43	SUMMER	STANDARD31516	S
29-Jul-14	W LANTAU	4	0.92	SUMMER	STANDARD31516	S
29-Jul-14	SW LANTAU	2	1.57	SUMMER	STANDARD31516	P
29-Jul-14	SW LANTAU	3	2.34	SUMMER	STANDARD31516	P
29-Jul-14	SW LANTAU	2	0.36	SUMMER	STANDARD31516	S
29-Jul-14	SW LANTAU	3	8.74	SUMMER	STANDARD31516	S
29-Jul-14	SE LANTAU	2	4.49	SUMMER	STANDARD31516	S
29-Jul-14	SE LANTAU	3	3.26	SUMMER	STANDARD31516	S
30-Jul-14	NINEPINS	2	8.08	SUMMER	STANDARD31516	P
30-Jul-14	PO TOI	1	4.40	SUMMER	STANDARD31516	P
30-Jul-14	PO TOI	2	53.19	SUMMER	STANDARD31516	P
30-Jul-14	PO TOI	3	7.45	SUMMER	STANDARD31516	P
30-Jul-14	PO TOI	2	5.16	SUMMER	STANDARD31516	S
30-Jul-14	PO TOI	3	2.00	SUMMER	STANDARD31516	S
8-Aug-14	NW LANTAU	1	1.52	SUMMER	STANDARD31516	P
8-Aug-14	NW LANTAU	2	9.55	SUMMER	STANDARD31516	P
8-Aug-14	NW LANTAU	3	6.57	SUMMER	STANDARD31516	P
8-Aug-14	NW LANTAU	4	7.55	SUMMER	STANDARD31516	P
8-Aug-14	NW LANTAU	2	2.14	SUMMER	STANDARD31516	S
8-Aug-14	NW LANTAU	3	2.00	SUMMER	STANDARD31516	S
8-Aug-14	NW LANTAU	4	1.98	SUMMER	STANDARD31516	S
8-Aug-14	DEEP BAY	2	1.92	SUMMER	STANDARD31516	P
8-Aug-14	DEEP BAY	3	9.81	SUMMER	STANDARD31516	P
8-Aug-14	DEEP BAY	4	0.90	SUMMER	STANDARD31516	P
8-Aug-14	DEEP BAY	5	0.90	SUMMER	STANDARD31516	P
8-Aug-14	DEEP BAY	3	4.57	SUMMER	STANDARD31516	S
8-Aug-14	DEEP BAY	4	1.60	SUMMER	STANDARD31516	S
8-Aug-14	NE LANTAU	2	10.86	SUMMER	STANDARD31516	P
8-Aug-14	NE LANTAU	3	1.27	SUMMER	STANDARD31516	P
8-Aug-14	NE LANTAU	2	7.12	SUMMER	STANDARD31516	S
8-Aug-14	NE LANTAU	3	0.85	SUMMER	STANDARD31516	S
21-Aug-14	NE LANTAU	2	15.57	SUMMER	STANDARD31516	P
21-Aug-14	NE LANTAU	3	1.70	SUMMER	STANDARD31516	P
21-Aug-14	NE LANTAU	1	1.10	SUMMER	STANDARD31516	S
21-Aug-14	NE LANTAU	2	7.13	SUMMER	STANDARD31516	S
21-Aug-14	NE LANTAU	3	1.70	SUMMER	STANDARD31516	S
21-Aug-14	NW LANTAU	2	3.14	SUMMER	STANDARD31516	P
21-Aug-14	NW LANTAU	3	19.86	SUMMER	STANDARD31516	P
21-Aug-14	NW LANTAU	2	3.93	SUMMER	STANDARD31516	S
21-Aug-14	NW LANTAU	3	2.69	SUMMER	STANDARD31516	S
21-Aug-14	DEEP BAY	2	8.29	SUMMER	STANDARD31516	P
21-Aug-14	DEEP BAY	3	5.11	SUMMER	STANDARD31516	P
21-Aug-14	DEEP BAY	2	3.91	SUMMER	STANDARD31516	S
21-Aug-14	DEEP BAY	3	2.29	SUMMER	STANDARD31516	S
22-Aug-14	SW LANTAU	2	3.76	SUMMER	STANDARD31516	P
22-Aug-14	SW LANTAU	3	4.24	SUMMER	STANDARD31516	P

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
22-Aug-14	SW LANTAU	2	8.09	SUMMER	STANDARD31516	S
25-Aug-14	SAI KUNG	2	39.00	SUMMER	STANDARD31516	P
25-Aug-14	SAI KUNG	2	16.00	SUMMER	STANDARD31516	S
25-Aug-14	NINEPINS	2	15.54	SUMMER	STANDARD31516	P
25-Aug-14	NINEPINS	3	12.76	SUMMER	STANDARD31516	P
25-Aug-14	NINEPINS	1	1.70	SUMMER	STANDARD31516	S
25-Aug-14	NINEPINS	2	2.00	SUMMER	STANDARD31516	S
25-Aug-14	NINEPINS	3	2.10	SUMMER	STANDARD31516	S
26-Aug-14	NINEPINS	2	3.12	SUMMER	STANDARD31516	P
26-Aug-14	NINEPINS	3	31.85	SUMMER	STANDARD31516	P
26-Aug-14	NINEPINS	3	2.00	SUMMER	STANDARD31516	S
26-Aug-14	PO TOI	2	5.10	SUMMER	STANDARD31516	P
26-Aug-14	PO TOI	3	23.72	SUMMER	STANDARD31516	P
26-Aug-14	PO TOI	4	5.56	SUMMER	STANDARD31516	P
26-Aug-14	PO TOI	2	6.30	SUMMER	STANDARD31516	S
26-Aug-14	PO TOI	3	9.42	SUMMER	STANDARD31516	S
27-Aug-14	W LANTAU	2	0.52	SUMMER	STANDARD31516	S
27-Aug-14	W LANTAU	3	7.23	SUMMER	STANDARD31516	S
27-Aug-14	NW LANTAU	2	1.23	SUMMER	STANDARD31516	P
27-Aug-14	NW LANTAU	3	8.55	SUMMER	STANDARD31516	P
27-Aug-14	NW LANTAU	4	7.15	SUMMER	STANDARD31516	P
27-Aug-14	NW LANTAU	3	5.47	SUMMER	STANDARD31516	S
27-Aug-14	NW LANTAU	4	1.40	SUMMER	STANDARD31516	S
28-Aug-14	NW LANTAU	2	4.40	SUMMER	STANDARD31516	P
28-Aug-14	NW LANTAU	3	17.76	SUMMER	STANDARD31516	P
28-Aug-14	NW LANTAU	4	3.32	SUMMER	STANDARD31516	P
28-Aug-14	NW LANTAU	2	3.96	SUMMER	STANDARD31516	S
28-Aug-14	NW LANTAU	3	3.03	SUMMER	STANDARD31516	S
28-Aug-14	NW LANTAU	4	1.29	SUMMER	STANDARD31516	S
28-Aug-14	NE LANTAU	2	4.20	SUMMER	STANDARD31516	P
28-Aug-14	NE LANTAU	3	19.01	SUMMER	STANDARD31516	P
28-Aug-14	NE LANTAU	4	8.66	SUMMER	STANDARD31516	P
28-Aug-14	NE LANTAU	2	2.20	SUMMER	STANDARD31516	S
28-Aug-14	NE LANTAU	3	7.93	SUMMER	STANDARD31516	S
3-Sep-14	PO TOI	2	13.60	AUTUMN	STANDARD31516	P
3-Sep-14	PO TOI	3	33.20	AUTUMN	STANDARD31516	P
3-Sep-14	PO TOI	2	2.10	AUTUMN	STANDARD31516	S
3-Sep-14	PO TOI	3	7.32	AUTUMN	STANDARD31516	S
3-Sep-14	NINEPINS	2	0.80	AUTUMN	STANDARD31516	P
3-Sep-14	NINEPINS	3	27.47	AUTUMN	STANDARD31516	P
3-Sep-14	NINEPINS	4	3.10	AUTUMN	STANDARD31516	P
3-Sep-14	NINEPINS	3	4.03	AUTUMN	STANDARD31516	S
4-Sep-14	SAI KUNG	1	6.90	AUTUMN	STANDARD31516	P
4-Sep-14	SAI KUNG	2	23.50	AUTUMN	STANDARD31516	P
4-Sep-14	SAI KUNG	3	6.23	AUTUMN	STANDARD31516	P
4-Sep-14	SAI KUNG	1	2.00	AUTUMN	STANDARD31516	S
4-Sep-14	SAI KUNG	2	5.17	AUTUMN	STANDARD31516	S
4-Sep-14	NINEPINS	1	6.21	AUTUMN	STANDARD31516	P
4-Sep-14	NINEPINS	2	16.80	AUTUMN	STANDARD31516	P
4-Sep-14	NINEPINS	1	1.75	AUTUMN	STANDARD31516	S
4-Sep-14	NINEPINS	2	1.94	AUTUMN	STANDARD31516	S
10-Sep-14	W LANTAU	2	8.17	AUTUMN	STANDARD31516	S
10-Sep-14	W LANTAU	3	1.16	AUTUMN	STANDARD31516	S
12-Sep-14	SE LANTAU	2	9.33	AUTUMN	STANDARD31516	P
12-Sep-14	SE LANTAU	3	6.69	AUTUMN	STANDARD31516	P
12-Sep-14	SE LANTAU	4	2.00	AUTUMN	STANDARD31516	P
12-Sep-14	SE LANTAU	2	3.72	AUTUMN	STANDARD31516	S
12-Sep-14	SE LANTAU	3	5.90	AUTUMN	STANDARD31516	S
12-Sep-14	SE LANTAU	4	4.24	AUTUMN	STANDARD31516	S
12-Sep-14	SW LANTAU	2	3.61	AUTUMN	STANDARD31516	P
12-Sep-14	SW LANTAU	3	18.20	AUTUMN	STANDARD31516	P

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
12-Sep-14	SW LANTAU	4	2.18	AUTUMN	STANDARD31516	P
12-Sep-14	SW LANTAU	2	2.26	AUTUMN	STANDARD31516	S
12-Sep-14	SW LANTAU	3	10.79	AUTUMN	STANDARD31516	S
23-Sep-14	W LANTAU	2	9.60	AUTUMN	STANDARD31516	S
23-Sep-14	W LANTAU	3	0.22	AUTUMN	STANDARD31516	S
25-Sep-14	SE LANTAU	1	5.50	AUTUMN	STANDARD31516	P
25-Sep-14	SE LANTAU	2	13.34	AUTUMN	STANDARD31516	P
25-Sep-14	SE LANTAU	1	2.04	AUTUMN	STANDARD31516	S
25-Sep-14	SE LANTAU	2	4.34	AUTUMN	STANDARD31516	S
25-Sep-14	SW LANTAU	2	6.32	AUTUMN	STANDARD31516	P
25-Sep-14	SW LANTAU	3	0.52	AUTUMN	STANDARD31516	P
25-Sep-14	SW LANTAU	2	4.52	AUTUMN	STANDARD31516	S
25-Sep-14	SW LANTAU	3	1.15	AUTUMN	STANDARD31516	S
25-Sep-14	W LANTAU	2	5.73	AUTUMN	STANDARD31516	S
25-Sep-14	W LANTAU	3	3.79	AUTUMN	STANDARD31516	S
8-Oct-14	SW LANTAU	2	12.10	AUTUMN	STANDARD31516	P
8-Oct-14	SW LANTAU	2	7.51	AUTUMN	STANDARD31516	S
9-Oct-14	NE LANTAU	2	13.58	AUTUMN	STANDARD31516	P
9-Oct-14	NE LANTAU	3	3.69	AUTUMN	STANDARD31516	P
9-Oct-14	NE LANTAU	2	7.68	AUTUMN	STANDARD31516	S
9-Oct-14	NE LANTAU	3	2.26	AUTUMN	STANDARD31516	S
9-Oct-14	NW LANTAU	2	12.95	AUTUMN	STANDARD31516	P
9-Oct-14	NW LANTAU	3	1.75	AUTUMN	STANDARD31516	P
9-Oct-14	NW LANTAU	2	7.22	AUTUMN	STANDARD31516	S
9-Oct-14	NW LANTAU	3	2.15	AUTUMN	STANDARD31516	S
9-Oct-14	DEEP BAY	2	9.86	AUTUMN	STANDARD31516	P
9-Oct-14	DEEP BAY	3	2.25	AUTUMN	STANDARD31516	P
9-Oct-14	DEEP BAY	2	3.78	AUTUMN	STANDARD31516	S
9-Oct-14	DEEP BAY	3	2.29	AUTUMN	STANDARD31516	S
10-Oct-14	W LANTAU	3	6.36	AUTUMN	STANDARD31516	S
10-Oct-14	W LANTAU	4	3.10	AUTUMN	STANDARD31516	S
10-Oct-14	SW LANTAU	2	13.32	AUTUMN	STANDARD31516	P
10-Oct-14	SW LANTAU	3	5.21	AUTUMN	STANDARD31516	P
10-Oct-14	SW LANTAU	4	1.91	AUTUMN	STANDARD31516	P
10-Oct-14	SW LANTAU	2	4.86	AUTUMN	STANDARD31516	S
10-Oct-14	SW LANTAU	3	4.06	AUTUMN	STANDARD31516	S
10-Oct-14	SE LANTAU	1	2.07	AUTUMN	STANDARD31516	P
10-Oct-14	SE LANTAU	2	12.33	AUTUMN	STANDARD31516	P
10-Oct-14	SE LANTAU	2	6.09	AUTUMN	STANDARD31516	S
15-Oct-14	NW LANTAU	2	15.98	AUTUMN	STANDARD31516	P
15-Oct-14	NW LANTAU	3	6.84	AUTUMN	STANDARD31516	P
15-Oct-14	NW LANTAU	2	7.57	AUTUMN	STANDARD31516	S
15-Oct-14	NW LANTAU	3	0.67	AUTUMN	STANDARD31516	S
21-Oct-14	PO TOI	1	10.59	AUTUMN	STANDARD31516	P
21-Oct-14	PO TOI	2	39.19	AUTUMN	STANDARD31516	P
21-Oct-14	PO TOI	2	5.52	AUTUMN	STANDARD31516	S
21-Oct-14	NINEPINS	2	27.10	AUTUMN	STANDARD31516	P
21-Oct-14	NINEPINS	2	2.10	AUTUMN	STANDARD31516	S
22-Oct-14	W LANTAU	2	0.73	AUTUMN	STANDARD31516	S
22-Oct-14	W LANTAU	3	7.74	AUTUMN	STANDARD31516	S
22-Oct-14	W LANTAU	4	1.54	AUTUMN	STANDARD31516	S
22-Oct-14	NE LANTAU	2	8.82	AUTUMN	STANDARD31516	P
22-Oct-14	NE LANTAU	3	4.99	AUTUMN	STANDARD31516	P
22-Oct-14	NE LANTAU	2	6.09	AUTUMN	STANDARD31516	S
22-Oct-14	NE LANTAU	3	0.60	AUTUMN	STANDARD31516	S
24-Oct-14	NW LANTAU	2	12.75	AUTUMN	STANDARD31516	P
24-Oct-14	NW LANTAU	3	17.60	AUTUMN	STANDARD31516	P
24-Oct-14	NW LANTAU	2	4.07	AUTUMN	STANDARD31516	S
24-Oct-14	NE LANTAU	2	12.25	AUTUMN	STANDARD31516	P
24-Oct-14	NE LANTAU	3	6.51	AUTUMN	STANDARD31516	P
24-Oct-14	NE LANTAU	2	8.34	AUTUMN	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
24-Oct-14	NE LANTAU	3	1.92	AUTUMN	STANDARD31516	S
24-Oct-14	DEEP BAY	2	4.90	AUTUMN	STANDARD31516	P
24-Oct-14	DEEP BAY	3	8.39	AUTUMN	STANDARD31516	P
24-Oct-14	DEEP BAY	2	6.34	AUTUMN	STANDARD31516	S
30-Oct-14	NW LANTAU	2	2.67	AUTUMN	STANDARD31516	P
30-Oct-14	NW LANTAU	3	29.85	AUTUMN	STANDARD31516	P
30-Oct-14	NW LANTAU	2	3.77	AUTUMN	STANDARD31516	S
30-Oct-14	NW LANTAU	3	6.96	AUTUMN	STANDARD31516	S
30-Oct-14	W LANTAU	2	4.04	AUTUMN	STANDARD31516	P
30-Oct-14	W LANTAU	3	3.21	AUTUMN	STANDARD31516	P
30-Oct-14	W LANTAU	2	12.56	AUTUMN	STANDARD31516	S
30-Oct-14	W LANTAU	3	0.32	AUTUMN	STANDARD31516	S
31-Oct-14	W LANTAU	1	2.31	AUTUMN	STANDARD31516	S
31-Oct-14	W LANTAU	2	7.76	AUTUMN	STANDARD31516	S
31-Oct-14	W LANTAU	3	0.83	AUTUMN	STANDARD31516	S
31-Oct-14	SW LANTAU	2	5.28	AUTUMN	STANDARD31516	P
31-Oct-14	SW LANTAU	3	12.91	AUTUMN	STANDARD31516	P
31-Oct-14	SW LANTAU	4	0.64	AUTUMN	STANDARD31516	P
31-Oct-14	SW LANTAU	2	4.00	AUTUMN	STANDARD31516	S
31-Oct-14	SW LANTAU	3	8.16	AUTUMN	STANDARD31516	S
31-Oct-14	SW LANTAU	4	1.47	AUTUMN	STANDARD31516	S
31-Oct-14	SE LANTAU	3	13.72	AUTUMN	STANDARD31516	P
31-Oct-14	SE LANTAU	2	1.51	AUTUMN	STANDARD31516	S
31-Oct-14	SE LANTAU	3	5.41	AUTUMN	STANDARD31516	S
31-Oct-14	SE LANTAU	4	2.06	AUTUMN	STANDARD31516	S
5-Nov-14	W LANTAU	2	3.10	AUTUMN	STANDARD31516	S
5-Nov-14	W LANTAU	3	4.95	AUTUMN	STANDARD31516	S
5-Nov-14	W LANTAU	4	2.46	AUTUMN	STANDARD31516	S
5-Nov-14	NW LANTAU	2	8.00	AUTUMN	STANDARD31516	P
5-Nov-14	NW LANTAU	3	7.71	AUTUMN	STANDARD31516	P
5-Nov-14	NW LANTAU	2	1.79	AUTUMN	STANDARD31516	S
5-Nov-14	NW LANTAU	3	4.80	AUTUMN	STANDARD31516	S
6-Nov-14	W LANTAU	1	2.96	AUTUMN	STANDARD31516	S
6-Nov-14	W LANTAU	2	5.93	AUTUMN	STANDARD31516	S
6-Nov-14	SW LANTAU	2	8.50	AUTUMN	STANDARD31516	P
6-Nov-14	SW LANTAU	3	4.93	AUTUMN	STANDARD31516	P
6-Nov-14	SW LANTAU	1	2.64	AUTUMN	STANDARD31516	S
6-Nov-14	SW LANTAU	2	3.54	AUTUMN	STANDARD31516	S
6-Nov-14	SW LANTAU	3	2.08	AUTUMN	STANDARD31516	S
6-Nov-14	SE LANTAU	2	18.58	AUTUMN	STANDARD31516	P
6-Nov-14	SE LANTAU	3	6.68	AUTUMN	STANDARD31516	P
6-Nov-14	SE LANTAU	2	3.01	AUTUMN	STANDARD31516	S
6-Nov-14	SE LANTAU	3	4.03	AUTUMN	STANDARD31516	S
11-Nov-14	W LANTAU	2	10.47	AUTUMN	STANDARD31516	P
11-Nov-14	W LANTAU	3	10.17	AUTUMN	STANDARD31516	P
11-Nov-14	W LANTAU	2	10.28	AUTUMN	STANDARD31516	S
11-Nov-14	W LANTAU	3	10.40	AUTUMN	STANDARD31516	S
11-Nov-14	NW LANTAU	2	4.78	AUTUMN	STANDARD31516	P
11-Nov-14	NW LANTAU	3	17.81	AUTUMN	STANDARD31516	P
11-Nov-14	NW LANTAU	4	0.60	AUTUMN	STANDARD31516	P
11-Nov-14	NW LANTAU	3	5.47	AUTUMN	STANDARD31516	S
11-Nov-14	NW LANTAU	4	2.34	AUTUMN	STANDARD31516	S
17-Nov-14	NW LANTAU	2	1.00	AUTUMN	STANDARD31516	P
17-Nov-14	NW LANTAU	3	13.74	AUTUMN	STANDARD31516	P
17-Nov-14	NW LANTAU	2	1.82	AUTUMN	STANDARD31516	S
17-Nov-14	NW LANTAU	3	2.94	AUTUMN	STANDARD31516	S
17-Nov-14	NW LANTAU	4	0.70	AUTUMN	STANDARD31516	S
17-Nov-14	W LANTAU	3	3.03	AUTUMN	STANDARD31516	S
17-Nov-14	W LANTAU	4	3.43	AUTUMN	STANDARD31516	S
20-Nov-14	NE LANTAU	2	15.11	AUTUMN	STANDARD31516	P
20-Nov-14	NE LANTAU	3	4.96	AUTUMN	STANDARD31516	P

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
20-Nov-14	NE LANTAU	2	9.73	AUTUMN	STANDARD31516	S
20-Nov-14	NE LANTAU	3	2.40	AUTUMN	STANDARD31516	S
20-Nov-14	NW LANTAU	2	16.87	AUTUMN	STANDARD31516	P
20-Nov-14	NW LANTAU	3	2.40	AUTUMN	STANDARD31516	P
20-Nov-14	NW LANTAU	2	6.02	AUTUMN	STANDARD31516	S
20-Nov-14	DEEP BAY	2	16.26	AUTUMN	STANDARD31516	P
20-Nov-14	DEEP BAY	3	1.47	AUTUMN	STANDARD31516	P
20-Nov-14	DEEP BAY	2	5.75	AUTUMN	STANDARD31516	S
20-Nov-14	DEEP BAY	3	0.42	AUTUMN	STANDARD31516	S
21-Nov-14	W LANTAU	2	13.01	AUTUMN	STANDARD31516	P
21-Nov-14	W LANTAU	3	6.21	AUTUMN	STANDARD31516	P
21-Nov-14	W LANTAU	2	8.70	AUTUMN	STANDARD31516	S
21-Nov-14	W LANTAU	3	1.15	AUTUMN	STANDARD31516	S
21-Nov-14	SW LANTAU	2	1.78	AUTUMN	STANDARD31516	P
21-Nov-14	SW LANTAU	3	10.11	AUTUMN	STANDARD31516	P
21-Nov-14	SW LANTAU	4	3.23	AUTUMN	STANDARD31516	P
21-Nov-14	SW LANTAU	3	2.22	AUTUMN	STANDARD31516	S
21-Nov-14	SW LANTAU	4	1.99	AUTUMN	STANDARD31516	S
24-Nov-14	W LANTAU	3	1.72	AUTUMN	STANDARD31516	P
24-Nov-14	W LANTAU	2	17.07	AUTUMN	STANDARD31516	S
24-Nov-14	W LANTAU	3	1.77	AUTUMN	STANDARD31516	S
24-Nov-14	W LANTAU	4	0.73	AUTUMN	STANDARD31516	S
24-Nov-14	NW LANTAU	2	21.90	AUTUMN	STANDARD31516	P
24-Nov-14	NW LANTAU	2	4.76	AUTUMN	STANDARD31516	S
24-Nov-14	DEEP BAY	2	10.33	AUTUMN	STANDARD31516	P
24-Nov-14	DEEP BAY	3	0.16	AUTUMN	STANDARD31516	P
24-Nov-14	DEEP BAY	2	1.02	AUTUMN	STANDARD31516	S
24-Nov-14	DEEP BAY	3	0.99	AUTUMN	STANDARD31516	S
25-Nov-14	W LANTAU	2	13.50	AUTUMN	STANDARD31516	S
25-Nov-14	W LANTAU	3	0.58	AUTUMN	STANDARD31516	S
25-Nov-14	SW LANTAU	2	7.09	AUTUMN	STANDARD31516	P
25-Nov-14	SW LANTAU	2	8.82	AUTUMN	STANDARD31516	S
25-Nov-14	SW LANTAU	3	1.29	AUTUMN	STANDARD31516	S
25-Nov-14	SE LANTAU	2	10.43	AUTUMN	STANDARD31516	P
25-Nov-14	SE LANTAU	2	2.07	AUTUMN	STANDARD31516	S
3-Dec-14	W LANTAU	2	8.98	WINTER	STANDARD31516	S
3-Dec-14	W LANTAU	3	1.76	WINTER	STANDARD31516	S
3-Dec-14	NE LANTAU	1	2.20	WINTER	STANDARD31516	P
3-Dec-14	NE LANTAU	2	11.72	WINTER	STANDARD31516	P
3-Dec-14	NE LANTAU	2	7.48	WINTER	STANDARD31516	S
10-Dec-14	SW LANTAU	1	3.82	WINTER	STANDARD31516	P
10-Dec-14	SW LANTAU	2	5.92	WINTER	STANDARD31516	P
10-Dec-14	SW LANTAU	3	1.95	WINTER	STANDARD31516	P
10-Dec-14	SW LANTAU	2	2.35	WINTER	STANDARD31516	S
10-Dec-14	SW LANTAU	3	1.86	WINTER	STANDARD31516	S
10-Dec-14	W LANTAU	1	0.96	WINTER	STANDARD31516	S
10-Dec-14	W LANTAU	2	10.64	WINTER	STANDARD31516	S
11-Dec-14	W LANTAU	3	1.54	WINTER	STANDARD31516	S
11-Dec-14	W LANTAU	4	6.69	WINTER	STANDARD31516	S
11-Dec-14	W LANTAU	5	1.66	WINTER	STANDARD31516	S
11-Dec-14	SW LANTAU	2	1.10	WINTER	STANDARD31516	P
11-Dec-14	SW LANTAU	3	12.06	WINTER	STANDARD31516	P
11-Dec-14	SW LANTAU	4	1.21	WINTER	STANDARD31516	P
11-Dec-14	SW LANTAU	2	2.00	WINTER	STANDARD31516	S
11-Dec-14	SW LANTAU	3	4.65	WINTER	STANDARD31516	S
11-Dec-14	SW LANTAU	4	3.08	WINTER	STANDARD31516	S
11-Dec-14	SE LANTAU	1	0.90	WINTER	STANDARD31516	P
11-Dec-14	SE LANTAU	2	18.70	WINTER	STANDARD31516	P
11-Dec-14	SE LANTAU	3	6.59	WINTER	STANDARD31516	P
11-Dec-14	SE LANTAU	1	1.70	WINTER	STANDARD31516	S
11-Dec-14	SE LANTAU	2	6.24	WINTER	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
19-Dec-14	NW LANTAU	2	7.19	WINTER	STANDARD31516	P
19-Dec-14	NW LANTAU	3	10.74	WINTER	STANDARD31516	P
19-Dec-14	NW LANTAU	2	1.00	WINTER	STANDARD31516	S
19-Dec-14	NW LANTAU	3	1.09	WINTER	STANDARD31516	S
19-Dec-14	DEEP BAY	2	10.22	WINTER	STANDARD31516	P
19-Dec-14	DEEP BAY	3	3.38	WINTER	STANDARD31516	P
19-Dec-14	DEEP BAY	2	5.60	WINTER	STANDARD31516	S
19-Dec-14	DEEP BAY	3	0.64	WINTER	STANDARD31516	S
19-Dec-14	NE LANTAU	2	16.34	WINTER	STANDARD31516	P
19-Dec-14	NE LANTAU	2	4.22	WINTER	STANDARD31516	S
19-Dec-14	NE LANTAU	3	6.58	WINTER	STANDARD31516	S
24-Dec-14	W LANTAU	2	3.80	WINTER	STANDARD31516	S
24-Dec-14	W LANTAU	3	4.82	WINTER	STANDARD31516	S
24-Dec-14	W LANTAU	4	1.98	WINTER	STANDARD31516	S
24-Dec-14	SW LANTAU	1	0.60	WINTER	STANDARD31516	P
24-Dec-14	SW LANTAU	2	15.16	WINTER	STANDARD31516	P
24-Dec-14	SW LANTAU	3	0.70	WINTER	STANDARD31516	P
24-Dec-14	SW LANTAU	1	1.60	WINTER	STANDARD31516	S
24-Dec-14	SW LANTAU	2	9.69	WINTER	STANDARD31516	S
24-Dec-14	SW LANTAU	3	2.74	WINTER	STANDARD31516	S
24-Dec-14	SE LANTAU	2	20.58	WINTER	STANDARD31516	P
24-Dec-14	SE LANTAU	2	6.14	WINTER	STANDARD31516	S
29-Dec-14	NE LANTAU	2	8.50	WINTER	STANDARD31516	P
29-Dec-14	NE LANTAU	3	6.85	WINTER	STANDARD31516	P
29-Dec-14	NE LANTAU	2	5.85	WINTER	STANDARD31516	S
29-Dec-14	NE LANTAU	3	3.80	WINTER	STANDARD31516	S
29-Dec-14	NW LANTAU	2	8.37	WINTER	STANDARD31516	P
29-Dec-14	NW LANTAU	3	15.23	WINTER	STANDARD31516	P
29-Dec-14	NW LANTAU	2	1.78	WINTER	STANDARD31516	S
29-Dec-14	NW LANTAU	3	3.95	WINTER	STANDARD31516	S
29-Dec-14	DEEP BAY	1	1.40	WINTER	STANDARD31516	P
29-Dec-14	DEEP BAY	2	10.75	WINTER	STANDARD31516	P
29-Dec-14	DEEP BAY	3	0.65	WINTER	STANDARD31516	P
29-Dec-14	DEEP BAY	2	5.62	WINTER	STANDARD31516	S
29-Dec-14	DEEP BAY	3	0.39	WINTER	STANDARD31516	S
30-Dec-14	W LANTAU	2	5.86	WINTER	STANDARD31516	P
30-Dec-14	W LANTAU	3	6.34	WINTER	STANDARD31516	P
30-Dec-14	W LANTAU	2	3.81	WINTER	STANDARD31516	S
30-Dec-14	W LANTAU	3	6.69	WINTER	STANDARD31516	S
30-Dec-14	SW LANTAU	2	5.88	WINTER	STANDARD31516	P
30-Dec-14	SW LANTAU	3	8.38	WINTER	STANDARD31516	P
30-Dec-14	SW LANTAU	2	3.10	WINTER	STANDARD31516	S
30-Dec-14	SW LANTAU	3	5.94	WINTER	STANDARD31516	S
5-Jan-15	SE LANTAU	2	24.10	WINTER	STANDARD31516	P
5-Jan-15	SE LANTAU	3	1.65	WINTER	STANDARD31516	P
5-Jan-15	SE LANTAU	1	1.70	WINTER	STANDARD31516	S
5-Jan-15	SE LANTAU	2	4.48	WINTER	STANDARD31516	S
5-Jan-15	SE LANTAU	3	2.07	WINTER	STANDARD31516	S
5-Jan-15	SW LANTAU	2	10.44	WINTER	STANDARD31516	P
5-Jan-15	SW LANTAU	3	10.42	WINTER	STANDARD31516	P
5-Jan-15	SW LANTAU	2	2.00	WINTER	STANDARD31516	S
5-Jan-15	SW LANTAU	3	2.04	WINTER	STANDARD31516	S
6-Jan-15	LAMMA	1	2.33	WINTER	STANDARD31516	P
6-Jan-15	LAMMA	2	69.01	WINTER	STANDARD31516	P
6-Jan-15	LAMMA	1	3.20	WINTER	STANDARD31516	S
6-Jan-15	LAMMA	2	22.76	WINTER	STANDARD31516	S
9-Jan-15	SW LANTAU	2	7.07	WINTER	STANDARD31516	P
9-Jan-15	SW LANTAU	3	0.91	WINTER	STANDARD31516	P
9-Jan-15	SW LANTAU	4	5.00	WINTER	STANDARD31516	P
9-Jan-15	SW LANTAU	2	1.47	WINTER	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
9-Jan-15	SW LANTAU	3	3.45	WINTER	STANDARD31516	S
9-Jan-15	SW LANTAU	4	2.20	WINTER	STANDARD31516	S
14-Jan-15	NE LANTAU	2	5.60	WINTER	STANDARD31516	P
14-Jan-15	NE LANTAU	3	12.22	WINTER	STANDARD31516	P
14-Jan-15	NE LANTAU	4	1.77	WINTER	STANDARD31516	P
14-Jan-15	NE LANTAU	2	4.58	WINTER	STANDARD31516	S
14-Jan-15	NE LANTAU	3	5.93	WINTER	STANDARD31516	S
14-Jan-15	NW LANTAU	3	11.61	WINTER	STANDARD31516	P
14-Jan-15	NW LANTAU	4	10.49	WINTER	STANDARD31516	P
14-Jan-15	NW LANTAU	3	4.90	WINTER	STANDARD31516	S
14-Jan-15	DEEP BAY	1	0.66	WINTER	STANDARD31516	P
14-Jan-15	DEEP BAY	2	6.07	WINTER	STANDARD31516	P
14-Jan-15	DEEP BAY	3	6.30	WINTER	STANDARD31516	P
14-Jan-15	DEEP BAY	4	0.50	WINTER	STANDARD31516	P
14-Jan-15	DEEP BAY	2	1.79	WINTER	STANDARD31516	S
14-Jan-15	DEEP BAY	3	3.28	WINTER	STANDARD31516	S
14-Jan-15	DEEP BAY	4	1.00	WINTER	STANDARD31516	S
16-Jan-15	SE LANTAU	2	17.48	WINTER	STANDARD31516	P
16-Jan-15	SE LANTAU	3	3.69	WINTER	STANDARD31516	P
16-Jan-15	SE LANTAU	2	6.58	WINTER	STANDARD31516	S
16-Jan-15	SW LANTAU	2	14.87	WINTER	STANDARD31516	P
16-Jan-15	SW LANTAU	3	2.00	WINTER	STANDARD31516	P
16-Jan-15	SW LANTAU	2	6.14	WINTER	STANDARD31516	S
2-Feb-15	SW LANTAU	2	1.14	WINTER	STANDARD31516	P
10-Feb-15	W LANTAU	2	9.81	WINTER	STANDARD31516	S
10-Feb-15	W LANTAU	3	1.98	WINTER	STANDARD31516	S
11-Feb-15	LAMMA	1	13.82	WINTER	STANDARD31516	P
11-Feb-15	LAMMA	2	52.26	WINTER	STANDARD31516	P
11-Feb-15	LAMMA	1	7.74	WINTER	STANDARD31516	S
11-Feb-15	LAMMA	2	13.38	WINTER	STANDARD31516	S
12-Feb-15	SE LANTAU	1	3.21	WINTER	STANDARD31516	P
12-Feb-15	SE LANTAU	2	22.92	WINTER	STANDARD31516	P
12-Feb-15	SE LANTAU	1	1.60	WINTER	STANDARD31516	S
12-Feb-15	SE LANTAU	2	6.73	WINTER	STANDARD31516	S
12-Feb-15	SW LANTAU	1	11.54	WINTER	STANDARD31516	P
12-Feb-15	SW LANTAU	2	5.18	WINTER	STANDARD31516	P
12-Feb-15	SW LANTAU	1	8.59	WINTER	STANDARD31516	S
12-Feb-15	SW LANTAU	2	0.17	WINTER	STANDARD31516	S
3-Mar-15	SE LANTAU	2	10.8	SPRING	STANDARD31516	P
3-Mar-15	SE LANTAU	3	6.43	SPRING	STANDARD31516	P
3-Mar-15	SE LANTAU	2	7.01	SPRING	STANDARD31516	S
3-Mar-15	SE LANTAU	3	2.08	SPRING	STANDARD31516	S
3-Mar-15	LAMMA	2	13.03	SPRING	STANDARD31516	P
3-Mar-15	LAMMA	3	24.36	SPRING	STANDARD31516	P
3-Mar-15	LAMMA	4	3	SPRING	STANDARD31516	P
3-Mar-15	LAMMA	2	5.21	SPRING	STANDARD31516	S
3-Mar-15	LAMMA	3	2	SPRING	STANDARD31516	S
12-Mar-15	NW LANTAU	1	7.51	SPRING	STANDARD31516	P
12-Mar-15	NW LANTAU	2	23.15	SPRING	STANDARD31516	P
12-Mar-15	NW LANTAU	3	9.97	SPRING	STANDARD31516	P
12-Mar-15	NW LANTAU	1	0.29	SPRING	STANDARD31516	S
12-Mar-15	NW LANTAU	2	9.08	SPRING	STANDARD31516	S
12-Mar-15	DEEP BAY	2	13.64	SPRING	STANDARD31516	P
12-Mar-15	DEEP BAY	2	5.88	SPRING	STANDARD31516	S
12-Mar-15	NE LANTAU	2	9.01	SPRING	STANDARD31516	P
12-Mar-15	NE LANTAU	2	10.26	SPRING	STANDARD31516	S
16-Mar-15	LAMMA	1	1.9	SPRING	STANDARD31516	P
16-Mar-15	LAMMA	2	62.91	SPRING	STANDARD31516	P
16-Mar-15	LAMMA	3	2.46	SPRING	STANDARD31516	P
16-Mar-15	LAMMA	1	2.3	SPRING	STANDARD31516	S
16-Mar-15	LAMMA	2	18.44	SPRING	STANDARD31516	S

Appendix I. (cont'd.)

DATE	AREA	BEAU	EFFORT	SEASON	VESSEL	P/S
19-Mar-15	W LANTAU	2	10.1	SPRING	STANDARD31516	S
20-Mar-15	LAMMA	1	6.48	SPRING	STANDARD31516	P
20-Mar-15	LAMMA	2	31.34	SPRING	STANDARD31516	P
20-Mar-15	LAMMA	1	1.91	SPRING	STANDARD31516	S
20-Mar-15	LAMMA	2	3.13	SPRING	STANDARD31516	S
20-Mar-15	SE LANTAU	1	8.24	SPRING	STANDARD31516	P
20-Mar-15	SE LANTAU	2	11.65	SPRING	STANDARD31516	P
20-Mar-15	SE LANTAU	1	3.28	SPRING	STANDARD31516	S
20-Mar-15	SE LANTAU	2	2.61	SPRING	STANDARD31516	S
27-Mar-15	SW LANTAU	1	13.28	SPRING	STANDARD31516	P
27-Mar-15	SW LANTAU	2	3.3	SPRING	STANDARD31516	P
27-Mar-15	SW LANTAU	1	3.07	SPRING	STANDARD31516	S
27-Mar-15	SW LANTAU	2	4.45	SPRING	STANDARD31516	S
30-Mar-15	W LANTAU	2	2.1	SPRING	STANDARD31516	S
30-Mar-15	W LANTAU	3	6.35	SPRING	STANDARD31516	S
30-Mar-15	W LANTAU	4	1.65	SPRING	STANDARD31516	S
31-Mar-15	LAMMA	2	13.73	SPRING	STANDARD31516	P
31-Mar-15	LAMMA	3	19.7	SPRING	STANDARD31516	P
31-Mar-15	LAMMA	1	1	SPRING	STANDARD31516	S
31-Mar-15	LAMMA	2	6.27	SPRING	STANDARD31516	S
31-Mar-15	LAMMA	3	1	SPRING	STANDARD31516	S
31-Mar-15	SE LANTAU	2	15.62	SPRING	STANDARD31516	P
31-Mar-15	SE LANTAU	3	10.54	SPRING	STANDARD31516	P
31-Mar-15	SE LANTAU	1	0.35	SPRING	STANDARD31516	S
31-Mar-15	SE LANTAU	2	4.95	SPRING	STANDARD31516	S
31-Mar-15	SE LANTAU	3	4.09	SPRING	STANDARD31516	S

Appendix II. HKCRP-AFCD Chinese White Dolphin Sighting Database (April 2014 - March 2015)

(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
7-Apr-14	1	1538	1	SW LANTAU	3	ND	OFF	HELI	804596	804051	SPRING	NONE	
9-Apr-14	6	1531	4	W LANTAU	3	378	ON	HKCRP	805587	801846	SPRING	NONE	S
9-Apr-14	7	1552	1	W LANTAU	2	ND	OFF	HKCRP	807460	801046	SPRING	NONE	
10-Apr-14	1	1113	5	NW LANTAU	2	363	ON	HKCRP	827727	805470	SPRING	NONE	P
10-Apr-14	2	1303	5	DEEP BAY	2	391	ON	HKCRP	831967	805952	SPRING	NONE	S
10-Apr-14	3	1618	3	NE LANTAU	3	178	ON	HKCRP	823535	815525	SPRING	NONE	P
15-Apr-14	1	1113	2	NW LANTAU	3	42	ON	HKCRP	830095	806061	SPRING	NONE	S
15-Apr-14	2	1547	4	W LANTAU	4	178	ON	HKCRP	806530	800755	SPRING	NONE	S
15-Apr-14	3	1602	2	W LANTAU	2	187	ON	HKCRP	809973	801237	SPRING	NONE	S
15-Apr-14	4	1620	1	W LANTAU	2	105	ON	HKCRP	812540	802408	SPRING	NONE	S
23-Apr-14	1	1035	4	W LANTAU	3	200	ON	HKCRP	810460	801249	SPRING	NONE	S
28-Apr-14	10	1520	1	W LANTAU	2	326	ON	HKCRP	807027	801592	SPRING	NONE	S
28-Apr-14	11	1549	1	W LANTAU	2	286	ON	HKCRP	811799	801953	SPRING	NONE	S
29-Apr-14	1	1203	9	DEEP BAY	2	107	ON	HKCRP	831114	806043	SPRING	NONE	S
29-Apr-14	2	1233	5	DEEP BAY	2	460	ON	HKCRP	832444	805561	SPRING	NONE	P
29-Apr-14	3	1337	4	DEEP BAY	4	152	ON	HKCRP	831435	806064	SPRING	NONE	P
7-May-14	1	1555	5	SW LANTAU	2	58	ON	HKCRP	805851	802631	SPRING	PURSE SEINE	S
8-May-14	1	1124	2	NW LANTAU	1	81	ON	HKCRP	830451	805465	SPRING	NONE	P
8-May-14	2	1140	1	NW LANTAU	1	ND	OFF	HKCRP	830415	806669	SPRING	NONE	
8-May-14	3	1316	4	DEEP BAY	2	371	ON	HKCRP	831835	805591	SPRING	NONE	S
12-May-14	1	1030	6	W LANTAU	2	ND	OFF	HKCRP	813749	801308	SPRING	NONE	
12-May-14	2	1108	7	W LANTAU	2	531	ON	HKCRP	811544	802200	SPRING	NONE	S
12-May-14	3	1149	8	W LANTAU	3	191	ON	HKCRP	809800	799711	SPRING	NONE	S
12-May-14	4	1223	4	W LANTAU	3	3	ON	HKCRP	808483	799409	SPRING	NONE	S
12-May-14	5	1246	2	W LANTAU	3	114	ON	HKCRP	806395	801735	SPRING	NONE	P
12-May-14	6	1255	3	W LANTAU	2	ND	OFF	HKCRP	806293	802879	SPRING	PURSE SEINE	
12-May-14	7	1324	4	W LANTAU	3	3	ON	HKCRP	806464	800776	SPRING	NONE	P
12-May-14	8	1344	3	W LANTAU	3	642	ON	HKCRP	806621	799899	SPRING	NONE	S
12-May-14	9	1356	3	W LANTAU	2	25	ON	HKCRP	807451	800015	SPRING	NONE	P
12-May-14	10	1419	7	W LANTAU	1	ND	OFF	HKCRP	808811	800967	SPRING	NONE	
12-May-14	11	1438	3	W LANTAU	3	81	ON	HKCRP	809421	800535	SPRING	NONE	P
12-May-14	12	1452	4	W LANTAU	1	500	ON	HKCRP	810110	799732	SPRING	NONE	S
12-May-14	13	1537	10	W LANTAU	2	425	ON	HKCRP	815298	802002	SPRING	NONE	S

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
14-May-14	1	1349	3	NW LANTAU	3	26	ON	HKCRP	826595	806456	SPRING	NONE	P
15-May-14	1	1050	1	W LANTAU	3	727	ON	HKCRP	810029	801176	SPRING	NONE	S
15-May-14	2	1113	5	W LANTAU	3	9	ON	HKCRP	806240	802054	SPRING	NONE	S
15-May-14	3	1138	2	SW LANTAU	2	50	ON	HKCRP	806557	803550	SPRING	NONE	S
15-May-14	6	1500	1	SW LANTAU	1	327	ON	HKCRP	807717	811245	SPRING	NONE	P
20-May-14	1	1319	5	W LANTAU	4	ND	OFF	HKCRP	806018	801899	SPRING	NONE	
20-May-14	2	1333	3	SW LANTAU	4	ND	OFF	HKCRP	806239	802374	SPRING	NONE	
20-May-14	3	1339	4	SW LANTAU	3	223	ON	HKCRP	806602	803416	SPRING	NONE	S
20-May-14	4	1625	3	W LANTAU	3	114	ON	HKCRP	808080	801171	SPRING	NONE	S
26-May-14	1	1619	6	SW LANTAU	2	ND	OFF	HELI	803902	807938	SPRING	NONE	
30-May-14	1	920	15	SW LANTAU	2	ND	OFF	THEO	806118	802157	SPRING	NONE	
4-Jun-14	1	1023	10	W LANTAU	2	106	ON	HKCRP	813072	802275	SUMMER	NONE	S
4-Jun-14	2	1051	11	W LANTAU	2	ND	OFF	HKCRP	812020	801871	SUMMER	NONE	
4-Jun-14	3	1104	3	W LANTAU	2	83	ON	HKCRP	810992	801405	SUMMER	NONE	S
4-Jun-14	4	1115	1	W LANTAU	2	121	ON	HKCRP	809830	800969	SUMMER	NONE	S
4-Jun-14	5	1120	8	W LANTAU	2	75	ON	HKCRP	809154	800926	SUMMER	NONE	S
4-Jun-14	6	1128	3	W LANTAU	2	358	ON	HKCRP	808113	801120	SUMMER	NONE	S
4-Jun-14	7	1132	17	W LANTAU	2	98	ON	HKCRP	807060	801561	SUMMER	NONE	S
4-Jun-14	8	1201	3	SW LANTAU	2	14	ON	HKCRP	806943	804376	SUMMER	NONE	S
4-Jun-14	9	1321	2	SW LANTAU	2	201	ON	HKCRP	807689	808213	SUMMER	NONE	S
4-Jun-14	10	1331	2	SW LANTAU	2	34	ON	HKCRP	807410	809161	SUMMER	NONE	S
4-Jun-14	11	1440	9	SW LANTAU	2	78	ON	HKCRP	807562	811152	SUMMER	NONE	P
9-Jun-14	1	939	2	W LANTAU	2	218	ON	HKCRP	814750	804639	SUMMER	NONE	S
9-Jun-14	2	950	18	W LANTAU	2	ND	OFF	HKCRP	813745	803040	SUMMER	NONE	
9-Jun-14	3	1036	1	W LANTAU	3	341	ON	HKCRP	810880	801621	SUMMER	NONE	S
9-Jun-14	1	1555	1	W LANTAU	4	ND	OFF	HELI	807305	800963	SUMMER	NONE	
9-Jun-14	2	1558	3	W LANTAU	3	ND	OFF	HELI	813668	803153	SUMMER	NONE	
13-Jun-14	1	1112	2	W LANTAU	2	1157	ON	HKCRP	812930	801048	SUMMER	NONE	S
13-Jun-14	2	1134	1	W LANTAU	2	50	ON	HKCRP	811467	801653	SUMMER	NONE	P
13-Jun-14	3	1144	2	W LANTAU	2	230	ON	HKCRP	811425	800962	SUMMER	NONE	P
13-Jun-14	4	1211	3	W LANTAU	2	31	ON	HKCRP	810449	801445	SUMMER	NONE	P
13-Jun-14	5	1233	2	W LANTAU	2	455	ON	HKCRP	808859	799461	SUMMER	NONE	S
13-Jun-14	6	1244	4	W LANTAU	2	312	ON	HKCRP	808435	800821	SUMMER	NONE	P
13-Jun-14	7	1351	1	SW LANTAU	2	ND	OFF	HKCRP	805884	802693	SUMMER	NONE	

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
13-Jun-14	8	1412	7	SW LANTAU	1	168	ON	HKCRP	804895	804330	SUMMER	NONE	P
13-Jun-14	9	1456	1	SW LANTAU	2	269	ON	HKCRP	804891	806341	SUMMER	NONE	P
13-Jun-14	10	1531	8	SW LANTAU	2	280	ON	HKCRP	806105	808417	SUMMER	NONE	P
13-Jun-14	11	1600	1	SW LANTAU	3	ND	OFF	HKCRP	806444	811109	SUMMER	NONE	
17-Jun-14	1	1010	10	NW LANTAU	3	ND	OFF	HKCRP	814981	805083	SUMMER	NONE	
17-Jun-14	2	1039	10	W LANTAU	2	95	ON	HKCRP	814330	803989	SUMMER	NONE	S
17-Jun-14	3	1114	3	W LANTAU	3	55	ON	HKCRP	811157	801591	SUMMER	NONE	S
17-Jun-14	4	1124	1	W LANTAU	2	337	ON	HKCRP	809951	801062	SUMMER	NONE	S
17-Jun-14	5	1130	5	W LANTAU	3	296	ON	HKCRP	809110	800916	SUMMER	NONE	S
25-Jun-14	1	1542	7	W LANTAU	3	ND	OFF	HKCRP	812828	802357	SUMMER	NONE	
2-Jul-14	1	1541	7	SW LANTAU	2	ND	OFF	HELI	806372	802219	SUMMER	NONE	
2-Jul-14	2	1549	2	W LANTAU	4	ND	OFF	HELI	808036	800882	SUMMER	NONE	
2-Jul-14	3	1551	5	W LANTAU	4	ND	OFF	HELI	812650	802728	SUMMER	NONE	
4-Jul-14	1	1515	7	W LANTAU	3	263	ON	HKCRP	807040	800880	SUMMER	NONE	S
4-Jul-14	2	1535	8	W LANTAU	3	63	ON	HKCRP	808423	801048	SUMMER	NONE	S
4-Jul-14	3	1549	9	W LANTAU	2	7	ON	HKCRP	810128	801413	SUMMER	NONE	S
4-Jul-14	4	1608	1	W LANTAU	2	200	ON	HKCRP	812861	802574	SUMMER	NONE	S
9-Jul-14	1	1010	1	W LANTAU	2	ND	OFF	HKCRP	814739	804691	SUMMER	NONE	
9-Jul-14	2	1020	10	W LANTAU	2	69	ON	HKCRP	813635	803101	SUMMER	NONE	S
9-Jul-14	3	1037	1	W LANTAU	1	361	ON	HKCRP	811799	801840	SUMMER	NONE	S
9-Jul-14	4	1042	1	W LANTAU	1	82	ON	HKCRP	810682	801414	SUMMER	NONE	S
9-Jul-14	5	1049	6	W LANTAU	1	506	ON	HKCRP	809232	801009	SUMMER	NONE	S
9-Jul-14	6	1051	15	W LANTAU	1	327	ON	HKCRP	808424	800801	SUMMER	NONE	S
24-Jul-14	1	1316	1	NW LANTAU	3	121	ON	HKCRP	827953	808508	SUMMER	NONE	P
28-Jul-14	1	1301	1	SE LANTAU	2	ND	OFF	HKCRP	809852	812506	SUMMER	PURSE SEINE	
28-Jul-14	2	1425	3	SW LANTAU	2	559	ON	HKCRP	807177	809439	SUMMER	NONE	P
28-Jul-14	3	1450	7	SW LANTAU	2	619	ON	HKCRP	807447	807388	SUMMER	PURSE SEINE	P
28-Jul-14	4	1540	5	SW LANTAU	2	167	ON	HKCRP	806277	805313	SUMMER	NONE	P
28-Jul-14	5	1554	5	SW LANTAU	2	ND	OFF	HKCRP	806312	804199	SUMMER	NONE	
28-Jul-14	6	1603	3	SW LANTAU	2	ND	OFF	HKCRP	806315	802962	SUMMER	NONE	
28-Jul-14	7	1609	6	W LANTAU	2	118	ON	HKCRP	806517	801879	SUMMER	NONE	S
28-Jul-14	8	1618	2	W LANTAU	3	40	ON	HKCRP	807016	801581	SUMMER	NONE	S
28-Jul-14	9	1622	11	W LANTAU	2	289	ON	HKCRP	807913	801449	SUMMER	NONE	S
28-Jul-14	10	1639	3	W LANTAU	3	195	ON	HKCRP	812683	802532	SUMMER	NONE	S

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
29-Jul-14	1	1058	4	W LANTAU	3	151	ON	HKCRP	813756	803246	SUMMER	NONE	S
29-Jul-14	2	1109	4	W LANTAU	2	ND	OFF	HKCRP	813436	802926	SUMMER	NONE	
29-Jul-14	3	1134	1	W LANTAU	2	129	ON	HKCRP	812465	801253	SUMMER	NONE	P
29-Jul-14	4	1142	1	W LANTAU	2	872	ON	HKCRP	812475	801810	SUMMER	NONE	P
29-Jul-14	5	1156	2	W LANTAU	2	133	ON	HKCRP	811456	801797	SUMMER	NONE	P
29-Jul-14	6	1217	1	W LANTAU	2	340	ON	HKCRP	810450	801177	SUMMER	NONE	P
29-Jul-14	7	1244	4	W LANTAU	2	51	ON	HKCRP	808435	800770	SUMMER	NONE	P
29-Jul-14	8	1301	1	W LANTAU	1	73	ON	HKCRP	807437	801582	SUMMER	NONE	S
29-Jul-14	9	1308	10	W LANTAU	3	ND	OFF	HKCRP	806373	801900	SUMMER	NONE	
29-Jul-14	10	1402	6	W LANTAU	2	ND	OFF	HKCRP	806749	801838	SUMMER	NONE	
29-Jul-14	11	1419	1	W LANTAU	2	272	ON	HKCRP	807450	800592	SUMMER	NONE	P
29-Jul-14	12	1432	3	W LANTAU	2	548	ON	HKCRP	806463	801044	SUMMER	NONE	P
29-Jul-14	13	1454	7	SW LANTAU	2	ND	OFF	HKCRP	806195	802291	SUMMER	NONE	
29-Jul-14	14	1536	3	SW LANTAU	3	73	ON	HKCRP	805607	808416	SUMMER	NONE	S
8-Aug-14	1	1057	2	NW LANTAU	2	625	ON	HKCRP	822841	806366	SUMMER	NONE	S
8-Aug-14	2	1105	3	NW LANTAU	2	504	ON	HKCRP	823683	806110	SUMMER	NONE	S
8-Aug-14	3	1130	1	NW LANTAU	1	97	ON	HKCRP	826783	806477	SUMMER	NONE	P
8-Aug-14	4	1149	1	NW LANTAU	2	208	ON	HKCRP	827481	806468	SUMMER	NONE	P
8-Aug-14	5	1206	5	NW LANTAU	2	130	ON	HKCRP	827780	806469	SUMMER	NONE	P
18-Aug-14	1	859	5	SW LANTAU	3	ND	OFF	THEO	806306	802137	SUMMER	NONE	
18-Aug-14	2	935	9	SW LANTAU	3	ND	OFF	THEO	806317	802126	SUMMER	NONE	
18-Aug-14	3	1043	7	SW LANTAU	3	ND	OFF	THEO	806261	802178	SUMMER	NONE	
21-Aug-14	1	1344	2	NW LANTAU	3	52	ON	HKCRP	825639	808524	SUMMER	NONE	P
21-Aug-14	2	1739	1	NE LANTAU	2	ND	OFF	HKCRP	820723	814512	SUMMER	NONE	
22-Aug-14	1	1539	6	SW LANTAU	2	96	ON	HKCRP	806554	805313	SUMMER	NONE	P
22-Aug-14	2	1613	1	SW LANTAU	2	280	ON	HKCRP	807401	808068	SUMMER	NONE	S
22-Aug-14	3	1621	3	SW LANTAU	2	99	ON	HKCRP	807434	808429	SUMMER	NONE	S
22-Aug-14	4	1641	2	SW LANTAU	2	750	ON	HKCRP	807484	811214	SUMMER	NONE	S
27-Aug-14	1	1022	6	W LANTAU	3	ND	OFF	HKCRP	814198	803690	SUMMER	NONE	
27-Aug-14	2	1054	4	W LANTAU	3	220	ON	HKCRP	809121	800844	SUMMER	NONE	S
27-Aug-14	3	1111	2	W LANTAU	3	348	ON	HKCRP	807727	800572	SUMMER	NONE	S
28-Aug-14	1	1139	6	NW LANTAU	3	70	ON	HKCRP	820642	809968	SUMMER	NONE	S
10-Sep-14	1	1418	2	SW LANTAU	1	ND	OFF	HKCRP	806301	804488	AUTUMN	NONE	
10-Sep-14	2	1446	5	SW LANTAU	2	ND	OFF	HKCRP	806869	808397	AUTUMN	NONE	

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
10-Sep-14	3	1520	3	SW LANTAU	2	ND	OFF	HKCRP	806338	802786	AUTUMN	NONE	
10-Sep-14	4	1548	3	W LANTAU	2	192	ON	HKCRP	808146	801161	AUTUMN	NONE	S
17-Sep-14	1	1505	1	W LANTAU	4	ND	OFF	HELI	811489	801715	AUTUMN	NONE	
23-Sep-14	1	1019	5	W LANTAU	2	272	ON	HKCRP	813115	802482	AUTUMN	NONE	S
23-Sep-14	2	1036	2	W LANTAU	2	64	ON	HKCRP	811257	801374	AUTUMN	NONE	S
23-Sep-14	3	1044	5	W LANTAU	3	ND	OFF	HKCRP	811036	801240	AUTUMN	NONE	
23-Sep-14	4	1107	10	W LANTAU	2	23	ON	HKCRP	810074	800588	AUTUMN	NONE	S
23-Sep-14	5	1138	4	W LANTAU	2	1025	ON	HKCRP	808513	800646	AUTUMN	NONE	S
25-Sep-14	6	1450	6	SW LANTAU	2	114	ON	HKCRP	803138	808050	AUTUMN	NONE	S
25-Sep-14	7	1506	8	SW LANTAU	2	91	ON	HKCRP	804378	808300	AUTUMN	NONE	S
25-Sep-14	8	1547	4	SW LANTAU	2	ND	OFF	HKCRP	806227	802600	AUTUMN	NONE	
25-Sep-14	9	1627	3	W LANTAU	2	35	ON	HKCRP	812407	802418	AUTUMN	NONE	S
25-Sep-14	10	1640	4	W LANTAU	2	14	ON	HKCRP	813568	803163	AUTUMN	NONE	S
25-Sep-14	11	1649	1	W LANTAU	2	47	ON	HKCRP	814440	804247	AUTUMN	NONE	S
8-Oct-14	1	1317	4	SW LANTAU	2	ND	OFF	HKCRP	806040	802373	AUTUMN	NONE	
8-Oct-14	2	1337	3	SW LANTAU	2	1086	ON	HKCRP	804365	803442	AUTUMN	NONE	P
8-Oct-14	3	1342	1	SW LANTAU	2	287	ON	HKCRP	803900	803400	AUTUMN	NONE	P
8-Oct-14	4	1352	4	SW LANTAU	2	853	ON	HKCRP	802470	804139	AUTUMN	NONE	S
8-Oct-14	5	1412	4	SW LANTAU	2	281	ON	HKCRP	804173	805309	AUTUMN	NONE	P
8-Oct-14	6	1438	2	SW LANTAU	2	27	ON	HKCRP	808168	806554	AUTUMN	NONE	S
8-Oct-14	7	1448	4	SW LANTAU	2	147	ON	HKCRP	808056	807368	AUTUMN	PURSE SEINE	P
8-Oct-14	8	1513	25	SW LANTAU	2	23	ON	HKCRP	804977	807363	AUTUMN	NONE	P
9-Oct-14	1	1259	4	NW LANTAU	2	274	ON	HKCRP	822095	808508	AUTUMN	NONE	P
9-Oct-14	2	1527	2	DEEP BAY	2	752	ON	HKCRP	832000	806055	AUTUMN	NONE	S
10-Oct-14	1	1030	1	W LANTAU	3	80	ON	HKCRP	812197	802170	AUTUMN	NONE	S
10-Oct-14	2	1044	1	W LANTAU	4	411	ON	HKCRP	810571	801321	AUTUMN	NONE	S
10-Oct-14	3	1118	4	SW LANTAU	2	82	ON	HKCRP	806932	804324	AUTUMN	NONE	P
10-Oct-14	4	1133	1	SW LANTAU	3	274	ON	HKCRP	805526	804280	AUTUMN	NONE	P
10-Oct-14	5	1237	4	SW LANTAU	2	340	ON	HKCRP	807249	806336	AUTUMN	NONE	P
10-Oct-14	6	1253	1	SW LANTAU	2	87	ON	HKCRP	807257	808419	AUTUMN	NONE	P
10-Oct-14	7	1434	1	SE LANTAU	3	ND	OFF	HKCRP	807993	811967	AUTUMN	NONE	
15-Oct-14	1	1111	3	NW LANTAU	2	158	ON	HKCRP	824919	808513	AUTUMN	NONE	P
15-Oct-14	2	1203	7	NW LANTAU	3	ND	OFF	HKCRP	827414	806499	AUTUMN	NONE	
22-Oct-14	1	1334	1	W LANTAU	3	ND	OFF	HKCRP	806286	801301	AUTUMN	NONE	

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
22-Oct-14	2	1406	1	W LANTAU	3	9	ON	HKCRP	810726	801517	AUTUMN	NONE	S
24-Oct-14	1	1006	4	NW LANTAU	3	142	ON	HKCRP	816752	805447	AUTUMN	NONE	P
24-Oct-14	2	1106	2	NW LANTAU	2	32	ON	HKCRP	827716	805459	AUTUMN	NONE	P
30-Oct-14	1	1107	4	NW LANTAU	3	882	ON	HKCRP	825451	808514	AUTUMN	NONE	P
30-Oct-14	2	1223	8	NW LANTAU	3	644	ON	HKCRP	824945	806484	AUTUMN	NONE	P
30-Oct-14	3	1335	2	NW LANTAU	3	328	ON	HKCRP	827684	804676	AUTUMN	NONE	P
30-Oct-14	4	1440	4	W LANTAU	3	173	ON	HKCRP	815405	803785	AUTUMN	NONE	P
30-Oct-14	5	1506	6	W LANTAU	2	58	ON	HKCRP	813559	802019	AUTUMN	NONE	P
30-Oct-14	6	1550	8	W LANTAU	3	483	ON	HKCRP	810176	799846	AUTUMN	NONE	S
30-Oct-14	7	1624	2	W LANTAU	2	27	ON	HKCRP	810095	801310	AUTUMN	NONE	S
31-Oct-14	1	1104	1	W LANTAU	2	61	ON	HKCRP	808246	800976	AUTUMN	NONE	S
31-Oct-14	2	1111	1	W LANTAU	2	0	ON	HKCRP	807881	801057	AUTUMN	NONE	S
31-Oct-14	3	1154	3	SW LANTAU	3	295	ON	HKCRP	805393	804280	AUTUMN	NONE	P
5-Nov-14	1	1044	7	W LANTAU	3	67	ON	HKCRP	810261	801341	AUTUMN	NONE	S
5-Nov-14	2	1058	11	W LANTAU	3	18	ON	HKCRP	809819	801041	AUTUMN	NONE	S
6-Nov-14	1	1031	2	W LANTAU	2	997	ON	HKCRP	811899	801922	AUTUMN	NONE	S
6-Nov-14	2	1043	13	W LANTAU	2	238	ON	HKCRP	810007	801114	AUTUMN	NONE	S
6-Nov-14	3	1114	4	W LANTAU	1	123	ON	HKCRP	807370	801448	AUTUMN	NONE	S
6-Nov-14	4	1136	3	SW LANTAU	1	13	ON	HKCRP	807219	804809	AUTUMN	NONE	S
6-Nov-14	5	1158	3	SW LANTAU	2	237	ON	HKCRP	807015	807387	AUTUMN	NONE	P
11-Nov-14	1	1043	5	W LANTAU	2	227	ON	HKCRP	813712	803070	AUTUMN	NONE	S
11-Nov-14	2	1107	3	W LANTAU	2	314	ON	HKCRP	812687	800862	AUTUMN	NONE	S
11-Nov-14	3	1129	3	W LANTAU	3	760	ON	HKCRP	810891	801796	AUTUMN	NONE	S
11-Nov-14	4	1141	2	W LANTAU	3	105	ON	HKCRP	809420	800989	AUTUMN	NONE	P
11-Nov-14	5	1524	2	NW LANTAU	3	391	ON	HKCRP	828768	805461	AUTUMN	NONE	P
17-Nov-14	1	1442	4	W LANTAU	4	14	ON	HKCRP	810792	801672	AUTUMN	NONE	S
17-Nov-14	2	1504	2	W LANTAU	4	46	ON	HKCRP	813723	803112	AUTUMN	NONE	S
21-Nov-14	1	1150	6	W LANTAU	2	734	ON	HKCRP	809213	799483	AUTUMN	PURSE SEINE	S
21-Nov-14	2	1228	7	W LANTAU	2	420	ON	HKCRP	808424	800626	AUTUMN	PURSE SEINE	P
21-Nov-14	3	1311	5	W LANTAU	2	185	ON	HKCRP	806464	800673	AUTUMN	PURSE SEINE	P
21-Nov-14	4	1343	5	SW LANTAU	3	ND	OFF	HKCRP	806470	803168	AUTUMN	PURSE SEINE	
24-Nov-14	1	1041	5	W LANTAU	2	803	ON	HKCRP	813073	801554	AUTUMN	NONE	S
24-Nov-14	2	1103	11	W LANTAU	2	382	ON	HKCRP	809710	800206	AUTUMN	PURSE SEINE	S
24-Nov-14	3	1220	27	W LANTAU	2	618	ON	HKCRP	809774	801319	AUTUMN	NONE	S

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
24-Nov-14	4	1432	1	NW LANTAU	2	661	ON	HKCRP	827516	805459	AUTUMN	NONE	P
25-Nov-14	1	1012	3	NW LANTAU	2	ND	OFF	HKCRP	816431	805364	AUTUMN	NONE	
25-Nov-14	2	1054	3	W LANTAU	2	854	ON	HKCRP	812518	802212	AUTUMN	NONE	S
25-Nov-14	3	1101	5	W LANTAU	2	0	ON	HKCRP	811655	801819	AUTUMN	NONE	S
25-Nov-14	4	1115	13	W LANTAU	2	225	ON	HKCRP	810261	801362	AUTUMN	NONE	S
25-Nov-14	5	1324	1	SW LANTAU	2	243	ON	HKCRP	807019	811151	AUTUMN	NONE	S
25-Nov-14	6	1454	1	SE LANTAU	2	41	ON	HKCRP	807965	815287	AUTUMN	NONE	P
26-Nov-14	1	901	5	SW LANTAU	3	ND	OFF	THEO	806240	802023	AUTUMN	NONE	
3-Dec-14	1	1006	8	W LANTAU	2	309	ON	HKCRP	809852	800979	WINTER	NONE	S
10-Dec-14	1	1417	8	SW LANTAU	2	529	ON	HKCRP	803518	806328	WINTER	NONE	P
10-Dec-14	2	1458	6	SW LANTAU	2	ND	OFF	HKCRP	806206	802322	WINTER	NONE	
11-Dec-14	1	1021	5	W LANTAU	3	17	ON	HKCRP	814143	803494	WINTER	NONE	S
11-Dec-14	2	1043	3	W LANTAU	5	115	ON	HKCRP	812009	802056	WINTER	NONE	S
19-Dec-14	1	1250	8	DEEP BAY	2	82	ON	HKCRP	832188	806148	WINTER	NONE	S
24-Dec-14	1	1010	1	W LANTAU	2	132	ON	HKCRP	810637	801455	WINTER	NONE	S
24-Dec-14	2	1027	1	W LANTAU	3	208	ON	HKCRP	808168	801140	WINTER	NONE	S
29-Dec-14	1	1440	4	DEEP BAY	2	527	ON	HKCRP	832244	806014	WINTER	NONE	S
30-Dec-14	1	1043	1	W LANTAU	3	85	ON	HKCRP	813571	801967	WINTER	NONE	P
30-Dec-14	2	1109	1	W LANTAU	2	814	ON	HKCRP	811753	802427	WINTER	NONE	S
30-Dec-14	3	1118	4	W LANTAU	3	208	ON	HKCRP	811468	801323	WINTER	PURSE SEINE	P
30-Dec-14	4	1158	4	W LANTAU	3	ND	OFF	HKCRP	809487	800659	WINTER	NONE	
30-Dec-14	5	1242	2	W LANTAU	2	ND	OFF	HKCRP	805556	800908	WINTER	NONE	
30-Dec-14	6	1247	8	W LANTAU	2	682	ON	HKCRP	805444	801268	WINTER	NONE	P
14-Jan-15	1	1558	1	NW LANTAU	4	659	ON	HKCRP	821426	805446	WINTER	NONE	P
22-Jan-15	1	1019	5	W LANTAU	3	208	ON	HKCRP	814087	803690	WINTER	NONE	S
22-Jan-15	2	1039	2	W LANTAU	3	110	ON	HKCRP	811964	802139	WINTER	NONE	S
22-Jan-15	3	1045	1	W LANTAU	3	343	ON	HKCRP	811113	801498	WINTER	NONE	S
22-Jan-15	4	1052	1	W LANTAU	2	113	ON	HKCRP	810007	801021	WINTER	NONE	S
22-Jan-15	5	1100	10	W LANTAU	2	137	ON	HKCRP	808401	800986	WINTER	NONE	S
22-Jan-15	6	1112	3	W LANTAU	2	240	ON	HKCRP	806484	801859	WINTER	NONE	S
22-Jan-15	7	1126	1	SW LANTAU	3	ND	OFF	HKCRP	806238	802673	WINTER	NONE	
22-Jan-15	8	1157	1	SW LANTAU	2	ND	OFF	HKCRP	807214	807439	WINTER	NONE	
22-Jan-15	9	1257	1	W LANTAU	3	ND	OFF	HKCRP	805753	801950	WINTER	NONE	
26-Jan-15	3	1110	1	SW LANTAU	2	ND	OFF	HKCRP	806836	808088	WINTER	PURSE-SEINE	

Appendix II. (cont'd.)

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	NORTHING	EASTING	SEASON	BOAT ASSOC.	P/S
30-Jan-15	1	1031	1	SW LANTAU	2	ND	OFF	HKCRP	807089	809429	WINTER	NONE	
30-Jan-15	2	1330	2	SW LANTAU	2	ND	OFF	HKCRP	807299	809440	WINTER	NONE	
2-Feb-15	1	1013	3	SW LANTAU	2	ND	OFF	HKCRP	807109	804768	WINTER	NONE	
2-Feb-15	2	1034	3	W LANTAU	3	ND	OFF	HKCRP	806318	801858	WINTER	NONE	
2-Feb-15	3	1111	1	SW LANTAU	2	ND	OFF	HKCRP	805844	805652	WINTER	NONE	
4-Feb-15	1	1013	1	SW LANTAU	2	ND	OFF	HKCRP	805512	805662	WINTER	NONE	
4-Feb-15	2	1202	3	SW LANTAU	1	ND	OFF	HKCRP	806543	805231	WINTER	NONE	
6-Feb-15	1	1002	1	SW LANTAU	1	ND	OFF	HKCRP	807649	805924	WINTER	NONE	
6-Feb-15	2	1202	5	SW LANTAU	2	ND	OFF	HKCRP	806250	802415	WINTER	NONE	
9-Feb-15	3	1554	4	W LANTAU	2	ND	OFF	HELI	809696	801381	WINTER	NONE	
9-Feb-15	4	1559	3	W LANTAU	2	ND	OFF	HELI	813336	802750	WINTER	NONE	
10-Feb-15	1	1423	8	W LANTAU	2	22	ON	HKCRP	806951	800653	WINTER	NONE	S
12-Feb-15	3	1305	1	SW LANTAU	1	ND	OFF	HKCRP	809289	811330	WINTER	NONE	
12-Mar-15	1	1323	3	NW LANTAU	2	120	ON	HKCRP	827492	806468	SPRING	NONE	P
19-Mar-15	1	1328	4	W LANTAU	3	ND	OFF	HKCRP	806740	800993	SPRING	NONE	
27-Mar-15	1	1333	2	SW LANTAU	2	ND	OFF	HKCRP	806018	802208	SPRING	NONE	
30-Mar-15	1	1035	3	W LANTAU	3	197	ON	HKCRP	811301	801498	SPRING	NONE	S
30-Mar-15	2	1038	1	W LANTAU	3	117	ON	HKCRP	810549	801249	SPRING	NONE	S
30-Mar-15	3	1043	6	W LANTAU	3	199	ON	HKCRP	809431	800886	SPRING	NONE	S
30-Mar-15	4	1050	3	W LANTAU	4	30	ON	HKCRP	807814	801109	SPRING	NONE	S
30-Mar-15	5	1051	3	W LANTAU	4	174	ON	HKCRP	807382	801293	SPRING	NONE	S

Appendix III. HKCRP-AFCD Finless Porpoise Sighting Database (April 2014 - March 2015)

(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
9-Apr-14	1	1028	4	805725	818378	SE LANTAU	2	91	ON	SPRING	P
9-Apr-14	2	1108	1	804321	816314	SE LANTAU	2	91	ON	SPRING	P
9-Apr-14	3	1113	2	804664	816324	SE LANTAU	2	176	ON	SPRING	P
9-Apr-14	4	1158	1	806394	814254	SE LANTAU	3	171	ON	SPRING	P
9-Apr-14	5	1303	2	803267	810464	SW LANTAU	3	70	ON	SPRING	P
17-Apr-14	1	1350	2	804511	826019	LAMMA	3	155	ON	SPRING	P
17-Apr-14	2	1504	1	806486	820998	LAMMA	2	ND	OFF	SPRING	
17-Apr-14	3	1514	2	806729	821782	LAMMA	2	92	ON	SPRING	S
28-Apr-14	1	1053	1	806157	817646	SE LANTAU	3	323	ON	SPRING	S
28-Apr-14	2	1107	1	808107	817350	SE LANTAU	2	346	ON	SPRING	P
28-Apr-14	3	1142	1	806493	815285	SE LANTAU	2	10	ON	SPRING	P
28-Apr-14	4	1149	3	805507	815284	SE LANTAU	2	136	ON	SPRING	P
28-Apr-14	5	1156	3	804732	815283	SE LANTAU	2	89	ON	SPRING	P
28-Apr-14	6	1235	1	805322	813211	SE LANTAU	2	258	ON	SPRING	P
28-Apr-14	7	1248	2	807161	812677	SE LANTAU	2	ND	OFF	SPRING	
28-Apr-14	8	1319	2	802457	811143	SW LANTAU	2	100	ON	SPRING	P
28-Apr-14	9	1335	3	800898	809480	SW LANTAU	2	102	ON	SPRING	P
15-May-14	4	1408	12	804428	811147	SW LANTAU	2	77	ON	SPRING	P
15-May-14	5	1445	3	805336	811169	SW LANTAU	2	366	ON	SPRING	P
15-May-14	7	1534	2	806660	814275	SE LANTAU	2	133	ON	SPRING	P
15-May-14	8	1539	10	805918	814253	SE LANTAU	2	68	ON	SPRING	P
4-Jun-14	12	1623	1	803842	818964	SE LANTAU	2	13	ON	SUMMER	S
6-Jun-14	1	1510	2	803496	812187	SE LANTAU	2	102	ON	SUMMER	P
6-Jun-14	2	1517	1	802455	812175	SE LANTAU	2	328	ON	SUMMER	P
6-Jun-14	3	1526	1	802044	813536	SE LANTAU	2	33	ON	SUMMER	S
7-Jul-14	1	1334	2	803493	848658	PO TOI	1	439	ON	SUMMER	P
7-Jul-14	2	1419	1	804120	841562	PO TOI	2	126	ON	SUMMER	S
7-Jul-14	3	1431	1	805449	842417	PO TOI	1	10	ON	SUMMER	P
7-Jul-14	4	1553	2	807486	855389	PO TOI	2	78	ON	SUMMER	P
8-Jul-14	1	1107	3	814520	864275	NINEPINS	1	60	ON	SUMMER	P
8-Jul-14	2	1122	2	814514	867192	NINEPINS	1	116	ON	SUMMER	P
8-Jul-14	3	1209	3	812483	864608	NINEPINS	1	93	ON	SUMMER	P
8-Jul-14	4	1602	2	808486	847355	NINEPINS	2	73	ON	SUMMER	P
30-Jul-14	1	1355	1	804720	846409	PO TOI	3	11	ON	SUMMER	P
4-Aug-14	1	1515	2	840063	854042	SAI KUNG	1	ND	OFF	SUMMER	
4-Aug-14	3	1549	4	815503	854946	NINEPINS	2	ND	OFF	SUMMER	
4-Aug-14	4	1555	3	814692	861317	NINEPINS	1	ND	OFF	SUMMER	
4-Aug-14	5	1619	1	803629	812373	SE LANTAU	2	ND	OFF	SUMMER	
26-Aug-14	1	1145	1	808504	854552	NINEPINS	3	91	ON	SUMMER	P
3-Sep-14	1	1015	1	802495	847339	PO TOI	3	ND	OFF	AUTUMN	
3-Sep-14	2	1348	2	806946	857266	PO TOI	3	ND	OFF	AUTUMN	
4-Sep-14	1	1100	1	824383	868151	SAI KUNG	2	286	ON	AUTUMN	P
4-Sep-14	2	1449	3	814492	861142	NINEPINS	2	47	ON	AUTUMN	P
12-Sep-14	1	1249	1	801518	809801	SW LANTAU	3	51	ON	AUTUMN	P
12-Sep-14	2	1530	1	806186	813222	SE LANTAU	2	82	ON	AUTUMN	S
25-Sep-14	1	1130	8	806660	814265	SE LANTAU	2	191	ON	AUTUMN	P
25-Sep-14	2	1213	2	802032	814113	SE LANTAU	2	28	ON	AUTUMN	P
25-Sep-14	3	1230	2	802045	812535	SE LANTAU	2	ND	OFF	AUTUMN	
25-Sep-14	4	1331	18	801816	810472	SW LANTAU	2	238	ON	AUTUMN	P
25-Sep-14	5	1424	2	800855	808820	SW LANTAU	2	7	ON	AUTUMN	S
8-Oct-14	9	1614	1	804825	812406	SE LANTAU	2	ND	OFF	AUTUMN	
10-Oct-14	8	1506	1	802033	813164	SE LANTAU	2	26	ON	AUTUMN	S
10-Oct-14	9	1526	2	804446	814251	SE LANTAU	2	78	ON	AUTUMN	P
21-Oct-14	1	1237	5	806464	861412	PO TOI	2	40	ON	AUTUMN	P
31-Oct-14	4	1330	1	801998	807749	SW LANTAU	3	36	ON	AUTUMN	S
31-Oct-14	5	1515	1	806228	814243	SE LANTAU	3	216	ON	AUTUMN	P
6-Nov-14	6	1440	2	808065	815287	SE LANTAU	2	19	ON	AUTUMN	P
11-Dec-14	3	1348	3	803749	813219	SE LANTAU	2	64	ON	WINTER	P

Appendix III. (cont'd)

DATE	STG #	TIME	HRD SZ	NORTHING	EASTING	AREA	BEAU	PSD	EFFORT	SEASON	P/S
24-Dec-14	3	1300	2	801705	810472	SW LANTAU	2	ND	OFF	WINTER	
24-Dec-14	4	1311	1	801096	810450	SW LANTAU	2	198	ON	WINTER	P
24-Dec-14	5	1335	2	804283	812188	SE LANTAU	2	221	ON	WINTER	P
24-Dec-14	6	1345	2	805224	812190	SE LANTAU	2	56	ON	WINTER	P
24-Dec-14	7	1444	4	802951	814249	SE LANTAU	2	39	ON	WINTER	P
24-Dec-14	8	1509	2	802826	816301	SE LANTAU	2	69	ON	WINTER	P
5-Jan-15	1	1531	3	804691	813055	SE LANTAU	3	ND	OFF	WINTER	
16-Jan-15	1	1120	12	806403	815935	SE LANTAU	2	209	ON	WINTER	P
16-Jan-15	2	1220	1	805675	814253	SE LANTAU	2	259	ON	WINTER	P
16-Jan-15	3	1231	1	804291	814251	SE LANTAU	2	ND	OFF	WINTER	
26-Jan-15	1	1047	1	807860	811833	SE LANTAU	2	ND	OFF	WINTER	
26-Jan-15	2	1052	4	807596	810915	SW LANTAU	1	ND	OFF	WINTER	
9-Feb-15	1	1516	1	820458	866037	SAI KUNG	4	ND	OFF	WINTER	
9-Feb-15	2	1546	2	804680	812952	SW LANTAU	4	ND	OFF	WINTER	
11-Feb-15	1	1244	2	805489	821472	LAMMA	1	438	ON	WINTER	P
11-Feb-15	2	1412	2	807425	823227	LAMMA	2	116	ON	WINTER	P
12-Feb-15	1	1153	4	805099	814242	SE LANTAU	2	233	ON	WINTER	P
12-Feb-15	2	1207	3	803128	814239	SE LANTAU	2	240	ON	WINTER	P
12-Feb-15	4	1344	1	802934	810463	SW LANTAU	1	59	ON	WINTER	P
12-Feb-15	5	1356	3	801174	810460	SW LANTAU	1	88	ON	WINTER	P
12-Feb-15	6	1425	1	802585	807544	SW LANTAU	2	89	ON	WINTER	S
12-Feb-15	7	1601	2	805988	812015	SE LANTAU	3	ND	OFF	WINTER	
03-Mar-15	1	1022	1	805879	819410	SE LANTAU	2	56	ON	SPRING	P
03-Mar-15	2	1033	1	804339	819418	SE LANTAU	2	30	ON	SPRING	P
03-Mar-15	3	1132	7	808851	815845	SE LANTAU	2	68	ON	SPRING	S
03-Mar-15	4	1204	2	806703	815296	SE LANTAU	2	96	ON	SPRING	P
03-Mar-15	5	1216	5	805928	815460	SE LANTAU	2	ND	OFF	SPRING	
03-Mar-15	6	1250	1	804142	817850	SE LANTAU	2	134	ON	SPRING	P
16-Mar-15	1	933	2	809457	834683	LAMMA	2	98	ON	SPRING	P
16-Mar-15	2	1224	5	804980	820512	LAMMA	2	38	ON	SPRING	S
16-Mar-15	3	1242	2	805466	822482	LAMMA	2	192	ON	SPRING	P
16-Mar-15	4	1354	5	807425	823185	LAMMA	2	58	ON	SPRING	P
16-Mar-15	5	1406	5	808012	823175	LAMMA	2	221	ON	SPRING	S
20-Mar-15	1	955	4	808099	824691	LAMMA	1	102	ON	SPRING	S
20-Mar-15	2	1001	4	807978	824299	LAMMA	2	91	ON	SPRING	S
20-Mar-15	3	1011	5	807558	822794	LAMMA	2	136	ON	SPRING	S
20-Mar-15	4	1125	4	806485	822370	LAMMA	2	98	ON	SPRING	P
20-Mar-15	5	1146	2	805478	821544	LAMMA	2	269	ON	SPRING	P
20-Mar-15	6	1316	7	805103	819409	SE LANTAU	2	42	ON	SPRING	P
20-Mar-15	7	1358	3	805615	817470	SE LANTAU	1	257	ON	SPRING	P
27-Mar-15	2	1501	1	801855	807429	SW LANTAU	1	167	ON	SPRING	P
27-Mar-15	3	1535	4	803142	812155	SW LANTAU	1	ND	OFF	SPRING	
27-Mar-15	4	1539	3	803285	812599	SE LANTAU	1	ND	OFF	SPRING	
27-Mar-15	5	1554	2	804333	815427	SE LANTAU	1	ND	OFF	SPRING	
27-Mar-15	6	1559	1	804521	816087	SE LANTAU	1	ND	OFF	SPRING	
27-Mar-15	7	1604	1	804841	816985	SE LANTAU	2	ND	OFF	SPRING	
31-Mar-15	1	1252	4	804410	816211	SE LANTAU	3	ND	OFF	SPRING	
31-Mar-15	2	1429	2	801989	812968	SE LANTAU	3	116	ON	SPRING	P

Appendix IV. Individual dolphins identified during AFCD surveys (Apr 2014 to March 2015)

(in black: vessel survey sightings; in blue: sightings made from land; **in bold: new individuals**)

DOLPHIN ID	DATE	STG#	AREA
CH12	12/05/14	10	WL
	04/06/14	2	WL
	28/07/14	7	WL
	24/11/14	3	WL
	25/11/14	4	WL
	03/12/14	1	WL
	30/12/14	6	WL
	22/01/15	4	WL
CH34	10/04/14	2	DB
	08/05/14	1	NWL
	08/08/14	4	NWL
	28/08/14	1	NWL
	24/10/14	1	NWL
	12/03/15	1	NWL
CH38	30/05/14	1	SWL
	25/09/14	7	SWL
	24/11/14	2	WL
	24/11/14	3	WL
	25/11/14	4	WL
	03/12/14	1	WL
CH98	10/04/14	2	DB
	29/04/14	1	DB
CH108	12/05/14	7	WL
	09/07/14	6	WL
	18/08/14	3	SWL
	06/11/14	2	WL
	25/11/14	3	WL
	10/12/14	2	SWL
CH113	04/06/14	1	WL
CH153	27/08/14	1	WL
CH181	04/07/14	2	WL
CH187	18/08/14	2	SWL
EL01	12/05/14	10	WL
	12/05/14	11	WL
	12/05/14	12	WL
NL12	29/04/14	1	DB
	09/07/14	4	WL
NL24	10/04/14	3	NEL
NL33	09/07/14	6	WL
NL46	30/10/14	2	NWL
NL48	10/04/14	2	DB
	29/04/14	1	DB
	14/05/14	1	NWL
	28/08/14	1	NWL
	19/12/14	1	DB
	12/03/15	1	NWL
NL49	09/06/14	2	WL
NL80	10/04/14	1	NWL
	29/04/14	1	DB
NL93	14/05/14	1	NWL
	04/06/14	2	WL
NL98	18/08/14	1	SWL
	30/10/14	1	NWL
	30/10/14	2	NWL
NL103	09/06/14	2	WL
	08/10/14	1	SWL
NL104	10/04/14	2	DB
	24/10/14	2	NWL
	19/12/14	1	DB
NL105	09/06/14	2	WL
NL120	17/06/14	2	WL
NL123	09/10/14	1	NWL
	30/10/14	5	WL
NL128	20/05/14	1	WL
NL136	29/04/14	1	DB
	09/06/14	2	WL
	28/08/14	1	NWL
	15/10/14	1	NWL
	19/12/14	1	DB
	12/03/15	1	NWL

DOLPHIN ID	DATE	STG#	AREA
NL139	10/04/14	3	NEL
	04/07/14	2	WL
NL145	04/06/14	1	WL
NL150	09/06/14	2	WL
	29/07/14	2	WL
	29/07/14	9	WL
	10/12/14	2	SWL
NL153	10/04/14	1	NWL
	29/04/14	1	DB
NL156	08/10/14	8	SWL
	05/11/14	2	WL
	30/12/14	6	WL
NL165	30/05/14	1	SWL
	04/07/14	2	WL
NL182	21/08/14	1	NWL
	28/08/14	1	NWL
	15/10/14	1	NWL
NL188	09/07/14	6	WL
	18/08/14	3	SWL
	27/08/14	1	WL
	10/09/14	4	WL
	25/09/14	9	WL
	30/10/14	2	NWL
NL202	15/04/14	1	NWL
	15/10/14	1	NWL
	24/10/14	1	NWL
	19/12/14	1	DB
NL206	08/10/14	8	SWL
	30/10/14	6	WL
	05/11/14	1	WL
	06/11/14	2	WL
	24/11/14	3	WL
	19/03/15	1	WL
NL212	12/05/14	4	WL
	09/06/14	2	WL
NL213	08/05/14	3	DB
	13/06/14	2	WL
	13/06/14	3	WL
NL220	10/04/14	3	NEL
	17/06/14	2	WL
	28/08/14	1	NWL
	15/10/14	1	NWL
	24/10/14	1	NWL
	30/10/14	1	NWL
	19/12/14	1	DB
NL224	25/06/14	1	WL
	18/08/14	2	SWL
	23/09/14	4	WL
NL226	30/12/14	3	WL
NL233	08/05/14	3	DB
NL242	24/10/14	1	NWL
	30/10/14	1	NWL
NL247	12/05/14	10	WL
	12/05/14	11	WL
	12/05/14	12	WL
	04/06/14	5	WL
	25/06/14	1	WL
NL249	09/07/14	2	WL
NL259	09/07/14	6	WL
	10/09/14	4	WL
	30/10/14	5	WL
NL260	09/06/14	2	WL
	25/06/14	1	WL
	30/12/14	3	WL
NL262	08/08/14	2	NWL
NL264	04/06/14	5	WL
NL269	04/06/14	7	WL
	09/06/14	2	WL
	09/07/14	2	WL
	23/09/14	4	WL
	25/09/14	10	WL

DOLPHIN ID	DATE	STG#	AREA
NL272	13/06/14	6	WL
	08/10/14	8	SWL
NL276	25/06/14	1	WL
NL278	12/05/14	13	WL
	04/06/14	2	WL
NL279	09/07/14	2	WL
NL284	09/06/14	2	WL
	08/08/14	2	NWL
	08/08/14	4	NWL
NL285	09/10/14	1	NWL
	30/10/14	5	WL
NL286	15/04/14	1	NWL
	15/10/14	1	NWL
	24/10/14	1	NWL
	19/12/14	1	DB
NL287	04/06/14	1	WL
NL293	17/06/14	1	NWL
	09/07/14	1	WL
NL296	08/08/14	2	NWL
	08/08/14	4	NWL
	30/12/14	3	WL
NL299	10/04/14	1	NWL
	04/06/14	2	WL
	08/08/14	3	NWL
NL300	12/05/14	1	WL
	12/05/14	13	WL
	30/10/14	2	NWL
NL301	10/04/14	1	NWL
	29/04/14	1	DB
NL302	29/04/14	1	DB
	23/09/14	1	WL
	23/09/14	3	WL
NL306	28/07/14	3	SWL
NL307	08/10/14	8	SWL
NL308	30/10/14	2	NWL
NL309	23/09/14	4	WL
NL311	12/05/14	4	WL
	15/05/14	2	WL
NL312	04/06/14	2	WL
NL313	23/09/14	4	WL
	25/09/14	8	SWL
NL315	***29/04/14***	***1***	***DB***
NL316	***13/06/14***	***4***	***WL***
NL317	***04/07/14***	***3***	***WL***
NL318	***19/12/14***	***1***	***DB***
NL319	***08/05/14***	***3***	***DB***
SL05	30/05/14	1	SWL
	18/08/14	1	SWL
	25/09/14	6	SWL
	08/10/14	8	SWL
	31/10/14	1	WL
	05/11/14	2	WL
	21/11/14	2	WL
	24/11/14	2	WL
SL27	04/06/14	8	SWL
	04/06/14	9	SWL
	04/06/14	11	SWL
	29/07/14	14	SWL
	08/10/14	8	SWL
	10/12/14	1	SWL
	24/12/14	1	WL
	22/01/15	7	SWL
	12/02/15	3	SWL
SL35	07/05/14	1	SWL
	28/07/14	1	SEL
SL40	30/05/14	1	SWL
	26/11/14	1	SWL
	03/12/14	1	WL
	10/12/14	2	SWL

Appendix IV. (cont'd)

(in black: vessel survey sightings; in blue: sightings made from land; **in bold: new individuals**)

DOLPHIN ID	DATE	STG#	AREA
SL42	23/09/14	4	WL
SL44	28/07/14	3	SWL
	28/07/14	4	SWL
	30/10/14	5	WL
	06/11/14	4	SWL
	24/11/14	3	WL
SL47	09/06/14	2	WL
	18/08/14	2	SWL
SL50	15/05/14	6	SWL
	08/10/14	8	SWL
	06/11/14	5	SWL
SL51	21/11/14	1	WL
SL52	28/07/14	3	SWL
	21/11/14	4	SWL
SL53	***30/12/14***	***6***	***WL***
	02/02/15	***2***	***WL***
SL54	***04/06/14***	***11***	***SWL***
	04/07/14	***1***	***WL***
	22/08/14	***1***	***SWL***
	11/11/14	***1***	***WL***
SL55	***18/08/14***	***2***	***SWL***
	10/10/14	***3***	***SWL***
SL56	***08/10/14***	***8***	***SWL***
WL04	24/11/14	3	WL
	25/11/14	4	WL
WL05	08/05/14	1	NWL
	30/10/14	2	NWL
WL15	04/06/14	1	WL
	28/07/14	3	SWL
	29/07/14	9	WL
	24/11/14	3	WL
	25/11/14	1	NWL
WL17	12/05/14	9	WL
	15/05/14	2	WL
	18/08/14	2	SWL
WL21	04/06/14	1	WL
	17/06/14	1	NWL
	29/07/14	1	WL
	18/08/14	1	SWL
WL25	12/05/14	2	WL
	15/05/14	2	WL
	30/05/14	1	SWL
	04/06/14	11	SWL
WL29	17/06/14	5	WL
WL42	30/05/14	1	SWL
	29/07/14	7	WL
	29/07/14	9	WL
	22/08/14	2	SWL
	05/11/14	2	WL
	24/11/14	3	WL
	30/12/14	6	WL
	30/03/15	3	WL
WL46	12/05/14	1	WL
	12/05/14	13	WL
	04/06/14	2	WL
	09/06/14	2	WL
	17/06/14	2	WL
	09/07/14	2	WL
	22/01/15	4	WL
WL47	21/11/14	1	WL
WL50	20/05/14	2	SWL
	30/05/14	1	SWL
	04/06/14	7	WL
	09/07/14	6	WL
	29/07/14	9	WL
	25/09/14	8	SWL
	05/11/14	2	WL
	25/11/14	4	WL
	30/12/14	6	WL

DOLPHIN ID	DATE	STG#	AREA
WL58	12/05/14	2	WL
	04/06/14	7	WL
	04/07/14	2	WL
	23/09/14	4	WL
WL61	12/05/14	7	WL
	20/05/14	2	SWL
	04/06/14	7	WL
	28/07/14	5	SWL
	29/07/14	9	WL
	29/07/14	10	WL
	18/08/14	2	SWL
	18/08/14	3	SWL
	25/09/14	6	SWL
	05/11/14	2	WL
	25/11/14	4	WL
	10/12/14	2	SWL
WL62	07/05/14	1	SWL
	30/05/14	1	SWL
	10/10/14	5	SWL
	06/11/14	5	SWL
	21/11/14	1	WL
	21/11/14	4	SWL
	24/11/14	2	WL
	02/02/15	1	SWL
WL68	28/07/14	9	WL
	08/10/14	8	SWL
	06/11/14	2	WL
	24/11/14	3	WL
	03/12/14	1	WL
WL69	15/05/14	2	WL
	08/10/14	8	SWL
	10/10/14	3	SWL
	10/10/14	5	SWL
	10/10/14	7	SWL
	21/11/14	1	WL
	21/11/14	2	WL
	21/11/14	3	WL
	25/11/14	5	SWL
	25/11/14	6	SEL
	10/12/14	1	SWL
WL72	12/05/14	7	WL
	17/06/14	5	WL
	09/07/14	6	WL
	28/07/14	4	SWL
	29/07/14	7	WL
	29/07/14	9	WL
	05/11/14	2	WL
	06/11/14	2	WL
	25/11/14	3	WL
	10/12/14	2	SWL
WL73	08/10/14	8	SWL
WL74	25/09/14	7	SWL
	24/11/14	3	WL
WL76	09/06/14	2	WL
WL79	12/05/14	2	WL
	25/06/14	1	WL
WL84	12/05/14	6	WL
WL86	15/05/14	3	SWL
WL91	04/06/14	11	SWL
	13/06/14	10	SWL
	21/11/14	1	WL
	10/12/14	1	SWL
	02/02/15	2	WL
WL92	25/09/14	7	SWL
	08/10/14	8	SWL
	05/11/14	1	WL
	24/11/14	3	WL

DOLPHIN ID	DATE	STG#	AREA
WL93	20/05/14	1	WL
	30/05/14	1	SWL
	13/06/14	10	SWL
	28/07/14	3	SWL
	25/11/14	4	WL
WL94	18/08/14	2	SWL
	06/11/14	2	WL
	17/11/14	1	WL
WL97	04/06/14	1	WL
	18/08/14	3	SWL
	25/11/14	3	WL
	30/12/14	6	WL
WL98	12/05/14	4	WL
	04/06/14	7	WL
WL109	12/05/14	5	WL
	24/11/14	2	WL
	25/11/14	4	WL
	02/02/15	1	SWL
WL114	13/06/14	10	SWL
	25/09/14	6	SWL
	08/10/14	8	SWL
	10/10/14	3	SWL
	10/10/14	5	SWL
	30/10/14	6	WL
	24/11/14	3	WL
	02/02/15	1	SWL
WL116	28/07/14	6	SWL
	25/09/14	7	SWL
	08/10/14	8	SWL
	05/11/14	1	WL
	06/11/14	2	WL
	24/11/14	2	WL
	24/11/14	3	WL
	19/03/15	1	WL
WL118	13/06/14	8	SWL
	27/08/14	2	WL
	23/09/14	3	WL
	25/11/14	3	WL
WL120	09/07/14	2	WL
	29/07/14	2	WL
WL122	08/10/14	6	SWL
WL123	04/06/14	11	SWL
	08/10/14	8	SWL
	21/11/14	2	WL
	24/11/14	2	WL
	30/12/14	6	WL
	02/02/15	1	SWL
	30/03/15	5	WL
WL124	12/05/14	13	WL
	04/06/14	5	WL
	09/06/14	1	WL
	13/06/14	4	WL
	29/07/14	2	WL
	18/08/14	1	SWL
	23/09/14	1	WL
WL128	04/06/14	7	WL
	28/07/14	6	SWL
	29/07/14	9	WL
	05/11/14	2	WL
	06/11/14	2	WL
	24/11/14	3	WL
WL129	10/09/14	2	SWL
	08/10/14	8	SWL
	25/11/14	4	WL
	03/12/14	1	WL

Appendix IV. (cont'd)

(in black: vessel survey sightings; in blue: sightings made from land; **in bold: new individuals**)

DOLPHIN ID	DATE	STG#	AREA
WL130	12/05/14	6	WL
	30/05/14	1	SWL
	28/07/14	4	SWL
	18/08/14	3	SWL
	06/11/14	2	WL
	21/11/14	1	WL
	21/11/14	4	SWL
	24/11/14	2	WL
	26/11/14	1	SWL
WL131	15/05/14	1	WL
	04/07/14	2	WL
	25/09/14	6	SWL
	08/10/14	8	SWL
	06/11/14	3	WL
	24/11/14	3	WL
	25/11/14	4	WL
	30/03/15	3	WL
WL132	07/05/14	1	SWL
	08/10/14	7	SWL
	06/11/14	5	SWL
	21/11/14	1	WL
	21/11/14	2	WL
	21/11/14	3	WL
	24/11/14	2	WL
WL137	22/08/14	1	SWL
	05/11/14	1	WL
	22/01/15	1	WL
WL142	30/05/14	1	SWL
	25/09/14	7	SWL
	05/11/14	1	WL
	24/11/14	2	WL
	24/11/14	3	WL
WL144	06/11/14	2	WL
WL152	05/11/14	2	WL
	24/11/14	2	WL
	24/11/14	3	WL
	25/11/14	4	WL
	10/12/14	2	SWL
	30/12/14	6	WL
	02/02/15	2	WL
WL153	17/06/14	2	WL
WL159	09/06/14	2	WL
	13/06/14	3	WL
WL165	15/05/14	3	SWL
	20/05/14	3	SWL
	18/08/14	3	SWL
	08/10/14	8	SWL
	06/11/14	2	WL
	24/11/14	3	WL
WL166	23/09/14	3	WL
WL170	30/05/14	1	SWL
	26/11/14	1	SWL
	10/12/14	1	SWL
WL171	04/07/14	1	WL
	28/07/14	2	SWL
	10/12/14	1	SWL
WL172	12/05/14	1	WL
	12/05/14	13	WL
	26/05/14	1	NWL
	30/10/14	2	NWL
WL173	28/07/14	3	SWL
	25/09/14	6	SWL
	08/10/14	8	SWL
	24/11/14	3	WL
	25/11/14	4	WL
	10/12/14	1	SWL
WL174	08/10/14	8	SWL
WL177	20/05/14	1	WL
	28/07/14	9	WL
WL178	10/10/14	6	SWL

DOLPHIN ID	DATE	STG#	AREA
WL179	23/09/14	2	WL
WL180	13/06/14	10	SWL
	28/07/14	2	SWL
	08/10/14	8	SWL
	24/11/14	3	WL
	30/12/14	6	WL
WL186	10/10/14	3	SWL
WL189	09/06/14	2	WL
WL191	23/09/14	4	WL
WL193	12/05/14	13	WL
	04/06/14	2	WL
WL198	12/05/14	12	WL
WL199	10/09/14	3	SWL
	24/11/14	3	WL
WL203	12/05/14	9	WL
WL205	08/10/14	1	SWL
	21/11/14	1	WL
	21/11/14	2	WL
	21/11/14	3	WL
WL206	23/09/14	4	WL
WL207	09/06/14	2	WL
	09/07/14	2	WL
	29/07/14	1	WL
WL208	23/09/14	3	WL
	11/11/14	1	WL
WL210	12/05/14	3	WL
	12/05/14	4	WL
	25/09/14	7	SWL
WL211	10/09/14	2	SWL
	03/12/14	1	WL
WL212	12/05/14	4	WL
	12/05/14	9	WL
	22/01/15	9	WL
	26/01/15	1	SWL
	30/01/15	1	SWL
	02/02/15	3	SWL
	04/02/15	1	SWL
	06/02/15	1	SWL
WL213	12/05/14	12	WL
	13/06/14	6	WL
	23/09/14	4	WL
WL214	04/07/14	3	WL
WL215	22/08/14	1	SWL
	05/11/14	1	WL
	22/01/15	1	WL
WL216	12/05/14	11	WL
	04/06/14	2	WL
	13/06/14	3	WL
	17/06/14	2	WL
	18/08/14	1	SWL
WL217	04/06/14	1	WL
WL220	24/11/14	2	WL
	24/11/14	3	WL
	25/11/14	4	WL
	30/12/14	6	WL
WL221	07/05/14	1	SWL
	04/06/14	9	SWL
	04/06/14	11	SWL
	13/06/14	11	SWL
	22/08/14	1	SWL
	08/10/14	6	SWL
WL225	10/09/14	2	SWL
WL226	04/06/14	2	WL
	17/06/14	2	WL
	09/07/14	2	WL
	29/07/14	9	WL
WL227	17/06/14	2	WL
WL229	***04/06/14***	***3***	***WL***
WL230	***04/06/14***	***7***	***WL***
WL231	***04/07/14***	***1***	***WL***

DOLPHIN ID	DATE	STG#	AREA
WL232	***04/06/14***	***11***	***SWL***
	08/10/14	***8***	***SWL***
WL233	***15/05/14***	***2***	***WL***
	04/06/14	***7***	***WL***
	09/06/14	***2***	***WL***
WL234	***04/06/14***	***7***	***WL***
WL235	***04/07/14***	***1***	***WL***
	11/11/14	***1***	***WL***
	15/11/14	***1***	***NWL***
	24/11/14	***3***	***WL***
WL237	***12/05/14***	***10***	***WL***
WL238	***20/05/14***	***1***	***WL***
	09/06/14	***2***	***WL***
WL239	***20/05/14***	***3***	***SWL***
	08/10/14	***8***	***SWL***
WL240	***04/07/14***	***1***	***WL***
	28/07/14	***2***	***SWL***
	06/11/14	***5***	***SWL***
	10/12/14	***1***	***SWL***
WL241	***28/07/14***	***5***	***SWL***
	30/12/14	***1***	***WL***
WL242	***12/05/14***	***6***	***WL***
WL243	***12/05/14***	***1***	***WL***
	22/08/14	***3***	***SWL***
	27/08/14	***1***	***WL***
WL245	***09/06/14***	***2***	***WL***
	09/07/14	***2***	***WL***
WL246	***17/06/14***	***1***	***NWL***
WL247	***09/06/14***	***2***	***WL***
WL248	***17/06/14***	***2***	***WL***
	25/06/14	***1***	***WL***
WL249	***04/07/14***	***2***	***WL***
	28/07/14	***9***	***WL***
WL250	***28/07/14***	***3***	***SWL***
WL251	***30/12/14***	***4***	***WL***
WL252	***25/09/14***	***9***	***WL***
WL253	***06/11/14***	***2***	***WL***
WL254	***17/11/14***	***1***	***WL***

Appendix V. HKCRP-AFCD Underwater Acoustic Database (April 2014 - March 2015)

Date	File #	Begin Time	End Time	Location		Area	Event	Beau	Hp	Hp Depth	HPF	ICP Gain	Note(s)
				Latitude	Longitude								
10-Apr-14	47	10:48:10	10:51:58	22.3500	113.8777	NW LANTAU	NWL Station#1	2	CR1	4	N	10x	Trim = 0, Croaker sounds
10-Apr-14	48	13:29:12	13:32:14	22.4226	113.9021	DEEP BAY	DB Station#1	3	CR1	4	N	10x	Radio interference
10-Apr-14	49	16:04:02	16:09:20	22.3636	113.9773	NE LANTAU	NEL Station#3	3	CR1	7	N	10x	
28-Apr-14	51	11:27:24	11:30:24	22.2195	113.9728	SE LANTAU	SEL Station#2	2	CR1	7	N	10x	
29-Apr-14	52	14:18:34	14:23:34	22.3911	113.9077	NW LANTAU	NWL Station#3	3	CR1	4	N	10x	
29-Apr-14	53	15:07:52	15:12:52	22.3319	113.9267	NW LANTAU	NWL Station#5	3	CR1	4	N	10x	Croaker sound; Interference noise heard
29-Apr-14	54	16:25:44	16:30:44	22.3635	113.9805	NE LANTAU	NEL Station#3	3	CR1	7	N	10x	Interference noise heard
8-May-14	57	12:02:54	12:07:54	22.4134	113.8952	DEEP BAY	DB Station#1	1	CR1	7	N	10x	
8-May-14	59	15:31:26	15:36:26	22.3601	113.9811	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	
8-May-14	61	15:57:58	16:01:28	22.3304	113.9818	NE LANTAU	NEL Station#2	3	CR1	7	N	10x	
8-May-14	63	17:04:18	17:09:46	22.3529	114.0279	NE LANTAU	NEL Station#4	3	CR1	7	N	10x	
12-May-14	64	16:19:00	16:24:00	22.2797	113.8613	W LANTAU	WL Station#1	2	CR1	7	N	10x	Gain change from 10x to 100x @ 00:35; croaker sound recorded
15-May-14	65	13:24:14	13:28:44	22.1739	113.9217	SW LANTAU	SWL Station#2	2	CR1	7	N	10x	
4-Jun-14	66	12:40:36	12:43:36	22.1528	113.8956	SW LANTAU	SWL Station#1	2	CR1	7	N	10x	ICP changed from ON to OFF@00:36
4-Jun-14	67	16:08:02	16:11:02	22.1832	113.9930	SE LANTAU	SEL Station#1	3	CR1	7	N	10x	ICP gain changed from 10X to 100X@00:50
13-Jun-14	68	10:35:38	10:39:38	22.2773	113.8549	W LANTAU	WL Station#1	2	CR1	7	N	10x	
13-Jun-14	69	12:55:40	12:58:40	22.2111	113.8332	W LANTAU	WL Station#2	4	CR1	7	N	10x	
17-Jun-14	70	10:21:00	10:28:15	22.2709	113.8736	W LANTAU	STG#1	3	CR1	7	N	0x	Dolphin click @00:46, @03:03 (~150m); @03:36; @04:06 (~109m); @04:47
17-Jun-14	71	10:28:44	10:30:14	22.2725	113.8767	W LANTAU	STG#1	2	CR1	7	N	0x	
17-Jun-14	72	12:48:38	12:51:38	22.2058	113.8773	SW LANTAU	SWL Station#3	3	CR1	7	N	10x	
17-Jun-14	73	13:36:24	13:41:29	22.1476	113.8979	SW LANTAU	SWL Station#1	3	CR1	7	N	10x	
17-Jun-14	75	15:43:30	15:46:30	22.2203	113.9747	SE LANTAU	SEL Station#2	3	CR1	5.5	N	10x	
4-Sep-14	85	13:26:38	13:30:38	22.3047	114.4173	NINEPINS		2	CR1	7	N	10x	
12-Sep-14	87	11:09:04	11:14:14	22.1935	113.9733	SE LANTAU	SEL Station#1	3	CR1	7	N	10x	
12-Sep-14	89	11:37:32	11:41:34	22.2232	113.9733	SE LANTAU	SEL Station#2	2	CR1	5.5	N	10x	
12-Sep-14	90	11:47:06	11:51:06	22.2231	113.9733	SE LANTAU	SEL Statoin#2	2	CR3	5.5	N	10x	
12-Sep-14	92	13:51:20	13:55:22	22.2015	113.8772	SW LANTAU	SWL Station#3	4	CR1	5.5	N	10x	
12-Sep-14	93	14:45:54	14:49:56	22.1743	113.9213	SW LANTAU	SWL Station#1	3	CR1	7	N	10x	
25-Sep-14	95	11:13:34	11:16:32	22.1894	113.9831	SE LANTAU	SEL Station#1	2	CR1	7	N	10x	
25-Sep-14	96	12:27:24	12:30:30	22.1567	113.9480	SE LANTAU	SEL Station#3	2	CR1	7	N	10x	
25-Sep-14	97	14:32:08	14:35:10	22.1460	113.9056	SW LANTAU	SWL Station#1	2	CR1	7	N	10x	
26-Sep-14	98	13:52:40	13:56:42	22.3535	114.0280	NE LANTAU	NEL Station#4	2	CR1	7	N	10x	
26-Sep-14	99	14:29:02	14:33:08	22.3620	113.9833	NE LANTAU	NEL Station#3	1	CR1	7	N	10x	
26-Sep-14	100	14:53:28	14:57:30	22.3309	113.9780	NE LANTAU	NEL Station#2	2	CR1	7	N	10x	
9-Oct-14	102	10:49:24	10:52:26	22.3619	113.9844	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	
9-Oct-14	103	11:08:44	11:11:18	22.3309	113.9845	NE LANTAU	NEL Station#2	2	CR1	7	N	10x	
9-Oct-14	104	11:13:38	11:15:44	22.3305	113.9847	NE LANTAU	NEL Station#2	2	CR1	7	N	10x	
9-Oct-14	105	13:44:12	13:47:14	22.3843	113.9072	NW LANTAU	NWL Station#3	2	CR1	7	N	10x	
9-Oct-14	106	14:15:20	14:20:20	22.4135	113.8961	DEEP BAY	DB Station#1	3	CR1	7	N	10x	
9-Oct-14	107	16:53:30	16:57:32	22.3355	113.9267	NW LANTAU	NWL Station#5	3	CR1	5.5	N	10x	
10-Oct-14	110	12:33:02	12:37:04	22.2026	113.8864	SW LANTAU	SWL Station#3	2	CR1	5.5	N	10x	
10-Oct-14	111	13:17:34	13:21:34	22.1744	113.9080	SW LANTAU	SWL Station#2	2	CR1	5.5	N	10x	
10-Oct-14	112	13:43:58	13:48:00	22.1433	113.9075	SW LANTAU	SWL Station#1	3	CR1	7	N	10x	
15-Oct-14	113	12:02:04	12:07:04	22.3862	113.8878	NW LANTAU	STG#2	3	CR1	7	N	10x	Dolphin 144m@02:02; dolphin 157m@02:29

Appendix V. (cont'd)

Date	File #	Begin Time	End Time	Location		Area	Event	Beau	Hp	Hp Depth	HPF	ICP Gain	Note(s)
				Latitude	Longitude								
24-Oct-14	114	10:45:30	10:49:52	22.3528	113.8773	NW LANTAU	NWL Station#1	3	CR1	7	N	10x	
24-Oct-14	115	11:48:08	11:52:10	22.4137	113.8952	DEEP BAY	DB Station#1	2	CR1	7	N	10x	
24-Oct-14	116	14:40:23	14:44:22	22.3571	113.9329	NW LANTAU	NWL Station#4	3	CR1	7	N	10x	
24-Oct-14	117	15:27:44	15:31:44	22.3569	113.9749	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	
30-Oct-14	118	10:30:18	10:34:30	22.3601	113.9262	NW LANTAU	NWL Station#4	3	CR1	7	N	10x	
30-Oct-14	119	14:46:42	14:50:44	22.2750	113.8588	W LANTAU	WL Station#1	2	CR1	7	N	10x	
30-Oct-14	120	16:16:42	16:20:44	22.2212	113.8337	W LANTAU	WL Station#2	2	CR1	7	N	10x	
31-Oct-14	121	11:27:08	11:32:20	22.1917	113.8429	W LANTAU	WL Station#3	2	CR1	7	N	10x	
31-Oct-14	122	15:31:56	15:37:08	22.2196	113.9636	SE LANTAU	SEL Station#2	3	CR1	7	N	10x	croaker sound
31-Oct-14	123	16:03:54	16:08:58	22.1878	113.9832	SE LANTAU	SEL Station#1	3	CR1	7	N	10x	
11-Nov-14	124	11:52:40	11:56:40	22.2241	113.8361	W LANTAU	WL Station#2	3	CR1	7	N	10x	
11-Nov-14	125	12:48:26	12:52:30	22.1970	113.8332	W LANTAU	WL Station#3	3	CR1	7	N	10x	
11-Nov-14	126	16:03:34	16:07:38	22.3888	113.8980	NW LANTAU	NWL Station#3	3	CR1	7	N	10x	
20-Nov-14	128	11:08:02	11:12:14	22.3630	113.9757	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	
20-Nov-14	129	13:43:26	13:47:26	22.3853	113.8972	NW LANTAU	NWL Station#3	2	CR1	7	N	10x	
20-Nov-14	130	14:13:18	14:17:18	22.4134	113.8949	DEEP BAY	DB Station#1	3	CR1	7	N	10x	
21-Nov-14	131	12:19:30	12:23:42	22.2211	113.8325	W LANTAU	WL Station#2	2	CR1	7	N	10x	Beeping noise
21-Nov-14	132	14:38:58	14:42:58	22.1980	113.8769	SW LANTAU	SWL Station#3	3	CR1	5.5	N	10x	
25-Nov-14	133	14:16:54	14:20:54	22.1586	113.9536	SE LANTAU	SEL Station#1	2	CR1	7	N	10x	
19-Dec-14	134	11:12:56	11:16:56	22.3869	113.8974	NW LANTAU	NWL Station#3	3	CR1	7	N	10X	
19-Dec-14	135	11:43:16	11:48:26	22.4135	113.8929	DEEP BAY	DB Station #1	3	CR1	7	N	10X	
19-Dec-14	137	15:17:34	15:21:34	22.3275	113.9755	NE LANTAU	NEL Station#2	2	CR1	7	N	10X	
19-Dec-14	139	15:42:30	15:46:30	22.3620	113.9748	NE LANTAU	NEL Station#3	2	CR1	7	N	10X	
29-Dec-14	140	9:45:26	9:49:26	22.3584	114.0440	NE LANTAU	NEL Station#4	2	CR1	7	N	10x	
29-Dec-14	141	12:11:00	12:15:05	22.3614	113.9281	NW LANTAU	NWL Station#3	3	CR1	7	N	10x	
29-Dec-14	142	12:32:02	12:36:02	22.3354	113.9267	NW LANTAU	NWL Station#2	3	CR1	7	N	10x	
29-Dec-14	143	15:06:00	15:10:05	22.4224	113.8975	DEEP BAY	DB Station#1	2	CR1	5.5	N	10x	
30-Dec-14	144	11:53:08	11:57:08	22.2238	113.8308	W LANTAU	WL Station#2	3	CR1	7	N	10x	
30-Dec-14	145	12:40:58	12:45:04	22.1880	113.8348	W LANTAU	WL Station#3	2	CR1	7	N	10x	
30-Dec-14	146	14:18:56	14:22:56	22.1465	113.8984	SW LANTAU	SWL Station#1	3	CR1	7	N	10x	
30-Dec-14	148	15:23:04	15:27:04	22.1733	113.9206	SW LANTAU	SWL Station#2	3	CR1	7	N	10x	
14-Jan-15	149	12:49:00	12:53:00	22.3847	113.9068	NW LANTAU	NWL Station#3	3	CR1	7	N	10X	
14-Jan-15	150	13:18:00	13:22:00	22.4137	113.8953	DEEP BAY	DB Station#1	3	CR1	7	N	10X	
14-Jan-15	151	15:42:00	15:46:00	22.3507	113.8780	NW LANTAU	NWL Station#1	3	CR1	5.5	N	10X	
16-Jan-15	152	11:03:00	11:07:00	22.1862	113.9833	SE LANTAU	SEL Station#1	2	CR1	7	N	10X	
16-Jan-15	153	13:58:00	14:02:00	22.1537	113.9066	SW LANTAU	SWL Station#1	2	CR1	7	N	10X	
3-Mar-15	155	11:38:53	11:43:54	22.2183	113.9785	SE LANTAU	SEL Station#2	1	CR1	7	N	10X	ICP gain change from 10X to 100X@01:00, porpoise @02:35 ~100m
3-Mar-15	156	12:14:24	12:21:24	22.1923	113.9756	SE LANTAU	SEL Station#1	2	CR1	7	N	100X	Porpoise @04:45 ~100m
4-Mar-15	157	15:14:14	15:19:14	22.3334	113.9846	NE LANTAU	NEL Station#2	2	CR1	7	N	10X	
4-Mar-15	158	15:37:40	15:42:41	22.3631	113.9846	NE LANTAU	NEL Station#3	3	CR1	7	N	10X	
4-Mar-15	159	16:30:46	16:35:46	22.3530	114.0231	NE LANTAU	NEL Station#4	3	CR1	7	N	10X	
11-Mar-15	160	12:11:14	12:16:14	22.3580	113.9365	NW LANTAU	NWL Station#4	2	CR1	7	N	10X	
11-Mar-15	161	12:50:20	12:52:34	22.3244	113.9162	NW LANTAU	NWL Station#5	2	CR1	5.5	N	10X	
11-Mar-15	162	12:54:32	12:58:32	22.3244	113.9158	NW LANTAU	NWL Station#5	2	CR1	5.5	N	10X	
11-Mar-15	163	14:41:52	14:46:52	22.3835	113.8793	NW LANTAU	NWL Station#2	3	CR1	5.5	N	10X	

Appendix V. (cont'd)

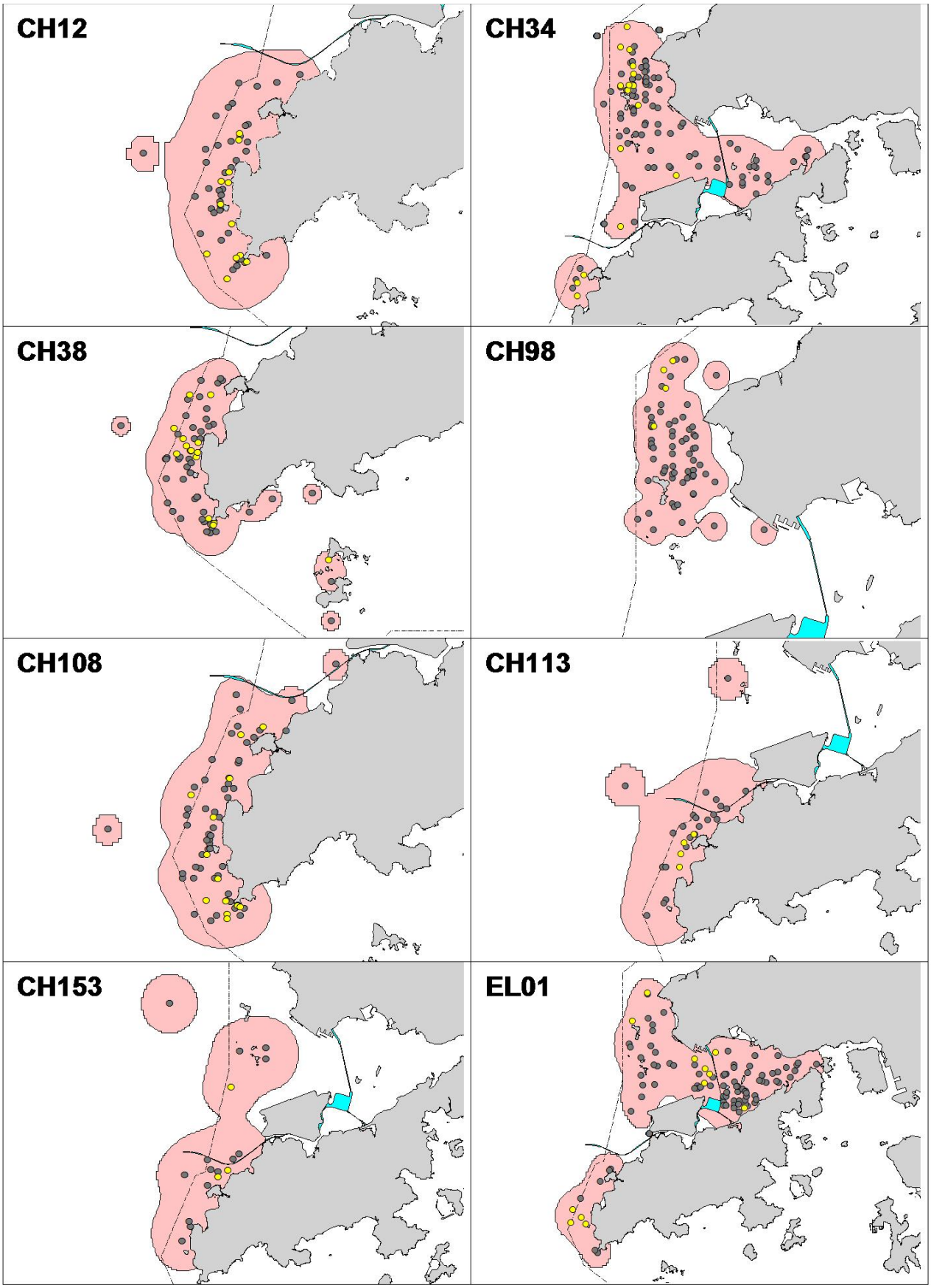
Date	File #	Begin Time	End Time	Location		Area	Event	Beau	Hp	Hp Depth	HPF	ICP Gain	Note(s)
				Latitude	Longitude								
12-Mar-15	164	11:39:22	11:44:27	22.4140	113.8967	DEEP BAY	DB Station#1	2	CR1	7	N	10X	
12-Mar-15	165	14:52:14	14:57:19	22.3928	113.9067	NW LANTAU	NWL Station#2	2	CR1	5.5	N	10X	
12-Mar-15	166	17:13:58	17:18:58	22.3538	114.0289	NE LANTAU	NEL Station#4	2	CR1	7	N	10X	
17-Mar-15	167	14:36:58	14:41:28	22.3154	113.9662	NE LANTAU	NEL Station#1	2	CR1	5.5	N	10x	
17-Mar-15	168	15:06:42	15:11:42	22.3325	113.9842	NE LANTAU	NEL Station#2	2	CR1	7	N	10x	
17-Mar-15	169	15:28:10	15:33:10	22.3635	113.9849	NE LANTAU	NEL Station#3	2	CR1	7	N	10x	
20-Mar-15	170	14:45:00	14:50:02	22.1914	113.9774	SE LANTAU	SEL Station#1	2	CR1	7	N	10x	
20-Mar-15	171	15:13:02	15:18:02	22.2252	113.9682	SE LANTAU	SEL Station#2	2	CR1	5.5	N	10x	
31-Mar-15	173	13:14:18	13:19:18	22.1896	113.9817	SE LANTAU	SEL Station#1	3	CR1	7	N	10X	
31-Mar-15	174	13:46:22	13:50:22	22.2253	113.9669	SE LANTAU	SEL Station#2	1	CR1	5.5	N	10X	
31-Mar-15	175	14:42:16	14:46:16	22.1590	113.9418	SE LANTAU	SEL Station#3	3	CR1	7	N	10X	

Appendix VI. Land-based Theodolite Tracking Database (April 2014 - March 2015)

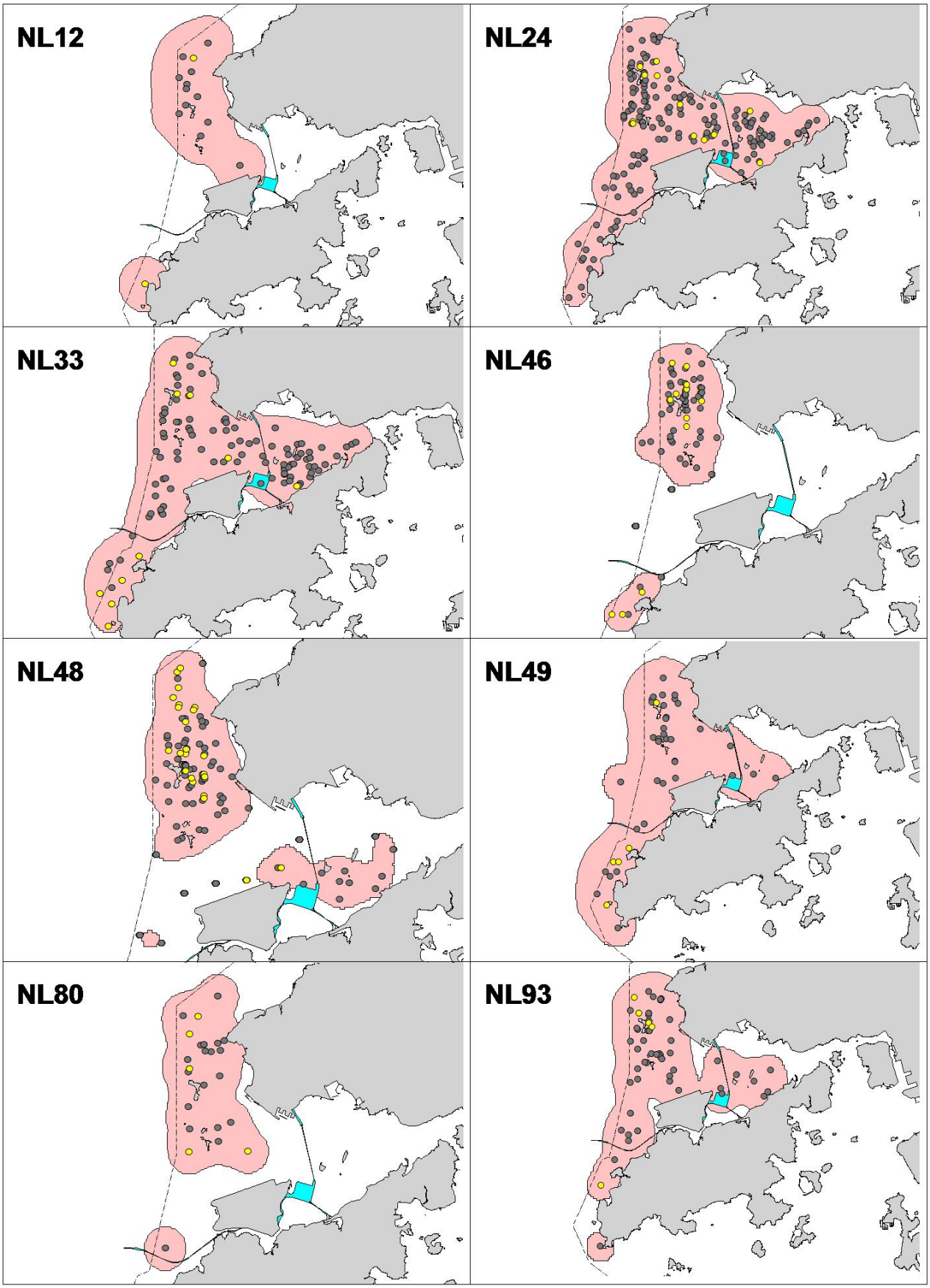
(in blue: Tracking effort at Cheung Chau and Shek Kwu Chau for a feasibility study on theodolite tracking of finless porpoises)

Date	Station	Start Time	End Time	Duration	Beaufort	Visibility	Number of CWD/FP Groups	Total No. of Fixes	No. of fix (dolphin/ porpoise)	No. of fix (dolphin-tour boat)	No. of fix (fishing boat)	No. of fix (high-speed ferry)	No. of fix (other vessels)
22/04/14	Cheung Chau	9:59	16:07	6:08	1-2	3	0	104	0	0	13	0	86
22/04/14	Shek Kwu Chau	10:13	15:15	5:02	2	3-3.5	3	166	27	0	13	79	46
28/04/14	Cheung Chau	10:09	15:30	5:21	1-3	2	1	200	3	0	73	53	69
29/04/14	Tai O	8:51	14:25	5:34	1-2	2.5-3	2	309	43	86	83	13	83
05/05/14	Tai O	10:29	15:32	5:03	2-4	1.5-2	3	275	51	79	18	8	118
13/05/14	Sham Wat	9:54	13:58	4:04	3-4	1.5	0	312	0	0	0	6	304
16/05/14	Shek Kwu Chau	10:19	11:53	1:34	2	2-3	0	26	0	0	12	0	13
16/05/14	Cheung Chau	14:06	15:17	1:11	2	3	0	31	0	0	21	0	9
20/05/14	Tai O	9:53	14:34	4:41	3-4	1	8	232	151	13	0	7	58
30/05/14	Fan Lau	8:57	14:21	5:24	2-3	1	4	474	233	0	2	134	102
01/08/14	Tai O	8:54	13:48	4:54	1	1	9	268	64	44	45	10	104
07/08/14	Tai O	8:56	13:40	4:44	3	2	2	257	91	28	20	9	108
12/08/14	Siu Ho Wan	8:10	13:30	5:20	2	1.5	0	204	0	0	5	0	199
18/08/14	Fan Lau	8:54	14:18	5:24	3	1	16	594	245	0	3	220	124
18/09/14	Tai O	8:59	14:19	5:20	2-3	2	12	347	150	35	34	10	117
06/10/14	Tai O	8:51	14:03	5:12	2-4	2	3	207	41	0	6	6	152
17/10/14	Tai O	8:47	13:49	5:02	2	2.5-3	3	526	335	63	30	7	90
14/11/14	Tai O	8:52	13:58	5:06	3-4	2.5-3	1	179	24	26	35	7	85
19/11/14	Tai O	8:53	14:01	5:08	2-3	1.5-2.5	0	238	0	66	13	10	148
26/11/14	Fan Lau	8:52	14:22	5:30	2-5	2.5-3	1	594	282	0	7	219	85
16/01/15	Shek Kwu Chau	10:08	15:51	5:43	2	2-3	4	87	21	0	29	0	34
18/03/15	Shek Kwu Chau	10:13	15:46	5:33	2	1.5-3	6	246	117	0	8	0	119

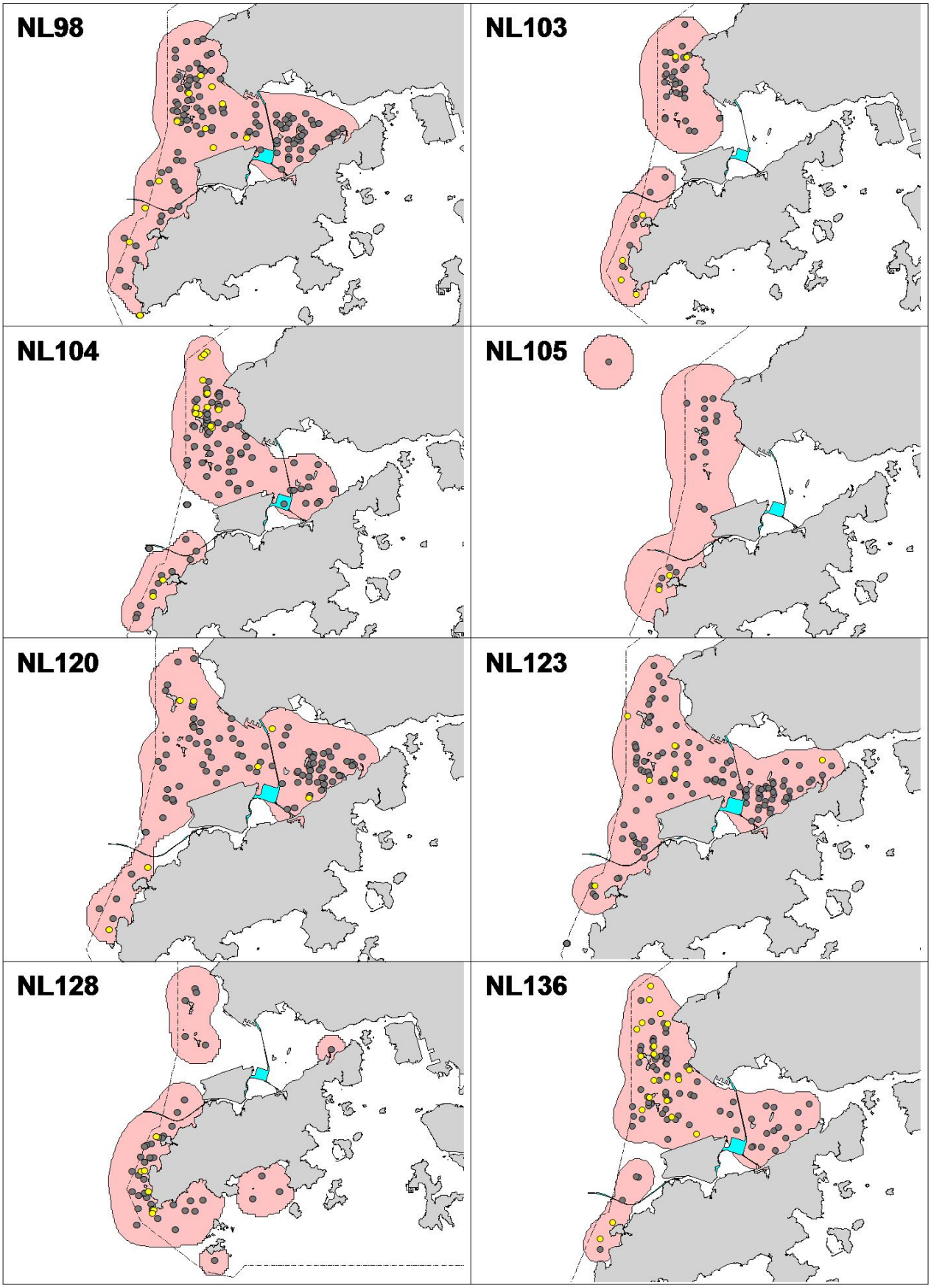
Appendix VII. Ranging patterns (95% kernel ranges) of 139 individual dolphins with 10+ re-sightings that were sighted during 2014-15 monitoring period (note: yellow dots indicates sightings made in 2014)



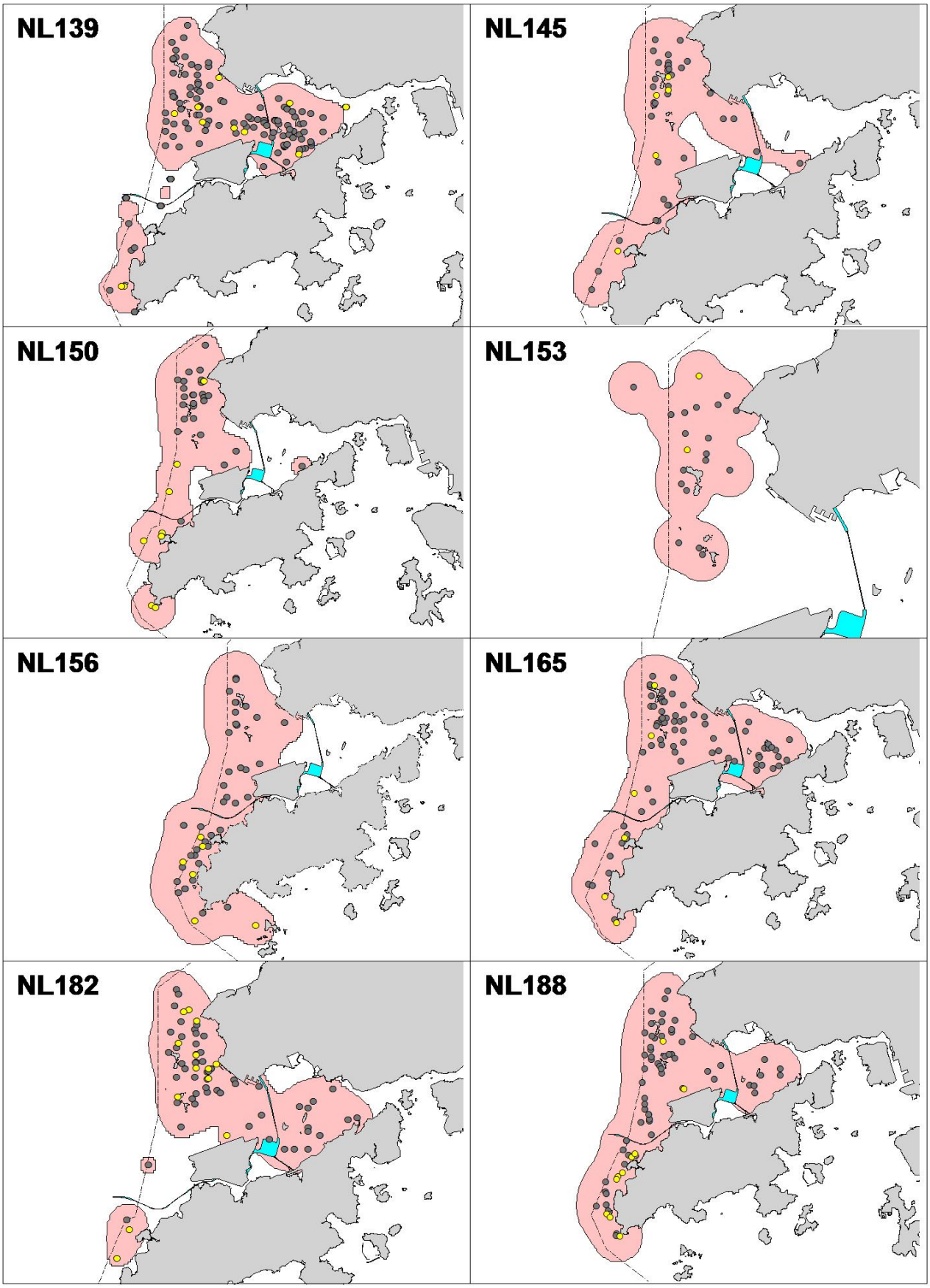
Appendix VII (cont'd).



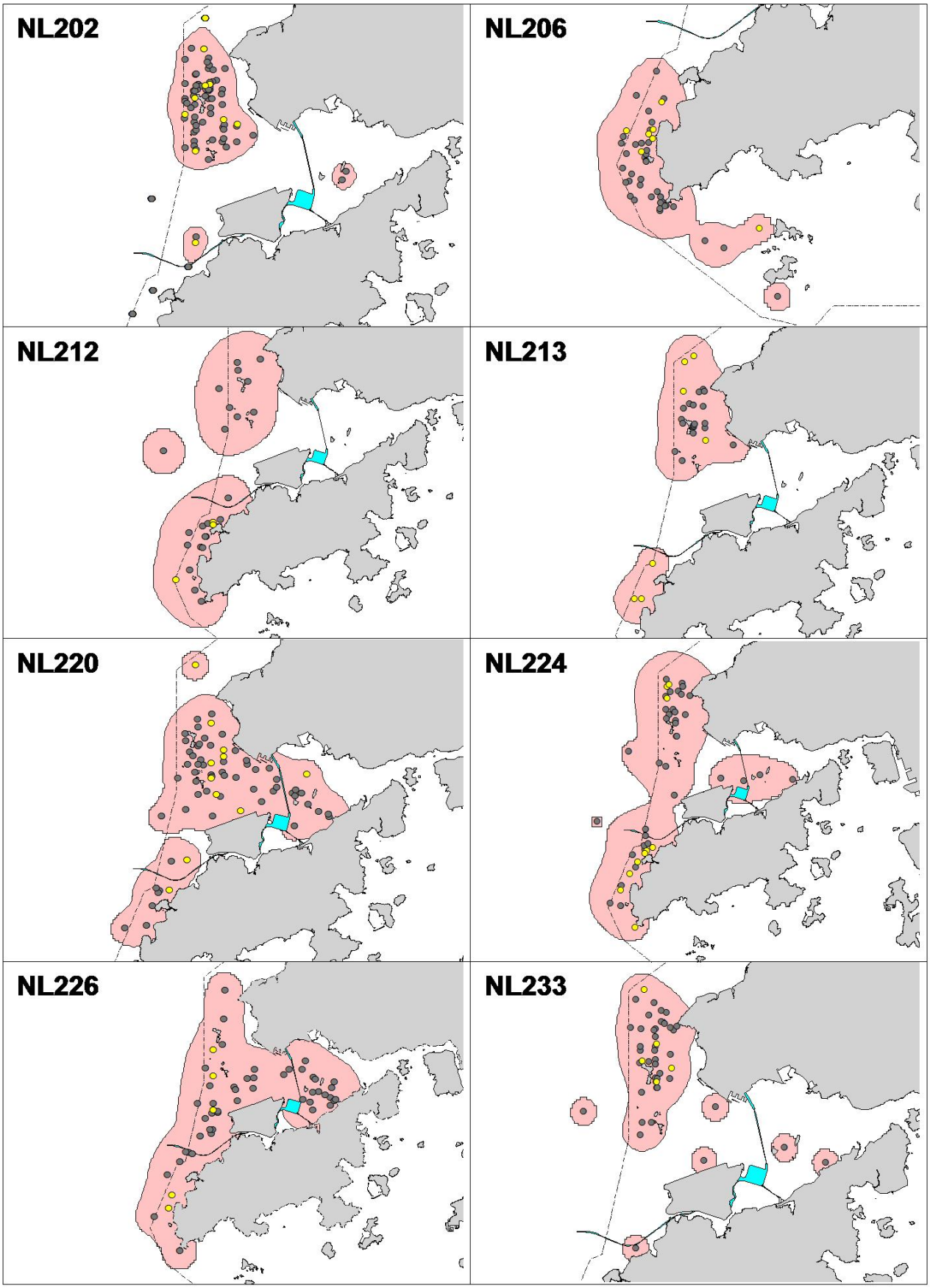
Appendix VII (cont'd).



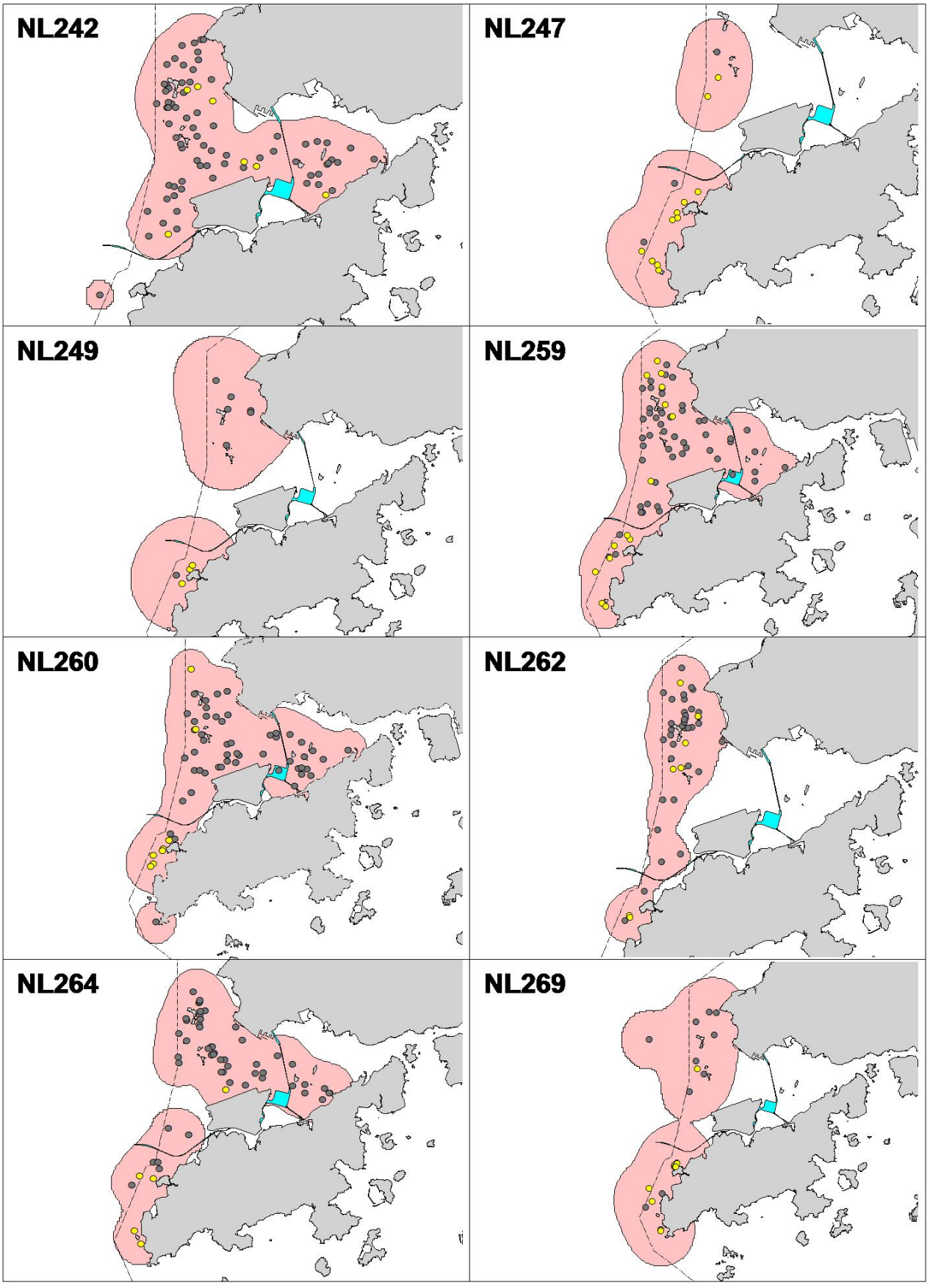
Appendix VII (cont'd).



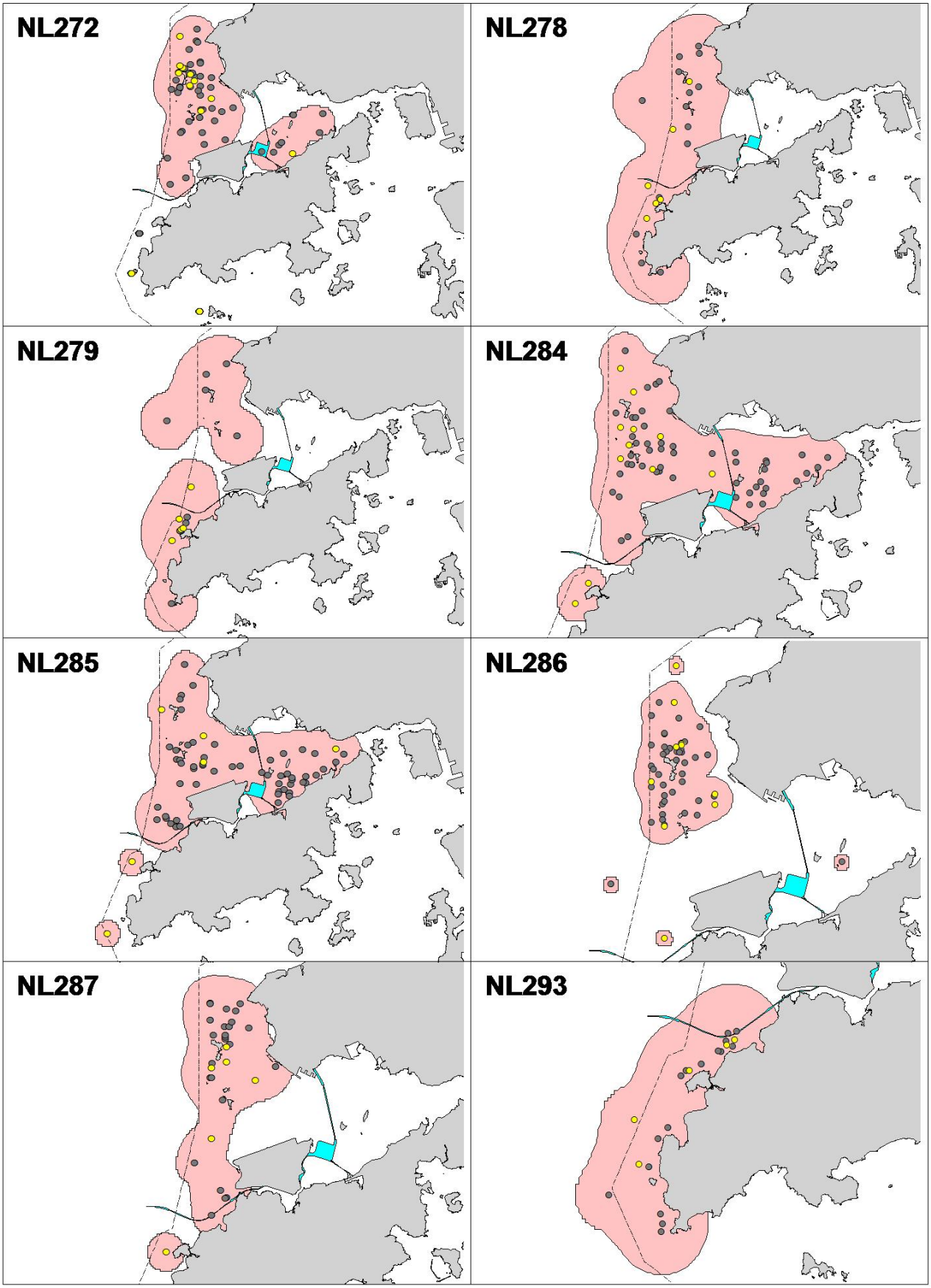
Appendix VII (cont'd).



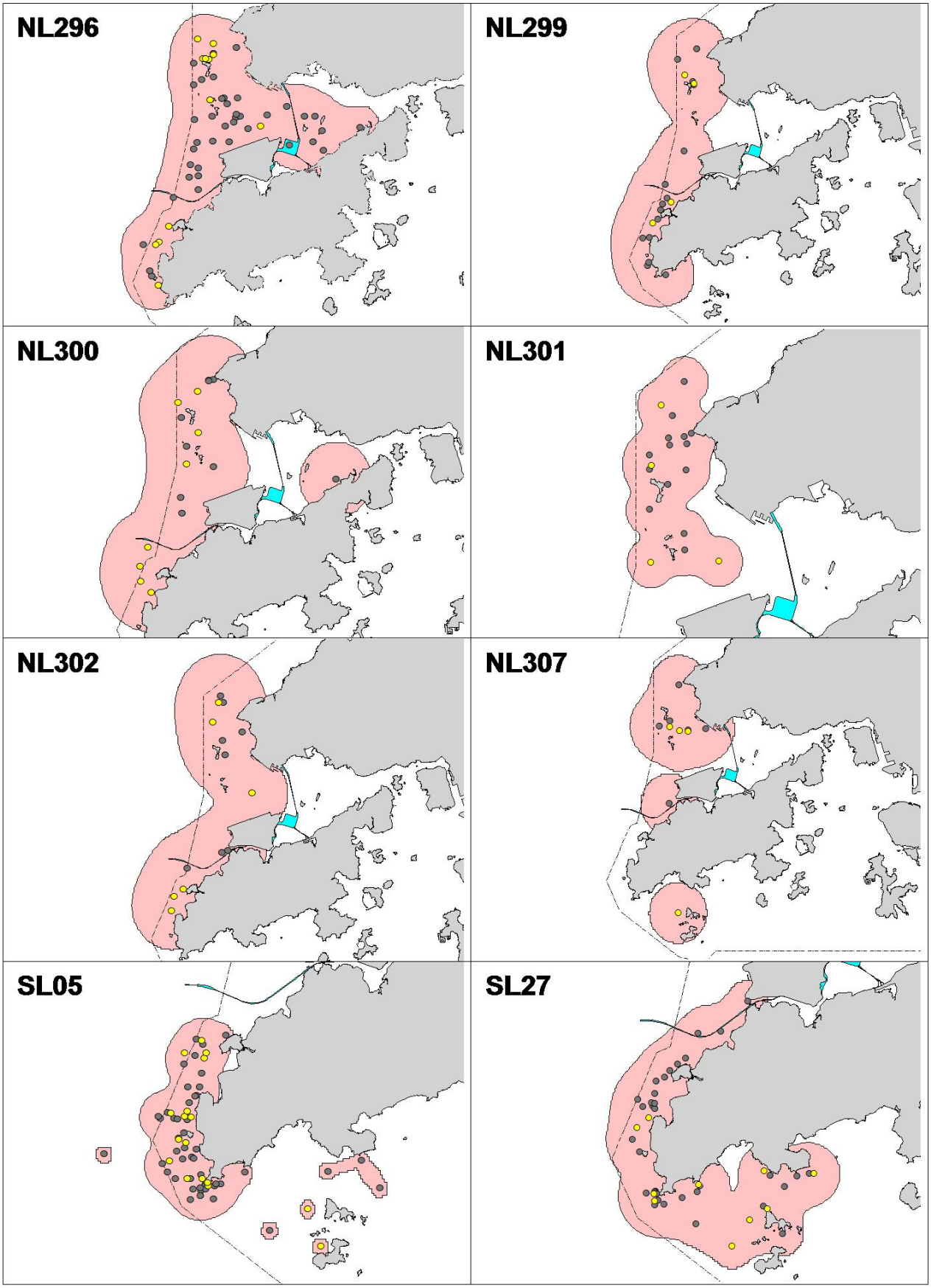
Appendix VII (cont'd).



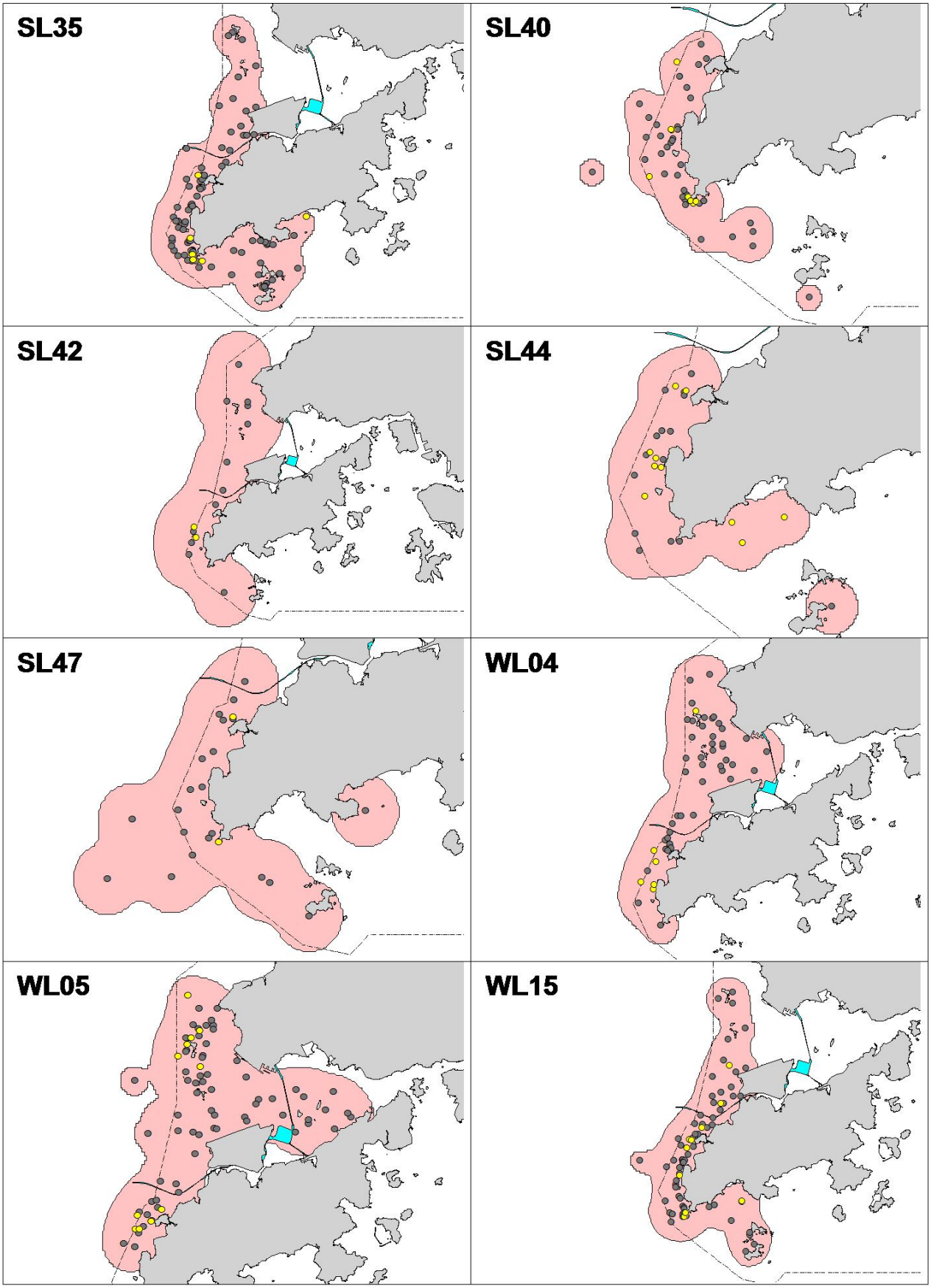
Appendix VII (cont'd).



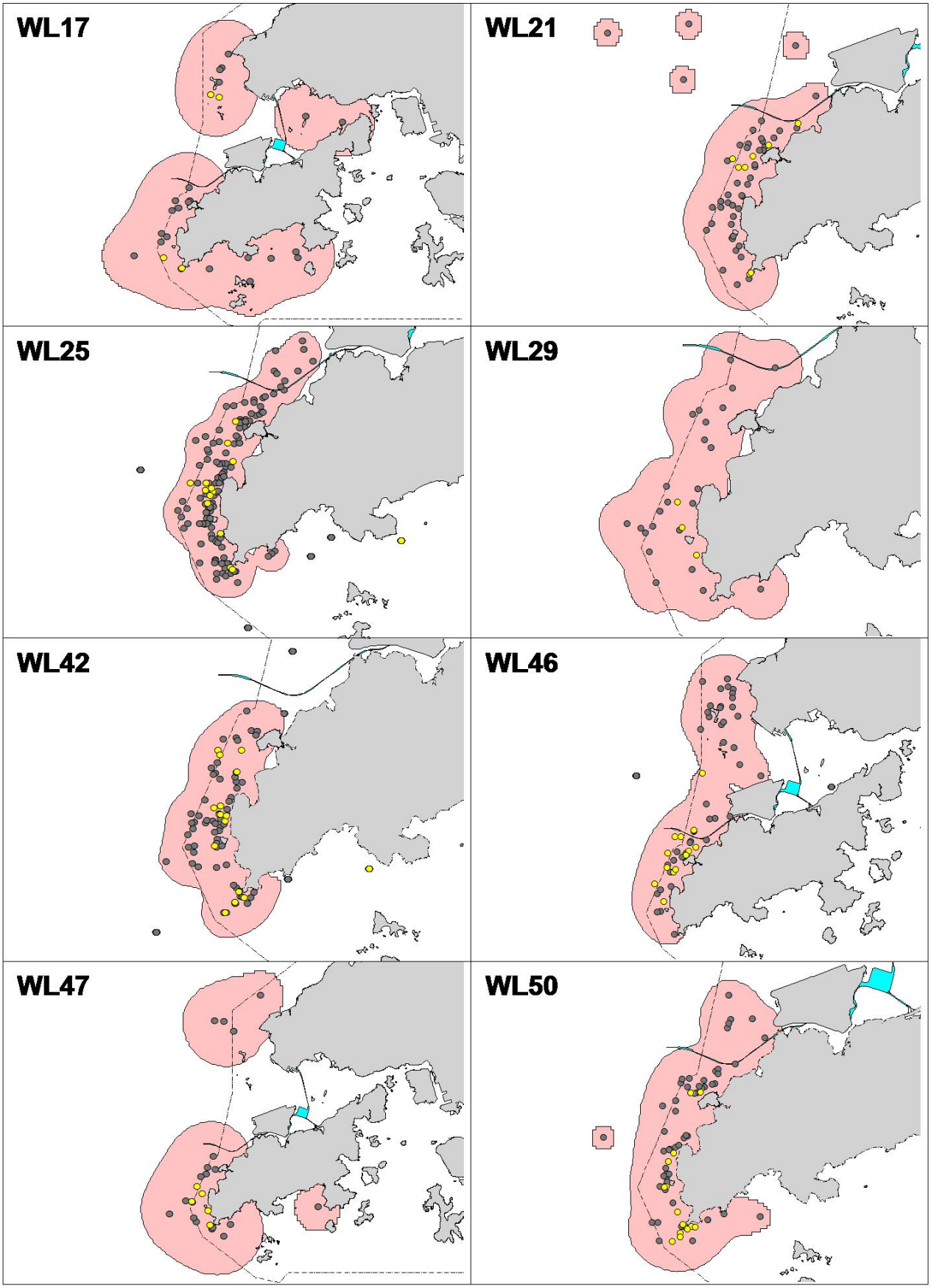
Appendix VII (cont'd).



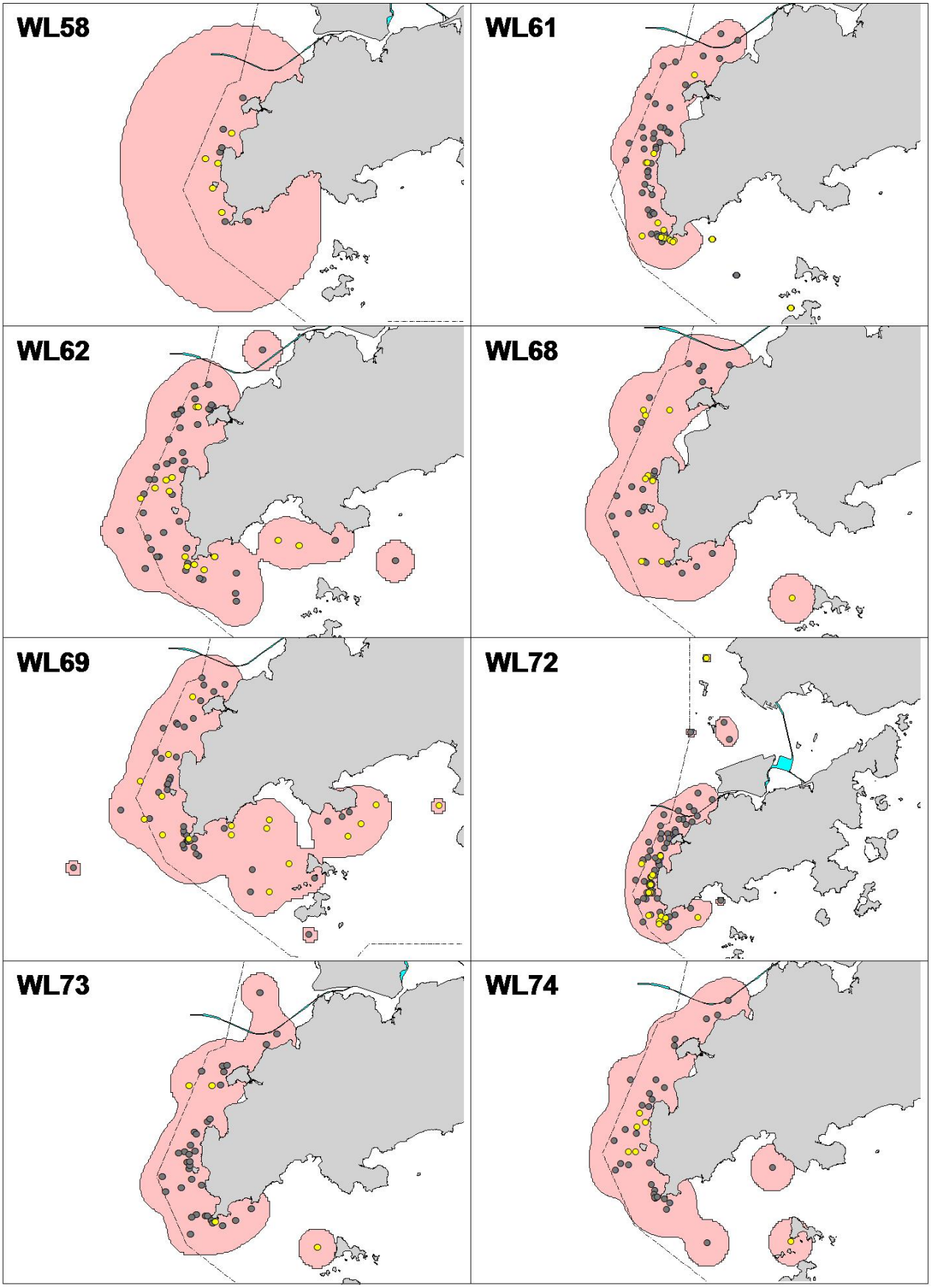
Appendix VII (cont'd).



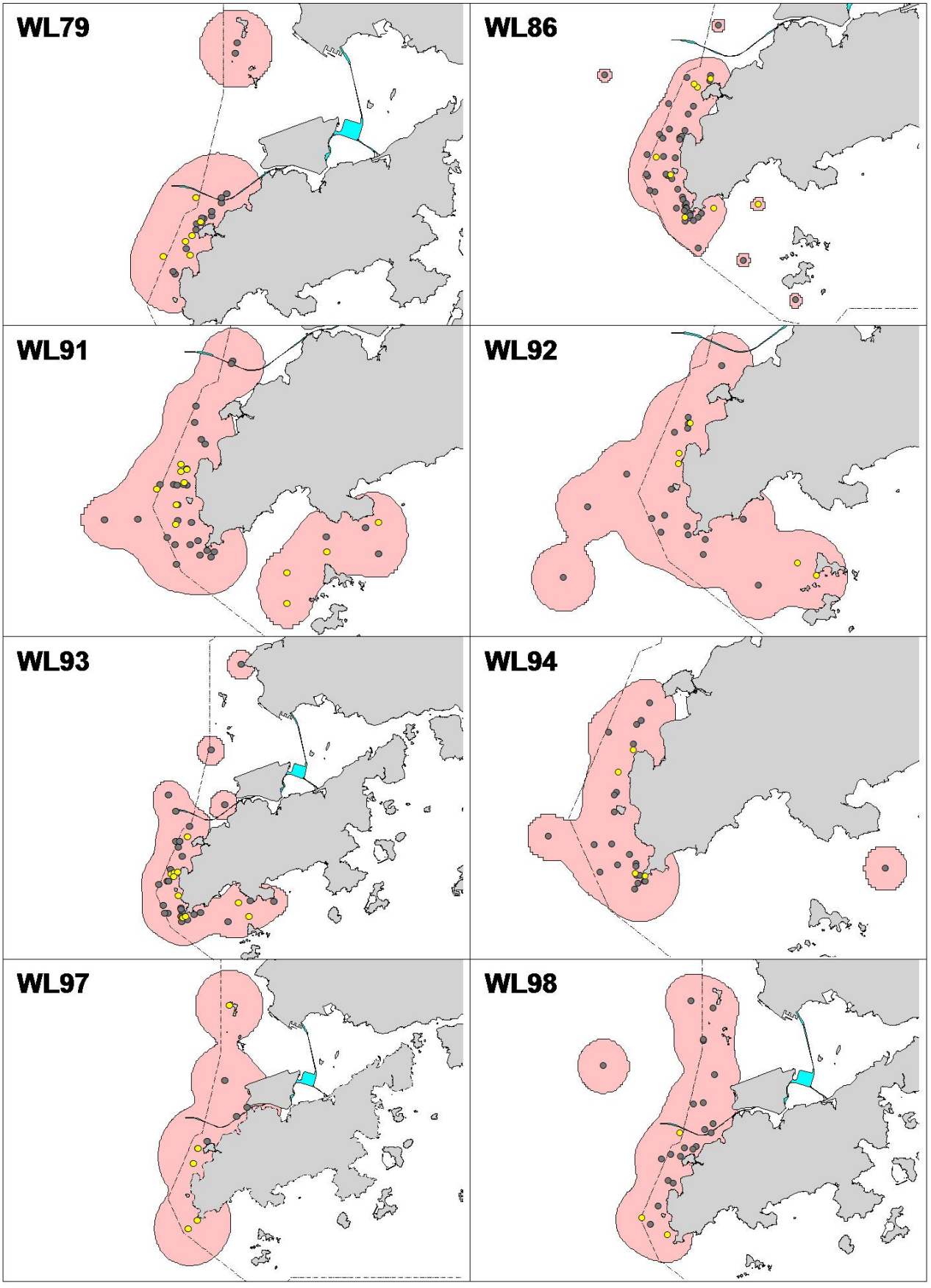
Appendix VII (cont'd).



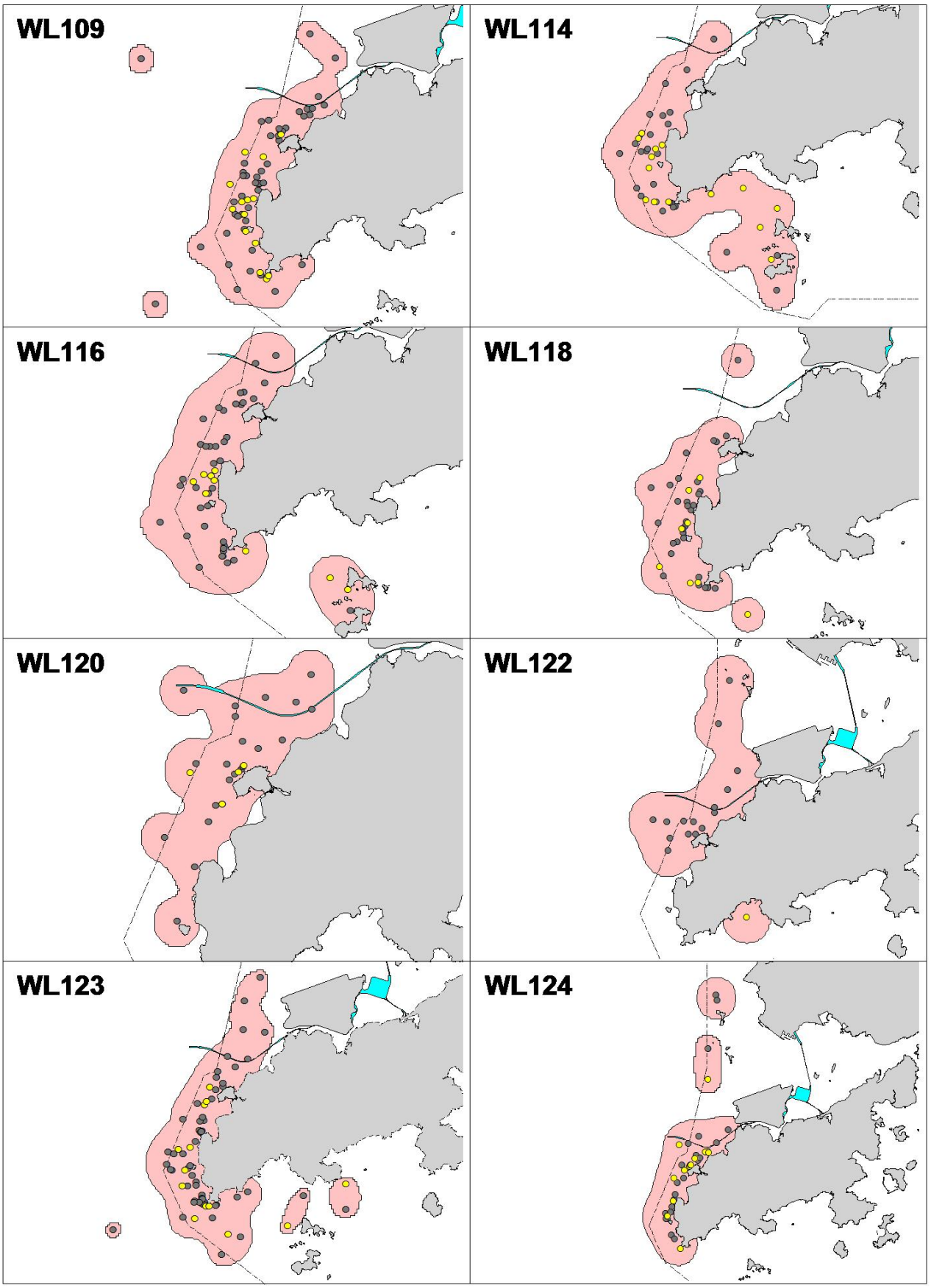
Appendix VII (cont'd).



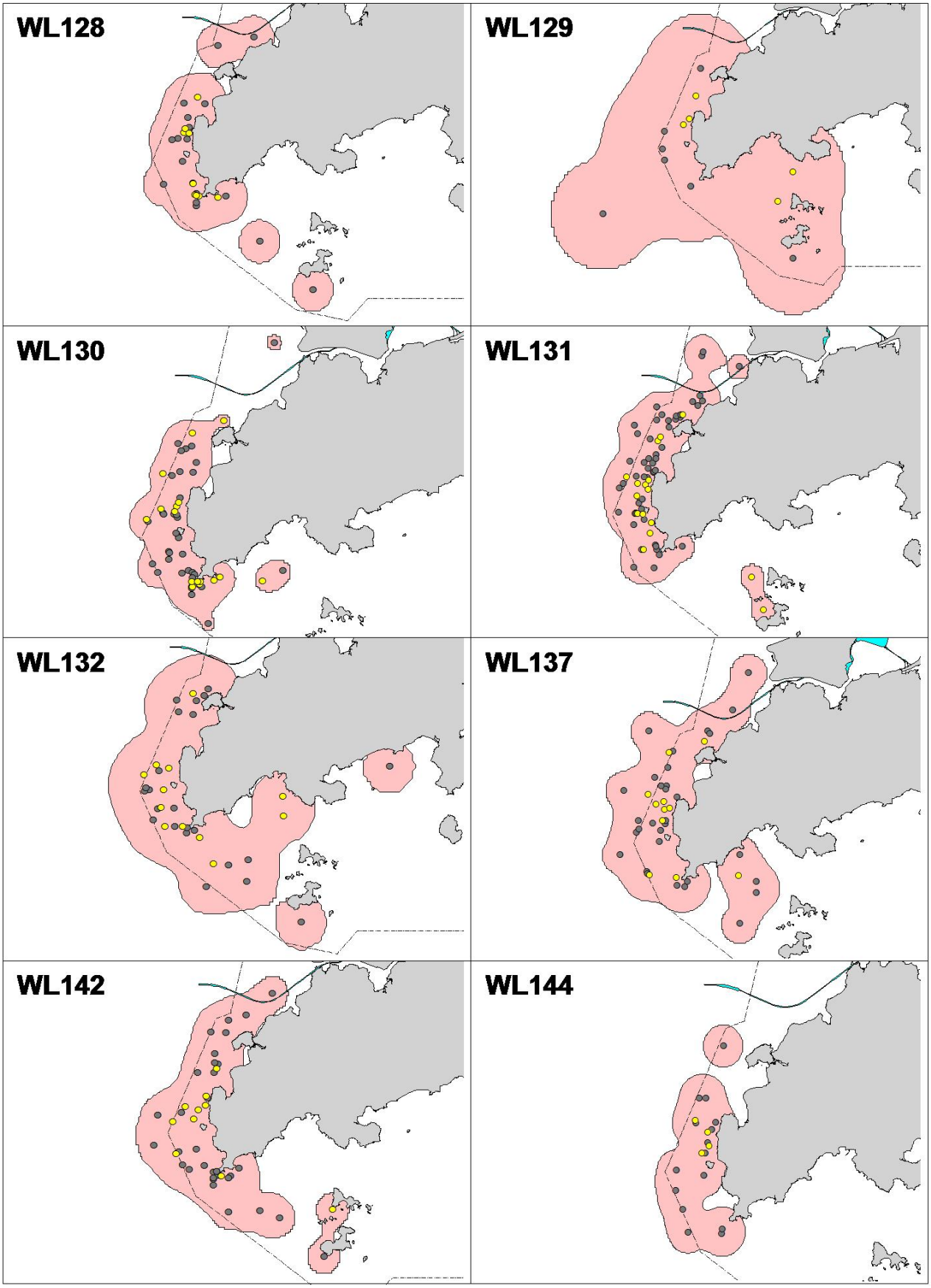
Appendix VII (cont'd).



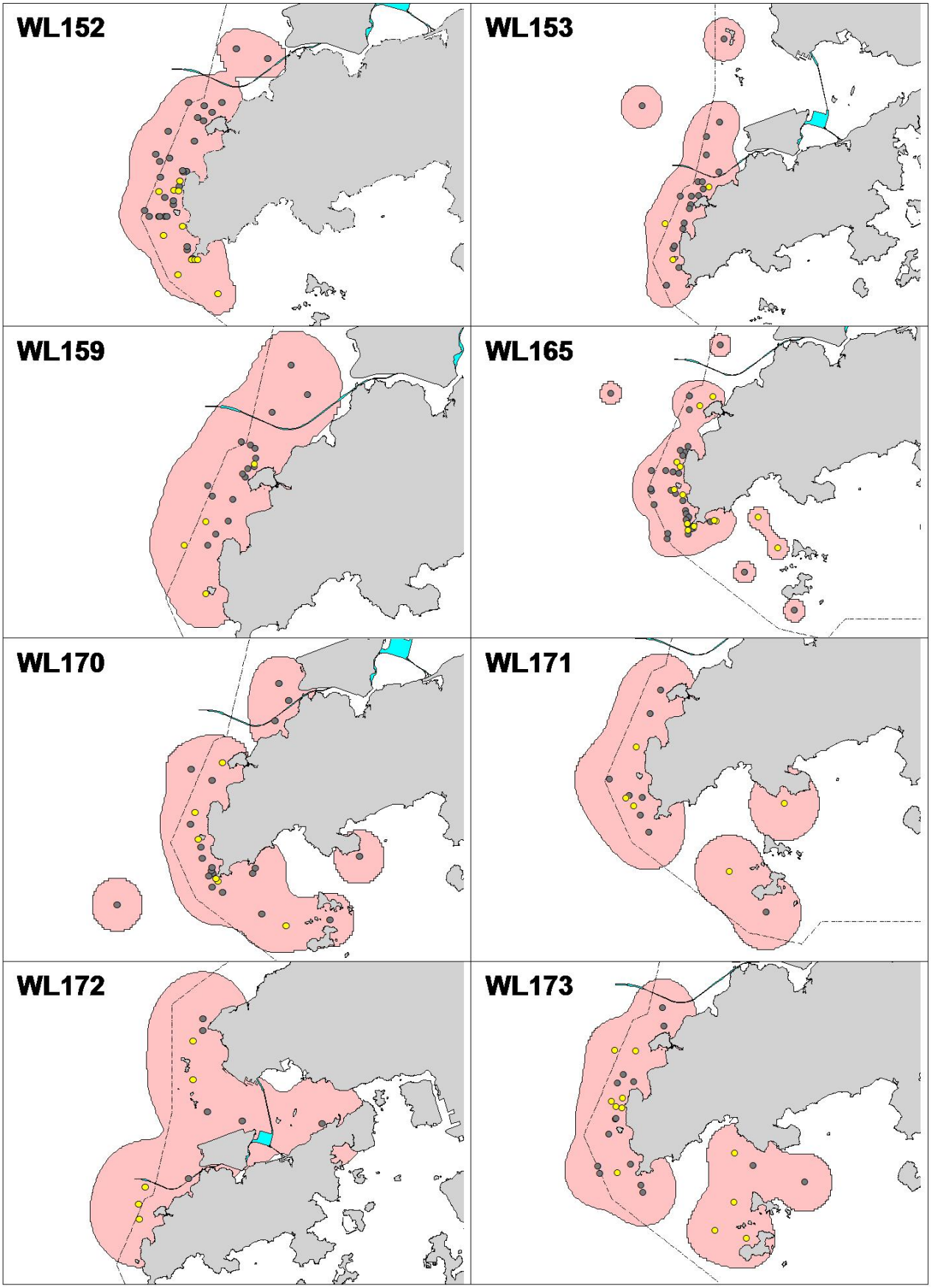
Appendix VII (cont'd).



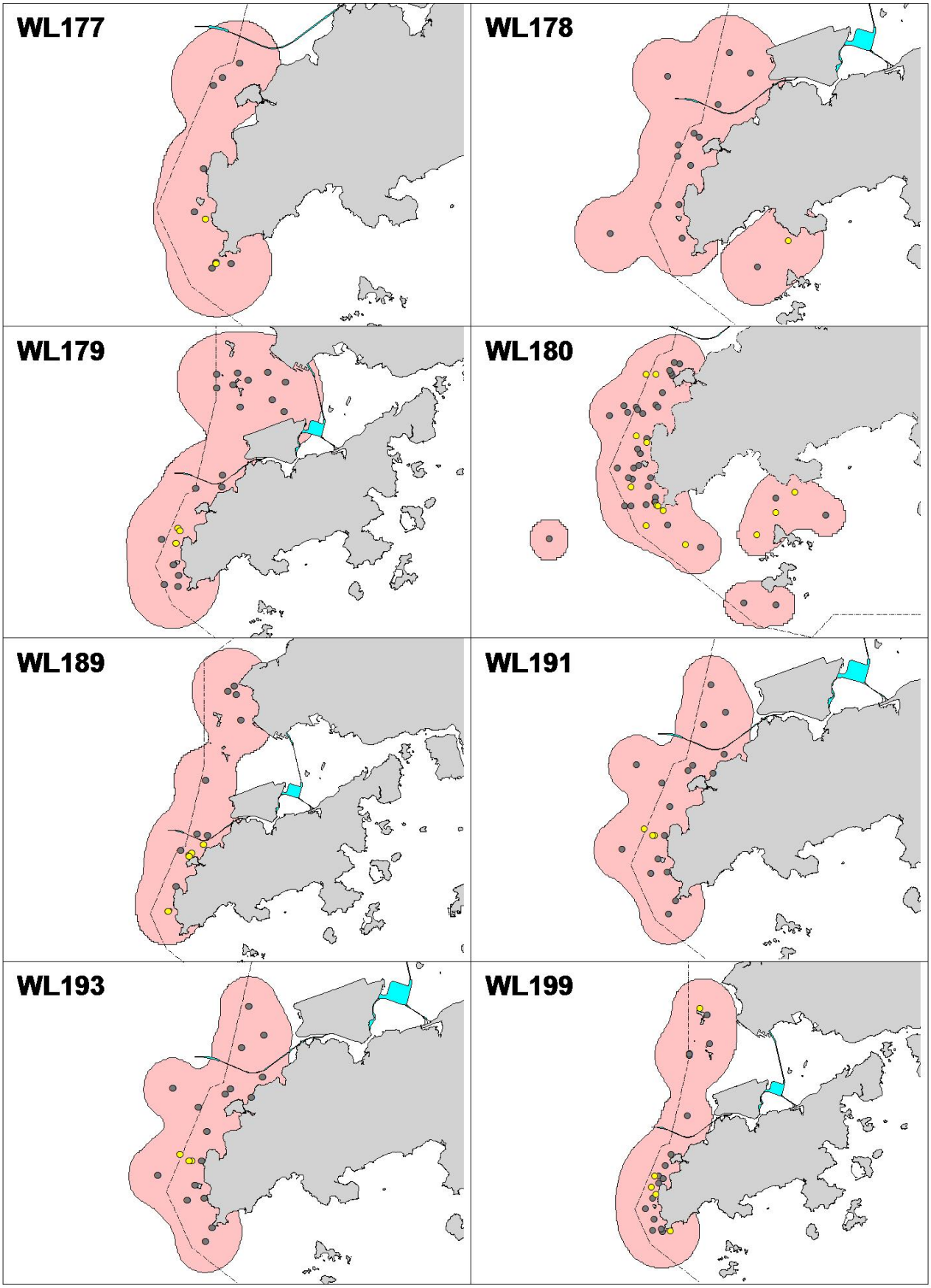
Appendix VII (cont'd).



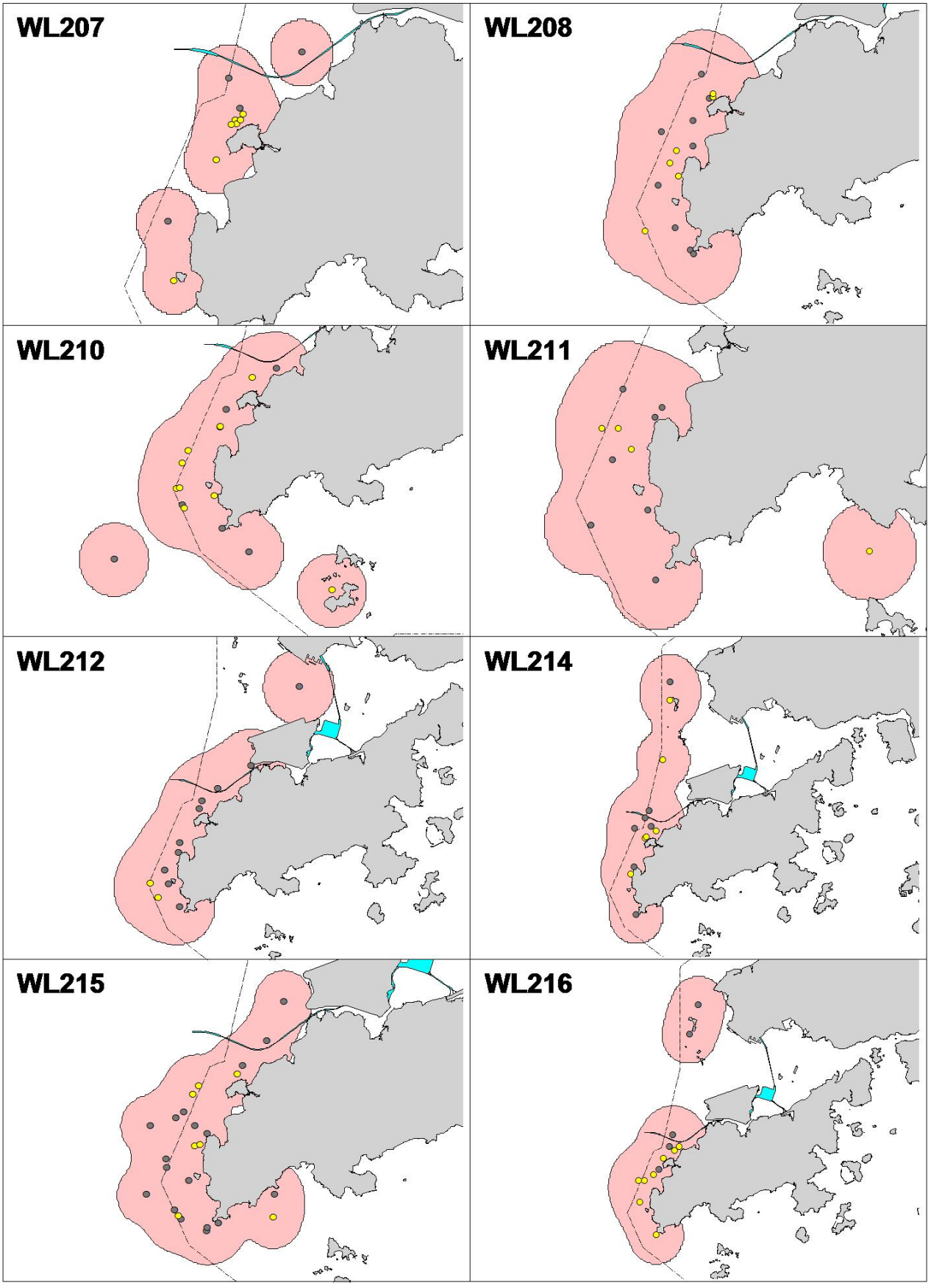
Appendix VII (cont'd).



Appendix VII (cont'd).



Appendix VII (cont'd).



Appendix VII (cont'd).