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ANNEX

9 MARINE ECOLOGY ASSESSMENT

9.1 INTRODUCTION

This section of the EIA report presents the findings of the marine ecological impact assessment associated with the construction and operation of a LNG terminal at Black Point. It summarises baseline information on the potentially affected marine ecological resources and also presents the findings of a field survey programme. Detailed information on the baseline conditions and results of the field surveys are presented in *Annex 9*.

9.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

The criteria for evaluating marine ecological impacts are laid out in the *EIAO-TM* and Study Brief (no. ESB-126/2005). *Annex 16* sets out the general approach and methodology for assessment of marine ecological impacts arising from a project or proposal. This assessment allows a complete and objective identification, prediction and evaluation of the potential marine ecological impacts. *Annex 8* of the *EIAO-TM* recommends the criteria that can be used for evaluating marine ecological impacts.

Legislative requirements and evaluation criteria relevant to the study for the protection of species and habitats of marine ecological importance are summarised below. The details on each are presented in *Annex 9*.

1. *Marine Parks Ordinance (Cap 476);*
2. *Wild Animals Protection Ordinance (Cap 170);*
3. *Protection of Endangered Species of Animals and Plants Ordinance (Cap 586);*
4. *Town Planning Ordinance (Cap 131);*
5. *Hong Kong Planning Standards and Guidelines Chapter 10 (HKPSG);*
6. *The Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAOTM);*
7. *United Nations Convention on Biodiversity (1992);*
8. *Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramsar Convention);*
9. *PRC Regulations and Guidelines; and,*
10. *City University of Hong Kong (2001). Agreement No. CE 62/98, Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment, AFCD, Final Report July 2001.*

9.3 *EXISTING CONDITIONS*

The site for the proposed LNG terminal at Black Point is in close proximity to the existing Black Point Power Station (BPPS) near the northern reaches of the Urmston Road and on the outskirts of Deep Bay. Black Point is located in the northwestern waters of the Hong Kong Special Administrative Region (SAR). The surrounding waters are relatively shallow, often less than –5mPD.

In terms of water quality, the Study Area experiences relatively dynamic estuarine-influenced conditions. The waters are a mixture of flows from the waters in Deep Bay which mainly come from the Pearl River Estuary and the Shenzhen River, and oceanic waters. The former two flows are freshwater and the latter is saline marine water, which mix together and result in wide variations of salinity with depth, location and time. During the wet season when river flows are at their highest, the surface salinity decreases to estuarine conditions, whereas, during the dry season, typical oceanic salinity prevails throughout the water column.

9.3.1 *Summary of Baseline Conditions*

The findings of the literature review and field surveys and, an evaluation of the ecological importance of marine resources within the Study Area are summarised in the following section. The details are presented in full in *Annex 9*. The ecological resources and importance of marine habitats, in particular the Black Point headland's various habitats and organisms, have been characterised with reference to the available literature, comprehensive seasonal field surveys, comparisons with other similar habitats in Hong Kong and the criteria presented in *Annexes 8* and *16* of the *Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAOTM)*.

Detailed and comprehensive seasonal surveys were conducted examining the major habitats and species in the marine environment surrounding Black Point. The baseline surveys have included both the dry and wet seasons. The findings of the field surveys are presented in *Annex 9*.

Dolphins

The key finding of the literature review was the recorded presence in the waters in Deep Bay and Northwest Lantau of humpback dolphins (*Sousa chinensis*). From October 1995 to November 2004, there were 29 sightings of humpback dolphins (20 from vessels and 9 from helicopter) in Deep Bay (1). It was reported that Deep Bay is used by a small number of humpback dolphins (3 to 6) throughout the year. Dolphins occurred almost exclusively in the southern portion of Deep Bay, mostly near Black Point. The review highlighted that the waters around Black Point did not report large numbers of sightings.

(1) Jefferson, *pers.comm.*

For this EIA, an extensive programme of land and vessel-based surveys has been conducted to supplement data available from ongoing long-term AFCD monitoring. In accordance with the requirements of the Study Brief the surveys have been conducted monthly covering the period October 2005 through May 2006. Since this EIA study commenced in July 2005 surveys were also conducted during July, August and September 2005. These surveys have provided a detailed overview of dolphin utilisation of Hong Kong western waters including the Northwest Lantau and Deep Bay areas. During the field surveys, dolphins were observed throughout the surveyed areas.

The survey data gathered to date (July 2005 through May 2006) supported previous findings in the literature and indicated that Deep Bay has relatively low densities (0.08 - 0.232 dolphins km^{-2} depending on the season) and low estimates of abundance (<10 dolphins). For the Northwest Lantau area, encounter rates increased from summer (25) to autumn (46) and then increased again from autumn to winter (167), followed by a drop in spring (17). Northwest Lantau had significantly higher levels of dolphin density (0.57 - 0.94) and abundance (49-82) than Deep Bay.

Subtidal Hard Bottom Habitat

Surveys in Northwest waters (1) have found that only a few hermatypic hard corals (Family Faviidae) were recorded within the subtidal of the survey area. Although these surveys were conducted at some distance from Black Point, the results of these surveys are deemed applicable due to similar environmental conditions. As such, coral communities of ecological value are not predicted to occur within the Study Area.

Subtidal Soft Bottom Habitats

Literature was reviewed as part of the EIA which indicated that field sampling would be necessary due to the lack of comprehensive data in the Project Area. Consequently, for this EIA benthic surveys were conducted. A total of 18 grab samples were taken from three sites off Black Point during both the wet and dry seasons. In both seasons, benthic assemblages were dominated by polychaete worms except for the Urmston Road during the wet season where bivalves had higher numbers. In terms of diversity, benthic communities at the sites were similar to other locations reported in Hong Kong. Owing to a generally higher proportion of bivalves, the biomass of benthos off Black Point was relatively high compared to the Hong Kong average reported in the literature.

(1) ERM – HK Ltd 1995. Environmental Impact Assessment of the Proposed Aviation Fuel Receiving Facility at Sha Chau, prepared for the Provisional Airport Authority.

Intertidal Hard Bottom Habitat

Quantitative transect surveys and spotchecks were conducted on natural rocky shore and artificial seawalls on the west and south coasts of the Black Point headland. Rocky shore species were common and widespread and no species of conservation interest were recorded. In comparison to records of other shores in Hong Kong reported in the literature, the diversity of intertidal biota at Black Point, was low.

The details of all of the baseline surveys conducted for this EIA are summarised in *Table 9.1*.

Table 9.1 Marine Ecology Baseline Surveys

Survey Type	Methodology	Date
Intertidal Assemblages	Quantitative (belt transects at 4 locations) survey, three 100 m belt transects (at high, mid and low intertidal zones) for each location, covered both wet and dry seasons.	22 & 23 March and 15 & 30 July 2004
Subtidal Benthic Assemblages	Quantitative grab sampling survey; covered both wet and dry seasons. Six stations sampled in each of 3 locations (reclamation area, approach channel and turning circle).	25 & 26 February and 5 & 6 July 2004.
Marine Mammal	Land-based visual survey during daytime, 5 days per month and 6 hours per day, covered four seasons and 12 months.	16, 17, 18, 19 & 26 February, 19, 22, 23, 25 & 26 March, 6, 7, 13, 14 & 15 April, 11, 13, 17, 18 & 20 May, 11, 15, 24, 25 & 29 June 2004, 9, 14, 15, 20 & 25 July 2004, 25, 26, 27, 30 & 31 August, 15, 16, 17, 20 & 21 September 2004, 27, 28, 29, 30 & 31 October 2004, 24, 25, 27, 29 & 30 November 2004, 7, 8, 9, 13 & 14 December 2004, 21, 24, 25, 26 & 27 January 2005.
	Quantitative vessel based survey using transect methods spanning Hong Kong western waters (Deep Bay, Southwest Lantau, Northwest Lantau and West Lantau) 3 days, 2 times per month	18, 19, 20,,21, 22, 25, 26, 27 July 2005, 3, 4, 5,15,24 & 25 August 2005, 5,7,15, 16 & 20 September 2005, 5, 6, 7, 17, 18 & 19 October 2005, 22, 24, 25, 28, 29 & 30 November 2005, 6,7,8 & 22 December 2005, 13, 16, 17, 19, 20, 24 January 2006, 1, 2, 3, 7, 8, 9 February 2006, 17, 23, 28, 29, 31 March 2006, 3, 6, 18, 25, 26, 27 April 2006, 2, 4, 8, 9, 10, 11 May 2006.

9.3.2 *Ecological Importance*

The ecological importance of the habitats was determined with reference to the following:

- Literature review findings;
- Findings of the field surveys;
- Comparison with other areas in Hong Kong; and,
- *Annexes 8* and *16* of the *EIAO TM*.

The ecological importance of the marine habitats and their locations relative to the LNG terminal layout are summarised in *Table 9.2*. The key findings are presented below:

- **Areas to be Reclaimed:** The information on marine ecological resources presented in this report has not identified any habitats of high ecological value within the reclamation area.
- **Inshore Marine Waters off Black Point:** The ecologically important marine mammals, *Sousa chinensis* have been sighted in the area. Based on analysis of the density of dolphins sighted, marine waters around the Black Point headland were regarded as medium importance to these marine mammals.

The ecological importance of the marine habitats and their locations relative to the LNG terminal layout are summarised in *Table 9.2*.

Table 9.2 Ecological Importance of the Marine Habitats

Habitat	Ecological Importance
Natural Rocky Shore	Low
Artificial Shoreline	Low
Subtidal Soft Bottom Habitats at Black Point	Low to Medium
Subtidal Hard Surface Habitat along Artificial shoreline	Low
Marine Waters off the Black Point Headland	Medium for *Sousa chinensis*

9.3.3 *Marine Ecological Sensitive Receivers*

Based on the results of the marine ecological surveys and a review of the available information on existing conditions in the study area and its immediate vicinity, the potential sensitive receivers that may be affected by the proposed works associated with the Project are identified as follows:

- Designated Sha Chau & Lung Kwu Chau Marine Park; and
- Seagrass Beds, Mangroves, Intertidal Mudflats and Horseshoe Crabs.

The locations of the sensitive receivers identified are shown in *Figure 6.4* (see *Part 3 Section 6*).

9.4 ASSESSMENT METHODOLOGY

A desktop literature review and supporting field surveys (summarised in *Part 3 Section 9.3* and detailed in full in *Part 3 Annex 9*) were conducted in order to establish the ecological profile of the area within and surrounding the Study Area. The Study Area for the marine ecology baseline include the boundary of 500m from the proposed Project Area and incorporated the proposed approach channel and turning circle as well as the reclamation area. The importance of potentially impacted ecological resources identified within the Study Area was assessed using the methodology defined in the *EIAO-TM*. The potential impacts due to the construction and operation of the terminal and associated developments were then assessed (following the *EIAO-TM Annex 16* guidelines) and the impacts evaluated (based on the criteria in *EIAO-TM Annex 8*).

9.5 POTENTIAL SOURCES OF IMPACT ON MARINE ECOLOGICAL RESOURCES

9.5.1 Construction Phase

Potential impacts to marine ecological resources arising from the construction works may be divided into those due to direct disturbances to the habitat and those due to perturbations to key water quality parameters. Potential impacts to marine mammals are discussed in *Part 3 Section 9.7*. As discussed in *Section 3*, the construction of the proposed LNG terminal at Black Point will involve dredging to construct a seawall and reclamation, backfilling for reclamation and dredging for the turning circle and approach channel. Construction of the jetty may require percussive piling. Impacts associated with the proposed LNG terminal are thus divided into those occurring during:

- Dredging and reclamation for the terminal, including dredging seawall trenches, filling with sand and suitable fill etc;
- Dredging for the approach channel and turning basin; and
- Construction of the jetty.

Dredging and Reclamation for the Terminal

Along the line of the seawalls the existing marine sediments will be dredged to provide suitable foundations. After completion of the seawall, the muds within the reclamation sites will be partially dredged and then filled using sand and public fill. Impacts to the marine ecological resources potentially arising from dredging and reclamation at Black Point are as follows and summarised in *Table 9.3*.

Table 9.3 Summary of Potential Construction Phase Impacts associated with Dredging and Reclamation for the LNG terminal at Black Point (including the intake and outfall)

Nature of Impact	Marine Habitat Affected	Location	Potential Impact
Habitat Loss	Subtidal Soft Bottom Habitat	Black Point	Permanent loss of approximately 16 ha of seabed
	Subtidal Hard Bottom Habitat	Black Point	Permanent loss of approximately 600 m of subtidal natural rocky coastline and approximately 120 m of artificial shore
	Intertidal Natural Rocky Shore	Black Point	Permanent loss of approximately 600 m natural rocky shore
	Intertidal Artificial Shore	Black Point	Permanent loss of approximately 120 m of artificial shore
Short term Changes in Water Quality	Subtidal Soft Bottom Habitat	Black Point	Potential smothering and burial of benthic organisms during dredging
	Subtidal Hard Bottom Habitat	Black Point	Potential water quality impacts on subtidal organisms
	Intertidal Natural Rocky Shore	Black Point	Potential water quality impacts on intertidal organisms

Habitat Loss

Subtidal Soft Bottom Habitats

Within the reclamation site, primary impacts will be the smothering and burial of organisms during filling, or removal of organisms during dredging. These impacts will be an unavoidable consequence of the works during dredging and sandfilling operations associated with the reclamation works for the terminal. It is important, therefore, to determine whether the reclamation site contains unique or otherwise noteworthy benthic assemblages which will be lost. Findings from a literature review, supplemented by focussed field surveys, indicate that the benthic assemblage within, and in the vicinity of the reclamations were dominated by polychaetes and characterised by similar species diversity and dry season biomass as found elsewhere in Hong Kong. The wet season biomass of the benthic assemblage at Black Point was comparatively higher than other areas in Hong Kong Waters. However, all of the species recorded occur frequently in Hong Kong and no rare species were observed. As a result, the assemblages were regarded as being of low ecological value.

The scale of the reclamation has been reduced as far as practicable through modifications to the engineering layout. Although the proposed reclamation and dredging will result in permanent loss of approximate 16 ha (due to the reclamation) of subtidal soft benthic habitats, the severity of the impact is anticipated to be acceptable in terms of loss of benthic assemblages, as the seabed areas to be reclaimed and dredged are of low ecological value and support benthic species which are common in Hong Kong waters.

Subtidal Hard Surface Habitats

The construction of the reclamations for the Project will result in the permanent loss of low ecological value subtidal hard surface habitats (no coral communities expected to be found along the approximately 600 m of natural rocky shore). The assemblages within the Black Point reclamation areas will be lost through the burial of organisms present there.

Rubble mound and/or armour rock/concrete armour seawalls will be used along the reclamation area and will provide approximately 1.1 km of habitat for subtidal organisms to colonise. It has been demonstrated that similar marine organisms have recolonised such seawalls after construction (1) (2). It is anticipated that assemblages of subtidal organisms will settle on and recolonise the newly constructed seawalls, as environmental conditions of that area would be similar to existing conditions that have allowed the growth of subtidal organisms. The potential habitat provided by the total surface area of the rubble mound and/or armour rock/concrete armour seawalls on the reclamations is expected to allow the recolonisation of the subtidal assemblages within the reclamation sites.

Intertidal Habitats - Rocky Shores and Artificial Shorelines

A length of approximately 600 m of low ecological value natural rocky shore and approximately 120 m of low ecological value artificial shore will be lost as a result of reclamation activities for the terminal. The results from field surveys indicated that the intertidal assemblages recorded on the rocky shores are typical of semi-exposed rocky shore communities observed in Hong Kong. Artificial seawalls will replace these intertidal habitats. The artificial seawalls can, over time, support similar assemblages of intertidal fauna and flora. Organisms present on intertidal shores in Hong Kong rely on larval settlement for recruitment. Assuming that there is a regular supply of larvae brought to the area, recolonisation of new seawalls will occur. The design of the seawall is important in determining the extent to which the community re-establishes post reclamation. The more heterogeneous the seawall, the more diverse a community the habitat can support such as tetrapods or rubble mound/rock or concrete armour. Although the reclamation works will result in the loss of approximately 600 m of natural intertidal habitats, the severity of the impact is reduced by the provision of approximately 1.1 km of sloping ecologically enhancing seawalls. The sloping seawalls are all expected to be of rubble mound/rock or concrete armour design.

(1) Binnie Consultants Limited. 1996. Coral Growth at High Island Dam, for Civil Engineering Department.

(2) Binnie Consultants Ltd. 1997. Chek Lap Kok Qualitative Survey Final Report. For the Geotechnical Engineering Office, Civil Engineering Department, December 1997.

Changes in Water Quality

Suspended Sediments

The construction of the reclamation for the terminal will involve dredging of sediments within the reclamation site and along the line of the seawalls to provide suitable foundations, and filling of the reclamations using sand and public fill. The modelling works have analysed suspended sediment (SS) dispersion from dredging of the reclamation site in the case that some marine muds have to be removed (see *Part 3 Section 3*).

Subtidal Soft Benthos: The subtidal soft benthos in and around the proposed terminal is considered to be of low ecological value (*Part 3 Annex 9*); however, these sessile organisms will be susceptible to the effects of increased sediment loads through smothering and burial. Sediment may be deposited on the seabed outside the reclamation sites during backfilling (through dispersion of sediment plumes) and post-placement (through erosion and wave-induced re-suspension), and outside the turning circle and approach channel during dredging. Impacts to benthic assemblages immediately outside of the reclamation site and dredged areas are expected to occur temporarily. The area is expected to be small as sediment will be deposited within a short distance of the dredging and filling works. With reference to the water quality modelling results, elevations in suspended sediment levels would be localised and confined to the works area. It should be noted that dredging for the reclamation may take place behind constructed seawalls which would greatly reduce the dispersion of SS. As the area is often disturbed by demersal trawling and SS laden discharges from the Pearl River, the organisms present are thus assumed to be adapted to seabed disturbances. Based on the assumption that eventually the affected areas will be recolonised by fauna typical of the area, then the temporary loss of these low ecological value assemblages is deemed acceptable.

Subtidal Hard Surface Habitats: Since there were no coral assemblages (including soft corals, gorgonians, black corals and hard corals) of ecological interest recorded within or in the vicinity of Black Point, adverse impacts to corals are not predicted to occur.

Intertidal Habitats: Intertidal habitats within the Study Area which may be affected by the reclamation and dredging activities include the natural rocky shores located at Black Point. With reference to the water quality modelling results (*Part 3 Section 6*), elevations in SS levels are predicted to be localised and confined to the works area. Furthermore, the dredging is expected to be partially enclosed by newly constructed seawall which would further limit the spread of SS in the water column. Due to the low quality of the intertidal habitats identified within the Study Area and the intertidal assemblages being naturally exposed to high levels of suspended solids in the Pearl River Estuary, adverse impacts to the intertidal assemblages on the south side of the Black Point headland arising from elevated SS levels are not anticipated.

Dissolved Oxygen

The relationships between suspended sediment (SS) and dissolved oxygen (DO) are complex, with increased SS in the water column combining with a number of other factors to reduce DO concentrations in the water column. Elevated SS (and turbidity) reduces light penetration, lowers the rate of photosynthesis by phytoplankton (primary productivity) and thus lowers the rate of oxygen production in the water column. This has a particularly adverse effect on the eggs and larvae of fish, as at these stages of development, high levels of oxygen in the water are required for growth due to their high metabolic rate. DO depletions are most likely to affect sessile organisms as they cannot move away from areas where DO is low (unlike mobile species such as fish). The low elevations of SS are not expected to cause marked decreases in DO levels. It is expected, therefore, that unacceptable impacts to marine ecological habitats and populations present in the vicinity of the reclamation sites, including marine mammal and intertidal habitats, are unlikely to occur.

Nutrients

High levels of nutrients (total inorganic nitrogen - TIN and ammonia) in seawater can cause rapid increases in phytoplankton to the point where an algal bloom may occur. An intense bloom of algae can lead to sharp increases in DO levels in surface water. However, at night and when these algae die there is usually a sharp decrease in the levels of dissolved oxygen in the water, as dead algae fall through the water column and decompose on the bottom. Anoxic conditions may result if DO concentrations are already low or are not replenished. This may result in mortality to marine organisms due to oxygen deprivation. The results have indicated that low levels of SS elevations are expected outside of the works areas. Consequently, elevations in nutrients desorbed from the sediment particles are expected to be in low concentrations. Algal blooms are therefore not expected through works and unacceptable impacts to the marine ecological habitats and populations present in the vicinity of the terminal and dredging areas will not occur.

Dredging for the Approach Channel and Turning Basin

Dredging for the approach channel and turning basin will be scheduled after the completion of the dredging under the seawall and with similar timing as the filling of the reclamations using sand and public fill. Impacts to the marine ecological resources potentially arising from the dredging activities in the open water near Black Point are as follows.

Table 9.4 Summary of Potential Construction Phase Impacts associated with Dredging for the Approach Channel and Turning Basin at Black Point

Nature of Impact	Marine Habitat Affected	Location	Potential Impact
Habitat Loss	Subtidal Soft Bottom Habitat	Off Black Point	Temporary disturbance of approximately 47 ha of seabed
Change in Water Quality	Subtidal Soft Bottom Habitat	Off Black Point	Potential sediment deposition on benthic organisms
	Subtidal Hard Bottom Habitat	Off Black Point	Potential water quality impacts on subtidal organisms
	Intertidal Natural Rocky Shore	Off Black Point	Potential water quality impacts on intertidal organisms

Habitat Loss

The areas within the boundary of the proposed turning basin and approach channel are approximately 47 ha. Dredging will be only required for those areas with a water depth less than 15 m. This direct impact on the subtidal soft bottom habitat will be temporary in nature and the disturbed seabed will be available for recolonisation by benthic fauna after the removal of sediment. For these reasons as well as the low ecological value of this habitat, the severity of the impact is anticipated to be acceptable. Intertidal and subtidal hard surface habitats will not be directly affected due to the dredging works.

Changes in Water Quality

Suspended Sediments

The existing marine sediments along the section of turning basin and approach channel of a depth less than 15 m will be dredged to allow navigation of the LNG carrier. The dredging will only affect the seabed for a short duration. The modelling works have analysed SS dispersion from dredging of the turning basin and approach channel.

Subtidal Soft Benthos: Water quality modelling results indicated that the extent of the sediment plume is localised to the works areas and would be compliant with WQO. Mean depth averaged SS level of > 10 mg L^{-1} in the absence of mitigation measures would be generally confined to the works area in both the dry and wet seasons (*see Part 3 Section 6*). The impacts are expected to be of short duration. As the area is often disturbed by demersal trawling, the organisms present are thus assumed to be adapted to seabed disturbances. The affected areas will be recolonised by fauna typical of the area and hence the temporary loss of these low ecological value assemblages is deemed acceptable.

Intertidal Habitats: Intertidal habitats within the Study Area which may be affected by the dredging activities include the natural rocky shores located at Black Point. Sediment dispersion results predict that, elevations in SS levels are expected to be localised and confined to the works area in the both dry season and wet seasons (*Part 3 Section 3*). The intertidal assemblages at Black Point are naturally exposed to high levels of suspended solids in the Pearl River Estuary. Due to the low quality of the intertidal habitats within the Study Area and the short duration of the dredging activities, adverse impacts to the intertidal assemblages arising from elevated SS levels are not anticipated.

Dissolved Oxygen

Depletions of DO as a result of dredging activities are expected to be low and compliant with the relevant WQOs (refer to *Part 3 Section 6* for details). It is, thus, expected that unacceptable impacts to the marine ecological habitats and populations present in the vicinity of the dredging areas will not occur.

Nutrients

The levels of nutrients are not expected to increase appreciably from background conditions during the reclamation and dredging operations (refer to *Part 3 Section 6* for details). Algal blooms are not expected through works and unacceptable impacts to the marine ecological habitats and populations present in the vicinity of the terminal and dredging areas will not occur.

Construction of the Jetty

Construction of the jetty on the newly reclaimed land at Black Point is scheduled after completion of dredging works for the approach channel and turning basin. The jetty would be constructed using piling construction methods. Water quality impacts associated with piling are negligible and would not impact marine ecological resources. Potential impacts that would arise due to the construction of the jetty are introduced in *Table 9.5* and discussed below.

Table 9.5 Summary of Potential Construction Phase Impacts associated with Jetty Construction at Black Point

Nature of Impact	Marine Habitat Affected	Location	Potential Impact
Habitat Loss	Intertidal Hard Bottom Habitat	Black Point	Disturbance of approximate 20m of newly constructed artificial shore
	Subtidal Soft Bottom Habitat	Black Point	Disturbance to small areas of seabed under the jetty
	Subtidal Hard Bottom Habitat	Black Point	Permanent loss of approximate 20m of newly constructed artificial coastline

Habitat Loss

Intertidal Hard Bottom Habitat

Construction of the jetty will result in minor disturbance to a small stretch of newly constructed seawall. Being newly constructed, it is expected that this stretch of seawall would be of low ecological value and the impact would be acceptable.

Subtidal Hard Bottom Habitat

The jetty would connect to the newly constructed reclamation area for the LNG terminal. Being newly constructed, it is expected that this stretch of seawall would be of low ecological value and the impact would be acceptable.

Hydrotest Water

A potential additive to the hydrotest water for the LNG tanks will be low concentrations of chlorine (0.05 mgL^{-1}). The impacts on marine ecology due to the discharge of such hydrotest water are similar to the cooled water discharge and were addressed in the following section (*Part 3 Section 9.5.2*).

9.5.2 *Operation Phase*

Hydrodynamic Regime

The reclamation for the LNG terminal will bring about a change in the shape of the existing coastline. If this causes significant change in the hydrodynamic regime of the surrounding waters, there would be potential for impacts on marine ecological resources to occur. Impacts of this nature could lead to increased seabed current velocities which may cause seabed scour thus impacting subtidal assemblages, or conversely the current speeds may drop, affecting flushing and water exchange of an area. Inadequate flushing could lead to a reduction in dissolved oxygen (DO), an increase in nutrient levels and consequent impacts to marine ecological resources. The effect of changes in coastal configuration on the current velocities have been assessed (see *Part 3 Section 6*). The hydrodynamic modelling has indicated that the reclamation in Black Point will have little effect on current velocity. Consequently, no operational phase impacts on marine ecological resources due to changes in the hydrodynamic regime are expected.

Maintenance Dredging

To the extent practical, the selection of the fairway transit and approach channel for the LNG carrier was based on the availability of the required charted water depth. The intent is to reduce the dredging quantities and hence potential impacts to water quality. The difference in water depth between the dredged channel and areas in the vicinity is approximately 8 m, and consequently the maintenance dredging will be approximately once every 4 - 5 years. Dredging works associated with maintenance of the approach channel and turning basin are expected to be of a lower magnitude than those associated with the construction phase dredging requirements discussed above. As no unacceptable adverse impacts to water quality have been predicted to occur as a result of construction phase dredging, it can be expected that no unacceptable adverse impacts to marine ecological resources would occur through maintenance dredging.

Discharge of Cooled Water

<u>Cooled Water - Temperature</u>

Cooled water with a decreased temperature of approximately 12.5°C from ambient will be discharged at the seawater outfall, which is located at the seabed off the proposed LNG terminal at Black Point. The flow rate of the discharge is equivalent to 18,000 $m^3 hr^{-1}$ (peak flow). The potential impacts of this discharge are principally related to the ecological effects of a zone of reduced temperature near the point of discharge. The water quality model has predicted the minimum temperature that would be experienced in waters adjacent to the discharge point (see *Part 3 Section 6* for details). The results show that water temperatures between 2 to 5°C lower than ambient conditions would occur in a localised area close to the outfall. Beyond the close vicinity of the outfall point, temperatures would not be more than 2°C lower than ambient conditions. In this way, cooling water discharge from the LNG terminal is not expected to cause any significant changes in water temperature that would impact subtidal or intertidal habitats. In terms of temperature differences, cooled water discharges are not expected to cause adverse impacts on marine ecological resources of the area.

<u>Cooled Water - Antifoulants</u>

There are considerable operational and ecological issues caused by organisms within, and passing through industrial water systems and, these problems can be costly [(1)]. Mussels, oysters and other marine organisms growing within cooled water circuits have resulted in losses in thermal efficiency and even total shutdowns. To counteract settling and actively growing fouling organisms, cooled water circuits are usually dosed with antifoulants (typically chlorine in the form of sodium hypochlorite). This causes mortalities of both the fouling and non-fouling organisms in the circuit. The discharge of the resulting chlorinated effluents may in turn have effects on the habitat beyond the outfall.

The effluent from the cooled water system will contain traces of antifoulant at a concentration of 0.3 mg L^{-1}, which is below EPD's [(2)] statutory limit of 1.0 mg L^{-1}. Values are available from the literature on the physiological response to chlorine in water which can be used for reference purposes (*Table 9.6*). For

(1) Langford TE. 1983. Electricity generation and the ecology of natural waters. Liverpool University Press.

(2) Technical Memorandum Standards for Effluents Discharged from Drainage an Sewerage Systems, Inland and Coastal Waters, Water Pollution Control Ordinance, Cap 358.

the majority of organisms the toxicity of residual free chlorine depends on the concentration and exposure time. Short exposure to high concentrations often leads to lethal effects as do long term exposures to low concentrations (1).

Table 9.6 *Toxic Responses of Marine Organisms to Residual Free Chlorine in Discharges*

Organism	Toxic Responses	Cl (mg L^{-1})
Phytoplankton	Photosynthesis of marine phytoplankton depressed by 70-80%	0.02-0.04
Zooplankton	Short term exposure has led to rapid but temporary responses demonstrated through depression in metabolic rate and reproductive activity.	0.01
Oyster Larvae (*Ostrea edulis*)	Tolerant of short term exposure with no demonstrated toxic response.	0.2-0.5
Barnacle Larvae (*Elminius modestus*)	Tolerant of short term exposure with no demonstrated toxic response.	0.2-0.5
Lobster Larvae (*Homarus americanus*)	Respiration rate increased after 60 minute exposure to 0.1 mg L^{-1} and after 30 minute exposure to 0.1 mg L^{-1}.	0.01 0.1

Note: Information gathered from references contained in Langford TE (1983) Electricity generation and the ecology of natural waters

Concentrations of residual chlorine diminish rapidly with time and distance from the discharge point (2). The modelling exercises conducted for the water quality assessment (reported in *Part 3 Section 6*) indicate that residual chlorine concentrations exceeding 0.01 mg L^{-1} are only likely to occur within 300m of the outfall and are mainly confined to the bed layer of the water column. These predicted increases do not exceed tolerance thresholds established in the literature (0.02 mg L^{-1}) and are in accordance with those levels recommended in previous studies in Hong Kong (0.01 mg L^{-1}). As a result, impacts to marine ecology as a result of potential concentrations of residual chlorine are not expected to occur.

Impingement and Entrainment of Fauna in the Seawater System

In order to provide water for regasification of LNG, seawater will be extracted via a submarine intake in the seawall.

There is a potential for impingement and subsequent entrainment of marine organisms in the intake system. This affects different groups of animals to differing degrees. Smaller pelagic species are the most vulnerable, while burrowing animals are rarely impinged, and large pelagic species are usually strong enough to avoid the intake stream.

(1) Redrawn after Mattice and Zittel. 1976. Site Specific Evaluation of Power Plant Chlorination. *Journal of Water Pollution Control*, 48:(10) 2284-2308.

(2) Mattice JS & Zittel HE. 1976. Site specific evaluation of power plant chlorination. Journal of Water Pollution Control. 48 (10): 2284 - 2308.

Not all animals that impinge on the system will be entrained within it. Screening of water intakes will prevent the entrainment of all but the smallest organisms. Impinged animals may suffer mechanical and physiological stress, but evidence from power station cooling systems suggest that this is not a significant source of mortality (1).

Entrained animals may be subject to additional thermal stresses and mortality is relatively high. However, these will typically be confined to plankton, which have an extremely high natural mortality. Extensive research shows that the mortality of plankton in seawater systems does not give rise to a significant impact (2) (3).

An assessment of impacts associated with impingement and entrainment of marine organisms is presented in the *Fisheries Impact Assessment* (*Part 3 Section 10*). It was concluded that impacts associated with operation of the water intake would not cause unacceptable impacts on fisheries resources. In conclusion, operation of the water intake would not be expected to result in unacceptable impacts on marine ecological resources.

Accidental Spillage of LNG

An accidental LNG release would be vaporized quickly into the atmosphere and would not be expected to impact marine ecology. If spilled onto the LNG terminal platform or into the ocean (LNG is less dense than water), LNG would boil rapidly (due to exposure to higher ambient temperatures). Because of the material's density and turbulence created by the rapid boiling, an LNG spill would vaporize rapidly, leaving no environmental residue. Any accidental LNG spill would therefore be of short duration, reversible and will occur within a limited and transient mixing zone. This issue is further discussed in *Part 3 Section 6 – Water Quality* and *Part 3 Section 13 Quantitative Risk Assessment* (in particular the consequential fire hazard).

Accidental Spill of Fuel from LNG Carrier

It is considered that a spillage of fuel is highly unlikely (for details refer to *Part 3 Section 6.7.8*), therefore potential risk on Chinese White Dolphins due to accidental spill of fuel is expected to be low.

9.6 EVALUATION OF THE MARINE ECOLOGICAL IMPACTS

The following section discusses and evaluates the impacts to marine ecological habitats as a result of the resources identified in the previous Sections. Based upon the information presented above, the significance of the marine

(1) Majewski W. & Miller D.C. 1979. Predicting effects of power plant once-through cooling on aquatic systems. UNESCO.

(2) *Ibid.*

(3) Turnpenny A.W.H. 1988. *Fish impingement at estuarine power stations and its significance to commercial fishing*. Journal of Fish Biology, **33**, 103-110.

ecological impact associated with the construction and operation of the LNG terminal has been evaluated in accordance with the *EIAO-TM (Annex 8, Table 1)* as follows.

- *Habitat Quality*: Impacts are predicted to occur only to the low quality coastal habitats (inter-tidal and subtidal) and benthic habitats identified during the field surveys within the reclamation site. The selection of the reclamation site has avoided habitats of high ecological value and the Sha Chau and Lung Kwu Chau Marine Park. Operational phase discharges from the terminal are not expected to impact any habitats of high ecological value.

- *Species:* Based on literature and field surveys, no organisms of ecological interest were identified in proximity to Black Point. Marine ecological sensitive receivers including horseshoe crab, seagrass and mangrove habitat were situated at distant locations from the proposed works. No construction phase impacts are expected to these sensitive receivers. Operational phase discharges from the terminal are not expected to impact these sensitive receivers.

- *Size:* The total size of the reclamation site is 16 ha, including 600 m of natural rocky shore and 120 m of artificial shore. Low ecological value intertidal, subtidal hard surface and benthic assemblages within the terminal footprint will be directly impacted. The low ecological value benthic assemblages within certain areas of the turning basin and approach channel will be lost during dredging but are expected to become re-established within a year (see *Reversibility*).

- *Duration:* The reclamation works are predicted to last for 7 - 8 months and the dredging for the turning basin and approach channel approximately 7 - 8 months. Increases in SS levels in the vicinity of sensitive receivers are expected to be low and temporary, and within environmentally acceptable limits. Operational phase discharges will continue during the life of the LNG terminal but are not predicted to cause adverse impacts to marine ecological resources as the discharges disperse rapidly and do not affect high ecological value habitats.

- *Reversibility:* Impacts to the benthic assemblages inhabiting the soft bottom habitats within the dredged areas are expected to be relatively short term and recolonisation of the sediments is expected to occur. Similarly the low ecological value assemblages present on the artificial seawall and natural rocky shore can be expected to recolonise the seawall once it is reinstated.

- *Magnitude:* No unacceptable impacts to the ecologically sensitive habitats have been predicted to occur. Operational phase impacts are not expected to cause adverse impacts and are considered to be of low magnitude.

The impact assessment presented above indicates that no unacceptable impacts to marine ecology are expected to occur. Although soft bottom habitat will be temporarily lost, it has been demonstrated through long-term monitoring of previously dredged areas and existing Contaminated Mud Pits in the East of Sha Chau area that marine organisms have recolonised the areas following the completion of the works [1]. As such, it is anticipated that subtidal assemblages influenced by dredging will settle on and recolonise the seabed returning it to the former conditions.

The previous discussion has indicated that the loss of intertidal and subtidal assemblages within the Study Area is expected to be compensated through the provision of seawalls that provide adequate surfaces for colonisation once reclamation works have been completed (1.1 km of rubble mound and/or concrete armour seawalls). It has been demonstrated that marine organisms have recolonised these seawalls after construction [2]. It is anticipated that intertidal and subtidal assemblages similar to those recorded in the field surveys, will settle on and recolonise the newly constructed seawalls of the reclamation.

Impacts to marine ecological resources during operation of the terminal are predicted to be within acceptable levels in ecologically important areas through appropriate design of the seawater outfall (as discussed in *Part 3 Section 6 - Water Quality*).

Hence no additional marine ecology specific mitigation measures to control discharges are required during project operation.

9.7 *POTENTIAL SOURCES OF IMPACT ON MARINE MAMMALS*

In this section of the report, the potential for impacts associated with various marine works and activities involved in the proposed project are examined in detail to provide an assessment of the significance of the effects on the Indo-Pacific Humpback Dolphin. The significance of a potential impact from works or activities on marine mammals can be determined by examining the consequences of the impact on the affected animals. This is related to the source, nature, magnitude and duration of the impact, the level of exposure to the impact in terms of the number (and lifestage) of affected animals and their response to an impact.

The consequences of an impact on these marine mammals have the potential to range from behavioural changes of individual animals through to

(1) Qian PY, Qiu JW, Kennish R and Reid C. 2003. Recolonization of benthic infauna subsequent to capping of contaminated dredged material in East Sha Chau, Hong Kong. Estuarine, Coastal and Shelf Science 56: 819-831.

(2) Binnie Consultants Ltd. 1997. Chek Lap Kok Qualitative Survey Final Report. For the Geotechnical Engineering Office, Civil Engineering Department, December 1997.

population level effects[(1) (2) (3)]. The potential consequences of impacts on marine mammals are as follows:

- **Behavioural changes:** Affected individual animals may change travelling speed, dive times, avoid areas, change travel direction to evade vessels, change vocalisation due to acoustic interference, reduce resting, socialising and mother-calf nursing. Provided that disturbances leading to behavioural changes are temporary and localised, disturbances causing behavioural changes would generally not be considered significant (i.e. effects would be of short duration, normal activities will resume with no appreciable effect on fitness or vital rates).

- **Life function immediately affected:** Avoidance of affected areas may diminish individual animals' feeding activity. Loss of a marine area to reclamation will permanently eliminate a foraging area. Similarly, disturbance/loss of prey resources due to water quality impacts may diminish available feeding opportunities in the vicinity of works. Interference with echolocation through underwater noise could also affect feeding. Provided that disturbances are temporary and localised, or permanent losses of habitat represent a small portion of available habitat, impacts would generally not be considered to have a significant effect on marine mammals (i.e. effect would be short term and therefore have no appreciable effect on fitness or vital rates).

- **Fitness and Vital Rates:** If works cause widespread and prolonged adverse impacts, with limited or no alternative habitat available for animals to use, fitness and vital rates will be affected including growth rates, reproduction rates and survival rates (life-stage specific). In the same way, any works or activity likely to result in injury or mortality of marine mammals would self-evidently affect survival rates. Activities causing impacts on fitness and vital rates would be considered significant (i.e. if effects are long-term or inescapable, they will diminish the health and survival of individuals).

- **Population effect:** Impacts on the fitness and survival of individuals have the potential to, for instance, affect population growth rates and population structure. Impacts resulting in population effects would be considered significant (i.e if effects are long term and detrimental to the population as a whole).

(1) National Research Council (2005) *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects*. National Academies Press. Washington DC. 126p.

(2) Wursig B, Greene CR, Jefferson TA. 2000. Development of an air bubble curtain to reduce underwater noise of percussive piling. Marine Environmental Research 49, 79-93.

(3) Greene CR, Moore SE. 1995. Man-made noise. In: Marine Mammals and Noise. (Eds. Richardson WJ, Greene CR, Malme CI and Thomson DH). Academic Press. London, pp. 101-158.

9.7.1 *Construction Phase*

As discussed previously, works for the proposed LNG terminal will involve:

- Dredging and reclamation for the terminal, including dredging seawall trenches, filling with sand and suitable fill etc;
- Dredging for the approach channel and turning basin; and
- Construction of the jetty.

The following sections provide an assessment of potential impacts associated with these works and activities and effects on dolphins.

Reclamation Works - Habitat Loss

The approximately 16 ha of proposed reclamation at Black Point for the LNG terminal would cause the permanent loss of sea area and hence the permanent loss of marine mammal habitat [(1)]. The physical loss of habitat during and after reclamation works, could affect some individuals of Indo-Pacific Humpback Dolphin, *Sousa chinensis,* which utilise Black Point waters as a part of their home range. Based on the vessel-based and land-based survey findings as well as AFCD monitoring records, it is known that the inshore waters affected by the proposed reclamation are an area of medium density dolphin sightings and have been evaluated to be of medium ecological importance. Although, the area is subject to considerable disturbance by high volumes of vessel traffic, the loss of this area of Northwest Lantau waters where medium densities of dolphins have been recorded, is assessed to be an adverse impact because it would be a permanent and irreversible loss of a sizeable area of medium ecological importance marine mammal habitat.

Although the loss of these waters due to reclamation is assessed to be an adverse consequence of the Project, it should be noted that the loss is not likely to significantly impact the fitness or vital rates of affected individual animals that currently utilise these waters. Information from the fisheries impact assessment (*Part 3 Section 10*) indicates that the permanent loss of marine habitat due to reclamation is not predicted to adversely impact the fisheries resources that would be available in the waters surrounding the reclaimed area (the fisheries resources in the marine habitat serve as marine mammal's food prey). Photo-identification studies have shown Indo-Pacific Humpback Dolphins have extensive home ranges typically extending over 100 km^2 (see *Figures 28* and *29* of *Part 3 Annex 9* for details) and may forage and feed throughout. In the context of the size of the home ranges which may encompass extensive areas across North Lantau waters and beyond, although sizeable, the 16 ha of habitat would represent a relatively small portion of individual animal's home range.

(1) Justification for the size of the reclamation is presented in Section 2 and 3 of this EIA report.

Potential Impacts from Works Vessels (all marine works)

Increased marine traffic: Construction of the terminal has the potential to result in an increase in marine traffic which may affect the Indo-Pacific Humpback Dolphin. In Hong Kong, there have been instances when dolphins in Hong Kong have been killed or injured by vessel collisions (1) (2), and it is thought that this risk is mainly associated with high-speed vessels such as ferries. In terms of potential impacts arising due to increased vessel traffic associated with the dredging and reclamation works for the LNG terminal, the risk of vessel collision is considered to be very small as work vessels would be slow moving. Slow moving vessels would not pose a significant risk to dolphins including young animals. To err on the side of caution, the risk of vessel strike will also be managed through a series of precautionary measures (see *Part 2 – Sections 9.9.3* and *9.10* for details). It should be noted that waters off Black Point have existing high levels of marine traffic using the Urmston Road channel. In this context, vessel traffic associated with the proposed project would represent a minor increase in marine traffic in this area.

The effect of the physical presence of work vessels and other vessels on dolphins would be limited to temporary behavioural disturbance of a number of animals, if and when encounters with vessels occur. It would be expected that these animals may avoid the vicinity of the works areas whilst works vessels are in operation. These disturbances would not be expected to have a biologically significant impact on the affected animals. As detailed in *Part 3 –Annex 9 – Baseline Marine Ecological Resources*, photo-identification of individual dolphins has shown these animals have extensive home ranges typically of more than 100 km^2 and perform their main functions (feeding, socialising, breeding) throughout their home ranges. Therefore any works areas avoided would constitute a very small portion of the waters they inhabit.

This assumption that the presence of work vessels would not adversely impact marine mammals is consistent with other EIA and environmental monitoring studies in Hong Kong. Contaminated mud disposal facilities have been in operation in the East of Sha Chau area for over ten years. Data available on the use of the waters does not indicate that the operations of these facilities are resulting in avoidance behaviours by the dolphins (3). In addition, dolphins have returned and are using the waters near the Chek Lap Kok airport (4).

(1) Parsons, E. C. M. and T. A. Jefferson. 2000. Post-mortem investigations on stranded dolphins and porpoises from Hong Kong waters. *Journal of Wildlife Diseases* 36(2):342-356.

(2) Jefferson, T. A., B. E. Curry, and R. Kinoshita. 2002. Mortality and morbidity of Hong Kong finless porpoises, with special emphasis on the role of environmental contaminants. *Raffles Bulletin of Zoology* (Supplement) 10:161- 171

(3) ERM. 2002. Environmental Monitoring and audit for Contaminated Mud Pit IV at East Sha Chau. Report for the Civil Engineering Department.

(4) Jefferson, T. A. (ed.). 2005. Monitoring of Indo-Pacific humpback dolphins (*Sousa chinensis*) in Hong Kong waters – data analysis: final report. Unpublished report submitted to the Hong Kong Agriculture, Fisheries and Conservation Department.

Underwater sound: Construction of the terminal has the potential to result in a minor and short term increase in underwater sound from marine vessels, which may affect the Indo-Pacific Humpback Dolphin. Effects from pile driving are considered in a later section. Small cetaceans are acoustically sensitive at certain frequencies, and sound is important to their behavioural activities. Most dolphins can hear within the range of 1 to 150 kHz, though the peak for a variety of species is between 8 and 90 kHz [1]. Indo-Pacific Humpback dolphins have been reported to use five categories of vocalisation associated with different activities[2]. These animals use high frequency broad-band clicks in the range of 8 kHz to > 22 kHz during foraging. During both foraging and socialising, burst pulse sounds of barks and quacks in the frequency range of 0.6 kHz to >22 kHz are used. Low frequency narrow band grunt vocalisations in the range of 0.5 kHz to 2.6 kHz are also used during socialising activity. Dolphins also have whistle vocalisations in a wide frequency from 0.9 kHz to 22 kHz. Dredging and large vessel traffic generally results in low frequency noise, typically in the range of 0.02 to 1 kHz [3], which is below the peak range of 8 - 90 kHz reported for dolphins. For this reason, noise generated by dredging operations is not expected to acoustically interfere significantly with dolphins.

Water Quality Impacts

High SS levels do not appear to have a direct impact on dolphins. Indo-Pacific Humpback Dolphins have evolved to inhabit areas near river mouths and are therefore well-adapted for hunting in turbid waters owing to their use of echolocation rather than visual information. In addition, dolphins are air breathing and therefore SS in the water column has no effect on their respiratory surfaces. Impacts may occur to these mammals as an indirect result of increased SS levels. The construction of the terminal and dredging may cause perturbations to water quality which have the potential to impact the fisheries resources of the Northwestern Waters. The Indo-Pacific Humpback Dolphin is thought to be an opportunistic feeder with the most important prey species being demersal fish (such as croakers, Sciaenidae) as well as several pelagic groups (engraulids, clupeids and trichiurids). They are thus likely to be affected by any significant changes in key water quality parameters (such as SS and DO) arising from the development. A deterioration in water quality would cause these mobile fish to move out of the area thus interfering with the dolphin normal feeding patterns.

Information from the fisheries impact assessment (*Part 3 Section 10*) indicates that indirect impacts are not predicted to adversely impact fisheries resources as the SS elevation are localized to the works areas. The consequences of this are that impacts to marine mammals through loss of localised habitat access food supply (fisheries resources) are not predicted to occur. It is thus

(1) Richardson et al. 1995. Marine Mammals and Noise. Academic Press.

(2) Van Parijs SM & Corkeron PJ (2001) Vocalizations and behaviour of Pacific Humpback Dolphins *Sousa chinensis*. *Ethology* 107: 701-716.

(3) *Ibid.*

expected that unacceptable impacts to marine mammals arising from elevated SS levels will not occur. It should be noted that the the Indo-Pacific Humpback Dolphin, and their prey species are naturally exposed to high levels of suspended solids in the Pearl River Estuary (see *Part 3 Section 6* for a discussion of how SS levels fluctuate greatly in this part of Hong Kong) (1).

The basis for this assessment are water quality modelling predictions presented in *Part 3 – Section 6*. While contour plots of water quality parameters were used to determine the extent and severity of impacts close to the works areas, which is the most important information for determining impacts on marine mammal habitat, in addition reference was made to a variety of assessment points for various water sensitive receivers that are distributed at various points across marine mammal habitat including SR1, SR4, SR5a-b, SR6a-e and SR8 (see *Figure 6.4* in *Part 2 – Section 6*).

Other EIA Studies which have addressed impacts due to elevated SS have drawn similar conclusions. For instance, a previously approved EIA study for the Permanent Aviation Fuel Facility (PAFF) (EIA-077/2002) (2) stated that: "There is no reason to assume that suspended solid releases during pipeline construction will have an impact on dolphins." Similarly, construction of a blockwork jetty and dredging at Lung Kwu Chau inside Lung Kwu Chau and Sha Chau Marine Park have not significantly affected dolphin utilisation in this area. Dolphins were observed in proximity to major reclamation works at Penny's Bay (3).

Based on the assessment above and other experience of the effect of suspended sediment on marine mammals, elevations in SS associated with the reclamation works for the LNG terminal are not anticipated to adversely impact dolphins.

The above analysis is supported by experience with ongoing projects in Hong Kong. Contaminated mud disposal facilities have been in operation in the East of Sha Chau area for over ten years. Data available on the use of the waters do not appear to indicate that the operations of these facilities are resulting in avoidance behaviour by dolphins.

Contaminant Release

Another potential impact on marine mammals associated with disturbance of bottom sediment that require assessment in accordance with *Clause 3.7.5.5* of the Study Brief, is the potential bioaccumulation of released contaminants. The potential for release of contaminants from dredged sediments has been

(1) Data from EPD Water Quality Monitoring in 2003 at Station NM8 of the North Western Water Control Zone.

(2) Mouchel Asia Limited. 2002. EIA for Permanent Aviation Fuel Facility for Hong Kong International Airport, prepared for Hong Kong Airport Authority.

(3) Maunsell 2003. Environmental Monitoring and Audit for Penny's Bay Reclamation Stage 2. Report for the Civil Engineering Department.

assessed in *Part 3 Section 6*, whereas, a comprehensive set of data on the quality of marine sediment is provided in *Part 3 Section 7 – Waste Management.*

Within these sections it is concluded that some of the samples from the reclamation and dredging area contained levels of arsenic in excess of the Lower Chemical Exceedance Level (LCEL) but below the Upper Chemical Exceedance Level (UCEL), ie Category M. It is highly likely that the elevated levels of arsenic are derived from natural sources and are not present as a result of human activity.

In terms of the potential for impacts to occur to marine mammals, a recent EIA conducted on the continuation of the disposal of highly contaminated marine muds into dedicated mud pits in the East of Sha Chau area provides the best available information on bioaccumulation in marine mammals in Hong Kong [(1)]. The assessment, which was based on bio-concentration factors and metal concentrations in local fish and shellfish species, determined that the bioaccumulation potential from contaminant concentrations in marine water and sediments presented no unacceptable risk to marine mammals associated with consuming prey items in the vicinity of the contaminated mud pits as elevations in body burden levels were expected to be minor.

The aforementioned assessment was based on highly contaminated mud, ie Category H. As mentioned, extensive monitoring of sediment quality in the West Lantau area has been documented in *Part 3 Section 7 – Waste Management*. The suite of analytes has included a range of organic compounds specified in the relevant Technical Circular (ETWBTC No. 34/2002) and 12 chlorinated pesticides. All samples reported concentrations of these substances below the reporting limits.

Therefore, as unacceptable water quality impacts due to the potential release of heavy metals and micro-organic pollutants from the dredged sediment are not expected to occur, impacts on marine mammals due to bioaccumulation of released contaminants from dredged sediments are also not expected to occur.

Potential Impacts from Piling Works

Underwater sound: Marine piling works will be required to construct the jetty off the newly constructed reclamation area for the LNG terminal. Certain piling activities are known to generate high intensity underwater sound, which due to the potential presence of dolphins in the vicinity of works, requires assessment. Based on engineering conditions of the jetty site, it is proposed that the jetty would be constructed using large diameter bored piles with pre-bored H-piles. For the construction of the approximately 100 m long trestle which connects to the jetty, it is proposed that percussive piling would be used. No underwater blasting is required. Details on the differences between bored and percussive piling are presented below.

(1) ERM - Hong Kong, Ltd (2005) Op cit.

Bored piling: The pile installation of the main jetty will be carried out by bored piling works. This involves the sinking of a casing down to almost the rock head level with underwater excavation of the soil by grab and the top layer of rock using a reverse circulation drilling rig (RCD). Noise created by the bored piling method tends to be a less intensive continuous noise, rather than the pulsed high power sounds emitted through percussive piling and is expected to be similar to that associated with dredging.

Bored piling usually creates a steady sound that is less disruptive to dolphins than the pulsed or burst sounds associated with activity such as percussive piling (1). Dolphins are known to habituate to low-level sounds such as those produced through bored piling (2).

Percussive piling: The trestle foundations will consist of circular piles installed by the percussive method using piling barge with hydraulic hammer. As detailed in *Part 3 Section 3*, the equipment for percussive piling works used in Hong Kong is typically fitted with a bubble jacket for reducing underwater sound propagation. Although percussive piling will produce high-intensity underwater sound, the progress of piling works is quicker than bored piling. It is expected it would take approximately 4 months to complete the piling for the 100 m long trestle. Sound from percussive piling activities will be transmitted to the water via both structure-borne and air-borne sound pathways. Structure-borne vibrations from the percussive hammer will be re-radiated as sound into the water via the piles, the rock substrata and the piling rig to the barge. The air-borne sound pathway consists of sound propagation from the percussive hammer and the piles through the air and into the water. The sound transmitted to the water via the air-borne path is not expected to be significant as a large proportion of this sound will be reflected at the water and air interface and therefore not penetrate the water.

Dolphins, in general have acute hearing above 500Hz and have been found to communicate within the 400 to 800 Hz range (3). Activities such as percussive piling have their highest energy at lower frequencies from about 20Hz to 1kHz, and whilst smaller cetaceans (~ 3 - 4m in length) are not known to be highly sensitive to sounds below 1kHz they can hear in some of this range (peak range of 8 - 90 kHz reported for dolphins). Cetaceans are animals that rely on acoustic information to communicate and to explore their environment. Therefore, sound that disrupts communication or echolocation channels could have a potential impact. The reactions from impacted cetaceans can range from brief interruption of normal activities to short- or long-term displacement from noisy areas.

(1) Wursig B, Greene CR, Jefferson TA. 2000. Development of an air bubble curtain to reduce underwater noise of percussive piling. Marine Environmental Research 49, 79-93.

(2) Greene CR, Moore SE. 1995. Man-made noise. In: *Marine Mammals and Noise*. (Eds. Richardson WJ, Greene CR, Malme CI and Thomson DH). Academic Press. London, pp. 101-158.

(3) Mouchel Asia Limited. 2002. EIA for Permanent Aviation Fuel Facility for Hong Kong International Airport, prepared for Hong Kong Airport Authority.

As noted previously, in line with common local practice, the percussive piling equipment used in Hong Kong is typically fitted with bubble jacket or bubble curtains to reduce underwater sound. This feature of the percussive piling equipment is beneficial in reducing underwater sound propagation from the works site. Bubble curtains have been reported to be effective at reducing transmission of underwater sound generated during pile driving. A study (1) conducted during the construction of the Aviation Fuel Receiving Facility on Sha Chau reported sound level reduction by 3 to 5 dB in the overall broadband range. The largest sound attenuation was between 1.6 to 6.4 KHz where a reduction of 15 to 20 dB was recorded (2) .

The size of the disturbed area will be small in the context of the size of the range of these animals. With a bubble jacket/curtain in place to reduce the generation of high-intensity impulsive sounds, and taking account previous experience of reaction of marine mammals to marine works, underwater sound associated with the piling works is not expected to give rise to unacceptable adverse impacts. Any effect of underwater sound caused by piling works would be limited to behavioural disturbance impacts on affected dolphins, and there may be some avoidance of the waters in close proximity to the works. These impacts are not likely to cause biologically significant impacts on affected animals.

9.7.2 *Operation Phase*

Vessel Traffic

Tugs will be used to manoeuvre the LNG carrier to until moored along side the jetty. Owing to the slow approach speed and slow manoeuvring of the LNG carrier under tug control, it is not expected that there would be a significant risk of carrier/ tug collision (boat strike) with dolphins. Consequently, operational phase vessel traffic is not expected to cause unacceptable risk of impacts to this species.

9.8 *EVALUATION OF THE IMPACTS TO MARINE MAMMALS*

The following section discusses and evaluates the impacts to marine mammals identified in the previous section. Based upon the information presented above, the significance of the marine ecological impact associated with the construction and operation of the LNG terminal has been evaluated in accordance with the *EIAO-TM (Annex 8, Table 1)* as follows.

- *Habitat Quality*:

(1) Wursig B, Greene CR, Jefferson TA 200. *ibid.*

(2) Wursig B, Greene CR, Jefferson TA. 2000. *ibid.*

  - Reclamation Area: The reclamation works will affect approximately 16 ha of marine waters at Black Point where analysis of sightings data indicates medium densities of Indo-Pacific Humpback Dolphins may occur. These waters, which are marine mammal habitat of medium ecological importance, represent a small portion of extensive home ranges of affected animals. The marine waters at this location have been disturbed through reclamation in the past and are not considered to represent key habitat for dolphins. These waters are also disturbed by high volumes of vessel traffic.

  - Approach Channel and Turning Circle: The approach channel and turning circle are located off Black Point an area where Indo-Pacific Humpback Dolphins occur at medium density. Significant impacts due to the dredging works are not predicted to occur to these species, as water quality perturbations are predicted to be transient, localised and generally compliant with the WQO.

  - LNG Receiving Jetty: The jetty is located at Black Point in an area where medium density of Indo-Pacific Humpback Dolphins was found to occur.

  - Operational Phase Discharges: The outfall is located in an area where sightings of Indo-Pacific Humpback Dolphin are generally low.

- *Species:* Organisms of ecological interest reported from the literature and field surveys include the Indo-Pacific Humpback Dolphin. Significant impacts are not predicted to occur to this species due to the marine works as water quality perturbations are predicted to be transient and compliant with the WQO. Only indirect, temporary disturbance to marine mammals are expected during marine piling works, as construction methodologies have been designed to reduce underwater sound transmission. Operational phase discharges from the terminal or marine vessel movements are not expected to impact marine mammals present in the area of the LNG terminal.

- *Size:* The reclamation works will affect approximately 16 ha of marine waters where medium levels of Indo-Pacific Humpback Dolphin density have been recorded. The marine waters have been disturbed through reclamation in the past and are not considered to represent key habitat for dolphins. The loss of 16 ha of marine waters would be an unavoidable consequence of the proposed project since the reclamation engineering required for the LNG terminal has been reduced in size to the greatest extent practicable.

- *Duration:* The reclamation works are predicted to last for 7 - 8 months and the dredging for the turning basin and approach channel approximately 7 - 8 months. Increases in SS levels in the vicinity of sensitive receivers are expected to be low and temporary, and within environmentally acceptable limits. The duration for the percussive piling will last for 4 months. The underwater sound impact is unlikely to adversely affect dolphins. Operational phase discharges will continue during the life of the LNG terminal but are not predicted to cause adverse impacts to marine ecological resources as the discharges disperse rapidly and only affect an area close to the LNG jetty where low sightings of dolphins occur.

- *Reversibility:* The only permanent impacts at Black Point to dolphins are likely to be from the reclamation works which will affect approximately 16 ha of marine waters where Indo-pacific Humpback Dolphin have been recorded in medium densities.

- *Magnitude:* No unacceptable impacts to affected individual dolphins have been predicted to occur. Although the reclamation is 16 ha in size, it represents a small portion of available dolphin habitat. Also although analysis shows medium densities of dolphins occur off Black Point, this area would not be regarded as key dolphin habitat in particular due to considerable disturbance caused by heavy marine traffic. Operational phase impacts are not expected to cause significant adverse impacts and are considered to be of low magnitude.

The impact assessment presented above indicates that with appropriate mitigation and precautionary measures, no biologically significant impacts to individual marine mammals whose home ranges overlap with the proposed project area are expected to occur. Nevertheless, the 16 ha reclamation will cause permanent and irreversible loss of marine mammal habitat of medium ecological importance.

Impacts to marine mammals during operation of the terminal are predicted to be within environmentally acceptable levels through appropriate design of the seawater outfall (as discussed in *Part 3 Section 6 - Water Quality*).

9.9 SUMMARY OF MITIGATION MEASURES

9.9.1 General

In accordance with the guidelines in the *EIAO-TM* on marine ecology impact assessment, the general policy for mitigating impacts to marine ecological resources, in order of priority, are:

- **Avoidance:** Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives;

- **Minimisation:** Unavoidable impacts should be minimised by taking appropriate and practicable measures such as constraints on the intensity of works operations (eg dredging rates) or timing of works operations; and

- **Compensation:** The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures should always be considered whenever possible.

To summarise, this initial assessment of impacts demonstrates that impacts have largely been *avoided* during the construction and operation of the Black Point terminal, particularly to the key ecological sensitive receivers (marine mammals), through the following measures:

- **Avoid Direct Impacts to Ecologically Sensitive Habitats:** The site for the Black Point has been selected based on a review of alternative locations (*Part 1, Section 5*) and avoided the key habitats for Indo-Pacific Humpback Dolphin (including Sha Chau and Lung Kwu Chau Marine Park, Peaked Hill Island, West Lantau) and areas of high marine mammal sighting density. The location of the LNG terminal at Black Point has a medium sighting density of marine mammals.

- **Avoid Indirect Impacts to Ecologically Sensitive Habitats:** The site for the Black Point has been selected so dispersion of sediment from dredging and sand filling does not affect the receivers at levels of concern.

- **Adoption of Acceptable Working Rates**: The modelling work has demonstrated that the selected working rates for the dredging will not cause unacceptable impacts to the receiving water quality. Consequently, unacceptable indirect impacts to marine ecological resources have been avoided.

9.9.2 General Measures for Marine Ecological Resources

The following measures to mitigate the impact of the construction and operation of the on marine ecological resources are recommended:

- The vessel operators will be required to control and manage all effluent from vessels;

- A policy of no dumping of rubbish, food, oil, or chemicals will be strictly enforced. This will also be covered in the contractor briefings; and

- The effects of construction of the Project on the water quality of the area will be reduced as described in the *Water Quality* section (*Part 3 Section 6*).

9.9.3 Specific Measures for Marine Mammals

Measures to mitigate the impact of the construction and operation of the terminal have been developed in consultation with an internationally recognised marine mammal expert. The following recommendations may be considered to reduce potential construction and operation impacts on dolphins.

- All vessel operators working on the Project construction or operation will be given a briefing, alerting them to the possible presence of dolphins in the area, and the guidelines for safe vessel operation in the presence of cetaceans. If high speed vessels are used, they will be required to slow to 10 knots when passing through a high density dolphin area (west Lantau, Sha Chau and Lung Kwu Chau) With implementation of this measure, the chance of boat strike resulting in physical injury or mortality of marine mammals will be extremely unlikely. Similarly, by observing the guidelines, vessels will be operated in an appropriate manner so that marine mammals will not be subjected to undue disturbance or harassed;

- The vessel operators will be required to use predefined and regular routes, as these will become known to dolphins using these waters This measure will further serve to minimise disturbance to marine mammals due to vessel movements;

Periodic re-assessment of mitigation measures for marine mammals and their effectiveness will be undertaken.

9.10 *ADDITIONAL (PRECAUTIONARY) MEASURES FOR MARINE MAMMALS*

In accordance with the requirements of Clause 3.7.5.5 (vii) of the Study Brief, precautionary measures have been identified to assist the protection of marine mammals. During piling works for the jetty construction, the following additional measures will be adopted:

- To reduce underwater sound levels associated with percussive piling, the following steps will be taken:
    - Quieter hydraulic hammers should be used instead of the noisier diesel hammers;
    - Acoustic decoupling of noisy equipment on work barges should be undertaken.

- Additional practices are recommended during percussive piling including:
    - Instigate 'ramping-up' of the piling hammer to gradually increase the level of underwater sound generation;
    - Activities will be continuous without short-breaks and avoiding sudden random loud sound emissions.

- An exclusion zone of 500 m radius will be scanned around the work area for at least 30 minutes prior to the start of piling from the barge or an elevated observation point on land. If cetaceans are observed in the exclusion zone, piling will be delayed until they have left the area. This measure will ensure the area in the vicinity of the piling is clear of marine mammals prior to the commencement of works and will serve to reduce any disturbance to marine mammals;

- When dolphins are spotted by qualified personnel within the exclusion zone, construction works will cease and will not resume until the observer confirms that the zone has been continuously clear of dolphins/ porpoises for a period of 30 minutes. This measure will ensure the area in the vicinity of the piling is clear of marine mammals during works and will serve to reduce any disturbance to marine mammals;

- Consistent with standard Hong Kong practice, the percussive pile driving will be conducted during the day time for a maximum of 12 hours, avoiding generation of underwater sounds at night time.

- Percussive pile driving will not be conducted during the peak calving season of the Indo-Pacific Humpback dolphin, ie March through August.

After discussion with project stakeholders including the Government of the Hong Kong SAR on potential additional construction restrictions, during the dredging works for the project, the following additional measures will be adopted:

- A marine mammal exclusion zone within a radius of 250 m from dredgers will be implemented during the construction phase. Qualified observer(s) will scan an exclusion zone of 250 m radius around the work area for at least 30 minutes prior to the start of dredging. If cetaceans are observed in the exclusion zone, dredging will be delayed until they have left the area. This measure will ensure the area in the vicinity of the dredging work is clear of marine mammals prior to the commencement of works and will serve to reduce any disturbance to marine mammals. As per previous practice in Hong Kong, should cetaceans move into the dredging area during dredging, it is considered that cetaceans will have acclimatised themselves to the works therefore cessation of dredging is not required (1).

- Dredging for the Approach Channel and Turning Circle will be scheduled so it does not occur during the peak calving period for the Indo-Pacific Humpback dolphin at Black Point (March through August).

9.11 *RESIDUAL ENVIRONMENTAL IMPACTS*

Taking into consideration the ecological value of the habitats discussed in the previous sections and the resultant mitigation and precautionary measures, residual impacts occurring as a result of the proposed terminal have been determined and are as follows.

- The loss of approximately 600 m of natural rocky shore and approximately 120 m of artificial shoreline which are of low ecological

(1) This precautionary measure is consistent with conditions for grab dredging works inside the Sha Chau and Lung Kwu Chau Marine Park included in the issued Environmental Permit for the Permanent Aviation Fuel Facility for Hong Kong International Airport project.

value. The residual impact is considered to be acceptable, as the loss of these habitats will be compensated by the provision of approximately 1.1 km of sloping rubble mound/rock or concrete armour seawalls that have been demonstrated to become recolonised by assemblages of a similar nature after construction;

- The loss of approximately 600 m of subtidal hard surface habitats which are of low ecological value. The residual impact is considered to be acceptable as the loss of these habitats is compensated by the provision of seawalls (providing approximately 1.1 km of habitat) that have been demonstrated to become recolonised by assemblages of a similar nature after construction; and

- The loss of approximately 16 ha of subtidal soft bottom assemblages within the reclamation sites. The residual impact is considered to be acceptable as the habitat is of low ecological concern and relatively small in size in the context of surrounding similar habitat.

- The loss of approximately 16 ha of marine waters within the reclamation sites. Although the habitat loss would be an inevitable and adverse consequence of the project, the residual impact is assessed to be acceptable after taking into consideration a number of factors. The loss of marine mammal habitat is small in the context of the size of habitat available to dolphins. Taking account of the sizable home ranges and mobility of affected animals, it is expected that the loss would not give rise to biologically significant adverse impacts on individual dolphins or the dolphin population as a whole. Even though medium densities of dolphins may occur in these waters, the habitat which would be lost would not be considered key marine mammal habitat in particular due to considerable disturbance by heavy marine traffic.

- Maintenance dredging of small specific areas of the approach channel and turning is expected to be required once every 4 - 5 years. Since impact to water quality is expected to be compliant with current WQO standards (refer to *Part 3 Section 6.7.2*), the residual impact associated with maintenance dredging is considered to be acceptable.

9.12 *CUMULATIVE IMPACTS*

The cumulative impacts of the various project specific construction activities have been demonstrated in *Part 3 Section 6 – Water Quality* as not causing unacceptable impacts to water quality. Consequently, unacceptable cumulative impacts to marine ecological resources are not predicted to occur. No operational phase cumulative impacts are predicted as there are no ongoing projects in the immediate vicinity of Black Point.

Since there is no publicly available information on the Hong Kong Macau Zhuhai bridge project, an assessment of cumulative impacts related to this project cannot be currently undertaken.

9.13 ENVIRONMENTAL MONITORING AND AUDIT

The following presents a summary of the Environmental Monitoring and Audit (EM&A) measures focussed on ecology during the construction and operation phases of the LNG terminal at Black Point. Full details are presented in the separate EM&A Manual.

9.13.1 *Construction Phase*

During the construction phase, the following EM&A measures will be undertaken to verify the predictions in the EIA and ensure the environmental acceptability of the construction works:

- Water quality impacts will be monitored and checked through the implementation of a Water Quality EM&A programme (refer to *Part 3 Section 6* for details). The monitoring and control of water quality impacts will also serve to avoid unacceptable impacts to marine ecological resources.

- An exclusion zone will also be monitored for the presence of marine mammals in waters surrounding any marine percussive piling works during construction of the LNG jetty as described in *Part 3 Section 9.10*. Through implementation of the recommended EM&A measures, unacceptable impacts on marine mammals will be avoided.

Details of the marine mammal exclusion zone monitoring components are presented in full in the EM&A Manual.

9.13.2 *Operation Phase*

The assessment presented above as indicated that operational phase impacts are not expected to occur to marine ecological resources. The maintenance dredging of the approach channel and turning circle is expected to take place once every 4 – 5 years. This dredging would result in minor direct impacts due to temporary loss of small areas of low ecological value subtidal soft bottom habitat. Indirect impacts associated with water quality impacts due to maintenance dredging are not expected to be small scale and localised to the works area and would cause exceedance of current Water Quality Objective standards (refer to *Part 3 Section 6.7.2* for details). As a consequence, impacts on marine ecology are not expected.

No marine ecology specific operational phase monitoring is considered necessary.

9.14 CONCLUSIONS

The proposed Black Point terminal was studied in detail through a site selection study in order to select a preferred site that avoided to the extent practical, adverse impacts to habitats or species of high ecological value. The marine ecological sensitive receivers include Sha Chau and Lung Kwu Chau Marine Park and the Indo-Pacific Humpback Dolphin (*Sousa chinensis*).

Potential construction phase impacts to marine ecological resources, as well as impacts to marine mammals, may arise from the permanent loss of habitat due to reclamation, disturbances to benthic habitats in the turning basin and approach channel, or through changes to key water quality parameters, as a result of the dredging and reclamation. As impacts arising from the proposed dredging works are predicted to be largely confined to the specific works areas and the predicted elevations of suspended sediment due to the Project are not predicted to cause large exceedances of the WQO, adverse impacts to water quality, and hence marine ecological resources or marine mammals, are not anticipated.

Although the loss of 16 ha of marine mammal habitat would be an inevitable and adverse consequence of the project, the residual impact is assessed to be acceptable after taking into consideration a number of factors. The loss of marine mammal habitat is small in the context of the size of habitat available to dolphins. Taking account of the sizable home ranges and mobility of affected animals, it is expected that the loss would not give rise to biologically significant adverse impacts on individual dolphins or the dolphin population as a whole. Even though medium densities of dolphins may occur in these waters, the habitat which would be lost would not be considered key marine mammal habitat in particular due to considerable disturbance by heavy marine traffic.

Operational phase adverse impacts to marine ecological resources are not expected to occur. Unacceptable impacts from discharges of cooled water and antifoulants are not anticipated to occur as the effects from these discharges will be localised to the direct vicinity of the outfall.

Construction methods and specific mitigation measures that will be adopted include the provision of rubble mound/armour rock seawalls on the edges of the reclamations to facilitate colonisation by intertidal and subtidal organisms. Measures designed to reduce impacts to the population of marine mammals that use the area include restrictions on vessel speed. The mitigation measures designed to mitigate impacts to water quality to acceptable levels (compliance with WQOs) are also expected to mitigate impacts to marine ecological resources.

Additional (precautionary) measures have been identified for marine works taking place in areas where marine mammals are sighted and these include monitored exclusion zones during marine percussive piling work for the construction of the jetty. In line with common local practice in Hong Kong, percussive piling works in the marine environment will be conducted inside bubble jackets, so as to ameliorate underwater sound level transmission.

Annex 9

Baseline Marine Ecological Resources

CONTENTS

ANNEX

9 BASELINE MARINE ECOLOGICAL RESOURCES

9.1 INTRODUCTION

This Annex presents the findings of ecological studies of Black Point and the surrounding Study Area. Marine ecological habitats and resources have been identified and the ecological value of the Study Area evaluated. The assessment has been based on a review of the currently available literature, as well as detailed field surveys to provide the most up-to-date information on existing conditions. Rationales for the surveys are presented, followed by the methodologies employed, results obtained and a discussion of the results and comparison with other similar studies. The findings of this report will form the basis of establishing the ecological importance of Black Point.

9.1.1 Ecological Study Area

The Study Area for the ecological assessment is 500m from the boundary of the proposed LNG terminal at Black Point. The Black Point LNG terminal is proposed to be located on the north face of the Black Point headland, as presented in *Figure 9.1*. Due to the steep slopes on the existing headland, some reclamation will be required to provide sufficient land for development. The jetty for the LNG carrier extends northwest, perpendicular to the coastline. To allow navigation for the LNG carrier, an approach channel and turning circle is required.

The Study Area for the terrestrial ecology baseline has included the footprint of the proposed LNG terminal at Black Point and the surrounding land-based habitats (500m from the Project Area). The Study Area for the marine ecology baseline has incorporated the proposed approach channel and turning circle as well as the reclamation area.

9.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

9.2.1 Introduction

This section summarizes all legislative requirements and evaluation criteria for the protection of species and habitats of marine ecological importance.

9.2.2 Legislative Requirements and Evaluation Criteria

Legislative requirements and evaluation criteria relevant to the study are as follows:

1. *Marine Parks Ordinance (Cap 476);*
2. *Wild Animals Protection Ordinance (Cap 170);*
3. *Protection of Endangered Species of Animals and Plants Ordinance (Cap 586);*
4. *Town Planning Ordinance (Cap 131);*

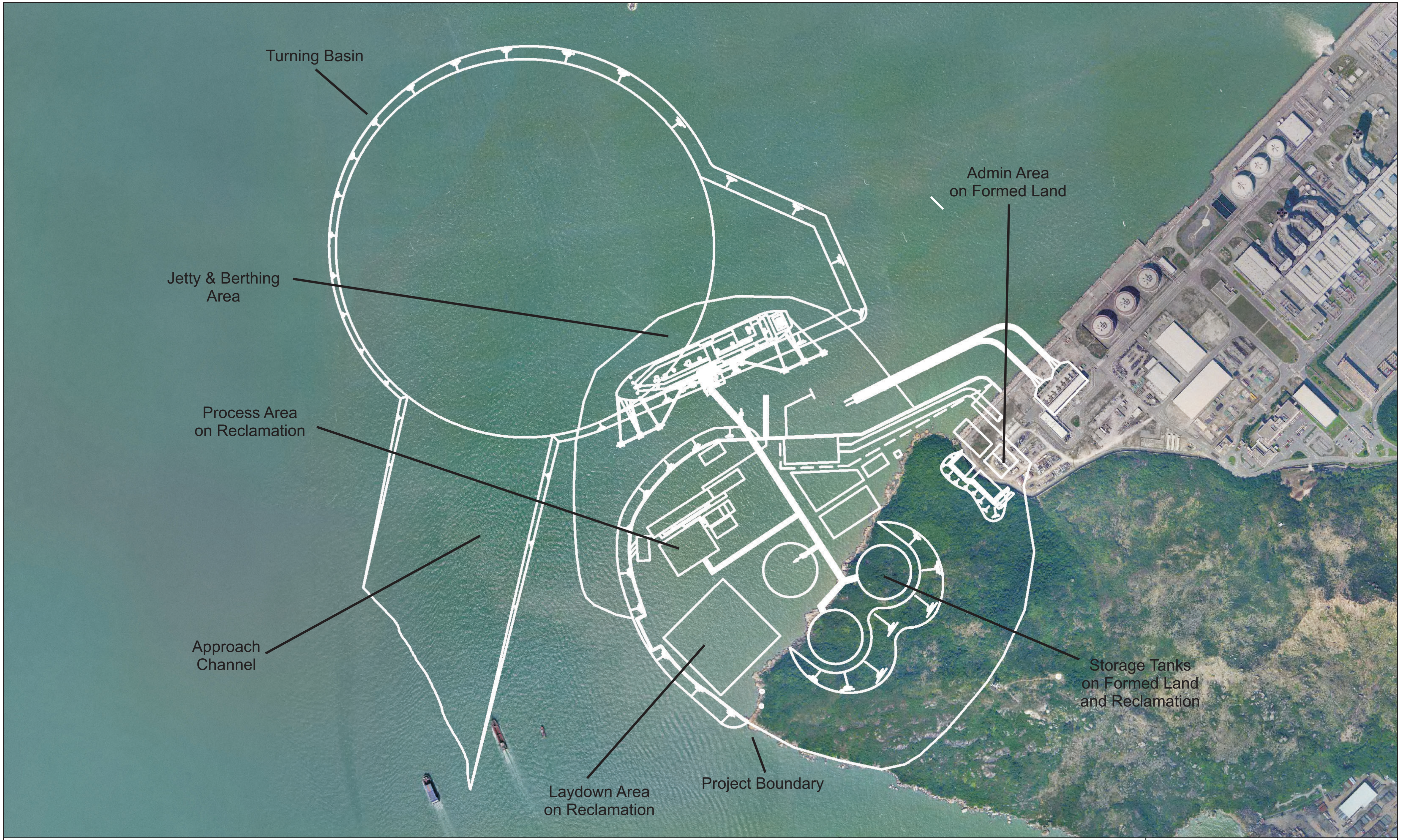

Figure 9.1

Layout for the Proposed Black Point LNG Terminal
(Aerial photograph source: Lands Department)

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5. *Hong Kong Planning Standards and Guidelines Chapter 10 (HKPSG);*
6. *The Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAOTM);*
7. *United Nations Convention on Biodiversity (1992);*
8. *Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramseur Convention);*
9. *PRC Regulations and Guidelines; and,*
10. *City University of Hong Kong (2001). Agreement No. CE 62/98, Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment, AFCD, Final Report July 2001.*

9.2.3 *Marine Parks Ordinance (Cap 476)*

The Marine Parks Ordinance (Cap 476) provides for the designation, control and management of marine parks and marine reserves. It also stipulates the Director of Agriculture and Fisheries as the Country and Marine Parks Authority which is advised by the Country and Marine Parks Board. The Marine Parks and Marine Reserves Regulation was enacted in July 1996 to provide for the prohibition and control certain activities in marine parks or marine reserves.

9.2.4 *Wild Animals Protection Ordinance (Cap 170)*

Under the *Wild Animals Protection Ordinance* (Cap 170), designated wild animals are protected from being hunted, whilst their nests and eggs are protected from destruction and removal. All birds and most mammals including all cetaceans are protected under this Ordinance, as well as certain reptiles (including all sea turtles), amphibians and invertebrates. The Second Schedule of the Ordinance that lists all the animals protected was last revised in June 1997.

9.2.5 *Protection of Endangered Species of Animals and Plants Ordinance (Cap 586)*

The *Protection of Endangered Species of Animals and Plants Ordinance* (Cap 586) was enacted to align Hong Kong's control regime with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). With effect from 1 July 2006, it replaces the *Animals and Plants (Protection of Endangered Species) Ordinance* (Cap 187). The purpose of the *Protection of Endangered Species of Animals and Plants Ordinance* is to restrict the import and export of species listed in CITES Appendices so as to protect wildlife from overexploitation or extinction. The Ordinance is primarily related to controlling trade in threatened and endangered species and restricting the local possession of them. Certain types of corals are CITES listed, including Blue coral (*Heliopora coerulea*), Organ pipe corals (family Tubiporidae), Black corals (order Antipatharia), Stony coral (order Scleractinia), Fire corals (family Milleporidae) and Lace corals (family Stylasteridae). The import, export and possession of listed species, no matter dead or living, is restricted.

9.2.6 *Town Planning Ordinance (Cap 131)*

The recently amended *Town Planning Ordinance* (Cap 131) provides for the designation of areas such as "Coastal Protection Areas", "Sites of Special Scientific Interest (SSSIs)", "Green Belt" and "Conservation Area" to promote conservation or protection or protect significant habitat.

9.2.7 *Hong Kong Planning Standards and Guidelines Chapter 10*

Chapter 10 of the *HKPSG* covers planning considerations relevant to conservation. This chapter details the principles of conservation, the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities. It also addresses the issue of enforcement. The appendices list the legislation and administrative controls for conservation, other conservation related measures in Hong Kong, and Government departments involved in conservation.

9.2.8 *Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance*

Annex 16 of the *EIAOTM* sets out the general approach and methodology for assessment of ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. *Annex 8* recommends the criteria that can be used for evaluating ecological impacts.

9.2.9 *Other Relevant Legislation*

The Peoples' Republic of China (PRC) is a Contracting Party to the *United Nations Convention on Biological Diversity* of 1992. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. The Government of the Hong Kong Special Administrative Region has stated that it will be "committed to meeting the environmental objectives" of the Convention (1).

The *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (the Ramseur Convention) applies in the HKSAR. The Convention requires parties to conserve and make wise use of wetland areas, particularly those supporting waterfowl populations. Article 1 of the Convention defines wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters." The Mai Po/Inner Deep Bay wetland was declared a Wetland of International Importance ("Ramseur site") under the Convention in 1995.

(1) Planning Environment and Lands Bureaux 1996. Environmental Policy Commitments.

The PRC in 1988 ratified the *Wild Animal Protection Law* of the PRC, which lays down basic principles for protecting wild animals. The Law prohibits killing of protected animals, controls hunting, and protects the habitats of wild animals, both protected and non-protected. The Law also provides for the creation of lists of animals protected at the state level, under Class I and Class II. There are 96 animal species in Class I and 156 in Class II. Class I provides a higher level of protection for animals considered to be more threatened.

9.3 MARINE ECOLOGICAL RESOURCES

9.3.1 *Introduction*

This section of the report describes the baseline conditions of the marine ecological resources at Black Point and the Study Area. Baseline conditions have been assessed based on a review of the findings of relevant studies and the collation of available information regarding the marine ecological resources of this part of Hong Kong.

Based on this review, an evaluation of the information collected was conducted to identify any gaps that need to be filled in order to conduct an assessment of ecological importance of the marine habitats. Where information gaps were identified, or where certain habitats or species were considered to warrant further attention, field surveys have been conducted.

9.3.2 *Site History*

The site for the proposed LNG terminal at Black Point is in close proximity to the existing Black Point Power Station near the northern reaches of the Urmston Road and at outer Deep Bay. Black Point is located in the northwestern waters of the Hong Kong Special Administrative Region (SAR). The surrounding waters are relatively shallow, often less than –5mPD.

9.3.3 *Literature Review*

Based on the literature review the following habitats and/or organisms of ecological interest have been identified at Black Point:

- Hard Bottom Habitats; and
  - *Intertidal Hard Bottom Habitats*
  - *Subtidal Hard Bottom Habitats*
- Soft Bottom Habitats;
  - *Subtidal Soft Bottom Habitats*
    - <u>Epifaunal Assemblages</u>
    - <u>Infaunal Assemblages</u>
- Marine Mammals.

The existing conditions of each of the above habitats/organisms based on available literature are presented in the following sections.

9.3.4 Hard Bottom Habitats

Approximately 80% of Hong Kong's complex shorelines and many islands are composed of rocky outcrops. Shores in Hong Kong display characteristic zonation patterns, with a progression of different species along the vertical gradient from terrestrial to marine environments. For the purposes of this review, information will be presented on assemblages that occur along the full gradient from the essentially marine, subtidal area, to the semi-terrestrial, intertidal area.

Intertidal Hard Bottom Habitats

No recent studies have been conducted on the shoreline at Black Point, a study in the early 1990's to the south of the headland indicated that the intertidal hard bottom communities contained species that were typical of semi-exposed shores in Hong Kong (1).

Prior to the construction of the Black Point Power Station, shoreline surveys were conducted along the Black Point headland. The results recorded that the rocky shoreline did not possess a diverse intertidal community nor habitats of significance in comparison to those found in southern and eastern Hong Kong (2).

A more recent study reported that the majority of intertidal species recorded in the northern part of Lung Kwu Tan Bay were common in Hong Kong and of generally low abundance and diversity (3). No species of conservation value were recorded.

Subtidal Hard Bottom Habitats

Coral reefs support a range of species providing shelter, feeding, spawning and nursery areas, resulting in the large and diverse community for which they are renowned. The coral reef system has been shown to be sensitive to pollution and impacts from development can cause the ecosystem to collapse, resulting in widespread mortality of coral and the numerous associated organisms. Natural fluctuations in water quality can also regulate coral communities.

(1) ERL Asia Ltd. 1992. Environmental Impact Assessment of the Proposed 6000MW Thermal Power Station at Black Point: Initial Assessment Report Volume 1 The Surrounding Environment, prepared for China Light and Power Company Limited.

(2) ERL Asia Ltd. 1992. *op. cit.*

(3) ERM - HK Ltd. 2000. Sludge Treatment and Disposal Strategy: Site Specific Feasibility Study of Sludge Management Strategy (SMS) and Sludge Disposal Plan (SDS). Final Report for the Environmental Protection Department.

The Agriculture, Fisheries and Conservation Department report that there are over 80 species of corals recorded in Hong Kong waters (1). It appears that coral distribution in Hong Kong is primarily controlled by hydrodynamic conditions as Hong Kong's western waters are influenced by the Pearl River Estuary, which lowers salinities. The greatest diversity and abundances of corals are generally found in the northeastern waters of Hong Kong due to the optimal environmental conditions for settlement, growth and survival found in these waters. The western and southern waters of Hong Kong are influenced by the Pearl River Estuary, greatly reducing salinities, increasing turbidity and therefore reducing light penetration. Ahermatypic octocorals, including soft and black corals, which unlike the hermatypic hard corals do not require light for zooxanthellae photosynthesis, are more widely distributed and often occur at greater depths.

As part of a study for the EIA of the Aviation Fuel Receiving Facility at Sha Chau, dive surveys were undertaken at Sha Chau in order to investigate the hard bottom communities (2). The surveys found that only a few hermatypic hard corals (Family Faviidae) were recorded within the subtidal of the survey area.

Although these surveys were conducted at some distance from Black Point, the results of these surveys are deemed applicable due to similar environmental conditions. As such, coral communities of ecological value are not predicted to occur within the Study Area. Whilst it is possible that solitary gorgonians and sea pens may be present within the subtidal areas, large or important communities of hermatypic hard corals are not expected due to the unfavourable conditions imposed by the water quality.

9.3.5 *Soft Bottom Habitats*

Subtidal Soft Bottom Habitats

<u>Epifaunal Assemblages</u>

Subtidal soft bottom habitats, as well as supporting infaunal species, commonly support macro-benthic epifauna. These organisms are generally greater than 1mm in size and live either on or within the surface sediments.

A review of 10 years of data on fisheries resources collected from demersal trawls conducted as part of the ongoing marine monitoring of contaminated mud disposal at the East of Sha Chau Contaminated Mud Pits provides data on epifaunal assemblages in the vicinity of the Lung Kwu Chau and Sha Chau Marine Park (3). As these areas are in relatively close proximity to Black

(1) AFCD. 2004. Ecological Status and Revised Species Records of Hong Kong's Scleractinian Corals, undertaken by Marine Conservation Division.
(2) ERM – HK Ltd. 1995. Environmental Impact Assessment of the Proposed Aviation Fuel Receiving Facility at Sha Chau, prepared for the Provisional Airport Authority.

(3) ERM - HK Ltd. 2004. Environmental Monitoring and Audit Manual of the Permanent Aviation Fuel Facility for Hong Kong International Airport, prepared for Hong Kong Airport Authority.

Point, these data can be considered to be representative of the epifaunal assemblages in this area.

These data indicate that epifaunal assemblages are dominated by gastropods (eg *Turritella terebra*), crabs and mantis shrimps. Abundance and species composition was considered to be relatively low in comparison to other areas in Hong Kong. No species that were considered to be rare in Hong Kong were found.

Based on the above, the epifaunal assemblages in the proposed Study Area are considered to be of low abundance, diversity and biomass in comparison to other areas of Hong Kong and have, thus, not been identified of conservation interest.

Infaunal Assemblages

Soft sediments consisting of silt, clay and sand dominate the seabed of Hong Kong. These soft bottom habitats support infaunal assemblages that act as a food source for Hong Kong's inshore commercial fisheries resources. Due to the general dominance of these habitats in Hong Kong's subtidal marine environment, extensive studies have been conducted on infaunal assemblages throughout Hong Kong. However, the majority of these studies have focussed on providing a "snapshot" of infaunal assemblages either within or in close proximity to a proposed area for development, or as part of a specific monitoring programme. In order to provide an indication of the potential ecological value of the infaunal assemblages at the LNG terminal location, it is considered useful to review studies that have investigated infaunal assemblages in Hong Kong on a wide scale. Where considered useful, studies of infaunal assemblages at specific locations have also been included in the review.

Both the waters around the proposed terminal site were surveyed as part of a Hong Kong wide study conducted in 1976, however, the findings of this study are considered to be no longer applicable due to the extensive development in both Hong Kong and the Pearl River Estuary that has since occurred. This is supported by the findings of a recent, second, Hong Kong wide study on infaunal assemblages undertaken in 2001 (1).

The most up-to-date study on the soft bottom assemblages has revealed that the benthic communities in Hong Kong can be divided into the following broad types: a relatively similar benthic community covering the majority of Hong Kong waters; an impoverished community in the northeastern waters; a coarser sediment benthic group in Victoria Harbour; and a distinct benthic group in Deep Bay (2). Deep Bay, where the proposed terminal site situated, has its own distinct infaunal assemblages group resulting from the influence

(1) City U Professional Services Ltd. 2002. Consultancy Study on Marine Benthic Communities in Hong Kong: Final Report, prepared for Agriculture, Fisheries and Conservation Department.

(2) City U Professional Services Ltd. 2002. Consultancy Study on Marine Benthic Communities in Hong Kong: Final Report, prepared for Agriculture, Fisheries and Conservation Department.

of freshwater discharges from the Pearl River Estuary and the Shenzhen River. These conditions lead to seasonal changes in the assemblages between the summer and winter months.

A comparison of the results of the 1976 study and the 2001 study found that changes in benthic communities, particularly species composition had occurred. This was reported as being primarily a result of a wider distribution and increase in abundance of pollution tolerant species such as *Prionospio* spp and *Mediomastus* spp. The benthic biota consisted mainly of soft, muddy bottom species, but the diversity was less than those reported in South Lantau, Lamma and waters to the east of Hong Kong.

In addition to the above, a recent study in the Tuen Mun area found that the benthic infauna near Lung Kwu Tan, in the vicinity of Black Point has a generally mid-range total biomass and relatively high total number of individuals in comparison to other areas of Hong Kong (1). The fauna was found to be primarily polychaetes, which is typical for Hong Kong. The species richness was high compared to other sites surveyed using the same techniques. Overall the site was found to exhibit the same characteristics and ecological structure as other areas in the north Lantau and NWNT areas.

9.3.6 *Marine Mammals*

A total of 16 (and possibly up to 18) species of marine mammals, or cetaceans, have been recorded in Hong Kong waters (2). The Indo-Pacific Humpback Dolphin, *Sousa chinensis,* and the Finless Porpoise, *Neophocaena phocaenoides,* are the only two species of marine mammals regularly sighted in Hong Kong waters (3) (4).

Studies on the distribution, abundance, habitat use, and life history of humpback dolphins within Hong Kong have been undertaken since 1995 (5) (6) (7). The results of these ongoing studies indicated in 2004 that approximately 1,300 individual dolphins are estimated to utilise the waters of the Pearl River Estuary. Of these individual dolphins, approximately 360 are thought to include waters within Hong Kong as part of their range.

(1) ERM - HK Ltd. 2000. Sludge Treatment and Disposal Strategy: Site Specific Feasibility Study of Sludge Management Strategy (SMS) and Sludge Disposal Plan (SDS). Final Report for the Environmental Protection Department.

(2) Jefferson, pers comm.

(3) Parsons C, Mary L. Felly and Lindsay J. Porter. 1995. An Annotated Checklist of Cetaceans recorded from Hong Kong's Terrestrial Waters. The Swire Institute of Marine Science, The University of Hong Kong, Cape d' Aguilar, Shek O, Hong Kong.

(4) Jefferson T.A. 2000. Conservation Biology of the Finless Porpoise (*Neophocaena phocaenoides*) in Hong Kong waters: Final Report. Ocean Park Conservation Foundation Ocean Park Aberdeen, Hong Kong.

(5) Jefferson T.A. 2000. Population Biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs 144*:1-65.

(6) Jefferson T.A., S.K. Hung, L. Law, M. Torey and N. Tregenza.2002. Distribution and Abundance of Finless Porpoise in Hong Kong and Adjacent Waters of China. *The Raffles Bulletin of Zoology 2002 Supplement No. 10*: 43-55.

(7) Jefferson T.A. and S.K. Hung. 2004. A review of the status of the Indo-Pacific humpback dolphin in Chinese waters. *Aquatic Mammals (Special Issue) 30*: 149-158.

Historically, marine mammal data have been presented in terms of sightings [(1)]. Recent analysis adopted in the marine mammals monitoring study [(2)] has allowed data to be standardised to reflect numbers of sightings in terms of survey effort. Such data are considered to be closer to a direct indication of abundance and habitat usage than raw observational data. In order to utilise the most up-to-date data, yet still allow comparison with previous studies to be made, both types of data will be discussed.

Abundance of humpback dolphins in Hong Kong waters is highest in the north and west Lantau areas (*Figures 9.2 & 9.3*). North Lantau and West Lantau are considered to be the major habitats for humpback dolphins in Hong Kong waters where individuals of humpback dolphins have been consistently sighted throughout the year.

Humpback dolphins exhibit a seasonal shifting in abundance and density and thus a seasonal variation of abundance in different locations. The variation is thought to be due to the increased input of freshwater from the discharge of the Pearl River Estuary and the subsequent movements of estuarine prey species [(3)] [(4)] [(5)] .

Recently published information indicates that the abundance of dolphins in Hong Kong ranges from 78 in spring to 217 in winter [(6)]. Present estimates for the Pearl River Estuary population range from 731 in summer to 1,504 in winter [(7)]. Data on the utilisation of the waters around the proposed LNG terminal at Black Point have been reported [(8)] [(9)]. From October 1995 to November 2004, there were 29 sightings of humpback dolphins (20 from vessels and 9 from a helicopter) in Deep Bay [(10)]. Deep Bay is found to be used by a small number of humpback dolphins (3-6) throughout the year. Dolphins were found almost exclusively in the southern portion of Deep Bay, mostly near Black Point. Average group size for humpback dolphins near Black Point was 2.9 ± 2.06 (range = 1-8, n = 29), which contained a smaller average group size than other areas in Hong Kong [(11)]. Composition of humpback dolphin groups in Deep Bay, particularly near Black Point appeared to contain a higher proportion of calves and juveniles (SAs and

(1) AFCD. 2004. Monitoring of Chinese White Dolphins (*Sousa chinensis*) in Hong Kong waters – Data collection, Final Report (1 April 2003 to 31 March 2004), prepared by Hong Kong Cetacean Research Project

(2) AFCD. 2004. *op. cit.*

(3) Jefferson T.A. 2000. Population Biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs 144*:1-65.

(4) Jefferson T.A. and S.K. Hung. 2004. A review of the status of the Indo-Pacific humpback dolphin in Chinese waters. *Aquatic Mammals (Special Issue) 30*: 149-158.

(5) Barros, N.B., T.A. Jefferson, and E.C.M. Parsons. 2004. Feeding habits of Indo-Pacific humpback dolphins (Sousa chinensis) stranded in Hong Kong. *Aquatic Mammals (Special Issue) 30*: 179-188.

(6) Jefferson T.A. and S.K. Hung. 2004. A review of the status of the Indo-Pacific humpback dolphin in Chinese waters. *Aquatic Mammals* (Special Issue) 30: 149-158.

(7) AFCD. 2004. *ibid.*

(8) Jefferson, pers. comm.

(9) AFCD. 2004. *ibid.*

(10) Jefferson, pers. comm.

(11) Jefferson, pers. comm.

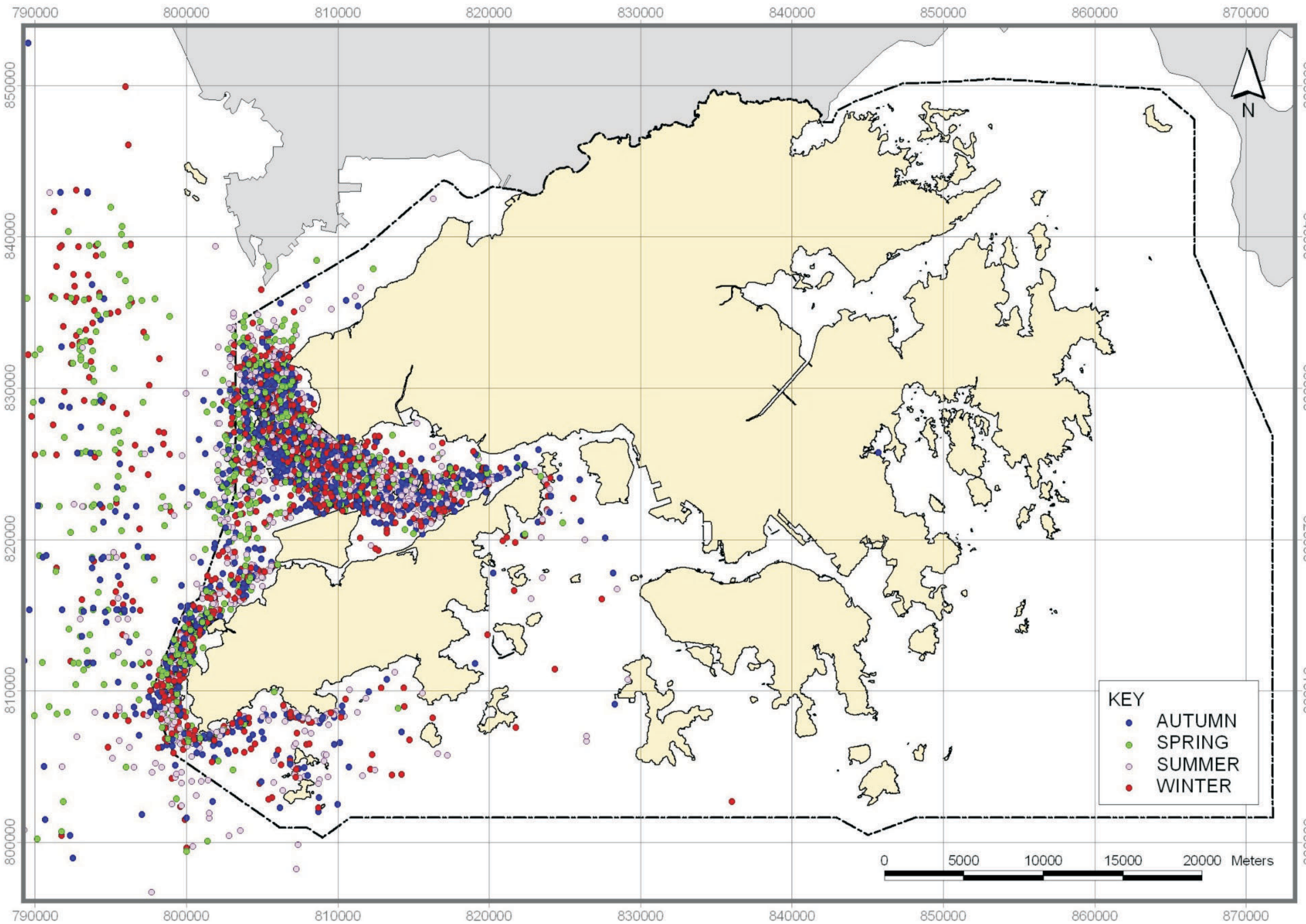

Figure 9.2

Seasonal Distribution of the Indo-Pacific Humpback Dolphin, *Sousa chinensis*, in Hong Kong waters.
Data Collected between 1995 and 2004 (AFCD 2004)

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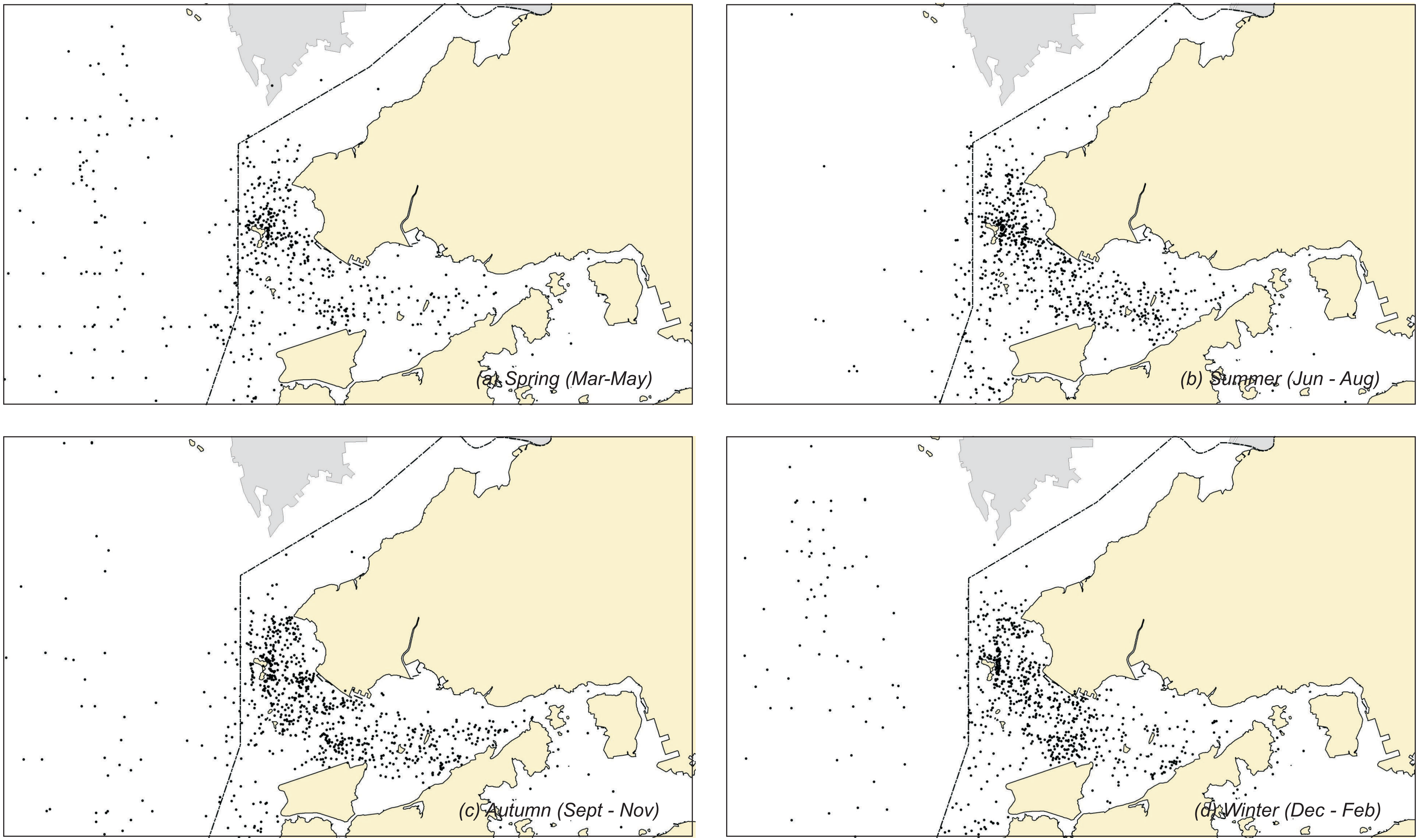

Figure 9.3

Seasonal Distribution of the Indo-Pacific Humpbacked Dolphin, *Sousa chinensis*, in Hong Kong waters.
Data Collected between 1995 and 2004 (AFCD 2004)

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DATE: 27/03/2006

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UAs) but a lower proportion of mottled animals (which are probably mostly young males) among the small number of recorded individuals (1).

The recent studies on marine mammals in Hong Kong have attempted to conduct quantitative analysis of habitat use (2). Sighting densities have been calculated in terms of number of on-effort sightings per km^2, with the survey area mapped using a 1 km by 1 km grid. These data are presented as Sightings Per Survey Effort (SPSE) values. The average SPSE per grid in West Lantau (most of the grids has SPSE value >20) is the highest (15.55) compared with the average in Northwest Lantau of 5.30. The grids around Black Point have SPSE values ranging between 0 – 12. The results indicate that the area around Black Point has low density for dolphins (3), and the nearest high density area is along the east coast of Lung Kwu Chau (5 km away).

In contrast to humpback dolphins, studies on the finless porpoise indicate that the majority of sightings have been recorded in the southern and eastern waters of Hong Kong. Few sightings have been recorded in the waters surrounding the proposed LNG terminal at Black Point and the Study Area(4)(5).

Based on the results of the information available from the long-term studies on marine mammals in the waters of Hong Kong, it appears that of Hong Kong's resident cetacean species, only humpback dolphins were recorded within the waters surrounding the proposed LNG terminal at Black Point.

9.3.7 *Baseline Marine Ecological Surveys*

The literature review of the marine ecological habitats and resources of the waters within, and in close proximity to, the proposed LNG terminal at Black Point has provided an indication of their ecological importance. However, in order to provide up-to-date information on the marine ecological baseline conditions the following field surveys were considered necessary (*Table 9.1).*

(1) Jefferson, pers. comm.
(2) AFCD. 2004. Monitoring of Chinese White Dolphins (Sousa chinensis) in Hong Kong waters – Data Collection, Final Report (1 April 2003 to 31 March 2004), prepared by Hong Kong Cetacean Research Project.
(3) Jefferson, pers. comm.
(4) Jefferson, pers. comm.
(5) AFCD. 2004. *ibid.*

Table 9.1 Marine Ecology Baseline Surveys at Black Point

Survey Type	Methodology	Date
Intertidal Assemblages	Quantitative (belt transects at 6 locations) survey, three 100 m belt transects (at high, mid and low intertidal zones) for each location, covered both wet and dry seasons.	22 & 23 March and 15 & 30 July 2004
Subtidal Benthic Assemblages	Quantitative grab sampling survey; covered both wet and dry seasons. Six stations sampled in each of 3 locations (BP1, BP2 and UR).	25 & 26 February and 5 & 6 July 2004.
Marine Mammal	Land-based visual survey during daytime, 5 days per month and 6 hours per day, covered four seasons (12 months).	16, 17, 18, 19 & 26 February, 19, 22, 23, 25 & 26 March, 6, 7, 13, 14 & 15 April, 11, 13, 17, 18 & 20 May, 11, 15, 24, 25 & 29 June 2004, 9, 14, 15, 20 & 25 July 2004, 25, 26, 27, 30 & 31 August, 15, 16, 17, 20 & 21 September 2004, 27, 28, 29, 30 & 31 October 2004, 24, 25, 27, 29 & 30 November 2004, 7, 8, 9, 13 & 14 December 2004, 21, 24, 25, 26 & 27 January 2005.
	Quantitative vessel based survey using line transect methods spanning Hong Kong western waters (Deep Bay, Southwest Lantau, Northwest Lantau and West Lantau) 3 days, 2 times per month.	18, 19, 20,,21, 22, 25, 26, 27 July 2005, 3, 4, 5,15, 22, 23, 24, 25, 26 August 2005, 5, 6, 7,15, 16 & 20 September 2005, 5, 6, 7, 17, 18 & 19 October 2005, 22, 24, 25, 28, 29 & 30 November 2005, 1, 2, 6,7,8 & 22 December 2005, 13, 16, 17, 19, 20 & 24 January 2006, 1, 2, 3, 7, 8 & 9 February 2006, 17, 23, 28, 29, 31 March 2006, 3, 6, 18, 25, 26, 27 April 2006, 2, 4, 8, 9, 10, 11 May 2006.

No surveys were considered necessary for subtidal hard bottom habitats and epifaunal assemblages as a review of the available literature provided sufficient evidence of low ecological importance habitats in the waters surrounding the proposed LNG terminal at Black Point.

Survey methodologies have been selected to follow standard and accepted techniques for marine ecological surveys. In addition, each methodology has been previously conducted as part of other Environmental Impact Assessments (EIA) studies, accepted under the Hong Kong Environmental Protection Department *Environmental Impact Assessment Ordinance* (*EIAO*).

Survey schedules were undertaken in accordance with the *Environmental Impact Assessment Ordinance, Cap.499 Guidance Note – Ecological Baseline Survey For Ecological Assessment*, specifically in terms of the following:

- Duration of Survey;
- Seasonality;

- Types of Survey Period; and
- Survey Effort.

The following sections present the methodology and results for each marine ecological survey undertaken as part of the assessment of marine ecological baseline conditions.

9.3.8 *Intertidal Habitats*

Methodology

Survey Locations

Six quantitative rocky shore surveys were conducted on the shores of Black Point, of which two were on natural rocky coastline and four on artificial rocky coastline (*Figure 9.4*).

Survey Methodology

Rocky Shore and Artificial Shoreline

A 100m transect tape was laid horizontally along the rocky and artificial shoreline at 2 metres above chart datum (CD). When tidal height was below 1m, transects could be started, local tide tables were used to assess tidal height at the site and times of surveys were adjusted accordingly. Random numbers between 1 and 100 were generated before the survey and these numbers corresponded to metres along the transect at which quadrats should be placed. Three sets of random numbers were generated per transect to represent upper, mid and low transects.

A 50cm x 50cm quadrat was used to assess abundance and distribution of flora and fauna. All fauna found within the quadrat were recorded to species level to allow density per square metre to be calculated. Sessile fauna such as barnacles and oysters recorded in samples were not counted but estimated as percentage cover on the rock surface. Species of algae (encrusting, foliose and filamentous) were also identified and recorded by estimating the percentage cover within the sample quadrat.

Results

Intertidal surveys have been conducted over two seasons, wet and dry. The date of each survey at each location is presented in *Table 9.2*. There were two types of coastal habitats, including natural rocky shore and artificial shoreline, recorded within the Study Area (*Figure 9.5*).

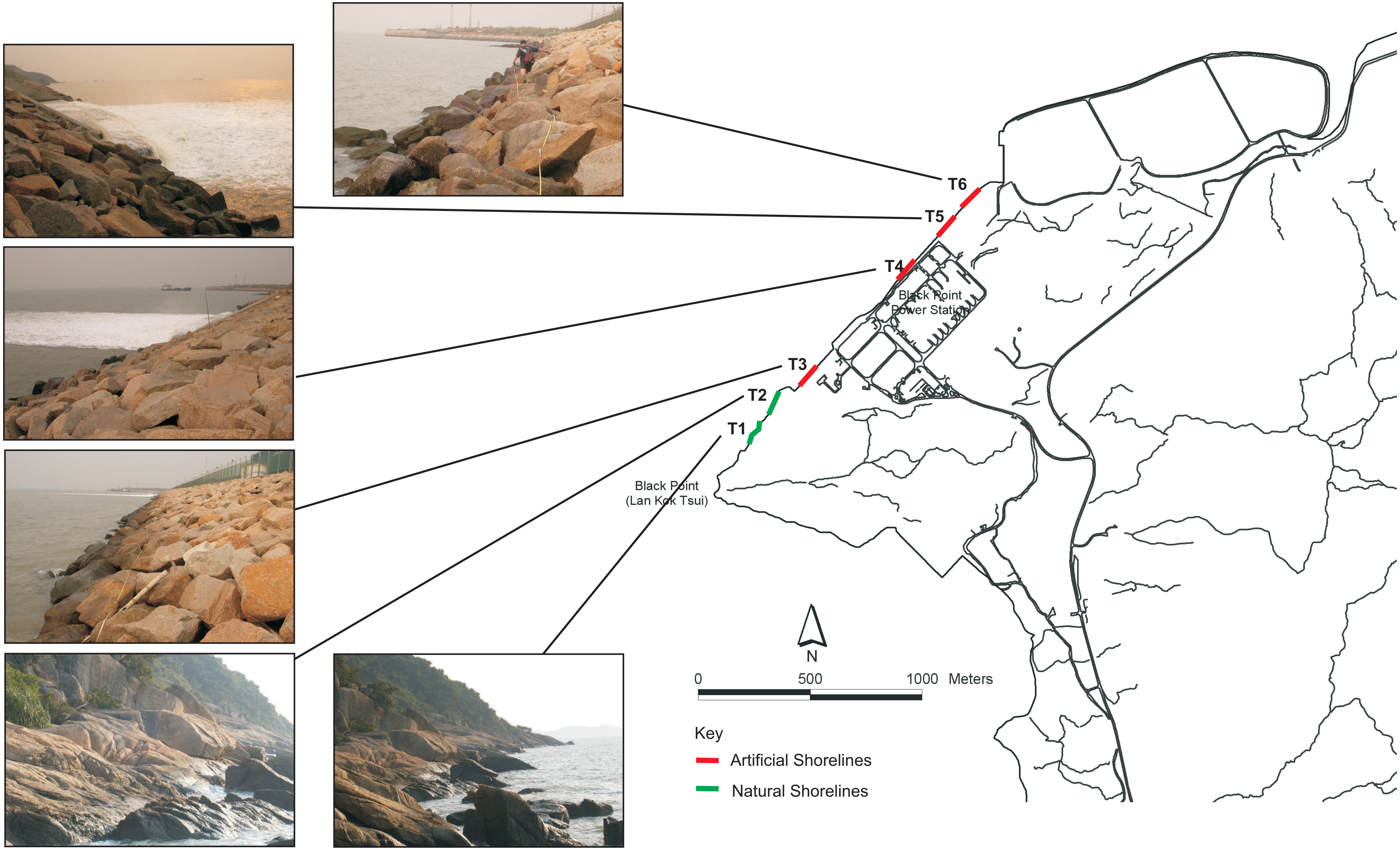

Figure 9.4

Black Point Intertidal Sampling Transect Locations

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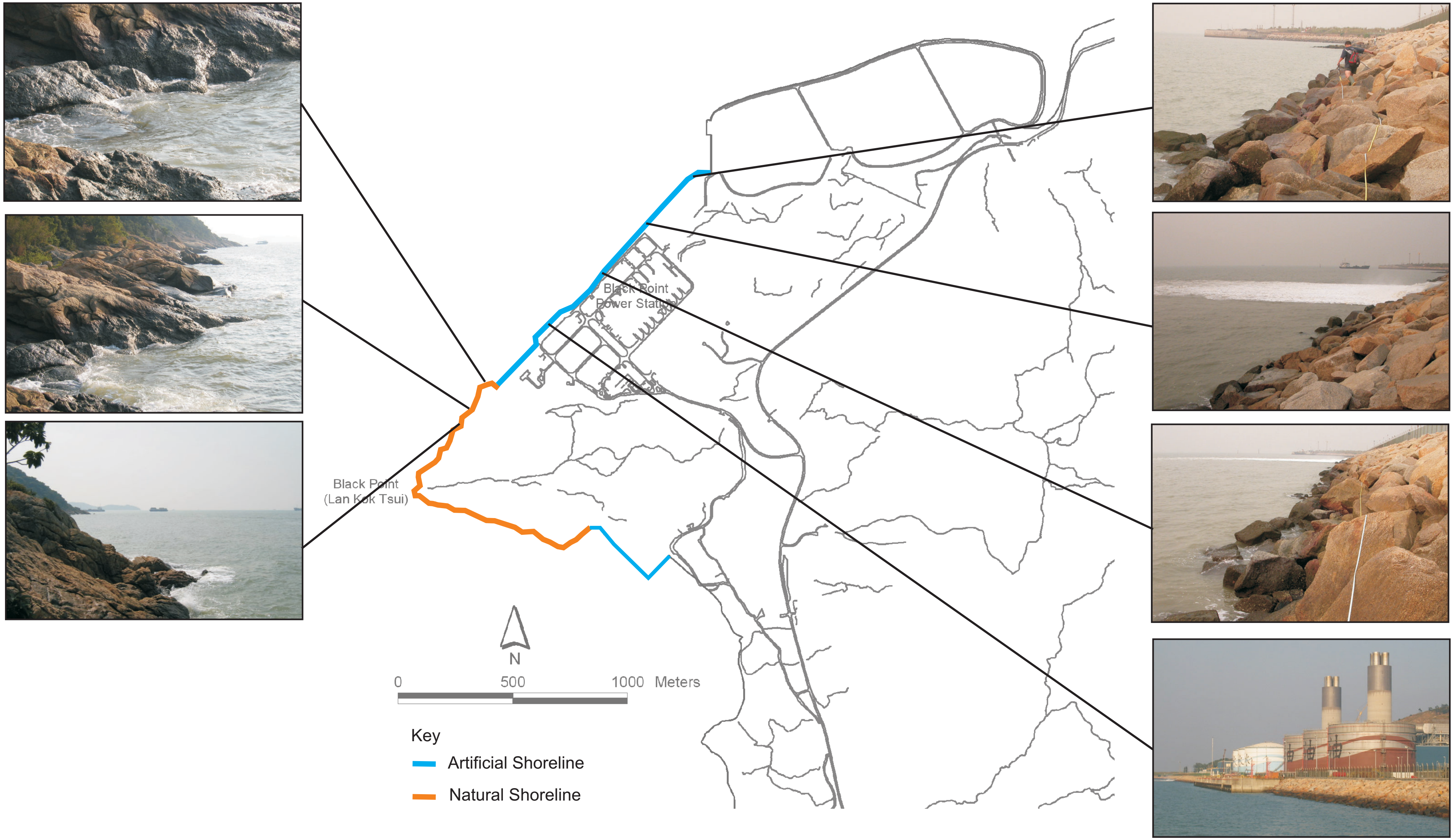

Figure 9.5

Intertidal Habitats Identified within the Study Area at Black Point

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Table 9.2 Description of the Survey Transects and Survey Dates for Intertidal Hard Bottom Surveys at Black Point

Transect	Site Description	Date of Survey	
		Dry Season	Wet Season
Natural Shoreline			
T1	Transect 1 is the furthest south of the rocky shore transects at Black Point and is a very steep natural shoreline made up of bedrock and the occasional boulder.	23 Mar 2004	15 July 2004
T2	Bedrock interspersed with a few large boulders and ranges from very steep to moderately steep sloping rock faces.	23 Mar 2004	15 July 2004
Artificial Shoreline			
T3	Southernmost artificial shoreline to the power stations cooling water outlet. Site consisted of steep large boulders.	23 Mar 2004	15 July 2004
T4	South of the power stations cooling water outlet. Steep artificial seawall consisting of large boulders.	22 Mar 2004	30 July 2004
T5	Adjacent to the power stations cooling water outlet. Steep artificial seawall consisting of large boulders.	22 Mar 2004	30 July 2004
T6	Located on the artificial shoreline on northern shore of Black Point power station. Steep artificial seawall consisting of large boulders.	22 Mar 2004	30 July 2004

Dry Season

The littorinid snails, including *Nodilittorina radiata, N. vidua* and *Littoraria articulata*, were the dominant species in the high intertidal zone on the rocky shore and artificial shoreline during the dry season at Black Point (*Tables 1* and *3* of *Annex 9-A*). The predatory gastropod *Thais clavigera* (the common dogwhelk), limpets (ie *Nipponacmea concinna* and *Siphonaria japonica*) and snail (*Monodonta labio* and *Planaxis sulcatus*) were recorded in the mid and low shore region. Sessile filter-feeding organisms such as the rock oyster (*Saccostrea cucullata*) and barnacles (*Capitulum mitella*, *Tetraclita japonica, Tetraclita squamosa, Balanus amphitrite*) were also recorded on the shores (*Tables 1* and *3* of *Annex 9-A*). There were only 2 types of algae, including *Ulva* sp. and encrusting algae, of low coverage recorded at Black Point during the dry season surveys.

In total, there were 21 species recorded on the natural and artificial shores. 12 species recorded on natural shoreline were also found on artificial shoreline (*Tables 3* and *4* of *Annex 9-A*). Except littorinid snails, all of the recorded species were in low abundances.

Wet Season

The species composition of the intertidal organisms during the wet season was similar to that of the dry season, with a total of 15 species on artificial shore and 12 species on natural shoreline (*Tables* 2 and *4* of *Annex 9-A*). The major differences between the seasons were the abundance of littorinid snails and rock oyster. The abundance of littorinid snails recorded during the wet season was much lower than those recorded during dry season, and vice versa for rock oyster. The total abundance of the intertidal organisms recorded in wet season was generally lower than the dry season.

9.3.9 *Comparison of Black Point Intertidal Habitats With Other Hong Kong Sites*

The intertidal organisms found at Black Point are distinct due to the influence of freshwater influx from the Pearl River Estuary and the Shenzhen River. The intertidal communities were not as diverse as those recorded in the eastern waters.

In comparison to other sites, species diversity of intertidal organisms recorded at Black Point was low. At Fa Peng and Pa Tau Kwu on Lantau Island to the East where 44 species were found in the dry season [(1)], only 12 and 21 species of flora and fauna were recorded at Black Point during the wet and dry seasons (*Figure 9.6*). During a study on the west coast of Lamma Island, 37 species were recorded.

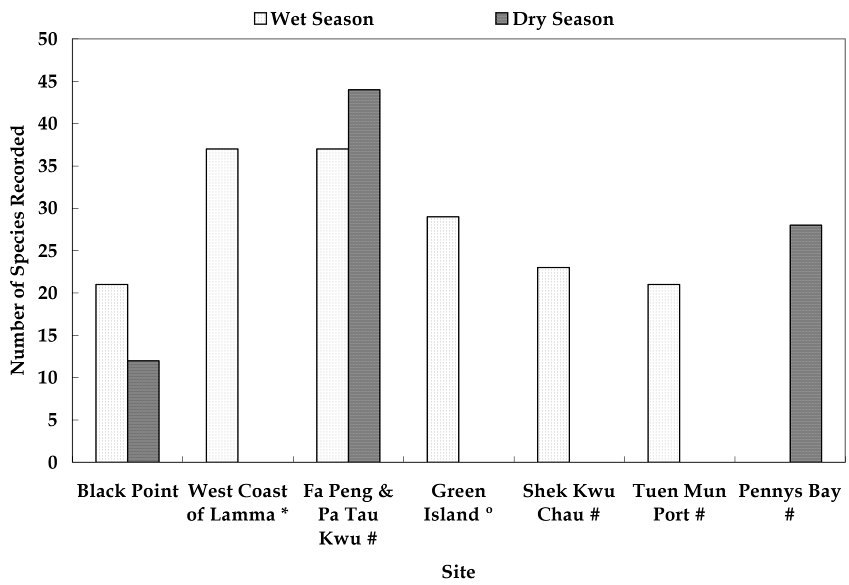
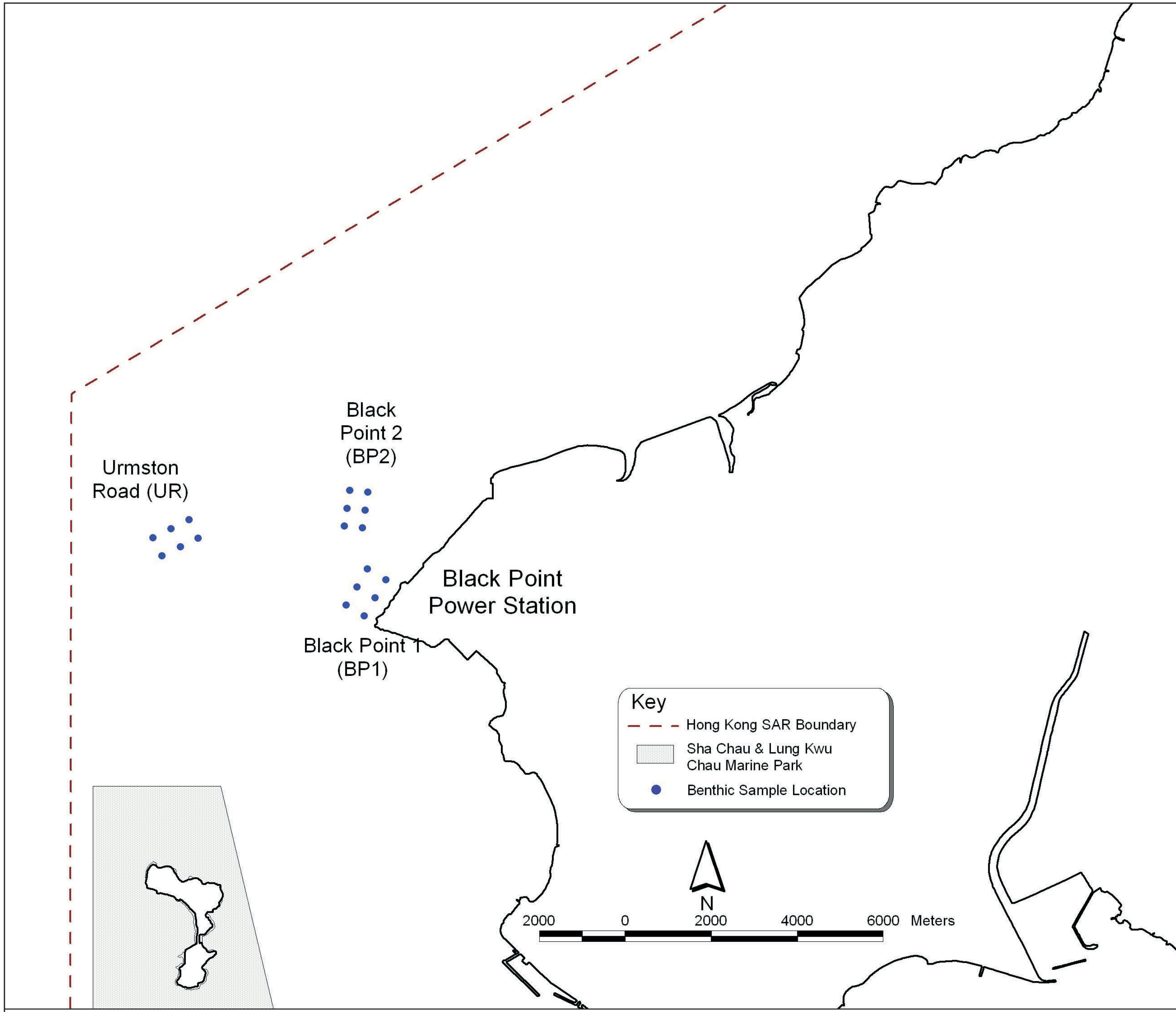


Figure 9.6 *Comparison of Intertidal Fauna and Flora at Various Sites in Hong Kong (Sources: # ERM 2000b, * ERM 1998 and º Babtie BMT 1999)* [(2)(1)(2)]

(1) ERM – HK Ltd. 2000. Environmental Impact Assessment of the Construction of an International Theme Park in Penny's Bay of North Lantau and its Essential Associated Infrastructures, prepared for Civil Engineering Department.

(2) ERM – HK Ltd. 2000. Environmental Impact Assessment of the Construction of an International Theme Park in Penny's Bay of North Lantau and its Essential Associated Infrastructures, prepared for Civil Engineering Department.



Modified Van Veen grab as used to collect samples at Black Point and the Study Area

An example of a benthic grab sample before sieving.

Benthic sieving being carried out by an ERM Marine Scientist

Figure 9.7

Subtidal Soft Bottom Sampling Stations

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9.3.10 *Infaunal Assemblages (Benthos)*

Survey Methodology

Sampling Locations

Benthic samples were collected at three sites representative of subtidal soft bottom habitats in the vicinity of the proposed LNG terminal at Black Point (*Figure 9.7*). Sampling sites were as follows:

- Black Point (BP1 and BP2) and,
- Urmston Road (UR).

Field Sampling Methodology

In each survey site, six stations approximately 50 m apart were established and one grab sample was collected from each station. Stations were sampled using a modified Van Veen grab sampler (960 cm^2 sampling area; 11,000 cm^3 capacity) with a supporting frame attached to a swivelling hydraulic winch cable.

Sediment from the grab samples were sieved on board the survey vessel.. The sediments were washed onto a sieve stack (comprising 1 mm and 500 μm meshes) and gently rinsed with seawater to remove all fine material. Material remaining on the two screens following rinsing was combined and carefully rinsed using a minimal volume of seawater into pre-labelled thick triple-bagged ziplock plastic bags. A 20% solution of buffered formalin containing rose bengal in seawater was then added to the bag to ensure tissue preservation. Samples were sealed in plastic containers for shipment to the taxonomy laboratory for sorting and identification.

Laboratory Techniques

The benthic laboratory performed sample re-screening after the samples had been held in formalin for a minimum of 24 hours to ensure adequate fixation of the organisms. Individual samples from the 500 mm and 1 mm^2 mesh sieves were gently rinsed with fresh water into a 250 mm sieve to remove the formalin from the sediments. Sieves were partially filled while rinsing a specific sample to maximize washing efficiency and prevent loss of material. All material retained on the sieve was placed in a labelled plastic jar, covered with 70% ethanol, and lightly agitated to ensure complete mixing of the alcohol with the sediments. Original labels were retained with the re-screened sample material.

(1) ERM – HK Ltd. 1998. Environmental Impact Assessment of a 1800 MW Gas-Fired Power Station at Lamma Extension: Marine Ecological Assessment – Final Benthic Ecology Survey Report, prepared for the Hong Kong Electric Co Ltd.

(2) Babtie BMT (Hong Kong) Ltd. 1999. Green Island Development EWQIA & MTIA Studies. Final Environmental and Water Quality Impact Assessment Report. For the Territory Development Department.

Standard and accepted techniques were used for sorting organisms from the sediments. Small fractions of a sample were placed in a petri dish under a 10-power magnification dissecting microscope and scanned systematically with all animals and fragments removed using forceps. Each petri dish was sorted at least twice to ensure removal of all animals. Organisms representing major taxonomic groups including Polychaeta, Arthropoda, Mollusca, and miscellaneous taxa were sorted into separate, labelled vials containing 70% ethanol.

Taxonomic identifications were performed using stereo dissecting and high-power compound microscopes. These were generally to the family level except for dominant taxa, which were identified to species. The careful sampling procedure employed minimizes fragmentation of organisms. If breakage of soft-bodied organisms occurs, only anterior portions of fragments were counted, although all fragments were retained and weighed for biomass determinations (wet weight).

Survey Results

Survey Dates and Conditions

Grab samples were collected in each site in both the dry (25-26th February 2004) and wet (5-6th July 2004) seasons. In general, conditions during surveys were fine with relatively calm sampling conditions throughout.

Dry Season Survey Results

A total of 674 individual organisms were collected from the 18 grab sampling stations in the vicinity of Black Point and the Study Area during the dry season survey in 2004. The specimens belong to 6 Phyla with a total of 37 families and 50 genera identified. *Table 9.3* presents information on the number of identified families, number of identified genera, number of individuals and biomass for each Phyla. A complete set of raw data is presented in *Table 5* of *Annex 9-A.*

A breakdown of dry season 2004 benthic data by site revealed relatively large differences in terms of number of individuals, biomass and taxonomic richness (here represented by number of families of infaunal organisms) (refer to *Table 5* of *Annex 9-A*). The Black Point site (BP2) recorded the highest number of individuals with mean of 63.3 individuals grab^{-1} (± 47.8 SD) recorded, equating to 657.0 m^{-2} (± 497.7 SD). In comparison, Urmston Road (UR) recorded the lowest mean numbers of individuals (15.2 (± 13.7 SD) grab^{-1}). The Black Point site BP1 recorded comparatively medium numbers, with 33.8 grab^{-1} (± 39.3 SD) recorded. As can be seen from the standard deviation at each site, the numbers varied greatly between stations, particularly at the site with high numbers of individuals (BP2).

Table 9.3 Grab Sample Composition (Infaunal Assemblages) of Each Sample Site for the Soft Bottom Habitat Surveys at Black Point and the Study Area during the Dry Season 2004

Site	Number of Stations Sampled	Total Number of Infaunal Individuals	Mean Number of Individuals Station^{-1} (±SD)	Mean Number of Individuals Station m^{-2} (±SD)	Total Biomass (g wet weight)	Mean Taxonomic Richness (No. Families) Station^{-1} (±SD)	Mean Taxonomic Richness (No. Genera) Station^{-1} (±SD)	Mean Biomass Individual^{-1} (g wet weight)
UR	6	91	15.2 (± 13.7)	157.3 (± 142.8)	8.20	5.5(± 3.5)	5.8 (± 3.8)	0.09
BP1	6	203	33.8 (± 39.3)	351.0 (± 408.7)	56.9	6.7 (± 4.1)	6.8 (± 4.4)	0.28
BP2	6	380	63.3 (± 47.8)	657.0 (± 497.7)	25.2	11.0 (± 5.8)	12.0 (± 6.1)	0.07

The highest total biomass in the dry season 2004 was recorded at the Black Point (BP1) site, with 56.9 g wet weight (*Table 9.3*). The Black Point Station (BP2) and the Urmston Road (UR) site also recorded comparatively high biomass, with a total biomass of 25.2 and 8.2 g wet weights, respectively.

The Black Point site BP2 recorded the highest diversity in the dry season 2004, with a mean number of 11.0 (± 5.8 SD) families and 12.0 (± 6.1 SD) genera grab^{-1}. Both the Black Point (BP1) and Urmston Road (UR) sites recorded lower diversity under the dry season survey.

Overall, the majority (89.7%) of organisms recorded were from the Phyla Annelida. The remainder were the Arthropoda (4.2%), Echinodermata (3.1%), Mollusca (2.5%), Echiura (0.3%) and Sipuncula (0.1%). The polychaete worm from the family Spionidae, namely *Prionospio queenslandica*, was the most abundant species from the surveys, particularly at the Black Point (BP1 and BP2) sites. No rare or uncommon species were recorded in the dry season 2004 survey at Black Point and the Study Area.

The composition of infaunal assemblages in terms of the mean number of individuals grouped by class collected at each site during the dry season 2004 survey, is presented in *Figure 9.8*. The majority of organisms collected at each site are from the class Polychaeta, in particular the Black Point (BP2) site.

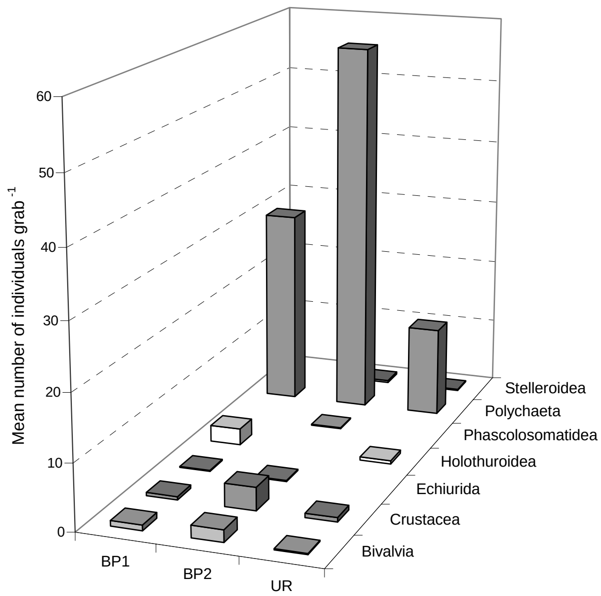

Figure 9.8 ***Mean numbers of individuals of infaunal organisms (Class level) from benthic samples collected at Black Point and the Study Area during the Dry Season Surveys 2004***

The composition of infaunal assemblages at each site in terms of mean biomass of infaunal organisms grouped to class level is presented in *Figure 9.9*. From this figure it is clear that whilst the number of individuals is dominated by polychaetes, the distribution of biomass appears to be from different classes, with notable values for the class Holothuroidea in the Black Point (BP1) site and Crustacea at the Black Point (BP2) site.

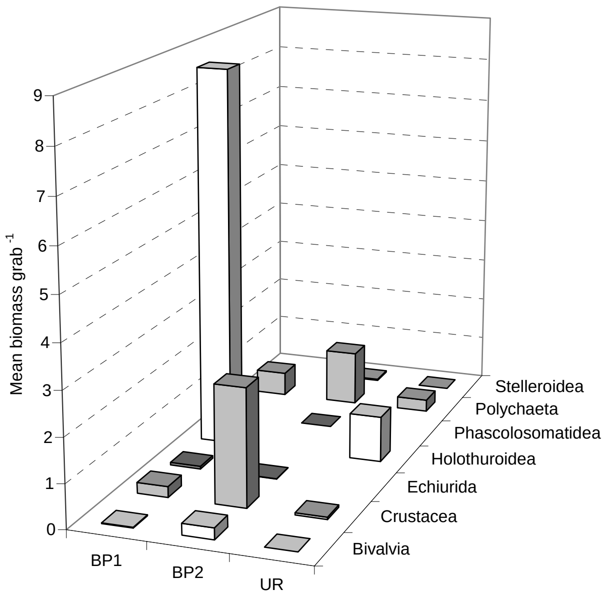

Figure 9.9 ***Mean biomass grab^{-1} infaunal organisms (Class level) from benthic samples collected at Black Point and the Study Area during the Dry Season Surveys 2004***

Wet Season Survey Results

A total of 3,562 individual organisms were collected from the 18 grab sampling stations in vicinity of Black Point and the Study Area during the wet season survey in 2004. The specimens belong to 4 Phyla with a total of 36 families and 84 genera identified. A complete set of raw data is presented in *Table 6* of *Annex 9-A*.

A breakdown of wet season 2004 benthic data by site revealed relatively large difference in terms of number of individuals, biomass and taxonomic richness (here represented by number of families of infaunal organisms). The Urmston Road (UR) recorded the highest number of individuals with mean of 498.8 individuals grab^{-1} (± 997.3 SD) recorded, equating to 5,187.9 m^{-2} (± 10,372.1 SD) (*Table 9.4*). In comparison, the Black Point (BP1 and BP2) sites both recorded the relatively low mean numbers of individuals (55.8 (± 38.1 SD) and (39.0 (± 24.1 SD) individuals grab^{-1}, respectively). As can be seen from the standard deviation at each site, the numbers varied greatly between stations, particularly at the Urmston Road (UR) site with high number of individuals.

Table 9.4 Grab Sample Composition (Infaunal Assemblages) of Each Sample Site for the Soft Bottom Habitat Surveys at Black Point and the Study Area during the Wet Season 2004

Site	Number of Stations Sampled	Total Number of Infaunal Individuals	Mean Number of Individuals Station^{-1} (±SD)	Mean Number of Individuals Station m^{-2} (±SD)	Total Biomass (g wet weight)	Mean Taxonomic Richness (No. Families) Station^{-1} (±SD)	Mean Taxonomic Richness (No. Genera) Station^{-1} (±SD)	Mean Biomass Individual^{-1} (g wet weight)
UR	6	2,993	498.8 (± 997.3)	5,174.6 (± 10,372.1)	174.5	7.0 (± 5.2)	11.5 (± 5.8)	0.06
BP1	6	335	55.8 (± 38.1)	580.7 (± 396.2)	161.4	10.0 (± 3.7)	6.0 (± 5.9)	0.48
BP2	6	234	39.0 (± 24.1)	405.6 (± 250.7)	376.6	8.0 (± 2.8)	7.2 (± 3.1)	1.61

The highest total biomass in the wet season 2004 was recorded at the Black Point (BP2) site, with 376.6 g wet weight (*Table 9.4*). The Black Point Station (BP1) and the Urmston Road (UR) site also recorded comparatively high biomass, with a total biomass of 161.4 and 174.5 g wet weight, respectively.

The Black Point (BP1) site recorded the highest diversity in the wet season 2004, with a mean number of 10.0 (± 3.7 SD) families and 6.0 (± 5.9 SD) genera grab^{-1}. Both the Black Point (BP2) and Urmston Road (UR) sites recorded slightly lower diversity under the wet season survey.

Overall, the majority (81.5%) of organisms recorded were Mollusca. The remainder were representatives from the Phyla Annelida (16.6%), Arthropoda (1.3%), or Echinodermata (0.6%).

The estuarine clam *Potamocorbula laevis*, from the family Corbulidae, was the most abundant species from the surveys owing to high numbers in samples from Urmston Road (UR). No rare or uncommon species were recorded in the wet season 2004 survey at Black Point and the Study Area.

The distribution of the mean number of individuals collected at each site during the wet season 2004 survey, according to class level, is presented in *Figure 9.10*

The distribution of mean biomass of infaunal organisms at each site according to class level is presented in *Figure 9.11.* The biomass of organisms is mainly contributed by the class Bivalvia at the Urmston Road (UR) site and Polychaeta at the Black Points sites (BP1 and BP2).

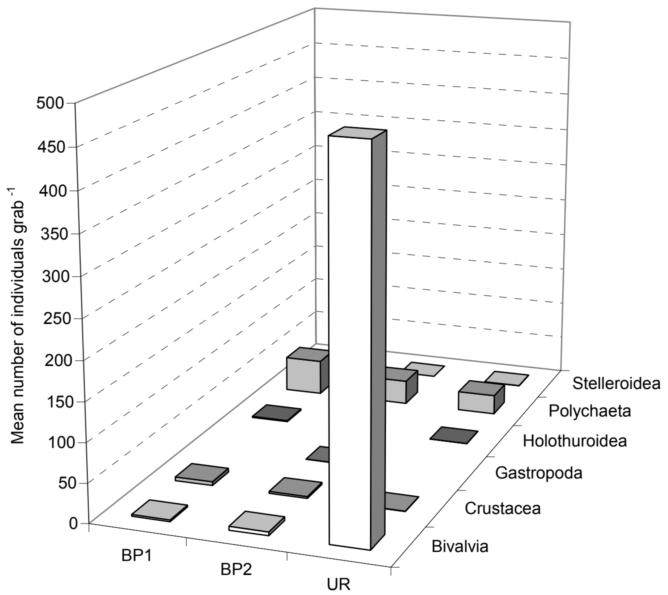

Figure 9.10 ***Mean numbers of individuals of infaunal organisms (Class level) from benthic samples collected at Black Point and the Study Area during the Wet Season Surveys 2004***

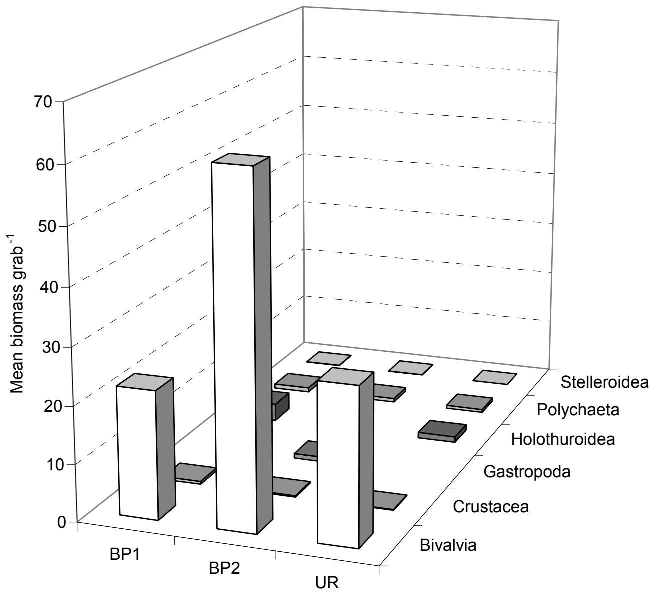

Figure 9.11 ***Mean biomass grab^{-1} infaunal organisms (Class level) from benthic samples collected at Black Point and the Study Area during the Wet Season Surveys 2004***

9.3.11 *Comparison of Black Point Benthic Fauna With Other Sites in Hong Kong*

A comparison with similar sites in Hong Kong puts the ecological value of the study site in perspective with the ecology of the surrounding area and also other sites that may share the same physical attributes such as outlying islands around Hong Kong. Sources of information that were used in compiling this comparative data were the Seabed Ecology studies conducted by ERM (1), the study on marine benthic communities conducted by City U Professional Services Ltd (2) along with other EIAs and reports conducted by ERM.

The benthic biomass of comparable areas in Hong Kong varies greatly including across seasons (*Figure 9.12*). Compared with results of the previous surveys, biomass recorded during this survey at Black Point (BP1 and BP2) and at Urmston Road (UR) was comparatively higher than all other areas during the wet season while the biomass at Black Point (BP1 and BP2) was similar to or slightly lower than Western Lantau during the dry season. The biomass at Urmston Road (UR) was similar to areas such as Lung Kwu Chau & Sha Chau, Peng Chau and South West of Po Toi during the dry season.

(1) ERM – HK Ltd. 1998. Environmental Impact Assessment of a 1800 MW Gas-Fired Power Station at Lamma Extension: Marine Ecological Assessment – Final Benthic Ecology Survey Report, prepared for the Hong Kong Electric Co Ltd.

(2) City U Professional Services Ltd. 2002. Consultancy Study on Marine Benthic Communities in Hong Kong: Final Report, prepared for Agriculture, Fisheries and Conservation Department.

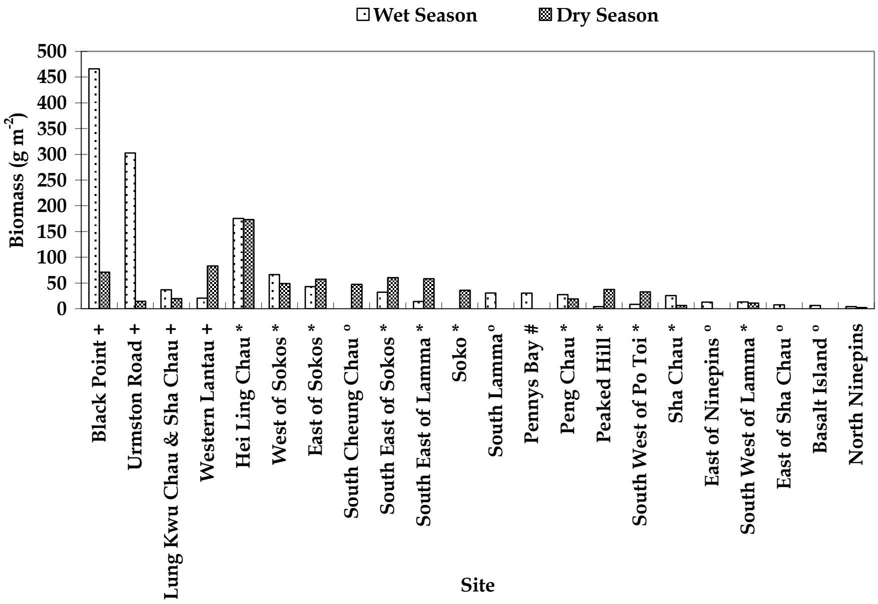

Figure 9.12 ***Comparison of mean biomass of benthic communities around Hong Kong (Sources: +Present Study, *City U 2002, ºERM 1998 and #ERM 2000)*** (1)(2)(3)

The species diversity of the benthic community at Black Point and Urmston Road (UR) was recorded similar to most of the locations in Hong Kong (4). The number of species of the benthic organisms in Black Point and Urmston Road were recorded in the range of 26 to 31 species per 0.576 m^2 during wet season and 20 to 35 species per 0.576 m^2 during dry season, in which the mean number of species of the 120 stations surveyed by CityU (5) were 32.9 per 0.5 m^2 (wet season) and 33.7 per 0.5 m^2 (dry season) respectively.

9.3.12 *Marine Mammals*

Methodology

Land-based Visual Survey

Land-based visual surveys were conducted in the Study Area to qualitatively estimate marine mammal use of habitats in the vicinity of Black Point and nearshore areas. The results yielded from the land-based survey are qualitative in nature and were not intended for quantitative determination of marine mammal abundance. Land-based surveys were conducted to provide additional information to supplement the quantitative vessel-based surveys results. The observation site was on the natural rocky shore located at a

(1) City U Professional Services Ltd. 2002. Consultancy Study on Marine Benthic Communities in Hong Kong: Final Report, prepared for Agriculture, Fisheries and Conservation Department.

(2) ERM – HK Ltd. 1998. Environmental Impact Assessment of a 1800 MW Gas-Fired Power Station at Lamma Extension: Marine Ecological Assessment – Final Benthic Ecology Survey Report, prepared for the Hong Kong Electric Co Ltd.

(3) ERM – HK Ltd. 2000. Environmental Impact Assessment of the Construction of an International Theme Park in Penny's Bay of North Lantau and its Essential Associated Infrastructures, prepared for Civil Engineering Department.

(4) City U Professional Services Ltd. 2002. *ibid.*

(5) City U Professional Services Ltd. 2002. *ibid.*

distance of approximately 60 metres from Black Point Power Station. The 180° view of the existing environment around the observation site is shown in *Figure 9.13*. The location of the observation point was selected to allow the greatest visual coverage of the proposed reclamation and dredging area. In this way, the chosen site for the observation point was relatively close to the shoreline since this allowed visual coverage of the whole of the reclamation area of the proposed LNG terminal. However, any dolphin sightings located at a far distance (beyond approximately beyond 800 m) from the observation point may not be identified clearly due to the low elevation of the observer's position on the shoreline.

During the survey period, one of the paired observers scanned the survey area continuously with Olympus 10 x 42 hand-held marine binoculars while the other used naked eye and occasional binocular scans to identify, estimate group size, and study behaviour of the any marine mammals observed in the Study Area. The role of observers rotated every 30 minutes. Each survey was 6 hours in length. Survey times shifted to record marine mammal activity during all possible daylight hours during the survey period.

Monitoring surveys were conducted for five days of each month. Surveys have been conducted monthly, commencing in February 2004, for a full calendar year up to end January 2005.

Data Collected

The locations of all marine mammals sighted within 800 m of the sighting point were recorded on a data sheet (*Table 7* of *Annex 9-A*). The species and number of marine mammals, number of sightings and age classes were recorded, together with observed behaviours at the times of sightings. If fifteen minutes had passed with no sightings after an initial sighting was made, any observed marine mammals were then considered to be a new group or individual. As such, the "sighting" data recorded represents first count data, or the location where the marine mammals were first observed.

Distinguishing Features

Only the Indo-Pacific Humpback Dolphin was observed during the surveys. The Indo-Pacific Humpback Dolphin (*Sousa chinensis*) is distinguished by its wide-based, slightly falcate dorsal fin, located at mid-back. They have a long slender rostrum, with a shallow groove between the melon and the beak. Adults are white to pink in colour, and often have a variable degree of black spotting or mottling.

Age Classes

Age class of humpback dolphins was identified in accordance with the six age classes defined by Jefferson [(1)]. The classification of their age class was

(1) Jefferson T.A. 2000. Population biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs* 144:1-65.

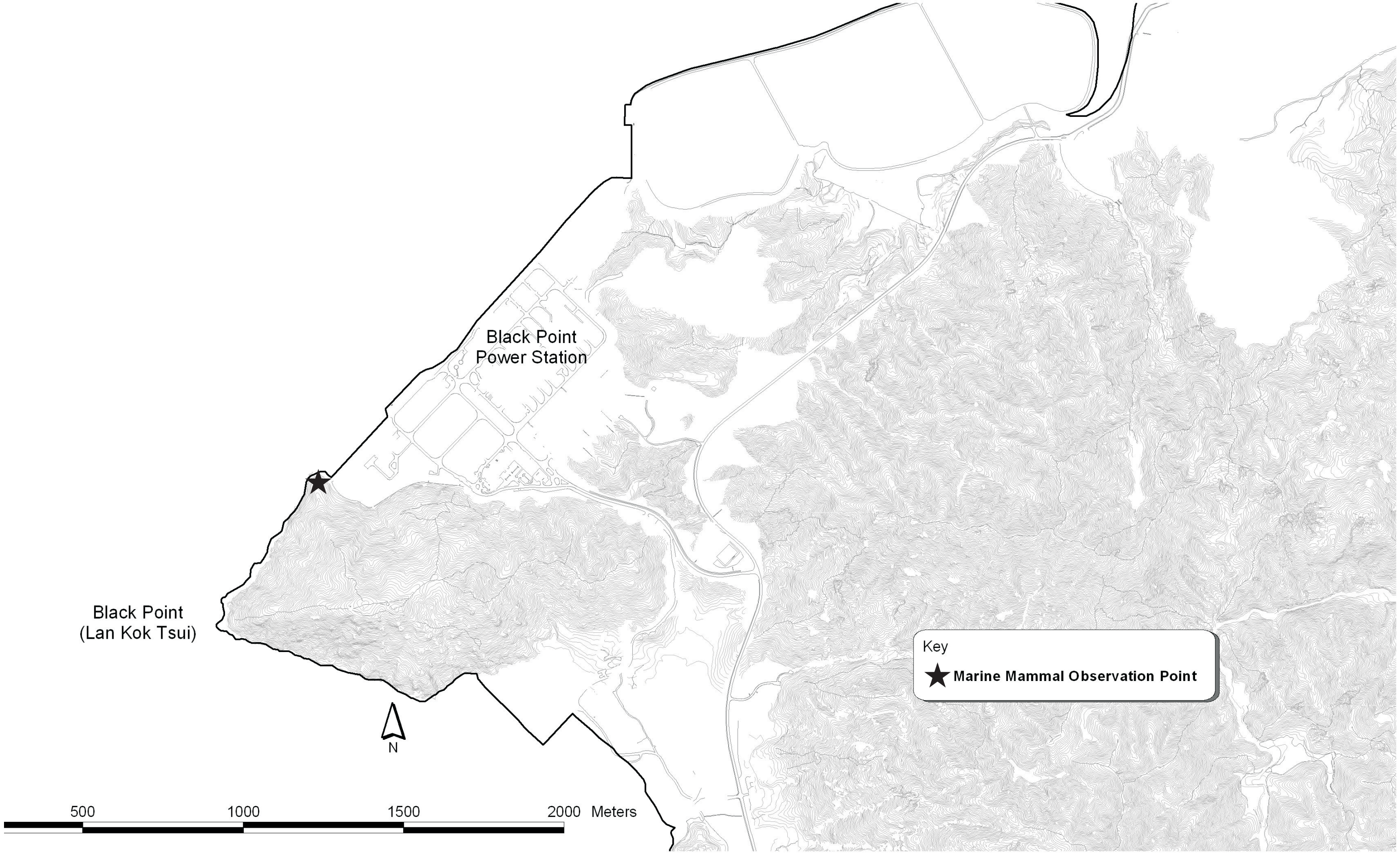

Figure 9.13

180⁰ Overview of the Existing Environment from the Marine Mammal Observation Point at Black Point

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mainly based on their body size and length, skin colouring pattern, and density of spotting. Their skin colour pattern changes dramatically throughout their lifespan, whitening increases as age increases. The spot patterns on juveniles and subadults disappear gradually as they get older, as presented in *Table 9.5* (1).

Table 9.5 *Age Classes of Sousa chinensis*

Age Class	Body Length (m)	Colour Pattern	Spotted Pattern	Behaviour
Unspotted Calf (UC)	1 m to 1.3 m (approximately half length of adults); up to 6-8 months of age	Uniform black to dark grey	No spots	Swim dependently of adult, presumably the mother
Unspotted Juvenile (UJ)	Approximately 1.5 m to 2 m (two-third of the adult length)	Uniform light grey	No spots	Occur in the vicinity of adults
Mottled (MO)	Approximately similar length as SAs and UAs	Light pinkish grey	Heaving spotting	Same as SAs and UAs
Speckled (SP)	With same size as SAs and UAs	Pale pink to white	Less spotting pattern than MO	Full independence of movement and association; hard to distinguish from SA
Spotted Adult (SA)	Same as UA	Purely pink to white	Less spotting pattern than MO or SP	Same as SPs
Unspotted Adult (UA)	Up to 2.6 m	Purely pink to white	Essentially no spotting pattern but may have a few tiny spots	Same as SAs and SPs

Only three classes, adult (include MO, SP, SA and UA), juvenile (UJ) and calf (UC), can be identified during the land-based visual survey due to the distant observation.

Behaviour

Marine mammals exhibit certain behaviour and for humpback dolphins this has been previously characterised based on ongoing studies (2) (3). These are presented in *Table 9.6*.

(1) Jefferson T.A. 2000. Population biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs* 144:1-65.

(2) Parsons E.C.M. 1998. The Behaviour of Hong Kong's Resident Cetaceans: the Indo-Pacific Hump-Backed Dolphin and the Finless Porpoise. *Aquatic Mammals* 1998, 24.3, 91-110.

(3) Jefferson, pers comm.

Table 9.6 A Summary and Description of Specific Types of Behaviour and Activities exhibited by Indo-Pacific Humpback Dolphin **Sousa chinensis**

Type of Social Behaviours and Activities	Descriptions
Activities	
Free Travelling	Directional motion, swimming fast, taking regular breaths on water surface.
Feeding/Foraging	Long jumping and high-speed chasing while hunting fish; On sea surface, swimming slowly rising intermittently before commencing the next dive. They may display certain behaviours such as feeding rushes, fish whacking, carousels, and fluking dives.
Boat chasing/ Feeding behind trawlers	Following behind trawlers as a sign of feeding, they catch fish through the net or escaping from it.
Milling/Resting	Remaining in one area without any sign of feeding or social interaction; move slowly with a drifting or gliding motion, rising slowly, or breathing while circling over the same area.
Socializing	Extensive bodily contact, inverted swimming, somersaulting, leaping and chasing with aerial activity; group activities centred on animate or inanimate objects; two to three individuals form a group.
Spot Behaviour	
Breaching	A behavioural pattern also known as body slamming or a "log" jump. The animal rises out of the water at an angle between 90° to 45° to the sea surface. When exiting the water the dolphin's flippers, its abdomen or peduncle may clear the surface.
Spyhopping	Raising the head vertically out of the water, then sinking below the water without a splash. Used to check an area for hazards.
Tail slapping	The act of slapping the tail against the sea surface.
Porpoising	Fast, shallow, arching leaps with the dolphin coming either partially or entirely out of the water. It was only observed when the dolphins were boat chasing and allows the animals to combine shallow dives for fish with a fast rate of travel. The adults will show noticeable colour changes, turning from white to a deep pink. This is probably due to vascular dilation in the blubber layer and is, possibly, a flush response to prevent overheating.
Nursing	An act of nursing a calf by a mother.

Site and Weather Conditions

Site conditions including sea state, weather and visibility were also recorded along with any changes in environmental conditions if they occurred during the duration of a survey. Surveys were only conducted under acceptable sighting and weather conditions. Acceptable sighting conditions were defined as days with sea state conditions of Beaufort 0 – 5, and visibility of at least 2 km from the observation point. No surveys were conducted during unacceptable weather conditions, such as during low visibility or during typhoons, thunderstorms or heavy rainstorm warnings reported by the Hong Kong Observatory.

Vessel Based Visual Survey

Survey Subareas and General Approach

Vessel-based surveys were undertaken to provide the scientific basis for calculating all quantitative estimates of dolphin abundance around Black Point and nearby waters for this EIA Study. Surveys were conducted in two subareas. General characteristics of the two survey subareas are listed in *Table 9.7*. Northwest Lantau (40 km^2) is a narrow strip along the western border of Hong Kong, and it includes waters of the Sha Chau and Lung Kwu Chau Marine Park. The survey area for this project represents only the western portion of the Northwest Lantau area of the long-term study (1) (2). The very northern edge of the area would be affected by the LNG terminal, approach channel and turning basin.

Table 9.7 Summary of Characteristics of the Two Survey Subareas in Hong Kong

Survey Area	Area (km^2)	Effort (km) (1)	Description
Deep Bay (DB)	30 (2)	1,679	Very shallow enclosed bay with extensive mudflats and mangroves; influenced by the Pearl River (high turbidity)
Northwest Lantau (NWL)	38	530	Strong influence from Pearl River; location of Sha Chau/Lung Kwu Chau Marine Park; Urmston Road shipping channel goes through north end

Note: (1) Total survey effort conducted during this study is presented here, but the survey effort (L) presented in *Table 9.17* is only that used in calculation of the abundance estimates (i.e., Beaufort 0-3 data).

(2) The total area of Deep Bay is about 97 km^2, but the portion that is within the Hong Kong SAR boundary is 60 km^2. However, only half of this area could be surveyed, due to the northern portion of the bay being too shallow for our vessel to operate. Thus, abundance was only estimated for the surveyed area of 30 km^2.

The Deep Bay subarea contains the Black Point site at its southern boundary. The Black Point Power Station is the ultimate destination of the gas pipeline. Deep Bay itself is actually about 97 km^2, but it is bisected by the Hong Kong SAR/Guangdong boundary. The portion that occurs within the Hong Kong SAR is only 60 km^2. However, the northern portion of Deep Bay is very shallow, with mud flats often exposed at low tides. Due to this fact, as well as the confounding presence of the Crosslinks Bridge (Deep Bay Link) and several oyster rafts, survey vessel were unable to safely navigate into the northern portion of Deep Bay. As a consequence, the vessel-based surveys were conducted only in the southern portion of Deep Bay (30 km^2).

(1) Jefferson T.A. 2000. Population biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Mongraphs* 144:1-65.
(2) Jefferson T.A. 2005. Final report to AFCD

The seasons were defined as follows: Winter (December-February), Spring (March-May), Summer (June-August), and Autumn (September-November). This is the same as in the long-term study.

The survey transect lines were presented in *Figure 9.14*.

Survey Methods

Vessel surveys were conducted from two survey vessels, the King Dragon and the Tsun Wing (both ca. 12-15 m length, with similar configuration), weather permitting (Beaufort 0-6, no heavy rain, and visibility > 1,200 m). However, only data collected in calm conditions of Beaufort 0-3 are useable in calculating line transect estimates of density and abundance [(1)] [(2)]. The vessel had an open upper deck, affording relatively unrestricted visibility. The observer team conducted searches and observations from the flying bridge area, 4-5 m eye height above the water's surface. Two observers made up the on-effort survey team. As the vessel transited the survey lines at a relatively constant speed of approximately 15 km/hr, the primary observer searched for dolphins and porpoises continuously through 7 X 50 Brunton marine binoculars. The data recorder searched with unaided eye and filled-out the data sheets. Both observers searched ahead of the vessel, between 270° and 90° (in relation to the bow, which is defined as 0°). On most surveys, there were three observers, and one auditor. Observers rotated positions after approximately 30 minutes of effort, to give them a rest after each hour of search effort, thereby minimizing fatigue. Observers had undergone a 3-day training program before the start of data collection, which included detailed classroom instruction and a day of at-sea training. Only two species of small cetaceans regularly occur in Hong Kong, the humpback dolphin and finless porpoise [(3)] [(4)]. These two species are radically different in appearance and behavior, and so all sightings (even those seen briefly or from a distance) could be identified to species.

Effort data collected during on-effort survey periods included time and position for the start and end of search effort, vessel speed, sea state (Beaufort scale), visibility, and distance traveled in each series (a continuous period of search effort). When dolphins or porpoises were sighted, the data recorder filled out a sighting sheet, and generally the team was taken off-effort and the vessel diverted from its course to approach the dolphin group for group size estimation, assessment of group composition, behavioral observations, and collection of identification photos. The sighting sheet included information on initial sighting angle and distance, position of initial sighting, sea state, group size and composition, and behavior, such as response to the survey

(1) Jefferson T.A. 2000. Population biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Mongraphs* 144:1-65.

(2) Jefferson T. A., S. K. Hung, L. Law, M. Torey, and N. Tregenza. 2002. Distribution and abundance of finless porpoises in Hong Kong and adjacent waters of China. *Raffles Bulletin of Zoology Supplement* 10:43-55.

(3) Parsons C, M. L. Felley and L. J.Porter. 1995. An Annotated Checklist of Cetaceans Recorded From Hong Kong's Territorial Waters. *Asian Marine Biology* 12: 79 - 100.

(4) Jefferson T. A., S. K. Hung, L. Law, M. Torey, and N. Tregenza. 2002. *ibid.*

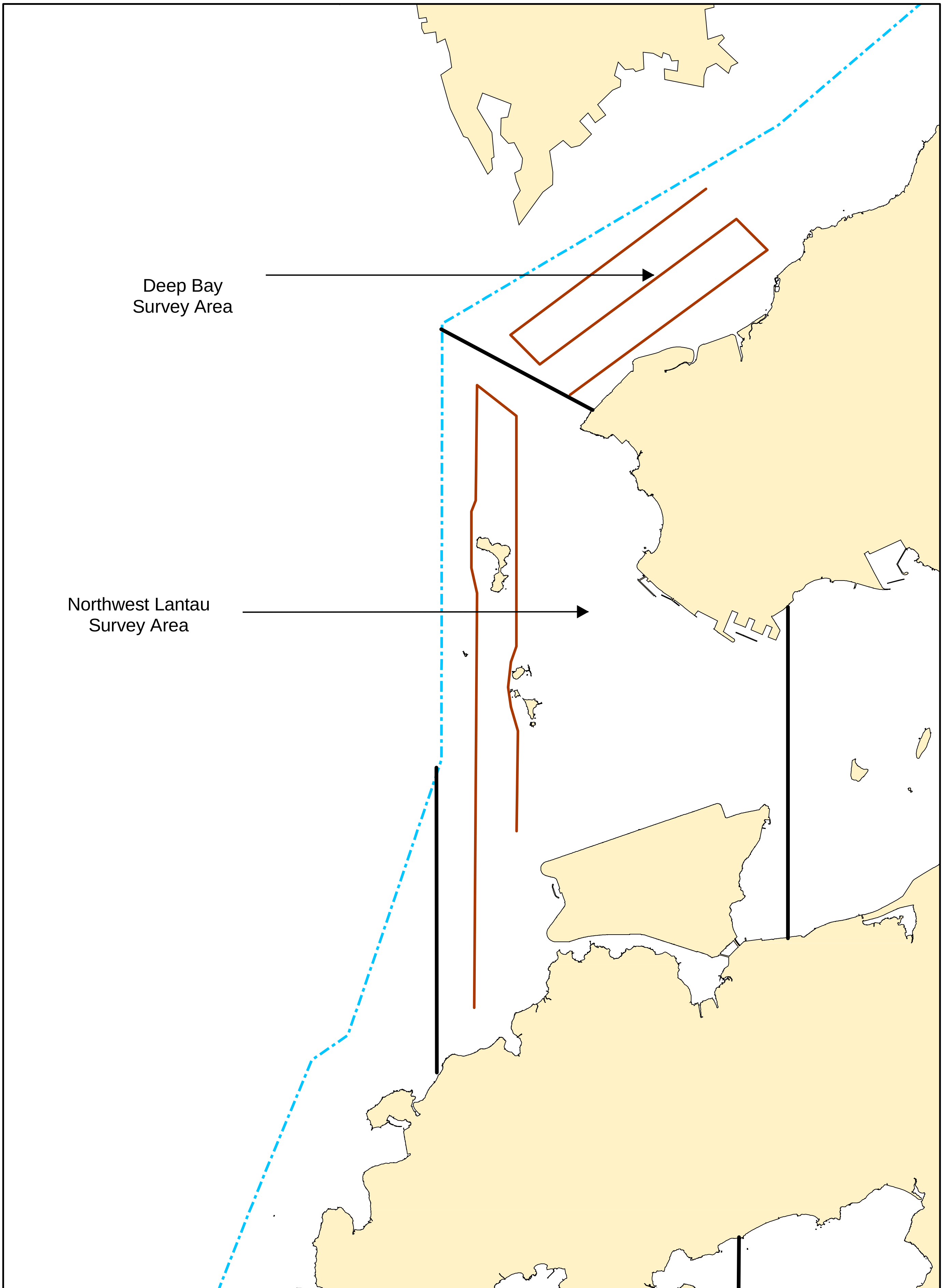

FIGURE 9.14

Survey Transect Lines in
Deep Bay and Northwest Lantau

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vessel and associations with fishing vessels (*Tables 9 and 10 of Annex 9-A*). Position, distance traveled, and vessel speed were obtained from a hand-held Global Positioning System (a Garmin Gecko GPS unit).

Observers were trained and calibrated in distance estimation, by asking them to make distance estimates to various objects (e.g., other boats, specific points on shore, floating debris, etc.). Simultaneously, a distance reading was taken with a laser rangefinder (Leica 800 or Bushnell Yardage Pro 800 model). Plots of measured vs. estimated distance were shown to observers occasionally, so they could see if they needed to refine their distance estimates. This procedure resulted in increased accuracy of observer distance estimates, and previous efforts have shown that significant bias is not caused by the remaining inaccuracy in distance estimation (1) (2) (3).

When dolphins were sighted, the observers typically went off-effort and the vessel approached the dolphin group for accurate estimation of group size/composition and for photo-identification. Photographs were taken with Canon 35-mm SLR autofocus cameras (EOS 20D digital model). Cameras were equipped with digital data recorders and date and time were associated with each frame, allowing it to be correlated with a particular sighting. The primary lens used was a Canon L series 300 mm / f4.0 image stabilizer telephoto. Usually, the lens was used with a 1.4 X teleconverter, thereby increasing its effective focal length. Images were shot at the highest available resolution (8.2 megapixels) and stored on Compact Flash cards (mostly 1.0 GB).

For photo-identification, generally, dolphin groups were approached slowly from the side and behind (4). Maneuvering the boat to within 15-40 m, directly alongside a moving group of dolphins resulted in the best shots. Every attempt was made to photograph each dolphin in the group, even those that appeared to have no unique markings. If possible, both sides of the dolphins were photographed, since the coloration markings are not completely symmetrical.

Data Analysis Methods

Line Transect Analysis

One day's survey effort was used as the sample for analyses. For estimation of density and abundance, only surveys with at least 2.0 km of useable effort were included. Estimates were calculated from sighting and effort data

(1) Jefferson T. A. and S. Leatherwood. 1997. Distribution and abundance of Indo-Pacific hump-backed dolphins (*Sousa chinensis* Osbeck, 1765) in Hong Kong waters. *Asian Marine Biology* 14:93-110.

(2) Jefferson T. A. 2000. Population biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs 144*:1-65.

(3) Jefferson T. A., S. K. Hung, L. Law, M. Torey, and N. Tregenza. 2002. Distribution and abundance of finless porpoises in Hong Kong and adjacent waters of China. *Raffles Bulletin of Zoology Supplement* 10:43-55.

(4) Würsig B. and T. A. Jefferson. 1990. Methods of photo-identification for small cetaceans. *Reports of the International Whaling Commission (Special Issue)* 12:43-52.

collected during conditions of Beaufort 0-3 (1) (2) (3), using line transect methods(4). The estimates were made using the computer program DISTANCE Version 2.2 (Laake *et al.* 1994) (5). The following formulae were used to estimate density, abundance, and their associated coefficient of variation:

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

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

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

where D = density (of individuals),

n = number of on-effort sightings,

f(0) = trackline probability density at zero distance,

E(s) = unbiased estimate of average group size,

L = length of transect lines surveyed on effort,

g(0) = trackline detection probability,

N = abundance,

A = size of the survey area,

CV = coefficient of variation, and

var = variance.

For the Northwest Lantau area, because the current study did not survey the entire survey area used in the long-term study, individual encounter rates for each season were calculated as a basis for comparison. This is largely equivalent to calculating densities, but it does not explicitly take into account variations in sightability of the dolphins. However, despite this, it provides a useful basis for comparison with future surveys. The encounter rates were calculated by dividing the number of individual dolphins observed on a particular day by the amount of effort conducted on that day. Seasonal averages and their standard deviations were then computed. Only data collected during Beaufort 0-3 conditions were used for this.

(1) Jefferson T. A. and S. Leatherwood. 1997. Distribution and abundance of Indo-Pacific hump-backed dolphins (*Sousa chinensis* Osbeck, 1765) in Hong Kong waters. *Asian Marine Biology* 14:93-110.

(2) Jefferson T. A. 2000. Population biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs 144*:1-65.

(3) Jefferson T. A., S. K. Hung, L. Law, M. Torey, and N. Tregenza. 2002. Distribution and abundance of finless porpoises in Hong Kong and adjacent waters of China. *Raffles Bulletin of Zoology Supplement 10*:43-55.

(4) Buckland S. T., D. R. Anderson, K. P. Burnham and J. L. Laake. 2001. Distance Sampling: Estimating Abundance of Biological Populations. Chapman and Hall, Landon, UK.

(5) Laake J.L., S. T. Buckland, D. R. Anderson and K. P. Burnham. 1994. DISTANCE User's Guide, Version 2.1. Colorado Cooperative Fish and Wildlife Research Unit, Fort Collins, CO, USA.

Pooling and Stratification Strategies

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 [(1)]. Data from the long-term database were pooled with data from the present study to increase sample sizes and improve the robustness of the analyses. It was applied directly to the Deep Bay areas. The Northwest Lantau area of the current study was defined specifically for this project, and this subarea was not used in the long-term study. Different strategies were used for various line transect components, and these are described below:

Sighting Rate [n/L] - Sighting rate varies strongly with season and area [(2) (3)], and thus a fully-stratified analysis (full stratification by both season and survey area) was used. Clearly, sighting rate is one of the major parameters affecting density and abundance estimates, and although sample sizes were small for some strata (n < 5), pooling of data was not deemed justified.

Trackline Probability Density [f(0)] - Because biases associated with small sample sizes can strongly affect the accuracy of density and abundance estimates, Buckland *et al.*'s [(4)] guidelines regarding minimal sample sizes for estimation of the trackline probability density were followed. They suggested a minimum sample size of 60 sightings for modeling of this parameter. Several mathematical models were fitted to the data (hazard-rate, half-normal, and uniform), and the model with the lowest value of the Akaike's Information Criterion was automatically chosen by DISTANCE for estimation of f(0). Because most seasons within a phase did not have adequate numbers of sightings, all the data (from all four seasons and the three main survey subareas) were pooled to calculate a single humpback dolphin trackline probability density, and then used this in all the estimates of density and abundance. This strategy ensured sample sizes of > 100 for humpback dolphins.

Average Group Size [E(s)] - Because of indications that group size varies by geographic region and season [(5) (6)], a fully-stratified analysis was used. DISTANCE computed both the arithmetic mean and a size-bias corrected mean; the lesser of these two values was used in the calculations (in order to avoid size-bias generally caused by missing smaller groups at large perpendicular distances).

(1) Buckland S. T., D. R. Anderson, K. P. Burnham and J. L. Laake. 2001. Distance Sampling: Estimating Abundance of Biological Populations. Chapman and Hall, Landon, UK.

(2) Jefferson T. A. 2000. Population biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Mongraphs 144*:1-65.

(3) Jefferson T. A., S. K. Hung, L. Law, M. Torey, and N. Tregenza. 2002. Distribution and abundance of finless porpoises in Hong Kong and adjacent waters of China. *Raffles Bulletin of Zoology Supplement 10*:43-55.

(4) Buckland S. T., D. R. Anderson, K. P. Burnham and J. L. Laake. 2001. *ibid.*

(5) Jefferson T. A. 2000. Population biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs 144*:1-65.

(6) Jefferson T. A., S. K. Hung, L. Law, M. Torey, and N. Tregenza. 2002. Distribution and abundance of finless porpoises in Hong Kong and adjacent waters of China. *Raffles Bulletin of Zoology Supplement 10*:43-55.

Trackline Detection Probability [g(0)] - For Hong Kong humpback dolphins, Jefferson (1) reported group dive time data and collected 71.8 hours of independent observer data, and from this estimated that the detection probability is unity for that study. The present study was an extension of Jefferson's study (2), with all survey techniques held constant. Therefore the previously estimated value of g(0) = 1.0 was used for all density and abundance calculations.

Coefficient of Variation [CV] – The variance component for the appropriate estimate of each component of the line transect equation was used in calculating the overall CV of the estimated density and abundance (see formula above). This resulted in more precise estimates for some areas and seasons than would have been the case with a fully-stratified analysis. However, this came at the expense of some slight potential for increase in bias.

Photo-identification and Age Class Composition

Photographs of dolphins taken during surveys were first examined and sorted into those that contained a potentially identifiable individual. Then, those photos were again examined in detail and any identifiable individuals were compared to the photo-ID catalog accumulated over the last 10+ years of dolphin research in Hong Kong and the Pearl River Estuary. Any new individuals were given a new identification number and their data were added to the catalog. Most of the analyses used data from the long-term database.

Observers attempted to classify dolphins observed into the six age classes identified in the long-term study on humpback dolphins in Hong Kong (see *Table 9.5*). However, many animals were not seen at close enough range to place them into an age class, and therefore only data on groups from which the age class composition of the entire group was determined were analyzed.

Grid Analysis of Habitat Use

For the quantitative grid analysis of habitat use of humpback dolphins and finless porpoises, positions of on-effort sightings were plotted onto 1 km^2 grids within the two survey subareas. Sighting densities (number of on-effort sightings per km^2) were calculated for each grid. Sighting density grids were then further normalized with the amount of survey effort conducted within each grid. The survey effort spent in each grid for each survey day was examined in detail (i.e., when the survey boat traversed through a specific grid once, one unit of survey effort was counted for that grid), and then the amount of survey effort per grid was calculated for all sighting density grids. After normalizing the original sighting density grids by survey effort, a new sighting density data were generated. The new density unit is termed "SPSE", representing the number of on-effort sightings

(1) Jefferson T. A. 2000. *ibid.*

(2) Jefferson T. A. 2000. *ibid.*

per unit of survey effort. This sighting density information was further elaborated to look at actual dolphin densities (exact number of dolphins from on-effort sightings per km^2). The new unit for this approach was termed "DPSE", which is the number of individual dolphins per unit of survey effort. Plotting the DPSE values of surveyed grid squares on maps allows areas where the most dense sightings of dolphins occur to be identified.

Ranging Pattern Analysis

Location data were obtained from the long-term sighting database and photoidentification catalog, and only those individuals sighted ten times or more were included for analysis of individual home ranges (1). A desktop GIS (ArcView© 3.1) with the Animal Movement Extension was used to examine individual ranging patterns. Using the Animal Movement Extension for ArcView©, a polygon joining the outermost sighting positions was formed, indicating the area used by an individual dolphin during the long-term study period. Range dimensions of the dolphin were then calculated by GIS with land masses excluded.

Behavioural Data Analysis

When dolphins were sighted during vessel surveys, their behaviors were recorded through direct observations and by digital video system. Different activities were categorized (i.e., feeding, milling/resting, traveling, socializing) and recorded on the sighting datasheets, and the dolphin behaviors were taped by a digital video recorder. These data were input into a separate database with sighting information, which was then used to determine the distribution of behaviors with desktop GIS.

Survey Results

Landbased Visual Survey

<u>Seasonal Records</u>

During February 2004 to January 2005, there were a total of 60 marine mammal surveys undertaken (a total of 360 hours). Over this period, only one of the two resident marine mammals in Hong Kong, the Indo-Pacific Humpback Dolphin *Sousa chinensis,* was observed and recorded at Black Point. There were 74 sighting records of humpback dolphins (a total of 141 individuals), and no sighting records of finless porpoise reported during the surveys. Seasonal records of marine mammal sightings are presented in *Table 8* of *Annex 9-A*. Humpback dolphins were recorded in all four seasons.

(1) Jefferson T.A. and S.K. Hung. 2004. A review of the status of the Indo-Pacific humpback dolphin in Chinese waters. *Aquatic Mammals (Special Issue) 30*: 149-158.

The locations of sightings within the 0.8km radius survey area were plotted in relation to season, and are presented in *Figure 9.15* [(1)].

Corrected for effort sightings and number of individuals of marine mammals are presented in *Figure 9.16*.

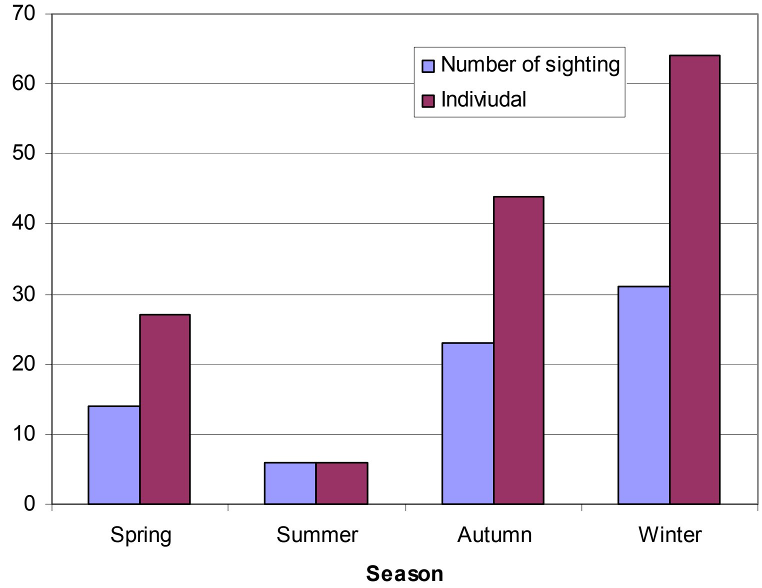

Figure 9.16 ***Number of Sightings and Individuals of Indo-Pacific Humpback Dolphin*** **Sousa chinensis** ***at Black Point (Data collected from February to January 2005)***

Humpback dolphins exhibited a seasonal pattern at Black Point. The majority of dolphins (seasonal average) were recorded in winter (with 31 sightings and 64 individuals) and autumn (with 23 sightings and 44 individuals) (*Figure 9.16*). Only a few sightings of *Sousa chinensis* were recorded during summer and spring months [(2)] .

Marine Mammal Age Class

The majority of humpback dolphins recorded during the land-based surveys were identified as Adults (SA/ UA/ SP/ MO) (109 individuals). Juveniles (UJ) (25 individuals) and Calves (UC) (7 individuals) were also recorded(*Table 8* of *Annex 9-A)*.

Vessel Based Visual Survey

<u>Data Collected</u>

In the 11 months (July 2005 to May 2006) of this study, 70 days of survey have been conducted. During this time, a total of 1,561 km of transect lines were

(1) There are certain limitiations associated with the land-based survey. It should be noted that there is a decrease in detection objects with increase in distance from the observer. It should also be noted that areas to the south of Black Point were obstructed from view..

(2) These seasonal trends in dolphin abundance also evident from vessel-based survey results (see Sections below).

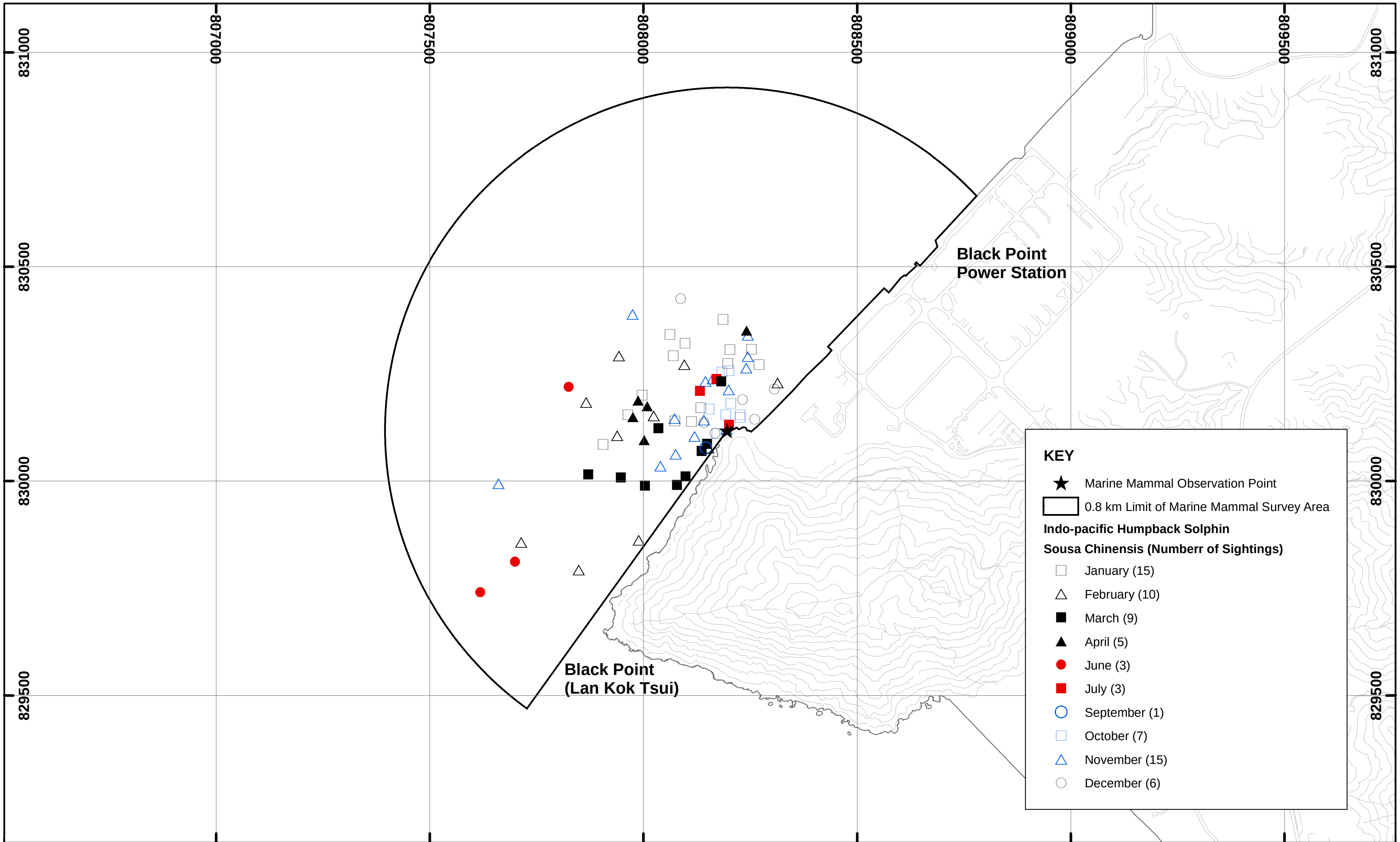

Figure 9.15

Land-based Marine Mammal Sighting Records
(Survey data collected from February 2004 to January 2005)

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Date: 03/07/2006

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surveyed. Of this, 1,291 km (83% of the total) were done during relatively calm sea conditions of Beaufort 0-3, and therefore were useable in the estimation of density and abundance. Of the effort conducted in Beaufort 0-3 conditions, 385 km was in Northwest Lantau, and 906 km was in Deep Bay.

There were a total of 87 sightings of Indo-Pacific Humpback Dolphins during the LNG surveys. Most sightings took place in Northwest Lantau (n = 62), and fewer in Deep Bay (n = 25).

Distribution

It is important to recognize that, due to differential survey effort in various survey subareas, it is not possible to compare densities of dolphins by examining maps of distribution. The distribution maps are only useful for determining where animals do and do not occur, and for comparing use of the area on a small scale (within a survey subarea). Comparisons of density or habitat use on a larger scale should make use of numerical density estimates or the results of the grid analyses (discuss below).

Dolphins were observed throughout both of the surveyed areas, and sightings occurred in nearly all areas except directly south of the Sha Chau/ Lung Kwu Chau Marine Park and at the very northern end of the Deep Bay survey area (*Figure 9.17*). To date, there appears to be no strong seasonal differences in distribution of dolphins between the different survey subareas, except there are fewer dolphins around in the spring months (*Figures 9.18* & *9.19*).

The distribution of young dolphins (Unspotted Calves and Unspotted Juveniles) (*Figures 9.20* & *9.21*) indicated that they were concentrated in two areas: (1) southern Deep Bay, and (2) around Lung Kwu Chau. If the analysis focuses at Unspotted Calves, then Deep Bay drops-out, and only the latter area looks to be important. One further point of interest is the strong tendency for any Unspotted Calves and Unspotted Juveniles in the Northwest Lantau area to be found close to (within a few hundred meters of) Lung Kwu Chau – consistent with previous indications that the waters around Lung Kwu Chau may be a "nursery area."

The distribution of dolphins engaged in feeding and socializing behaviours are shown in *Figures 9.22* & *9.23*, respectively. These will be discussed in more detail under the Behaviour section below.

Abundance and Density

Estimates of density and abundance, and their associated parameters are presented for Deep Bay in *Table 9.8*. For humpback dolphins, Deep Bay had low densities (0.08 - 0.23 dolphins km^{-2}) and low estimates of abundance (<10 dolphins in all seasons). It is clear that dolphins use the mouth of Deep Bay at a low level throughout the year. Northwest Lantau had higher levels of dolphin density (0.57-0.94) and abundance (49-82) than Deep Bay.

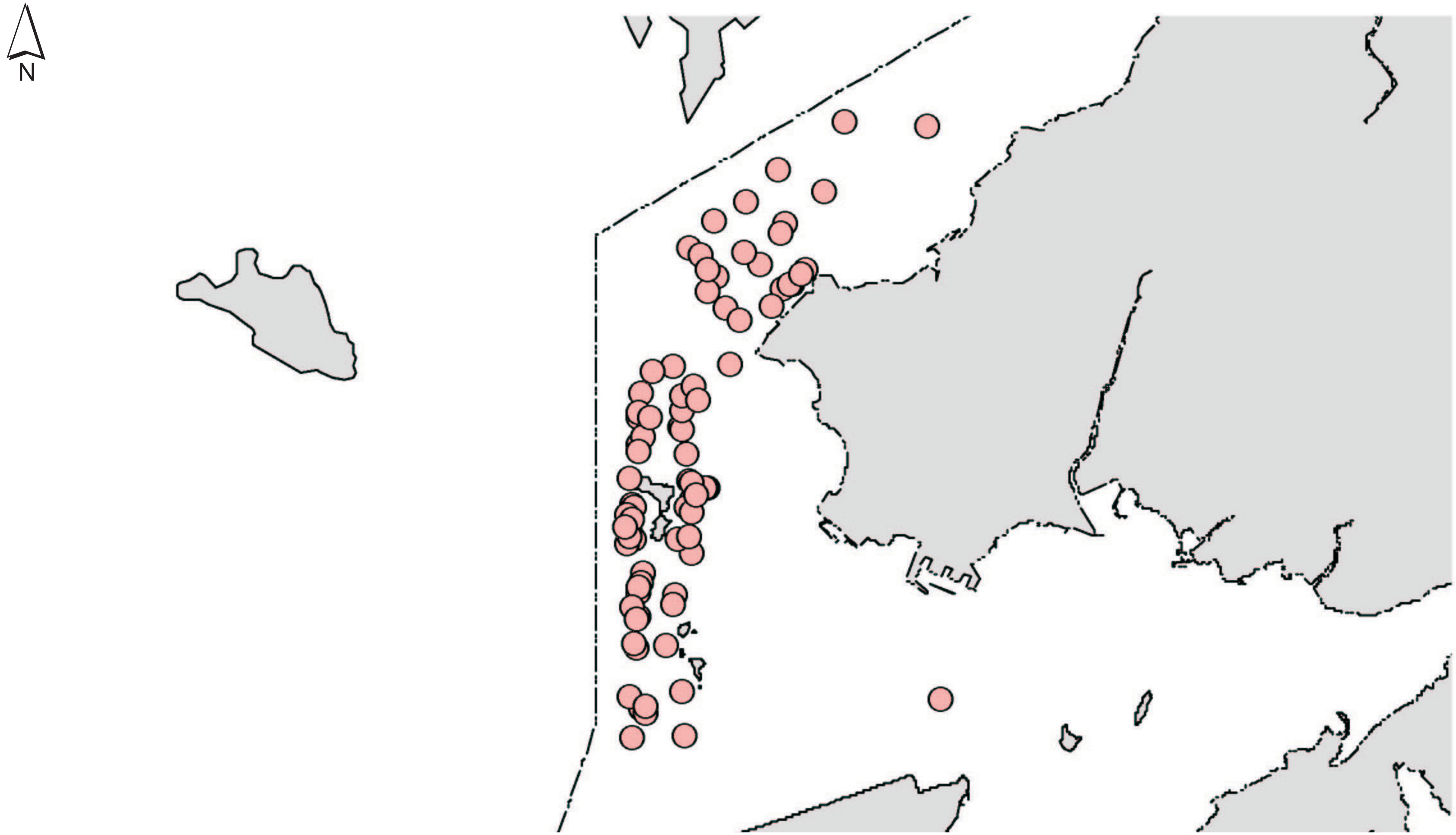

Figure 9.17

Distribution of Indo-Pacific Humpback Dolphin recorded during the 11 months (July 2005 - May 2006) Survey

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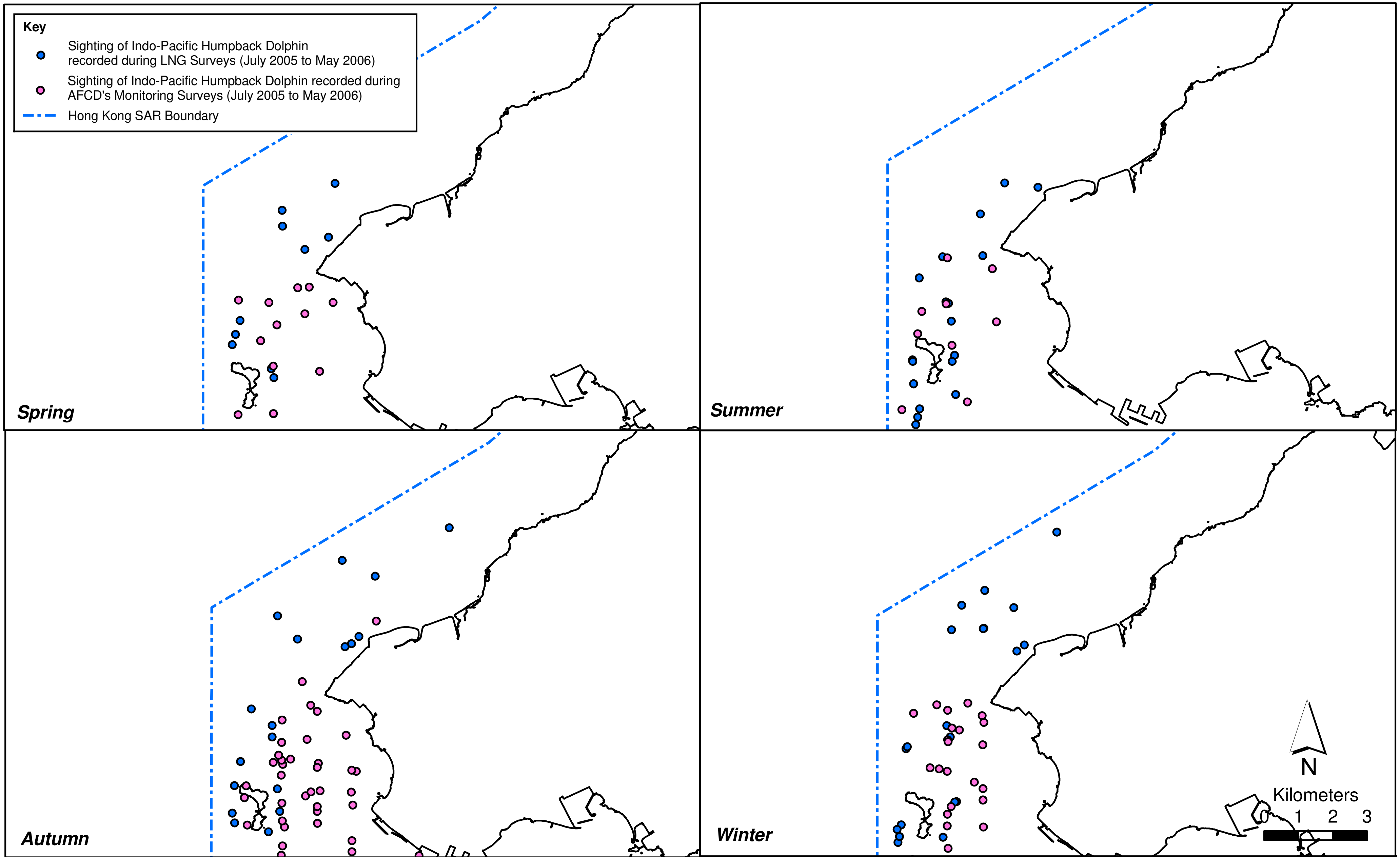

Figure 9.18

Distribution of Indo-Pacific Humpback Dolphin with Seasonal Variation at Deep Bay

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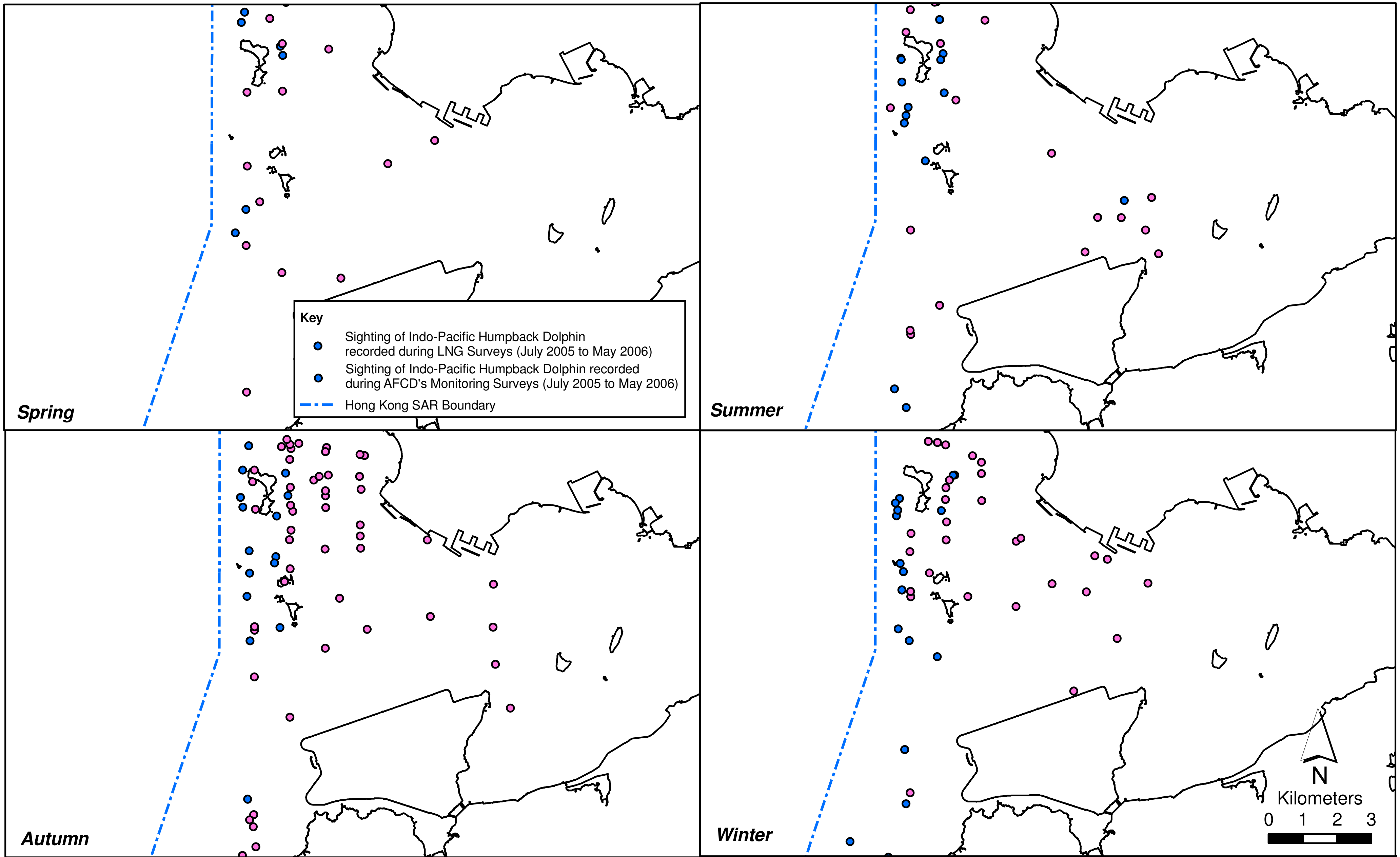

Figure 9.19

Distribution of Indo-Pacific Humpback Dolphin with Seasonal Variation at Northwest Lantau

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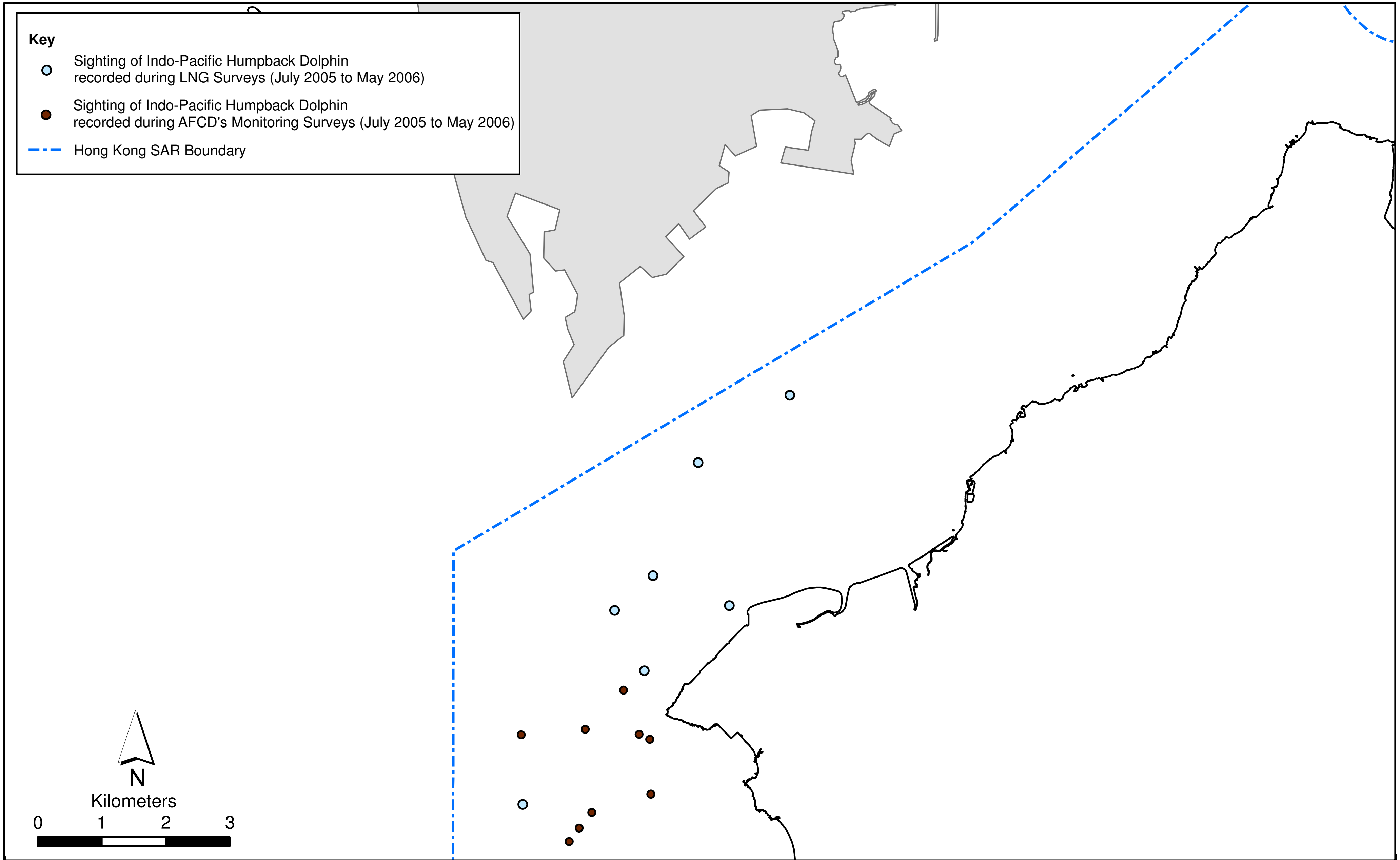

Figure 9.20

Distribution of Young Animals of Indo-Pacific Humpback Dolphin
(Unspotted Calves and Unspotted Juveniles) at Deep Bay

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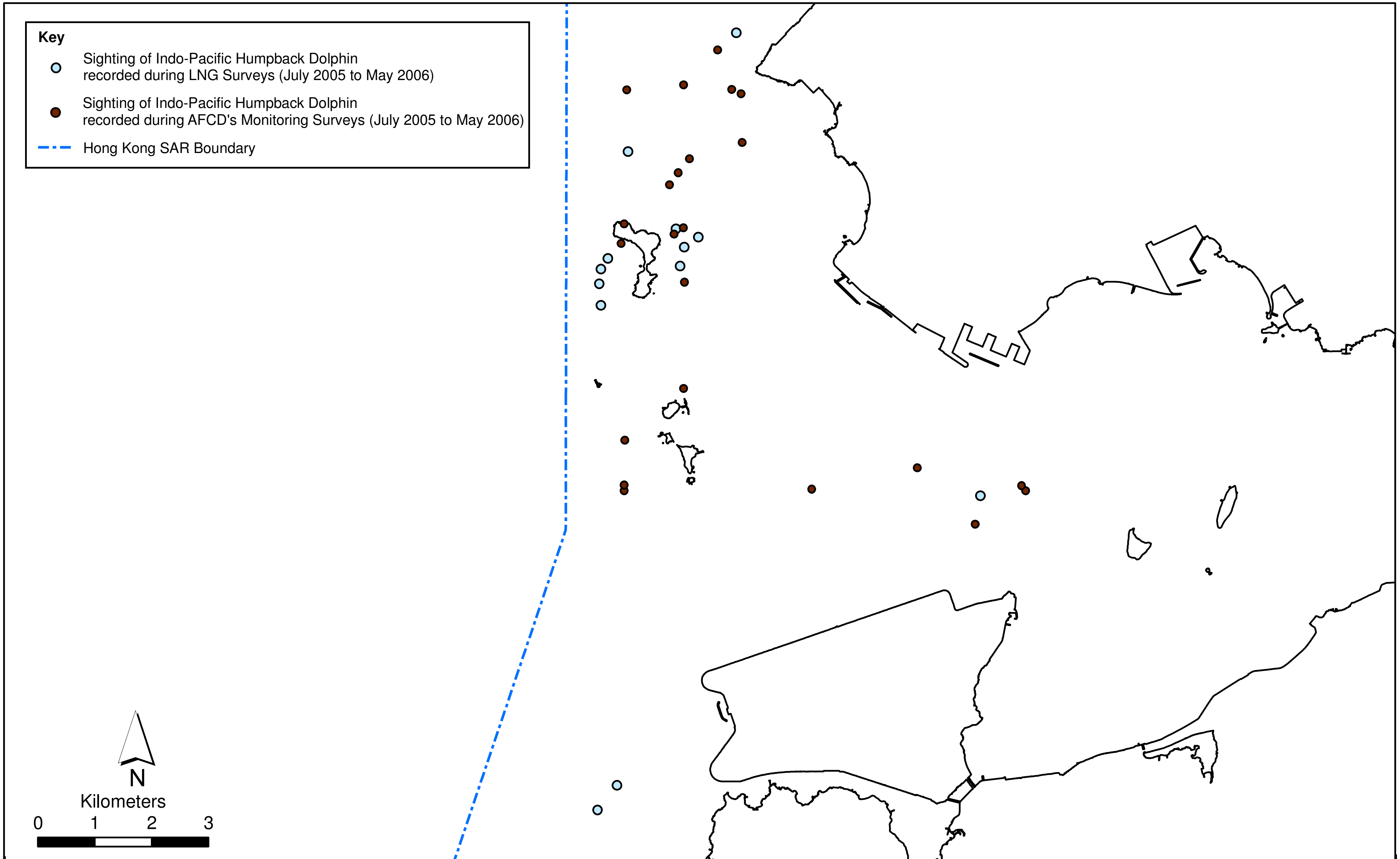

Figure 9.21

Distribution of Young Animals of Indo-Pacific Humpback Dolphin
(Unspotted Calves and Unspotted Juveniles) at Northwest Lantau

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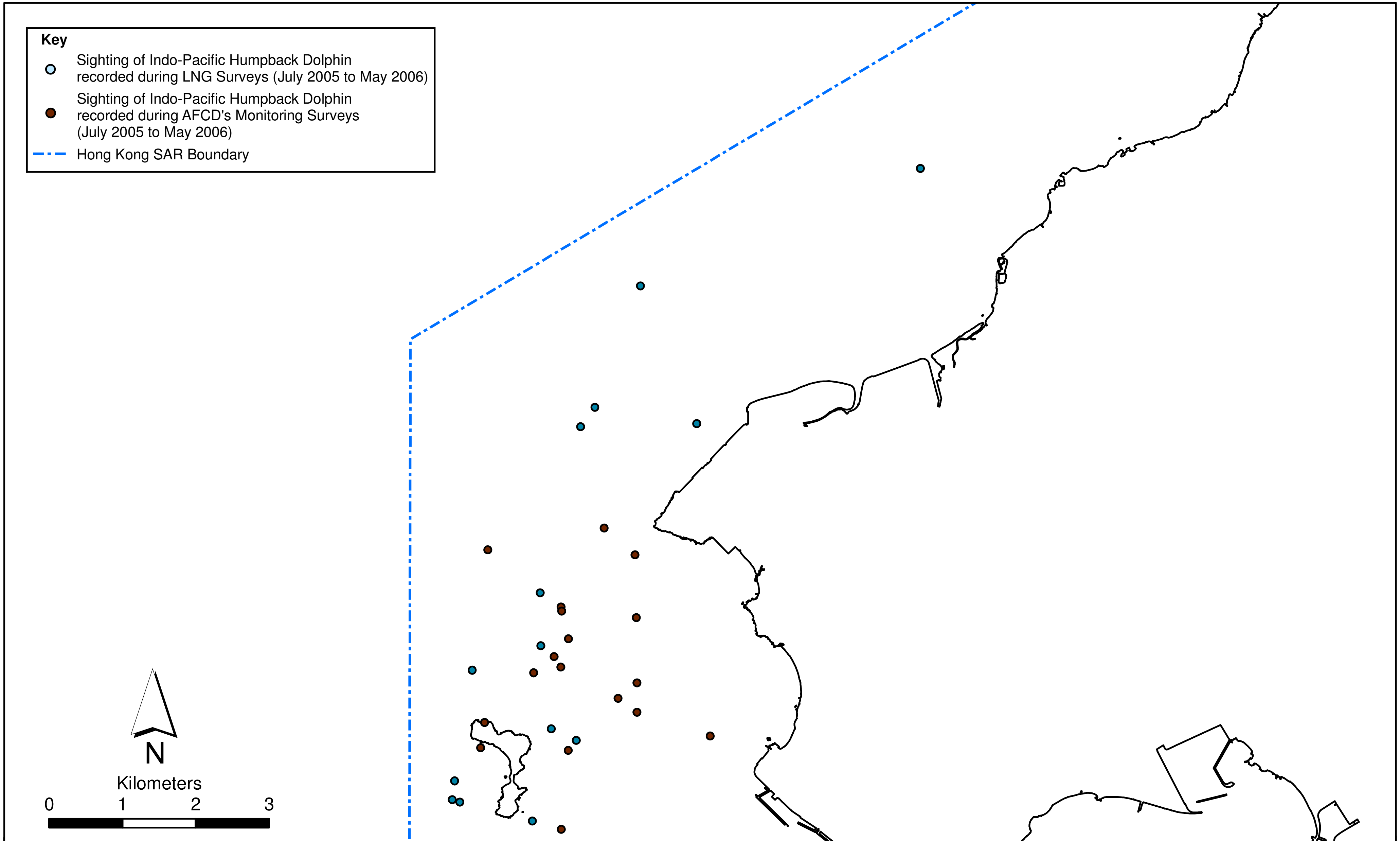

Figure 9.22

Distribution of Indo-Pacific Humpback Dolphin with Feeding Activities at Deep Bay

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Date: 11/10/2006

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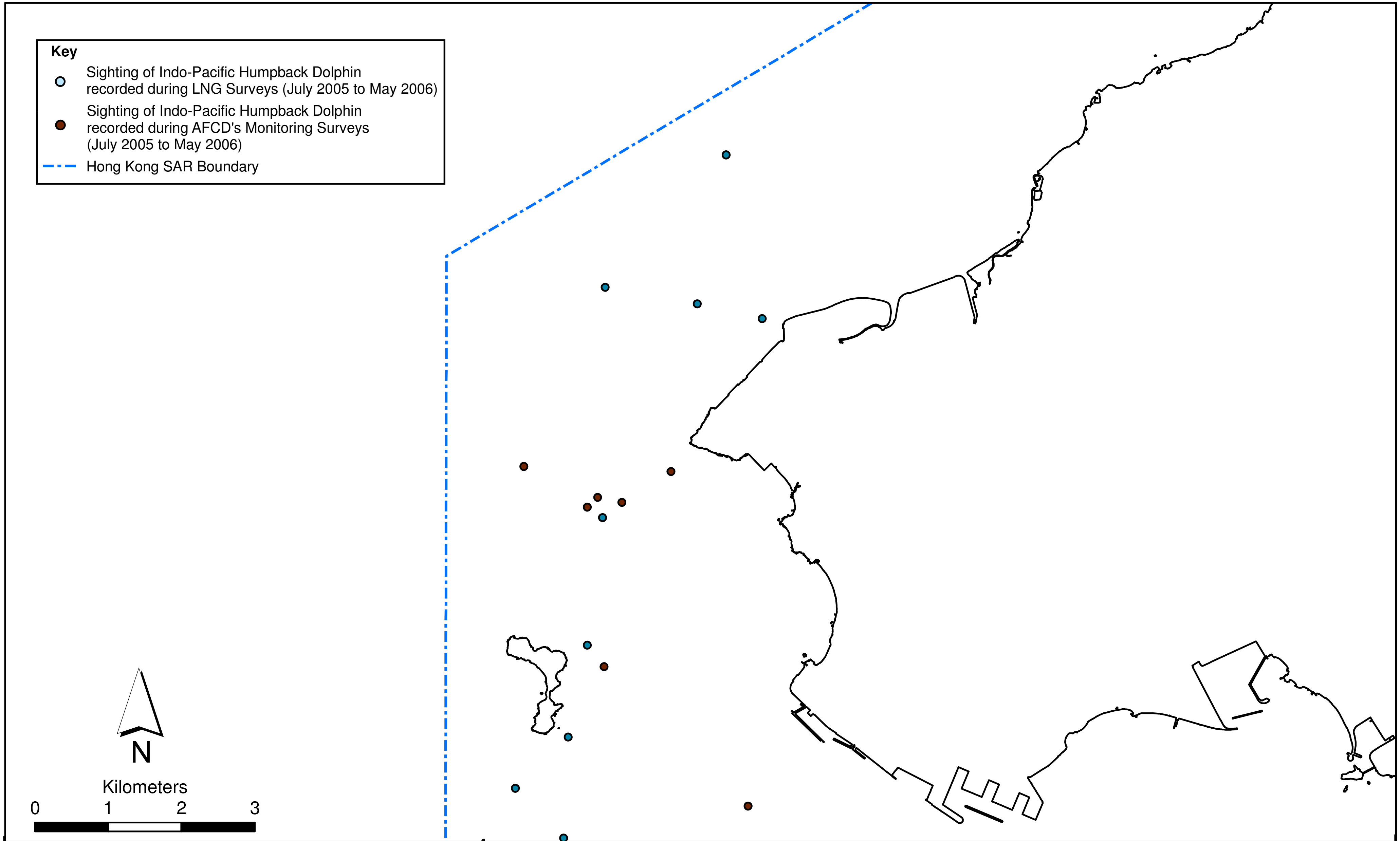

Figure 9.23

Distribution of Indo-Pacific Humpback Dolphin with Socialising Activities at Deep Bay

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Table 9.8 ***Estimates of Abundance and Associated Parameters for Humpback Dolphins in Deep Bay Survey Subareas (NWL is discussed in the text).***

Survey Area	Survey Days	L (km)	n	f(0) (km^{-1})	E (s)	D (km^{-2})	N	CV (%)
Indo-Pacific Humpback Dolphin *Sousa chinensis*								
Deep Bay								
Winter	19	314	11	4.7071	2.72	0.23	7	46
Spring	21	354	5	4.7071	4.80	0.16	5	55
Summer	21	376	5	4.7071	2.60	0.08	2	49
Autumn	20	374	9	4.7071	4.11	0.23	7	42
Northwest Lantau								
Winter	36	1,051	107	3.6502	3.90	**0.73**	63	17
Spring	36	1,059	93	3.6502	3.51	**0.57**	49	17
Summer	38	1,084	113	3.6502	3.78	**0.72**	63	15
Autumn	38	1,229	152	3.6502	4.16	**0.94**	82	12

Note: (1) L=total length of transect surveyed; n=number of on-effort sightings; f(0)=trackline probability density; E(s)=unbiased mean group size; D=individual density; N=individual abundance; and CV=coefficient of variation.
(2) Only data collected in Beau 0-3 conditions are included here.
(3) As explained previously, the individual density value (D) represents an estimate of the number of individual dolphins in a 1 km^2 grid square area.

For the Northwest Lantau area, the seasonal estimates of average individual encounter rate are also shown in *Table 9.9*. Encounter rates increased from summer to autumn and then increased again from autumn to winter, finally decreasing dramatically in spring months [(1)].

Table 9.9 ***Individual Encounter Rate Information for Dolphins in Northwest Lantau (Analysis Uses only Data Collected during Beaufort 0-3 Conditions)***

Season	No. Surveys	Individuals	Encounter Rate	Std. Dev.
Summer	7	36	24.9	31.7
Autumn	6	53	46.5	20.6
Winter	3	65	166.3	52.6
Spring	6	18	17.1	20.9

Grid Analysis of Habitat Use (July 2005 – 2006)

Grid analysis of habitat use provides the best way to compare dolphin use of specific areas, especially on a small scale. Because the data are standardized for differential survey effort, it is possible to compare density of two grids, even if they are in different survey subareas.

Using the line-transect survey data from the 11 months of the study, combined with AFCD data collected during the same period, survey effort data and dolphin sighting data were retrieved to calculate DPSE values for 158 grids among the four study subareas. The map of dolphin density (DPSE) with corrected survey effort per km^2 of the two areas is shown in *Figure 9.24*.

(1) These data reflect a similar trend to estimates of abundance for Northwest Lantau presented in Jefferson 2005 *ibid*. (Winter: 73 (cv=23%), Spring; 47 (cv=22%), Summer: 72 (cv=18%) and Autumn: 103 (cv=18%).

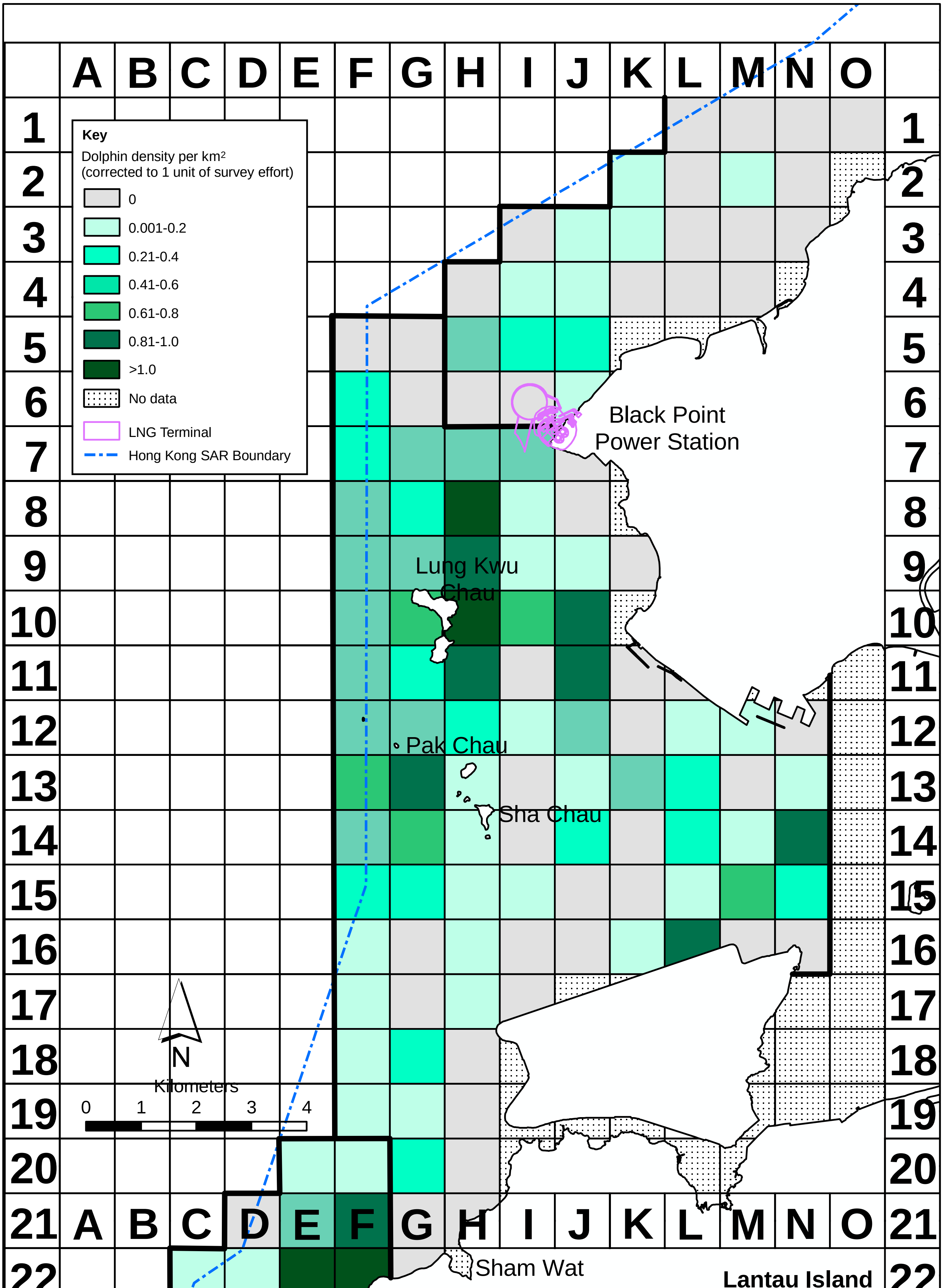

FIGURE 9.24

Density of Chinese White Dolphins with Corrected Survey Effort per km in Waters around Black Point (Using data from ERM's July 2005-May 2006 survey combined with AFCD's monitoring data for the same period)

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Date: 05/09/2006

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The western end of Northwest Lantau indicated high dolphin usage, with average DPSE values and 0.443 respectively. However, Deep Bay was only used to a small extent (*Table 9.10*).

Table 9.10 Average DPSE for Different Survey Subareas during the Study

	# grids	Ave. DPSE	# grids w/ DPSE>1
Deep Bay	26	0.06 ± 0.12	0
Northwest Lantau	28	0.44 ± 0.54	2

Habitat use of humpback dolphins was very uneven among the 1 km^2 grids in the two areas. In Deep Bay, dolphin usage was higher toward the south western end of the survey area, and the highest densities occurred near the Black Point Power Station (Grids H5, I5 & J5). In Northwest Lantau, dolphin usage was higher around Lung Kwu Chau, especially at the eastern sides of the island. Dolphin densities were also higher around the small island of Pak Chau (Grid G13). On the contrary, the southern portion of Northwest Lantau was less heavily used by dolphins, especially the waters just west and northwest of the airport platform.

<u>Grid Analysis of Habitat Use (Seasonal)</u>

To examine the seasonal habitat use patterns of humpback dolphins quantitatively in recent years, survey effort and dolphin sighting data from the long-term monitoring database and the additional LNG survey data were stratified by season to calculate DPSE values (total number of dolphin/porpoises per unit of survey effort) within 1 km^2 grids in the survey subareas. For humpback dolphins, line-transect data collected during 2003-06 was used, and DPSE values for grid squares in Deep Bay, Northwest Lantau and Northeast Lantau were examined (see *Figure 9.25*).

Seasonal habitat use patterns were less obvious in Northwest Lantau, and dolphins appeared to use this area as their important habitats with very high densities throughout the four seasons. Several areas were heavily used by dolphins in all four seasons, including the northern waters of Lung Kwu Chau (G9-10 & H9-10).

In Northeast Lantau, dolphin densities were moderately high in summer, autumn and winter months, but were generally low in spring months. Off Black Point (I7), dolphin density was highest in autumn. Similarly, the waters around the Brothers Islands were used consistently throughout the year, with higher dolphin densities in summer and autumn months.

In Deep Bay, dolphin usage was very low in spring and summer months, but was more intensified in autumn and winter months. In these two seasons, dolphins appeared to have preference to use the waters near the mouth of Deep Bay (H5, I5 & J55).

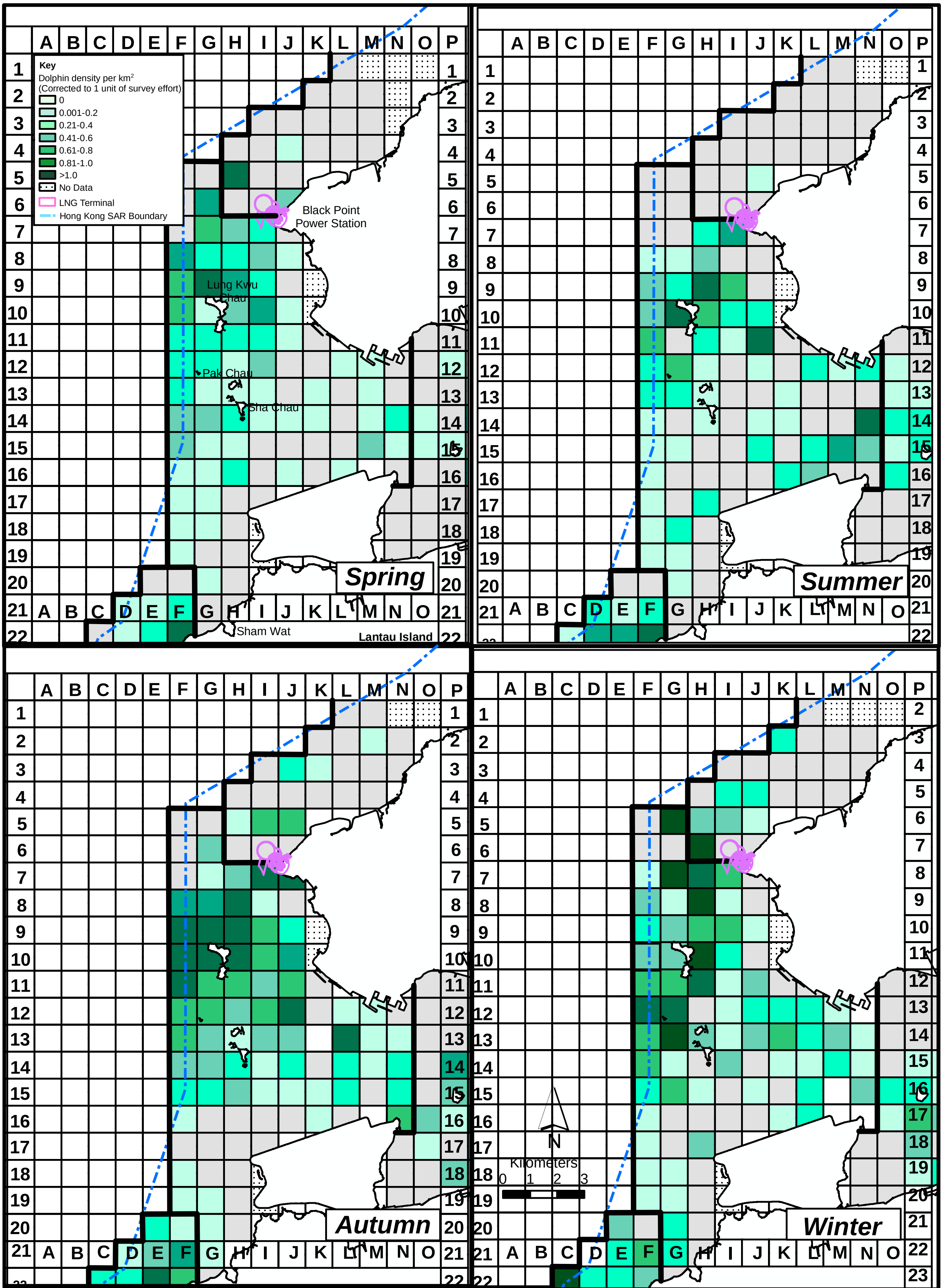

FIGURE 9.25

Seasonal Density of Chinese White Dolphins with Corrected Survey Effort per km^2 in Western Waters around Deep Bay and Northwest Lantau (Using 2003-2006 data)

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Individual Movements and Patterns of Use

During the study period, a number of individual dolphins in both of the study subareas were successfully identified. The individuals identified so far are listed in *Table 9.11*, along with an assessment of the importance of the subarea as part of the dolphin's home range. The subarea was considered an important part of the dolphin's range if >25% of the sightings of that individual occurred in the area.

Table 9.11 ***Individual Humpback Dolphins Observed during the LNG Study (July 2005 – May 2006)***

Dolphin's ID	Total sightings (1)	EIA Study sightings (2)	DB (3) (4)	West NWL (3) (4)	HR Study?
CH03	18	1		4 (22%)	Yes
CH37	7	1		1 (14%)	
DB02	2	2	**2 (100%)**		
DB03	1	1	**1 (100%)**		
EL01	43	1		6 (14%)	Yes
EL03	5	1		1 (20%)	
EL07	57	1		2 (4%)	Yes
NL11	45	3	1 (2%)	**16 (36%)**	Yes
NL24	95	2		18 (19%)	Yes
NL37	35	1		5 (14%)	Yes
NL46	15	1		**8 (53%)**	Yes
NL59	18	1		3 (17%)	Yes
NL60	16	1		**8 (50%)**	Yes
NL76	10	1		**6 (60%)**	Yes
NL98	47	1		6 (13%)	Yes
NL123	43	5		**11 (26%)**	Yes
NL128	10	1		1 (10%)	Yes
NL136	8	1		**5 (63%)**	
NL139	42	1		5 (12%)	Yes
NL141	31	1		6 (19%)	Yes
NL150	7	1	1 (14%)	**6 (86%)**	
NL169	10	3	**3 (30%)**	**6 (60%)**	Yes
NL170	4	1		**2 (50%)**	
NL181	14	5	**4 (29%)**	**9 (64%)**	Yes
NL191	9	1		2 (22%)	
NL202	6	1		**4 (67%)**	
SL07	13	2			Yes
WL11	16	2		**6 (38%)**	Yes
WL25	22	2		1 (5%)	Yes
WL30	2	1	**1 (50%)**		

Note: (1) Total sightings in the long-term database.
(2) Sightings in ERM's surveys (July 2005 – May 2006) for this EIA Study.
(3) Number of sightings in each of the LNG survey areas (along with the proportion of the total in parentheses).
(4) Areas with >25% of the total sightings are in bold.

Twenty-six dolphins were observed in Northwest Lantau during the LNG surveys, and there appear to be at least 12 different dolphins that used Northwest Lantau as part of their range during the study period.

The Deep Bay subarea contains the Black Point site at its southern boundary. Only seven dolphins in Deep Bay were identified during the LNG study. However, of these, five (DB02, DB03, WL26, NL169 and NL181) appeared to use Deep Bay as a portion of their home range during the study period (although the sample sizes were small). In addition, two other dolphins were identified in Deep Bay in previous surveys, and both of them used it as a part of their home range.

The ranging patterns of 18 individual dolphins identified during the 11-month surveys are shown in *Figures 9.28* & *9.29*. Of these individuals, 18 were identified in Northwest Lantau, and three in Deep Bay.

Currently, among the 398 individuals identified in Hong Kong and Chinese waters of the Pearl River Estuary, 59 individuals (15%) were re-sighted 10 or more times, which were used in the ranging pattern analysis. Among them, 51 individuals (86%) had home ranges covering the western end of Northwest Lantau. On the contrary, only one (NL11) had range covering Deep Bay. The large proportion of identified individuals sighted in Northwest Lantau strongly suggested the importance of this habitat to dolphins residing in the Pearl River Estuary.

Group Size and Composition

Humpback dolphin average group size was smaller for the Deep Bay than for the Northwest Lantau subarea (*Table 9.12*).

Table 9.12 ***Average Group Size for Dolphins and Porpoises among the Different Survey Subareas***

Species	Subarea	N	Mean	±Sd	Range
Humpback dolphin	Deep Bay	55	3.0	2.37	1 to 12
	Northwest Lantau	62	3.7	2.89	1 to 17

Due to the need to observe dolphin groups for extended periods at close range (which somewhat conflicted with the goal of completing all the transect lines), the surveys were only able to accurately record complete age class composition for a portion of the groups observed in each area (*Table 9.13*). In this subsample, no Unspotted Calves were found in Northwest Lantau. However, as discussed previously, Unspotted Calves are seen in Northwest Lantau waters with sightings clustered within a few hundred meters of Lung Kwu Chau.

Table 9.13 ***Age Class Composition of Groups of Dolphins among the Two Survey Subareas (Percentage of Total Given in Parentheses). Note that only groups in which the composition of the entire group was determined are presented***

Area	No. of Groups	UC	UJ	SJ	SS	SA	UA
Deep Bay	19	4 (7%)	8 (14%)	13 (24%)	14 (25%)	13 (23%)	4 (7%)
Northwest Lantau	16	0 (0%)	5 (11%)	6 (13%)	12 (26%)	18 (39%)	5 (11%)

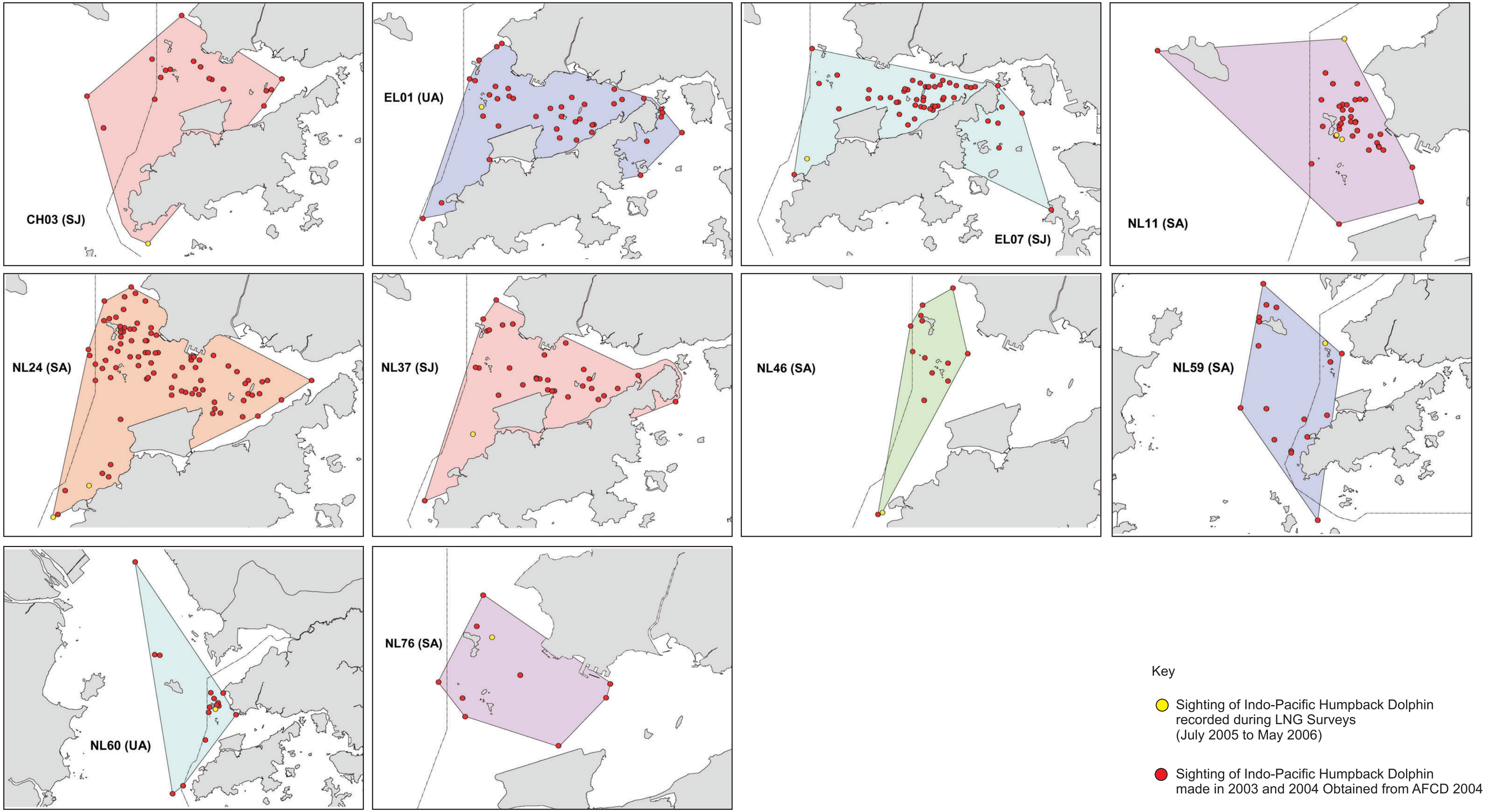

Figure 9.28

Ranging Pattern of Selected Individual Indo-Pacific Humpback Dolphin Present in the Western Waters of Hong Kong during the 11 months (July 2005 - May 2006) Surveys

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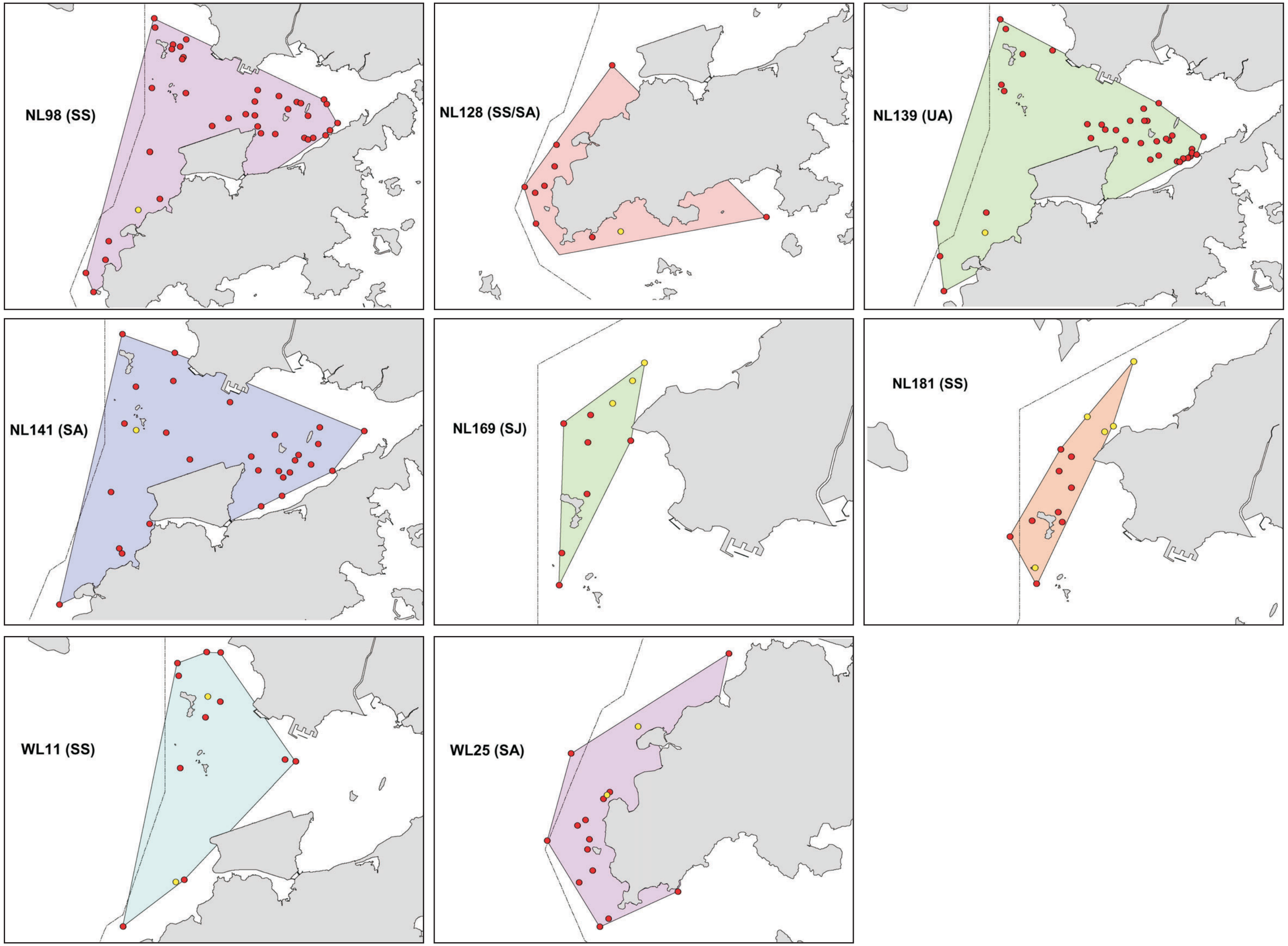

Key

Sighting of Indo-Pacific Humpback Dolphin recorded during LNG Surveys (July 2005 to May 2006)

Sighting of Indo-Pacific Humpback Dolphin made in 2003 and 2004 Obtained from AFCD 2004

Figure 9.29

Ranging Pattern of Selected Individual Indo-Pacific Humpback Dolphin Present in the Western Waters of Hong Kong during the 11 months (July 2005 - May 2006) Surveys

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DATE: 23/06/2006

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Besides that mentioned above, there were no dramatic differences in group composition among the different subareas, but there were some differences in the age classes most represented (i.e., those with greater than 20% of the total).

Behaviour

Dolphin sightings associated with different types of activities were examined on GIS to determine important areas for certain types of dolphin activity. In Northwest Lantau, most of the feeding activities occurred around Lung Kwu Chau and Sha Chau (*Figures 9.22* & *9.23*). Feeding activities were rarely observed in Deep Bay.

Dolphins were occasionally observed socializing during the study period, and there was no particular area where sightings associated with socializing activities were frequently observed. These socializing sightings were sparsely made around Lung Kwu Chau and within Deep Bay (*Figures 9.22* & *9.23*).

9.4 *EVALUATION OF ECOLOGICAL IMPORTANCE OF THE STUDY AREA*

The existing conditions of the marine ecological habitats and resources in the waters of the proposed LNG terminal at Black Point have been assessed. These baseline conditions have been based on available literature and, where considered necessary, detailed field surveys to update and supplement the data. Based on this information, the ecological importance of each habitat has been determined according to the *EIAO-TM Annex 8* criteria, as follows:

- Naturalness
- Size
- Diversity
- Rarity
- Re-creatability
- Fragmentation
- Ecological Linkage
- Potential Value
- Nursery Ground
- Age
- Abundance

9.4.1 *Intertidal Habitats*

The criteria listed below have been applied to the information gathered or reviewed on the marine ecology of the intertidal habitats at Black Point in order to determine the ecological value. The application of these criteria has led the artificial shoreline and natural rocky shore to be classified as low ecological importance (*Table 9.13*).

Table 9.14 Ecological Importance of Intertidal Habitats at Black Point

Criteria	Rocky Shore	Artificial Shorelines
Naturalness	The natural rocky shoreline is interspersed with areas of artificial seawall and are largely undisturbed prior to the development of the thermal power station (BPPS) commenced in 1993.	Artificial, constructed habitat.
Size	Large. Within the Study Area, rocky shore habitat are approximately 600 m in total length and are predominant habitat on Black Point headland.	Large. The total length of the artificial shore in the Study Area at Black Point is approximately 120 m and are predominant habitat to the north of the power station.
Diversity	Low. The intertidal communities are composed of typical biota of semi-exposed rocky shores in Hong Kong, but with low diversity.	Records indicate that sloping artificial shores support similar assemblages to natural intertidal shores.
Rarity	No species recorded are considered rare or of recognised conservation interest.	No species recorded are considered rare or of recognised conservation interest.
Re-creatability	The habitat can be re-created.	n/a.
Fragmentation	Low. The surrounding environment contains similar intertidal habitats.	Low. The surrounding coastlines are composed of a mixture of natural and artificial intertidal shores.
Ecological Linkage	The habitat is not functionally linked to any high value habitat in a significant way.	The habitat is not functionally linked to any high value habitat in a significant way.
Potential Value	Unlikely that the site can develop conservation interest.	Unlikely to become an area of conservation value
Nursery Area	No significant records identified during the literature review or field surveys.	No significant records identified during the literature review or surveys.
Age	n/a for these assemblages as the life cycle of the fauna and flora is very short.	The artificial seawall has been in place since the site access of Black Point Power Station was obtained in March 1993.
Abundance	Typical of other semi exposed shores in Hong Kong.	Lower abundance than natural rocky shore habitat.
SUMMARY	The fauna of the intertidal region appears to be typical of semi exposed shores in Hong Kong, but with low diversity. The sites appear to have suffered some human disturbance. **Ecological Importance - Low.**	The fauna of the intertidal region of the artificial shores is reported to support a similar diversity and abundance of intertidal organisms as natural shores. **Ecological Importance - Low.**

Note: n/a: Not Applicable

9.4.2 *Subtidal Habitats*

The criteria listed above have been applied to the information gathered or reviewed on the marine ecology of the subtidal soft bottom benthic habitat at Black Point in order to determine the ecological importance. The application of these criteria has led the habitat to be classified as of low - moderate ecological importance (*Table 9.15*).

Table 9.15 Ecological Importance of the Subtidal Soft Benthos Assemblages at Black Point and the Study Area

Criteria	Subtidal Soft Benthos at Black Point (BP1, BP2 and UR)
Naturalness	Habitat disturbed to some extent by fisheries vessel trawling activities and is influenced by discharges from the Pearl River and Shenzhen River.
Size	Large in extent.
Diversity	The assemblages are of similar diversity to other areas in the western waters.
Rarity	No organisms were found that are considered as rare or of conservation interest.
Re-creatability	Benthic organisms may recolonise disturbed seabed area.
Fragmentation	The habitat is not fragmented.
Ecological Linkage	The habitat is not functionally linked to any high value habitat in a significant way.
Potential Value	Unlikely that the site can develop conservation interest.
Nursery Area	No significant record identified in the review or surveys.
Age	The fauna appear to be typical of those present in Hong Kong's soft benthos. The sediments in the habitat are constantly accreting and eroding and the fauna present there are typically short lived.
Abundance	In comparison to parts of the southern and western waters the assemblages are of moderate abundance.
SUMMARY	The sediments support moderate diversity and abundance of benthic organisms that are typical of Hong Kong's benthos. **Ecological Importance – Low – Moderate.**

Note: n/a: Not Applicable

9.4.3 *Marine Waters off Black Point*

The same assessment criteria have been applied to the marine waters within the Study Area with regard to the usage of the area by marine mammals. This habitat has been classified as of medium importance on the use of the area by Indo-Pacific Humpback Dolphins *Sousa chinensis* (*Table 9.16*).

Table 9.16 Ecological Importance of the Marine Waters off Black Point

Criteria	Marine Waters off Black Point and the Study Area
Naturalness	Close proximity to marine traffic lanes in Hong Kong.
Rarity	Indo-Pacific humpback dolphin *Sousa chinensis* has been recorded in coastal waters near Lan Kok Tsui and off Black Point Power Station.
Re-creatability	n/a
Ecological Linkage	Preferred marine mammal habitat occurs to the south (north-western and west Lantau) for humpback dolphin. Based on photo-identification studies, identified individual dolphins sighted near Black Point have extensive home ranges which span large areas of North Lantau waters and beyond (see *Figures 9.28* and *9.29*). In this context, Black Point waters form only a small portion of individual dolphin's home range.
Potential Value	Limited value due to fishing activities and marine traffic of the area.
Nursery Area	Not key nursery area in the review of baseline conditions or field surveys.
Abundance	Seasonal changes in the distribution patterns of dolphins were observed near the areas of the proposed LNG terminal, with comparatively higher densities in autumn and winter months. Analysis of dolphin density data indicates these animals occur in moderate densities in waters in proximity to the proposed reclamation.
SUMMARY	Sightings of humpback dolphin have been made in these waters in all seasons in spite of significant vessel traffic, and dolphin density (DPSE) levels in waters in proximity to the proposed reclamation are considered to be moderate compared to preferred habitat elsewhere in Northwest Lantau and West Lantau. **Ecological Importance – Medium** for humpback dolphin at Black Point**.**

9.4.4 *Species of Conservation Interest*

In accordance with *EIAO-TM Annex 8* criteria, an evaluation of species of conservation value recorded from the Study Area is presented in *Table 9.17.*

Table 9.17 Species of Conservation Interest within the Study Area

Common Name	Scientific Name	Protection Status	Distribution, Rarity and other Notes
Chinese White Dolphin (also known as the Indo-Pacific Humpback dolphin)	*Sousa chinensis*	Wild Animals Protection Ordinance Class I Protected Species in the PRC. CITES Appendix 1	Range across Pearl River estuary and across Hong Kong western and Southern Waters from Deep Bay to Lamma.

9.5 SUMMARY

The findings from the literature review and field surveys on marine ecological conditions are detailed above and are summarized as follows.

The key finding of the literature review was the recorded presence in the waters in outer Deep Bay of the Indo-Pacific humpback dolphin *Sousa chinensis*. The review highlighted that the waters around Black Point reported sightings occurred throughout the year.

No recent studies of the subtidal hard bottom habitats in vicinity to the proposed Black Point LNG terminal have been conducted.

Due to the limited literature available for some components of the marine environment, field surveys were necessary to fill the information gaps identified for the baseline conditions of the habitats. The baseline surveys commenced in February 2004 and have included both the dry and wet seasons. Detailed and comprehensive seasonal surveys were conducted examining the major habitats and species surrounding Black Point and the Study Area. The details of the baseline surveys are summarized in *Table 9.18*.

Table 9.18 Marine Ecology Baseline Surveys

Survey Type	Methodology	Date
Intertidal Assemblages	Quantitative (belt transects at 4 locations) survey, three 100 m belt transects (at high, mid and low intertidal zones) for each location, covered both wet and dry seasons.	22 & 23 March and 15 & 30 July 2004
Subtidal Benthic Assemblages	Quantitative grab sampling survey; covered both wet and dry seasons. Six stations sampled in each of 3 locations (BP1, BP2 and UR).	25 & 26 February and 5 & 6 July 2004.
Marine Mammal	Land-based visual survey during daytime, 5 days per month and 6 hours per day, covered four seasons (12 months).	16, 17, 18, 19 & 26 February, 19, 22, 23, 25 & 26 March, 6, 7, 13, 14 & 15 April, 11, 13, 17, 18 & 20 May, 11, 15, 24, 25 & 29 June 2004, 9, 14, 15, 20 & 25 July 2004, 25, 26, 27, 30 & 31 August, 15, 16, 17, 20 & 21 September 2004, 27, 28, 29, 30 & 31 October 2004, 24, 25, 27, 29 & 30 November 2004, 7, 8, 9, 13 & 14 December 2004, 21, 24, 25, 26 & 27 January 2005.

Survey Type	Methodology	Date
	Quantitative vessel based survey using line transect methods spanning Hong Kong western waters (Deep Bay, Southwest Lantau, Northwest Lantau and West Lantau) 3 days, 2 times per month.	18, 19, 20,,21, 22, 25, 26, 27 July 2005, 3, 4, 5,15, 23, 24, 25 & 26 August 2005, 5, 6, 7,15, 16 & 20 September 2005, 5, 6, 7, 17, 18 & 19 October 2005, 22, 24, 25, 28, 29 & 30 November 2005, 1, 2, 6,7,8 & 22 December 2005, 13, 16, 17, 19, 20 & 24 January 2006, 1, 2, 3, 7, 8 & 9 February 2006, 17, 23, 28, 29, 31 March 2006, 3, 6, 18, 25, 26, 27 April 2006, 2, 4, 8, 9, 10, 11 May 2006.

The ecological importance of the habitats was determined through reference to the following:

- Literature review;
- Findings of the field surveys;
- Comparison with other areas in Hong Kong; and,
- *Annexes 8 and 16 of the EIAO TM.*

The information on marine ecological resources presented in this report has not identified any habitats of high ecological value. Humpback dolphins have been sighted in the area. Although the waters do not support high number of sightings in comparison to other areas in Hong Kong, such as West and Northwest Lantau, marine waters around Black Point were regarded as of medium importance to the humpback dolphins. The majority of other marine habitats were considered to be of low ecological importance.

Annex 9-A

Data of Marine Ecological Resources

Table 1 *Density (m^{-2}) of Intertidal Fauna and Percentage Cover (%) of Sessile Fauna and Flora recorded at Natural Rocky Shore Transects T1 and T2 at Black Point during Dry Season 2004*

	High-Intertidal Zone		Mid-Intertidal Zone		Low-Intertidal Zone	
Species	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**
Snail						
Nodilittorina trochoides						
Nodilittorina radiata	61.6 ±170	3.60 ±5.15	2.40 ±5.06	3.60 ±5.80		
Nodilittorina vidua						
Littoraria articulata	173 ±207	93.2 ±102	74.0 ±101	140 ±140		
Planaxis sulcatus						
Lunella coronata						
Monodonta labio			0.40 ±1.26	0.80 ±2.53	0.40 ±1.26	0.80 ±2.53
Monodonta neritoides						
Nerita albicilla			4.00 ±7.54	7.60 ±11.8		1.20 ±2.70
Thais clavigera					1.20 ±3.79	
Limpet						
Siphonaria japonica				3.20 ±7.73		13.6 ±11.2
Nipponacmea concinna						2.00 ±3.40
Cellana toreuma						
Bivalves %						
Saccostrea cucullata			1.00 ±2.11	0.90 ±1.52	21.1 ±26.3	4.30 ±3.71
Barbatia virescens						
Perna viridis						

	High-Intertidal Zone		Mid-Intertidal Zone		Low-Intertidal Zone	
Species	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**
Barnacles %						
Capitulum mitella						
Tetraclita japonica			1.60±3.34	3.80±3.74	16.2±21.9	12.2±11.9
Tetraclita squamosa						
Balanus amphitrite	0.50±1.58		0.60±1.58	1.90±2.85	9.60±12.7	27.5±19.3
Algae %						
Ulva spp						
Epiphytic Algae			6.50±12.5		17.0±18.7	25.5±29.9
Others %						
Cyanobacteria			4.00±9.37	5.00±7.07	0.50±1.58	11.0±12.0
Haliplanella lineata						
Lyngbya spp						

Table 2 *Density (m^{-2}) of Intertidal Fauna and Percentage Cover (%) of Sessile Fauna and Flora recorded at Natural Rocky Shore Transects T1 and T2 at Black Point during Wet Season 2004*

	High-Intertidal Zone		Mid-Intertidal Zone		Low-Intertidal Zone	
Species	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**
Snail						
Nodilittorina trochoides		0.80±2.53				
Nodilittorina radiata	9.20±21.2	9.60±16.9				
Nodilittorina vidua						
Littoraria articulata	27.2±38.6	31.2±44.9	2.40±7.59			
Planaxis sulcatus						
Lunella coronata						
Monodonta labio		1.20±3.79				
Monodonta neritoides						
Nerita albicilla		0.40±1.26	2.40±3.86	34.4±55.5		1.60±2.80
Thais clavigera					0.40±1.26	1.60±5.06
Limpet						
Siphonaria japonica			1.20±2.70	4.80±10.3		
Nipponacmea concinna						
Cellana toreuma			3.20±10.1	2.00±4.32		
Bivalves %						
Saccostrea cucullata		0.10±0.32	12.1±18.4	10.8±12.7	1.00±3.16	4.00±9.66
Barbatia virescens						
Perna viridis						

	High-Intertidal Zone		Mid-Intertidal Zone		Low-Intertidal Zone	
Species	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**
Barnacles %						
Capitulum mitella						
Tetraclita japonica		0.10 ±0.32	12.3 ±16.1	18.8 ±21.5	66.0 ±17.1	44.0 ±31.7
Tetraclita squamosa						
Balanus amphitrite						
Algae %						
Ulva spp						
Epiphytic Algae					27.4 ±17.7	50.0 ±29.1
Others %						
Cyanobacteria	40.0 ±33.7	18.0 ±29.0	21.0 ±23.3	9.00 ±17.3		
Haliplanella lineata						
Lyngbya spp						

Table 3 *Density (m^{-2}) of Intertidal Fauna and Percentage Cover (%) of Sessile Fauna and Flora recorded at Artificial Shoreline Transects T3, T4, T5 and T6 at Black Point during Dry Season 2004*

	High-Intertidal Zone				**Mid-Intertidal Zone**				**Low-Intertidal Zone**			
	T3	**T4**	**T5**	**T6**	**T3**	**T4**	**T5**	**T6**	**T3**	**T4**	**T5**	**T6**
Snail												
Nodilittorina trochoides			28.4 ±54.1									
Nodilittorina radiata	6.80 ±17.5	4.40 ±6.10		150 ±156				5.20 ±12.8				
Nodilittorina vidua			112 ±125									
Littoraria articulata	117 ±171	140 ±196		75.2 ±77.5	60.4 ±119	13.6 ±26.7	5.20 ±15.1	12.0 ±17.5	0.40 ±1.26			
Planaxis sulcatus			83.6 ±152									
Lunella coronata								5.20 ±11.3				
Monodonta labio				0.80 ±1.69	2.00 ±2.83	0.40 ±1.26						
Monodonta neritoides								2.00 ±4.32		12.0 ±18.4	0.80 ±1.69	2.40 ±5.40
Nerita albicilla		1.20 ±3.79		4.00 ±7.54	4.00 ±7.77	12.0 ±36.6	32.0 ±49.4	1.20 ±2.70	0.40 ±1.26		1.20 ±3.79	
Thais clavigera						0.80 ±2.53	2.00 ±4.32	4.00 ±5.66	3.20 ±8.80	6.00 ±11.2	4.00 ±7.54	0.80 ±1.69
Limpet												
Siphonaria japonica					1.20 ±1.93	42.4 ±48.1		53.2 ±69.7	1.20 ±2.70	48.8 ±103	82.0 ±60.0	98.0 ±62.9
Nipponacmea concinna						0.40 ±1.26	42.8 ±57.9					
Cellana toreuma												
Bivalves %												
Saccostrea cucullata					3.90 ±6.08				0.50 ±0.53			
Barbatia virescens												
Perna viridis												

	High-Intertidal Zone				Mid-Intertidal Zone				Low-Intertidal Zone			
	T3	T4	T5	T6	T3	T4	T5	T6	T3	T4	T5	T6
Barnacles %												
Capitulum mitella						4.00 ±6.02		3.00 ±4.22		0.50 ±1.58	9.00 ±15.8	0.80 ±1.55
Tetraclita japonica					3.00 ±3.20	9.70 ±17.9	4.00 ±3.94	0.70 ±1.57	1.00 ±2.11	47.5 ±28.6	8.00 ±5.37	8.10 ±7.78
Tetraclita squamosa							1.60 ±2.37					
Balanus amphitrite					12.5 ±29.2	4.50 ±8.32			50.0 ±38.3	13.0 ±13.4	23.0 ±28.7	21.5 ±29.3
Algae %												
Ulva spp								1.00 ±3.16			10.0 ±21.6	1.00 ±3.16
Epiphytic Algae			4.50 ±6.85		3.00 ±9.49	30.5 ±26.7	5.10 ±9.37	9.00 ±15.1	21.8 ±24.2	12.9 ±19.6	4.00 ±6.58	3.00 ±4.83
Others %												
Cyanobacteria					11.1 ±23.3				3.00 ±4.22	1.00 ±3.16		
Haliplanella lineata					0.40 ±1.26		10.3 ±16.2					
Lyngbya spp												

Table 4 *Density (m⁻²) of Intertidal Fauna and Percentage Cover (%) of Sessile Fauna and Flora recorded at Artificial Shoreline Transects T3, T4, T5 and T6 at Black Point during Wet Season 2004*

	High-Intertidal Zone				**Mid-Intertidal Zone**				**Low-Intertidal Zone**			
Species	**T3**	**T4**	**T5**	**T6**	**T3**	**T4**	**T5**	**T6**	**T3**	**T4**	**T5**	**T6**
Snail												
Nerita albicilla	0.80 ±2.53		4.00 ±12.6	17.2 ±18.4	17.2 ±31.9	4.40 ±8.53	66.8 ±113	11.6 ±21.1	2.40 ±6.31		2.00 ±5.08	2.00 ±5.08
Nodilittorina trochoides	5.60 ±16.4	1.60 ±3.86										
Nodilittorina radiata	5.20 ±9.05	1.20 ±3.79	117 ±207	23.6 ±27.8				0.40 ±1.26				
Nodilittorina vidua												
Littoraria articulata	14.4 ±17.2					2.40 ±7.59						
Planaxis sulcatus			20.8 ±50.9	1.20 ±2.70								0.40 ±1.26
Lunella coronata												
Monodonta labio					1.20 ±2.70	0.40 ±1.26						
Monodonta neritoides												
Thais clavigera					0.80 ±1.69				1.60 ±2.80	2.80 ±5.35	1.60 ±2.80	2.80 ±6.27
Limpet												
Siphonaria japonica						0.40 ±1.26				6.00 ±11.2		
Nipponacmea concinna						0.80 ±2.53						
Cellana toreuma												
Bivalves %												
Saccostrea cucullata				0.10 ±0.32		9.30 ±8.10	10.5 ±12.3	10.0 ±8.16		0.70 ±1.57	2.20 ±3.39	5.10 ±6.59
Barbatia virescens					1.20 ±2.57							
Perna viridis												1.10 ±3.14

	High-Intertidal Zone				Mid-Intertidal Zone				Low-Intertidal Zone			
Species	**T3**	**T4**	**T5**	**T6**	**T3**	**T4**	**T5**	**T6**	**T3**	**T4**	**T5**	**T6**
Barnacles %												
Capitulum mitella			0.80±1.62									1.00±3.16
Tetraclita japonica	0.10±0.32	0.50±1.58		1.00±3.16	10.8±12.7	9.00±15.5		2.70±3.40	48.5±23.8	13.5±17.3	39.1±29.8	19.6±20.2
Tetraclita squamosa												
Balanus amphitrite												
Algae %												
Ulva spp												
Epiphytic Algae				9.00±28.5		3.00±6.75	51.0±40.9	51.9±32.8	51.5±23.8	43.0±25.4	58.5±27.5	68.8±20.1
Others %												
Cyanobacteria	17.0±15.7	2.00±4.22	1.60±3.34		18.8±21.5	30.5±26.3				1.00±3.16		
Haliplanella lineata												
Lyngbya spp												

Table 5 Benthic Grab Survey Raw Data during Dry Season

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP1-1	0.0596	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Alpheus sp.*
BP1-1	0.0026	1	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus sp.*
BP1-1	0.028	1	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Eteone	*Eteone sp.*
BP1-1	0.0059	1	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
BP1-1	0.3785	9	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP1-1	0.1215	6	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-1	0.0162	1	Annelida	Polychaeta	Opheliida	Opheliidae	Ophelia	*Ophelina grandis*
BP1-1	0.008	2	Annelida	Polychaeta	Terebellida	Pectinariidae	Pectinaria	*Pectinaria sp.*
BP1-1	0.0012	1	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce	*Phyllodoce sp.*
BP1-1	0.8212	64	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP1-1	0.0242	1	Coelentera	Anthozoa	Pennatulacea	Veretillidae	Cavernularia	*Cavernularia obesa*
BP1-1	7.4262	2	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra sp.*
BP1-1	0.3819	1	Echiura	Echiurida	Echiuroinea	Echiuridae	Thalassema	*Thalassema sabinum*
BP1-1	0.0661	1	Mollusca	Bivalvia	Veneroida	Veneridae	Ruditapes	*Ruditapes philippinarum*
BP1-1	0.0273	2	Mollusca	Bivalvia	Veneroida	Solenidae	Solen	*Solen sp.*
BP1-2a	0.0253	1	Annelida	Polychaeta	Amphinomida	Amphinomidae	Amphinome	*Amphinome rostrata*
BP1-2a	0.0027	1	Annelida	Polychaeta	Phyllodocida	Polynoidae	Gattyana	*Gattyana sp.*
BP1-2a	0.198	4	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP1-2a	0.1443	19	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-2a	0.7182	41	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP1-2a	0.8699	2	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Tritodynamia	*Tritodynamia sp.*
BP1-2a	2.3773	1	Coelentera	Anthozoa	Pennatulacea	Veretillidae	Cavernularia	*Cavernularia obesa*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP1-2a	15.5977	5	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra sp.*
BP1-2a	0.0145	1	Mollusca	Bivalvia	Veneroida	Tellinidae	Nitidotellina	*Nitidotellina iridella*
BP1-2a	0.0063	1	Mollusca	Bivalvia	Veneroida	Veneridae	Ruditapes	*Ruditapes philippinarum*
BP1-3a	0.2304	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Alpheus sp.*
BP1-3a	0.063	1	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP1-3a	0.0179	1	Annelida	Polychaeta	Spionida	Spionidae	Laonice	*Laonice cirrata*
BP1-3a	0.0186	1	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrinereis sp.*
BP1-3a	0.0218	1	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-3a	0.0054	1	Annelida	Polychaeta	Spionida	Poecilochaetidae	Poecilochaetus	*Poecilochaetus serpens*
BP1-3a	0.018	1	Annelida	Polychaeta	Phyllodocida	Sigalionidae	Sthenolepis	*Sthenolepis japonica*
BP1-3a	11.2027	4	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra sp.*
BP1-4	0.1189	8	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP1-4	0.6044	1	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP1-5	0.0136	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
BP1-5	0.0085	1	Annelida	Polychaeta	Phyllodocida	Nereidae	Ceratonereis	*Ceratonereis sp.*
BP1-5	0.0633	3	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-5	0.0204	1	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP1-5	8.3038	1	Chordata	Osteichthyes	Perciformes	Taenioididae	Odontamblyopus	*Odontamblyopus rubicundus*
BP1-5	3.4676	1	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra sp.*
BP1-6	0.0195	1	Annelida	Polychaeta	Spionida	Spionidae	Laonice	*Laonice cirrata*
BP1-6	0.0994	4	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-6	0.0285	1	Coelentera	Anthozoa	Pennatulacea	Virgulariidae	Virgularia	*Virgularia gustaviana*
BP1-6	13.9764	3	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra sp.*
BP2-1a	0.0092	4	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP2-1a	0.053	1	Annelida	Polychaeta	Phyllodocida	Nereidae	Ceratonereis	*Ceratonereis sp.*
BP2-1a	0.0425	6	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus sp.*
BP2-1a	0.0228	1	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
BP2-1a	0.4076	6	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP2-1a	0.0055	1	Annelida	Polychaeta	Phyllodocida	Goniadidae	Goniada	*Goniada sp.*
BP2-1a	0.0016	1	Annelida	Polychaeta	Spionida	Magelonidae	Magelona	*Magelona pacifica*
BP2-1a	0.043	3	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP2-1a	0.0061	1	Annelida	Polychaeta	Spionida	Poecilochaetidae	Poecilochaetus	*Poecilochaetus serpens*
BP2-1a	0.6473	33	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-1a	0.0425	6	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos sp.*
BP2-1a	0.0919	1	Arthropoda	Crustacea	Decapoda	Portunidae	Charybdis	*Charybdis variegata*
BP2-1a	1.3596	2	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP2-1a	17.0773	7	Coelentera	Anthozoa	Pennatulacea	Veretillidae	Cavernularia	*Cavernularia obesa*
BP2-1a	0.0204	1	Coelentera	Anthozoa	Pennatulacea	Virgulariidae	Virgularia	*Virgularia gustaviana*
BP2-2a	0.0058	2	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
BP2-2a	0.0325	1	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus sp.*
BP2-2a	0.0768	2	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
BP2-2a	0.0771	1	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP2-2a	0.0103	2	Annelida	Polychaeta	Phyllodocida	Goniadidae	Goniada	*Goniada sp.*
BP2-2a	0.0066	1	Annelida	Polychaeta	Spionida	Spionidae	Laonice	*Laonice cirrata*
BP2-2a	0.0107	1	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrineris sp.*
BP2-2a	0.0019	1	Annelida	Polychaeta	Spionida	Magelonidae	Magelona	*Magelona pacifica*
BP2-2a	0.0048	1	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP2-2a	0.007	2	Annelida	Polychaeta	Phyllodocida	Hesionidae	Ophiodromus	*Ophiodromus angustifrons*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP2-2a	0.1552	1	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	Pherusa	*Pherusa parmata*
BP2-2a	0.0302	2	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce	*Phyllodoce (A.) chinensis*
BP2-2a	1.1077	60	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-2a	0.0057	1	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos sp.*
BP2-2a	0.012	1	Annelida	Polychaeta	Phyllodocida	Sigalionidae	Sthenolepis	*Sthenolepis japonica*
BP2-2a	2.0372	4	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP2-2a	0.0549	1	Chordata	Osteichthyes	Perciforms	Callionymidae	Callionymus	*Callionymus richardsoni*
BP2-2a	1.3529	2	Coelentera	Anthozoa	Pennatulacea	Veretillidae	Cavernularia	*Cavernularia obesa*
BP2-2a	0.1434	8	Coelentera	Anthozoa	Pennatulacea	Virgulariidae	Virgularia	*Virgularia gustaviana*
BP2-2a	0.039	1	Coelenterata	Anthozoa	Actiniaria	Actiniidae	Actinia	*Actinia sp.*
BP2-2a	0.1837	2	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	Amphioplus	*Amphioplus depressus*
BP2-2a	0.1435	1	Mollusca	Bivalvia	Veneroida	Tellinidae	Cadella	*Cadella sp.*
BP2-2a	0.0737	1	Mollusca	Bivalvia	Veneroida	Cultellidae	Cultellus	*Cultellus scalprum*
BP2-2a	0.1117	1	Mollusca	Bivalvia	Veneroida	Solenidae	Solen	*Solen canaliculatus*
BP2-3	0.3681	1	Annelida	Polychaeta	Eunicida	Onuphidae	Diopatra	*Diopatra sp.*
BP2-3	0.0329	2	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-3	0.9786	1	Arthropoda	Crustacea	Decapoda	Goneplacidae	Eucrate	*Eucrate haswelli*
BP2-3	12.0195	5	Coelentera	Anthozoa	Pennatulacea	Veretillidae	Cavernularia	*Cavernularia obesa*
BP2-3	0.2549	8	Coelentera	Anthozoa	Pennatulacea	Virgulariidae	Virgularia	*Virgularia gustaviana*
BP2-4a	0.0065	1	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus sp.*
BP2-4a	0.0053	1	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
BP2-4a	0.8139	32	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-4a	0.0027	1	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos sp.*
BP2-4a	0.0131	1	Arthropoda	Crustacea	Amphipoda	Corophiidae	Corophium	*Corophium sp.*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP2-4a	9.5386	6	Coelentera	Anthozoa	Pennatulacea	Veretillidae	Cavernularia	*Cavernularia obesa*
BP2-4a	0.0153	1	Coelentera	Anthozoa	Pennatulacea	Virgulariidae	Virgularia	*Virgularia gustaviana*
BP2-4a	0.0583	1	Mollusca	Bivalvia	Veneroida	Veneridae	Dosinia	*Dosinia exasperata*
BP2-4a	0.2236	1	Mollusca	Bivalvia	Veneroida	Veneridae	Ruditapes	*Ruditapes philippinarum*
BP2-5	0.0212	1	Annelida	Polychaeta	Spionida	Cirratulidae	Chaetozone	*Chaetozone setosa*
BP2-5	0.0046	2	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus sp.*
BP2-5	0.2984	4	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP2-5	0.0038	1	Annelida	Polychaeta	Phyllodocida	Goniadidae	Goniada	*Goniada sp.*
BP2-5	0.0069	1	Annelida	Polychaeta	Spionida	Spionidae	Laonice	*Laonice cirrata*
BP2-5	0.0168	1	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrineris sp.*
BP2-5	0.0018	1	Annelida	Polychaeta	Spionida	Magelonidae	Magelona	*Magelona pacifica*
BP2-5	0.0173	3	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP2-5	0.4733	21	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-5	0.0054	1	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos sp.*
BP2-5	4.8969	4	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP2-5	0.0016	1	Coelentera	Anthozoa	Pennatulacea	Virgulariidae	Virgularia	*Virgularia gustaviana*
BP2-5	0.2494	1	Mollusca	Bivalvia	Mytiloida	Pinnidae	Atrina	*Atrina pectinata*
BP2-5	0.0122	1	Mollusca	Bivalvia	Veneroida	Veneridae	Ruditapes	*Ruditapes philippinarum*
BP2-6a	0.0019	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
BP2-6a	0.4054	5	Annelida	Polychaeta	Spionida	Cirratulidae	Chaetozone	*Chaetozone setosa*
BP2-6a	0.0381	2	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus sp.*
BP2-6a	0.1429	3	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP2-6a	0.0761	5	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP2-6a	0.0096	3	Annelida	Polychaeta	Phyllodocida	Hesionidae	Ophiodromus	*Ophiodromus angustifrons*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP2-6a	0.0059	2	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce	*Phyllodoce (A.) chinensis*
BP2-6a	0.001	1	Annelida	Polychaeta	Spionida	Spionidae	Polydora	*Polydora sp.*
BP2-6a	1.7667	98	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-6a	0.0495	8	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos sp.*
BP2-6a	6.6138	8	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP2-6a	2.1041	3	Coelentera	Anthozoa	Pennatulacea	Veretillidae	Cavernularia	*Cavernularia obesa*
BP2-6a	0.017	3	Coelentera	Anthozoa	Pennatulacea	Virgulariidae	Virgularia	*Virgularia gustaviana*
BP2-6a	0.0589	1	Echiura	Echiurida	Echiuroinea	Echiuridae	Thalassema	*Thalassema sabinum*
BP2-6a	0.4582	2	Mollusca	Bivalvia	Veneroida	Psammobiidae	Gari	*Gari hosoyai*
BP2-6a	0.0042	1	Mollusca	Bivalvia	Veneroida	Veneridae	Ruditapes	*Ruditapes philippinarum*
BP2-6a	0.2282	1	Mollusca	Bivalvia	Veneroida	Solenidae	Solen	*Solen sp.*
BP2-6a	0.0022	1	Sipuncula	Phascolosomatidea	Phascolosomaliformes	Phascolosomatidae	Apionsoma	*Apionsoma trichocephalus*
UR1	0.0117	1	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
UR2	0.0185	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
UR2	0.0049	1	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
UR2	0.0041	2	Annelida	Polychaeta	Capitellida	Capitellidae	Mediomastus	*Mediomastus californiensis*
UR2	0.0198	1	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
UR2	0.0037	1	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos sp.*
UR3	0.1074	2	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
UR3	0.0087	1	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus sp.*
UR3	0.15	6	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
UR3	0.0027	1	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
UR4	0.1336	3	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
UR4	0.0104	1	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
UR4	0.002	1	Annelida	Polychaeta	Phyllodocida	Polynoidae	Lepidonotus	*Lepidonotus sp.*
UR4	0.0781	13	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
UR4	0.3554	3	Annelida	Polychaeta	Eunicida	Onuphidae	Onuphis	*Onuphis eremita*
UR4	0.3114	6	Annelida	Polychaeta	Spionida	Spionidae	Paraprionospio	*Paraprionospio pinnata*
UR4	0.129	7	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
UR4	0.001	1	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos sp.*
UR4	0.0147	2	Annelida	Polychaeta	Phyllodocida	Sigalionidae	Sthenolepis	*Sthenolepis japonica*
UR4	0.0078	1	Arthropoda	Crustacea	Amphipoda	Corophiidae	Corophium	*Corophium sp.*
UR4	0.0012	1	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	Amphiodia	*Amphiodia sp.*
UR4	2.3578	1	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra sp.*
UR5	0.01	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
UR5	0.0197	2	Annelida	Polychaeta	Phyllodocida	Polynoidae	Lepidonotus	*Lepidonotus sp.*
UR5	0.1082	13	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
UR5	0.0036	1	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
UR5	3.8906	2	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra sp.*
UR6	0.0063	1	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrinereis sp.*
UR6	0.0125	1	Annelida	Polychaeta	Phyllodocida	Nereidae	Nectoneanthes	*Nectoneanthes ijimai*
UR6	0.0277	5	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
UR6	0.0005	1	Annelida	Polychaeta	Spionida	Poecilochaetidae	Poecilochaetus	*Poecilochaetus serpens*
UR6	0.0968	3	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
UR6	0.0006	1	Arthropoda	Crustacea	Amphipoda	Corophiidae	Corophium	*Corophium sp.*
UR6	0.3103	2	Arthropoda	Crustacea	Decapoda	Pilumnidae	Typhlocarcinus	*Typhlocarcinus nudus*
UR6	0.0026	1	Mollusca	Bivalvia	Veneroida	Semelidae	Theora	*Theora lata*

Table 6 Benthic Grab Survey Raw Data during Wet Season

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP1-1	0.1763	4	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus sp.*
BP1-1	0.0148	1	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
BP1-1	0.1211	2	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP1-1	0.0573	4	Annelida	Polychaeta	Terebellida	Ampharetidae	Isolda	*Isolda pulchella*
BP1-1	0.021	2	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-1	0.0144	1	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	Pherusa	*Pherusa parmata*
BP1-1	0.0297	6	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP1-1	0.1646	1	Arthropoda	Crustacea	Decapoda	Porcellanidae	Raphidopus	*Raphidopus ciliatus*
BP1-1	134.4296	13	Mollusca	Bivalvia	Veneroida	Veneridae	Ruditapes	*Ruditapes philippinarum*
BP1-2	0.0644	4	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus* sp.
BP1-2	0.1717	4	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP1-2	0.0023	1	Annelida	Polychaeta	Terebellida	Ampharetidae	Isolda	*Isolda pulchella*
BP1-2	0.0246	4	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-2	0.6016	1	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	Pherusa	*Pherusa parmata*
BP1-2	0.0171	1	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce	*Phyllodoce (A.) chinensis*
BP1-2	0.0006	1	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio cirrifera*
BP1-2	0.4413	78	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP1-2	0.0048	2	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos* sp.
BP1-2	0.0043	2	Annelida	Polychaeta	Spionida	Cirratulidae	Tharyx	*Tharyx* sp.
BP1-2	0.1015	2	Arthropoda	Crustacea	Decapoda	Alpheidae	Alpheus	*Alpheus* sp.
BP1-2	0.071	1	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP1-2	0.1069	1	Arthropoda	Crustacea	Decapoda	Porcellanidae	Raphidopus	*Raphidopus ciliatus*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP1-2	0.0181	1	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	Amphioplus	*Amphioplus laevis*
BP1-3	0.0029	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
BP1-3	0.4797	7	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus* sp.
BP1-3	0.4712	9	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP1-3	0.0091	3	Annelida	Polychaeta	Terebellida	Ampharetidae	Isolda	*Isolda pulchella*
BP1-3	0.0683	3	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrineris* sp.
BP1-3	0.005	1	Annelida	Polychaeta	Orbiniida	Orbiniidae	Naineris	*Naineris laevigata*
BP1-3	0.2631	1	Annelida	Polychaeta	Phyllodocida	Nereidae	Nereis	*Nereis* sp.
BP1-3	0.0358	6	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-3	0.001	1	Annelida	Polychaeta	Opheliida	Opheliidae	Ophelia	*Ophelina grandis*
BP1-3	0.2185	32	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP1-3	0.0021	1	Annelida	Polychaeta	Spionida	Spionidae	Scolelepis	*Scolelepis* sp.
BP1-3	0.0019	1	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos* sp.
BP1-3	0.0627	1	Arthropoda	Crustacea	Decapoda	Alpheidae	Alpheus	*Alpheus* sp.
BP1-3	0.3922	5	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP1-3	0.2516	5	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	Amphioplus	*Amphioplus laevis*
BP1-3	0.7528	1	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra* sp.
BP1-3	0.1359	1	Mollusca	Bivalvia	Veneroida	Tellinidae	Nitidotellina	*Nitidotellina iridella*
BP1-4	0.0038	1	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrineris* sp.
BP1-4	0.1048	11	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-4	0.0321	1	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP1-4	1.0502	1	Arthropoda	Crustacea	Decapoda	Pilumnidae	Typhlocarcinus	*Typhlocarcinus nudus*
BP1-4	10.9442	5	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra* sp.
BP1-5	0.0026	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP1-5	0.0947	2	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP1-5	0.0129	1	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrineris* sp.
BP1-5	0.0899	5	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-5	0.004	1	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP1-5	0.0026	1	Annelida	Polychaeta	Spionida	Cirratulidae	Tharyx	*Tharyx* sp.
BP1-5	7.013	3	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra* sp.
BP1-6	0.3154	8	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus* sp.
BP1-6	0.2361	1	Annelida	Polychaeta	Eunicida	Onuphidae	Diopatra	*Diopatra* sp.
BP1-6	0.0017	1	Annelida	Polychaeta	Phyllodocida	Polynoidae	Gattyana	*Gattyana* sp.
BP1-6	0.3594	5	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP1-6	0.0333	1	Annelida	Polychaeta	Phyllodocida	Hesionidae	Leocrates	*Leocrates chinensis*
BP1-6	0.0182	1	Annelida	Polychaeta	Phyllodocida	Polynoidae	Lepidonotus	*Lepidonotus* sp.
BP1-6	0.0088	2	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrineris* sp.
BP1-6	0.0426	4	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP1-6	0.0211	2	Annelida	Polychaeta	Phyllodocida	Hesionidae	Ophiodromus	*Ophiodromus angustifrons*
BP1-6	0.1913	44	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP1-6	0.0051	1	Annelida	Polychaeta	Phyllodocida	Sigalionidae	Sthenolepis	*Sthenolepis japonica*
BP1-6	0.058	4	Arthropoda	Crustacea	Decapoda	Alpheidae	Alpheus	*Alpheus* sp.
BP1-6	0.5987	7	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP1-6	0.3456	5	Arthropoda	Crustacea	Decapoda	Porcellanidae	Raphidopus	*Raphidopus ciliatus*
BP2-1	0.0013	1	Annelida	Polychaeta	Orbiniida	Paraonidae	Aricidea	*Aricidea fragilis*
BP2-1	0.0119	1	Annelida	Polychaeta	Phyllodocida	Nereidae	Ceratonereis	*Ceratonereis* sp.
BP2-1	0.4596	10	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus* sp.
BP2-1	0.1379	6	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP2-1	0.8076	10	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP2-1	0.0196	4	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP2-1	0.0011	1	Annelida	Polychaeta	Opheliida	Opheliidae	Ophelia	*Ophelina grandis*
BP2-1	0.0015	1	Annelida	Polychaeta	Phyllodocida	Lacydoniidae	Paralacydonia	*Paralacydonia paradoxa*
BP2-1	0.4351	28	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-1	0.0425	10	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos* sp.
BP2-1	0.0338	2	Arthropoda	Crustacea	Decapoda	Alpheidae	Alpheus	*Alpheus* sp.
BP2-1	1.1984	9	Arthropoda	Crustacea	Decapoda	Pinnotheridae	Neoxenophthalmus	*Neoxenophthalmus obscurus*
BP2-2a	0.1384	7	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
BP2-2a	0.1357	5	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP2-2a	0.1219	1	Annelida	Polychaeta	Terebellida	Terebellidae	Loimia	*Loimia medusa*
BP2-2a	0.0082	1	Annelida	Polychaeta	Phyllodocida	Nereidae	Nereis	*Nereis* sp.
BP2-2a	0.0048	2	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP2-2a	0.1714	29	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-2a	0.2736	1	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	Amphioplus	*Amphioplus depressus*
BP2-2a	0.3215	1	Mollusca	Bivalvia	Veneroida	Tellinidae	Nitidotellina	*Nitidotellina iridella*
BP2-3	0.0358	2	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus* sp.
BP2-3	0.1405	6	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
BP2-3	0.0654	2	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP2-3	0.0139	4	Annelida	Polychaeta	Terebellida	Ampharetidae	Isolda	*Isolda pulchella*
BP2-3	0.03	1	Annelida	Polychaeta	Terebellida	Ampharetidae	Melinna	*Melinna* sp.
BP2-3	0.0049	1	Annelida	Polychaeta	Phyllodocida	Hesionidae	Ophiodromus	*Ophiodromus angustifrons*
BP2-3	0.0934	9	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-3	0.042	12	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos* sp.

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
BP2-4	0.0535	1	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus* sp.
BP2-4	0.1826	1	Annelida	Polychaeta	Eunicida	Onuphidae	Diopatra	*Diopatra* sp.
BP2-4	0.0977	4	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
BP2-4	0.0644	1	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP2-4	0.0196	1	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
BP2-4	0.025	10	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-4	0.0046	2	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos* sp.
BP2-5	0.0122	1	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
BP2-5	0.0044	1	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
BP2-5	0.4393	2	Annelida	Polychaeta	Terebellida	Terebellidae	Loimia	*Loimia medusa*
BP2-5	0.006	1	Annelida	Polychaeta	Terebellida	Pectinariidae	Pectinaria	*Pectinaria* sp.
BP2-5	0.0438	6	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
BP2-5	0.0629	1	Annelida	Polychaeta	Spionida	Spionidae	Scolelepis	*Scolelepis* sp.
BP2-5	0.0066	2	Annelida	Polychaeta	Orbiniida	Orbiniidae	Scoloplos	*Scoloplos* sp.
BP2-5	0.0214	1	Arthropoda	Crustacea	Decapoda	Alpheidae	Alpheus	*Alpheus* sp.
BP2-5	0.1348	1	Arthropoda	Crustacea	Decapoda	Porcellanidae	Raphidopus	*Raphidopus ciliatus*
BP2-5	0.1629	1	Mollusca	Gastropoda	Stenoglossa	Pyrenidae	Mitrella	*Mitrella bella*
BP2-5	0.1374	1	Mollusca	Bivalvia	Veneroida	Veneridae	Ruditapes	*Ruditapes philippinarum*
BP2-6	0.085	1	Annelida	Polychaeta	Phyllodocida	Nereidae	Nectoneanthes	*Nectoneanthes ijimai*
BP2-6	0.0271	1	Arthropoda	Crustacea	Decapoda	Alpheidae	Alpheus	*Alpheus* sp.
BP2-6	2.9699	1	Mollusca	Bivalvia	Veneroida	Veneridae	Dosinia	*Dosinia aspera*
BP2-6	4.8207	1	Mollusca	Gastropoda	Mesogastropoda	Naticidae	Natica	*Natica* sp.
BP2-6	362.4198	25	Mollusca	Bivalvia	Veneroida	Veneridae	Ruditapes	*Ruditapes philippinarum*
UR1	2.3627	48	Mollusca	Bivalvia	Myoida	Corbulidae	Potamocorbula	*Potamocorbula laevis*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
UR2	0.0044	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dobranchis*
UR2	0.2063	2	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
UR2	0.0499	4	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
UR2	0.0118	4	Annelida	Polychaeta	Spionida	Spionidae	Paraprionospio	*Paraprionospio pinnata*
UR2	0.006	1	Annelida	Polychaeta	Spionida	Cirratulidae	Tharyx	*Tharyx* sp.
UR2	0.15	1	Arthropoda	Crustacea	Decapoda	Porcellanidae	Raphidopus	*Raphidopus ciliatus*
UR2	7.8496	127	Mollusca	Bivalvia	Myoida	Corbulidae	Potamocorbula	*Potamocorbula laevis*
UR3	0.0023	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
UR3	0.0829	4	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus* sp.
UR3	0.0672	1	Annelida	Polychaeta	Phyllodocida	Polynoidae	Lepidonotus	*Lepidonotus* sp.
UR3	0.0024	1	Annelida	Polychaeta	Spionida	Magelonidae	Magelona	*Magelona pacifica*
UR3	0.2358	12	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
UR3	0.0028	1	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
UR3	0.0008	1	Annelida	Polychaeta	Phyllodocida	Syllidae	Syllis	*Syllis* sp.
UR3	0.3881	1	Arthropoda	Crustacea	Decapoda	Pilumnidae	Typhlocarcinus	*Typhlocarcinus nudus*
UR3	5.1869	1	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra* sp.
UR4	0.0323	2	Annelida	Polychaeta	Spionida	Cirratulidae	Cirratulus	*Cirratulus* sp.
UR4	0.0063	1	Annelida	Polychaeta	Capitellida	Maldanidae	Euclymene	*Euclymene* sp.
UR4	0.0028	1	Annelida	Polychaeta	Eunicida	Eunicidae	Eunice	*Eunice indica*
UR4	0.655	2	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
UR4	0.1957	1	Annelida	Polychaeta	Terebellida	Terebellidae	Loimia	*Loimia medusa*
UR4	0.0023	1	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrineris* sp.
UR4	0.1397	4	Annelida	Polychaeta	Phyllodocida	Nereidae	Nectoneanthes	*Nectoneanthes ijimai*
UR4	0.3864	35	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*

Station	Wet weight (g)	Abundance	Phylum	Class	Order	Family	Genus	Species
UR4	0.0004	1	Annelida	Polychaeta	Phyllodocida	Lacydoniidae	Paralacydonia	*Paralacydonia paradoxa*
UR4	0.0266	1	Annelida	Polychaeta	Terebellida	Pectinariidae	Pectinaria	*Pectinaria* sp.
UR4	0.0606	1	Annelida	Polychaeta	Terebellida	Terebellidae	Pista	*Pista cristata*
UR4	0.0143	6	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
UR4	0.1915	1	Arthropoda	Crustacea	Decapoda	Pilumnidae	Typhlocarcinus	*Typhlocarcinus nudus*
UR4	0.1053	1	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	Amphiodia	*Amphiodia* sp.
UR4	1.0223	1	Echinodermata	Holothuroidea	Apoda	Synaptidae	Protankyra	*Protankyra* sp.
UR4	143.2537	2468	Mollusca	Bivalvia	Myoida	Corbulidae	Potamocorbula	*Potamocorbula laevis*
UR5	0.0034	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus dibranchis*
UR5	0.1252	1	Annelida	Polychaeta	Phyllodocida	Nephtyidae	Aglaophamus	*Aglaophamus* sp.
UR5	0.0436	1	Annelida	Polychaeta	Eunicida	Onuphidae	Diopatra	*Diopatra* sp.
UR5	0.4696	4	Annelida	Polychaeta	Phyllodocida	Glyceridae	Glycera	*Glycera onomichiensis*
UR5	0.0087	1	Annelida	Polychaeta	Eunicida	Lumbrineridae	Lumbrineris	*Lumbrineris* sp.
UR5	0.5785	25	Annelida	Polychaeta	Capitellida	Capitellidae	Notomastus	*Notomastus latericens*
UR5	0.0016	1	Annelida	Polychaeta	Spionida	Spionidae	Paraprionospio	*Paraprionospio pinnata*
UR5	0.0191	3	Annelida	Polychaeta	Spionida	Spionidae	Prionospio	*Prionospio queenslandica*
UR5	0.0012	1	Annelida	Polychaeta	Phyllodocida	Pilargiidae	Sigambra	*Sigambra hanaokai*
UR5	0.0259	1	Echinodermata	Stelleroidea	Ophiurida	Amphiuridae	Amphiodia	*Amphiodia* sp.
UR5	10.0876	202	Mollusca	Bivalvia	Myoida	Corbulidae	Potamocorbula	*Potamocorbula laevis*
UR6	0.4769	14	Mollusca	Bivalvia	Myoida	Corbulidae	Potamocorbula	*Potamocorbula laevis*

Table 7 Data Sheet for Marine Mammal Recording During Land-based Observation Survey

Date: ____________ **Weather:** ____________ **Site: Black Point ( ) Soko Islands ( )** **Observers:** ____________

Time	Event	Beaufort	Visibility	Mammal Species	Group Size	Behaviour	Other Comments

Table 8 Marine Mammal Land-based Sighting Records at Black Point (Survey data collected from February 2004 to January 2005)

Season	Survey Date	Weather	Beaufort	Visibility	First Sighting Records (Time)	Mammal Species (a	Number of Individuals	Age Class of the Mammals (b)	Activities of the Mammals(c)
Winter	16th February 2004 (1100-1700)	Partly Raining	1	Unlimited	1149	SC	3	3 Adults	Feeding and active on water surface
					1215	SC	5	4 Adults, 1 Juvenile	Feeding and active on water surface
					1318	SC	1	1 Adult	Feeding and active on water surface
	17th February 2004 (0935-1535)	Partly Raining	1	Unlimited	0955	SC	1	1 Adult	Feeding followed the shrimp trawler
					1018	SC	6	6 Adults	Feeding followed the shrimp trawler
					1041	SC	1	1 Adult	Feeding followed the shrimp trawler
					1043	SC	1	1 Adult	Feeding followed the shrimp trawler
					1101	SC	1	1 Adult	Feeding followed the shrimp trawler
					1128	SC	1	1 Adult	Feeding followed the shrimp trawler
	18th February 2004 (0900-1500)	Cloudy	1-2	Unlimited	-	-	-	-	-
	19th February 2004 (0905-1505)	Cloudy, Calm	1-2	Unlimited	-	-	-	-	-

Season	Survey Date	Weather	Beaufort	Visibility	First Sighting Records (Time)	Mammal Species [a]	Number of Individuals	Age Class of the Mammals [b]	Activities of the Mammals[c]
	20th February 2004 (0900-1500)	Calm, Light Wind, Sunny	1-2	Unlimited	1003	SC	1	1 Juvenile	Free Travelling
	7th December 2004 (0945-1545)	Sunny, Breeze	4	Unlimited	-	-	-	-	-
	8th December 2004 (0945-1545)	Sunny, Breeze	3-4	Unlimited	1025	SC	2	2 Adults	Feeding/Foraging
					1500	SC	1	1 Juvenile	Feeding/Foraging, Milling
	9th December 2004 (0945-1545)	Sunny, Breeze	3	Unlimited	1350	SC	1	1 Adult	Breaching, Feeding/Foraging
	13th December 2004 (0945-1545)	Sunny, Breeze	3	Unlimited	1058	SC	2	1 Juvenile, 1 Adult	Free Travelling
					1135	SC	2	1 Juvenile, 1 Adult	Free Travelling
					1205	SC	2	1 Juvenile, 1 Adult	Free Travelling, Feeding/Foraging, Milling
	14th December 2004 (0945-1545)	Sunny, Breeze	3-4	Unlimited	-	-	-	-	-
	21st January 2005 (0855-1455)	Cloudy, Rainy	3-4	Unlimited	-	-	-	-	-
	24th January 2005 (0840-1440)	Sunny	1-2	Unlimited	0903	SC	1	1 Adult	Breaching
					0905	SC	2	2 Adults	Breaching
					1318	SC	1	1 Adult	Free Travelling
	25th January 2005 (0930-1530)	Sunny	1-3	Unlimited	0947	SC	3	2 Adults, 1 Juvenile	Breaching, Tail Slapping
					1210	SC	4	3 Adults, 1 Juvenile	Free Travelling
	26th January 2005 (0900-1500)	Sunny	1-2	Unlimited	-	-	-	-	-

Season	Survey Date	Weather	Beaufort	Visibility	First Sighting Records (Time)	Mammal Species [(a]	Number of Individuals	Age Class of the Mammals [(b)]	Activities of the Mammals[(c)]
	27th January 2005 (0900-1500)	Cloudy	2	Unlimited	0930	SC	4	2 Adults, 2 Juvenile	Breaching, Porposing
					1010	SC	3	1 Adult, 2 Juveniles	Breaching, Porpoising, Feeding/Foraging
					1030	SC	2	2 Adults	Free Travelling
					1030	SC	1	1 Adult	Free Travelling
					1030	SC	1	1 Adult	Free Travelling
					1049	SC	2	2 Adults	Free Travelling, Breaching
					1101	SC	3	3 Adults	Breaching, Feeding/Foraging
					1134	SC	1	1 Adult	Free Travelling
					1142	SC	2	2 Adults	Free Travelling, Porposing
					1147	SC	3	2 Adults, 1 Juvenile	Free Travelling, Porposing
Spring	19th March 2004 (1000-1600)	Cloudy, Calm	1	Unlimited	-	-	-	-	-
	22nd March 2004 (1018-1618)	Sunny, Light Wind, Calm	1	Unlimited	1152	SC	1	1 Adult	Free Travelling
	23rd March 2004 (1122-1722)	Cloudy, Light Wind	1-2	Unlimited	-	-	-	-	-
	25th March 2004 (0730-1330)	Cloudy, Light Wind	2	Unlimited	0920	SC	1	1 Adult	Free Travelling
					0922	SC	1	1 Adult	Free Travelling
					0940	SC	1	1 Juvenile	Breaching
					1219	SC	4	4 Adults	Porpoising, Breaching
	26th March 2004 (1015-1445)	Sunny, Calm	3	Unlimited	1320	SC	2	2 Adults	Free Travelling, Milling

Season	Survey Date	Weather	Beaufort	Visibility	First Sighting Records (Time)	Mammal Species [a]	Number of Individuals	Age Class of the Mammals [b]	Activities of the Mammals[c]
					1353	SC	1	1 Adult	Milling, Free Travelling
					1405	SC	1	1 Adult	Milling, Free Travelling
					1445	SC	4	1 Adult, 3 Juveniles	Free Travelling, Milling
	6th April 2004 (0930-1530)	Sunny, Misty	3	Unlimited	1315	SC	2	1 Juvenile, 1 Adult	Feeding/Foraging
					1340	SC	2	1 Juvenile, 1 Adult	Breaching, Milling
					1345	SC	2	1 Juvenile, 1 Adult	Milling
	7th April 2004 (0930-1530)	Sunny	3	Unlimited	1252	SC	3	3 Adults	Free Travelling, Feeding/ Foraging, Milling
	13th April 2004 (0935-1535)	Sunny, Calm	2	Unlimited	-	-	-	-	-
	14th April 2004 (0925-1525)	Calm, Windy	2-3	Unlimited	-	-	-	-	-
	15th April 2004 (0920-1520)	Sunny, Calm	2-3	Unlimited	1015	SC	2	2 Adults	Free Travelling
	11th May 2004 (0715-1315)	Sunny, Light Wind	2	Unlimited	-	-	-	-	-
	13th May 2004 (0715-1315)	Cloudy, Sunny Patches	3	Unlimited	-	-	-	-	-
	17th May 2004 (0730-1330)	Sunny, Light Breeze	2	Unlimited	-	-	-	-	-
	18th May 2004 (0800-1400)	Sunny, Breeze	2	Unlimited	-	-	-	-	-
	20th May 2004 (0860-1230)	Sunny, Light Breeze	2	Unlimited	-	-	-	-	-
Summer	11th June 2004 (0900-1500)	Sunny	2	Unlimited	-	-	-	-	-
	15th June 2004 (1100-1700)	Light Breeze, Cloudy	2	Unlimited	-	-	-	-	-
	24th June 2004 (0845-1445)	Sunny, Light Wind	1	Unlimited	0930	SC	1	1 Adult	Free Travelling

Season	Survey Date	Weather	Beaufort	Visibility	First Sighting Records (Time)	Mammal Species (a	Number of Individuals	Age Class of the Mammals (b)	Activities of the Mammals(c)
				Unlimited	1030	SC	1	1 Adult	Breaching
	25th June 2004 (0845-1445)	Sunny, Breeze	2-3	Unlimited	1115	SC	1	1 Adult	Free Travelling
	29th June 2004 (0800-1400)	Sunny, Windy	3	Unlimited	-	-	-	-	-
	9th July 2004 (0709-1209)	Sunny, Calm	2	Unlimited	-	-	-	-	-
	14th July 2004 (0715-1215)	Sunny, Slightly Windy	2	Unlimited	-	-	-	-	-
	15th July 2004 (0901-1501)	Sunny, Light Breeze	2	Unlimited	1004	SC	1	1 Juvenile (Dark Grey Body)	Free Travelling
	20th July 2004 (1000-1600)	Sunny, Light Breeze	3	Unlimited	1027	SC	1	1 Juvenile (Grey Body)	Free Travelling
					1321	SC	1	1 Juvenile (Grey Body)	Free Travelling
	25th August 2004 (0830-1430)	Sunny, Light Breeze	2	Unlimited	-	-	-	-	-
	26th August 2004 (0830-1230)	Cloudy, Windy and Wavy	4	Unlimited	-	-	-	-	-
	27th August 2004 (1000-1600)	Cloudy, Slightly Rain	1-2	Unlimited	-	-	-	-	-
	30th August 2004 (1000-1600)	Sunny, Light Breeze	2	Unlimited	-	-	-	-	-
	31st August 2004 (1000-1600)	Sunny, Light Breeze	2	Unlimited	-	-	-	-	-
Autumn	15th September 2004 (0900-1500)	Sunny, Light Breeze	3	Unlimited	-	-	-	-	-
	16th September 2004 (0900-1500)	Sunny, Calm	2-3	Unlimited	-	-	-	-	-

Season	Survey Date	Weather	Beaufort	Visibility	First Sighting Records (Time)	Mammal Species (a	Number of Individuals	Age Class of the Mammals (b)	Activities of the Mammals(c)
	17th September 2004 (0900-1500)	Sunny, Calm	2-3	Unlimited	-	-	-	-	-
	20th September 2004 (0900-1500)	Sunny, Light Breeze	2-3	Unlimited	1016	SC	2	2 Adults	Travelling following shrimp trawler
	21st September 2004 (0900-1500)	Sunny, Calm	2	Unlimited	-	-	-	-	-
	27th October 2004 (0900-1500)	Cloudy, Hazy	3	Unlimited	1044	SC	1	1 Adult	Free Travelling
	28th October 2004 (0900-1500)	Hazy	2	Unlimited	0920	SC	2	2 Adults	Free Travelling
					1155	SC	2	2 Adults	Feeding/Foraging
					1245	SC	2	2 Adults	Socializing, Breaching
	29th October 2004 (0900-1500)	Sunny	2	Unlimited	0950	SC	2	1 Adult, 1 Calf	Feeding/ Foraging
					1020	SC	1	1 Adult	Free Travelling
	30th October 2004 (1100-1700)	Sunny	2	Unlimited	1250	SC	4	2 Adults, 2 Calves	Free Travelling
	31st October 2004 (1030-1630)	Sunny	1-2	Unlimited	-	-	-	-	-
	24th November 2004 (0930-1630)	Cloudy, Slightly windy	1-2	Unlimited	0950	SC	2	1 Calf, 1 Adult	Free Travelling, Breaching
					1004	SC	1	1 Adult	Feeding behind the hang trawler
					1005	SC	4	3 Adults, 1 Calf	Free Travelling, Breaching
					1022	SC	1	1 Adult	Free Travelling
					1329	SC	1	1 Adult	Breaching
					1401	SC	1	1 Adult	Free Travelling

Season	Survey Date	Weather	Beaufort	Visibility	First Sighting Records (Time)	Mammal Species (a	Number of Individuals	Age Class of the Mammals (b)	Activities of the Mammals(c)
					1404	SC	1	1 Adult	Free Travelling, Feeding/Foraging
	25th November 2004 (1000-1600)	Sunny	2	Unlimited	1105	SC	5	4 Adults, I Calf	Socializing
					1340	SC	1	1 Calf	Feeding/Foraging
					1420	SC	2	2 Juveniles	Feeding/Foraging
	27th November 2004 (0900-1500)	Sunny, Wavy	4-5	Unlimited	1336	SC	2	2 Adults	Free Travelling
					1415	SC	2	2 Adults	Free Travelling
	29th November 2004 (0900-1500)	Cloudy, Windy	3	Unlimited	-	-	-	-	-
	30th November 2004 (0900-1500)	Sunny, Windy	3-4	Unlimited	0945	SC	2	2 Adults	Free Travelling
					1012	SC	2	2 Adults	Breaching
					1024	SC	1	1 Adult	Free Travelling

Notes: (a) SC = Indo-Pacific Humpback Dolphin, *Sousa chinensis*; FP = Finless Porpoise, *Neophocaena phocaenoides*

(b) Adult of Indo-Pacific Humpback Dolphin include MO (Mottled); SP (Speckled); SA (Spotted Adult) and UA (Unspotted Adult)

(c) The underlined behaviour is the first sighted behaviour when marine mammals being spotted. The remaining behaviours are those observed after the first sighted behaviour being recorded.

Table 9 Dolphin/Porpoise Vessel Based Sighting Sheet

DOLPHIN / PORPOISE SIGHTING SHEET

HIGH PRIORITY DATA (Record at Initial Sighting)

Date ________ Time ________ Sighting No. ________

Sighting Distance (metres) ________ Sighting Angle (º) ________

Sighting Angle – Dolphins ________ Sighting Angle – Bow of Boat ________

Sighting Position (initial) ________

Sighting Position (dolphin) ________ (Trip: km)

LOW PRIORITY DATA (Record During or After Sighting)

Species ☐ Humpback Dolphin ☐ Finless Porpoise ☐ Other ________

Effort ☐ on ☐ off Seen by ________

Group Size Best ________ High ________ Low ________

CWD Group Composition UC ____ UJ ____ SJ ____ SS ____ SA ____ UA ____

FP Group Composition Calves ________ Adults ________

Beaufort 0 1 2 3 4 5 6 7 + Boat Assoc. ☐None ☐ Pair ☐ Shrimp ☐ Hang ☐ Other ________

Photos ☐ No ☐ Yes Videos ☐ No ☐ Yes

Survey Area ________ Survey Type ________

BEHAVIOUR / COMMENTS

☐ Feeding ☐ Socializinig ☐ Traveling ☐ Milling/Resting ☐ Breaching ☐ Spy-hopping ☐ Porpoising

Other Behaviour ________

Identified Individual(s) ________

Other Comments ________

CONVERTED DATA (To Be Filled by SH)

Perpendicular Distance (m) ________ Position (3 decimal places) ________

Table 10 Vessel Survey Effort Data Sheet

VESSEL SURVEY EFFORT DATA SHEET

P. ____ of ____

Date ____________ Survey Area ____________ Survey Direction ____________

Weather condition ____________ Survey Type ____________

Observers ____________ Vessel ____________

Flood Tide ____________ Ebb Tide ____________

Event	Series	Time	Position	Speed	Beau	Visib.	Trip	Stg.#

Table 11 Vessel Survey EffortT

Date	Area	Sea Condition (Beaufort Scale)	Transect Distance Seached (Km)	Season	Vessel
18-Jul-05	DEEP BAY	2	3.39	SUMMER	KING DRAGON II
18-Jul-05	DEEP BAY	3	8.81	SUMMER	KING DRAGON II
19-Jul-05	DEEP BAY	2	1.98	SUMMER	KING DRAGON II
19-Jul-05	DEEP BAY	3	14.32	SUMMER	KING DRAGON II
20-Jul-05	NW LANTAU	1	4.07	SUMMER	KING DRAGON II
20-Jul-05	NW LANTAU	2	7.63	SUMMER	KING DRAGON II
20-Jul-05	NW LANTAU	3	12.40	SUMMER	KING DRAGON II
20-Jul-05	NW LANTAU	4	1.30	SUMMER	KING DRAGON II
20-Jul-05	DEEP BAY	2	16.59	SUMMER	KING DRAGON II
20-Jul-05	DEEP BAY	3	2.01	SUMMER	KING DRAGON II
21-Jul-05	NW LANTAU	3	7.69	SUMMER	KING DRAGON II
21-Jul-05	NW LANTAU	4	2.18	SUMMER	KING DRAGON II
21-Jul-05	NW LANTAU	5	5.53	SUMMER	KING DRAGON II
22-Jul-05	DEEP BAY	1	1.00	SUMMER	KING DRAGON II
22-Jul-05	DEEP BAY	2	6.19	SUMMER	KING DRAGON II
22-Jul-05	DEEP BAY	3	7.98	SUMMER	KING DRAGON II
22-Jul-05	DEEP BAY	4	1.92	SUMMER	KING DRAGON II
25-Jul-05	DEEP BAY	2	5.67	SUMMER	KING DRAGON II
25-Jul-05	DEEP BAY	3	5.70	SUMMER	KING DRAGON II
25-Jul-05	DEEP BAY	4	7.13	SUMMER	KING DRAGON II
26-Jul-05	NW LANTAU	2	5.58	SUMMER	KING DRAGON II
26-Jul-05	NW LANTAU	3	10.32	SUMMER	KING DRAGON II
26-Jul-05	NW LANTAU	4	5.78	SUMMER	KING DRAGON II
26-Jul-05	DEEP BAY	2	4.69	SUMMER	KING DRAGON II
26-Jul-05	DEEP BAY	3	10.40	SUMMER	KING DRAGON II
26-Jul-05	DEEP BAY	4	3.22	SUMMER	KING DRAGON II
27-Jul-05	DEEP BAY	2	11.66	SUMMER	KING DRAGON II
27-Jul-05	DEEP BAY	3	5.14	SUMMER	KING DRAGON II
03-Aug-05	DEEP BAY	2	6.67	SUMMER	KING DRAGON II
03-Aug-05	DEEP BAY	3	11.33	SUMMER	KING DRAGON II
04-Aug-05	DEEP BAY	2	9.43	SUMMER	KING DRAGON II
04-Aug-05	DEEP BAY	3	4.87	SUMMER	KING DRAGON II
04-Aug-05	DEEP BAY	4	2.20	SUMMER	KING DRAGON II
05-Aug-05	DEEP BAY	1	5.04	SUMMER	KING DRAGON II
05-Aug-05	DEEP BAY	2	12.66	SUMMER	KING DRAGON II
05-Aug-05	DEEP BAY	3	0.10	SUMMER	KING DRAGON II
05-Aug-05	NW LANTAU	1	6.38	SUMMER	KING DRAGON II
05-Aug-05	NW LANTAU	2	13.60	SUMMER	KING DRAGON II
12-Aug-05	DEEP BAY	3	12.21	SUMMER	KING DRAGON II
12-Aug-05	DEEP BAY	4	5.49	SUMMER	KING DRAGON II
15-Aug-05	NW LANTAU	2	15.01	SUMMER	KING DRAGON II
15-Aug-05	NW LANTAU	3	8.39	SUMMER	KING DRAGON II
15-Aug-05	DEEP BAY	2	16.62	SUMMER	KING DRAGON II
22-Aug-05	DEEP BAY	3	10.02	SUMMER	KING DRAGON II
22-Aug-05	DEEP BAY	4	7.78	SUMMER	KING DRAGON II

Date	Area	Sea Condition (Beaufort Scale)	Transect Distance Seached (Km)	Season	Vessel
23-Aug-05	DEEP BAY	3	16.20	SUMMER	KING DRAGON II
23-Aug-05	DEEP BAY	4	0.20	SUMMER	KING DRAGON II
24-Aug-05	NW LANTAU	0	4.48	SUMMER	KING DRAGON II
24-Aug-05	NW LANTAU	1	4.85	SUMMER	KING DRAGON II
24-Aug-05	NW LANTAU	2	12.48	SUMMER	KING DRAGON II
25-Aug-05	NW LANTAU	2	13.20	SUMMER	KING DRAGON II
25-Aug-05	NW LANTAU	3	6.65	SUMMER	KING DRAGON II
25-Aug-05	NW LANTAU	4	4.63	SUMMER	KING DRAGON II
26-Aug-05	DEEP BAY	2	17.60	SUMMER	KING DRAGON II
05-Sep-05	DEEP BAY	1	3.45	AUTUMN	TSUN WING
05-Sep-05	DEEP BAY	2	11.55	AUTUMN	TSUN WING
05-Sep-05	DEEP BAY	3	3.90	AUTUMN	TSUN WING
06-Sep-05	DEEP BAY	1	11.81	AUTUMN	TSUN WING
06-Sep-05	DEEP BAY	2	7.27	AUTUMN	TSUN WING
07-Sep-05	DEEP BAY	2	15.65	AUTUMN	TSUN WING
07-Sep-05	DEEP BAY	3	4.35	AUTUMN	TSUN WING
07-Sep-05	NW LANTAU	2	17.49	AUTUMN	TSUN WING
07-Sep-05	NW LANTAU	3	4.65	AUTUMN	TSUN WING
15-Sep-05	DEEP BAY	2	14.12	AUTUMN	TSUN WING
15-Sep-05	DEEP BAY	3	4.07	AUTUMN	TSUN WING
15-Sep-05	DEEP BAY	4	0.81	AUTUMN	TSUN WING
16-Sep-05	DEEP BAY	2	10.70	AUTUMN	TSUN WING
16-Sep-05	DEEP BAY	3	5.38	AUTUMN	TSUN WING
16-Sep-05	DEEP BAY	4	2.60	AUTUMN	TSUN WING
20-Sep-05	NW LANTAU	0	3.50	AUTUMN	TSUN WING
20-Sep-05	NW LANTAU	1	5.70	AUTUMN	TSUN WING
20-Sep-05	NW LANTAU	2	14.98	AUTUMN	TSUN WING
05-Oct-05	DEEP BAY	2	8.50	AUTUMN	TSUN WING
05-Oct-05	DEEP BAY	3	10.50	AUTUMN	TSUN WING
06-Oct-05	DEEP BAY	2	4.67	AUTUMN	TSUN WING
06-Oct-05	DEEP BAY	3	10.23	AUTUMN	TSUN WING
06-Oct-05	DEEP BAY	4	3.83	AUTUMN	TSUN WING
07-Oct-05	NW LANTAU	2	14.61	AUTUMN	TSUN WING
07-Oct-05	NW LANTAU	3	8.61	AUTUMN	TSUN WING
07-Oct-05	DEEP BAY	2	9.78	AUTUMN	TSUN WING
07-Oct-05	DEEP BAY	3	8.56	AUTUMN	TSUN WING
07-Oct-05	DEEP BAY	4	0.21	AUTUMN	TSUN WING
17-Oct-05	DEEP BAY	1	4.30	AUTUMN	TSUN WING
17-Oct-05	DEEP BAY	2	5.71	AUTUMN	TSUN WING
17-Oct-05	DEEP BAY	3	6.45	AUTUMN	TSUN WING
17-Oct-05	DEEP BAY	4	1.04	AUTUMN	TSUN WING
18-Oct-05	DEEP BAY	2	4.14	AUTUMN	TSUN WING
18-Oct-05	DEEP BAY	3	9.83	AUTUMN	TSUN WING
18-Oct-05	DEEP BAY	4	3.68	AUTUMN	TSUN WING
19-Oct-05	NW LANTAU	3	8.12	AUTUMN	TSUN WING
19-Oct-05	NW LANTAU	4	14.50	AUTUMN	TSUN WING
19-Oct-05	NW LANTAU	5	2.39	AUTUMN	TSUN WING

Date	Area	Sea Condition (Beaufort Scale)	Transect Distance Seached (Km)	Season	Vessel
22-Nov-05	DEEP BAY	1	2.49	AUTUMN	TSUN WING
22-Nov-05	DEEP BAY	2	15.71	AUTUMN	TSUN WING
24-Nov-05	DEEP BAY	3	6.90	AUTUMN	TSUN WING
24-Nov-05	DEEP BAY	4	4.90	AUTUMN	TSUN WING
24-Nov-05	DEEP BAY	5	6.85	AUTUMN	TSUN WING
25-Nov-05	NW LANTAU	2	13.91	AUTUMN	TSUN WING
25-Nov-05	NW LANTAU	3	7.37	AUTUMN	TSUN WING
25-Nov-05	DEEP BAY	1	1.18	AUTUMN	TSUN WING
25-Nov-05	DEEP BAY	2	4.46	AUTUMN	TSUN WING
25-Nov-05	DEEP BAY	3	11.71	AUTUMN	TSUN WING
25-Nov-05	DEEP BAY	4	1.35	AUTUMN	TSUN WING
28-Nov-05	DEEP BAY	2	16.40	AUTUMN	TSUN WING
28-Nov-05	DEEP BAY	3	2.00	AUTUMN	TSUN WING
29-Nov-05	DEEP BAY	2	2.22	AUTUMN	TSUN WING
29-Nov-05	DEEP BAY	3	3.54	AUTUMN	TSUN WING
29-Nov-05	DEEP BAY	4	12.32	AUTUMN	TSUN WING
30-Nov-05	NW LANTAU	2	3.94	AUTUMN	TSUN WING
30-Nov-05	NW LANTAU	3	12.92	AUTUMN	TSUN WING
30-Nov-05	NW LANTAU	4	3.85	AUTUMN	TSUN WING
30-Nov-05	NW LANTAU	5	2.51	AUTUMN	TSUN WING
01-Dec-05	DEEP BAY	2	16.83	WINTER	TSUN WING
01-Dec-05	DEEP BAY	3	1.77	WINTER	TSUN WING
02-Dec-05	DEEP BAY	2	18.50	WINTER	TSUN WING
02-Dec-05	DEEP BAY	3	0.30	WINTER	TSUN WING
06-Dec-05	NW LANTAU	4	12.13	WINTER	TSUN WING
06-Dec-05	NW LANTAU	5	5.23	WINTER	TSUN WING
06-Dec-05	NW LANTAU	6	2.18	WINTER	TSUN WING
06-Dec-05	DEEP BAY	3	8.47	WINTER	TSUN WING
06-Dec-05	DEEP BAY	4	5.70	WINTER	TSUN WING
06-Dec-05	DEEP BAY	5	4.13	WINTER	TSUN WING
07-Dec-05	DEEP BAY	2	2.80	WINTER	TSUN WING
07-Dec-05	DEEP BAY	3	15.20	WINTER	TSUN WING
08-Dec-05	DEEP BAY	2	2.96	WINTER	TSUN WING
08-Dec-05	DEEP BAY	3	8.28	WINTER	TSUN WING
08-Dec-05	DEEP BAY	4	4.49	WINTER	TSUN WING
08-Dec-05	DEEP BAY	5	2.27	WINTER	TSUN WING
22-Dec-05	NW LANTAU	4	11.80	WINTER	TSUN WING
22-Dec-05	NW LANTAU	5	11.48	WINTER	TSUN WING
13-Jan-06	NW LANTAU	1	3.02	WINTER	TSUN WING
13-Jan-06	NW LANTAU	2	16.73	WINTER	TSUN WING
13-Jan-06	NW LANTAU	3	2.12	WINTER	TSUN WING
16-Jan-06	DEEP BAY	2	13.75	WINTER	TSUN WING
16-Jan-06	DEEP BAY	3	3.45	WINTER	TSUN WING
17-Jan-06	DEEP BAY	2	11.13	WINTER	TSUN WING
17-Jan-06	DEEP BAY	3	5.20	WINTER	TSUN WING
19-Jan-06	NW LANTAU	5	8.13	WINTER	TSUN WING
19-Jan-06	NW LANTAU	6	1.83	WINTER	TSUN WING

Date	Area	Sea Condition (Beaufort Scale)	Transect Distance Seached (Km)	Season	Vessel
19-Jan-06	DEEP BAY	1	1.00	WINTER	TSUN WING
19-Jan-06	DEEP BAY	2	6.05	WINTER	TSUN WING
19-Jan-06	DEEP BAY	3	8.85	WINTER	TSUN WING
19-Jan-06	DEEP BAY	4	1.01	WINTER	TSUN WING
20-Jan-06	DEEP BAY	2	10.70	WINTER	TSUN WING
24-Jan-06	DEEP BAY	2	10.98	WINTER	TSUN WING
24-Jan-06	DEEP BAY	3	6.52	WINTER	TSUN WING
01-Feb-06	DEEP BAY	2	14.96	WINTER	TSUN WING
01-Feb-06	DEEP BAY	3	2.01	WINTER	TSUN WING
02-Feb-06	DEEP BAY	0	1.43	WINTER	TSUN WING
02-Feb-06	DEEP BAY	1	13.08	WINTER	TSUN WING
02-Feb-06	DEEP BAY	2	1.72	WINTER	TSUN WING
03-Feb-06	NW LANTAU	1	3.78	WINTER	TSUN WING
03-Feb-06	NW LANTAU	2	13.59	WINTER	TSUN WING
03-Feb-06	NW LANTAU	3	6.55	WINTER	TSUN WING
03-Feb-06	DEEP BAY	1	3.35	WINTER	TSUN WING
03-Feb-06	DEEP BAY	2	14.15	WINTER	TSUN WING
07-Feb-06	DEEP BAY	1	4.89	WINTER	TSUN WING
07-Feb-06	DEEP BAY	2	11.71	WINTER	TSUN WING
08-Feb-06	NW LANTAU	2	5.09	WINTER	TSUN WING
08-Feb-06	NW LANTAU	3	12.99	WINTER	TSUN WING
08-Feb-06	NW LANTAU	4	1.99	WINTER	TSUN WING
09-Feb-06	DEEP BAY	1	0.40	WINTER	TSUN WING
09-Feb-06	DEEP BAY	2	11.20	WINTER	TSUN WING
09-Feb-06	DEEP BAY	3	5.20	WINTER	TSUN WING
15-Mar-06	DEEP BAY	2	0.80	SPRING	TSUN WING
15-Mar-06	DEEP BAY	3	16.60	SPRING	TSUN WING
17-Mar-06	NW LANTAU	3	7.84	SPRING	TSUN WING
17-Mar-06	NW LANTAU	4	4.41	SPRING	TSUN WING
17-Mar-06	NW LANTAU	5	7.39	SPRING	TSUN WING
17-Mar-06	DEEP BAY	2	9.26	SPRING	TSUN WING
17-Mar-06	DEEP BAY	3	8.64	SPRING	TSUN WING
23-Mar-06	NW LANTAU	2	6.75	SPRING	TSUN WING
23-Mar-06	NW LANTAU	3	7.35	SPRING	TSUN WING
23-Mar-06	NW LANTAU	4	8.45	SPRING	TSUN WING
28-Mar-06	DEEP BAY	2	1.49	SPRING	TSUN WING
28-Mar-06	DEEP BAY	3	15.91	SPRING	TSUN WING
29-Mar-06	DEEP BAY	1	1.85	SPRING	TSUN WING
29-Mar-06	DEEP BAY	2	5.90	SPRING	TSUN WING
29-Mar-06	DEEP BAY	3	10.03	SPRING	TSUN WING
31-Mar-06	DEEP BAY	3	15.95	SPRING	TSUN WING
31-Mar-06	DEEP BAY	4	0.87	SPRING	TSUN WING
03-Apr-06	DEEP BAY	1	5.96	SPRING	TSUN WING
03-Apr-06	DEEP BAY	2	7.73	SPRING	TSUN WING
03-Apr-06	DEEP BAY	3	3.96	SPRING	TSUN WING
06-Apr-06	DEEP BAY	1	12.10	SPRING	TSUN WING
06-Apr-06	DEEP BAY	2	6.10	SPRING	TSUN WING

Date	Area	Sea Condition (Beaufort Scale)	Transect Distance Seached (Km)	Season	Vessel
18-Apr-06	NW LANTAU	1	1.09	SPRING	TSUN WING
18-Apr-06	NW LANTAU	2	5.64	SPRING	TSUN WING
18-Apr-06	NW LANTAU	3	9.11	SPRING	TSUN WING
18-Apr-06	NW LANTAU	4	6.25	SPRING	TSUN WING
18-Apr-06	DEEP BAY	2	14.22	SPRING	TSUN WING
18-Apr-06	DEEP BAY	3	3.68	SPRING	TSUN WING
25-Apr-06	DEEP BAY	3	2.00	SPRING	TSUN WING
25-Apr-06	DEEP BAY	4	5.11	SPRING	TSUN WING
25-Apr-06	DEEP BAY	5	7.89	SPRING	TSUN WING
26-Apr-06	DEEP BAY	3	10.80	SPRING	TSUN WING
26-Apr-06	DEEP BAY	4	0.70	SPRING	TSUN WING
27-Apr-06	NW LANTAU	3	2.81	SPRING	TSUN WING
27-Apr-06	NW LANTAU	4	13.99	SPRING	TSUN WING
27-Apr-06	NW LANTAU	5	2.20	SPRING	TSUN WING
02-May-06	DEEP BAY	3	4.47	SPRING	TSUN WING
02-May-06	DEEP BAY	4	8.23	SPRING	TSUN WING
02-May-06	DEEP BAY	5	1.24	SPRING	TSUN WING
04-May-06	DEEP BAY	3	4.18	SPRING	TSUN WING
04-May-06	DEEP BAY	4	10.15	SPRING	TSUN WING
04-May-06	DEEP BAY	5	1.27	SPRING	TSUN WING
08-May-06	NW LANTAU	3	21.13	SPRING	TSUN WING
08-May-06	NW LANTAU	4	0.88	SPRING	TSUN WING
08-May-06	DEEP BAY	3	15.10	SPRING	TSUN WING
09-May-06	DEEP BAY	2	6.54	SPRING	TSUN WING
09-May-06	DEEP BAY	3	7.59	SPRING	TSUN WING
09-May-06	DEEP BAY	4	1.37	SPRING	TSUN WING
10-May-06	DEEP BAY	3	8.98	SPRING	TSUN WING
10-May-06	DEEP BAY	4	4.42	SPRING	TSUN WING
11-May-06	NW LANTAU	2	0.86	SPRING	TSUN WING
11-May-06	NW LANTAU	3	10.44	SPRING	TSUN WING
11-May-06	NW LANTAU	4	2.70	SPRING	TSUN WING
11-May-06	NW LANTAU	5	1.20	SPRING	TSUN WING

Table 12 Indo-Pacific Humpback Dolphin Sightings Records

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	DEC LAT	DEC LONG	SEASON	BOAT ASSOC	GRP. COMP.
15-Jul-05	1	0830	12	NW LANTAU	2	ND	OFF	ERM-LNG	22.3389	113.9399	SUMMER	NONE	
15-Jul-05	2	0936	2	DEEP BAY	2	581	OFF	ERM-LNG	22.4219	113.9119	SUMMER	NONE	
15-Jul-05	3	1117	6	NW LANTAU	2	ND	OFF	ERM-LNG	22.3672	113.8886	SUMMER	NONE	1 SJ, 1 SS, 2 SA, 2 UA
26-Jul-05	6	1111	2	NW LANTAU	2	235	ON	ERM-LNG	22.3592	113.8773	SUMMER	NONE	
26-Jul-05	7	1230	2	DEEP BAY	2	234	ON	ERM-LNG	22.4230	113.9024	SUMMER	NONE	1 SJ, 1 SS
26-Jul-05	8	1332	2	DEEP BAY	3	20	OFF	ERM-LNG	22.4148	113.8955	SUMMER	NONE	1 SJ, 1 SS
26-Jul-05	9	1343	3	NW LANTAU	3	ND	OFF	ERM-LNG	22.4038	113.8962	SUMMER	NONE	
26-Jul-05	10	1359	3	NW LANTAU	3	55	ON	ERM-LNG	22.3916	113.8858	SUMMER	NONE	
05-Aug-05	1	0900	3	NW LANTAU	1	115	ON	ERM-LNG	22.3634	113.8784	SUMMER	NONE	2 SS, 1 SA
05-Aug-05	2	0925	2	NW LANTAU	2	112	ON	ERM-LNG	22.3763	113.8763	SUMMER	NONE	
15-Aug-05	2	1123	2	NW LANTAU	3	93	ON	ERM-LNG	22.3979	113.8782	SUMMER	NONE	
15-Aug-05	3	1329	3	NW LANTAU	3	426	ON	ERM-LNG	22.3775	113.8883	SUMMER	NONE	
24-Aug-05	6	1536	2	NW LANTAU	1	426	ON	ERM-LNG	22.3492	113.8833	SUMMER	NONE	1 SA, 1 UA
24-Aug-05	7	1551	4	NW LANTAU	2	759	ON	ERM-LNG	22.3612	113.8778	SUMMER	NONE	
24-Aug-05	8	1600	1	NW LANTAU	2	412	ON	ERM-LNG	22.3759	113.8764	SUMMER	NONE	
24-Aug-05	9	1621	4	NW LANTAU	2	756	ON	ERM-LNG	22.4035	113.8848	SUMMER	NONE	
24-Aug-05	10	1628	2	NW LANTAU	2	28	ON	ERM-LNG	22.3912	113.8865	SUMMER	SHRIMP	1 SS, 1 SA
24-Aug-05	11	1632	4	NW LANTAU	2	30	ON	ERM-LNG	22.3865	113.8873	SUMMER	NONE	
24-Aug-05	12	1639	4	NW LANTAU	2	40	ON	ERM-LNG	22.3759	113.8876	SUMMER	NONE	
25-Aug-05	1	0936	3	NW LANTAU	4	5	OFF	ERM-LNG	22.3700	113.8766	SUMMER	NONE	
25-Aug-05	2	1022	5	NW LANTAU	4	45	ON	ERM-LNG	22.2842	113.8780	SUMMER	NONE	
06-Sep-05	1	0921	10	DEEP BAY	2	139	ON	ERM-LNG	22.4205	113.8936	AUTUMN	NONE	1 UJ, 2 SJ, 5 SS, 1 SA, 1 UA
07-Sep-05	6	1223	2	NW LANTAU	3	131	ON	ERM-LNG	22.3605	113.8776	AUTUMN	NONE	
07-Sep-05	7	1441	6	NW LANTAU	2	75	ON	ERM-LNG	22.3697	113.8854	AUTUMN	NONE	
07-Sep-05	8	1512	1	NW LANTAU	2	48	ON	ERM-LNG	22.3590	113.8852	AUTUMN	NONE	
07-Sep-05	9	1527	5	NW LANTAU	2	111	ON	ERM-LNG	22.3403	113.8864	AUTUMN	NONE	1 SJ, 1 SS, 2 SA, 1 UA
16-Sep-05	1	0845	4	DEEP BAY	2	74	ON	ERM-LNG	22.4212	113.9110	AUTUMN	NONE	1 UJ, 1 SJ, 1 SS, 1 SA
20-Sep-05	9	1646	2	NW LANTAU	1	403	ON	ERM-LNG	22.3947	113.8864	AUTUMN	NONE	
06-Oct-05	1	0905	1	DEEP BAY	2	173	ON	ERM-LNG	22.4499	113.9367	AUTUMN	NONE	1 SJ
07-Oct-05	4	1113	5	NW LANTAU	2	182	ON	ERM-LNG	22.3368	113.8779	AUTUMN	NONE	

DATE	STG #	TIME	HRD SZ	AREA	BEAU	PSD	EFFORT	TYPE	DEC LAT	DEC LONG	SEASON	BOAT ASSOC	GRP. COMP.
07-Oct-05	5	1134	3	NW LANTAU	3	52	ON	ERM-LNG	22.3485	113.8770	AUTUMN	NONE	
07-Oct-05	6	1236	3	DEEP BAY	3	170	ON	ERM-LNG	22.4413	113.9062	AUTUMN	NONE	
07-Oct-05	7	1414	2	NW LANTAU	2	216	ON	ERM-LNG	22.3573	113.8848	AUTUMN	NONE	1 SJ, 1 SS
18-Oct-05	1	0932	1	DEEP BAY	3	39	ON	ERM-LNG	22.4371	113.9156	AUTUMN	NONE	1 SJ
18-Oct-05	2	1013	5	DEEP BAY	3	51	ON	ERM-LNG	22.4185	113.9071	AUTUMN	NONE	
19-Oct-05	1	0859	2	NW LANTAU	3	15	ON	ERM-LNG	22.3751	113.8886	AUTUMN	NONE	1 UJ, 1 SA
19-Oct-05	2	0932	8	NW LANTAU	4	389	ON	ERM-LNG	22.3818	113.8757	AUTUMN	NONE	
19-Oct-05	3	0959	1	NW LANTAU	3	18	ON	ERM-LNG	22.3720	113.8758	AUTUMN	NONE	1 SA
19-Oct-05	4	1041	2	NW LANTAU	4	274	ON	ERM-LNG	22.2950	113.8773	AUTUMN	NONE	1 SJ, 1 SA
24-Nov-05	1	1008	2	DEEP BAY	5	81	ON	ERM-LNG	22.4193	113.9089	AUTUMN	NONE	
25-Nov-05	13	1415	3	NW LANTAU	2	22	ON	ERM-LNG	22.3977	113.8864	AUTUMN	NONE	
25-Nov-05	14	1433	9	NW LANTAU	2	84	ON	ERM-LNG	22.3810	113.8879	AUTUMN	NONE	2 UJ, 2 SJ, 3 SS, 2 SA
29-Nov-05	1	0929	1	DEEP BAY	4	0	ON	ERM-LNG	22.4266	113.8879	AUTUMN	NONE	1 SS
30-Nov-05	3	1313	1	NW LANTAU	3	84	ON	ERM-LNG	22.3546	113.8777	AUTUMN	NONE	
30-Nov-05	4	1328	6	NW LANTAU	3	137	ON	ERM-LNG	22.3746	113.8751	AUTUMN	NONE	
30-Nov-05	5	1353	1	NW LANTAU	3	4	ON	ERM-LNG	22.3882	113.8774	AUTUMN	NONE	1 SA
30-Nov-05	6	1407	4	NW LANTAU	3	165	ON	ERM-LNG	22.4021	113.8805	AUTUMN	NONE	
13-Jan-06	15	1529	1	NW LANTAU	2	71	ON	ERM-LNG	22.3073	113.8776	WINTER	NONE	
13-Jan-06	16	1543	5	NW LANTAU	2	797	ON	ERM-LNG	22.3360	113.8788	WINTER	NONE	
13-Jan-06	17	1608	1	NW LANTAU	1	121	ON	ERM-LNG	22.3936	113.8773	WINTER	NONE	
13-Jan-06	18	1642	3	NW LANTAU	2	204	ON	ERM-LNG	22.3318	113.8868	WINTER	NONE	
17-Jan-06	1	0912	6	DEEP BAY	2	239	ON	ERM-LNG	22.4250	113.8902	WINTER	NONE	
17-Jan-06	2	0939	4	DEEP BAY	3	165	ON	ERM-LNG	22.4309	113.9079	WINTER	NONE	
17-Jan-06	3	1021	1	DEEP BAY	2	25	ON	ERM-LNG	22.4194	113.9088	WINTER	NONE	1 SJ
19-Jan-06	5	1113	4	NW LANTAU	5	271	ON	ERM-LNG	22.3689	113.8751	WINTER	NONE	
19-Jan-06	6	1154	4	DEEP BAY	2	48	ON	ERM-LNG	22.4508	113.9201	WINTER	NONE	2 UJ, 1 SA, 1 UA
01-Feb-06	3	1442	4	DEEP BAY	2	34	ON	ERM-LNG	22.4254	113.8994	WINTER	NONE	1 UJ, 2 SJ, 1 SA
01-Feb-06	4	1505	1	DEEP BAY	2	107	ON	ERM-LNG	22.4315	113.8931	WINTER	NONE	1 SS
02-Feb-06	1	0913	2	DEEP BAY	1	0	ON	ERM-LNG	22.4354	113.8996	WINTER	NONE	1 SS, 1 UA
02-Feb-06	2	0937	2	DEEP BAY	1	54	ON	ERM-LNG	22.4253	113.8992	WINTER	NONE	
02-Feb-06	3	1016	1	DEEP BAY	1	109	ON	ERM-LNG	22.4210	113.9109	WINTER	NONE	1 SS
03-Feb-06	9	1126	2	NW LANTAU	2	795	ON	ERM-LNG	22.3391	113.8757	WINTER	NONE	
03-Feb-06	10	1133	2	NW LANTAU	1	40	ON	ERM-LNG	22.3494	113.8767	WINTER	NONE	1 SS, 1 SA

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03-Feb-06	11	1140	5	NW LANTAU	1	234	ON	ERM-LNG	22.3564	113.8762	WINTER	NONE	
03-Feb-06	12	1156	4	NW LANTAU	1	44	ON	ERM-LNG	22.3735	113.8760	WINTER	NONE	
03-Feb-06	13	1348	4	NW LANTAU	2	300	ON	ERM-LNG	22.3997	113.8889	WINTER	NONE	
03-Feb-06	14	1356	4	NW LANTAU	3	100	ON	ERM-LNG	22.3797	113.8917	WINTER	NONE	
03-Feb-06	15	1415	17	NW LANTAU	3	143	ON	ERM-LNG	22.3796	113.8912	WINTER	HANG	
03-Feb-06	16	1447	3	NW LANTAU	3	173	ON	ERM-LNG	22.3703	113.8879	WINTER	NONE	
03-Feb-06	17	1212	1	DEEP BAY	1	496	ON	ERM-LNG	22.3941	113.8777	WINTER	NONE	
08-Feb-06	1	0834	3	NW LANTAU	3	0	ON	ERM-LNG	22.2930	113.8780	WINTER	NONE	1 UJ, 1 SS, 1 UA
08-Feb-06	2	0915	1	NW LANTAU	3	24	ON	ERM-LNG	22.3542	113.8771	WINTER	NONE	
08-Feb-06	3	0927	2	NW LANTAU	3	536	ON	ERM-LNG	22.3704	113.8755	WINTER	NONE	
08-Feb-06	4	0938	6	NW LANTAU	2	0	ON	ERM-LNG	22.3723	113.8748	WINTER	NONE	
08-Feb-06	5	1007	12	NW LANTAU	3	72	ON	ERM-LNG	22.3967	113.8899	WINTER	NONE	
17-Mar-06	3	1108	1	NW LANTAU	3	74	ON	ERM-LNG	22.3895	113.8784	SPRING	NONE	1 SA
23-Mar-06	2	1342	2	NW LANTAU	2	56	ON	ERM-LNG	22.3805	113.8886	SPRING	NONE	1 SS, 1 SA
29-Mar-06	2	1307	12	DEEP BAY	3	18	ON	ERM-LNG	22.4181	113.8917	SPRING	NONE	
31-Mar-06	3	1420	1	DEEP BAY	3	83	ON	ERM-LNG	22.4294	113.9066	SPRING	NONE	1 SJ
03-Apr-06	5	1407	3	DEEP BAY	2	143	ON	ERM-LNG	22.4223	113.8916	SPRING	NONE	
18-Apr-06	5	1030	1	NW LANTAU	4	0	ON	ERM-LNG	22.3313	113.8759	SPRING	NONE	
18-Apr-06	6	1237	4	NW LANTAU	3	0	ON	ERM-LNG	22.3781	113.8893	SPRING	NONE	2 UJ, 2 SA
02-May-06	1	1344	3	DEEP BAY	4	75	ON	ERM-LNG	22.4152	113.9048	SPRING	NONE	
08-May-06	7	1118	4	NW LANTAU	2	575	ON	ERM-LNG	22.3375	113.8789	SPRING	PAIR	
08-May-06	8	1142	2	NW LANTAU	2	298	ON	ERM-LNG	22.3868	113.8775	SPRING	NONE	
08-May-06	9	1147	6	NW LANTAU	3	0	ON	ERM-LNG	22.3932	113.8797	SPRING	NONE	
09-May-06	1	0843	4	NW LANTAU	3	ND	OFF	ERM-LNG	22.4120	113.8981	SPRING	NONE	