Annex G

# Marine Ecology Impact

## 1.1 BASELINE CONDITIONS

This Annex describes the baseline conditions of marine ecological resources within the Marine Ecology Study Area. The Assessment Area was defined in the Study Brief as all sensitive receivers within the North Western, Western Buffer and Southern Water Control Zones (WCZs). However, on the basis of preliminary information from the water quality assessment, perturbations to water quality are unlikely to extend outside the area presented in *Figure 1.1a*, referred to as the Marine Ecology Assessment Area. Consequently, this assessment of impacts has focussed on the marine ecological resources of this area. Baseline conditions for each ecological component of the marine environment are evaluated based on information from the literature and specific field studies conducted for the purposes of this EIA.

### 1.1.1 *Literature Review*

The availability of literature on the marine ecology of the Marine Ecology Study Area is variable. As with the majority of Hong Kong it appears that certain ecological components have been comprehensively studied whereas others have not. The list of relevant reports in the Study Brief has been reviewed along with relevant information pertaining to the ecological characteristics of the Penny's Bay and East Lantau area. In order to assess the ecological value of these areas, a brief review of the relevant literature on the waters outside of the Marine Ecology Study Area has also been conducted. The findings of this desk-top assessment are presented below in *Section 2*.

### 1.1.2 *Focussed Field Surveys*

Due to the limited literature available for some components of the marine ecosystem within the Marine Ecology Study Area, field surveys were considered necessary to fill the information gaps identified and enable a complete and robust assessment of impacts to marine ecology to be performed. The findings of the field surveys are presented below as well as an outline of information on marine ecological resources, both within the Marine Ecology Study Area and within close proximity, based on information gathered through desk-top reviews of available literature.

## 2.1 SOFT BENTHOS ASSEMBLAGES

### 2.1.1 *Infaunal Assemblages*

A study of benthic assemblages throughout Hong Kong was undertaken by Shin & Thompson (1982). The study concluded that the western waters of Hong Kong supports assemblages that are polychaete dominated (82.5 %). Species diversity at locations near the Theme Park (*Figure 2.1a*) was ranked intermediate (34.4 $m^{-2}$) when compared with other areas in Hong Kong (values ranging from 32.4 to 38.4 $m^{-2}$). The mean number of individuals was 107.1 $m^{-2}$ which is higher than the average for Hong Kong (101.4 $m^{-2}$) and the mean biomass for the area was 23.9 g $m^{-2}$, which is low compared to the overall mean biomass for Hong Kong at 35.2 g $m^{-2}$.

One of the components of the EIA for the Lantau Port and Western Harbour Development (APH 1992) was a series of environmental surveys. These included a survey of marine benthic infauna. Samples were collected from two stations in the vicinity of the Study Area (Station 5 and 6, see *Figure 2.1a*). Three replicates were collected from each station, once in the dry season and once in the wet season.

In general, more species and individuals were recorded in the winter than in the summer (*Table 2.1a*). Values reported for both the December and June surveys were lower than those reported previously for the area by Shin & Thompson. Both Station 5 and 6 recorded the lowest biomass during the wet season survey of 2.4 and 2.8 g $m^{-2}$, respectively, and much higher corresponding biomass values of 10.18 and 11.25 g $m^{-2}$ were obtained in the December survey. These values are still considerably lower than the mean value (23.9 g $m^{-2}$) recorded by Shin & Thompson.

*Table 2.1a* ***Summary Information from Grab Survey in December 1991 and June 1992***

| Station | Number of Individuals (# $m^{-2}$) | | Total Biomass (g $m^{-2}$) | |
|---|---|---|---|---|
| | December | June | December | June |
| 5 | 40 | 13 | 10.80 | 2.40 |
| 6 | 80 | 20 | 11.25 | 2.80 |

Polychaetes were the most abundant species collected from the sampling stations during both sampling events. The species recorded from the two stations are listed in *Table 2.1b*. The most abundant species was *Notomastus latericeus*, followed by *Marphysa stragulum* and *Paraprionospio pinnata* (all of which are polychaetes).

*Table 2.1b* *Organisms (Number $m^{-2}$) Collected in the Lantau Port & Western Harbour Development Grab Sampling Survey*

| Phylum | Species | December 1991 | | June 1992 | |
|---|---|---|---|---|---|
| | | Station 5 | Station 6 | Station 5 | Station 6 |
| Annelida | *Algaophamus lyrochaeta* | - | 7 | - | - |
| | *Glycera chiori* | 7 | - | - | - |
| | *Lumbrineris* sp | - | - | - | 7 |
| | *Marphysa stragulum* | 7 | 7 | 7 | - |
| | *Notomastus latericeus* | 13 | 47 | 7 | 7 |
| | *Paraprionospio pinnata* | 13 | 7 | - | - |
| | *Sternaspis scutata* | - | - | - | 7 |
| Nemertea | *Nemertea* sp | - | 13 | - | - |

As part of the monitoring programme conducted for SSDS Stage 1 (Mouchel 1998), grab samples were collected throughout Hong Kong waters during four sampling events, May and October 1996, February and May 1997. One of the stations sampled (S03) was located offshore to the Study Area (*Figure 2.1a*). Five replicate grabs were collected from this station during the months listed above. The results of the surveys indicated that the sediments contained infaunal assemblages at a similar abundance to that reported by Shin & Thompson. The values ranged from 5 to 66 g $m^{-2}$ during the survey period with a mean value of 24.14 g $m^{-2}$. Polychaetes were again the most dominant group of organisms recorded for the soft bottom assemblages.

### 2.1.2 *Epifaunal Assemblages*

Trawl surveys were conducted in 1995 to collect epifaunal benthic community data at South Tsing Yi (ERM 1995). The results from one of the survey stations (T1), which is located near the Study Area (*Figure 2.1a*), showed that crabs and shrimps were the dominant faunal species. The demersal community was diverse but abundances were low. Of the species identified, gorgonian soft corals were considered in that study to be of ecological value.

### 2.1.3 *Intertidal Sandy Shore Assemblages*

In the lee of headlands or within shallow bays, wave action is reduced and there is an accumulation of sand and detrital material. Exposed sandy beaches are relatively unstable environments and the fauna is sparse. With increasing shelter, however, substrate stability allows for the development of a rich community of burrowing animals. Where a river or stream empties on to a sandy shore, forming an estuary, a greater percentage of very small particles are found, due to the deposition of terrigenous material eroded by the river. Such shores retain water more readily, and the beach comprises black, sloppy or compacted mud.

Within the Study Area there are numerous bays and inlets with sandy shores, however, only a few studies have been undertaken on such habitats. One study on macrobenthic species and density on the sandy beach at To Kau Wan to the north of the Study Area (now since reclaimed) was surveyed for

the Lantau Port Development - Stage I, Reclamation for Shipyard at To Kau Wan, North Lantau, although the findings of this study was that the sandy shore had a low species diversity and richness (Binnie 1994). The sandhopper (*Orchestia* sp) and an undetermined isopod species were recorded as being the most abundant organisms observed on the shore.

## 2.2 *HARD SURFACE ASSEMBLAGES*

Approximately 80% of Hong Kong's complex shorelines and many islands are composed of rocky outcrops. Like all intertidal areas, 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. There is little remaining natural hard surface habitat in the East Lantau and Western Harbour Area as a series of reclamations have replaced natural rocky outcrops with artificial seawalls. As a result, although a number of the following sites are outside of the Marine Ecology Study Area, the results of surveys and/or other information is presented to allow a comparison with the findings of the Focussed Field Surveys conducted in Penny's Bay and it's surroundings, as presented in *Section 3*.

### 2.2.2 *Subtidal*

Extensive dive surveys were conducted between October 1991 and November 1994 in Hong Kong waters (Binnie 1995). As part of these surveys, three sites, Pak Kok (the northern tip of Lamma Island) and south and north Telegraph Bay (Hong Kong Island) were selected and surveyed to describe the subtidal assemblages. Further, more recent, dive and Remotely Operated Vehicle (ROV) surveys were also conducted on the west coast of Lamma Island as part of the EIA for the proposed extension to the Lamma Power Station (ERM 1999). The findings of these surveys as well as a brief assessment of their ecological value in comparison to other sites in Hong Kong is presented below.

*Lamma Island and Hong Kong Island (Outside Marine Ecology Study Area)*

At Pak Kok, the area was composed of vertical seawall with a soft muddy bottom. The study area contained very rich soft coral (*Dendronephthya* sp) and sea fan assemblages (*Melithaea* sp). Sea urchins (*Anthocidaris crassisspina, Diadema setosum*), sea cucumber (*Holothuria leucospilota*), gastropods (*Thais* sp and cowries), barnacles, sponges, sea whips (*Junceella* sp), hard corals (*Tubastrea aurea*) and numerous shrimps were also recorded in high abundances along the transect. The subtidal communities of the two sites in Telegraph Bay were less diverse and were assigned a low conservation value based on the low abundance of corals and other macro-invertebrates. These two stations were similar, as both were composed of boulder habitats and a muddy soft bottom. Low abundance and diversity of macro-invertebrates

was recorded, these included sea urchins (*Diadema setosum*), barnacles, bryozoan (*Adeona yarraensis*) and gastropods (*Thais* sp). A few isolated sea whips (*Junceella* sp) were encountered during the survey.

The results of the subtidal ROV and dive surveys at five sites on the west coast of Lamma Island reported that with the exception of the southern most site at Ha Mei Tsui, the sites were of low ecological value (ERM 1999). Although many of the sites stretching the entire west coast of Lamma did support species of some ecological and conservation value (ie gorgonian sea whips, soft corals and hard corals) these organisms were reported to occur as isolated colonies. In comparison with other areas in Hong Kong, the assemblages on the west coast of Lamma were evaluated as being of low ecological value. The EIA report compared the coral cover with two sites in Hong Kong, Pak Kok on the northern tip of Lamma, and Ping Chau in the eastern waters of Hong Kong. Pak Kok was reported as having recorded soft corals and gorgonians with a cover of 13.09 %, whereas, in comparison the highest percent cover of corals (both hard and soft) for the sites on the west coast of Lamma were recorded in the EIA at 1.67 % (Binnie 1995 and ERM 1999). The comparison with an area of high conservation value, namely the coral colonies at Ping Chau, was used to emphasise the low ecological value of the sites on Lamma. The surveys at Ping Chau recorded coral covers (both hard and soft) of 55.9 % and 61.9 % in different areas, again considerably higher than those found at the sites on the west coast of Lamma during the EIA (Binnie 1996 & ERM 1999).

*Green Island (Outside Marine Ecology Study Area)*

A recent ROV survey as part of the ongoing *Green Island Development - Studies on EWQIA* revealed that the coral colonies found in the subtidal zones on both Green Island and Little Green Island were found in higher densities than those found at the subtidal sites surveyed on Lamma Island and described above (ERM 1999). This was especially apparent in the density of the soft coral *Dendronephthya* spp. This coral recorded a maximum density of 16.2 $m^{-2}$ for the Green Island survey yet was recorded as having a maximum density of only 0.05 $m^{-2}$ on the west coast of Lamma Island (ERM 1999). Similarly, the sea whip *Euplexaura curvata* which was the second most abundant coral found in the west coast of Lamma Island sites with a total of 170 colonies (ERM 1999). This species was recorded as having a maximum density of 0.19 $m^{-2}$ in Lamma whereas, in the Green Island survey the same species was recorded as having a far greater maximum density of 3.13 $m^{-2}$.

*Kau Yi Chau (Inside Marine Ecology Study Area)*

In February 1997, a qualitative survey of the hard-bottom communities was conducted on the northern side of Kau Yi Chau (Binnie 1997). Results from brief reconnaissance dives on the southeastern and eastern shores of the island during September 1996 were also included. The northern side of the island was composed of a gentle sloping shore with a seabed of boulders. At -2 mPD, at least 2-5 cm depth of fine sediment covered most of the substrate. Isolated colonies of hard corals (*Platygyra sinensis, Favis* sp, *Favites* sp,

*Plesiastrea versipora, Porites lobata* and *Oulastrea crispata*), prominent cover of filamentous algae (*Ceramium byssoideum* and *Gelidium pusillum*) and low abundance of sea anemones and gastropods were recorded. At a depth of -4 mPD, no hard corals existed, however, sea whips (*Elisella* sp) and sea urchins (*Diadema setosum*) were observed. Records from dive surveys of the fish assemblage indicated that rockfish (*Sebasticus marmoratus*), gobies (*Cryptocentrus cinctus*), blennies (*Istiblennius* sp) and sandperch (*Parapercis millepunctata*) were commonly found. On the eastern and southeastern sides of the island, similar communities to the northern side were recorded, but these showed a lower abundance of hard corals.

### 2.2.3 *Intertidal*

There is little published information describing and evaluating the ecological importance of the intertidal assemblages of the east coast of Lantau Island. Fauna of the rocky shore at To Kau Wan to the north of the Study Area was studied as a part of the EIA for the Lantau Port Development - Stage I, Reclamation for Shipyard at To Kau Wan, North Lantau (Binnie 1994). In total, only ten species were recorded on the shore with the periwinkles (*Nodilittorina* sp and *Littorina* sp) being the dominant species. The shore was regarded as having poor species richness.

## 2.3 *MARINE MAMMALS*

The review below is based on stranding records collected in Hong Kong since 1973 (Parsons et al. 1995), and detailed studies conducted on the ecology of Hong Kong's small cetaceans since 1994 (Jefferson 1997; Jefferson and Leatherwood 1997; Parsons 1997; Jefferson 1998; Parsons 1998; Jefferson and Braulik 1999; Hung 2000; Jefferson in press). The Indo-Pacific Humpback Dolphin, *Sousa chinensis*, and the Finless Porpoise, *Neophocaena phocaenoides*, are the only species of marine mammal regularly sighted in Hong Kong waters.

*Indo-Pacific Humpback Dolphin (Sousa chinensis)*

Humpback dolphins (also known locally as Chinese white dolphins) are found in all the waters surrounding Lantau Island (Parsons et al. 1995; Jefferson in press), however the area to the north of Lantau Island appears to be by far the most important habitat in Hong Kong. North Lantau is heavily used in all seasons, and the western portion of the North Lantau area has high densities of dolphins throughout the year (Jefferson 1998, in press). The most recent estimates of abundance for North Lantau range from 79 to 105 dolphins, depending on season (Jefferson 1998). North Lantau is the only place in Hong Kong where dolphins are seen year round. Schools of dolphins are most frequently sighted in the western part of these waters around the Sha Chau and Lung Kwu Chau Marine Park and the Chek Lap Kok platform.

The South Lantau and East Lantau areas are used much less extensively and only appear to be important seasonally. The waters to the south of Penny's

Bay and east of the Pa Tau Kwu and Fa Peng shores showed a seasonal pattern in sightings of the dolphin (Jefferson 1997). Dolphins do not normally appear to use the area in spring or early summer and they were largely observed during autumn and winter months. However, their abundance and density recorded in the area were very low when compared to North Lantau (the highest East Lantau sighting rate was only 15% of the yearly average for North Lantau). Findings of a 21 day boat-based dolphin-sighting survey conducted in 1994 near the Penny's Bay area, as part of the Environmental Impact Assessment for Lantau Port Development Stage 1, Container Terminals No. 10 & 11 Ancillary Works (Design) (Halcrow 1994), showed that the number of Indo-Pacific Humpback Dolphin recorded in the area is low when compared with such areas as Lung Kwu Chau and Sha Chau. East Lantau does not contain large numbers of dolphins and is apparently only used in autumn and winter (estimates of 4 and 6 dolphins, respectively - Jefferson in press). However, most of the dolphin sightings have occurred in the region of the northeast Lantau coastline, near Penny's and Discovery bays (Jefferson 1997).

South Lantau (mainly the western portion around Fan Lau and the Sokos Islands) is used by dolphins primarily in the summer and autumn seasons, when there are estimated to be 20 and 17 dolphins present, respectively (only about 3 dolphins are estimated to be present in winter, and none in spring - Jefferson in press).

Individual movements and ranging patterns of dolphins have recently been investigated (Hung 2000). It was found that, while most dolphins apparently do not use the East Lantau area, some individuals that occur primarily in North Lantau use the East Lantau area as part of their range. At least one individual that used to occur primarily in East Lantau (EL07) may have shifted its home range to the North Lantau area (Hung 2000). As the waters near the reclamation site do not appear to be highly utilised by the dolphins, it is unlikely that this area contains critical *Sousa chinensis* habitat. The information from this literature review has been updated in *Section 3* by the results of recent field survey investigations.

*Finless Porpoise (Neophocaena phocaenoides)*

Finless porpoises occur in the waters to the south and east of Lantau Island, but have never been sighted north or west of Lantau (Parsons et al. 1995; Jefferson and Braulik 1999). There was a single stranded porpoise found on Chek Lap Kok in 1995 (Jefferson unpublished data), but the animal was badly decayed and could easily have been moved by currents from further south or east. Due to the extensive survey effort in North Lantau in all seasons and the absence of sightings, it is clear that finless porpoises do not use the North Lantau area to any significant degree.

The entire South Lantau area is used seasonally by finless porpoises in winter and spring, when there are estimated to be 10 and 25 porpoises present, respectively (Jefferson and Braulik 1999). Interestingly, these are the seasons when humpback dolphins are not present in the area. Both strandings and

sightings indicate that East Lantau is used by finless porpoises (Parsons et al. 1995; Jefferson and Braulik 1999). However, up until now, small sample sizes have prevented reliable estimates of abundance to be made for the area - the first such estimates are presented below in *Section* 3.

Due to the difficulty in identifying individual finless porpoises, nothing is known of individual movements and home ranges for these animals. Therefore, it is not possible to determine how important different areas are to specific individuals, but apparently the home ranges of the animals extend outside those areas that are only used seasonally (such as South Lantau and East Lantau).

# 3 FIELD SURVEYS

## 3.1 INTRODUCTION

The habitats within Penny's Bay have not been studied and no information is available for establishing an ecological profile nor any baseline data at hand for assessing ecological value. To fill the information gap, surveys were conducted such that the ecological characteristics of the habitats and faunal and floral assemblages present could be identified and impacts due to Theme Park evaluated.

## 3.2 ROCKY SHORE

### 3.2.1 *Methodology*

Intertidal rocky shore surveys were undertaken at Fa Peng and Pa Tau Kwu to characterise the assemblages present in the intertidal region (*Figure 3.2a*). As seasonal changes in the intertidal region are generally obvious, surveys were conducted two times, once in the wet (September 1998) and once in the dry (February 1999) season. Field surveys were also conducted on the intertidal region of the rocky shores at Penny's Bay in December 1999 (dry season) to supplement the assemblage information obtained for Northeast Lantau.

Rocky shore organisms originated in purely marine habitats and have evolved and adapted to live on intertidal shores. The extent of their adaptations to this habitat will dictate where they are found on the shore. The more adapted a species is to terrestrial conditions the higher it will be found on the shore, causing zonation patterns. The survey design involved sampling throughout all of the intertidal zones so that the vertical range of all species was represented. At each site three 10 m wide horizontal (belt) transects were set up along the shore (no less than 50 m apart) and surveyed at three heights up the shore at 50 cm intervals perpendicular to the waterline starting at 1.5 m above Chart Datum. Previous studies of Hong Kong's rocky shores have shown that 10 quadrats (50 x 50 cm) randomly placed along each transect will produce accurate, unbiased samples of the community. On each transect, 10 quadrats (50 x 50 cm) were placed randomly to assess the abundance and distribution of flora and fauna. All animals found in each quadrat were identified and recorded to species level so that density $m^{-2}$ could be determined. Sessile organisms such as barnacles, oysters and algae in each quadrat were not counted but estimated as percentage cover on the rock surface.

### 3.2.2 *Results - Wet Season*

In total, 28 species of animals and 9 species of macroalgae were recorded on the rocky shores at the two wet season study sites. Pa Tau Kwu supported a

higher species diversity, with a total of 26 species of animals and 9 species of macroalgae, when compared with Fa Peng where lower numbers of species (animal: 23, macroalgae: 8) were recorded (*Figure 3.2b*).

Animals recorded on the shores at the surveyed sites were largely molluscs and crustaceans with comparatively higher densities of mobile assemblages being recorded at Pa Tau Kwu (*Figure 3.2c*). The most abundant were herbivorous molluscs, including the chiton (*Acanthopleura japonica*), the limpets (*Cellana grata, C. toreuma, Notoacmaea schrenkii, Patelloida pygmaea, P. saccharina, Siphonaria atra* and *S. sirius*), the snails (*Monodonta labio* and *Planaxis sulcatus*) and the nerite (*Nerita albicilla*) on the mid (2.0 m above Chart Datum) and low (1.5 m above CD) shore, and the periwinkles (*Nodilittorina radiata, N. trochoides* and *N. vidua*) on the high (2.5 m above CD) shore. The predatory gastropod *Thais clavigera* (the common dogwhelk) was also recorded in the low shore region. Sessile filter-feeding barnacles such as the stalked barnacle (*Capitulum mitella*) and the acorn barnacle (*Tetraclita squamosa*) were also common on the shores (*Table 3.2a*). Sea anemones, including *Anthopleura elegantissima* and *Haliplanella luciae*, were observed in the rock pools and low intertidal region of the shores. Bivalves such as the mussels (*Barbatia virescens, Perna viridis* and *Septifer virgatus*) and the rock oyster (*Saccostrea cucullata*) were also seen on the shores but in low abundances (*Figure 3.2d*).

Macroalgae at the two study sites were, in general, sparsely distributed, a pattern which is typical for Hong Kong rocky shores during the summer months when the survey was undertaken, low spring tides coincide with the hot noon time period. Of the algae present, encrusting algae (*Neogoniolithon misakiense, Hildenbrandia occidentalis* and *Ralfsia expansa*), the filamentous green algae (*Chaetomorpha antennina* and *Cladophora* sp) and the red algal tufts (*Corallina sessilis*) were of highest percentage cover (*Table 3.2a*). Small patches of the blue-green algae (*Kyrtuthrix maculans*) were also observed on the shores adhering closely to the rock surfaces. Mean macroalgal percentage cover of 16.7% and 20.8% were recorded, respectively, on the Fa Peng and Pa Tau Kwu shores (*Figure 3.2d*).

*Table 3.2a* ***Density ($m^{-2}$) of Intertidal Fauna and Percentage Cover (%) of Sessile Fauna and Flora Recorded at Fa Peng and Pa Tau Kwu***

| Species | Wet Season | | Dry Season | |
|---|---|---|---|---|
| | Fa Peng | Pa Tau Kwu | Fa Peng | Pa Tau Kwu |
| **Chiton** | | | | |
| *Acanthopleura japonica* | 14.8 | 22.5 | 10.5 | 17.2 |
| **Limpet** | | | | |
| *Cellana grata* | 1.7 | 2.9 | 1.5 | 3.2 |
| *Cellana toreuma* | 7.3 | 11.6 | 5.9 | 7.7 |
| *Cellana schrenkii* | 1.1 | 4.7 | 2.2 | 5.1 |
| *Patelloida saccharina* | 18.9 | 37.2 | 15.2 | 46.7 |
| *Patelloida pygmaea* | - | 3.1 | - | 1.5 |
| *Siphonaria atra* | 1.6 | 0.09 | 1.3 | 0.58 |
| *Siphonaria sirius* | 0.31 | 0.42 | 0.27 | 0.18 |
| **Snail** | | | | |
| *Lunella coronata* | - | 1.3 | 0.18 | 0.62 |
| *Monodonta labio* | 0.27 | 1.9 | 0.22 | 1.2 |
| *Nerita albicilla* | 0.62 | 0.72 | 0.27 | 0.71 |
| *Nodilittorina radiata* | 18.5 | 41.3 | 28.7 | 66.3 |
| *Nodilittorina trochoides* | 2.6 | 15.2 | 7.5 | 23.4 |
| *Nodilittorina vidua* | 1.3 | 3.2 | 3.8 | 6.7 |
| *Planaxis sulcatus* | 0.04 | 0.18 | 0.13 | 0.27 |
| *Thais clavigera* | 2.8 | 2.3 | 1.2 | 0.62 |
| *Morula musiva* | - | 0.22 | - | 0.13 |
| **Bivalve (% Cover)** | | | | |
| *Barbatia virescens* | 0.01 | 0.03 | 0.02 | 0.02 |
| *Perna viridis* | 0.02 | 0.01 | 0.01 | - |
| *Saccostrea cucullata* | 0.01 | 0.01 | 0.02 | 0.03 |
| *Septifer virgatus* | 0.02 | 0.03 | 0.04 | 0.08 |
| **Barnacle (% Cover)** | | | | |
| *Balanus amphitrite* | 0.02 | - | 0.53 | 0.20 |
| *Capitulum mitella* | 0.43 | 0.19 | 0.69 | 0.35 |
| *Tetraclita japonica* | 0.03 | - | - | - |
| *Tetraclita squamosa* | 2.6 | 1.1 | 1.3 | 2.8 |
| **Sea anemone (% Cover)** | | | | |
| *Anthopleura elegantissima* | - | 0.63 | - | 0.57 |
| *Haliplanella luciae* | 0.17 | 0.01 | 0.02 | 0.03 |
| **Porifera (% Cover)** | | | | |
| *Haliclona permollis* | - | 0.01 | - | 0.01 |
| **Macroalgae (% Cover)** | | | | |
| *Endoplura aurea* | 0.14 | 0.30 | - | 0.22 |
| *Ralfsia expansa* | 1.2 | 1.6 | 0.82 | 2.1 |
| *Hildenbrandia occidentalis* | 0.32 | 1.7 | 1.3 | 0.96 |
| *Neogoniolithon misakiense* | 3.2 | 2.1 | 1.6 | 1.7 |
| *Corallina sessilis* | 6.9 | 10.6 | 5.1 | 8.2 |
| *Corallina pilulifera* | - | 1.1 | - | 0.85 |
| *Kyrtuthrix maculans* | 1.8 | 1.7 | 2.7 | 3.5 |
| *Chaetomorpha antennina* | 0.9 | 0.10 | 0.58 | 0.2 |
| *Cladophora* sp | 2.2 | 1.6 | 2.4 | 0.21 |
| *Entermorpha linza* | - | - | 1.3 | 2.2 |
| *Enteromorpha prolifera* | - | - | 1.1 | 2.7 |
| *Ulva fasciata* | - | - | 0.34 | 0.98 |
| *Lyngbya* sp | - | - | 0.17 | 0.57 |
| *Hincksia mitchelliae* | - | - | 0.12 | 0.06 |
| *Endarachne binghamiae* | - | - | - | 0.02 |
| *Sargassum hemiphyllum* | - | - | 0.09 | 0.17 |
| *Ceramium byssoideum* | - | - | 0.83 | 0.09 |

### 3.2.3 *Results - Dry Season*

*Fa Peng and Pa Tau Kwu*

A total of 27 species of animals was recorded on the rocky shores at Fa Peng and Pa Tau Kwu which is similar to the number (28) obtained during the wet season survey for the two sites (*Figure 3.2b*). As with the wet season results, animals recorded on the shores were largely molluscs and crustaceans with sea anemones and bivalves occurring in low abundances (*Table 3.2a*).

The number of macroalgal species recorded during the dry season was 17 which is much higher than that of the wet season (9) (*Figure 3.2b*) and is a typical seasonal pattern of macroalgal growth on Hong Kong rocky shores (Hodgkiss 1984; Kaehler & Williams 1996; Kennish etal 1996). Most of the encrusting macroalgae recorded, including *Endoplura aurea, Neogoniolithon misakiense, Hildenbrandia occidentalis, Kyrtuthrix maculans* and *Ralfsia expansa,* were sparsely distributed on the shores. The red algal turfs (*Corallina sessilis*) were largely observed in the low intertidal areas. Emerging stands of algal species typical of the dry season such as the green (*Enteromorpha* spp and *Ulva fasciata*), brown (*Hincksia mitchelliae, Endarachne binghamiae* and *Sargassum hemiphyllum*) and blue-green algae (*Lyngbya* sp) and the red turf alga (*Ceramium byssoideum*) were recorded from the shores (*Table 3.2a*).

*Penny's Bay*

A total of 24 species of animals was recorded on the rocky shore at Penny's Bay (*Figure 3.2e*) in December 1999 which is comparable to the number obtained for Fa Peng (23) and Pa Tau Kwu (26) during the dry season survey in February 1999 (*Figure 3.2b*). As with the latter two sites, animals recorded on the Penny's Bay shore were largely molluscs and crustaceans with sea anemones and bivalves occurring in low abundances (*Table 3.2b*). Mean abundance of the chiton (*Acanthopleura japonica*) at Penny's Bay (5.1 $m^{-2}$) (*Figure 3.2f*) is comparatively lower than the other two survey sites (Fa Peng: 10.5 $m^{-2}$, Pa Tau Kwu: 17.2 $m^{-2}$) (*Figure 3.2c*) whereas for limpets, Penny's Bay showed the highest abundance (77.6 $m^{-2}$) (*Figure 3.2f*) among the three surveyed sites (Fa Peng: 26.4 $m^{-2}$, Pa Tau Kwu: 65.0 $m^{-2}$) (*Figure 3.2c*). Density of snails recorded at Penny's Bay (50.2 $m^{-2}$) (*Figure 3.2f*) is comparatively higher than that obtained for the Fa Peng shore (42.0 $m^{-2}$), but is much lower than that recorded at Pa Tau Kwu (99.8 $m^{-2}$) (*Figure 3.2c*). Percentage cover values recorded at Penny's Bay for bivalves (2.0%) and barnacles (13.9%) (*Figure 3.2d*) are much higher than the values obtained for Fa Peng (bivalve: 0.09%, barnacle: 2.5%) and Pa Tau Kwu (bivalve: 0.13%, barnacle: 3.4%) (*Figure 3.2g*).

The number of macroalgal species recorded at Penny's Bay was 4 (*Figure 3.2e*) which is much lower than the numbers recorded at Fa Peng (14) and Pa Tau Kwu (17) (*Figure 3.2b*). The encrusting macroalgae recorded on the Penny's Bay shore, including *Haplospongidion gelatinosum* and *Hildenbrandia occidentalis,* were sparsely distributed which is similar to the pattern observed

on the other two surveyed shores. Emerging stands of algal species typical of the dry season such as the green *Ulva* sp were recorded from the Penny's Bay shore (*Table 3.2b*).

*Table 3.2b* ***Density ($m^{-2}$) of Intertidal Fauna and Percentage Cover (%) of Sessile Fauna and Flora Recorded at Penny's Bay during the Dry Season***

| Species | Density ($m^{-2}$) | Percentage Cover (%) |
|---|---|---|
| **Chiton** | | |
| *Acanthopleura japonica* | 5.1 | |
| **Limpet** | | |
| *Cellana grata* | 32.3 | |
| *Cellana toreuma* | 13.8 | |
| *Patelloida saccharina* | 29.7 | |
| *Patelloida pygmaea* | 0.27 | |
| *Siphonaria atra* | 0.27 | |
| *Siphonaria sirius* | 1.2 | |
| **Snail** | | |
| *Nerita albicilla* | 1.2 | |
| *Nerita lineata* | 0.36 | |
| *Monodonta labio* | 1.4 | |
| *Nodilittorina vidua* | 40.8 | |
| *Nodilittorina trochoides* | 0.27 | |
| *Littoraria articulata* | 4.1 | |
| *Thais clavigera* | 2.6 | |
| **Bivalve** | | |
| *Barbatia virescens* | | 0.31 |
| *Brachidontes variabilis* | | 0.04 |
| *Perna viridis* | | 0.04 |
| *Saccostrea cucullata* | | 1.3 |
| *Septifer virgatus* | | 0.34 |
| **Barnacle** | | |
| *Balanus amphitrite* | | 0.23 |
| *Capitulum mitella* | | 2.1 |
| *Tetraclita japonica* | | 4.7 |
| *Tetraclita squamosa* | | 6.9 |
| **Sea anemone** | | |
| *Anthopleura japonica* | | 0.03 |
| **Macroalgae** | | |
| *Haplospongidion gelatinosum* | | 0.06 |
| *Hildenbrandia occidentalis* | | 0.87 |
| *Ulva* sp | | 0.01 |
| Cyanobacterial Biofilm | | 0.06 |

## 3.3 SANDY SHORE

### 3.3.1 *Methodology*

On the larger sandy shore at Pa Tau Kwu Pak Wan (*Figure 3.3a*), three line transects were deployed from the low tide mark up to the high tide mark and the presence of organisms were noted. At five equidistant points chosen along each of the transects, a 50 x 50 x 50 cm core was taken and all macrofauna visible to the naked eye within the core were identified and recorded. As for the rocky shore survey, the sandy shore sampling was

conducted during both the wet and dry seasons to ensure that no species of importance were overlooked.

### 3.3.2 *Results*

The sandy shore at Pa Tau Kwu supported a very low species diversity which is a typical feature of mobile sandy shores with unstable substrates (Morton & Morton 1983). The lower shore area is bordered by cobbles which provide habitats for the snail (*Monodonta labio*), the limpet (*Notoacmaea concinna*), the isopod (*Ligia exotica*) and the polychaete (*Hydroides elegans*). The amphipod, sand-hopper (*Orchestia* sp), was the only abundant animal observed on the shore. The macrofaunal communities recorded were largely similar in the two season surveys.

Within Penny's Bay there is a small sandy shore of less than 100m in length close to the Cheoy Lee shipyard. The beach appeared on a site visit to have suffered some form of disturbance as a result of its proximity to the shipyard. Given this and its small size it is unlikely to support assemblages of ecological interest.

## 3.4 *SUBTIDAL BENTHIC GRAB SURVEY*

### 3.4.1 *Objective*

The general objective of the survey was to provide a broad understanding of the characteristics of the infaunal benthic assemblages of the study site to determine their ecological value and hence the environmental impact of the proposed construction and operational activities in Penny's Bay. The infaunal and epifaunal assemblages will be lost permanently as a result of the construction within the area.

As a result, the specific objectives of the survey were as follows:

- to characterise the soft bottom benthic infaunal assemblages of Penny's Bay;
- to compare the findings of the survey with those recorded during previous studies in the surrounding area; and,
- to establish the ecological value of the soft bottom benthic infaunal assemblages of Penny's Bay.

### 3.4.2 *Methodology*

The locations of the sampling stations are shown in *Figure 3.4a.* All sampling stations were located within Penny's Bay to ensure that a detailed assessment of the infaunal benthic ecology of that area was made. No reference stations were selected as comprehensive data provided from sampling stations in other recent benthic ecology studies.

*Field Techniques*

A single grab sample was taken at each station 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. This has been designed to prevent the sampler twisting during deployment and to ensure proper contact with the bottom. The grab was lowered slowly through the water column (at an approximate rate of 30 cm $s^{-1}$) to prevent it from flipping during descent or creating a pressure wave sufficient to grossly disturb bottom sediments. After it was triggered, the grab was raised at a constant rate, carefully retrieved, and placed in a level position on a stand. The sample was evaluated for acceptance based upon the degree of disturbance, penetration depth, and amount of leakage from the grab. Samples with only minimal disturbance of surface sediments and with adequate penetration depth were accepted. Samples were rejected if the grab was overfilled or there was leakage of sample material from the grab.

Sediments in the grab were then washed into a sieve stack (comprising 1 $mm^2$ and 500 µm meshes) and gently rinsed with seawater by qualified ERM marine scientists to remove all fine material (*Figure 3.4a*). Material remaining on the screens was rinsed separately into thick triple-bagged ziplock plastic bags, using a minimal volume of seawater. A 10 % solution of Borax buffered formalin in seawater was added to ensure tissue preservation. In addition, Rose Bengal stain was added to the sample to aid sorting. Samples were triple-bagged, labelled internally and externally with indelible ink and inventoried. Chain-of-custody forms were then completed, and samples were placed in plastic buckets for shipment to the taxonomy laboratory for sorting.

*Laboratory Techniques*

Upon arrival at the benthic laboratory, all benthic samples were re-inventoried and checked against chain-of-custody forms. If a sample consisted of multiple containers, all containers were processed as a group.

Sample re-screening was performed by the benthic laboratory 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 µm and 1 $mm^2$ mesh sieves were gently rinsed with fresh water into a 250 µm 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.

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. All sorted samples were systematically checked to ensure all QA/QC procedures were adhered to before proceeding to the taxonomic identification, enumeration, and biomass determination phases of the project.

Taxonomic identifications were performed by the Hong Kong University of Science and Technology (HKUST) 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 minimises 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. Rare or questionable taxa were compared against reference collection specimens held by HKUST or compiled under previous studies for confirmation and consistency of identifications.

*QA/QC Techniques*

Sorting QA/QC was performed using 25-power magnification by someone other than the original sorter. Twenty percent of each sorted sample were re-sorted to ensure 95 percent sorting efficiency. A sample only passed QA/QC if the number of organisms found during the QA/QC check did not represent more than 5 percent of the total number of organisms found in the entire sample. If the number of organisms found was greater than 5 percent of the total number, the entire sample was resorted. Samples that contained uncertain identifications were sent out for independent re-identification by a qualified regional expert.

### 3.4.3 *Results*

This section presents the results of the benthic grab survey as well as presenting a comparison between the results from the present study and those obtained during previous benthic ecology studies in the surrounding area.

*Survey Conditions*

The survey was undertaken on 21 December 1999 in calm sea conditions, clear skies and fresh, light winds. Benthic grab samples were successfully collected at all of the 12 stations in the Penny's Bay area

*Grab Sample Composition*

Although a total of 882 individual organisms were collected from the 12 grab stations in Penny's Bay, only 877 of these organisms were infaunal. The remaining 5 individuals were epifaunal organisms and as a result will not be discussed further. The infaunal specimens collected belonged to 8 animal Phyla (*Table 3.4a*).

*Table 3.4a* *Organisms Collected in the December 1999 Grab Sampling Survey*

| Phylum | Number of Identified Families | Total Number of Individuals Recorded | Total Biomass (g wet weight) |
|---|---|---|---|
| Annelida | 23 | 647 | 3.26 |
| Arthropoda | 16 | 180 | 3.05 |
| Chordate | 1 | 1 | 6.18 |
| Coelenterata | 3 | 3 | 4.23 |
| Echinodermata | 2 | 9 | 16.13 |
| Mollusca | 6 | 23 | 1.96 |
| Nemertinea | 0 | 13 | 0.06 |
| Platyhelminthes | 0 | 1 | 0.53 |
| Unidentified Fragments | 0 | 0 | 0.45 |
| **Total** | **51** | **877** | **34.85** |

Specimens from the Phylum Nemertinea were not identified to family level due to taxonomic reference material and the need for histological analyses during the identification process. In total, 51 families were identified, most of them belonging to the Phylum Annelida (these all being polychaete worms) and Arthropoda.

The sediment samples contained on average 73.1 specimens per station, with the lowest number being recorded at station S6, with only 44 individuals. The biomass as 34.85 for all grab samples, with an average of 2.90 (g wet weight) station$^{-1}$, equivalent to 30.21 g m$^{-2}$. Taxonomic richness, measured as number of families, varied from 15 to 31 families station$^{-1}$.

A breakdown of the data revealed that there were large differences between the total biomass of organisms from each stations, however, these differences can be accounted for by the presence of large individuals. In terms of numbers of individuals and taxonomic richness there appeared to be a similar pattern between these two parameters, as shown in (*Figures 3.4b, 3.4c & 3.4d).* Overall, three of the twelve stations sampled (S2, S3 and S9) appeared to be different from the other stations as they recorded the highest biomass, number of individuals and number of families.

In terms of dominant Phyla and organisms, *Figure 3.4e* shows that the majority of the number of organisms recorded were either from the Phyla Annelida or Arthropoda. A number of stations were also found with a large number of organisms from the Phylum Mollusca, however, in comparison to the numbers from the Phyla Annelida and Arthropoda these values are small. This dominance of annelids, in terms of number of individuals, is also demonstrated in terms of species. In general, the majority of the stations contained a variety of species, but often in very low abundance. Eight species, however, can be considered as dominant in terms of abundance in the samples, with five of these eight species being from the Phylum Annelida. These species numbered 10 or more individuals and are listed below in *Table 3.4b* along with the stations from which they were collected.

*Table 3.4b* ***Most Abundant Species Collected During the December 1999 Grab Sampling Survey at Penny's Bay***

| Phylum | Class | Order | Family | Genus and Species | Station |
|---|---|---|---|---|---|
| Annelida | Polychaeta | Terebellida | Trichobranchidae | *Terebellides stroemii* | S7, S8 |
| Annelida | Polychaeta | Spionida | Cirratulidae | *Cirratulus filiformis* | S9, S12 |
| Annelida | Polychaeta | Spionida | Spionidae | *Minospio* sp | S1, S2, S3, S4, S7, S10, S12 |
| Annelida | Polychaeta | Capitellida | Capitellidae | *Mediomastus* sp | S11 |
| Annelida | Polychaeta | Spionida | Heterospionidae | *Heterospio sinica* | S2, S4 |
| Arthropoda | Crustacea | Amphipoda | Gammaridae | *Erioispa* sp | S2 |
| Arthropoda | Crustacea | Mysidacea | Mysidae | *Acanthomysis* sp | S2, S3 |
| Arthropoda | Crustacea | Amphipoda | Corophiidae | *Photis* sp | S3 |

*Comparison with Recent Studies*

The data collected was compared with other recent studies conducted in the surrounding area, as well as with the Hong Kong wide Seabed Ecology Studies (ERM 1998) (*Table 3.4c*).

*Table 3.4c* ***Biomass of Benthic Assemblages from the Penny's Bay Area and Elsewhere in Hong Kong***

| Study | Area/Date | Biomass g $m^{-2}$ |
|---|---|---|
| Shin and Thompson 1982 | Western Harbour | 20.20 |
| | Hong Kong Mean | 35.20 |
| APH Consultants 1994 | APH - 5 December 1991 | 10.80 |
| | APH - 5 June 1992 | 2.40 |
| | APH - 6 December 1991 | 11.25 |
| | APH - 6 June 1992 | 2.80 |
| | APH - 7 December 1991 | 29.26 |
| | APH - 7 June 1992 | 5.06 |
| ERM 1998 | East Sha Chau (August) 1996 | 7.50 |
| | Basalt Island (August) 1996 | 6.10 |
| | East of Ninepins (August) 1996 | 12.80 |
| | Sokos Island (November) 1996 | 35.70 |
| | South Cheung Chau (November) 1996 | 47.20 |
| | Eastern Waters (April) 1997 | 32.90 |
| | Tathong Channel (April) 1997 | 35.70 |
| | South Lamma (April) 1997 | 30.60 |
| ERM 1999 | Penny's Bay | 30.21 |

Although the surveys above differ in both time of sampling and the location of which the samples were taken, the values collected for Penny's Bay are considerably higher than those recorded for other surveys in the surrounding area. In terms of assemblages recorded from various locations sampled throughout Hong Kong waters through the recent Seabed Ecology Studies, the values recorded in the Penny's Bay area can be considered to be similar. Therefore, the results indicate that in context of other sediments around western harbour, those collected from stations within Penny's Bay support a higher biomass of infaunal organisms, however, in context with those

assemblages in sediments around Hong Kong, the infaunal assemblages of Penny's Bay can be considered to be similar.

## 3.5 SUBTIDAL HARD SURFACE HABITATS

### 3.5.1 *Methodology - Qualitative Survey*

The main objective of this work was to identify marine ecological assemblages of high ecological value or conservation interest within Penny's Bay. To fulfil this objective dive surveys to search for corals and marine fauna of conservation importance were conducted at two sites along the western coastline of Penny's Bay. A qualitative "scoping" survey along the length of the western shore of Penny's Bay was conducted to identify any locations that support assemblages of corals (Octocorals and/or hard corals).

During the qualitative survey the positions of any areas that support coral assemblages were recorded so that they could be surveyed quantitatively. Eight locations for follow-up surveys were selected in which the greatest number of coral colonies were observed.

### 3.5.2 *Methodology - Quantitative Dive Survey*

A quantitative dive survey was undertaken at each of the eight locations identified during the qualitative survey (*Figure 3.5a*). At each location a 50m transect running parallel to the shore was surveyed. Photographs of representative coral species located in the surveyed areas were taken using an underwater camera (*Figures 3.5a, b & c*). Video transects were recorded at each of the survey sites. Each transect was filmed at approximately 40cm above the substrate and at a constant speed in compliance with standard protocols for coral surveys (no more than 10 metres per minute). The video transects recorded a 40 cm swath of seabed (potentially containing corals). The video camera was held perpendicular to the substrate to minimise parallax error and to keep the substrate in focus.

The surveys were conducted along one transect at a depth range between -1m to -7m PD dependent on where corals were observed to be most abundant during the qualitative survey. Information was recorded during the surveys concerning the physical nature of the site. This information consisted of observations regarding the degree of exposure of the site to wave action, the nature of the substrate type and the topographic profile of the site. Data on colony abundance of hard corals and octocorals (soft corals and gorgonians) was extracted from the video transects. Counts were made for each site and the locations of the corals along the transects noted. Wherever possible, hard corals were identified to species level by coral specialists using regional texts.

### 3.5.3 *Results - Scleractinian coral communities of Penny's Bay, North Lantau*

Percent live coral cover was generally low (mean 8.99% ±5.4) and species richness was also low with a total of eleven species recorded from the eight

locations (transects). Percent live hard coral cover and coral colony abundance confirm the richest coral areas to be sites 4, 5, 6 and 8 (*Table 3.5a* and *Figures 3.5e & 3.5f*).

*Table 3.5a* ***Percent Live Coral Cover and Number of Coral Colonies. Each site represents one 50m transect***

| Site | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Mean |
|---|---|---|---|---|---|---|---|---|---|
| % live coral cover | 3.09 | 8.2 | 6.4 | 11.4 | 17.07 | 9.6 | 0.4 | 15.75 | 8.99 (±5.4) |
| No. colonies | 8 | 31 | 18 | 43 | 42 | 43 | 2 | 80 | 33.4 (±23.2) |

The overall diversity index for the eight transects was equal to 1.83 indicating a natural community diversity (natural communities generally fall in the range of $H' = 1.5$ to 3.5) (*Table 3.5b*). However, due to the low coral cover and similar species richness at sites 2, 3, 4, 5 and 8 the diversity index ($H'$) for sites 2 and 3 exhibited the highest diversity. The evenness index values indicate a relatively even distribution of the most common faviid corals at all sites. The size index values were low indicating a relatively small size range of coral colonies, however, this was distorted by the percent cover data (video evidence of partial mortality caused by the general heavy siltation of the area) which lowered the size index. Colonies of species such as *Favia speciosa, Platygyra sinensis* and *Cyphastrea* spp were of relatively large size and there was no evidence of new recruits or recent coral settlement (juvenile coral colonies 1-2 years old) at any of the eight locations.

*Table 3.5b* ***Species Richness (S), Diversity (H'), Evenness (J'), Size Index (SI) Values for Site 1-8 and Mean Value for Penny's Bay***

| Site: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Mean |
|---|---|---|---|---|---|---|---|---|---|
| S (videotransects) | 5 | 8 | 7 | 7 | 7 | 6 | 1 | 8 | 12 total |
| S (video + photos) | 6 | 7 | 6 | 8 | 10 | 7 | 1 | 9 | |
| H' | 1.46 | 1.75 | 1.77 | 1.55 | 1.53 | 1.28 | 0 | 1.6 | 1.83 |
| J' | 0.91 | 0.84 | 0.91 | 0.80 | 0.79 | 0.71 | 0 | 0.77 | 0.76 |
| SI | 0.39 | 0.26 | 0.36 | 0.27 | 0.41 | 0.22 | 0.2 | 0.2 | 0.27 |

Video transects recorded at sites 1-8 present evidence to suggest that a narrow, shallow, simple fringing scleractinian coral community exists along the southern coastline of Penny's Bay. The community consists of a thin veneer of live coral, with coral assemblages dominated by faviid corals (*Table 3.5c*).

*Table 3.5c* ***Scleractinian Coral Species List for Sites 1 - 8***

| Species | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 |
|---|---|---|---|---|---|---|---|---|
| *Goniopora stutchburyi* | | | | | | * | | |
| *Favia speciosa* | * | * | * | * | * | * | * | * |
| *Favites abdita* | * | * | | * | * | * | | * |
| *Favites pentagona* | | | * | * | * | | | * |
| *Goniastrea aspera* | | * | | * | * | * | | * |
| *Platygyra sinensis* | * | * | * | * | * | | | * |
| *Plesiastrea versipora* | * | * | | * | * | * | | * |
| *Leptastrea purpurea* | | * | * | * | * | * | | * |
| *Leptastrea pruinosa* | | | | | * | | | |
| *Cyphastrea spp.* | * | * | * | * | * | * | | * |
| *Turbinaria peltata* | * | | * | | * | | | * |
| *Leptoseris mycetoseroides* | | | | | | | | * |

The coral assemblages are dominated by faviid coral species which are known as resilient species which tolerate wide fluctuations in sea surface temperature, salinity and are able to survive relatively high sedimentation rates. Coral communities documented for the intertidal coral flats of Phuket, Thailand are dominated by *Goniastrea aspera, Porites* and *Platygyra* spp. (Brown *et al.* 1990). Encrusting or low massive coral growth forms were dominant along the transects recorded from Penny's Bay, possibly indicative of the turbid conditions and the heavy siltation of the substratum. Site 8 appeared to be the least silted site and this was reflected by the higher coral cover and coral abundance compared to the other seven sites. Five species were common and dominant at all sites. *Favia speciosa* was particularly abundant at site 8, *Favites abdita* was common at sites 4, 5, and 8, *Goniastrea aspera* was particularly abundant at site 8, *Platygyra sinensis* was abundant at sites 2, 4, 5 and 8 and *Cyphastrea* spp. (highest number of colonies) was abundant at sites 4, 5, 6 and particularly site 8 (*Tables 3.5d & 3.5e*).

All faviids and *Turbinaria peltata* are common, abundant local coral species with a wide distribution particularly on the eastern shores of Hong Kong. *Goniopora stutchburyi* is an uncommon local species and was recorded from site 6. It was the only poritid coral species recorded from Penny's Bay. *Leptoseris mycetoseroides* is a rare local coral species and was recorded from site 8 (one colony) (*Table 3.5e*). Coral colonies of the five common species reached a reasonable size and appeared healthy with no bleaching or major signs of stress. However, there was evidence of sediment smothering corals and causing partial mortality. Especially, vulnerable were the encrusting growth forms of coral species such as *Goniastrea aspera* and *Leptastrea* spp. There were also indications of tissue necrosis and tumour growths on *Platygyra sinensis* colonies, from photographic evidence. However, video transects did not indicate a high occurrence of these observations.

*Table 3.5d* ***Percentage Cover of Corals in Penny's Bay***

| Sites | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Mean | SE |
|---|---|---|---|---|---|---|---|---|---|---|
| *Goniopora stutchburyi* | | | | | | 0.6 | | | 0.08 | 0.20 |
| *Favia speciosa* | 0.44 | 1.4 | 2.2 | 2.2 | 1.77 | 4.6 | 0.4 | 3.33 | 2.04 | 1.32 |
| *Favites abdita* | 0.44 | 1 | 0.6 | 0.8 | 0.66 | 0.2 | | 0.44 | 0.52 | 0.30 |
| *Favites pentagona* | | 0.8 | | 0.2 | | | | 0.22 | 0.15 | 0.26 |
| *Goniastrea aspera* | | 0.2 | 0.4 | 0.8 | 0.66 | 0.2 | | 2.44 | 0.59 | 0.75 |
| *Platygyra sinensis* | 1.11 | 2.6 | 0.4 | 3.2 | 5.55 | | | 1.33 | 1.77 | 1.80 |
| *Plesiastrea versipora* | | 0.2 | | | | 1 | | | 0.15 | 0.33 |
| *Leptastrea purpurea* | | 0.2 | 1 | 0.2 | 1.55 | | | 1.11 | 0.51 | 0.58 |
| *Leptastrea pruinosa* | | | | | 0.44 | | | | 0.06 | 0.15 |
| *Cyphastrea* spp. | 0.22 | 1.8 | 1 | 4 | 6.44 | 3 | | 6.66 | 2.89 | 2.46 |
| *Turbinaria peltata* | 0.88 | | 0.8 | | | | | 0.22 | 0.24 | 0.36 |
| TOTAL LIVE CORAL | 3.09 | 8.2 | 6.4 | 11.4 | 17.07 | 9.6 | 0.4 | 15.75 | 8.99 | 5.40 |
| Dead coral | 0.22 | 0.6 | | 1 | 2.6 | 2.4 | | 1.77 | 1.07 | 0.99 |
| Sand | 78.34 | 31 | 51.2 | 31 | 32.33 | 48.8 | 19.8 | 8.49 | 37.62 | 20.15 |
| Rock/boulder | 17.24 | 59 | 40.8 | 56.4 | 48 | 39.2 | 79.8 | 73.11 | 51.69 | 18.71 |
| Zoanthids | 1.11 | 1.2 | 1.6 | 0.2 | | | | 0.88 | 0.62 | 0.61 |

*Table 3.5e* ***Number of Coral Colonies in Penny's Bay***

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Mean | SE |
|---|---|---|---|---|---|---|---|---|---|---|
| *Goniopora stutchburyi* | | | | | | 3 | | | 0.38 | 0.99 |
| *Favia speciosa* | 1 | 11 | 9 | 9 | 6 | 17 | 2 | 17 | 9 | 5.63 |
| *Favites abdita* | 2 | 4 | | 5 | 2 | 3 | | 10 | 3.25 | 3.03 |
| *Favites pentagona* | | | 1 | 1 | 1 | 2 | | 2 | 0.88 | 0.78 |
| *Goniastrea aspera* | | 1 | | 5 | 3 | | | 9 | 2.25 | 3.07 |
| *Goniastrea cf. favulus* | | | | | | | | | 0 | 0 |
| *Platygyra sinensis* | 2 | 6 | 3 | 6 | 6 | | | 14 | 4.63 | 4.27 |
| *Plesiastrea versipora* | 1 | 1 | | 1 | 3 | 1 | | 1 | 1 | 0.87 |
| *Leptastrea purpurea* | | 2 | 2 | 1 | 5 | 3 | | 2 | 1.88 | 1.54 |
| *Leptastrea pruinosa* | | | | | 1 | | | | 0.13 | 0.33 |
| *Cyphastrea* spp. | 1 | 6 | 2 | 15 | 14 | 14 | | 24 | 9.5 | 8 |
| *Turbinaria peltata* | 1 | | 1 | | 1 | | | 1 | 0.5 | 0.5 |
| TOTAL NO. | 8 | 31 | 18 | 43 | 42 | 43 | 2 | 80 | 33.4 | 23.2 |
| Total Cover | 3.09 | 8.2 | 6.4 | 11.4 | 17.1 | 9.6 | 0.4 | 15.8 | 8.99 | |
| Size Index | 0.39 | 0.26 | 0.36 | 0.27 | 0.41 | 0.22 | 0.2 | 0.2 | 0.27 | |

When compared to other sites in Hong Kong, especially those in the western harbour area, the assemblages are composed of a high number of coral colonies with a medium to high percentage cover. In comparison to areas of high ecological and conservation value in the eastern waters of Hong Kong, such as South Ninepin Island or Ping Chau, the assemblages are of lower diversity and abundance.

In summary, the coral community at Penny's Bay is composed of a shallow, thin veneer of common faviid coral species. Percent live coral cover is generally low, however, the inner part of the bay would appear to still support a relatively healthy, simple coral community. The findings are of some significance as the presence of scleractinian corals in Penny's Bay

extends the known local geographic range for local hard corals (Hodgson and Yau 1997).

## 3.6 *MARINE MAMMALS*

Because of the proposed construction of the theme park in the area of Penny's Bay (northeast Lantau Island), new estimates of abundance and distribution for both species of small cetaceans in the East Lantau survey area have been calculated from all available data in the OPCF database. These estimates can serve as a baseline against which potential impacts of the construction and operation of the theme park may be measured.

### 3.6.1 *Survey Methods*

Cetacean survey data were collected from September 1995 to November 1999. East Lantau survey lines were drawn up to cover the area evenly; no reference was made to dolphin or porpoise distribution patterns when drawing up the survey lines. The primary lines were designed to run perpendicular to the shoreline; they were parallel to each other, and spacing for most survey lines was 1-2 km apart. The total size of the East Lantau survey area is 109 $km^2$, and a total of 4310.7 km of survey effort was conducted in the East Lantau area during conditions of Beaufort 0-3.

Boat surveys were conducted from several 12-15 m inboard vessels. All had the same basic configuration. The vessel transited survey lines at a constant speed of 13-15 km/hr. Most boat drivers were experienced in cetacean surveys, and kept the vessel on a specific course at a fairly constant speed. 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. The Primary Observer searched for dolphins continuously through 7 X 35 Fujinon marine binoculars. The Data Recorder searched with unaided eye, in addition to filling out data sheets. Both observers searched the area ahead of the vessel, between 270° and 90°. Observers rotated positions every 30 minutes, and on most surveys, there were 1-3 additional observers on the boat, who would rotate into position to give each observer a rest after each 1-hour on-effort period, thereby minimizing fatigue.

Data were collected on data sheets, and later entered into a computer database (EXCEL). Effort data collected during on-effort survey periods included time and position for the start and end of effort, vessel speed, sea state (Beaufort scale), visibility, and distance traveled in each series. 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 was diverted from its course to approach the group for group size and behavioral evaluations. The sighting sheet included information on sighting angle and distance, position of initial sighting, sea state, group size and composition, and behavioral information such as response to the survey vessel and vessel associations.

Position, distance traveled, and vessel speed were obtained from a hand-held Global Positioning System (most commonly a Magellan Colortrack GPS unit).

All observers were experienced in small cetacean survey techniques, and in identification of local marine mammal species. Most had undergone at least one 3-day training program, including a day of at-sea training. Observers were trained in distance estimation, by asking them to make distance estimates to various objects (eg, other boats, specific points on shore, floating debris, etc). Simultaneously, a distance reading was taken with a pair of laser rangefinder binoculars (Leica Geovid or Bushnell Yardage Pro). The observer was told the actual distance immediately, and could then use this information to correct for errors. In addition, plots of measured vs. estimated distance were shown to observers occasionally, so they could see if they needed to make corrections in their estimates in the future.

### 3.6.2 *Photo-Identification*

When dolphins were sighted the observers typically went off-effort, and the vessel approached the dolphin group for accurate estimation of group size and for photo-identification. Photographs were taken with Nikon or Canon autofocus cameras (primarily Canon EOS 5, 50, and 100QD models). All cameras were equipped with databacks, and day of the month and time were imprinted on each frame, allowing frames to be correlated with a particular sighting. Two lenses, a Canon L series 35-300 mm / f5.6 zoom and a Canon L series 300 mm / f2.8 telephoto, were used to take most photographs. Generally, the 300 mm lens was used with a 1.4 teleconverter, effectively making it a 420 mm / f4.0 lens.

Slide (transparency) film was shot for all photo-identification work. Fujichrome Provia 100 ISO, Sensia 100 ISO, Astia 100 ISO, and Velvia 50 ISO film were used most commonly. Occasionally, when lighting conditions were very poor, the photographer switched to Sensia 200 ISO film. The preferred film was Velvia; the extremely fine grain of this film resulted in very sharp photos, ideal for identification of individuals. However, this film could only be used with the fast f2.8 telephoto lens on days with good lighting.

Ideally, dolphin groups were approached slowly from the side and behind. Maneuvering the boat to within 30-50 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.

### 3.6.3 *Data Analysis Methods*

Although data were collected in sighting conditions of Beaufort 0-5, previous studies indicated that using data from Beaufort 4-5 would result in downward bias in the resulting estimates of abundance (Jefferson and Leatherwood 1997). Therefore, only data from Beaufort conditions 0-3 were used in the estimation of density and abundance. Density and abundance estimates were calculated using line transect methods (Buckland et al. 1993). The estimates

were made using the computer program DISTANCE (Laake et al. 1994). The following formulae were used to calculate estimates of density, abundance, and their associated coefficient of variation:

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

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

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

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

Dolphin photos were examined after processing, and useless photos (those in which the dolphin surfacing was missed, or was badly out of focus) were discarded. The remaining photos were filed in archival slide sheets and separated by date and sighting number. Then, each slide was examined carefully with an 8X loupe, and those showing a distinctive individual were selected. Each distinctive animal was then compared to the existing photo-identification catalog (and supporting photos) to determine if it was a new individual or a resighting. Dolphins were identified by general dorsal fin shape and markings on the back and dorsal fin such as nicks and cuts on the dorsal fin, body scars, and deformities and injuries. Spot patterns were not used as the primary basis for identification because they appear to change over time (see Jefferson and Leatherwood 1997). However, spots and coloration were used in conjunction with other, more permanent, marks to aid in identification.

Photographs of each individual dolphin were kept in separate slide file sheets, in chronological order, so that comparisons could be made easily, and any changes in markings could be tracked over time. A computer database was kept, using the bibliographic software ENDNOTE®. Each dolphin as given its own record within the database, which included the catalog umber, name, date and location first identified, resightings, associated individuals, distinctive features, sex (if known), age class, and comments. A print catalog

was also kept for easy comparison. There was a single print of each dolphin (either right or left side), and the highest quality photograph was chosen for the print catalog. The print catalog was updated periodically.

### 3.6.4 *Results*

Humpback dolphin sightings occurred throughout much of the area, but were mostly made in the northwestern part of the survey area, very near the Lantau Island coastline in the area off Penny's Bay and to the north (*Figure 3.6a*). These apparently result mostly from forays of individuals or small groups of dolphins from the North Lantau area through the Kap Shui Mun channel. Additional sightings from before the OPCF study were mostly around Penny's Bay, although most survey effort was also concentrated near this area (see Jefferson 1997). Estimates of humpback dolphin abundance ranged from 3 dolphins in autumn to 5 dolphin in winter (*Table 3.6a*); these are similar to the previous estimates discussed above (Jefferson in press). Some dolphin sightings were also made in the area in spring and summer, but they were either off-effort or occurred during Beaufort conditions of 4 or above, and thus resulted in estimates of zero abundance for these seasons.

There are currently 228 individual humpback dolphins represented in the OPCF photo-identification catalog. Of these, 22 (9.6%) have been seen in the East Lantau area. However, with the exception of EL03 (which was only sighted once), all of these animals have also been sighted outside of the East Lantau area (mostly in North Lantau).

Finless porpoise sightings were rare in the East Lantau area, despite moderately heavy survey effort in all seasons. Most of the sightings were in the southern part of the survey area, far from the area where the humpback dolphins were sighted (*Figure 3.6a*). All finless porpoise sightings occurred in winter and spring months. Estimates of abundance were zero for all seasons except winter, in which an estimated 15 dolphins occurred (*Table 3.6a*). These animals are probably mainly porpoises from the South Lantau and Lamma areas (both high density areas in winter and spring), which are moving into the southern East Lantau area for short periods.

### 3.6.5 *Conclusions*

The following conclusions can be drawn from the above analyses:

1. Abundance of both species in East Lantau is low and they use the area only seasonally;

2. The East Lantau area probably does not represent critical habitat for either species, and appears to be used mainly as a peripheral portion of the home range for some North Lantau humpback dolphins;

3. Spring and summer appear to be the least important seasons of use, and winter is the most important season.

*Table 3.6a* ***Components of the line transect equation, estimates of density (D) and abundance (N), and associated coefficients of variation (%CV) for finless porpoises and humpback dolphins in the East Lantau area.***

| | Finless Porpoise | | | | | | | Humpback Dolphin | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Season | L (km) | n | f(O) | E(s) | D (/km2) | N | %CV | n | f(O) | E(s) | D (/km2) | N | %CV |
| Winter | 421.8 | 3 | 4.74 | 8.2 | 1.68 | 15 | 137 | 3 | 4.19 | 3.0 | 1.49 | 5 | 89 |
| Spring | 600.8 | 1* | - | 1.0 | - | 0 | - | 0 | - | - | - | 0 | - |
| Summer | 670.1 | 0 | - | - | - | 0 | - | 0 | - | - | - | 0 | - |
| Autumn | 2,618.0 | 0 | - | - | - | 0 | - | 15 | 2.00 | 4.6 | 0.57 | 3 | 49 |

* *The probability density function [f(O)] can not be calculated in cases in which n=1.*

# 4 ECOLOGICAL IMPORTANCE

## 4.1 EVALUATION CRITERIA

According to the Technical Memorandum of the EIAO (*EIAO TM*) *Annex 8* the ecological value/importance of a habitat can be evaluated using the following criteria:

- Naturalness;
- Size;
- Diversity;
- Rarity;
- Re-creatability;
- Ecological Linkage;
- Potential value;
- Nursery Ground;
- Age; and,
- Abundance.

## 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 within Penny's Bay in order to determine the ecological value. The application of these criteria has led the habitat to be classified as of low ecological value (*Table 4.2a*).

***Table 4.2a Ecological Value of the Subtidal Soft Benthos Assemblages within Penny's Bay***

| Criteria | Subtidal Soft Benthos in Penny's Bay |
|---|---|
| Naturalness | The assemblages are expected to be disturbed due to the reclamation that has occurred on the northern coast of Penny's Bay and the effects of the shipyard at the western end of the bay. |
| Size | Total area of the reclamation site will involve the loss of 280 hectares of subtidal habitats. |
| Diversity | In comparison to other parts of the western harbour the assemblages are more diverse in Penny's Bay and of similar diversity to assemblages from the Eastern Waters of Hong Kong. |
| Rarity | No organisms were found that are considered as rare. |
| Re-creatibility | The habitat cannot be re-created on site. |
| Ecological Linkage | The surrounding environment contains many other areas of soft substrate. |
| Potential Value | Unlikely that the site can develop conservation interest. |
| Nursery Area | None identified in the review. |
| 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 other parts of the western harbour the assemblages are more abundant in Penny's Bay and similar to assemblages from the |

| Criteria | Subtidal Soft Benthos in Penny's Bay |
|---|---|
| | Eastern Waters of Hong Kong. |
| SUMMARY | The sediments support average diversity and abundance of benthic organisms that are typical of Hong Kong's benthos. |
| | **Ecological Value - Low.** |

Note: n/a: Not Applicable

The criteria listed above have been applied to the information gathered or reviewed on the marine ecology of the subtidal hard surface benthic habitat within the Study Area. The habitat has been classified as of high ecological value (*Table 4.2b*). Although the habitat at Sze Pak was not surveyed it has been assumed for this Study that it supports similar assemblages to Penny's Bay. This is a conservative approach and is regarded as precautionary.

*Table 4.2b* ***Ecological Value of the Subtidal Hard Substrate Habitat within Penny's Bay and Sze Pak Wan***

| Criteria | Subtidal Hard Surface Habitat |
|---|---|
| Naturalness | There is evidence at the site of indirect impacts to the assemblages through poor water quality and deposited sediments. |
| Size | The assemblages within Penny's Bay extend along the entire length of the natural rocky coast as follows, 2.2 km along the southern shore and 0.78 km along the northeastern shore west of Pa Tau Kwu, but are only found along a narrow band at depths of 3-4m below chart datum. |
| Diversity | A total of 12 species of hard corals were recorded which for the western harbour of Hong Kong represents high diversity. The diversity index of 1.8 indicates a natural community. |
| Rarity | One of the species, *Goniopora stutchburyi* is regarded as uncommon (low abundance) in Hong Kong and *Leptoseris mycetoseroides* is thought of as rare. All the other species of corals are commonly recorded on rocky coasts in the East of Hong Kong. |
| Re-creatibility | The habitat can be recreated through the deployment of artificial reefs. |
| Ecological Linkage | It is suspected that Sze Pak Wan supports similar assemblages to Penny's Bay. |
| Potential Value | The site is of interest as the presence of scleractinian corals in Penny's Bay extends the known local geographical range for hard corals. |
| Nursery Area | None identified during the literature review or field surveys. |
| Age | Hard corals are known to be long lived and although the individual colonies were of small size some are likely to be more than 10 years old. |
| Abundance | The coral colonies appear to be of high abundance for the western waters of Hong Kong but of medium to low abundance when compared with known sites of high conservation importance in the Eastern waters of Hong Kong. |
| SUMMARY | The subtidal fauna appears to be diverse and abundance with many colonies of hard corals. |
| | **Ecological Value - High.** |

Note: n/a: Not Applicable

The criteria listed above have been applied to the information gathered or reviewed on the marine ecology of the subtidal hard surface benthic habitats along the coastlines of Kau Yi Chau. The habitat has been classified as of high ecological value (*Table 4.2c*).

*Table 4.2c* *Ecological Value of the Subtidal Hard Substrate Habitat at Kau Yi Chau*

| Criteria | Subtidal Hard Surface Habitat |
|---|---|
| Naturalness | There is evidence at the site of indirect impacts to the assemblages through poor water quality and deposited sediments. |
| Size | The assemblages are reported to consist of small isolated patches of hard and soft corals. |
| Diversity | The assemblages were reported as being of low diversity. |
| Rarity | All of the species of hard and soft corals are commonly recorded on rocky coasts in the East of Hong Kong. |
| Re-creatibility | The habitat can be recreated through the deployment of artificial reefs. |
| Ecological Linkage | Other natural hard substrate habitats in the vicinity include Green Island and Little Green Island. |
| Potential Value | Unlikely that the site can develop conservation interest. |
| Nursery Area | None identified during the literature review or field surveys. |
| Age | Hard corals are known to be long lived and although the individual colonies were of small size some are likely to be more than 10 years old. |
| Abundance | The abundances of the hard and soft corals in the assemblages were reported as being low. |
| SUMMARY | The subtidal fauna appears to be of low diversity and abundance with isolated colonies of hard and soft corals. The presence of hard and soft corals in the western harbour is however, regarded as of ecological interest. |
| | **Ecological Value - Medium.** |

Note: n/a: Not Applicable

## 4.3 *INTERTIDAL HABITATS*

The criteria listed above have been applied to the information gathered or reviewed on the marine ecology of the intertidal habitats in Penny's Bay in order to determine the ecological value. The application of these criteria has led the intertidal rocky shores to be classified as medium, whereas, the intertidal sandy shores have been classified as low (*Table 4.3a*).

*Table 4.3a* *Ecological Value of Intertidal Habitats Within Penny's Bay*

| Criteria | Hard Surface Habitat | Sandy Shore |
|---|---|---|
| Naturalness | The habitat is undisturbed by human impact due to the steep rocky terrain of much of the intertidal zone and remoteness of the shore. | The shores are undisturbed by human impact due to its remoteness. |
| Size | The area covers almost the entire length of the southern shore of Penny's Bay and a section of the northeastern shore (2.88 km). | There is a small sandy shore (100m) adjacent to the shipyard at the western end of Penny's Bay. |
| Diversity | The intertidal communities are typical of exposed rocky shores in Hong Kong. | Field survey of similar habitats in East Lantau indicate that assemblages are of low species diversity. |
| Rarity | No species recorded are considered rare. | No species recorded are considered rare. |
| Re-creatibility | The habitat can be re-created. | The habitat can be re-created. |

| Criteria | Hard Surface Habitat | Sandy Shore |
|---|---|---|
| Ecological Linkage | The surrounding environment contains similar intertidal habitats. | The surrounding environment contains few other similar intertidal habitats. |
| Potential Value | Unlikely that the site can develop conservation interest. | Unlikely that the site can develop conservation interest. |
| Nursery Area | None identified during the literature review or field surveys. | No nursery areas identified on the shore within the Study Area. |
| Age | n/a for these assemblages as the life cycle of the fauna and flora is very short. | n/a for these assemblages as the life cycle of the fauna is very short. |
| Abundance | Assemblages appear to be typical of other semi exposed shores in Hong Kong. | Field survey of similar habitats in East Lantau indicate that assemblages are of low faunal abundance. This finding is typical of semi-exposed sandy beaches in Hong Kong. |
| SUMMARY | The fauna of the intertidal region appears to be typical of semi exposed shores in Hong Kong. The sites appear to have suffered little human disturbance. **Ecological Value - Medium.** | The sandy shore located within Penny's Bay is expected to support low diversity and depauperate assemblages typical of other semi-exposed beaches in Hong Kong. **Ecological Value - Low.** |

Note: n/a: Not Applicable

The criteria listed above have been applied to the information gathered or reviewed on the marine ecology of the artificial seawall intertidal habitats in Penny's Bay and on the North Lantau coast in order to determine the ecological value. The application of these criteria has led the shores to be classified as of low value (*Table 4.3b*).

*Table 4.3b* ***Ecological Value of the Artificial Seawalls in the Marine Ecology Study Area***

| Criteria | Artificial Seawalls |
|---|---|
| Naturalness | The habitat is disturbed by human impacts through stormwater discharges and development of residential & industrial areas using artificial seawalls. |
| Size | The Yam O artificial seawall is approximately 900 m long and is sloping whereas the Penny's Bay seawall is approximately 2.37 km long the majority of which is vertical (371 m is sloping). |
| Diversity | Reviewed literature indicates that sloping artificial seawalls support similar assemblages to natural intertidal shores. Vertical seawalls, however, support lower diversity than natural shores. Corals have been reported colonising the subtidal sections of sloping artificial seawalls. |
| Rarity | No rare species were reported in the literature reviewed. |
| Re-creatibility | The habitat can be re-created. |
| Ecological Linkage | The surrounding coastlines are composed of a mixture of natural and artificial intertidal shores. |
| Potential Value | The site can develop conservation interest if over time it becomes colonised by hard or soft corals. |
| Nursery Area | None identified during the literature review. |
| Age | The seawalls at Yam O have been in place at least 3 years whereas those in Penny's Bay were constructed more than 10 years ago. |
| Abundance | Reviewed literature indicates that artificial seawalls support similar assemblages to natural intertidal shores. Corals have been reported |

| Criteria | Artificial Seawalls |
|---|---|
| | colonising the subtidal sections of sloping artificial seawalls (eg tetrapods, dolosse blocks or rubble mound). |
| SUMMARY | The fauna of the intertidal region of the artificial seawalls are reported to support similar diversity and abundance of intertidal organisms as natural seawalls. Subtidal portions of sloping seawalls can also support coral growth, however, this depends on the age of the seawall and environmental conditions of the area. The Yam O seawalls are relatively recent in construction and, therefore, it is unlikely that the assemblages are more than low ecological value. The Penny's Bay seawalls are largely vertical and as such do not support communities of more than low ecological value.<br>**Ecological Value - Low.** |

Note: n/a: Not Applicable

## 4.4 *MARINE WATERS WITHIN PENNY'S BAY AND IN EAST LANTAU*

The same assessment criteria have been applied to the marine waters within the Study Area with regard to the usage of the area by protected species of marine mammals. This habitat has been classified as of low and medium ecological value depending largely on the use of the area by protected species of marine mammals (*Table 4.4a*).

### *Table 4.4a Ecological Value of the Coastal Waters within Penny's Bay and in East Lantau*

| Criteria | Coastal Waters within Penny's Bay | Marine Waters off the Fa Peng and Pa Tau Kwu Coast of Lantau Island | Coastal Waters within Yam O Reclamation | Marine Waters off the North Lantau Coast |
|---|---|---|---|---|
| Naturalness | The assemblages are expected to be disturbed due to the reclamation that has occurred on the northern coast of Penny's Bay and the effects of the shipyard at the western end of the bay. | Disturbed as a result of fishing activities and in close proximity to some of the busiest shipping lanes in Hong Kong. | The assemblages are expected to be disturbed due to the reclamation that has occurred along the northern coast of Lantau | Disturbed as a result of fishing activities and in close proximity to some of the busiest shipping lanes in Hong Kong. |
| Rarity | No dolphins or porpoises have been recorded within the bay. | *Sousa chinensis* has been recorded in off-shore waters to the east and north and the finless porpoise far to the south. | No dolphins or porpoises have been recorded within the reclamation area. | The area is regarded as being at the eastern end of the critical habitat of *Sousa chinensis* which is located in northwest Lantau waters. No finless porpoises have been sighted in this area. |
| Re-creatibility | The habitat cannot be recreated after it has been reclaimed. | n/a | The habitat cannot be recreated after it has been reclaimed. | n/a |
| Ecological Linkage | Preferred marine mammal habitat occurs to the north, west and south of this area. | Preferred marine mammal habitat occurs to the north and south of this | Preferred (non-seasonal) marine mammal habitat occurs to the west | Preferred (non-seasonal) marine mammal habitat occurs to the west of |

| Criteria | Coastal Waters within Penny's Bay | Marine Waters off the Fa Peng and Pa Tau Kwu Coast of Lantau Island | Coastal Waters within Yam O Reclamation | Marine Waters off the North Lantau Coast |
|---|---|---|---|---|
| | | area. | this area. | this area. |
| Potential Value | Limited value due to its small size. | Limited value due to heavy navigational use of the area. | Limited value due to its small size. | Limited value due to heavy navigational use of the area. |
| Nursery Area | No nursery areas were identified in the review of baseline conditions or field surveys. | No nursery areas were identified in the review of baseline conditions or field surveys. | No nursery areas were identified in the review of baseline conditions or field surveys. | No nursery areas were identified in the review of baseline conditions or field surveys. |
| Abundance | Marine mammals have not been recorded within the bay. | Seasonal changes in the distribution patterns of dolphins were observed, with comparatively higher sightings in autumn and winter months. However, these abundances are low when compared to the preferred habitats in North Lantau. | Marine mammals have not been recorded within the reclamation are. | Many sightings have been made of dolphins in the North Lantau area. The population appears to be most abundant during Autumn. |
| SUMMARY | No marine mammals have been sighted in the area. **Ecological Value - Low for both species.** | Sightings of *Sousa chinensis* have been made in these waters. However, the number of sightings is low and varies seasonally. The area is heavily used by marine traffic at present. The finless porpoise occurs to the south of this area and has not been reported in these waters. **Ecological Value - Medium for *Sousa chinensis*, low for *Neophocaena phocaenoides*.** | No marine mammals have been sighted in the area. **Ecological Value - Low for both species.** | Sightings of *Sousa chinensis* have been made in these waters. However, the number of sightings is low and varies seasonally (autumn). The area is heavily used by marine traffic at present. The finless porpoise has not been reported in these waters. **Ecological Value - Medium for *Sousa chinensis*, low for *Neophocaena phocaenoides*.** |

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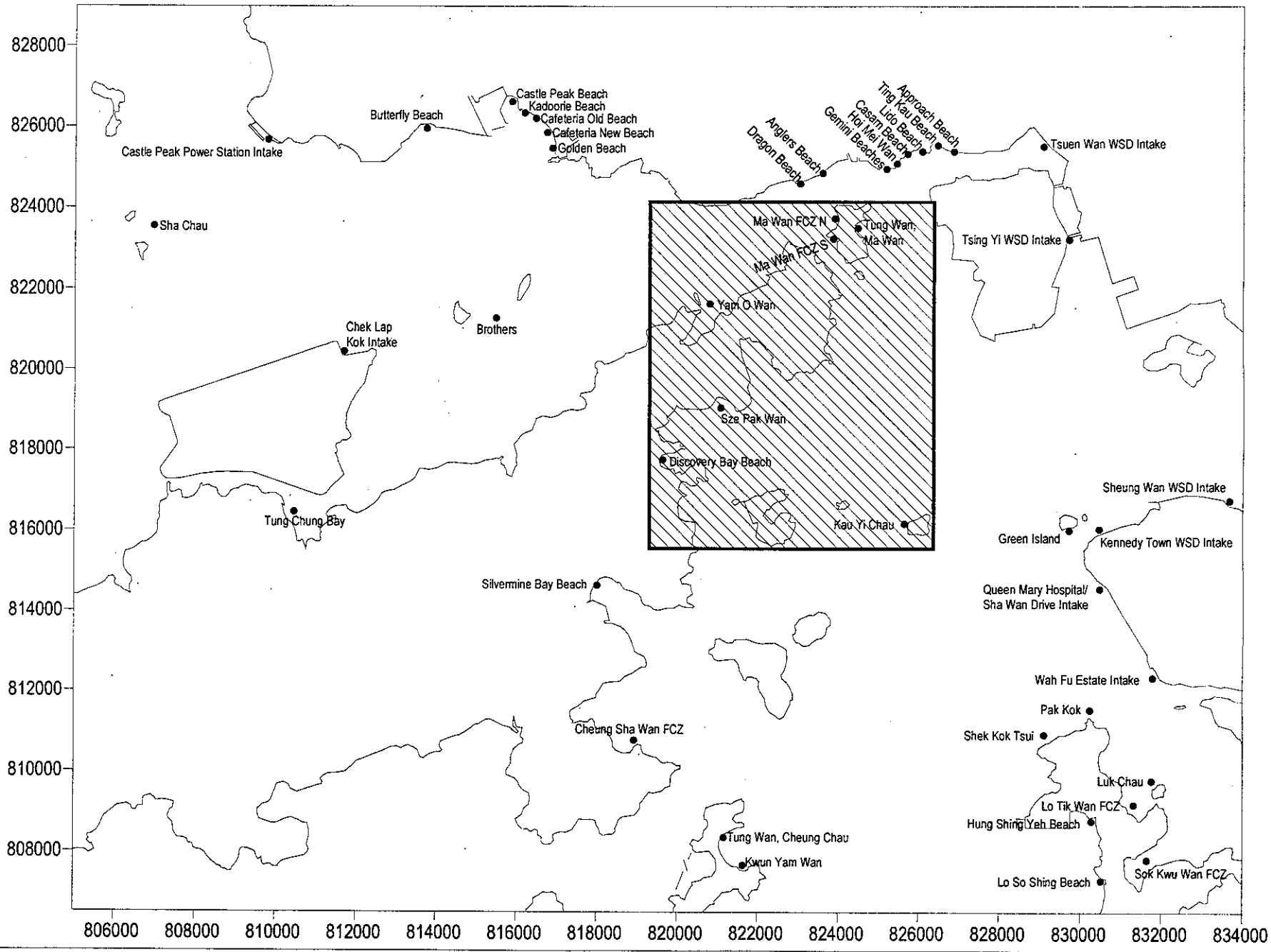


Figure 1.1a

MARINE ECOLOGY STUDY AREA

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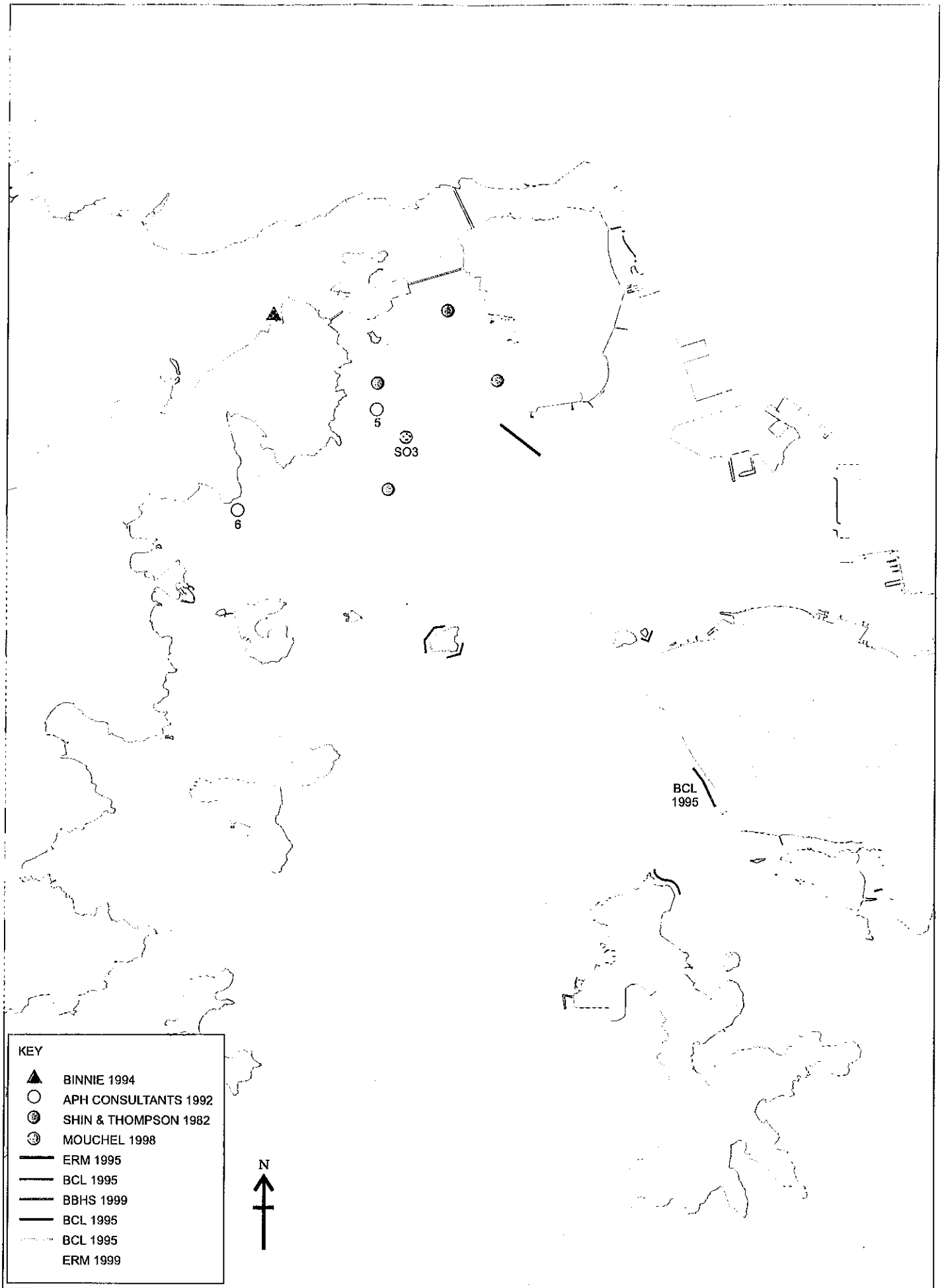


FIGURE 2.1a ECOLOGICAL INFORMATION IN THE VICINITY OF THE PENNY'S BAY RECLAMATION STUDY AREA

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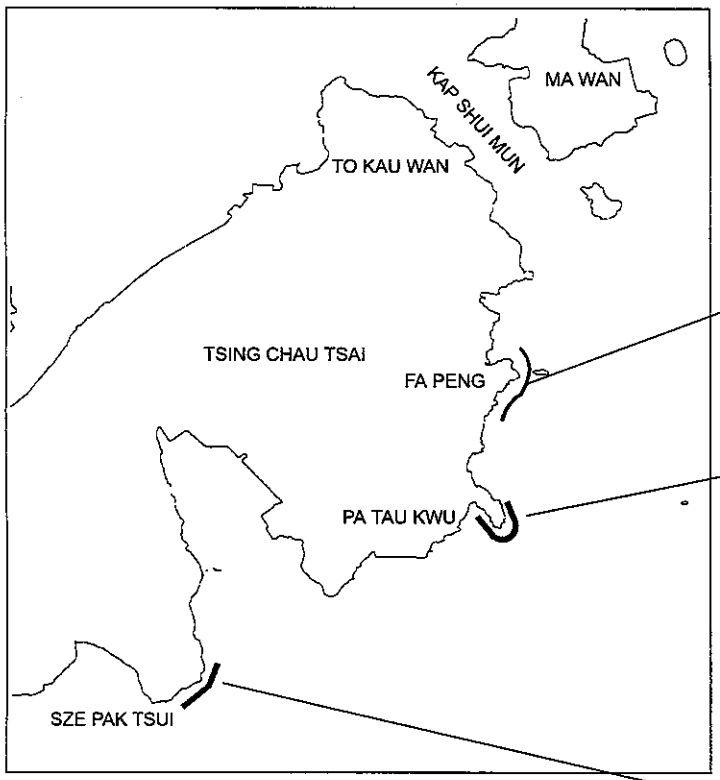
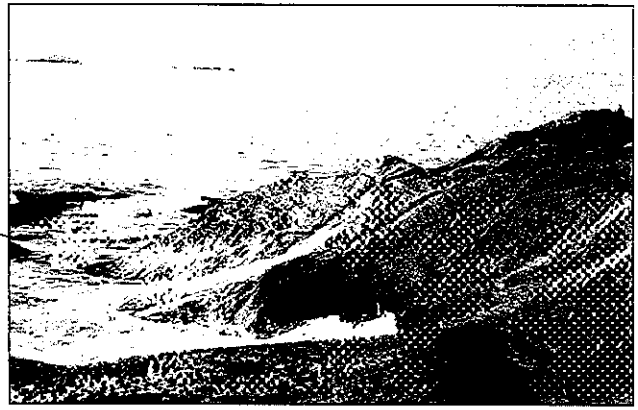
INTERTIDAL REGION OF THE ROCKY SHORE AT FA PENG SHOWING BARNACLES AND LIMPETS




INTERTIDAL REGION OF THE ROCKY SHORE AT PA TAU KWU



INTERTIDAL REGION OF THE ROCKY SHORE AT PENNY'S BAY

KEY

—— ROCKY SHORE SURVEY TRANSECT

FIGURE 3.2a

MARINE ECOLOGY SURVEY SITES ON NORTHEAST LANTAU

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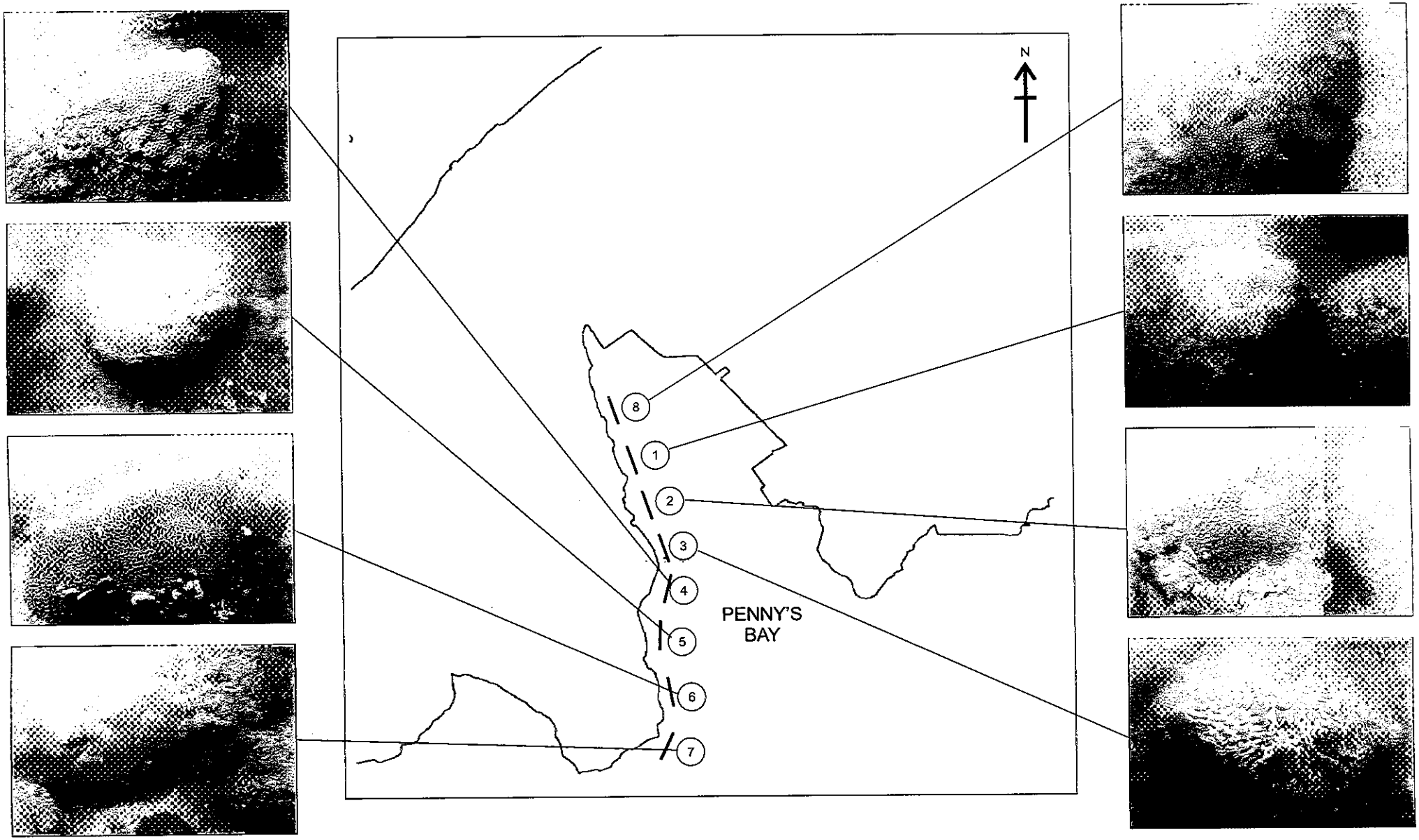


FIGURE 3.5a

LOCATIONS OF SUBTIDAL SURVEY SITES AT PENNY'S BAY

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DATE: 01/02/2000

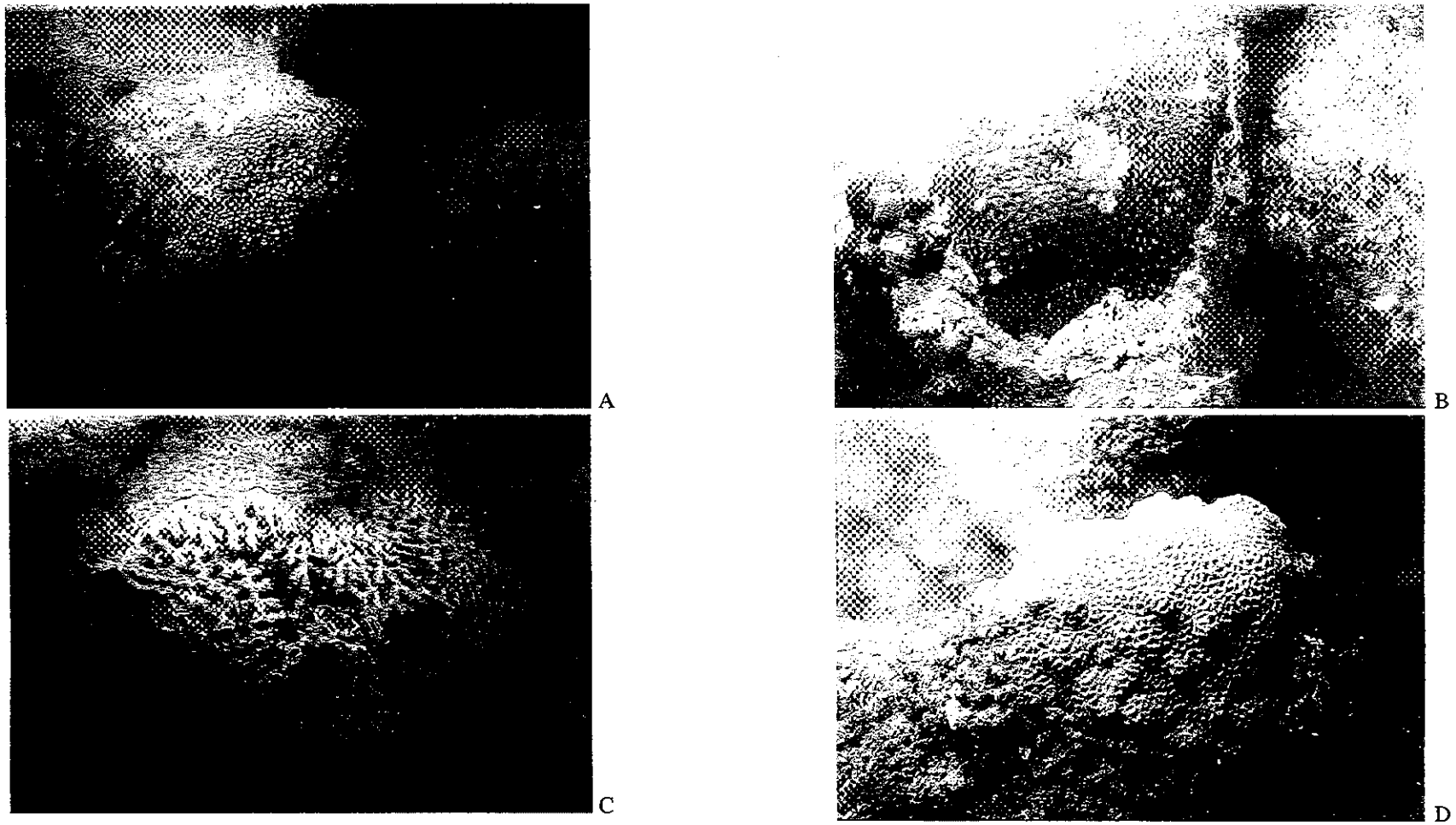


Figure 3.5b: Hard Coral Species Observed During Dive Surveys in Penny's Bay (A - *Goniopora stutchburyi;* B - *Favites abdita;* C - *Favia speciosa;* D - *Favites pentagona*).

FILE: C1819/MARINE/DIVE WORK (PENNY'S BAY)/Coral photos.doc
DATE: 21/1/2000

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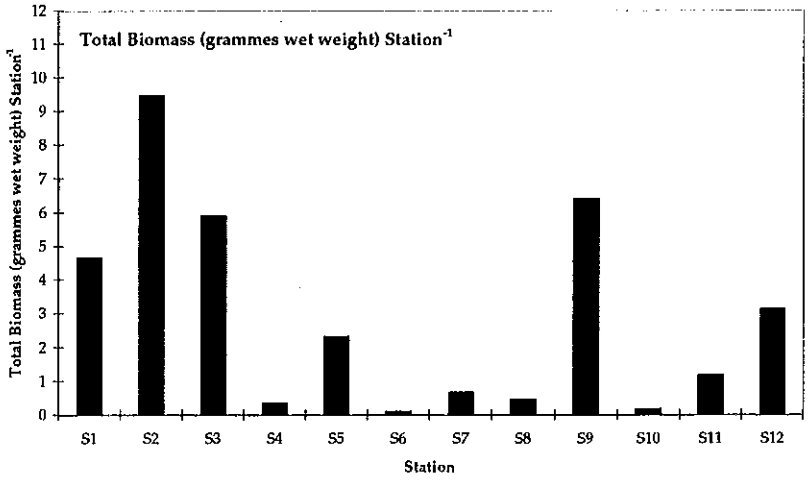


Figure 3.4b: Total biomass (grammes wet weight) station$^{-1}$ of infaunal organisms in samples collected from Penny's Bay during December 1999.

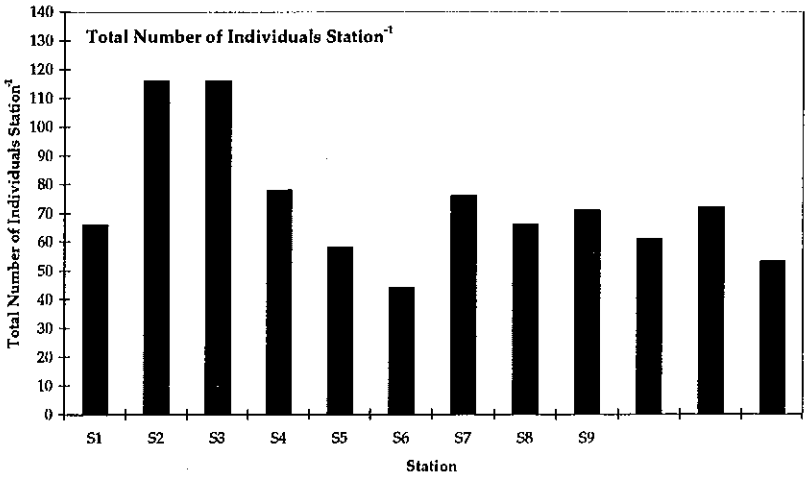


Figure 3.4c: Total number of individuals station$^{-1}$ of infaunal organisms in samples collected from Penny's Bay during December 1999.

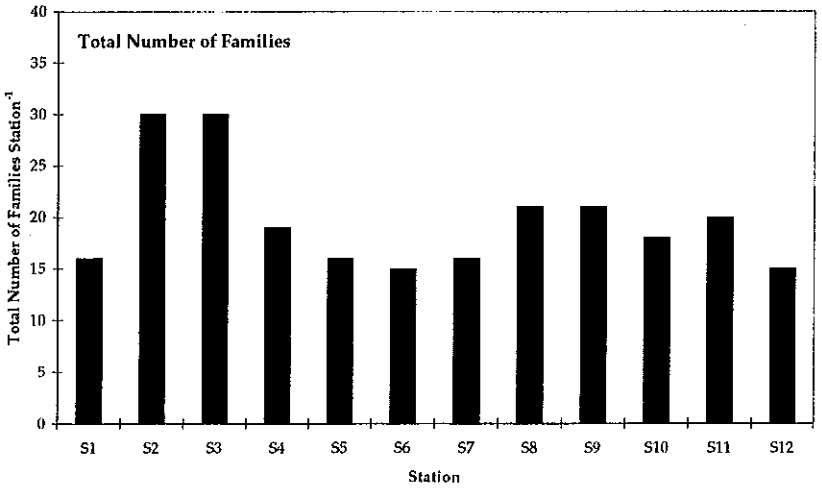


Figure 3.4d: Taxonomic richness (number of families) station$^{-1}$ of samples collected from Penny's Bay during December 1999.

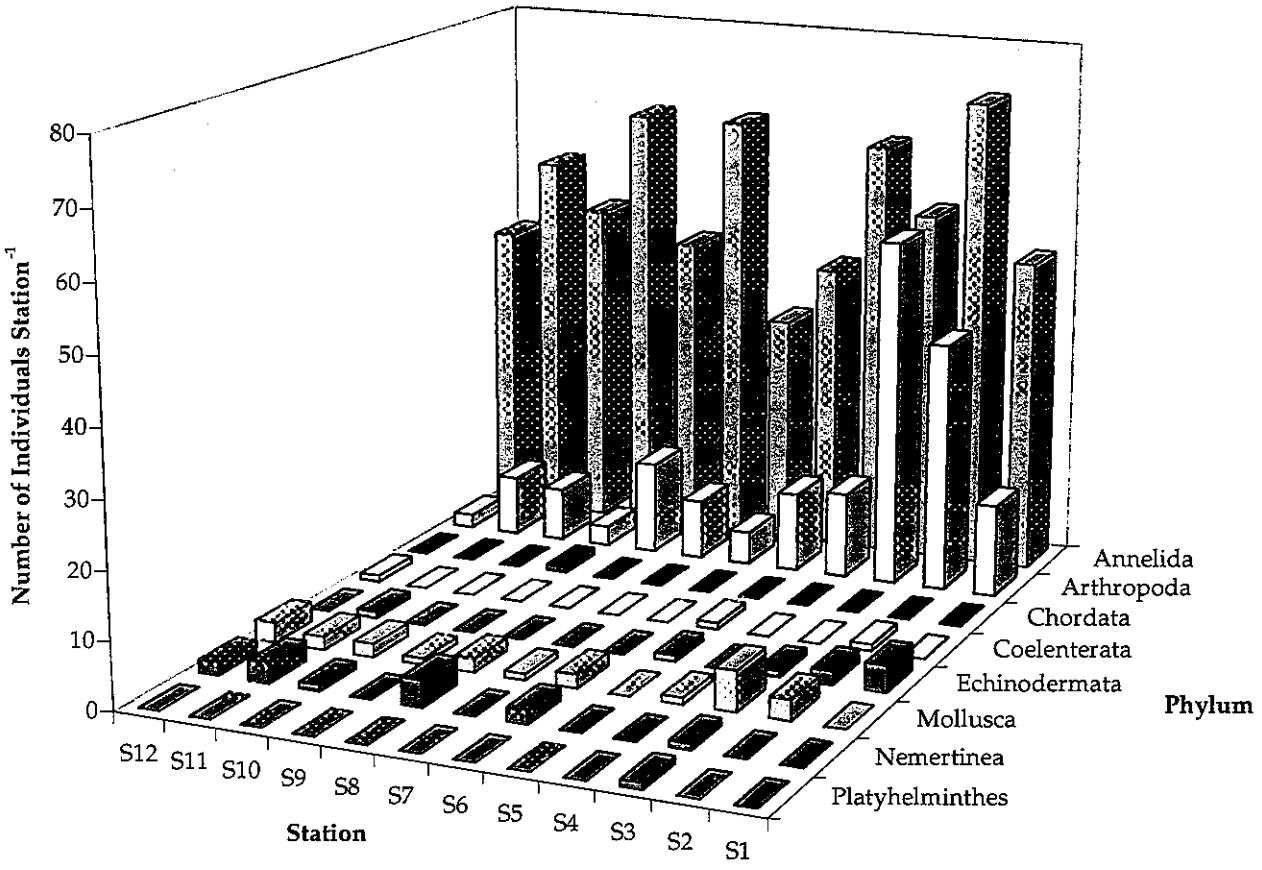


Figure 3.4e: Total abundance (number of individuals) of infaunal organisms station$^{-1}$ identified from samples collected in December 1999 from Penny's Bay
FILE: C1819/Marine/Benthic/Phyla_fig.doc
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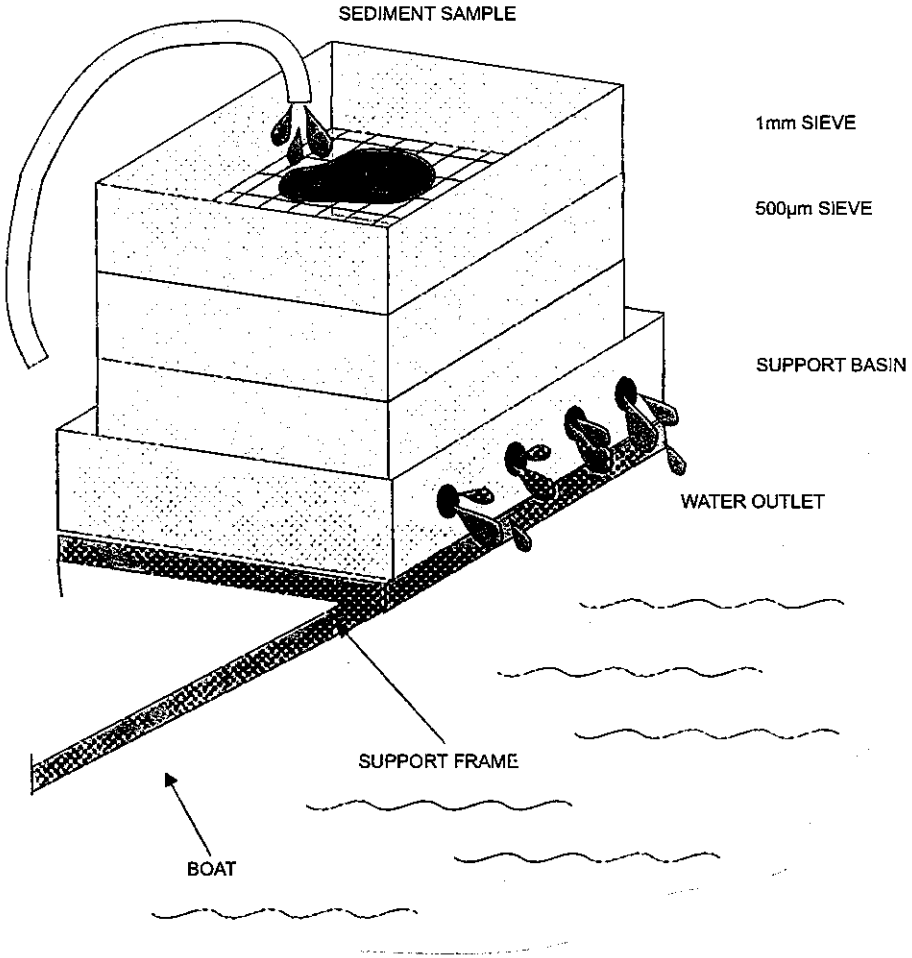


B) LOCATION OF STATIONS

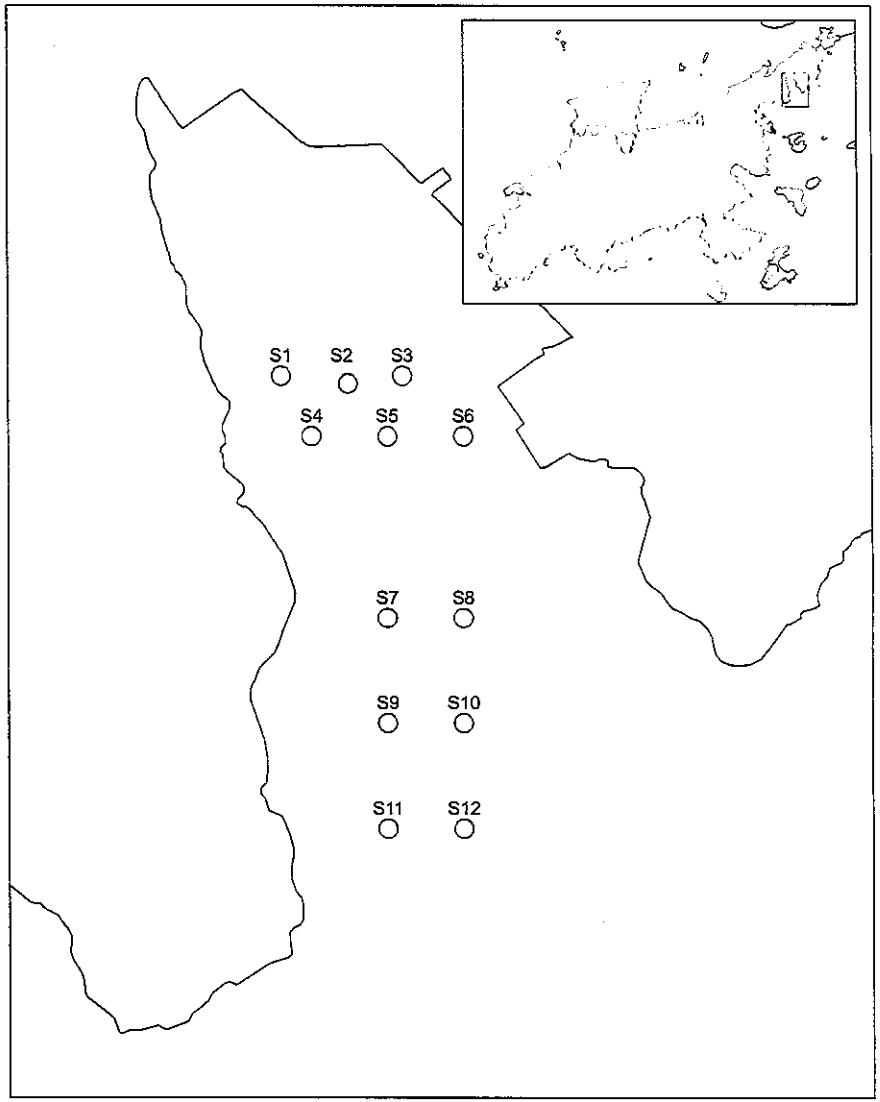


FIGURE 3.4a

LOCATION OF BENTHIC SAMPLING STATIONS

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DATE: 13/01/00

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SANDY SHORE AT YAM TSAI WAN

N

TSING CHAU TSAI

YAM TSAI WAN

PA TAU KWU PAK WAN

COBBLE BEACH AT PA TAU KWU PAK WAN

FIGURE 3.3a

MARINE ECOLOGY SURVEY SITES ON NORTH LANTAU

FILE: C1819r
DATE: 01/02/2000

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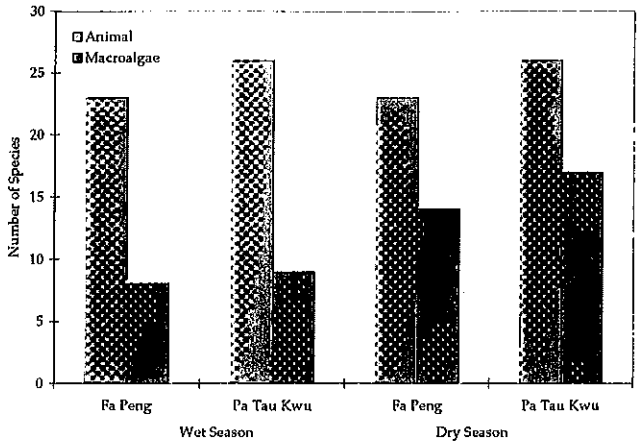



Figure 3.2b: Number of animal and macroalgal species at Fa Peng and Pa Tau Kwu during the wet and dry season.

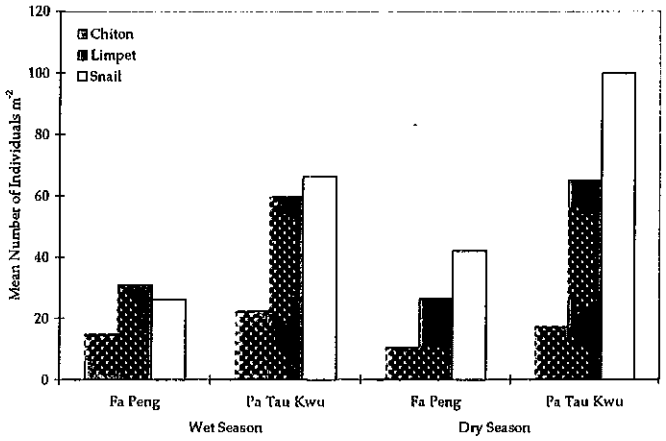



Figure 3.2c: Mean abundance of chiton, limpet and snail ($m^{-2}$) at Fa Peng and Pa Tau Kwu during the wet and dry season.

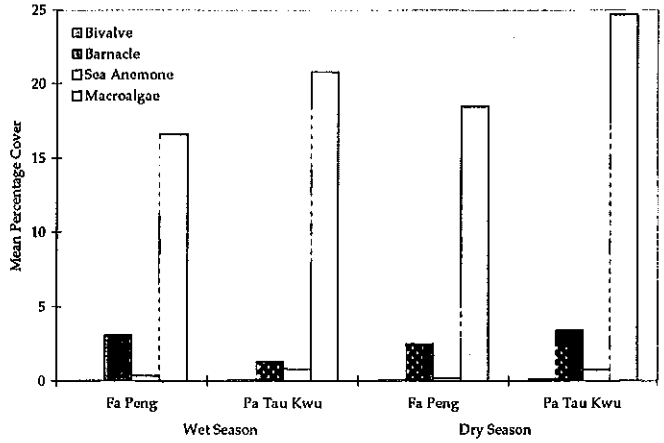



Figure 3.2d: Mean percentage cover of sessile animals and macroalgae at Fa Peng and Pa Tau Kwu during the wet and dry season.

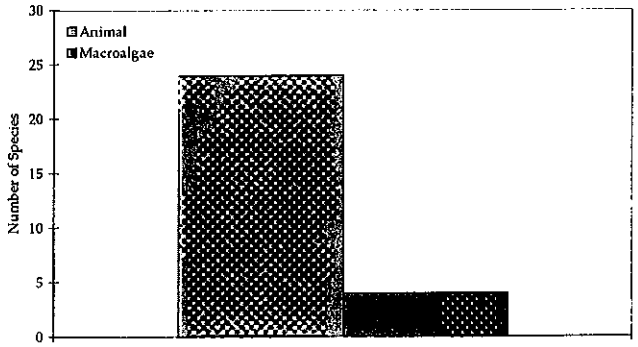



Figure 3.2e: Number of animal and macroalgal species at Penny's Bay recorded during the dry season.

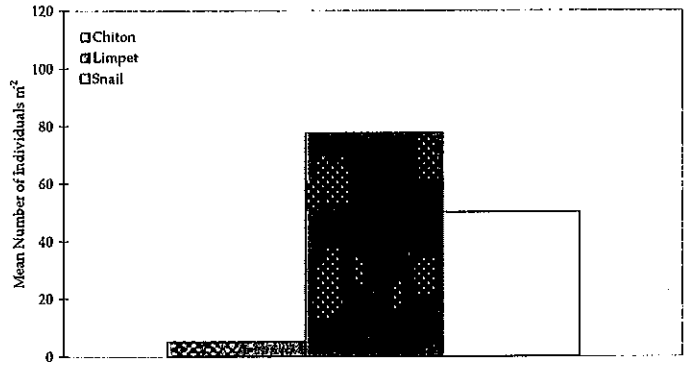



Figure 3.2f: Mean abundance of chiton, limpet and snail ($m^{-2}$) at Penny's Bay recorded during the dry season.

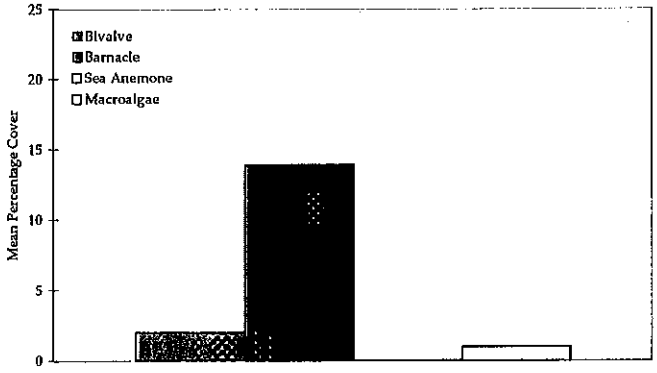
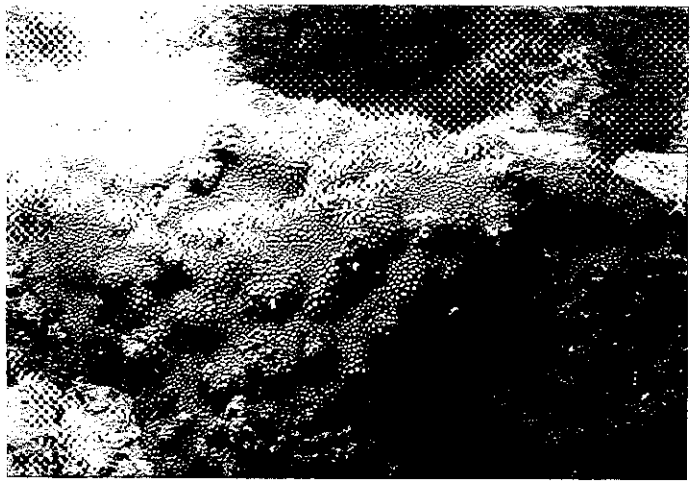
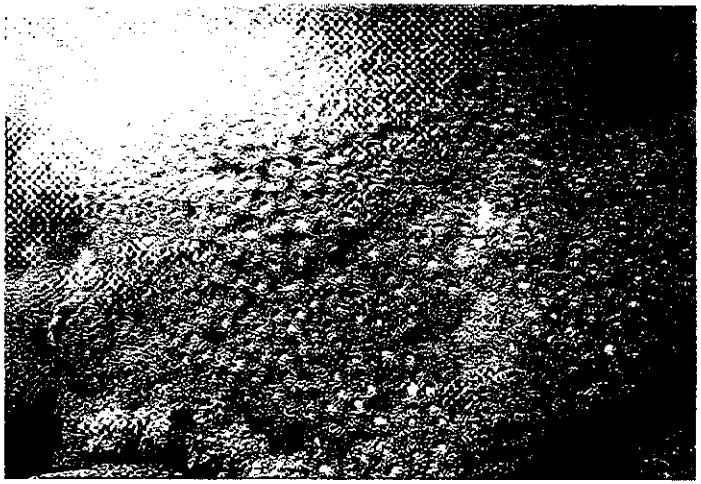



Figure 3.2g: Mean percentage cover of sessile animals and macroalgae at Penny's Bay recorded during the dry season.



I

J



K

L

Figure 3.5d: Hard Coral Species Observed During Dive Surveys in Penny's Bay (I - *Leptastrea pruinosa;* J - *Cyphastrea* spp.; K - *Turbinaria peltata;* L - *Leptoseris mycetoseroides*).

FILE: C1819/MARINE/DIVE WORK (PENNY'S BAY)/Coral photos2.doc
DATE: 21/1/2000

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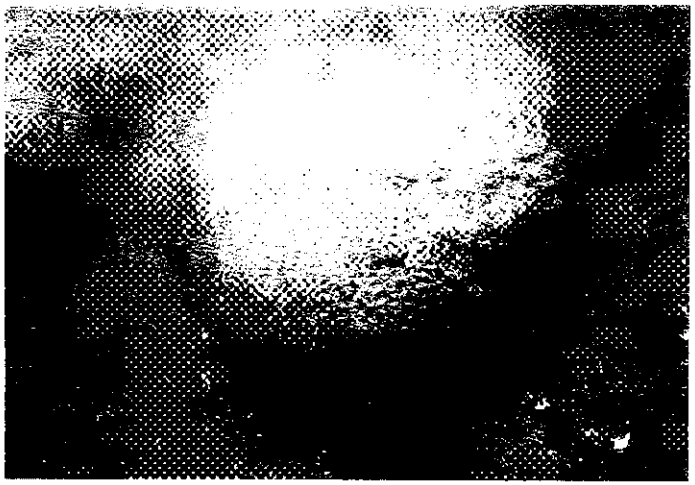

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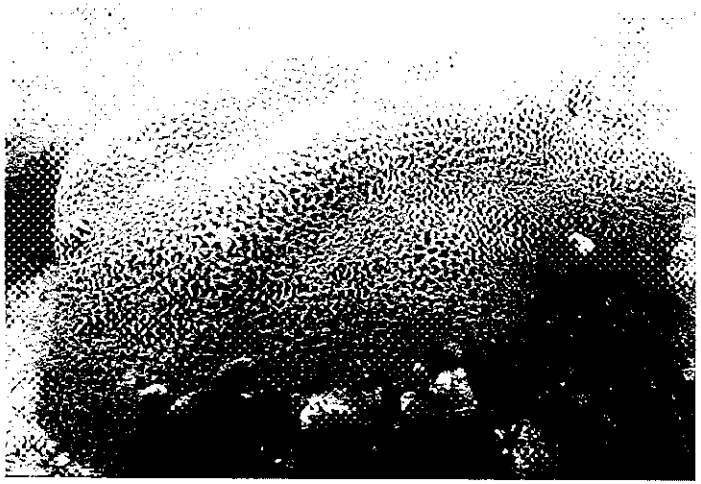

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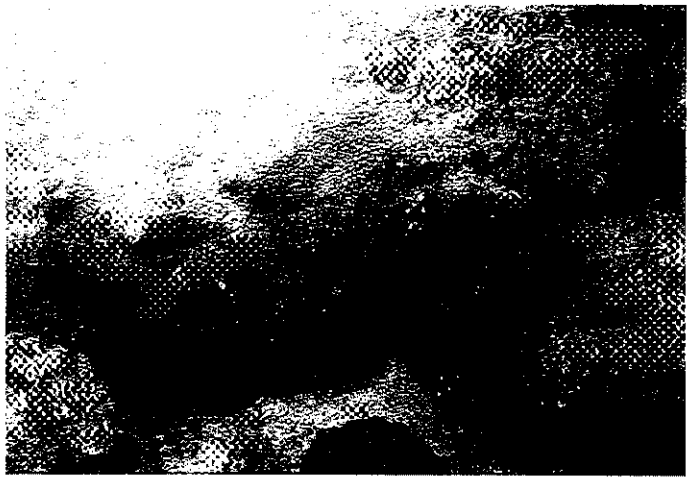

G

H

Figure 3.5c: Hard Coral Species Observed During Dive Surveys in Penny's Bay (E - *Goniastrea aspera;* F - *Platygyra sinensis;* G - *Plesiastrea versipora;* H - *Leptastrea purpurea*).

FILE: C1819/MARINE/DIVE WORK (PENNY'S BAY)/Coral photos1.doc
DATE: 21/1/2000

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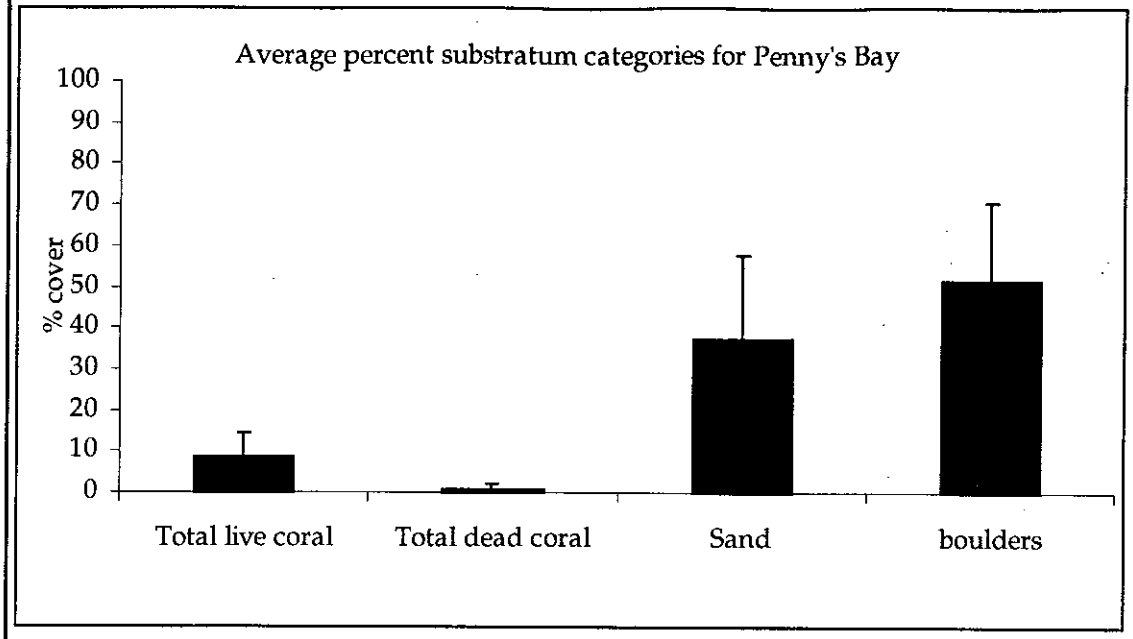


Figure 3.5e: Average percent cover of different substratum categories from eight study sites within Penny's Bay during December 1999.

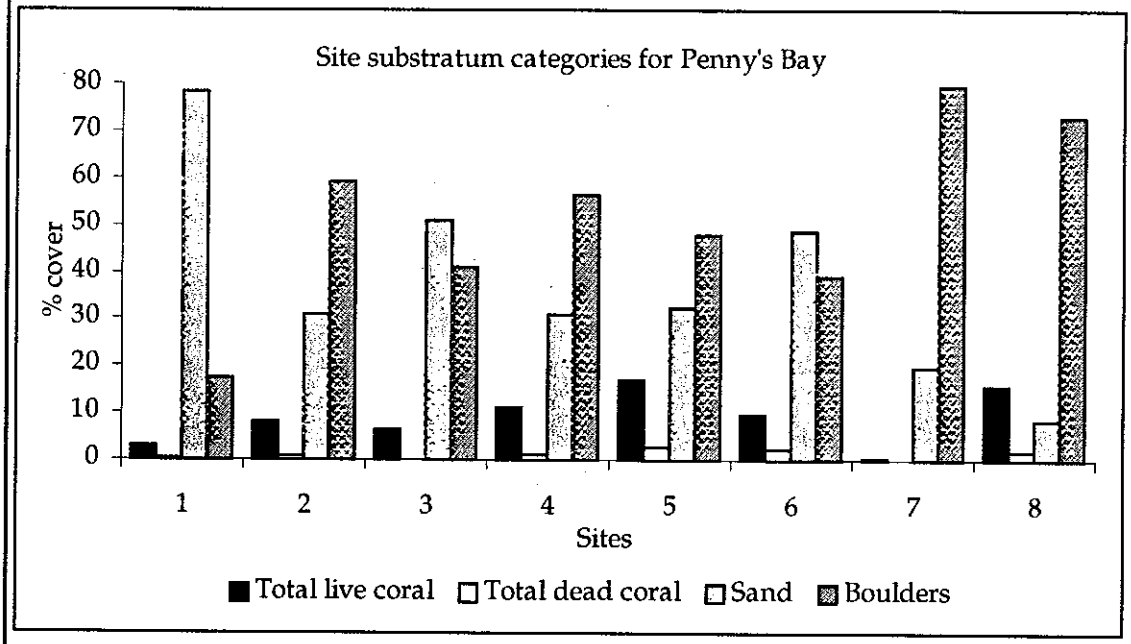


Figure 3.5f: Percent cover of different substratum categories from each individual study site within Penny's Bay during December 1999.

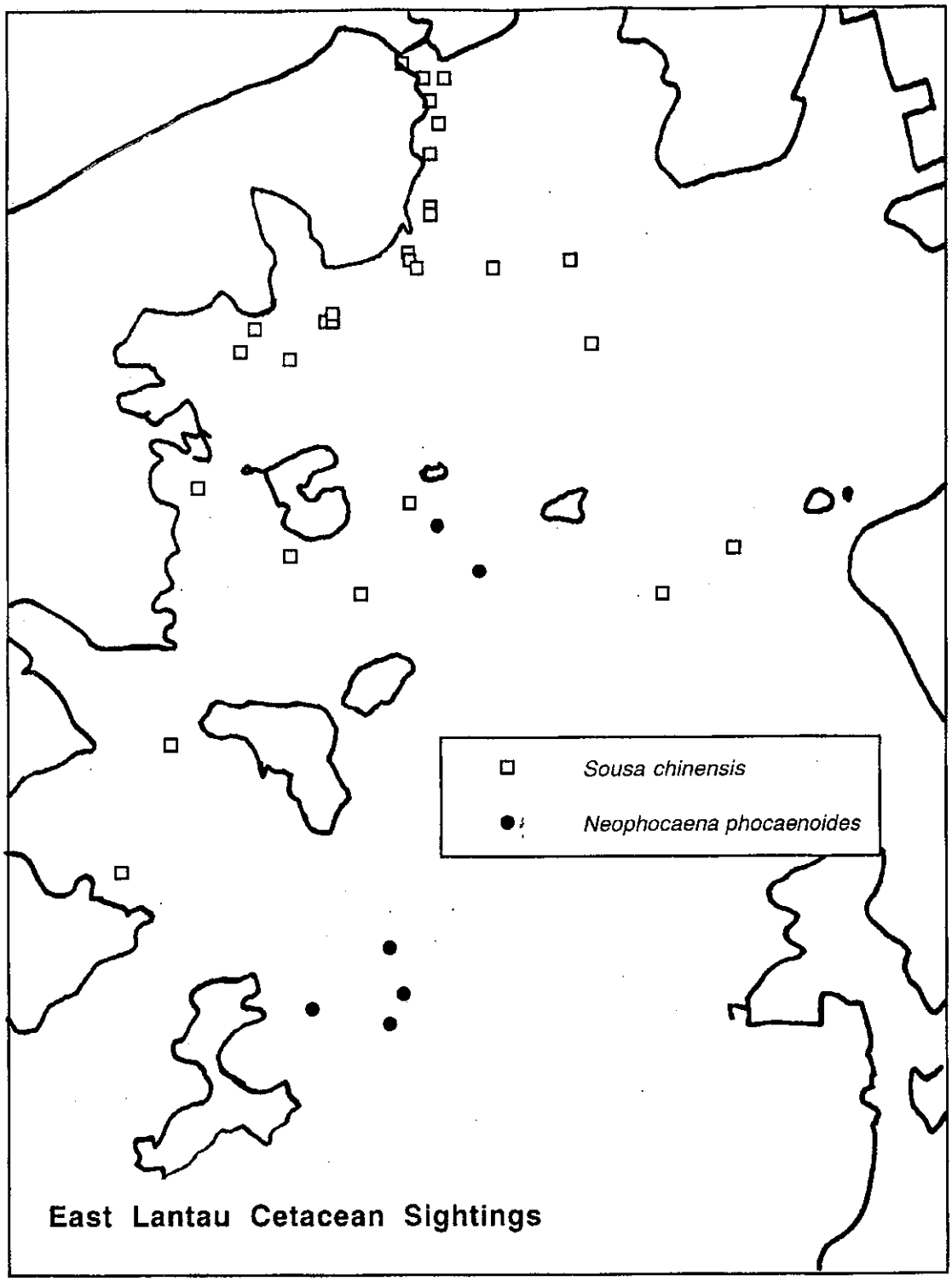


FIGURE 3.6a MAP OF THE EAST LANTAU SURVEY AREA, SHOWING LOCATION OF SIGHTINGS OF INDO-PACIFIC HUMPBACK DOLPHINS AND FINLESS PROPOISES DURING OPCF SUVEYS

FILE: C1819n6
DATE: 13/01/2000

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