APPENDIX 9A

Ecological Survey Results

Highways Department

Agreement No. CE 39/2001
Shenzhen Western Corridor - Investigation and Planning

Ecological Survey Results

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Annex A to AC

1. INTRODUCTION

1.1.1 The objective of this report is to present results of flora and fauna surveys carried out from 20 August 2001 through 13 June 2002. Results presented here cover the "wet season", which is normally considered to be the annual 7-month period from April through October (AFCD-EPD 2001), and the "dry season" (5-month period from November to March) (*ibid*.). The contract for the consultancy was signed on 21 August 2001, which precluded field survey of flora and fauna during the early months of the 2001 wet season. For this reason field surveys were commenced at the latter part of the wet season in 2001, and covered the 2001-2002 dry season, and also the early part of the wet season in 2002.

1.1.2 This report is presented in five sections. The introduction is followed by Section 2, a description of study methods. Section 3 lists results and presents analyses of field works. Section 4 is a discussion and interpretation of the survey results. Section 5 lists references cited in this paper.

1.1.3 This report summarises and provides cumulative data and results of the field surveys performed for the current study. References that are relevant to study methods or results are cited and listed in this report, but not all documents relevant to the overall study are cited or reviewed herein. Comprehensive review is presented in Section 9 of the main report.

1.1.4 According to section 3.4.5 of the Study Brief ecology studies should accomplish the following: "establish a comprehensive ecological profile of the study area based on data of previous studies and results of additional field surveys, and taking into consideration the variations across four seasons, and describe the characteristics of each habitat found; major information to be provided shall include:

(1) description of the physical environment;

(2) habitat maps of suitable scale showing the types and locations of habitats in the study area;

(3) ecological characteristics of each habitat type such as size, species present, dominant species found, species diversity and abundance, community structure, seasonality, inter-dependence of the habitats and species, and presence of any features of ecological importance;

(4) representative colour photographs of each habitat type and any important ecological features identified.

1.1.5 The Study Brief directs that the flora and fauna surveys should: "investigate and describe the existing wildlife uses of the various habitats with special attention to those wildlife groups and habitats with conservation interests, including but not limited to the following:

(1) inter-tidal mudflat

(2) mangrove

(3) seagrass bed

(4) avifauna, in particular, Black-faced Spoonbill (*Platalea minor*)

(5) egretries

(6) inter-tidal and sub-tidal benthic faunal communities

(7) Chinese White Dolphin (*Sousa chinensis*)

(8) Horseshoe crabs

(9) any other habitats and wildlife groups identified as having special conservation interests by this EIA study."

1.1.6 The programme of flora and fauna field study reported here has been designed to meet the above listed Study Brief requirements.

1.1.7 There is confusion in Hong Kong over application of the terms "wet season" and "dry season" to field study of wild flora and fauna. This confusion results from earlier (late 1980s through late 1990s) disregard in impact assessment studies for seasonality in various ecological or biological processes. Examples can be seen in studies where, for example, amphibian surveys were carried out in winter (when amphibians are difficult to see or hear), with the result that amphibian species representation and numbers were under-reported. This can be corrected by sampling in April-May, when amphibians can be seen and heard. Similarly, late summer surveys of birds resulted in under-reporting of passage migrants and winter residents. This can be corrected by sampling birds in September-October (for autumn migrants), January (for winter residents), April-May (for spring migrants), and May-June for summer residents and local breeders. In both of these examples the correct sampling regime would be missed by strict adherence to "wet season" and/or "dry season" surveys. In both cases application of professional judgment and local experience is required to specify the appropriate sampling regime.

1.1.8 Section 3.4.5.4 of the Study Brief directs in paragraph (i) that related studies should be reviewed, in particular the Feasibility Study for Additional Cross-border Links Stage 2 (Mouchel 2000, hereafter referred to as "Crosslinks2"), and the current Deep Bay Link study (Ove Arup, in process). Paragraph (ii) directs that reviewed information be analysed to identify data gaps relevant to this study, and a determination made "whether another full-year seasonal ecological survey shall be required to bridge any information gap or update the information to ensure that a comprehensive ecological profile can be established as required...". Paragraph (iii) directs that surveys deemed necessary to fill data gaps or update information be carried out, "the duration of which shall be at least 6 months and cover both the wet and dry seasons".

1.1.9 As noted in paragraph 1.1.7 above, sampling over 6 months to cover the wet and dry seasons is inappropriate for amphibians because it implies survey in the dry season when the resulting data would be largely useless: Breeding season surveys at the onset of the wet season are appropriate for amphibians. Similarly, 6 months of survey over wet and dry seasons for birds would yield useless data if surveys were not scheduled to coincide with the periods of ecological significance for birds in Hong Kong (see paragraph 1.1.7). When both migratory and resident birds are a concern, as they are in this study, 6 months of survey will generally be inadequate. This relationship between survey timing and effort is referenced in the TM Annex 16, Section 5.1.4.

1.1.10 As stated in AFCD-EPD (2001): "Each study has its specific constraints and, probably, unique circumstances where professional judgment is essential." The survey methods and programmes specified for this study reflect application of professional judgment that is based upon extensive experience of biodiversity inventory and impact assessment in HKSAR and throughout East Asia.

2. FLORA AND FAUNA STUDY METHODS

2.1 Introduction

2.1.1 The assessment area includes a portion of the coastal area of outer Deep Bay, New Territories, as well as Deep Bay WCZ (see Study Brief, section 3.4.5.2). The terrestrial component of this Area consists of three regions, i.e. Ngau Hom Shek in the east, Sheung Pak Nai in the west, and Ngau Hom Sha between the two. Sampling points and transects were established according to these three regions to cover the entire Area.

2.1.2 The area is divided into four zones corresponding to four general habitat groups:

(1) uplands (hill slopes),

(2) lowlands (including fishponds and agricultural lands),

(3) intertidal (including intertidal and backshore zones), and

(4) marine or subtidal (Deep Bay WCZ).

2.1.3 Due to the clarification of the demarcation mark between the SWC project and the adjacent Deep Bay Link project, the Assessment Area for the SWC was re-defined as the area below the high water mark. The terrestrial part of the area (i.e. uplands and lowlands) covered by the field surveys of the SWC project is re-named as Study Area, and the information collected in which is used primarily for supplementary purposes.

2.1.4 A study programme for ecology surveys is shown in Appendix Y.

2.2 Habitats

2.2.1 The study area for terrestrial ecology is defined as the area 500m either side of the site boundary. To account for the multiple landing locations initially considered under this project the study areas covers some 1.4 km^2 from Ngau Hom Shek to Sheung Pak Nai (**Figure 9.2**).

2.2.2 Macro-habitats were mapped on 1:5000 maps (reproduced on A3 size sheets in 1:50000 scale for presentation purposes). Mapping was based on habitat maps prepared for Crosslinks2 (Mouchel 1999), SAR Government aerial photos taken in 2000, and ground truthing. Habitat classification follows Crosslinks2 (Mouchel 1999) for consistency and comparison. Colour photographs were taken to provide views of representative and significant habitat types and important species recorded within the study area, together with other identified features of ecological importance.

2.3 Vegetation

2.3.1 Field surveys were conducted on 21 and 26 September and 5 December, 2001, 17 January, 5 March, and 3 April 2002 to describe habitats and record plant species and their relative abundance in each representative habitat type. Efforts were made to find species protected under local regulations or known to be uncommon or rare on a regional or territorial basis. The focus was on Pitcher Plants (*Nepenthes mirabilis*) and possibly orchids in the ravine woodlands/shrublands, and the mangroves and seagrass beds along the coastline.

2.3.2 Surveys for Pitcher Plants were performed along major streams within the assessment area. Qualitative surveys were carried out by visual observation of individuals or populations on stream banks.

2.3.3 Mangrove and seagrass survey: Qualitative surveys were conducted along the intertidal area from Pak Nai to Ngau Hom Shek to produce species lists and characterise mangroves, and to search for seagrass communities. Seagrasses in the assessment area display a growth form that is typically clumped, which accounts for the term “seagrass bed”, meaning a patch of mudflat occupied by seagrasses. Major seagrass beds were mapped and their areal extents were estimated. Habitats in the backshore zone within the assessment area had been altered by village houses, constructed seawalls, fishponds, cultivation, and light industry. Because of high levels

of prior and existing disturbance, and consequent alteration of habitats, the backshore zone was not surveyed.

2.4 Avifauna

2.4.1 Avifauna surveys were conducted in three different habitat types: Uplands, lowlands (fishponds), inter-tidal mudflats. Sampling locations are shown on **Figure 9.2 & 9.3**.

Upland habitats

2.4.2 Bird communities in upland habitats were surveyed 5 times in late breeding season (September 2001), 3 times in autumn migration season (October and November 2001), 3 times in winter season (December 2001 and February 2002) and 3 times in spring migration season (April and May 2002). The point count method was used. Ten minutes were spent counting by all birds seen or heard within 30 metres from each point. Surveyed habitats included shrubland (2 sampling points) and stream (1 sampling point). The Crosslinks2 EIA surveyed bird communities in upland habitats qualitatively. There are only a few published papers of quantitative studies on bird communities of terrestrial habitats, and all are confined to habitats relatively protected from development pressure (e.g., Kwok and Corlett 1999, Leven 2000, Kwok 2001). The purpose in sampling for the current project was to quantify bird abundance in upland habitats.

2.4.3 **Breeding bird species** (covered non-ardeid species) in the Study Area were surveyed qualitatively in April to June 2002. The recording method was a simplified version of that of Sharrock (1976). Birds seen were classified as possible breeders if they showed signs of attempt to breed (e.g., territory holding, carrying nesting materials) or confirmed breeders if signs of breeding are observed (e.g., nests found, recently fledged juveniles observed).

Lowland habitats

2.4.4 **Egretries**: The Pak Nai and Ngau Hom Shek egretries in Outer Deep Bay were surveyed on 11 and 16 April, 7 May and 13 June 2002. The breeding species and number of nests with incubating adults or chicks of each species in each egretry were recorded. The annual estimate of the ardeid breeding population in each egretry was taken to be the sum of the highest counts for each species in the surveys. Temporal trend in breeding population at each egretry was assessed using the Spearman Rank Correlation Coefficient (r_s) (Fowler and Cohen 1996), which is usually used as an indicator of temporal trend of breeding population (e.g., Schogolev 1996, Gawlik *et al*. 1998).

2.4.5 The uses of feeding habitats by nesting ardeids in the Pai Nai and Ngau Hom Shek egretries were studied using the "*Flight-line Method*" (Wong 2002). Each egretry was surveyed 3 times in May 2002: twice during low tides and once during high tide. Flight paths of ardeids flying from the two egretries were followed using 10x42 binoculars from vantages points shown on **Figure 9.3**. The same vantage point in two previous flight-line studies of Pak Nai egretry in 2000 and 2001 (City University of Hong Kong 2001, Wong 2002) was used in this study, and this will facilitate comparison of observations between studies. Landing locations were plotted on a 1:5000 scale topographic map to determine the type of habitats the birds landed and flight distances flew. Birds that flew out of the field of view from the observation point were recorded as "missing" and the directions of missing birds were recorded (e.g., to Lau Fau Shan, Nim Wan). Six types of foraging habitat were identified: sea surface, mangrove, intertidal mudflat, river channel, fishponds and cultivated lands.

2.4.6 **Fishpond**: Birds in fishponds during high tides in Ngau Hom Shek, Ngau Hom Sha and Sheung Pak Nai were surveyed 3 times in late breeding season, 3 times in autumn migration season, 3 times in winter season and 3 times in spring migration season. The Crosslinks2 EIA surveyed the same 3 fishpond areas, but did not attempt to synchronise counts with high tides. The purpose in sampling fishponds during high tides was to enable comparisons with bird counts on the nearby mudflats during low tide (see below). This comparison would help answer the question: To what extent to birds that feed on intertidal mudflats during low tides retreat to the

nearby fishponds during high tides for roosting or feeding? Numbers of birds in 5 fishponds at each of the 3 locations were counted by species during high tide. The 5 largest ponds at each area were selected for sampling in order to census ponds most likely to be used as high-tide roosts. Ponds were also selected with the objective of sampling equivalent total pond areas in all three locations. The purpose was to overcome the bias introduced into species richness totals by variation in census area size.

2.4.7 Birds in fishponds in Ngau Hom Shek, Ngau Hom Sha and Sheung Pak Nai were also surveyed 2 times during low tides in each of autumn migration season and winter season. Bird counts in low tides were then compared with counts at high tides to determine whether fishponds provide high tide roosts for wading birds and shorebirds.

2.4.8 All birds at the two small fishponds nearest the landing location of the proposed alignment at Ngau Hom Shek were sampled non-systematically and independent of the cluster sampling in December 2001 and April 2002 at the request of AFCD. Birds were identified to species and counted.

Intertidal habitats

2.4.9 **Mudflat**: Birds on the inter-tidal mudflats in Ngau Hom Shek, Ngau Hom Sha and Sheung Pak Nai were surveyed 5 times in late breeding season, 5 times in autumn migration season in 2001, 5 times in winter season and 5 times in spring migration season. The Crosslinks2 EIA surveyed birds feeding on the inter-tidal mudflats in Pak Nai and Ha Pak Nai, and sampling effort was not strictly standardized (area covered ranged between 4 and 5 ha). The purpose in sampling for the current project was to quantify abundance of birds foraging on the mudflats during low tide, which is important to rate alternative options of landing location of the bridge. A 100m x 100m quadrat was sampled on the inter-tidal mudflats in each of these 3 locations (**Figure 9.2**). The quadrats at Ngau Hom Shek and Sheung Pak Nai were set on the proposed landing locations of the bridge. The Ngau Hom Sha site will serve as a control site for future ecological monitoring. Bird abundance was recorded by species in the 1-ha quadrats during low tide. Bird abundance by species was also noted outside but near the quadrats. Ornithological nomenclature, commonness and distribution of bird species in Hong Kong in this report followed Viney *et al*. (1996). Conservation status was assessed following Fellowes *et al*. (2002).

2.4.10 **Tideline**: Wading birds and shorebirds (e.g., ducks, Dunlin *Calidris alpina*) usually forage along the edge of moving tides (Peking University 1995, Melville *et al*. 1997). Cornish (1996) suggested that this is because tides bring in some prey items of birds. The Crosslinks2 EIA did not distinguish between birds feeding on the inter-tidal mudflats versus those feeding along the edge of the moving tide. The purpose in sampling for the current project was to quantify abundance of birds foraging at the moving tideline because that is considered to be a preferred foraging location. Birds along the tideline at Ngau Hom Shek, Ngau Hom Sha and Sheung Pak Nai were surveyed at tide levels between 0.4 and 0.7 m five times in late breeding season, 5 times in autumn migration season in 2001, 5 times in winter season and 5 times in spring migration season. Bird abundance was recorded by species within a 10 m wide belt centered on the tideline and extending a total length of 500 m along the tideline to sample a total area of 0.5 ha at each of the 3 locations during low tide (10 x 500 m).

2.4.11 **Mangrove**: Bird communities in mangroves were surveyed using the point count method. One sampling point was set in mangroves in each of the 3 sites (**Figure 9.2**). Ten minutes were spent counting birds during low tides and all birds seen or heard within 30 metres from the point were identified and recorded. Point count surveys in mangroves were carried out 5 times in late breeding season, 3 times in each of autumn migration season, winter season and spring migration season. The Crosslinks2 EIA surveyed bird communities in mangroves qualitatively. The purpose in sampling for the current project was to quantify bird abundance in mangroves.

2.4.12 **Flight behaviour**: Mortality of birds due to collision with structures has been reported in other parts of the world (e.g., Anonymous 1930, Weston 1966, Banks 1979, Avery *et al*. 1980). For this reason the potential hazards to birds of the Shenzhen Western Corridor were investigated through literature review and discussions with overseas specialists. These investigations

revealed that systematic study of flight behaviours/heights/paths of Deep Bay birds has not been undertaken in Hong Kong. We began to address this data gap by recording the altitudes at which birds flew above the sea surface during low tide at the 3 mudflat quadrat sampling locations and during high tide at a vantage point near Pak Nai (**Figure 9.3**). For birds flying in flocks the modal height of the flock was recorded (not the heights of individual birds in the flock) because birds flying in the same flock tended to fly at similar heights, thus the flight heights of individual birds in a flock cannot be considered statistically independent. Therefore each flock was taken as a sampling unit. Data were analysed as the frequency of flight heights within specified ranges of altitude above the mudflat or sea surface. Birds flushed by observers or following trawlers in the sea were ignored.

2.4.13 **Black-faced Spoonbill** is classified as "endangered" by IUCN (BirdLife International 2000), and is a Class II Protected Animal in China (Wang 1998). This species is known to forage on intertidal mudflats, and have been recorded on the mudflats of Outer Deep Bay (WWF-HK 2001a). Surveys for Black-faced Spoonbills were carried out between November 2001 and May 2002 by scanning the intertidal zone during low tide. Numbers of Black-faced Spoonbills at each of Ngau Hom Shek, Ngau Hom Sha and Sheung Pak Nai were recorded. Relative abundance of Black-faced Spoonbills at each location was expressed in number of birds per survey.

2.5 Non-avian Terrestrial Fauna

2.5.1 Surveys were conducted between September 2001 and May 2002 in both upland and lowland habitats (lowland habitats included fishponds). Surveys were qualitative. Efforts were made to produce lists of species for these groups to supplement species lists reported in the Crosslinks2 EIA (Mouchel 1999). An evening survey of amphibians was carried out on 8 May 2002. Fishponds and marshes within the Study Area were surveyed.

2.5.2 Dragonflies, butterflies, herpetofauna and mammals at fishponds in Ngau Hom Shek, Ngau Hom Sha and Sheung Pak Nai and upland habitats at Ngau Hom Shek were surveyed between September 2001 and May 2002. Tracks, roadkills and other signs of mammals observed during surveys were also noted. Nomenclature for dragonflies follows Wilson (1997), butterfly nomenclature follows Bascombe *et al*. (1999), reptile nomenclature follows Karsen *et al*. (1998), amphibian nomenclature follows Lau and Dudgeon (1999) and mammal nomenclature follows Reels (1996) and Wilson and Reeder (1992).

2.6 Freshwater Fauna

2.6.1 Aquatic fauna surveys were conducted in September 2001 and Februsry 2002. The surveys covered the natural stream above Deep Bay Road. Colour photos were taken, and aquatic fauna were studied by direct observation and active searching. The "kick sampling" method was proposed in the Inception Report for this project. However, kick sampling was not practical in the present study due to the sandy substrate of the streams surveyed and the intense streambed erosion and sedimentation caused by sediment-bearing runoff from the upper reaches of the catchment. Captured or observed aquatic fauna were counted and identified to species or the lowest practicable taxonomic level. Data are reported as species composition, abundance and species richness.

2.7 Intertidal Fauna

2.7.1 **Mudflat epifauna**: Intertidal mudflat epifauna were sampled in two 1 x 5 m quadrats sited at Ngau Hom Shek, Sheung Pak Nai, and Ngau Hom Sha. Crabs, crab burrows, mudskippers, and other invertebrates were counted within quadrats over 3 sampling sessions in the wet season (October 2001) and the dry season (January 2002). Reports include identification to the lowest possible taxon and numbers of individuals.

2.7.2 **Mudflat infauna**: Intertidal mudflat core samples were taken in areas too shallow to be accessible by vessel to assess the importance of the existing intertidal benthic community. Three

transects were established on the mudflat corresponding to the quadrat sampling points for bird surveys. The transect locations covered Ngau Hom Shek, Sheung Pak Nai, and Ngau Hom Sha as for epifauna sampling (**Figure 9.2**). On each transect five stations were designated at distances of 10m, 40m, 70m, 100m and 150m from the seaward edge of the mangrove. At each station two core samples (10 cm in diameter and 15 cm in depth) were taken from the mudflat. Samples were sieved using a 0.5 mm mesh-size sieve. Collected organisms were preserved with 5% formalin with Rose Bengal for identification to the lowest practicable taxonomic level using binocular dissecting microscopes. The species composition, biomass, species richness and diversity were reported.

2.7.3 **Mangrove fauna and Seagrass Bed fauna**: Surveys were carried out to describe the fauna that inhabits the mangroves and seagrass beds within the assessment area, and to provide an index of species representation, abundance and density. Three quadrats measuring 0.5 x 0.5 m (0.25 m^2) were arbitrarily located at each of three mangals. The locations of the three mangals covered Ngau Hom Shek, Ngau Hom Sha and Sheung Pak Nai, corresponding to the quadrat sampling points for bird surveys and the transects for infauna. All epifauna was identified to species and counted. Data were reported as species richness, species diversity, evenness, and abundance. Surveys for seagrass beds were conducted in the same methods as the mangrove survey.

2.7.4 **Horseshoe Crab**: Suitable habitats (mudflats) were surveyed monthly for horseshoe crabs during low tides from September 2001 through April 2002. Searches were conducted to locate any adult or juvenile horseshoe crabs on the mudflat. Special attention was given to searching for feeding trails around tidal pools in seagrass beds and on the mudflat surface. Feeding trails were sought in particular for juveniles, which are often partially or completely buried by sediment. Mouths of streams at the edge of the mudflat were targeted for searches, as those sites yielded the greatest encounter frequency during the Crosslinks2 studies.

2.7.5 Data recorded for all recovered horseshoe crabs include body weight to the nearest gram, the carapace length, the body length, and the maximum width of the prosoma, to the nearest millimeter using vernier calipers or rulers. Horseshoe crabs were identified to species by the morphometric ratio. General crab morphology was examined and any abnormal features were recorded. Notes on horseshoe crab behaviour and habitat use were also recorded. Horseshoe crab locations were plotted on 1:5000 maps of the assessment area.

2.8 Marine Fauna

2.8.1 **Subtidal infauna** was sampled in wet and dry seasons, i.e. October 2001 and January 2002. Two sampling stations were established in the subtidal zone along each of the three transects established for intertidal infauna survey (total of 6 stations, **Figure 9.2**) to survey marine soft bottom benthic fauna. Grab sampling stations were established both in locations on the bridge alignment, and in locations away from the alignment. Stations A and B were located on the proposed bridge alignment, while Station C & D were at Ngau Hom Sha. Stations E and F were located at Sheung Pak Nai. Three 0.1 m^2 grab samples of the seabed substrate were collected at each station (total of 18 grab samples) using a van Veen grab. Sieving, sorting, and identification followed methods proposed for intertidal infauna in paragraph 2.7.2 above.

2.8.2 Species diversity H' and evenness J were calculated for pooled data from each set of three replicates, using the formulae:

$H' = -\sum (Ni / N) \ln (Ni / N)$ (Shannon and Weaver 1963); and

$J = H' / \ln S$ (Pielou 1966),

where S is the total number of species in the sample, N is the total number of individuals, and Ni is the number of individuals of the i^{th} species. Species diversity and evenness were calculated and compared among the stations.

2.8.3 **Dolphin survey** was conducted monthly between November 2001 to March 2002 following the same survey transect as that used during the Crosslinks2 surveys. The survey was carried out from a fixed-wing aircraft in November and December 2001 (**Figure 9.4**), and from a helicopter in January, Februsry & March 2002 (**Figure 9.5**),

3. RESULTS

3.1 Introduction

3.1.1 The study area is divided into four zones corresponding to four general habitat groups:

(1) uplands,

(2) lowlands

(3) coastal/intertidal (embracing tidal zone and backshore), and

(4) marine or subtidal (Deep Bay WCZ).

3.2 Uplands

Habitat

3.2.1 Habitats recorded in the upland portion of the study area mainly included grassland/eroded hillside, shrubland, plantation and stream/channel (**Figures 9.6**). Fire, erosion, poor soil condition and historic use of the Castle Peak firing range have maintained most of this area at an early successional stage. Plant communities found in these upland areas are dominated by common, fire-tolerant, hardy species of low conservation interest. A number of small, steep streams drained the severely eroded and frequently burned uplands. The streams are affected by erosion and sedimentation, and there is no distinguishable riparian habitat. Recorded plant species and their relative abundance are listed in **Annex A**.

Vegetation

3.2.2 No plant species protected by local regulations or of conservation concern was recorded. Plant species recorded in grassland/eroded hillside included *Dicranopteris linearis, Lepidosperma chinensis, Ischaemum* spp., and *Melastoma candidum*. This habitat has low plant diversity and simple structure, and is maintained by the prevailing high frequency of hill fire. Shrubland of moderate plant diversity was found on a foothill distant from the firing range. Shrubland plants were well represented by tree and shrub species including *Acronychia pedunculata, Ilex asprella, Microcos paniculatus* and *Macaranga tanarius*. During the December 2001 survey it was noted that large areas of upland habitat had been burned by hillfire. Most of the shrubland and grassland habitats were burned. Hillfires appeared to have started at grave sites above Deep Bay Road. Two plants of conservation interest, *Brainea insignis* and *Pityrogramma tartarea* were preciously recorded in this habitat (Arup 2002), but were not seen during the current study. They were probably burnt by fire or not seen due to scarcity.

3.2.3 Isolated stands of plantation woodland were found on eroded hillsides within the study area. Dominant plantation species were exotics, including *Acacia auriculiformis, Lophostemon conferta* and *Pinus elliottii*. The plantation understorey typically supported little growth due to the dense canopy. Because they are dominated by exotic plant species that do not bear fruits edible by local wildlife, these plantations are of low ecological conservation value.

Avifauna

3.2.4 In total 30 bird species were recorded in shrubland habitats between September 2001 and May 2002 at Ngau Hom Shek (**Annex B**). Bird abundance in shrublands (20.4 birds ha^{-1}) was lower than in other local immature and older woodlands (20-year old woodland: 21.9 birds ha^{-1}, 40-year old woodland: 37.8 birds ha^{-1}) (Kwok and Corlett 1999, Kwok and Lock 2002), but higher than in shrublands less than 10 years of age (4.0 – 7.4 birds ha^{-1}) (Leven 2000). Apart from Crested Serpent Eagle *Spilornis cheela*, all bird species recorded in shrubland (e.g., Black Drongo *Dicrurus hottentottus*) are generally widely distributed in Hong Kong (Viney *et al*. 1996). Crested Serpent Eagle usually inhabits forests (Xu 1995).

3.2.5 Twenty-two bird species were recorded along the Ngau Hom Shek stream between September 2001 and May 2002 (**Annex C**). Apart from Crested Serpent Eagle, Crested Goshawk *Accipiter trivirgatus*, Broad-billed Roller *Eurystomus orientalis* and Scarlet Minivet *Pericrocotus*

flammeus, all birds recorded to date along the stream (e.g., Chinese Bulbul *Pycnonotus sinensis*) are common and widespread in Hong Kong (Viney *et al*. 1996). There are no published studies of bird communities along local freshwater streams in Hong Kong so no local comparisons can be made. Broad-billed Roller is an uncommon/rare passage migrant in Hong Kong and generally found in lightly-wooded hillsides (Carey *et al*. 2001). This species is most frequently reported from the central and eastern New Territories and western parts of Hong Kong Islands (*ibid*.). Crested Serpent Eagles were recorded three times at the upland sampling points between September 2001 and February 2002. This showed that the hillside may be part of the territory of this species. Crested Serpent Eagle is of local conservation concern (Fellowes *et al*. 2002). Crested Goshawk and Scarlet Minivet usually inhabit forests (Xu 1995, Viney *et al*. 1996). The Crested Goshawk was displaying and territorial calls were heard in the nearby plantations. This indicated that the hillside is part of the territory of this species.

Table 3.1 Bird density and species richness in upland habitats (mean ± standard error)

	Tall shrub/young woodland	Ngau Hom Shek Stream
Mean bird density (birds ha^{-1})	20.4 ± 3.33	15.4. ± 3.51
Total species	30	22

3.2.6 **Breeding Bird Survey**: A total of 39 bird species (**Annex D**) were recorded within and near the Study Area during the Hong Kong Breeding Bird Survey between 1993 and 1996 organised by Hong Kong Bird Watching Society (Carey *et al*. 2001). Surveys were carried out between March and August in each year. Eleven species were identified as breeding species and all are common and widespread in Hong Kong (e.g., White-breasted Waterhen *Amaurornis phoenicurus*, Chinese Bulbul *Pycnonotus sinensis*).

3.2.7 A total of 6 species were recorded as confirmed breeders and 11 as possible breeders in the Study Area between April and June 2002 (**Annex E**). All ardeid species were recorded nesting at Ngau Hom Shek egretry (see Sections 3.2.10 – 3.2.12). Apart from ardeid, the only species showing signs of breeding of conservation interest was the Crested Goshawk. This species was displaying near upland plantation at Ngau Hom Shek. The other species are common and widespread in distribution in Hong Kong.

Freshwater fauna

3.2.8 Several individuals of juvenile Guppy *Poecilia reticulata* were collected in the stream close to Ngau Hom Shek in wet season survey. The stream was located in a valley which was indeed filled up by eroded materials from the surrounding hill slopes. Surface runoff cut inside the sediment and formed a channel in the middle of the valley. The two banks of the channel were both loose sandy material. Continuous erosion and sedimentation in the channel were expected. The rest of the valley was completely covered by vegetation. Other than Guppies, no other aquatic fauna was found in the natural streams within the study area. No aquatic fauna was recorded during the dry season survey in streams within the study area in February 2002.

3.2.9 All the natural streams within the study area have sandy substrates. Erosion from the nearby hill slopes provides abundant sandy material to the streams. The topography of the stream beds changes frequently, with the result that litter does not accumulate. There are also few stable hard surfaces to which flora or fauna could attach. Under these conditions aquatic organisms do not readily become established on stream beds.

3.3 Lowlands

Habitats and vegetation

3.3.1 Lowland habitats within the study area were highly modified by human disturbances. Habitat types included fishponds (active and abandoned), cultivation (active and abandoned),

stream/channel, urbanised (roadside plantation, villages, and open storage areas) (**Figures 9.6**). These habitats all had low plant diversity, simple habitat structure, and were of limited botanical interest. Recorded plant species and their relative abundances are listed in **Annex A**. No plant species protected by local regulations and/or of conservation concern was recorded here.

3.3.2 Most cultivation consisted of orchards of fruit trees including litchi, longan, banana and wongpei. Manihot was also commonly planted in some fields. Abandoned cultivation had remnants of crops and fruit trees with various exotic grass and herb species including *Panicum maximum*, *Conyza canadensis* and *Mikania micrantha*.

3.3.3 Active fishponds were planted with fruit trees along the bunds. Pond bunds were either concreted or actively managed and had little vegetation other than planted trees. Abandoned pond bunds had more grassy bunds dominated by *Panicum maximum*, *Brachiaria mutica* and *Mikania micrantha.* During December 2001, many of the fish ponds were drained and bunds were sprayed. Ponds with sprayed bunds are reclassified as active because spraying and draining are considered a type of active management practice.

3.3.4 Some marshes occurred along the foothills at Ngau Hom Shek and Ngau Hom Sha. These marshes are remnants of abandoned agricultural fields fed by streams, and are covered with dense vegetation dominated by *Panicum repens*, and *Miscanthus micrantha*. The plant species diversity of freshwater marshes in the SAR appears to be governed by marsh size, topography, area of open water and range of microhabitats (Dudgeon and Chan 1996). Although the marshes at Ngau Hom Shek and Ngau Hom Sha covered a fairly large area, they showed little variation in microtopography, little area of open water and few microhabitats. As a result, they had relatively low plant species richness.

3.3.5 Lower reaches of streams within the study area have been culverted or modified for cultivation. No Pitcher Plants were recorded at Ngau Hom Shek area during the Crosslinks2 Study (Mouchel 1999) or during the current survey.

3.3.6 Village houses, roads and open storage areas constituted the urbanized habitat. Other than isolated landscaping or fruit trees, these areas were little vegetated and of little ecological interest.

Avifauna

3.3.7 **Fishponds**: In total 46 bird species were recorded at fishponds in the 3 sampling locations between September 2001 and May 2002 (**Annexes F, G, H**), and 56.4% of total birds were wading birds and shorebirds (which feed on mudflats). Both mean bird density and mean species richness were highest at Ngau Hom Shek (**Table 3.2**). The total number of species recorded in fishponds was highest at Ngau Hom Sha, and lowest at Sheung Pak Nai.

3.3.8 Abundance of wading birds and shorebirds in fishponds during high tides (251 birds) was twice as high as during low tides (121 birds). This showed that fishponds provided high tide roosting habitat for some of the wading birds and shorebirds feeding on the intertidal mudflat. There was no significant difference between densities of wading birds and shorebirds on intertidal mudflats (4.6 ± 0.29 birds ha^{-1}) (included only data of Sheung Pak Nai and Ngau Hon Sha, due to creation of oyster beds at Ngau Hom Sha) and fishponds (high tide counts) (5.4 ± 0.9 birds ha^{-1}) ($U = 34.7$ $p = 0.11$, Mann-Whitney U-test). However, as the total area of mudflats along the coastline of Outer Deep Bay is larger than the area of fishponds it is apparent that the mudflats support more birds during the low tide than do the fishponds at high tide. This indicates that the fishponds near the coastline do not provide adequate high-tide roosting or feeding habitats for wading birds and shorebirds that occupy the exposed mudflats during low tides. Birds that do not roost in the fishponds roost elsewhere during high tides (e.g., mangroves, drained fishponds, or *gei wais* in the Deep Bay area).

Table 3.2 Bird Density and Species Richness in Fishponds (Mean ± Standard Error)

	Ngau Hom Shek	Ngau Hom Sha	Sheung Pai Nai
Mean bird density (birds ha^{-1})	13.8 ± 4.17	8.7 ± 1.45	5.4 ± 0.60
Mean species richness (no. of species $survey^{-1}$)	9.7 ± 1.43	8.4 ± 0.87	8.8 ± 0.95
Total species	33	35	26

3.3.9 In total 34 birds of 15 species were recorded at the two fishponds near the landing location of the proposed alignment at Ngau Hom Shek (**Annex I**). All recorded bird species except Siberian Rubythroat *Luscinia calliope* were also found in other ponds in the study area. Siberian Rubythroat is commonly found in shrubland in Hong Kong (Viney *et al*. 1996).

3.3.10 **Pak Nai and Ngau Hom Shek egretries**: Four and two ardeid species nested in Pak Nai and Ngau Hom Shek egretries respectively in breeding season of 2002 (**Figure 9.3**). The Pak Nai egretry has been occupied at least since 1995, but nesting birds were not counted until 1996 (Young and Cha 1995). This was the first time Great Egret *Casmerodius albus* recorded nesting in Pak Nai colony, and Outer Deep Bay (**Table 3.3**). Grey Herons were also observed in the Pak Nai egretry in May 2002, but no nest of this species was found. Little Egret *Egretta garzetta*, Great Egret and Chinese Pond Heron *Ardeola bacchus* are of potential regional concern, while Cattle Egret *Bubulcus ibis* is of local concern (Fellowes *et al*. 2002). Little Egret *Egretta garzetta* is the dominant species in Pak Nai egretry for all surveyed year. No obvious temporal trend of ardeid nesting population was observed in Pak Nai egretry ($r_s = 0.421$, $p > 0.05$) (**Chart 3.1**). Systematic counts of nesting population of ardeids in Deep Bay started in 1998, surveys covered all known colonies in Hong Kong started in 1999 (Carey 1999, Wong *et al*. 2000). The nesting population in Pak Nai egretry ranged between 3.0 to 6.1% of the total over Hong Kong between 1998 and 2001. However, the nesting population in Pak Nai egretry made up significant proportion in Deep Bay area (**Table 3.4**).

Table 3.3 Total numbers of nesting birds at Pak Nai and Ngau Hom Shek egretries (Carey 1998, Wong *et al*. 2000, Kwok *et al*. 2001, Wong and Kwok 2002)

	Pak Nai Egretry					Ngau Hom Shek Egretry		
Species	**LE**	**CPH**	**CE**	**GE**	**Total**	**LE**	**CPH**	**Total**
1995	+	+			-			-
1996	40	1			41			-
1997	15	2			17			-
1998	52	5			57	2	4	6
1999	23	2			25	6	4	10
2000	40	2	2		47	11	4	15
2001	47	2	2		51	1	6	7
2002	42	1	3	3	49	4	6	10

Species: LE = Little Egret, CPH = Chinese Pond Heron, CE = Cattle Egret, GE = Great Egret
+ = species present but not counted

Table 3.4 Relative importance (%) of nesting populations at Pak Nai and Ngau Hom Shek egretries in Deep Bay area and Hong Kong (Carey 1998, Wong *et al*. 2000, Kwok *et al*. 2001, Wong and Kwok 2002)

	Pak Nai Egretry		Ngau Hom Shek egretry	
	DBA	**HK**	**DBA**	**HK**
1998	12.7	-	-	-
1999	17.9	3.0	7.1	1.2
2000	24.1	6.3	7.7	2.0
2001	17.3	6.1	2.4	1.2

DB = Deep Bay area, HK = Hong Kong

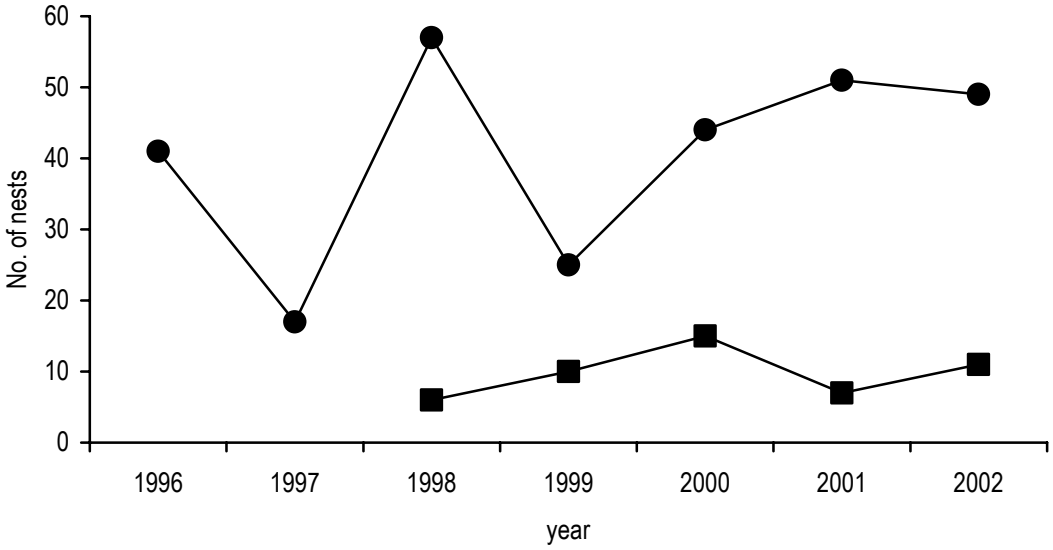

Chart 3.1 Total numbers of nesting birds at Pak Nai (circle) and Ngau Hom Shek egretries (square)

3.3.11 The Ngau Hom Shek egretry was discovered in 1998, and always supports fewer nesting pairs than the Pak Nai egretry. No obvious temporal trend of ardeid nesting population was observed in the Ngau Hom Shek egretry (r_s = 0.311, p > 0.05) (**Chart 3.1**). Except in breeding season of 2000, the nesting population in this egretry never exceeded 10 pairs and never made up more than 2% of the total over Hong Kong (**Table 3.3**).

3.3.12 A study on the effect of water pollution on the breeding success of ardeids carried out by The City University of Hong Kong showed that ardeid feather samples collected from Pak Nai egretry had the highest concentrations of lead (City University of Hong Kong 2001). Lead levels were generally higher in egretries located in the Deep Bay area than in other areas of Hong Kong (*ibid*.). Sources of lead contaminants were believed to come from both Shenzhen and Hong Kong.

Flight-line Study

3.3.13 **Pak Nai Egretry**: Four species of ardeids took off from the Pak Nai egretry were followed. These included Little Egrets, Chinese Pond Herons, Great Egrets and Cattle Egret. Most followed ardeids were Little Egrets, which was the dominant species in Pak Nai egretry. Apart from Little Egret, the other three ardeid species were only represented by fewer than 5 observations and sample sizes were too small for data analysis.

3.3.14 Flight lines of 198 Little Egrets were followed, 73 at high tide and 125 at low tide. The flight distances flown ranged from 90 to 1195m. The mean flight distance was 476.4 ± 21.6 m, and was shorter than that in breeding season of 2001 (1.3 km) (Wong 2002). The mean flight distances of Cattle Egrets and Chinese Pond Herons in breeding season of 2001 were 540 m and 488 m respectively in breeding season of 2001 (*ibid*.).

3.3.15 Nearly 7% of the followed Little Egrets soared and foraged close to the sea surface northwest of the Pak Nai egretry. These egrets were probably looking for preys near water surface. One of the Little Egrets took off from Pak Nai egretry followed a trawler in Outer Deep Bay. Little Egrets nesting in the former Tsim Bei Tsui and Tai O egretries have been observed foraging by flying low over sea surface (Cornish 1996, Kwok and Dahmer 2002).

3.3.16 "Missing" birds made up 42.4% of the all the Little Egrets followed. Of which 65.5% flew to the direction of Lau Fau Shan, 29.8% to Nim Wan and 4.7% to Shekou. Proportion of missing Little Egrets in this study was lower than those carried out in 2000 (50%) and 2001 (44.6%) (City University of Hong Kong 2001, Wong 2002). During the flight-line study of Ngau Hom Shek egretry, no observed landing Little Egret flew from the direction of Pak Nai. Therefore, most of the missing Little Egrets lost to the direction of Lau Fau Shan might land on feeding habitats (e.g., fish ponds, inter-tidal mudflat) between Pak Nai and Ngau Hom Sha.

3.3.17 Little Egrets landed most frequently on inter-tidal mudflat at Pak Nai and Ha Pak Nai (71.1%) (**Table 3.5**). Mangroves was the second most frequently landed habitats. Frequency of landing of other habitats was all lower than 10%. Inter-tidal mudflat was the most important feeding habitat of Little Egrets nesting in Pak Nai egretry in 2000 and 2001 (City University of Hong Kong 2001, Wong 2002).

Table 3.5 Percentage use of each type of foraging habitat for Little Egrets flying from Pak Nai egretry in May 2002

Habitat	% of Total Birds Followed
River channel	6.1
Cultivated lands	1.8
Fishpond	3.5
Mangroves	10.5
Inter-tidal mudflat	71.1
Sea	7.0

3.3.18 **Ngau Hom Shek Egretry**: Two species of ardeids took off from the Ngau Hom Shek Egretry were followed. These were the Little Egrets and Chinese Pond Herons. Flight lines of 23 Little Egrets and 52 Chinese Pond Herons were followed. The mean flight distances of Little Egret and Chinese Pond Heron were 407.8 ± 59.2m and 474.8 ± 38.6m respectively. "Missing" birds made up 26.1% and 19.2% of the total Little Egrets and Chinese Pond Herons followed. Inter-tidal mudflat was also the most frequently used habitats of Little Egrets (71.4% of total landings) and Chinese Pond Herons (60.5%) (Table 3.6).

Table 3.6 Percentage use of foraging habitat for Little Egrets and Chinese Pond Herons flying from Ngau Hom Shek egretry in May 2002.

Habitat	Little Egrets	Chinese Pond Herons
Cultivated lands	0.0	13.2
Fishpond	0.0	10.5
Mangroves	21.4	15.8
Inter-tidal mudflat	71.4	60.5
Sea	7.2	0.0

3.3.19 Results of flight-line studies of Pak Nai and Ngau Hom Shek egretries are summarized in Table 3.7. Intertidal mudflat is the most important habitats for Little Egrets in both egretries, and Chinese Pond Herons in Ngau Hom Shek egretry. Mangroves were also frequently used by Little Egrets and Chinese Pond Herons. The estimated mean flight distances of Little Egrets in both egretries were similar.

Table 3.7 Summary of Flight-line Studies of Pak Nai and Ngau Hom Shek Egretries

	Pak Nai Egretry	Ngau Hom Shek Egretry	
	Little Egret	Little Egret	Chinese Pond Heron
Mean Flight distance (m)	476.4 ± 21.6	407.8 ± 59.2	474.8 ± 38.6
Most important feeding habitats	Inter-tidal mudflat	Inter-tidal mudflat	Inter-tidal mudflat

Other fauna

3.3.20 Seven species of reptiles and three species of amphibians were recorded in the study area between September 2001 and May 2002 (**Annex J**). All are widely distributed in Hong Kong (Karen *et al*. 1998). Burmese Python *Python molurus* is listed in Appendix II of CITES (Zhao 1998) and is a Class I Protected Animal in PRC (Zhao 1998). This species has been protected in Hong Kong since 1976 (Karsen *et al*. 1998). Burmese Pythons occupy many types of habitats, but their primary habitats are shrubland, broadleaf woodland and edge of mangroves (*ibid*.). The Burmese Python recorded in Ngau Hom Shek was a road-killed juvenile.

3.3.21 Three species of amphibians were recorded in the assessment area between September 2001 and May 2002 (**Annex J**). These were the Common Toad *Bufo melanostictus*, Gunther's Frog *Rana guentheri* and Brown Tree Frog *Polypedates megacephalus*. All are common and widespread in Hong Kong (Lau and Dudgeon 1999). No new amphibian species was found during the evening survey in May 2002.

3.3.22 Five species of mammals, Sladen's Rat *Rattus sikkimensis*, Woodland Shrew *Crocidura attenuata*, Javan Mongoose *Herpestes javanicu*s, Japanese Pipistrelle *Pipistellus abramus*, Leschenault's Rousette Bat *Rousettus leschenaulti*, and one unidentified rat *Rattus* sp. were recorded in the study area between September 2001 and May 2002 (**Annex K**). A single Woodland Shrew was found dead in November 2001 on a road leading upslope from Ngau Hom Shek. Javan Mongoose, Japanese Pipistrelle and Leschenault's Rousette Bat are protected under Wild Animal Protection Ordinance (Cap. 170). The range of Javan Mongoose in Hong Kong has expanded from Mai Po where it was first reported in May 1990 (Goodyer 1992) to many areas of North West New Territories (Reels 1996, Corlett 2001). Based upon the rapid expansion of the range of Javan Mongoose in Hong Kong, the possibility has been raised that the species is introduced to the SAR (Corlett 2001). Japanese Pipistrelle is probably the commonest bat in Hong Kong (Ades 1999). This species is widely distributed in Hong Kong and is associated with most forms of buildings (*ibid*.). A dead Japanese Pipistrelle was found in January 2002 on a fishpond bund at Ngau Hom Sha. Leschenault's Rousette Bat is one of Hong Kong's two fruit bats (the other being the more common and more widely distributed Greater Short-nosed Fruit Bat *Cynopterus sphinx;* see Ades 1994). The species was rediscovered in

Hong Kong in 1989, and is considered to be localised but not uncommon in geographic distribution and abundance (Ades 1994). In 1994 only 3 roosts had been located, one each in Shek Kong, the Shenzhen boundary area, and Cheung Chau (*ibid*.). A single Leschenault's Rousette Bat was found in January 2002 on a fishpond bund at Ngau Hom Sha where the bat died due to entanglement in an illegally operated bird mist net. One rodent, *Rattus* sp., was found road-killed on Deep Bay Road. The rat could not be identified to species. A Sladen's Rat was observed in freshwater marsh near Ngau Hom Shek. This species usually prefers hillsides covered with scrub and grass near streams (Hill and Phillipps 1981).

3.3.23 Totals of 28 and 13 species of butterfly and dragonfly were recorded in the study area respectively between September and May 2002 (**Annexes L and M**). Most recorded butterfly (e.g., Common Mormon *Papilio polytes* and Common Grass Yellow *Eurema hecabe*) and all dragonfly species (e.g., *Agriocnemis femina*, *Orthetrum sabina*) are common or very common in Hong Kong (Walthew 1997, Wilson 1997). Two uncommon butterfly species were recorded – White Commodore *Parasarpa dudu* and Hong Kong Lacewing *Cethosia biblis*. Hong Kong Lacewing was recorded in shrubland and stream, and this species typically inhabits open areas (Bascombe *et al*. 1999). White Commodore was recorded in shrubland and is primarily a montane species (*ibid*.). Butterfly species richness was highest in shrubland (**Table 3.8**), probably due to the higher floral diversity in that habitat (Preston-Mafham and Preston-Mafham 1988). Dragonfly species richness was low in shrubland and along the stream, and was similar in fishponds in Ngau Hom Shek, Ngau Hom Sha and Sheung Pak Nai.

Table 3.8 Dragonfly and Butterfly Species Richness

Habitats	Fishponds			Shrubland	Stream
	Ngau Hom Shek	Ngau Hom Sha	Sheung Pai Nai		
Number of butterfly species	5	11	10	22	18
Number of dragonfly species	8	7	8	3	4

3.4 Intertidal Zone

Habitat and vegetation

3.4.1 The coastal mudflat from Ngau Hom Sha to Ngau Hom Shek was dominated by mangrove plantations that were planted by villagers (**Figures 9.2 & 9.3**). The mangroves *Kandelia candel* were planted in rows to protect the fishponds behind the shore. Plantings typically extended about 20-50 m seaward from the back shore (typically a constructed seawall). The oldest plantings had reached a height of over 3 m, while new plantings were also observed on the shoreward side of the old plantations. About five freshwater outflows through channels/ditches were seen flowing through part of the mangrove plantation within the study area. Other species of mangrove and mangrove associates naturally colonising the study area included *Avicennia marina, Aegiceras corniculatum, Acanthus ilicifolius* and *Derris trifoliata*. One plant species of restricted distribution, *Thespesia populnea*, was recorded at the coastal area at the fringe of the study area (**Figure 9.2**). Both mature fruiting trees and young saplings were seen, indicating a regenerating population. Plant species recorded and their relative abundance are listed in **Annex A**.

3.4.2 During the September 2001 (wet season) surveys, beds of seagrass *Halophila beccarii* were recorded spreading along the entire coastline within the study area. Seagrass beds were primarily located on the seaward side of and adjacent to mangroves, under the mangrove canopy and also near stream mouths. The total extent of seagrass beds is difficult to calculate due to their patchiness and varied seaward extent, but is estimated at approximately 0.8ha. Although the Shenzhen Western Corridor assessment area was surveyed during Crosslinks2 studies, *H.*

beccarii was not found northeast of Sheung Pak Nai (Mouchel 1999). Seagrass beds were, however, mapped from Sheung Pak Nai extending southwest to Ha Pak Nai *(ibid.)*. Because seagrasses are relatively quick to exploit suitable habitats, discovery of this species northeast of Sheung Pak Nai during the current study was not unexpected. During the January 2002 (dry season) surveys, both the range of distribution as well as the total extent of seagrass area (approximately 0.9 ha) increased slightly compared to September 2001. During the April 2002 (early wet season) survey, the spatial distribution of the seagrass beds was unchanged, bit the total extent was reduced (new total area of approximately 0.6ha) (**Figure 9.2**). The change in areal extent was probably due to seasonality: Die-back of the old growth and germination of new seedlings were seen on the old seagrass beds.

Avifauna

3.4.3 **Mudflat**: Twelve bird species were recorded on the intertidal mudflats in the 3 sampled locations between September 2001 and May 2002 (**Annexes N, O, P**). Herons and egrets (ardeids) were the dominant bird groups on the inter-tidal mudflats (85.9% of total birds at the 3 locations). Mean species richness and mean bird density throughout the study were highest at Ngau Hom Sha (control site) and lowest at Ngau Hom Shek (proposed landing location) (**Table 3.9**).

Table 3.9 Mean bird abundance and species richness in inter-tidal mudflats (mean ± standard error)

	Ngau Hom Shek	Ngau Hom Sha	Sheung Pai Nai
Mean bird density (birds ha^{-1})	2.3 ± 0.51	7.0 ± 1.77	4.2 ± 0.65
Mean species richness (no. of species $survey^{-1}$)	1.3 ± 0.24	2.2 ± 0.23	1.8 ± 0.25
Total species	8	8	9

3.4.4 There was no significant difference between bird density (K = 3.86, p = 0.145, Kruskal-Wallis test) or species richness (K = 0.257, p = 0.879, Kruskal-Wallis test) at the three surveyed sites during the late breeding season (August to September 2001). An oyster bed was set on the intertidal mudflat at Ngau Hom Shek since October 2001, and oyster cultches used for oyster culture occupied some of the feeding habitats of shorebirds. Oyster farmers were frequently seen on the intertidal mudflat at Ngau Hom Shek since October 2001, and may scarce birds. Significant difference between bird density (K = 7.8 p = 0.02, Kruskal-Wallis test) and species richness (K = 10.9, p = 0.004, Kruskal-Wallis test) were observed at the three surveyed sites between autumn migration season and spring migration season (**Table 3.10**).

3.4.5 Bird density and species richness at Ngau Hom Sha (Bird density: U = 11.5, p = 0.014, Mann-Whitney U-test; Species richness: U = 11.1, p = 0.007, Mann-Whitney U-test) and Sheung Pak Nai (Bird density: U = 11.9, p = 0.025, Mann-Whitney U-test; Species richness: U = 12, p = 0.029, Mann-Whitney U-test) were significantly higher than those at Ngau Hom Shek between autumn migration season and spring migration season (after oyster beds created at Ngau Hom Shek). Higher human disturbance and reduction of feeding habitats have reduced both the lowest mean bird density and species richness on intertidal mudflat at Ngau Hom Shek.

Table 3.10 Mean bird abundance and species richness in inter-tidal mudflats after oyster beds were created at Ngau Hom Shek (mean ± standard error)

	Ngau Hom Shek	Ngau Hom Sha	Sheung Pai Nai
Mean bird density (birds ha^{-1})	1.5 ± 0.46	5.0 ± 1.69	3.9 ± 0.83
Mean species richness (no. of species $survey^{-1}$)	0.9 ± 0.19	1.9 ± 0.28	1.5 ± 0.17

3.4.6 **Tideline**: Twelve bird species were recorded feeding on tidelines at the 3 combined sampling locations between September 2001 and May 2002 (**Annexes Q, R, S**). There were no significant differences between mean bird density (K = 0.33, p = 0.847, Kruskal-Wallis test) or mean species richness at tidelines (K = 1.13, p = 0.569, Kruskal-Wallis test) between the 3 surveyed sites (**Table 3.11**). During low tide bird surveys the tidelines at Ngau Hom Shek were always seaward of the oyster culture beds. Birds feeding on the tidelines at Ngau Hom Shek were therefore not affected by loss of intertidal habitat and human disturbance as they were on the exposed intertidal mudflat. However, birds tended to feed on the tideline in Ngau Hom Shek after the tides passed the oyster beds.

3.4.7 Bird density along the tideline (34.9 ± 9.78 birds ha^{-1}) was 7.6 times higher than on exposed mudflats (4.6 ± 0.29 birds ha^{-1}) (included only data of Sheung Pak Nai and Ngau Hon Sha, due to creation of oyster beds at Ngau Hom Sha), a result which was expected (Peking Univ. undated). Ardeid were the dominant bird group along the tideline (54.6% of all birds at the 3 locations). Large number of Curlews *Numenius arquata* were recorded in Sheung Pak Nai during the winter surveys (41.6% of all birds at the 3 locations). This species is abundant in Deep Bay during winter and early spring (Carey *et al*. 2001). Ospreys *Pandion haliaetus* were regularly recorded foraging at the tidelines at the three locations, and most frequently at Ngau Hom Sha between November 2001 and February 2002. This demonstrates that the subtidal and intertidal zones provide foraging habitat for Osprey, which is a fish-eating bird of regional conservation concern (Fellowes *et al*. 2002). During the systematic surveys of bird communities within the Study Area between November 2001 and May 2002, Black-faced Spoonbills were only recorded on tidelines.

Table 3.11 Bird Density and Species Richness in Tidelines (Mean ± Standard Error)

	Ngau Hom Shek	Ngau Hom Sha	Sheung Pai Nai
Mean bird density (birds ha^{-1})	23.2 ± 5.47	23.3 ± 6.88	58.2 ± 24.47
Mean species richness (no. of species $survey^{-1}$)	1.8 ± 0.24	2.3 ± 0.33	2.0 ± 0.22
Total species	7	10	8

3.4.8 **Mangrove**: A total of 23 bird species was recorded in mangroves in the 3 locations between September 2001 and May 2002 (**Annexes T, U, V**). Both mean bird density and species richness were lowest at Ngau Hom Sha (**Table 3.12**). There was insignificant difference in bird density (T = 28, p = 0.132, Wilcoxon's test for matched pairs), but significant difference in species richness (T = 13, p = 0.001, Wilcoxon's test for matched pairs) between the 2 proposed landing locations of the bridge. Species richness at Sheung Pai Nai was higher than that in Ngau Hom Shek.

3.4.9 Most bird species recorded in mangroves in the study area are common and widespread in Hong Kong, and occur in many types of habitats (e.g., Spotted Dove *Streptopelia chinensis* and

Japanese White-eye *Zosterops japonica*) (Viney *et al*. 1996). However, Banded Rail *Gallirallus striatus* (recorded in Sheung Pak Nai), Pied kingfisher *Ceryle rudis* (recorded in Ngau Hom Sha), White-breasted Kingfisher *Halcyon smyrnensis* (recorded in Ngau Hom Shek) and Chinese Starling *Sturnus sinensis* (recorded in Sheung Pak Nai) are of local conservation concern, while Red-billed Starling is of global conservation concern (Fellowes *et al*., 2002).

Table 3.12 Bird Density and Species Richness in Mangroves (Mean ± Standard Error)

	Ngau Hom Shek	Ngau Hom Sha	Sheung Pai Nai
Mean bird density (birds ha^{-1})	10.9 ± 4.1	4.5 ± 1.01	17.7 ± 2.62
Mean species richness (no. of species $survey^{-1}$)	1.4 ± 0.31	1.0 ± 0.21	3.4 ± 0.54
Total species	12	6	17

3.4.10 **Species of Conservation Concern**: In total 78 bird species were recorded within the study area during systematic and non-systematic surveys (**Annex W**). Peregrine Falcon *Falco peregrinus* was recorded in upland habitats in October 2001, White-cheeked Starling *Sturnus cineraceus* was recorded on fishpond bunds in Ngau Hom Shek in January 2002, and Large Hawk-Cuckoo *Cuculus spaverioides* and Indian Cuckoo *C. micropterus* at upland habitats in April and May 2002. Peregrine Falcon is locally rare and is of local conservation concern, while White-cheeked Starling is of potential regional concern (Fellowes *et al*., 2002). Emerald Dove *Chalcophaps indica* was recorded in upland habitat in January 2002. This species is primarily an inhabitant of thick woodland with good secondary growth (Viney *et al*. 1996). A flock of 2-3,000 Cormorants *Phalacrocorax carbo* was seen on the sea between Ngau Hom Shek and Lau Fau Shan in December 2001. This represents some 45.5-68.3% of the number of Cormorants in Deep Bay area in December 2001 (4391 birds) (Carey 2002). Fauna species of conservation concern are summarized in Appendix V. Level of conservation concern follows Fellowes *et al*. (2002). The protection status of these species is also listed.

3.4.11 **Previous local studies on flight behavior**: Apart from flight-line studies dealing with feeding habitat uses by nesting ardeids (e.g., Wong 1991, Kwok and Dahmer 2002, Wong 2002), there is no systematic study on flight behaviours/heights/paths of birds in Hong Kong. The study on birdstrike hazards and control at former Kai Tak Airport by Melville (1980a, 1980b) was the first systematic survey on flight behavior of birds during migration in Hong Kong. Bird migration through Hong Kong was studied using radar monthly between April 1975 and April 1979 (Melville 1980b). Peak migration activities were observed in April-May and September-November. Most of the birds moved southwestwards in autumn and northeastwards in spring when a considerable proportion also headed northwards (*ibid*.). Birds were flying at altitudes about 3700m (*ibid*.). Large scale of migration along "narrow-defined flyway" was not observed in Hong Kong (*ibid*.).

3.4.12 **Flight behaviour**: Most birds recorded flying during high tides (91% of total birds) and low tides (65%) were ardeids, the dominant bird group on the intertidal mudflats. Recorded flight heights ranged from 1–60 m during high tides, and from 3–30 m during low tides. Only two birds were seen flying at altitudes greater than 48 m above the water during high tides, and both were Black-eared Kites *Milvus lineatus*. Birds tended to fly within 200 m from the coastline during both high tides and low tides. The distribution of flight heights during high tides and low tides is shown in **Charts 3.2 & 3.3.** No prominent modal flight height was observed, but 82% and 92% of observed birds flew lower than 15 m in high tides and low tides respectively (**Chart 3.4**). This compares to the approximate height of the underside of the proposed bridge (13 m).

3.4.13 Birds feeding in the center of Outer Deep Bay were also noticed during the surveys for Chinese White Dolphin in the SWC EIA and Crosslinks2 EIA. Foraging bird species included Cormorants, Little Egrets, White-bellied Sea Eagle *Haliaeetus leucogaster*, gulls *Larus spp*. and Caspian Terns *Sterna caspia*. Egrets and gulls feed in the center of Outer Deep mostly followed

trawlers, and fly close to the sea surface. Cormorants usually fly in big flocks (> 50 birds) and fly close to sea surface.

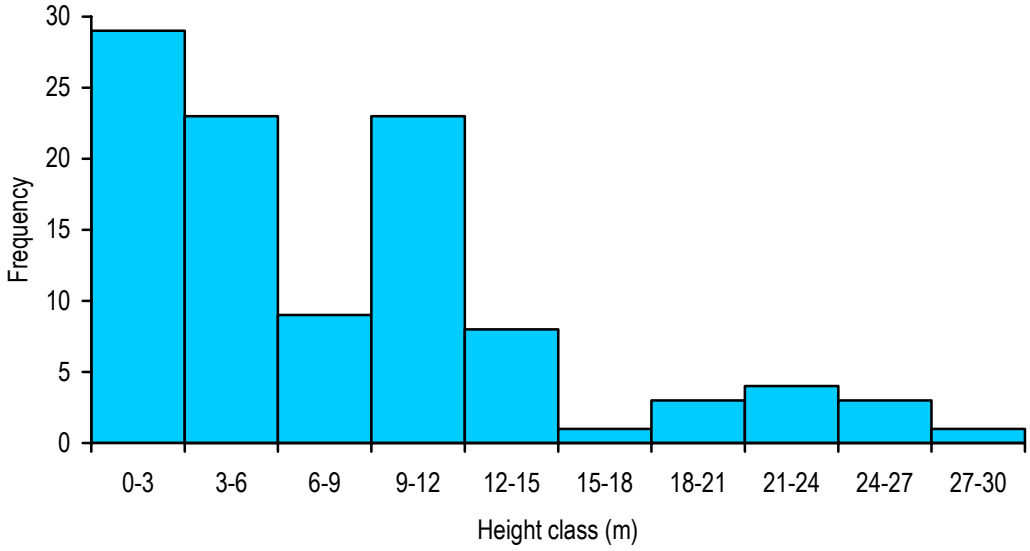

Chart 3.2 Frequency of Flight Heights during Low Tide

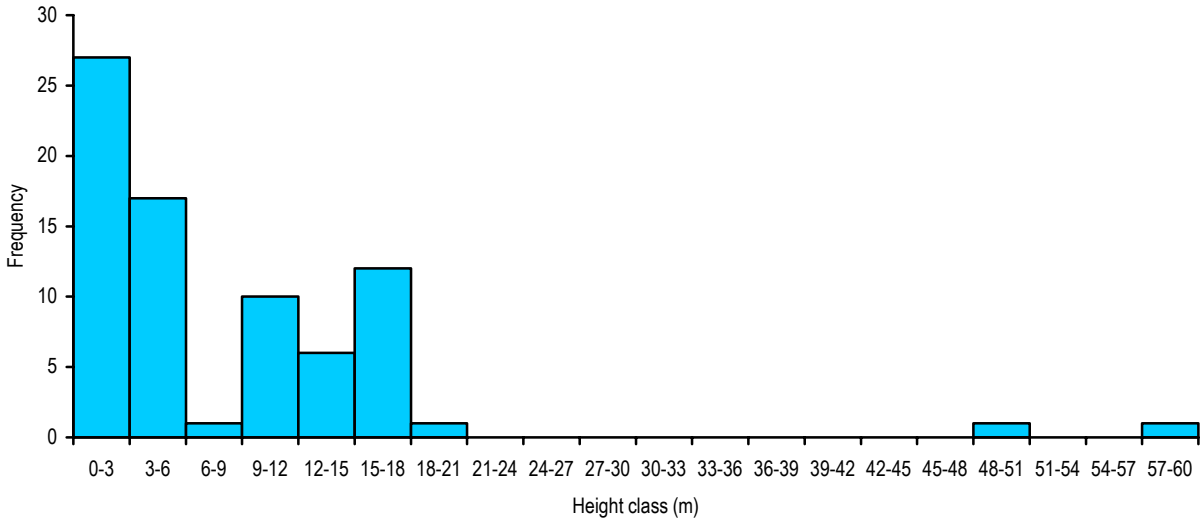

Chart 3.3 Frequency of Flight Heights during High Tide

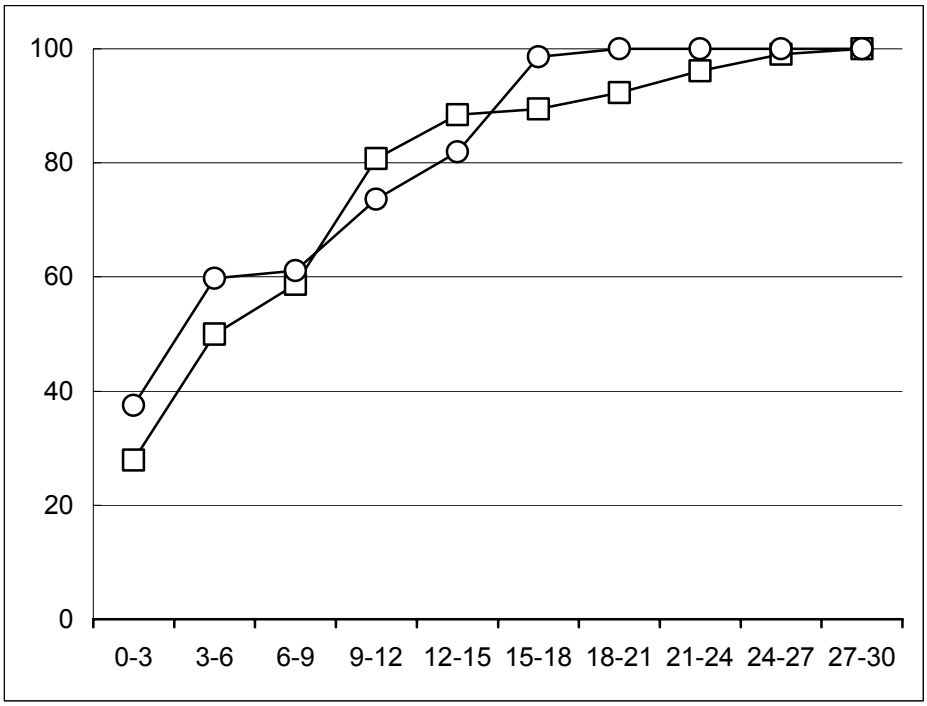

Chart 3.4 **Cumulative percentage of recorded flight heights at 3 m altitude intervals above the mudflat during high tides (circles) and low tides (squares) (Two Black-eared Kites at high tides are excluded).**

3.4.14 **Black-faced Spoonbills:** The two most important aspects of wintering ecology of Black-faced Spoonbills in Deep Bay are feeding and roosting. Black-faced Spoonbills usually roost inside Mai Po Marshes Nature Reserve, possibly due to the low levels of human disturbance there (WWFHK 2001b). Black-faced Spoonbills roost on *gei wai* bunds with where vegetation is short or completely lacking, trees on *gei wai* bunds and short mangrove trees (*ibid*.). They also roost on the mud surface in drained *gei wais*, and inter-tidal mudflats in Mai Po and Tsim Bei Tsui, when the tide is low.

3.4.15 The main feeding habitats of Black-faced Spoonbills in Deep Bay are inter-tidal mudflat, drained fishponds and drained gei wais (WWFHK 2001c). In this EIA study, Black-faced Spoonbills were only recorded feeding on tidelines. Studies on feeding ecology showed that feeding rates were highest in drained *gei wais*, and lowest on inter-tidal mudflats (WWFHK 2001c). However, inter-tidal mudflats were considered to be more important as feeding habitats because rich food items in drained fishponds or *gei wais* are only available for the initial few days after draining (WWFHK 1999). The most common prey in the feeding habitats of Black-faced Spoonbills included shrimps *Macrobrachium nipponense* and *Exopalaemon styliferus*, and mosquito fishes *Gambusia affinis* (Leader 1998, WWFHK 2001c). Analyses of stomach contents of dead birds collected outside Hong Kong showed that small fishes are potentially the most common prey (Hseuh *et al*. 1993 in WWFHK 2001c).

3.4.16 Inter-tidal mudflats in Inner Deep Bay and Tsim Bei Tsui are known as important feeding habitats of Black-faced Spoonbills (WWF 2001a). The uses of other areas of inter-tidal mudflat in the northwest New Territories by Black-faced Spoonbills were studied between November 1999 and March 2000 (total 23 surveys) (*ibid.*). Most Black-faced Spoonbills were recorded on inter-tidal mudflat in Tsim Bei Tsui (66%) (Yu, Y. T., unpubli. data). Proportions of total birds counted in Sheung Pak Nai, Pak Nai and Ha Pak Nai were 6.2%, 2.9% and 0.2% respectively (Yu, Y. T., unpubli. data). The use of mudflat in Outer Deep Bay by Black-faced Spoonbills is not considered high.

3.4.17 During the 70 waterfowl counts by HKBWS carried out between January 1979 and March 2002 in NW/LFS, only 28 Black-faced Spoonbills were recorded (in 3 surveys). The importance of mudflat in Outer Deep Bay to Black-faced Spoonbills is not considered high.

3.4.18 Flocks of foraging Black-faced Spoonbills were observed in intertidal habitats between October 2001 and May 2002 in this EIA study (**Table 3.13**). Black-faced Spoonbills only feed along the moving tides, and were mostly moving from Sheung Pak Nai to Ngau Hom Shek. Relative abundance (no. of birds per survey) was highest near Ngau Hom Shek. Encounter rates of Black-faced Spoonbills at the 3 surveyed locations were low, and none exceeded 1 bird survey^{-1}. High abundance of Black-faced Spoonbills (87 birds on 14 March 2002) was observed on mudflat near the Tsim Bei Tsui channel between December 2001 and March 2002 (Ecosystems Ltd, public. data). The importance of mudflat in Outer Deep Bay to Black-faced Spoonbills is not considered high.

Table 3.13 Number of Black-faced Spoonbills in the Study Area

Date	Ngau Hom Shek	Ngau Hom Sha	Sheung Pak Nai	Pak Nai*	Total
31 October 2001					0
1 November 2001					0
6 December 2001					0
18 December 2001		5			5
7 January 2002	3	1		17	21
8 January 2002	9		6		15
9 January 2002					0
4 February 2002					0
19 February 2002					0
11 March 2002					0
11 April 2002				9**	9**
16 April 2002					0
7 May 2002					0
Mean (no. survey^{-1})	0.92	0.46	0.46	-	

Pak Nai was not surveyed in every survey

** birds flying but not observed landing

3.4.34 **Mudflat infauna**: Wet season mudflat infauna core sampling was completed in September 2001, while dry season sampling was conducted on 25 Jan. 2002. 1282 individuals of benthic infauna from 29 species were recorded (**Annex X**).

3.4.35 Polychaete *Neanthes glandicincta* was the most common and abundant infauna in the samples. It was present in most intertidal infaunal samples and its total number was 649, representing over 50 % of the total number of organisms recorded (1282). The highest number was over 120. It constituted over 50 % of the infauna counted (649 out of 1282). Polychaete *Heteromastus filiformis* was the second abundant infauna, reach the no. of 182

Table 3.14 Table of statistics of the intertidal infauna samples

	H'	Total Species richness	Total Abundance	Average Abundance	Total Biomass	Average Biomass
Wet season						
Sheung Pak Nai	0.35 ± 0.39	8	23	2.3 ± 1.7	0.17	0.02 ± 0.01
Ngau Hom	0.47 ± 0.51	8	66	6.6 ± 6.28	33.9	3.39 ± 4.52

	H'	Total Species richness	Total Abundance	Average Abundance	Total Biomass	Average Biomass
Sha						
Ngau Hom Shek	0.83 ± 0.85	8	45	4.5 ± 3.98	0.35	0.04 ± 0.03
Dry season						
Sheung Pak Nai	1.51 ± 0.37	13	170	17 ± 13.4	0.91	0.09 ± 0.09
Ngau Hom Sha	1.13 ± 0.35	20	683	68.3 ± 43.4	9.16	1.02 ± 0.54
Ngau Hom Shek	0.55 ± 0.31	15	295	29.5 ±24.22	5.52	0.55 ± 0.69

Table 3.15 List of benthic infauna recorded in the mudflat infauna samples

Phylum	Class/order	Species	Total no.
PLATYHELMINTHES	Turbellaria	Turbellarian sp.	1
NEMERTEA		Nemertean sp.	5
ANNELIDA	Polychaeta	*Ancistrosyllis* sp.	2
		Capitella capitata	4
		Dendronereis pinnaticirris	46
		Euclymene annandalei	1
		Glycinde kameruniana	2
		Heteromastus filiformis	182
		Isolda pulchella	19
		Leonnates decipiens	42
		Lugia sp.	1
		Neanthes glandicincta	649
		Nephtys oligobranchia	31
		Onuphis eremita	4
		Poecilochaetus serpens	5
		Prionospio sp.	28
		Pseudopolydora kempi	26
		Sigambra robusta	41
		Sternaspis scutata	14
		Tharyx marioni	38
	Oligochaeta	Oligochaete sp.	37
MOLLUSCA	Bivalvia	*Glauconome* sp.	47
		Laternula sp.	2
		Tellinidae sp.1	2
	Gastropoda	*Cerithidea cingulata*	3
CRUSTACEA	Amphipoda	*Corophium* sp.	15
	Tanaidacea	Tanaididae sp.	19
	Insecta	Chiromonidae sp.	3

Phylum	Class/order	Species	Total no.
PHORONIDA		*Phoronis* sp.	13
Abundance			1282
Species number			29
Biomass			53.61

3.4.36 **Mudflat epifauna**: Mudflat epifauna were absent from the quadrats established during the sampling period in September 2001. This might be attributable to the disturbance caused by quadrat establishment and other surveys on the mudflat. A second attempt at sampling was conducted in the same time period as bird surveys in October 2001, rather than other intertidal surveys. It was expected the epifauna would recover from the disturbance in this time period and disturbance would be reduced. Results of the mudflat epifauna survey are shown below (**Table 3.16; Annex Y**). Three sessions of counting were performed at each site. Contrasting distribution patterns of crabs and mudskippers were found at the two distances from the shoreline. Mudskippers were more abundant closer to the coastline while crabs were more abundant far from the coastline. At Ngau Hom Shek, the 40m distance area was occupied by oyster beds, so the counting was conducted at 30 m instead. However, no crabs and mudskippers, or activities of other epifauna, were found on the surface of mudflats at Ngau Hom Shek during the surveys. A dry season survey was conducted in February 2002. Crabs and mudskippers re-appeared on the mudflats at Ngau Hom Shek. The crab density (3.0 – 3.3 No./m^2) was similar with those recorded in Ngau Hom Sha and Sheung Pak Nai at the same sampling. The mudskipper density recorded, however, was still much lower than those of the other two sites.

Table 3.16 Results of Epifauna Survey on Mudflats

Organisms	Ngau Hom Shek (No./m^2)			Ngau Hom Sha (No./m^2)			Sheung Pak Nai (No./m^2)		
	20m	30m	Total	20m	40m	Total	20m	40m	Total
Wet Season									
Mudskippers	0	0	0	3.2	2.0	2.6	3.9	3.1	3.5
Crabs	0	0	0	1.2	3.9	2.5	1.0	4.5	2.7
Burrows	0.8	1.2	1.0	1.4	1.6	1.5	1.6	1.6	1.6
Dry Season									
Mudskippers	1.6	1.7	1.7	2.3	3.1	2.7	3.6	3.4	3.5
Crabs	3.3	3.0	3.1	2.8	3.1	2.9	2.1	3.7	2.9
Burrows	1.4	1.2	1.3	2.4	1.8	2.1	2.0	1.8	1.9

3.4.37 **Mangrove fauna**: All mobile fauna on the mangrove floor retreated into burrows when approached by observers. Only the slow-moving and dominant gastropods could be recorded during the quadrat surveys (**Table 3.17; Annex Z**). The epifauna recorded in mangroves was low in species richness and abundance. This could be explained by the relative absence of organic litter on the mudflat beneath the mangroves. The mangroves occupied a narrow belt along the coastline where tidal energy was high. These conditions may encourage removal of organic litter from beneath the mangroves, and could account for the paucity of young mangrove

seedlings colonising the mudflat immediately seaward of the plantations. In addition to the epifauna, a gastropod species, Large Ear Shell *Ellobium polita*, was found on the stems of mangrove trees in various locations. Littorinid snails and barnacles were also found on the leaves and stems of mangrove trees.

Table 3.17 Results of Epifauna Survey in Mangroves

Scientific name	Ngau Hom Shek	Ngau Hom Sha	Sheung Pak Nai
Wet season			
Cerithidea sp.	3 (No./m^2)	8 (No./m^2)	5.3 (No./m^2)
Nerita sp.	0 (No./m^2)	2.6 (No./m^2)	4 (No./m^2)
Dry season			
Cerithidea sp.	42.6 (No./m^2)	4 (No./m^2)	14.7 (No./m^2)
Nerita sp.	0 (No./m^2)	0 (No./m^2)	1.3 (No./m^2)
Mudskippers	6.7 (No./m^2)	0 (No./m^2)	0 (No./m^2)

3.4.38 **Seagrass bed fauna**: Organisms occupying seagrass beds were difficult to record due to the interwoven structure of the seagrass. To prevent damaging the seagrass bed, only the exposed or semi-exposed epifauna were recorded. Instead of an accurate number of individuals, relative abundance of each fauna species recorded in September 2001 and February 2002 was shown (**Table 3.18; Annex AA**). One individual of Leucosiid crab *Ebalia malefactrix* with carapace width of 6 mm was found on the seagrass beds in Ngau Hom Sha in October 2001. This species usually inhabits muddy intertidal zone and was recorded in India and Hainan Island (Dai & Yang 1991). It was recorded Hong Kong in 1998 (Lai 1999). A few more individuals of this crab species were recorded during dry-season survey. Bubble shells *Bulla* sp. was also recorded.

Table 3.18 Results of Epifauna Survey on Seagrass Beds

Scientific name	Ngau Hom Shek	Ngau Hom Sha	Sheung Pak Nai
Wet Season			
Cerithidea sp.	+++	+++	+
Clithon sp.	+	++	++
Nerita sp.	++	+	+
Dry Season			
Cerithidea sp.	+++	+++	+++
Bulla sp.	+	+	\

Relative abundance: +++ = abundant (>50/m^2); ++ = common (21-50/m^2); + = uncommon (1-20/m^2).

3.4.39 **Horseshoe crab**: The mudflat from Ngau Hom Shek to Sheung Pai Nai was searched for horseshoe crabs on six days during the wet season (12, 13, 19, 21, 26, and 27 September 2001). Part of a single adult horseshoe crab carapace was found on the mudflat at Sheung Pak Nai. The carapace width was approximately 16 cm. Surveys continued in the months of dry season. Surveys continued in the dry season. In October 2001, a single juvenile horseshoe crab *Tachypleus tridentatus* was found semi-buried near seagrass beds at Ngau Hom Sha (**Figure9.6**). The maximum prosomal width of the juvenile horseshoe crab was 27 mm, the carapace length was 35 mm, the body length was 66 mm (Figure 3.2), while the body weight was less than 10

grams. No abnormal feature was recorded. No further horseshoe record was made from November 2001 to February 2002. A second juvenile *Tachypleus tridentatus* was found near seagrass beds at Ngau Hom Sha again in March 2002. The maximum prosomal width of the juvenile horseshoe crab was 53 mm, the carapace length was 55 mm, the body length was 86 mm, while the body weight was 15 grams. No abnormal feature was recorded.

3.4.40 Villagers noted that large adult horseshoe crabs were captured some 10-20 years ago along the entire mudflat from Sheung Pak Nai to Ngau Hom Shek. However, in recent years only juvenile horseshoe crabs were found. Villagers attributed the decline in horseshoe crab abundance to excessive harvest of adults.

3.5 Marine Fauna

3.5.1 **Subtidal benthos:** Wet season subtidal infauna grab sampling was initially programmed to coincide with the site investigation survey. Due to logistical complications it was reprogrammed for mid-October 2001 and independent of the site investigation survey. A total of 18 0.1 m^2 grab samples were collected (three replicates from each of the two sampling stations established in the subtidal zone along each of the three transects, see **Figure 9.2**). Sieving and sorting followed methods for intertidal infauna. Dry season sampling was conducted on 25 January 2002. The species composition, biomass, species richness and diversity were provided. Identification of benthos have also make reference to the results of recent AFCD benthic surveys in Deep Bay.A total of 618 individuals form 29 species were collected in the two samplings. A species list is shown in Table 3.23, with the individual number and total abundance, total biomass, and species richness. Species diversity are provided in Table 3.24. The species composition, biomass, species richness and diversity were provided **Annex AB**. Grab sampling was carried out to establish benthic baseline conditions and to assess the importance of the existing benthic communities close to and outside the alignment. Six stations were selected, including two on the alignment and four outside. At each station, three replicates of grab samples over a 0.1m^2 area were collected. The sampling locations were shown in **Figure 9.2**.

Table 3.19 Species List of Infauna Found in The Subtidal Grab Samples

Phylum	Class/Order	Species	Number
NEMERTEA		Nemertean sp.	14
ANNELIDA	Polychaeta	*Ancistrosyllis* sp.	1
		Dalhausiella sp.	4
		Glycinde kameruniana	32
		Heteromastus filiformis	65
		Heteromastus sp.	2
		Isolda pulchella	6
		Laonome sp.	1
		Leonnates persica	14
		Lepidonotus sp.	4
		Lugia sp.	2
		Maldanidae	4
		Nephtys oligobranchia	8
		Notomastus latericeus	2
		Nereis sp.	20
		Paraprionospio pinnata	1
		Poecilochaetus sp.	14
		Polydora maculata	2
		Prionospio sp.	40
		Pseudopolydora kempi	102
		Sigambra robusta	58
		Sternaspis scutata	20

Phylum	Class/Order	Species	Number
	Oligochaeta	Oligochaete sp.	2
MOLLUSCA	Bivalvia	Tellinidae sp.1	8
	Gastropoda	*Architectonica* sp.	4
CRUSTACEA	Thoracica	*Balanus amphitrite*	26
	Amphipoda	Amphipod sp.	2
	Decapoda	*Alpheus* sp.	18
PHORONIDA		*Phoronis* sp.	142
Abundance			**618**
Species number			**29**
Biomass			**4.97**

3.5.2 Greiner Maunsell (1991) reported the results of 13 double-replicate trawls and grab-samples at 16 sites some 8 km north-east of Tai O for the Chek Lap Kok airport EIA. They concluded that the heterogeneity of sediment types and depths promoted high species richness and abundance of sublittoral infauna. Echinoderms were found to be the exception to the trend of high fauna diversity, presumably due to the freshwater influence of the Pearl River and the resulting low salinity. Two species new to science were reported. Dominant benthic species were found to be similar in many cases to those reported for the 1978/79 period by Richards and Wu (1985). Greiner Maunsell concluded that the sublittoral benthos near Chek Lap Kok and The Brothers Islands was a good example of that expected in Hong Kong coastal waters.

3.5.3 More up-to-date benthic data are available through the Study on Tonggu Waterway (Scott Wilson 1998b). Benthic grab sampling was conducted bimonthly over 12 months at three transects (Scott Wilson 1998b). Benthic samples at all stations were dominated by 3 groups - molluscs, polychaete worms, and crustaceans - which constituted over 80% of all species recorded (Scott Wilson 1998c). The bivalve *Potamocorbula laevis*, an estuarine species, constituted over 60% of total abundance and roughly 50% of total biomass (*ibid*.). Total numbers of species recorded ranged from 54 to 69, and total number of individuals from 1,102 to 1,687 (*ibid*.), which represented benthic fauna densities ranging from 62.6 to 818.0 individuals/m^2. Species recorded are common benthic infauna species of the South China Sea (*ibid*.). No strong seasonal variation in benthic infauna communities was recorded (*ibid*.). The transect with the highest species diversity was Transect 3 (Stations 11-15), which lay the closest to Tai O and had all data over the number of three. Higher diversity at this station was suggested to be due to greater stability of environmental conditions (lower influence from the Pearl River) along this transect. This station lay some 6 km from Tai O Bay and was located in open waters, hence conditions cannot be assumed to be highly similar to those at Tai O.

3.5.4 As noted, none of these studies sampled benthic communities close toLau Fau Shan. Baseline surveys of benthic fauna in the proposed bridge were therefore conducted in order to allow assessment of project impacts. Briefly, the findings of surveys indicated that the benthic fauna in was dominated by polychaetes, and phoronida, as is typical of Hong Kong in general. Those three taxonomic groups comprised over 70% of the total sample.

Table 3.20 Table showing the mean values of number of species, S; species diversity, H' (Shannon Wiener's Index); and species evenness, J for the 6 sites of dry and wet seasons in the subtidal infaunal survey.

	S	H'	J		S	H'	J		S	H'	J
Wet season											
E (Sheung Pak Nai outer)	3.33±0.58	1.13 ± 0.23	0.94 ± 0.07	C (Ngau Hom Sha outer)	2.67±1.15	0.87 ±0.41	0.94 ± 0.03	A (Ngau Hom Shek outer)	3.33±2.31	0.99 ±0.63	0.92±0.1
F (Sheung Pak Nai inner)	3.33±1.53	0.76 ±0.31	0.67 ± 0.11	D (Ngau Hom Sha inner)	2.67±0.58	0.81 ±0.44	0.79±0.31	B (Ngau Hom Shek inner)	3.33±2.52	0.86 ±0.87	\
Dry season											
E (Sheung Pak Nai outer)	4.67±2.52	1.07 ±0.68	0.69±0.26	C (Nngau Hom Sha outer)	3.33±0.58	1.04 ±0.16	0.87±0.05	A (Ngau Hom Shek outer)	4.33±2.52	1.12 ±0.37	0.97±0.05
F (Sheung Pak Nai inner)	6±2	1.40 ±0.27	0.81±0.15	D (Ngau Hom Sha inner)	6.33±0.58	1.56 ±0.26	0.84±0.1	B (Ngau Hom Shek inner)	5.67±2.08	1.44 ±0.26	0.86±0.07

3.5.5 No rare species was found in the samples. Polychaete and phoronida were the two main component fauna in the grab samples collected. Organisms of these two taxa constituted about 90 % of all organisms recorded. Statistic information is given below in Table 3.24. The number of species in each sample was low. None of them exceed 10. Diversity index (H') of all six sites in wet and dry seasons ranged from o.76 to 1.56. In terms of species number and diversity index, the benthic fauna was not diverse. The density of organisms was not high, with an average of 170 individuals per m^2 (derived from 618 organisms in 36 0.1 m^2 samples in two samplings).

3.5.6 **Indo-Pacific Hump-backed Dolphins:** Aerial dolphin survey was conducted monthly since November 2001. The surveys in November and December 2002 were performed by fixed-wing aircraft operated by Government Flying Service. No sighting of any cetaceans was recorded in the November 2001 survey, while there was one sighting in the December 2001 survey at the mouth of Deep Bay. A helicopter operated by Government Flying Service was used for the January, February, and March 2002 surveys. Five, five and nine dolphin sightings were recorded in the January 2002, February 2002 and March 2002 surveys respectively. All were seen near the mouth of Deep Bay (**Figure 9.12**).

4. DISCUSSION

4.1.1 Surveys covering the wet season of 2001, the dry season of 2001-2 and early wet season of 2002 were completed in June 2002 for all groups. Study brief requirements were met or exceeded in terms of survey effort for all flora and fauna groups. Where survey effort greatly exceeded study brief requirements (horseshoe crabs, terrestrial invertebrates, birds, terrestrial vertebrates, marine mammals) the objective was to initiate sampling and analytic regimes that are scientifically defensible and repeatable, therefore of potential use in future comparisons with construction- or operation-phase surveys designed to detect impacts or results of mitigation.

4.1.2 Field surveys from August 2001 to June 2002 documented the presence of numerous taxa of conservation concern in the assessment area. These included mangroves, seagrasses, horseshoe crabs, birds, reptiles, and mammals. Of these a primary concern is wading bird use of the Deep Bay mudflats. Mudflats were found to support abundant bird assemblages that were dominated by herons and egrets, species of regional conservation concern. Black-faced Spoonbill, a globally endangered species, was recorded in the intertidal zone in the assessment area.

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