

Executive Summary

Agreement No. CE 69/2000
Consultancy Study on
Marine Benthic Communities in Hong Kong

Submitted to

Agriculture, Fisheries and Conservation Department

CityU Professional Services Limited

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1. Except in eastern and southern shores where the shallow subtidal habitat is rocky and coral-encrusted, the majority of seabed of Hong Kong is soft and comprises an admixture of sand and mud. Soft sediments support a wide range of bottom-dwelling (benthic) communities and standing crops, and have long been recognized as valuable feeding areas for demersal fishery. The conditions of benthic organisms, especially the burrowing forms (infauna), are sessile and therefore, indicative of time-integrated effects of various kinds of environmental stress. Since the last in-depth territory-wide benthic survey in Hong Kong was undertaken some 25 years ago, the current study is commissioned to update our information on the benthic communities, with respect to their spatial distribution and abundance, species composition, dominant or keystone species, and distribution pattern in relation to key physical and environmental factors.
2. The present study aims to establish an updated baseline on local benthic communities, and identify areas that are susceptible to environmental changes and habitats that are worthwhile for conservation for the benefit of long-term protection and sustainability of the marine ecological resources in Hong Kong. These objectives were achieved through:
 - Design of a comprehensive survey strategy to characterize the subtidal benthic communities in the entire Hong Kong waters,
 - Undertaking of the necessary sampling programme, including sample processing and species identification,
 - Analysis, review and interpretation of the data collected,
 - Recommendations for applications of the findings with respect to assessment of potential impacts of development projects on marine benthic ecology and marine conservation,
 - Recommendations for a cost-effective programme for further update of information on marine benthic communities, and
 - Development of an electronic database to summarize and compile information obtained.
3. Two field surveys, one in the summer (wet season) and one in the winter (dry season), were conducted. A stratified sampling design was used, in which 5 replicate benthic samples were collected at 120 stations in a 4 km x 4 km grid (Figure 1), using a 0.1 m² sediment van Veen grab. One additional sediment sample was collected at each site for particle size and total organic matter determination. For faunal analysis, the sediment sample was washed with gentle seawater through a stack of top 1.0 and bottom 0.5 mm sieves. Large animals that were visible from the residues were hand-picked into a small plastic vial. All remains were then washed and transferred into a plastic container and preserved with 5% borax-buffered formalin and stained with 1% Rose Bengal. For sediment analysis, a photo on the colour of the sediment surface was taken prior to being sampled for particle size and total organic matter analysis.
4. Sorting of all faunal samples was carried out in the laboratory prior to taxonomic identification and biomass (wet weight) determination. For quality assurance / quality control, 10% of the samples were re-sorted to ensure all animals were picked out. Animals were identified to the lowest taxonomic level, as far as practicable, and counted. To ensure quality assurance / quality control, 10% of the specimens were also re-checked for confirmation of taxonomic identity. Total biomass of the benthic animals at each sampling location was determined as preserved wet weight.

5. Data obtained in the present study were analyzed using both univariate and multivariate statistical methods. Sediment data were subjected to principal component analysis, whereas faunal data were analyzed using univariate biological indices, abundance and biomass comparison plots, and clustering and non-metric multidimensional scaling methods to discern spatial community pattern and temporal changes.
6. In total, 59,394 specimens belonging to 603 species were collected in 1,200 samples. This comprised 32,408 specimens and 466 species from the summer survey, and 26,986 specimens and 424 species from the winter survey. The recorded species belong to 16 taxonomic groups, including porifera, coelenterates, platyhelminthes, nemertean, nematodes, annelids (polychaetes, oligochaetes), sipunculans, echiurans, molluscs (bivalves, gastropods), arthropods (crustaceans), bryozoans, phoronid, echinoderms, hemichordates, cephalochordate and osteichthyes (fish). Polychaete annelids, crustaceans and bivalves were by far the most abundant, comprising over 70% of the total species. Some widely spread or numerically dominant animals are depicted in Plate 1. Among all recorded species, the cephalochordate (amphioxus) *Branchiostoma belcheri* (Plate 2) was of conservation importance, as this animal is regarded as a living fossil link in the evolution of marine invertebrates to vertebrates. Most sediment at the 120 stations contained very fine silt and clay. Except at a few stations (i.e., Victoria Harbour and Tolo Harbour), where the sediment showed high organic enrichment, organic content at most sampling stations was relatively uniform and low (range: 3-6%), similar to those unpolluted background state.
7. Overall, the benthic communities in the existing and proposed marine parks are diverse, except in Yan Chau Tong. The poor diversity of benthic community in Yan Chau Tong could be due to the occurrence of natural periodic hypoxia in the water body in this region as well as to the very fine (silt/clay) nature of the sediment. Only few tolerant species may be able to survive in low oxygen conditions. In addition, fine sediments provide less interstitial niches for benthic infauna. Polychaete annelids comprise the bulk of benthic species in other existing and proposed marine parks. Other dominant species include small crabs, shrimps and brittle starfish. Whilst the majority of these species occur in both summer and winter surveys, difference in species composition is noted at specific park areas. Such difference is caused by changes in abundance of some relatively less dominant benthic species, e.g., bivalves, recorded in the sediment samples.
8. Results of both summer and winter surveys showed minimal seasonal changes in sediment characteristics at the stations. In terms of benthic infauna, a lower species diversity and evenness were found in Deep Bay, inner Mirs Bay and Victoria, as compared to eastern and southern waters, e.g., Mirs Bay and south Lamma Island. These indices thus reflect the response of benthic communities to prevailing hydrographic conditions. The findings were further confirmed by the spatial community pattern (Figures 2 and 3), which identified: (a) a large benthic assemblage comprising the bulk of sampling stations and representing typical Hong Kong relatively undisturbed infauna, (b) an impoverished benthic community in northeastern waters (inner Mirs Bay including Yan Chau Tong, Kat O and Sha Tau Kok Hoi), (c) a coarser sediment benthic group in Victoria Harbour, and (d) a distinct benthic assemblage in Deep Bay on the west. Results of the abundance and biomass

comparison, however, revealed signs of disturbance at certain sampling stations, including areas near to the proposed and existing marine parks. While these areas are remote from obvious source of pollution and anthropogenic activities, natural periodic hypoxia might be a possible cause for such poor benthic establishment. It is worthwhile to closely monitor the benthic communities at these sites to decipher whether the observed disturbance was due to natural or anthropogenic factors.

9. In terms of the 5 strata of sea area defined from the survey strategy, it was apparent from the analysis of spatial pattern that sampling locations in the northeastern waters, western waters and harbour proper (Victoria Harbour) showed distinct benthic composition as compared with the rest of the locations in other strata. In the northeastern waters, the benthic community is mainly characterized by poor species composition and diversity, and the area has relatively low ecological importance. In the western waters, the benthic fauna in Deep Bay is different principally because of the estuarine conditions within the bay. In the harbour proper (Victoria Harbour), the benthic fauna is characterized by species which can adapt to an eutrophic environment. The remaining two strata, eastern and southern waters, are more homogeneous in benthic composition and diversity, and thus reflect relatively higher ecological importance as compared with the above three regions.
10. Of the 603 species recorded, 287 species were present in both surveys, illustrating seasonal variations for certain infaunal species. However, in terms of overall spatial pattern, seasonal variations were not evident, except in Deep Bay and Tai Long Wan (Sai Kung). The major factor contributing to the seasonal changes in benthic infauna in Deep Bay is the freshwater discharge from Shenzhen River as well as freshwater outflow from the Pearl River delta especially in the summer. The seasonal variation in benthic composition in Tai Long Wan, however, needs further study, as data on sediment organic content and particle size distribution did not show significant changes in the summer and winter. One of the likely reasons for the observed differences in faunal composition between surveys in Tai Long Wan could be due to different oceanic currents passing through this area during summer and winter. Historical changes in benthic communities from the past study in 1976 to the present survey in 2001 were apparent in the majority of sampling stations in Hong Kong waters. This observation was supported by the separation of benthic data obtained from 1976 from that in 2001 in the multivariate statistical analyses. Most of the 1976 sampling stations were delineated from those in 2001 in both cluster and ordination analyses, indicating the difference in species composition, and hence, changes in benthic communities, between 1976 and 2001. The significant increase in sediment TOM could be an important factor leading to such changes in the composition of benthic communities from 1976 to 2001. The 2001 survey showed a wider distribution of some dominant species, e.g., *Mediomastus* spp., *Prionospio* spp. and *Paraprionospio pinnata*. Some of these species are known to be adapted well to organic pollution, indicating the response of the benthic communities to an increase in TOM in the sediments.
11. The surveys identified the presence of a residing population of amphioxus *Branchiostoma belcheri*, in Tong Long Wan. This important species is of high conservation value, and it warrants to consider designating Tai Long Wan as a Site of Special Scientific Interest /marine park/ marine reserve, so as to protect *B. belcheri* and its associated fauna from disturbance of anthropogenic activities, including

bottom trawling. Other areas that have high species diversity and warrant consideration for conservation include sites at Clearwater Bay, south Lantau, south Lamma, Tai Tam Bay and south Stanley. Conservation measures in maintaining diversity of the benthic infauna include the control of the extent and frequency of physical disturbance, such as seabed dredging and bottom trawling, and reduction in pollution in areas where eutrophication occurs.

12. The database established from the present study serves as a valuable and comprehensive baseline, especially for projects or proposals that may potentially disturb the subtidal seabed environment. It is suggested that the updated information collected by this study be made available to the consultants for evaluation of their projects. In determining whether or not additional field sampling work is necessary, factors such as (a) the nature and scale of the project, (b) the ecological value of the area, and (c) level of information collected in the present study (e.g., the proximity of the project site to the present sample location and homogeneity of the benthic communities in the area) should be considered. However, the present database can be used as a reference to check against the validity and accuracy of data collected in future EIA studies. In addition, the present study has offered appropriate sampling strategy, sampling protocol and different statistical techniques in analysis of benthic data, which are useful for the set up of future monitoring and audit programmes on benthic communities.
13. The following recommendations were made:
 1. Formulation of a future monitoring programme on benthic communities, especially in areas of high conservation value,
 2. Development of educational materials to introduce the diversity of benthic infauna to the public,
 3. Further surveys of the surface dwelling invertebrates (epibenthos) and studies on the ecology and biology of the local amphioxus population.