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Some Ecological Mitigation Measures for the Main Drainage Channel Projects in Hong Kong

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ABSTRACT: Since the enactment of the Environmental Impact Assessment (EIA) Ordinance in Hong Kong in 1998, a number of ecological mitigation measures have been recommended in EIA studies for river training projects, which aim at restoring affected habitats along the channelized rivers for wildlife use. This paper presents an overview of three of these measures, namely, (i) reinstatement of fishponds along a channelized river, (ii) planting of mangrove along channel embankments, and (iii) retention of original river meanders. Data gathered from post-construction monitoring programs indicate that these measures have created habitats attractive to a number of avifauna, in particular, wetland dependent species. Hence they are considered effective in restoring habitats affected by the river training works.

KEYWORDS: Reinstated ponds, Mangrove plantings, Enhanced meanders, Main drainage channel, Ecological mitigation measures, Habitat restoration

Introduction

In Hong Kong, low-lying floodplains are mainly found in the northwest and north of New Territories and these areas are more prone to flooding. To protect human lives and properties in these areas, several river training projects have been implemented in the past few years to reduce the flooding risk and improve the land drainage.

Although Hong Kong is a small territory, the major watercourses and their floodplains, like other places in the world, comprise a great variety of habitats for wildlife. For example, the Inner Deep Bay, an estuarine wetland system comprising inter-tidal mudflats, mangroves, marshes and fishponds adjacent to Shenzhen River and Kam Tin River in the northwest of the New Territories, is of international conservation importance. This area has been designated as a Ramsar Site since 1995 (Fig. 1). It is one of the most important sites in the South China region providing important habitats for numerous waterfowls, migratory birds and a number of species under threat on global scale, such as Black-faced Spoonbill (*Platalea minor*) and Nordmann's Grenshank (*Tringa guttifu*) (Tsim & Lock, 2003). Another good example is the Long Valley, which is located next to Sheung Yue River and is one of the largest remaining agricultural land practicing wet agriculture, in the northern part of the New Territories. It shares similar ecological characteristics as compared with a freshwater wetland habitat and has a record of some 210 species of birds (Fig. 1).

Inevitably, river training works will lead to a loss of habitat and have certain impacts on the ecological values of the rivers and their adjacent floodplains. To address the environmental concerns, a detailed Environment Impact Assessment ("EIA") study comprising an ecological impact assessment is required for all major river training projects under the EIA Ordinance. The project proponent is required to collect the relevant eco-

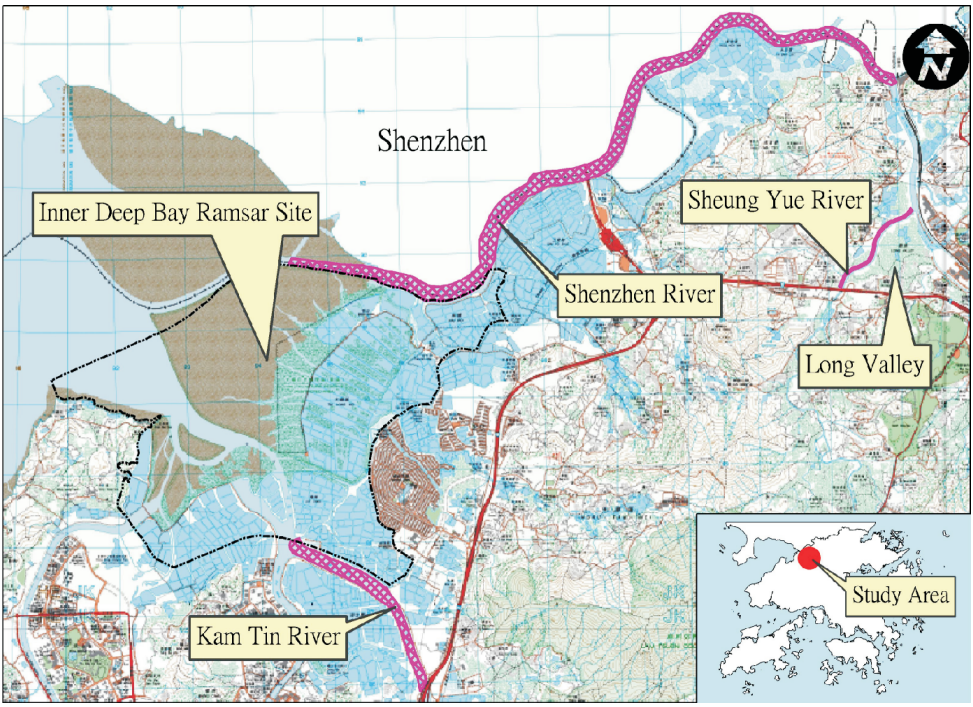

Fig. 1 Study area showing the Shenzhen River, Kam Tin River and Sheung Yue River, and sites of conservation concern in the vicinity.

logical information, predict and assess potential impacts of the project on the environment, propose remedial works and formulate suitable mitigation measures to avoid, minimize and compensate any adverse impacts identified.

Over the years, different ecological mitigation measures, such as preservation and enhancement of river meanders, provisions of environmentally friendly channel designs (e.g. natural or grasscreted channel lining, pond features and compensation of wetland habitats), have been recommended in the EIA reports of various river training projects. The objective of this paper is to present the approaches and designs of three of these ecological mitigation measures and the preliminary observations on their effectiveness based on the data gathered from post-construction monitoring programs. The measures are (i) reinstatement of fishponds along channelized rivers; (ii) planting mangrove along channel embankments; and (iii) enhancement of original river meanders.

Methodology

Study Sites

Reinstated ponds along the Shenzhen River

It refers to a series of fishponds located along the Shenzhen River with a total area of about 38.5ha (Fig. 2). These ponds were commercial fishponds affected by a river training project namely, the Shenzhen River Regulation Project Stage 2, which was jointly

commissioned by the Shenzhen Municipal Government and the Government of the Hong Kong Special Administrative Region in 1996. These ponds were temporarily drained to facilitate the construction works. Reinstatement works of the fishponds affected by the construction works were implemented after the completion of the construction works to minimize the impact of the project. The reinstatement works included provision of a gentle slope (1:3) at one side of each pond, planting trees (which are commonly found in the area nearby) along pond bunds, planting *Phragmites communis* along the edges of some ponds, and filling the ponds with natural rainwater (Peking University, 1995)

As there is no quantitative baseline information on the bird communities before commencements of the river training works, two commercial fishponds in the vicinity of the reinstated ponds and with similar nature were used for comparison and hence assessing the effectiveness of three selected reinstated ponds as an ecologically functional habitat for wildlife (Fig. 2).

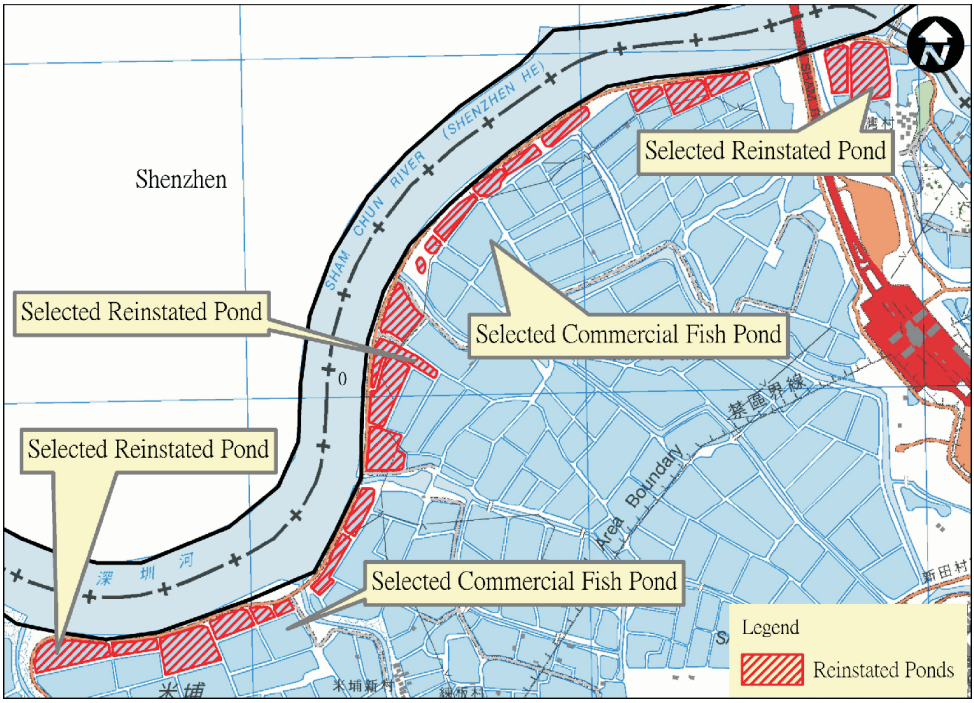

Fig. 2 Reinstated ponds and commercial fishponds along the channelized Shenzhen River.

Mangrove plantings along river embankment

Kam Tin River, one of the major watercourses in the northwest of the New Territories in Hong Kong, was channelized, widened and deepened under the project of Main Drainage Channel for Ngau Tam Mei, Yuen Long and Kam Tin (Fig. 3). After completion of the construction works in 1998, mangrove seedlings including *Aegiceras corniculatum*, *Kandelia candel* and *Acanthus ilicifolius* were planted on a 20m wide strip situated on both sides of the river to partly compensate the loss of mangroves due to the project

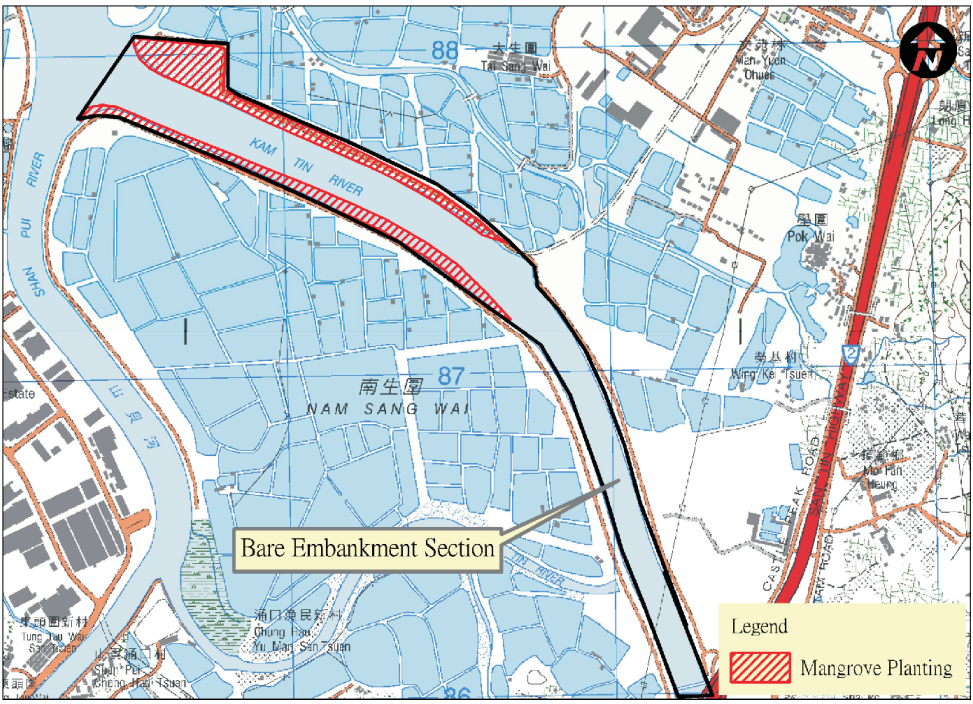

Fig. 3 Mangrove-planted section and bare embankment section of the channelized Kam Tin River

(ERM – Hong Kong Ltd., 1996). Similar to the study of Shenzhen River, an inter-tidal section of new river channel, which was without mangrove planting and connected to the mangrove-planted section at downstream (bare embankment), was selected for comparison.

Enhanced meanders along the Sheung Yue River

A total of 8 meanders were cut off from the Sheung Yue River under the Main Drainage Channel for Fanling, Sheung Shui and Hinterland Project (Fig. 4). To compensate the floodplain and riverine habitat loss due to the river training works and to create breeding and foraging habitats for wildlife, these cut-off meanders were retained and enhanced. According to the difference in hydrological design, two types of the enhanced meanders were created (Maunsell Consultants Asia Ltd., 1997). Type A enhanced meanders refer to those ponds or marshes converted from meanders through (i) retention of tributary stream input and connection to the main channel via pipeline through embankment; and (ii) maintaining water flow from the meander to the drainage channel. For type B enhanced meander, as there is no tributary input, the meanders serve as a depression to receive and hold surface flow during wet season. For both types of the meanders, wetland plant and indigenous riparian vegetation were planted within and along the meanders respectively, and the levels of the meanders were lowered as close as possible to the water table so that groundwater would contribute to the water levels at all times.

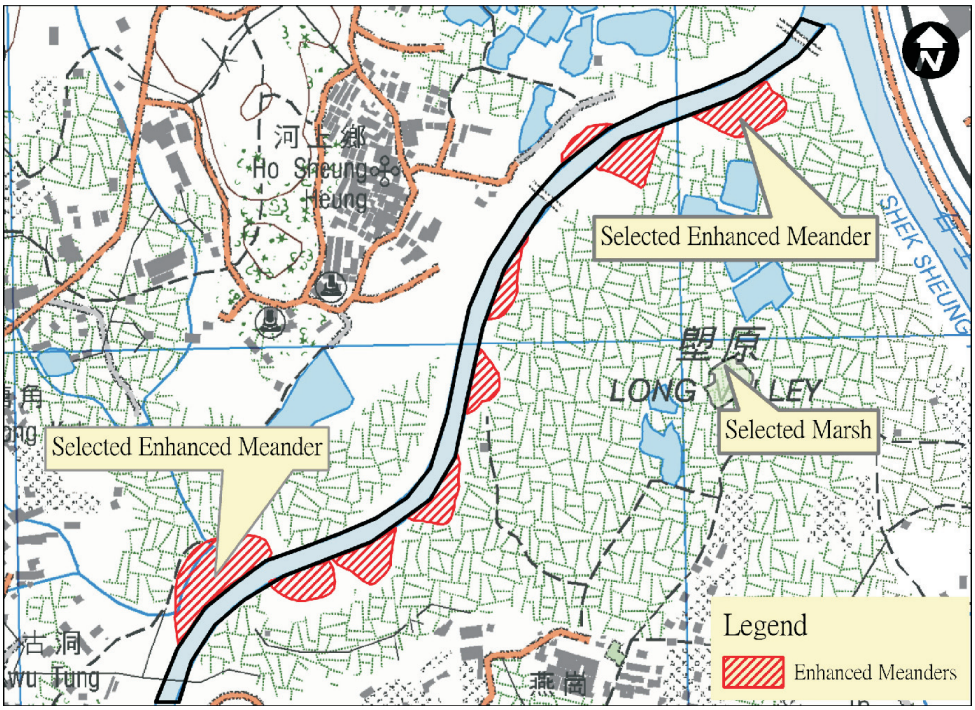

Fig. 4 Enhanced meanders and a marsh along the channelized Sheung Yue River.

To assess the effectiveness of these enhanced meanders as a wildlife habitat, particularly for avifauna, two enhanced meanders (one from each type) and a marsh habitat in the Long Valley (an area adjacent to the Sheung Yue River with many freshwater habitats and is being known to support a diverse avifauna including many species of conservation concern) were selected for study.

Bird Survey methods

In general, birds are useful indicators for habitat alteration and environmental changes (Greenwood et al., 1994). The bird community parameters are, therefore, used in this study to assess the effectiveness of the selected ecological mitigation measures.

5-minute point count method was employed for all study sites (i.e. commercial fishponds, reinstated ponds, marshes and meanders) along the Shenzhen River and Sheung Yue River, while line transect method (10 minutes for about 150m surveying distance) was used for two selected linear sections along the Kam Tin River. For the point count method, all countings were carried out in the early morning (within 4 hours after sun rise) to catch the period of the highest bird activities (Noske, 1995). For the Kam Tin River, as the selected river section is within inter-tidal zone, all bird countings were taken in the low tide period which is the peak foraging period for most of the shorebirds (Howes & Bakewell, 1989; Wong, et al., 2001).

For both of the methods, birds were counted by using a pair of binoculars (10X42 BC). Apart from direct observation, discrete bird calling was also counted. The details of the frequency, period of survey and duration of each survey are summarized in Table 1.

Table 1 Summary table for bird surveys

Site	Habitat Type	Frequency	Duration
Shenzhen River	Reinstated ponds Commercial fish ponds	Once every month	Nov. 1999 – Dec. 2000
Kam Tin River	River with mangrove planting on embankment River with concrete lining on embankment	Twice every month	Jan. 2001 – Mar. 2002
Sheung Yue River	Marshes Enhanced meanders	Six to nine times every season	Jan. 2002 – Feb. 2004

Data Treatment

Hong Kong has a sub-tropical climate and hence does not have a distinct four-season climate. Instead, a wet summer (April to October) ("Wet") and a dry winter (November to March) ("Dry") periods (Carey et al., 2001) are easy to be distinguished. The migratory pattern of bird in Hong Kong generally matches with these two periods. Therefore, all bird data collected within each of the periods were grouped, and means of bird density and species richness at different habitats were calculated. Bird community parameters of similar habitats (described above) were compared using paired t test.

Results and Discussion

Reinstated ponds along the Shenzhen River

In general, commercial fishponds are considered as an important habitat supporting a number of ardeids, particularly when the ponds are drained for harvesting fish of economic value (Young & Chan, 1997; Young, 1998). However, the results of this study indicated that the selected reinstated ponds were able to compensate the ecological functions of commercial fishponds and were even more attractive to birds than the commercial fishponds during the study period. From Figs. 5 and 6, it revealed that the density and species richness of birds in the selected reinstated ponds were significantly higher than those of the adjacent commercial fishponds ($p<0.05$). The differences were more apparent in the Dry season. This may be due to the influx of wintering birds in Hong Kong in the Dry season. Altogether 28 bird species were recorded in the selected reinstated ponds during the study period. Among all the birds recorded, wetland dependent birds e.g. wintering ducks and rails were dominant bird groups using the selected reinstated ponds. This suggests that the selected reinstated ponds may provide an alternative site for these birds which habitually utilize the mudflat of the Inner Deep Bay area.

One of the possible factors attributing to the high occurrence of birds in the selected reinstated ponds is the establishment of a number of small patches of *P. communis* in the middle and at the edge of the reinstated ponds. These vegetation provide a good natural barrier and make the birds less prone to disturbance from human activities and less accessible to predators. This was supported by a breeding record of a wetland dependent bird, Little Grebe (*Tachybaptus ruficollis*), in one of the selected reinstated ponds during the study period.

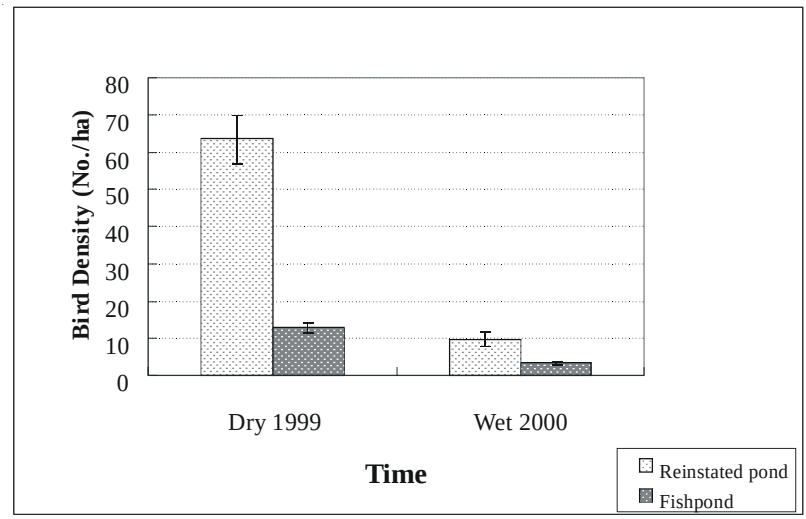

Fig. 5 Bird density recorded in the reinstated ponds and commercial fishponds. (bars represent standard errors)

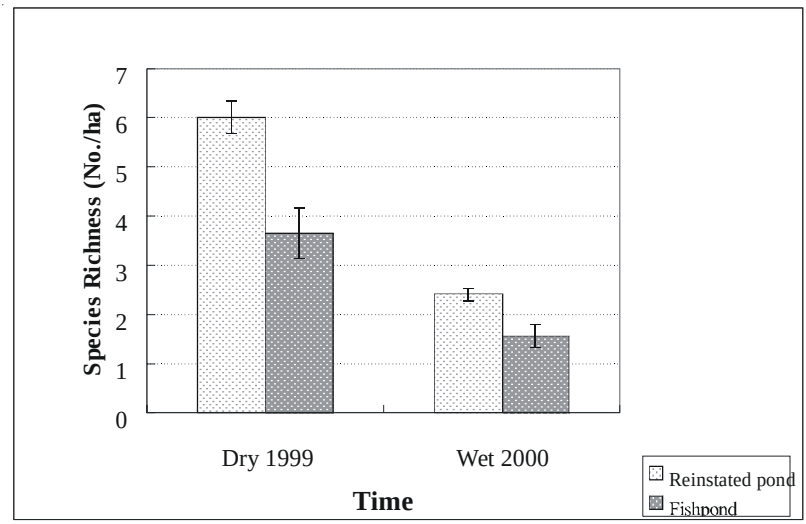

Fig. 6 Species richness recorded in the reinstated ponds and commercial fishponds. (error bars represent standard errors)

Provision of gentle pond slopes with a higher percentage of shallow water area along the pond bunds may also account for the preference of bird to use the reinstated ponds. During the survey period, wintering ducks and waterfowls were observed from time to time resting along the shallow pond margins of the reinstated ponds. Gilbert & Anderson (2000) suggested that the shallow edge of the ponds could offer greater seclusion to waterfowls and provide suitable habitats for invertebrates which were one of the main preys for many birds.

Mangrove plantings along river embankment

Similarly, the bird density and species richness recorded in the mangrove-planted section were significantly ($p<0.05$) higher than those from the bare embankment section, in particular, in the Dry season (Figs. 7 and 8). A total of 32 bird species were recorded in this river section while only 13 species were recorded in the bare embankment section. When compared with the avifauna species recorded in the EIA study of the project, about 46% bird species recorded in this area before the river training works in January 1995 were found again in the mangrove-planted section. All these observations suggest that the mangrove-planted section is more attractive to birds.

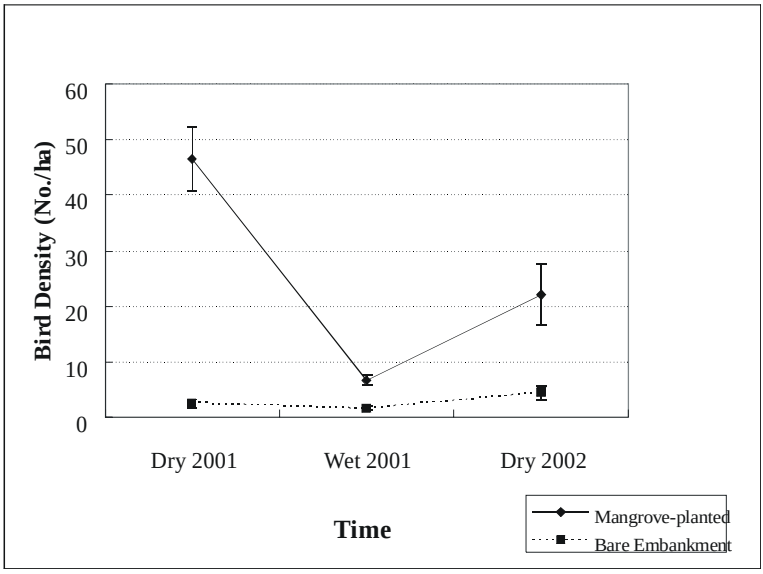

Fig. 7 Bird density recorded in the mangrove-planted and bare embankment sections of the channelized Kam Tin River. (bars represent standard errors)

The higher bird utilization in the mangrove-planted section is probably due to the presence of abundant food source. According to Tam et al., (1997), mangrove is a unique inter-tidal habitat with a high primary productivity and the mangrove plantings are primary food sources for various benthic organisms (e.g. mudskipper, crabs and other invertebrates) which are major food sources for inter-tidal bird community. It was observed that a large number of wetland dependent birds, including the globally endangered species Black-faced Spoonbill (*Platalea minor*), were feeding in the mangrove-planted section of the river from time to time during their wintering in Hong Kong.

The relatively natural appearance of the channel due to the presence of the mangrove plantings may also attribute to the higher occurrence of birds in the mangrove-planted section. The mangrove plantings along the river embankment could act as a corridor for wildlife by providing important roosting and nesting sites for birds, and a natural barrier for birds against human disturbance. During the study period, over hundreds of wintering ducks and waterfowls were observed from time to time roosting and feeding in the open water of the channel.

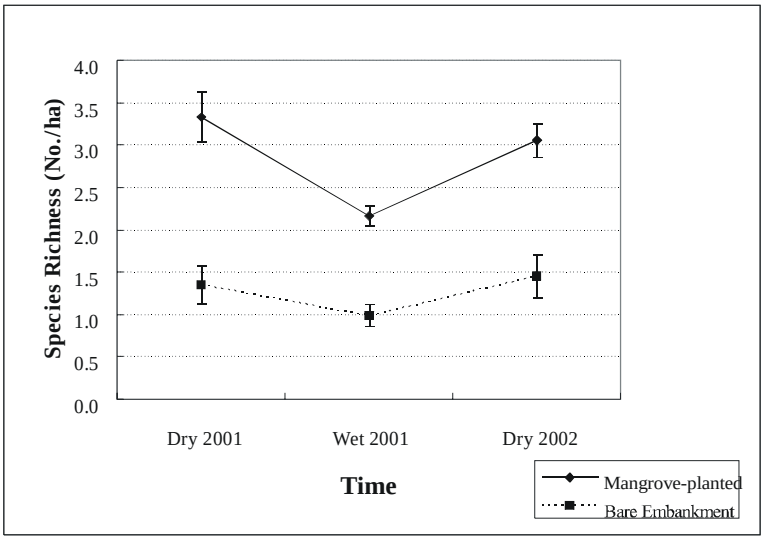

Fig. 8 Species richness recorded in the mangrove-planted and bare embankment sections of the channelized Kam Tin River. (bars represent standard errors)

Enhanced meanders along the Sheung Yue River

The results showed that a total of 39 species of birds, mainly wetland dependent birds and small insectivorous birds, were recorded throughout the study period. About 46% of bird species recorded in the agricultural lands and fishponds on the floodplain of Sheung Yue River during the pre-construction monitoring period were found again in the enhanced meanders. When compared the data of bird parameters (i.e. density and species richness of bird) with those recorded in the marsh, except the species richness in the Wet and Dry seasons of 2003, the differences between these two sites were not significant ($p>0.05$) (Figs. 9 and 10). The results suggest that the ecological conditions of the enhanced meanders could be quickly restored (2 years after the enhancement work) and are comparable with the marsh habitat in the Long Valley in terms of bird utilization.

This is probably due to the implementation of habitat restoration measures (e.g. re-profiling of the meanders, hydrological connection with other water sources nearby and careful selection of wetland and riparian vegetation). These measures could ensure that the enhanced meanders would be permanently "wet" (i.e. function as a wetland) and various types of micro-habitats would be created. It was found that swampy areas with patches of shallow open water and dense aquatic vegetation were utilized by many wetland dependent bird species. These habitats provided a suitable ground for feeding, sheltering, roosting and even breeding for these birds. That is why different life stages of a locally rare wetland dependent species *Rostratula benghalensis* (Greater Painted Snipe) were observed on numerous occasions during the study period.

From the results obtained, it suggests that the selected mitigation measures could certainly create suitable habitats within the reinstated/enhanced sites for a number of avifauna, in particular, wetland dependent species. A number of birds that previously

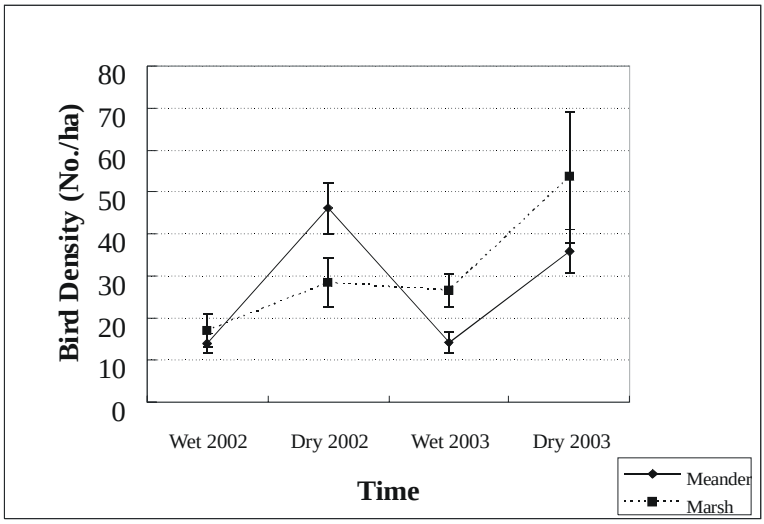

Fig. 9 Bird density recorded in the enhanced meanders and marsh. (bars represent standard errors)

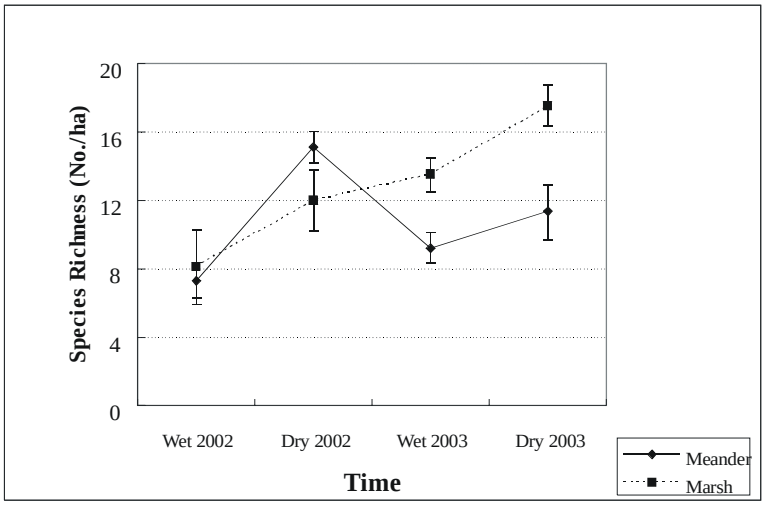

Fig. 10 Species richness recorded in the enhanced meanders and marsh. (bars represent standard errors)

recorded in or in the vicinity of the study areas were recorded again in these reinstated/enhanced sites 2 to 4 years after completion of the reinstatement/enhancement works. These sites are proved to be effective to be used as habitats for avifauna.

One of the possible factors attributing to the attractiveness of these reinstated/enhanced sites for the avifauna is the implementation of habitat restoration measures. The gentle slope provided in the reinstated ponds could create more shallow water areas along the edge of the

reinstated ponds which are favoured by many wetland dependent birds. The profiling of the enhanced meanders and hydrological connection with other water sources nearby could create a suitable wetland and marsh habitats for many wetland dependent birds.

Another factor for attracting the avifauna to these reinstated/enhanced sites may be the establishment of vegetation. The established vegetation not only could increase the food source in the reinstated/enhanced sites but also could enhance the naturalness of these sites. The vegetation could further provide important roosting and nesting sites for birds and a natural barrier for birds against predators and human disturbance.

Concluding Remarks

As more river training projects will be carried out in the future, when considering the mitigation measures, several aspects such as (i) types of habitats need to be created for compensation, (ii) the design for these habitats, (iii) the target species for these created/restored habitats, will have to be addressed. In view of little local experience on the ecological mitigation measures involving wetland habitat, it is hoped that the experience from this study could provide a useful reference for the design of similar mitigation measures in the future river training projects.

From the results of this study, the three selected mitigation measures could compensate the habitat loss caused by the river training works by providing feeding, roosting, sheltering and breeding sites for many birds, including some species of conservation concern. These reinstated or enhanced sites could even attract more birds than the similar habitats in the vicinity. About 50% of the species recorded in the pre-construction study were recorded again in the mangrove-planted section of the Kam Tin River and the enhanced meanders along the Sheung Yue River after a short period of time. The high bird utilization is probably due to the implementation of habitat restoration measures and establishment of vegetation in these sites. This study could provide a useful reference for the future river training projects when considering the similar mitigation measures.

As only bird community parameters were investigated in this study, in order to better understand whether these ecological mitigation measures could also provide a suitable habitat for the other wildlife, a more comprehensive study should be conducted.

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