8 Ecological Impact Assessment

8.1 Introduction

The ecological impact assessment (EcoIA) conducted as part of an environmental impact assessment (EIA) study, provides sufficient and accurate ecological data to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts affecting potentially important habitats. The potentially important habitats affected by Stage III of the Shenzhen River Regulation Project (the Project) includes natural stream course, freshwater marshes and woodlands (Annex 16, TM-EIA).

This chapter reviews the existing habitats of the Study Area (SA) based on the field results of the eight month baseline ecology surveys. The potential ecological impacts during the construction and operation of the Project are identified. The significance of the identified impacts is evaluated against criteria recommended in the Annex 8 and Annex 16 of *Technical Memorandum on Environmental Impact Assessment Process (TM-EIA, HK)*. Measures to avoid and minimize impacts are recommended. Mitigation measures are also proposed to restore, enhance or recreate wildlife habitats as compensation of habitat losses.

8.1.1 *Objectives of Ecological Impact Assessment*

The objectives of this ecological impact assessment are:

- to identify important ecological resources within and surrounding the Project Area;
- to determine the significance of potential impacts arising from the Project upon these important ecological resources; and
- to recommend practical measures to avoid, to minimize and to combat any significant impacts.

8.1.2 *Methods*

The ecological impact assessment consists of three major elements: (1) identification of existing ecological resources; (2) prediction of potential ecological impacts; and

(3) evaluation of significance of the identified ecological impacts.

Information concerning the existing ecological resources of the Study Area has been compiled from both literature and baseline ecology surveys. Literature relating to the Study Area and similar subjects has been reviewed. The following documents are of particular relevance to this project:

- Maunsell Consultants Asia Ltd., 1997. Main Drainage Channels for Fanling, Sheung Shui & Hinterland Environmental Impact Assessment, Final Assessment Report. 1997.

- Binnie Consultants Ltd., 1998. Yuen Long Bypass Floodway Feasibility Study, Final EIA Study Report. 1998.

- Peking University, 1994. Environmental Impact Assessment Study on Shenzhen River Regulation Project. Study Report for Stage I Works.

- Peking University, 1995. Environmental Impact Assessment Study on Shenzhen River Regulation Project. Environmental Impact Assessment Report.

- ERM-Hong Kong Ltd., 1996. Main Drainage Channels for Ngau Tam Mei, Yuen Long and Kam Tin: Environmental Impact Assessment, Final Report. 1996.

- ERM-Hong Kong Ltd., 1999. Main Drainage Channels and Poldered Village Protection Scheme for San Tin, NWNT: Environmental Impact Assessment Study, Final Assessment Report. 1999.

This literature provides general information about the downstream Shenzhen River system and other similar habitats. Specific information about the Study Area was the direct result of baseline ecology surveys as the Study Area was not studied previously.

Impact predictions are based on the nature of the project and construction process as detailed in the Engineering Review Report. The project alignment and works area were superimposed on the habitat map to facilitate identification of direct impacts. Identification of indirect impacts is based on the project nature and experience from similar projects.

The significance of the impacts was evaluated with dual consideration of existing eco-

logical resources and the nature of impacts. Objective criteria recommended in the Annex 8 of *Technical Memorandum on Environmental Impact Assessment Process (TM-EIA, HK)* were followed during the evaluation process.

8.2 Legislation and Guidelines

This section describes existing legislation and guidelines relevant to the ecological impact assessment of the present project.

8.2.1 *International Conventions*

(1) *Ramsar Convention*

The People's Republic of China (PRC) is a party to the *Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramsar Convention)*. Hong Kong, through the PRC, remains as a Party to the convention after 1 July 1997.

Article 1 of the Convention defines wetlands as "area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres." Article 3 requires the contracting parties strive for a "wise use" of wetlands in their territory.

All aquatic habitats within, and downstream of the Study Area, including streams, rivers and man-made fishponds qualify as "wetlands" under the Ramsar definition. The Mai Po Nature Reserve and Inner Deep Bay are the listed Ramsar wetlands 13.6 km downstream of the project area.

(2) *Bonn Convention*

The PRC is a Party to the Convention on the *Conservation of Migratory Species of Wild Animals (the Bonn Convention)*. Hong Kong, through the PRC, remains as a Party to the Bonn convention after 1 July 1997. The Bonn convention has two major objectives:

1) to provide strict protection for species listed in Appendix I of the Convention (migratory species in danger of extinction throughout all or a significant portion of their range); and

2) to encourage Range States for such species to conclude agreements for the conservation and management of Appendix Ⅱ species (migratory species which have an unfavourable conservation status and require international agreements for their conservation, or which have a conservation status which would significantly benefit from international co-operation).

The first objective above includes obligations to conserve and restore those habitats which are important in protecting the species from danger of extinction and removing obstacles that impede or prevent migration of the species. Deep Bay is a known migratory path to five bird species (*Dalmatian Pelican Pelecanus crispus*, *Chinese Egret Egretta eulophotes*, *Oriental White Stork Ciconia boyciana*, *Relict Gull Larus relictus and Saunder Gull Larus saundersi*) which are listed in *Appendix I of the Bonn Convention*.

8.2.2 *PRC Legislation and Guidelines*

Relevant national legislation and guidelines include:

(1) *Wildlife Protection Law of the People's Republic of China*

According to Chapter 2 Provision 12, the developer should submit an environmental impact assessment for construction projects, which potentially result in adverse impacts on wildlife habitat, protected by national or local regulations. In the approval process the Environmental Protection Department should consult the wildlife protection agencies at the same administrative level.

(2) *Regulations for Wildlife Protection Implementation of the People's Republic of China*

According to Chapter 2 Provision 10, preventative measures should be taken if relevant institutions and individuals might cause the adverse impacts on national or local key protected wildlife.

(3) *Management Methodologies of Nature Reserves for Forests and Wildlife Species*

According to Provision 11, the natural environment and natural resources in nature reserves should be managed solely by the administrative organization of nature reserves. Without permission of the Ministry of Forestry or the provincial, autonomous region or municipal administrative department of forests, no institution or individual

is allowed to enter the nature conservation area to establish institutions or construct facilities.

(4) *Regulations of Nature Reserve of the People's Republic of China*

According to Provision 32, any construction facility is prohibited in core areas and buffer zones of nature reserves. Construction facilities, which may cause environmental pollution, resource destruction, or landscape damage in the experimental areas, are also inhibited; pollutants discharged from other construction projects in the experimental areas could not exceed the national or local standards. For those existing facilities in the experimental area, if the effluents discharged exceed national or local standards, the rectification should be done within a definite time; mitigation measures must be taken for any damage.

Other construction projects in the surrounding area of nature reserves should not damage the environmental quality of nature reserves; any damage must be rectified within a definite time.

Timetables for the rectification will be set up by appropriate administrations authorised by relevant laws and regulations. The responsible enterprises and institutions must accomplish rectification within the specified time.

(5) *The National Protection List of Important Wild Animals*

The following mammals which live in the Shenzhen River catchment and Deep Bay area are listed among species to be protected in PRC (first class protection species are marked with *).

Otter	*Lutra lutra*
Small Indian Civet	*Viverricula indica*
Chinese White Dolphin	*Sousa chinesis*

The following birds which occur in the Shenzhen River catchment and Deep Bay are listed among species to be protected in PRC (first class protection species are marked with *).

Black-necked Grebe	*Podiceps nigricollis*
Dalmatian Pelican	*Pelecanus (philippensis) crispus*
Reef Egret	*Egretta sacra*

Swinhoe's Egret	*Egretta eulophotes*
Oriental White Stork*	*Ciconia (ciconia) boyciana*
Black Stork*	*Ciconia nigra*
White Ibis	*Threskiornis (aethiopicus) melanocephalus*
Glossy Ibis	*Plegadis falcinellus*
White Spoonbill	*Platalea leucorodia*
Black-faced Spoonbill	*Platalea minor*
Swan	*Cygnus sp.*
Mandarin Duck	*Aix galericulata*
Common Crane	*Grus grus*
Imperial Eagle*	*Aquila heliaca*
Black-shouldered Kite	*Elanus caeruleus*
Black Kite	*Milvus migrans*
White-bellied Sea Eagle	*Haliaeetus leucogaster*
Crested Goshawk	*Accipiter trivirgatus*
Marsh Harrier	*Circus aeruginosus*
Hen Harrier	*Circus cyaneus*
Pied Harrier	*Circus melanoleucos*
Japanese Sparrowhawk	*Accipiter gularis*
Besra	*Accipiter virgatus*
Horsfield's Goshawk	*Accipiter soloensis*
Grey-faced Buzzard-eagle	*Butastur indicus*
Buzzard	*Buteo buteo*
Spotted Eagle	*Aquila clanga*
Bonelli's Eagle	*Hieraaetus fasciatus*
Crested Honey Buzzard	*Pernis ptilorhnychus*
Serpent Eagle	*Spilornis cheela*
Osprey	*Pandion haliaetus*
Kestrel	*Falco tinnunculus*
Peregrine	*Falco peregrinus*
Hobby	*Falco subbuteo*
Saker Falcon	*Falco cherrug*

Little Whimbrel	*Numenius (borealis) minutus*
Spotted Greenshank	*Tringa guttifer*
Relict Gull*	*Larus relictus*
Greater Coucal	*Centropus sinensis*
Lesser Coucal	*Centropus bengalensis*
Rose-ringed Parakeet	*Psittacula krameri*
Short-eared Owl	*Asio flammeus*
Grass Owl	*Tyto capensis*
White-vented Needletail	*Hirundapus cochinchinensis*

The following reptiles which occur in the Shenzhen River catchment and Deep Bay are listed among species to be protected in PRC.

Water Monitor	*Varanus salvator*
Burmese Python	*Python molurus*

8.2.3 *Hong Kong Legislation and Guidelines*

The *Technical Memorandum (TM) on Environmental Impact Assessment (EIA) Process (Cap.* 499, *section* 16), provides guidance on the methodology for ecological impact assessment in Hong Kong (Annex 8 and Annex 16).

The *Forests and Countryside Ordinance (Cap.* 96), protects natural and plantation forest from unauthorized disturbance or destruction.

The *Forestry Regulations (Cap.* 96, *section* 3), protects listed plant species.

The *Wild Animal Protection Ordinance (Cap.* 170), protects wild animals by prohibiting hunting activities and collection of eggs or nests of listed species.

The *Animals and Plants (Protection of Endangered Species) Ordinance (Cap.* 187), restricts the importation, exportation and possession of listed animals and plants, and parts of such animals and plants.

Guidelines for Implementing the Policy on Off-site Ecological Mitigation Measures (Planning, Environment & Lands Branch Technical Circular No. 1/97 (*PELB TC* 1/97)), provide a set of guidelines on how the policy on off-site ecological mitigation measures should be implemented, and require that such a measure should be on a "like for like" basis as far as practicable and within the territory of HK SAR.

Tree Preservation (Planning, Environment & Lands Branch Technical Circular No. 3/94 (PELB TC 3/94)) emphasizes that the planning, design and construction of development projects have to take into account the need to preserve trees.

The *Town Planning Ordinance* (*Cap.* 131) provides for the drawing up of statutory plans to control development and the provision of land use zonings including Sites of Special Scientific Interest (SSSIs), Conservation Areas and Coastal Protection Areas to protect natural features.

8.3 Ecological Baseline Study

8.3.1 *Study Area*

The Study Area (SA) include the Project Area (PA) and areas up to 200 m on the Shenzhen side and 500 m on the Hong Kong side from the Project Area (Figure 8.1).

These areas are located within the border area between Mainland China and Hong Kong. For security and other reasons, historical on-site ecological information is very limited. Accordingly, several ecological surveys were conducted to collect the baseline information of the Study Area. The surveys covered four months of the wet season and another four months of the dry season within a ten months study period.

8.3.2 *Existing Environment*

The Study Area is a small floodplain valley of the Shenzhen River. Shenzhen City is on the northern bank while Hong Kong is to the south of the river. This section briefly describes the habitats of the Study Area, detailed information is presented in the subsequent sections.

The water of the Shenzhen River is highly polluted with organic waste. The river banks are densely covered with grasses and shrubs which are nourished by the organically enriched river water. The rapid urbanization of Shenzhen City has converted the floodplain area in Shenzhen into a concreted urban environment. The floodplain area on the Hong Kong side was previously used for agriculture and remains in a rural state. The floodplain in Hong Kong is separated from the urban area by the small hills of Sandy Ridge.

Low-lying grassland and agricultural land are the dominant habitats of the Study

Area. These habitats are subjected to seasonal flooding when the river overspills. Because of periodic flooding, most of the agricultural area is fallow during the wet season. This fallow cultivation area is rapidly colonized by grasses and has become a temporary grassland or marsh. The importance of these wetland habitats is limited in some areas by agricultural activities.

The flora of the Study Area is typical of riparian wetland and agricultural habitats. The fauna of the Study Area is typical of low-lying grassland. The flora and fauna diversity is moderate but seasonality is strong. Habitat and hence flora seasonality are mostly related to agricultural activity as discussed above. The abundance of most fauna decreases during the dry season. Birds are the notable exception and show increased species diversity and abundance during the dry season. Birds are among the most important ecological resources of the Study Area. Python and mongoose are the other important ecological resources found within the Study Area.

8.3.3 *Habitat Surveys*

Habitat surveys were carried out across the whole Study Area during two seasons. The objectives of these surveys were to:

- identify the types of all habitat areas present within the Study Area.
- provide an overview of habitats existing within the Study Area.
- observe ecological characteristics of each habitat.
- determine the seasonality of the habitats.

The habitat surveys provided basic information for other baseline surveys and facilitated the evaluation of different habitats/sites and assessment of potential impacts.

(1) *Methodology*

The Study Area is confined to 500 m on the Hong Kong side and 200 m on the Shenzhen side of the proposed Project Area. The wet- and dry-season field surveys were undertaken over the Study Area from 12-14 August 1998 and from 14-15 December 1998. Before the field surveys, major ecological features identified from the aerial photographs were mapped on a 1:5000 land survey map (base map). The aerial photographs of the Study Area were obtained from the Survey and Mapping Office,

Lands Department, HKSAR.

All ecological features marked on the rough field map were verified during the field habitat surveys. During these surveys, attention was paid to areas which potentially supported high species diversity such as woodlands, and/or species of ecological importance such as ponds and marshes. During the surveys of ponds, the operational status of ponds was recorded. During the surveys of vegetated areas, dominant floral species were recorded and used to identify the habitat types of the vegetated areas.

The information obtained from the habitat surveys and overall floral species surveys were integrated into GIS to refine the rough field map into the habitat map.

(2) *Results*

1) *Overview*

The broad habitats consist mainly of low-lying grasslands/fallow fields, hillside grasslands and woodlands on the Hong Kong side of the Shenzhen River. The Shenzhen side is mainly an urban environment of little ecological importance.

Habitat surveys were conducted during the wet season (12-14 August 1998) and the dry season (14-15 December 1998). The same habitat types were found during wet-season and dry-season surveys, but seasonal change was found in the habitat areas of low-lying grasslands/fallow fields and agricultural lands. Some areas which were low-lying grasslands/fallow fields during the wet-season surveys were found to grow vegetables and flowers during the dry-season surveys. No seasonal variation was found in other types of habitat between the wet and dry seasons. Therefore, dry-season habitat surveys were considered to represent the true baseline conditions of habitats along the Shenzhen River. A dry-season habitat map was prepared using the field survey information and aerial photographs obtained from the Survey & Mapping Office, Lands Department, Hong Kong SAR Government.

A dry-season habitat map showing these 10 habitats is presented in Figure 8. 1. The area of each habitat in the dry season within the Study Area is listed in Table 8. 1.

Table 8.1 Dry-season Habitat Types and Their Extent within the Study Area

Habitat type	Area (hm^2)	%
Woodland	43.8	13.5
Shrubland	3.5	1.1
Hillside grassland	26.3	8.1
Low-lying grassland/fallow field	65.9	20.4
Agricultural land	20.2	6.2
Marsh	9.3	2.9
Pond	15.8	4.9
River	9.1	2.8
Bareground	3.1	1.0
Urban environment	126.7	39.1
Total	323.7	100.0

2) *Woodland*

A total of 17 areas of woodland were found within the Study Area along the Shenzhen River, of which 16 exist on the Hong Kong side (Plate 8.1) and only one on the Shenzhen side. Some are of greater ecological importance while the others are of less ecological importance.

Nam Hang Woodland

The woodland south of the Man Kam To Police Station (or Nam Hang) is about 18.5 hm^2, the largest woodland area within the Study Area (Table 8.2). The Nam Hang woodland is mainly natural, but the trees in its southern area beside the two fishponds were artificially planted. The Nam Hang woodland is continuous and adjacent to the fishponds and bloodworm (*Chironomous* spp.) ponds which are also of much ecological importance. It carries more than 100 flora and fauna species with many old trees. This woodland is also used by bird species such as *Oriolus chinensis* who feed and breed in the bloodworm pond valley of the woodland hillside. Many species present in this woodland are native to Hong Kong. It is dominated by *Sterculia lanceolata*, *Celtis sinensis*, *Cinnamomum camphora*, *Macaranga tanarius*, *Bridelia tomentosa* and *Microcos paniculata*. The woodland at Nam Hang is of much ecological importance because of large size, species diversity, ecological linkage with the high quality wetland (ponds).

Table 8.2 Evaluation of the Nam Hang Woodland Existing in the Study Area

Criteria	Remarks
Naturalness	The woodland is mainly natural and dominated by species native to Hong Kong
Size	Largest in the Study Area
Diversity	Species diversity is moderate with over 100 flora species
Rarity	The woodland/wetland combination is a unique ecosystem in Hong Kong SAR
Re-creatability	This type of woodland is re-creatable in the long term (30-40 years)
Fragmentation	Continuous
Ecological linkage	Adjacent to the fishponds and bloodworm ponds
Potential value	High.
Nursery/breeding ground	The woodland provides an important breeding ground for many species, especially birds and mammals.
Age	Probably more than 50 years old
Abundance / richness of wildlife	The woodland contains high species richness for many taxa groups, especially plants and invertebrates.

Higher Quality Woodlands

The two woodlands north and south of Muk Wu Tsuen, and the woodland southeast of Muk Wu Tsuen, are fairly large in size (2 to 3 ha) and are also ecologically important (Table 8.3). They have been modified by cutting, planting and hill fire to small extents. Both of them are over 40 years old according to consultation with villagers of Muk Wu Tsuen. Many species present in these two woodlands are native to Hong Kong. The woodlands are dominated by *Pinus massoniana*, *Sterculia lanceolata*, *Celtis sinensis*, *Cinnamomum camphora*, *Macaranga tanarius*, *Bridelia tomentosa* and *Microcos paniculata*.

The woodland south of the village carries many trees of relatively old ages, especially trees of *Celtis sinensis* and *Cinnamomum camphora*. This woodland has experienced minor disturbance especially at its edges. Branches of some trees at the edges have been cut, while some shrubs and grasses under trees have been grazed by cattle or harvested by villagers. However, the plants inside the woodland do not show any sign of disturbance.

The edges of the woodland north of the village have been modified by planting and hill fire to a given extent. There are some fruit and ornamental trees planted on its edges. The planted trees include *Dimocarpus longan*, *Litchi chinensis* and *Psidium guajava*.

Table 8.3 Evaluation of Higher Quality Woodlands Existing in the Study Area

Criteria	Remarks
Naturalness	The woodlands are natural but have been modified by cutting, planting and hill fire to small extents.
Size	Fairly large, from 2 to 3 hm^2
Diversity	Species diversity is moderate
Rarity	This type of woodland is widespread in the New Territories
Re-creatability	This type of woodland is re-creatable in the long term (30 −40 years)
Fragmentation	The woodlands are not continuous
Ecological linkage	The woodlands are adjacent to agricultural land and provide breeding and resting cover for species that feed in this open habitat
Potential value	Moderate
Nursery/breeding ground	The woodlands provide important breeding grounds for many species, especially birds and mammals.
Age	Probably more than 40 years old
Abundance / richness of wildlife	The woodlands contain moderate species richness for many taxa groups, especially plants and invertebrates.

Lower Quality Woodlands

All of the other woodlands found within the Study Area are lower quality. They are also very small, most of which are smaller than 1 hm^2 (Table 8.4). They are fragmented and have been disturbed by cutting, planting and hill fire to great extents. Therefore they are of less ecological importance.

The two lower quality woodlands at Yuen Leng Chai and northwest of Nam Hang which are expected to be lost during construction are 0.3 to 1 hm^2 (Table 8.4). They have been disturbed by cutting and planting to great extents. Many of the trees there are planted and very common exotic species in Hong Kong SAR. They are of less ecological importance because of smaller size, low species diversity and history of much disturbance.

Commonly found in the lower quality woodlands were *Pinus massoniana*, *Acasia confusa*, *Casuarina equisetifolia*, *Sterculia lanceolata*, *Melaleuca leucadendron*, *Celtis sinensis*, *Macaranga tanarius*, *Bridelia tomentosa and Microcos paniculata*. There are some fruit and ornamental trees planted in the woodlands. The planted trees include *Dimocarpus longan*, *Litchi chinensis*, *Psidium guajava*, *Acacia confusa*, *Casuarina equisetifolia and Bauhinia purpurea*. Cutting disturbance is mainly caused by the

grave worshippers when a footpath is cut to the area around the grave.

Table 8.4 Evaluation of the Lower Quality Woodlands Existing in the Study Area

Criteria	Remarks
Naturalness	The woodlands are greatly modified with many planted trees and shrubs of exotic species
Size	Mostly small, from 0.2 to 2 hm^2
Diversity	Low
Rarity	This type of woodland is widespread in the New Territories
Re-creatability	This type of woodland is re-creatable in the long term
Fragmentation	The woodlands are fragmented.
Ecological linkage	Some woodlands are adjacent to fish ponds, rivers, marshes, agricultural land and hillside grasslands, and may provide breeding and resting cover for species that feed in these more open habitats
Potential value	Moderate
Nursery/breeding ground	The woodlands provide important breeding grounds for some species, especially birds and mammals.
Age	Relatively ancient to recent
Abundance / richness of wildlife	The woodlands contain moderate to low species richness for some taxa groups, especially plants and invertebrates.

3) *Shrubland*

Five shrublands were found in patches on the hillsides or at the bottoms of hillsides (Plate 8.2). They are small in size (0.5 to 1.1 hm^2), and fragmented (Table 8.5). Two shrublands at Nam Hang and Sandy Ridge are adjacent to marshes and may be of greater ecological importance. Most of the species existing in the shrublands are native to Hong Kong. These shrublands are dominated by *Rhodomyrtus tomentosa*, *Baeckea frutescens*, *Rhus chinensis*, *Helicteres angustifolia*, and *Smilax china*. These shrublands have experienced cutting and hillfire. The common shrub species there can survive cutting and hill fires (Chen et al. 1998 and Chau 1994). The shrublands vary greatly in height, some are shorter than 50 cm, others are taller than 2 m. Some of the shrublands are moderate in species-richness. Butterfly species such as *Athyma perius*, *Chilasa clytia* and *Hepliophorus epicles* which were observed in the shrublands are expected to rely often on the habitat for feeding and breeding. The taller shrublands support more animal species. Most of the Hong Kong's native and non-coastal birds are at home in shrubland and many species reach their highest densities there (Ashworth et al. 1993).

Table 8.5 Evaluation of Shrubland Existing in the Study Area

Criteria	Remarks
Naturalness	Natural with some modification. This habitat is at a middle stage of vegetation succession, and may develop to woodland without hillfire, harvesting and other human disturbance. Exotic species are also found although most are native.
Size	Small, from 0.5 to 1.1 hm^2.
Diversity	Moderate to low.
Rarity	The habitat is widespread in Hong Kong and South China, particularly on lower hillsides and abandoned land.
Re-creatability	Readily re-creatable.
Fragmentation	The habitat is fragmented.
Ecological linkage	The habitat may provide cover for some animals to forage and breed and to move between habitats.
Potential value	In the absence of fire and where soils are not heavily degraded, vegetation succession could lead to the development of woodlands, which would be of greater ecological importance.
Nursery/breeding ground	Moderate value.
Age	At an early successional stage, this habitat is young.
Abundance / richness of wildlife	Moderate.

4) *Hillside Grassland*

There are four areas of hillside grassland present within the Study Area along the Hong Kong side of the Shenzhen River (Table 8.6 and Plate 8.3). The hillside grassland between the Sandy Ridge and Nam Hang is the largest in size (66.3 hm^2) and continuous, whereas the two hillside grasslands at Lo Shue Ling are moderate in size and divided by an area of low-lying grassland/fallow field and fragmented by a small area of urban environment. These grasslands are dominated by species native to Hong Kong, including *Arundinella setosa*, *Ischaemum aristatum*, *Cymbopogon tortilis* and *Imperata cylindrica*. Some patches within the hillside grasslands are dominated by the fern of *Dicranopteris linearis*. The grasslands are maintained by hillfire and can be recreated naturally within one or two years of burn. The grasslands are also modified by cutting, planting and other human disturbance. Grave worshippers often cut hill grassland to make a footpath to their ancestor's grave on Ching Ming and Chung Yeung Festivals. Some villagers seasonally cut patches of hill grassland near their houses to grow certain crops including *Citrus spp.*, *Carica papaya*, and *Ipomoea batatas*.

Table 8.6 Evaluation of Hillside Grassland Existing in the Study Area

Criteria	Remarks
Naturalness	Semi-natural; maintained by hill fire, cutting and other human disturbance; dominated by native species
Size	0.05 to 66.3 hm^2. The grassland between Sandy Ridge and Nam Hang is large, the others are moderate.
Diversity	Low.
Rarity	Widespread in Hong Kong and South China.
Re-creatability	This habitat is at an early stage of vegetation succession that is easily re-created naturally and artificially within one or two years
Fragmentation	The grassland between Sandy Ridge and Nam Hang is continuous but the others are fragmented by the urban environment.
Ecological linkage	The value of this habitat increases if they are adjacent to fish ponds (water bodies) and marshes of higher value.
Potential value	In the absence of hill fire, cutting, soil erosion and other disturbance, the hillside grasslands could develop to shrublands and further woodlands through vegetation succession, which would be of much greater ecological value.
Nursery/breeding ground	Low value.
Age	Relatively recent and repeatedly re-created as a result of recurrent hill fires.
Abundance / richness of wildlife	Low.

5) *Low-lying Grassland/Fallow Field*

There are numerous areas of low-lying grasslands/fallow fields present within the Study Area, ranging from 0.02 to 8.5 hm^2 in size (Plates 8.4 and 8.5). The low-lying grasslands/fallow fields east of Lo Shue Ling and around Muk Wu Tsuen are very large but fragmented by roads, villages, Muk Wu Pumping Station, Man Kam To Border Crossing and other areas of the urban environment, the Shenzhen River and Ping Yuen River, and agricultural lands (active). The other low-lying grasslands/fallow fields are moderate to small in size and divided by other habitats (Table 8.7). These low-lying grasslands/fallow fields are dominated by species native to Hong Kong, including *Panicum repens*, *P. maximum*, *Paspalum conjugatum*, *Ischaemum rugosum* and *Imperata cylindrica*. During the field surveys, some food plants were found left or abandoned in these lands including *Ipomoea aquatica*, *Ipomoea batatas*, *Brassica parachinensis* and *Dimocarpus longan*. Paddy Frog *Rana limnocharis* was commonly present in fallow fields at the wet season. The low-lying grasslands/fallow fields are less easily subject to damage of hillfire since these lands are wet most of the year, but experience other disturbance including cattle grazing and frequent human

trampling (especially near roads and villages). Villagers burn these lands intentionally, or apply herbicides on some of the lands to kill the weeds before growing crops

Table 8.7 Evaluation of Low-lying Grassland/Fallow Field Existing in the Study Area

Criteria	Remarks
Naturalness	Semi-natural, and disturbed by agricultural practices, human trespassing and cattle grazing.
Size	Small to large, 0.02 to 8.5 hm^2
Diversity	Low.
Rarity	This habitat is widespread in the New Territories of Hong Kong, and in the Pearl River Delta and other economically-dynamic parts of South China.
Re-creatability	This habitat can be re-created naturally.
Fragmentation	Fragmented by the urban environment.
Ecological linkage	The value of this habitat may increase since some areas of the habitat are adjacent to agricultural lands (active), marshes and woodlands.
Potential value	In the absence of agricultural practices, human trampling, cattle grazing and other disturbance, this habitat could develop into marshes of greater ecological importance.
Nursery/breeding ground	Low value.
Age	One or several years old, and repeatedly re-created as a result of disturbance.
Abundance / richness of wildlife	Moderate

such as *Lactuca sativa*, *Brassica parachinensis*, *Chrysanthemum coronarium var. spatiosum*, *Brassica chinensis*, *Brassica caulorapa* and *Gladiolus gandavensis*.

6) *Agricultural Land*

Agricultural land is defined as active agricultural land. There are 10 areas of agricultural land within the Hong Kong side of the Study Area (Plate 8.6), ranging from 0.1 to 4.8 hm^2 in size. The two areas of agricultural land at Man Kam To and Muk Wu, are large but fragmented by roads. Eight others are moderate to small in size. Some areas of this agricultural land derive from low-lying grasslands/fallow fields in the dry season. The other areas of this agricultural land grow crops all the year round with different crops at different seasons. The common crops in these permanent agricultural lands are vegetables, fruits and flowers, including *Ipomoea aquatica*, *Lactuca sativa*, *Brassica parachinensis*, *Chrysanthemum coronarium var. spatiosum*, *Brassica chinensis*, *Brassica caulorapa*, *Citrus reticulata*, *C. sinensis*, *Litchi chinensis*, *Psidium guajava and Gladiolus gandavensis*. The agricultural land is of value for birds such

Table 8.8 Evaluation of Agricultural Land Existing in the Study Area

Criteria	Remarks
Naturalness	Highly artificial, but wet agricultural land has some ecological functions of natural freshwater marshes.
Size	Small to large, from 0.1 to 4.8 hm^2
Diversity	Plant diversity is very low with one to three cultivars of vegetables or fruits grown in a field at a given season.
Rarity	The habitat is widespread in South China. It was also widespread in the New Territories, but might decrease considerably with urbanization, seasonal flooding and cheaper produce from outside Hong Kong.
Re-creatability	The habitat is artificial and can be readily re-created in about one year
Fragmentation	Fragmented by roads and other areas of the urban environment
Ecological linkage	The agricultural land is protected by farmers from unwanted disturbance, and may be used for foraging by animals from the adjacent woodlands, marshes and water bodies.
Potential value	The value could increase (particularly for non-bird taxa), e.g. by improving water quality, reducing pesticide use, increasing habitat diversity, introducing polyculture.
Nursery/breeding ground	The agricultural land is used as foraging ground by nesting birds, and as a nursery for invertebrates and amphibians.
Age	From recent to old
Abundance / richness of wildlife	A number of animals especially such waterbirds as *Tringa glareola* and *Actitis hypoleucos* occur in the agricultural land

as *Tringa glareola* and *Actitis hypoleucos* and other wildlife since it provides food for them (Table 8.8). This type of agricultural land is very widespread in South China. It used to be very widespread in the New Territories of Hong Kong, but with the increased development planned in the New Territories, this habitat will decrease considerably.

7) *Marshes*

There are nine areas of marshes within the Hong Kong side Study Area, of which three are large and the others are moderate to small in size (Plate 8.7). These marshes are flooded almost all the year round, and dominated by wetland grasses, herbs and ferns including *Panicum repens*, *Echinochloa crus-galli*, *Phragmites communis*, *Ischaemum rugosum*, *Commelina nudiflora*, *Alocasia odora*, *Polygonum hydropiper*, *Colocasia esculenta*, *Lemna minor* and *Cyclosorus acuminatus*. Most of the plant species existing in the marshes are native to Hong Kong. Bird species occurring in the marshes include: *Phalacrocorax carbo*, *Nycticorax nycticorax*, *Ardeola bacchus*, *E-*

gretta garzetta, *Ardea cinerea*, *Amaurornis phoenicurus*, *Gallinula chloropus*, *Actitis hypoleucos*, *Alcedo atthis*, *Halcyon smyrnensis*, *Motacilla flava*, *Prinia inornata*, *Sturnus sericeus* and *Sturnus cineraceus*. During the field surveys, Paddy Frog *Rana limnocharis* was commonly found in the marshes. The later section of the Fauna Surveys will describe the wildlife species present within the marshes in greater detail. These marshes have existed in the Study Area for a long time and are relatively undisturbed. Many areas of this habitat are of ecological importance (Table 8.9).

Table 8.9 Evaluation of Marshes Existing in the Study Area

Criteria	Remarks
Naturalness	Natural with a little modification.
Size	Small to large, 0.2 to 3.5 hm^2
Diversity	Floral and faunal diversity is high to moderate
Rarity	Most plants and animals using these fishponds are common and widespread. This habitat may be decreasing considerably in Hong Kong and South China with increased development (in Hong Kong and South China) and agricultural practices (in South China).
Re-creatability	This habitat can be re-created, but it may take some time for newly re-created marshes to develop to such mature marshes.
Fragmentation	Some are fragmented by the urban environment and other habitats.
Ecological linkage	Some marshes are adjacent to fishponds and woodlands
Potential value	Moderate. The habitat can be enhanced by integrating several adjacent moderate and small areas of marshes and improving soil and water conditions.
Nursery/breeding ground	The habitat is used by a wide variety of birds, and insects which are important food sources for a variety of birds and bats.
Age	Approximately 20 years old
Abundance / richness of wildlife	Significant numbers of animals, in particular birds and butterflies, are supported by marshes within the study area.

8) *Ponds*

The ponds within the Study Area include fishponds and bloodworm (*Chironomous spp.*) production ponds (Plates 8.8 and 8.9). Some ponds are actively farmed for commercial fish and bloodworm production, the others are abandoned for many years (Table 8.10). The unmanaged fishponds are the fishpond (6.1 hm^2) along the Ng Tung River, the fishpond (1.6 hm^2) northwest of the Nam Hang bloodworm pond

valley, the two fishponds (1.1 & 0.4 hm^2 respectively) in the bloodworm valley. The managed ponds are two fishponds (2.2 & 3.3 hm^2 respectively) north of the Sandy Ridge Cemetery, and all the 12 connected bloodworm ponds (1.1 hm^2 together) south of the Man Kam To Police Station. The pond area at Nam Hang consisting of 12 small ponds is used to culture bloodworms for sale in Mongkok of Hong Kong SAR as feed of ornamental fish. These bloodworm ponds are of much ecological importance as they are adjacent to the largest woodland at Nam Hang and are used as a foraging and breeding ground by protected rare species such as *Oriolus chinensis* which have only been found recent years at this site. The ponds at Yuen Leng Chai and along the Ng Tung River are large and others are moderate to small.

The wetland plants in pond bunds were found to be species common in and native to Hong Kong and South China, including *Alocasia odora*, *Panicum repens*, *Commelina nudiflora*, *Echinochloa crus-galli*, *Phragmites communis*, *Ischaemum rugosum*, *Polygonum hydropiper* and *Cyclosorus acuminatus*. The aquatic species *Eichhornia crassipes* and *Lemna minor* were also seen on the water surface.

Birds, fish and other animals were observed around these ponds during the field surveys. The following bird species were observed in ponds: *Phalacrocorax carbo*, *Nycticorax nycticorax*, *Ardeola bacchus*, *Egretta garzetta*, *Ardea cinerea*, *Amaurornis phoenicurus*, *Gallinula chloropus*, *Actitis hypoleucos*, *Alcedo atthis*, *Halcyon smyrnensis*, *Motacilla flava*, *Prinia inornata*, *Sturnus sericeus* and *Sturnus cineraceus*. During fish surveys, the following fish species were found in fishponds: *Sarotherodon mossambicus*, *Aristichthys nobilis*, *Cirrhinus molitorella*, *Ctenopharyngodon idellus*, *Mugil cephalus* and *Gambusia affinis*.

Table 8.10 Evaluation of Ponds Existing in the Study Area

Criteria	Remarks
Naturalness	The ponds are natural with human modification.
Size	Small to large, 0.4 to 6.1 hm^2.
Diversity	Moderate.
Rarity	Fishponds are common and widespread in the New Territories of Hong Kong and in South China but the bloodworm ponds are unique and rare in Hong Kong
Re-creatability	The habitat can be re-created artificially
Fragmentation	Many of the ponds are fragmented.

Criteria	Remarks
Ecological linkage	Some ponds are adjacent to woodlands and marshes.
Potential value	The ponds could be considerably enhanced through improved water quality, habitat structure and management.
Nursery/breeding ground	The ponds provide important breeding grounds for birds and insects
Age	The ponds are of recent origin
Abundance / richness of wildlife	Moderate

9) *Rivers*

The rivers within the Study Area include the Shenzhen River and several small rivers (Plate 8.10). The Ping Yuen River (River Ganges), Nam Hang River and Shawan River are located upstream of the Shenzhen River while the Ng Tung River (River Indus) is located at Lo Wu KCR Station midstream of the Shenzhen River. The Shenzhen River is continuous, currently about 16.9 km long and will be 12.5 km long on completion of the regulation project. The lengths of the sections of the Shenzhen, Ping Yuen, Nam Hang, Shawan and Ng Tung Rivers within the Study Area are 6040, 889, 734, 713 and 651 m respectively. The average widths of the sections of the rivers within the Study Area are about 20, 6, 5, 23 and 58 m respectively. Therefore, the Shenzhen, Ping Yuen, Nam Hang and Ng Tung Rivers may be of ecological importance according the criteria in the TM-EIA of Hong Kong since each of them is more than 500 m long. The water quality of the rivers is poor owing to the discharge of organic sewage and industrial effluent. The Shawan River is concreted, the Shenzhen River is currently natural with some modification and will be greatly artificial on completion of the regulation project. The Ping Yuen and Nam Hang Rivers are natural. The Ng Tung River is undergoing channelizaton (Table 8.11).

The wetland plants in water and on river embankments were found to be species common in and native to Hong Kong and South China, including *Alcasia odora*, *Panicum repens*, *Commelina nudiflora*, *Echinochloa crus-galli*, *Phragmites communis*, *Ischaemum rugosum*, *Polygonum hydropiper* and *Cyclosorus acuminatus*. Some food plants such as *Colocasia esculenta* and *Ipomoea aquatica* found along river embankments. The aquatic species *Eichhornia crassipes* and *Lemna minor* were also seen on the water surface.

Table 8. 11 Evaluation of Rivers Existing in the Study Area

Criteria	Remarks
Naturalness	The Shenzhen and Ping Yuen Rivers are natural but modified to a great extent. The Ng Tung River is undergoing channelization
Size	Long, from 651 to 6040 m within the Study Area.
Diversity	Moderate to low.
Rarity	Common and widespread in the New Territories of Hong Kong and in South China
Re-creatability	The habitat can be re-created artificially. But it takes a long time, probably about 15 years to re-create a river to the original natural state.
Fragmentation	The rivers are continuous
Ecological linkage	The rivers may provide important ecological corridors.
Potential value	The rivers could be considerably enhanced through improved water quality, habitat structure and management.
Nursery/breeding ground	Under suitable conditions, the rivers provide important breeding grounds for insects and amphibians
Age	The rivers are old
Abundance / richness of wildlife	Moderate

10) *Baregound*

There are two areas of cleared and open ground near Lo Wu KCR Station on the Hong Kong side of the Study Area, with areas of 1. 1 and 1. 3 hm^2 respectively. Another three similar cleared areas are located near the mouth of the Shawan River on the Shenzhen side of the Study Area, with areas ranging from 0. 1 hm^2 to 0. 3 hm^2. Clearance of vegetation cover and filling with soil are quite recent. Little or no vegetation on any of these areas has re-established, and no wildlife was observed during the field surveys. They are believed to be of little or no ecological importance (Table 8. 12).

Table 8. 12 Evaluation of Baregrounds Existing in the Study Area

Criteria	Remarks
Naturalness	Artificial
Size	Small, from 0. 1 hm^2 to 1. 3 hm^2 within the Study Area.
Diversity	Extremely low.
Rarity	Widespread.
Re-creatability	The habitat can be re-created easily.
Fragmentation	Continuous
Ecological linkage	Bareground is of low value as ecological links between habitats.

Criteria	Remarks
Potential value	Low.
Nursery/breeding ground	It is of extremely low value as a breeding and feeding ground for wildlife.
Age	Recent
Abundance / richness of wildlife	Extremely low

11) *Urban Environment*

The urban environment within the Study Area broadly includes urban residential areas, villages, office / commercial / industrial buildings, roadways, pumping stations, and railway stations. Numerous areas of the urban environment occur on the Hong Kong side of the Study Area, with areas of 0.1—6.6 hm^2. The Shenzhen side of the Study Area is mainly an urban environment with the largest urban environment area being 80.0 hm^2. Some areas of the urban environment are ancient such as old villages, while the others are recent such as newly-built houses on the Shenzhen side. The urban environment is of extremely low value as a feeding and breeding ground for wildlife. This habitat is believed to be of little or no ecological importance (Table 8.13).

Table 8.13 Evaluation of the Urban Environment Existing in the Study Area

Criteria	Remarks
Naturalness	Artificial
Size	Small to very large, from 0.1 hm^2 to 80.0 ha within the Study Area.
Diversity	Extremely low.
Rarity	Widespread.
Re-creatability	The habitat can be re-created easily.
Fragmentation	Continuous
Ecological linkage	The urban environment within the Study Area is of low value as ecological links between habitats.
Potential value	Low.
Nursery/breeding ground	It is of extremely low value as a breeding and feeding ground for wildlife.
Age	From recent to ancient
Abundance / richness of wildlife	Very low.

8.3.4 *Flora Surveys*

(1) *Methodology*

The overall species surveys were conducted over the Hong Kong side of the Study Area in the wet (12－14 August 1998) and dry (14－15 December 1998) seasons. During the survey of each area where plants occurred, floral species were identified and their locations recorded. During the surveys of each season, three walks were made through large vegetated areas and one or two walks were made through vegetated areas which were small in size. Such survey walks were made along the linear vegetated areas such as river banks and pond bunds. Relative abundance of each floral species was recorded and this information used to classify habitat areas and prepare a habitat map.

Two 100－meter transects (VT1 and VT2) were established near Muk Wu Tsuen and Lo Wu KCR Station (see Figure 8.1). The transects were run from the bank of the Shenzhen River to terrestrial land mass. During the line transect woody survey, all woody species touching the transect line were identified, and their distance, DBH (diameter at breast height), CD (crown diameter), and height were recorded. During the belt transect flora survey, a 0.5 x 0.5 m quadrat was placed at 20－meter intervals along the transect to investigate floral species. All floral species present within the quadrat were identified and their percentage cover, height, and numbers of individuals were recorded.

(2) *Results*

1) *Overall Species Surveys*

The overall species surveys were conducted within the Hong Kong Study Area in August and December 1998. All plant species encountered during visits to all habitat areas present within the Hong Kong Study Area, including woodland, shrubland, hillside grassland, low-lying grassland/fallow field, agricultural land, marsh, pond and river, were identified and their qualitative abundance was estimated in each habitat type.

One tree (*Michelia alba*) protected under the Forestry Regulations was found on the edge of the agricultural land with Muk Wu Tsuen. *Michelia alba* is taxonomically within the family of Magnoliaceae which is protected under the Regulations. This tree

is not wild but was planted for amenity purposes. The tree is far from the Project Area of the Shenzhen River and is not expected to be affected by the proposed regulation works. A total of 136 floral species were recorded within the Hong Kong Study Area, of which 89 are native to Hong Kong, and the remaining 47 are exotic to Hong Kong (Table 8.14). The native species are of greater ecological importance than the exotic species. *Pinus massoniana*, *Sterculia lanceolata*, *Celtis sinensis*, *Cinnamomum camphora*, *Bridelia tomentosa*, *Microcos paniculata*, *Melia azedarach* and *Acacia confusa* were the common tree species present in the woodlands. Many trees of the species *Ficus microcarpa*, *Cinnamomum camphora*, *Sterculia lanceolata* are believed to be more than 70 years old. A 100—year—old woman who had been living almost life time in Muk Wu Tsuen said that the tree *Ficus microcarpa* located between the village and the woodland north of it is about 100 years old, and that many old trees of *Cinnamomum camphora* and *Sterculia lanceolata* present within the woodland south of the village are more than 50 year old. Although these species are not listed under the Forestry Regulations, these old trees are of great ecological importance since they provide a habitat and food for birds and other animals (see Table 8.35).

Flora Species and Their Relative Abundance Found

Table 8.14 **within the Hong Kong Study Area**

Species	Exotic species	WL	SL	HG	LF	AL	MA	PR
Trees								
Acacia confusa	*	+++	+					
Aleurites moluccana	*	++						
Annona squamosa	*	+	+					
Aporusa chinensis	—	+	+					
Bauhinia blakeana	—	+	+		+			
Bauhinia purpurea	—	+	+		+			
Bauhinia variegata	*	+	+		+			
Broussonetia papyrifera	—	+	++	++				
Bridelia tomentosa	—	+++	+					
Carica papaya	*					+		
Caryota ochlandra	*	+						
Casuarina equisetifolia	*	++	+					
Celtis sinensis	—	+++	+		+			
Cinnamomum camphora	—	+++						
Citrus reticulata	*				+	+++		

Species	Exotic species	WL	SL	HG	LF	AL	MA	PR
Citrus sinensis	*				+	+++		
Clerodendrum fortunatum	—	++						
Cratoxylum cochinchinense	—	+++	++					
Croton crassifolius	—	++						
Delonix regia	*	+++						
Dimocarpus longan	*	+			+	++		
Eucalyptus citriodora	*	+						
Eucalyptus robusta	*	++			+			
Evodia lepta	—	++	++	++				
Ficus microcarpa	—	++						
Gossampinus malabarica	*	+						
Liquidambar formosana	—	+						
Litchi chinensis	*	+				+++		
Macaranga tanarius	—	+			+		+	+
Mallotus apelta	—	+						
Mangifera indica	*					++		
Melia azedarach	*	+++	+		+			
Michelia alba	* p					+		
Microcos paniculata	—	+++	++					
Musa paradisiaca	*					+		
Pinus massoniana	—	+++	++	+				
Psidium guajava	*	+				+++		
Saccharum officinarum	*					+		
Sapium discolor	—	++						
Sapium sebiferum	—	+			++			+
Sterculia lanceolata	—	+++						
Syzygium jambos	*	+						
Tristania conferta	*	++	++	++				
Shrubs								
Artemisia lactiflora	—			+	+		++	+
Baeckea frutescens	—	+	+++	++				
Breynia fruticosa	—	+	++	+				
Desmodium heterocarpon	—				++	+	++	+
Embelia laeta	—	+	+++	+				
Eurya chinensis	—		+	+				
Glochidion dasyphyllum	—		++	+				
Glochidion puberum	—		++	+				
Helicteres angustifolia	—		+++	+				
Hibiscus rosa-sinensis	*	+			+			

Species	Exotic species	WL	SL	HG	LF	AL	MA	PR
Inula cappa	—		+	+				
Lantana camara	*	+	++		++			
Litsea rotundifolia	—	+	+++	++				
Livistona chinensis	*	+	+		+			
Manihot esculenta	*					+		
Melastoma sanguineum	—	+	++	++				
Phyllanthus emblica	—	+	++	+				
Pteroloma triquetrum	—	+	+	+				
Rhaphiolepis indica	—	+	+	+				
Rhodomyrtus tomentosa	—	+	+++	+				
Rhus chinensis	—	+	+++	+				
Schefflera octophylla	—	++	++					
Smilax china	—		+++	+				
Trema orientalis	—		++	++				
Grasses								
Arundinella setosa	—	+	++	+++				
Commelina nudiflora	—				+		+++	+++
Cymbopogon tortilis	—			+++	+			
Cynodon dactylon	—			+	+			
Echinochloa crus-galli	—				+++	++	+++	+++
Eleusine indica	—				+++	+	+	++
Eriachne pallescens	—		+	++				
Eulalia speciosa	—	+	+	++				
Imperata cylindrica	—		+	+++	+++	+	+	+
Isachne globosa	—			+				
Ischaemum aristatum	—	+	+	+++	+			
Ischaemum rugosum	—				++-	+	+++	+++
Miscanthus floridulus	—	+	++	+++	+		+	+
Panicum maximum	*			++	+++			
Panicum repens	—				+++	+	++-	+++
Paspalum conjugatum	—				+++	+	+++	+-
Paspalum distichum	—				+++	++	+-+	+-+
Paspalum orbiculare	—	+	++	+++				
Pennisetum alopecuroides	—				++	+	-+	++
Phragmites communis	—				+		+++	+++
Setaria pallide-fusca	*			+	++	+	+	+
Sporobolus fertilis	—				++	+	++	++
Herbs								
Agave angustifolia	*				+			

Species	Exotic species	WL	SL	HG	LF	AL	MA	PR
Allium fistulosum	*					++		
Alocasia macrorrhiza	—	++			++		+++	+++
Alternanthera sessilis	—						++	++
Amaranthus tricolor	*					++		
Amaranthus viridis	—				++			
Anisopappus chinensis	—	+	+	+				
Benincasa hispida	*					+++		
Brassica caulorapa	*				++	++		
Brassica chinensis	*				++	+++		
Brassica parachinensis	*				++	+++		
Canna indica	*						+	+
Chrysanthemum coronarium var. spatiosum	*				++	+++		
Colocasia esculenta	*					++	+++	+−−
Eichhornia crassipes	*						+++	+−−
Gladiolus gandavensis	*				++	+++		
Haloragis chinensis	—		+	+				
Hedyotis acutangula	—		+	+				
Lactuca sativa	—				++	+++		
Lemna minor	—						+−−	−−−
Ludwigia adscendens	—						+−	−−−
Maranta arundinacea	*					+		
Osbeckia chinensis	—	+	+	+				
Pennisetum purpureum	*						+	−
Polygonum glabrum	—				++		−−−	−−−
Polygonum hydropiper	—				++		−−−	−−−
Rorippa nasturtium aquaticum	—				++	+++		
Ruta graveolens	*		+	+	++	+	++	−+
Spinacia oleracea	*				+	−−−		
Zingiber officinale	—					−		
Ferns								
Adiantum flabellulatum	—	++	+	+				
Cyclosorus acuminatus	—				++		−−+	−−−
Dicranopteris linearis	—	+	+	+−−				
Hicriopteris glauca	—	+	+	+++				
Lygodium dichotomum	—	++	++	++				
Pteris cretica	—	++	+	++				
Bamboos								

Species	Exotic species	WL	SL	HG	LF	AL	MA	PR
Bambusa spp.		++			+			−
Sedges								
Cyperus difformis	−				++	+	++	++
Cyperus malaccensis	−				++	+	++	++
Scleria levis	−				+	+	++	++
Climbers								
Ipomoea aquatica	*				+	+++	++	+++
Ipomoea batatas	*				+	+		
Ipomoea cairica	−				+++		+++	+++
Mikania micrantha	*	+			+++		+++	+++
Morinda umbellata	−	+	+	+				
Paederia scandens	−	+	+		++	+		
Vigna sesquipedalis	*					++		

1. Habitat: WL = woodland, SL = shrubland, HG = hillside grassland, LF = low-lying grassland /fallow field, AL = agricultural land, MA = marsh, PR = pond + river
2. * = exotic species, − = native species.
3. Relative abundance: +++ = common, ++ = occasional, + = rare.
4. p = protected under the Forestry Regulations of the Forests and Countryside Ordinance.

2) *Transect Surveys*

The belt transect flora surveys showed that the hillside grasslands and fallow fields/ low-lying grasslands have very low floral species diversity. Only a total of nine species were encountered in the five quadrats placed along belt transect VT1 covering fallow fields/low-lying grasslands whereas 13 species were encountered in the five quadrats placed along the belt transect VT2 covering hillside and low-lying grasslands (Table 8.15). The exotic climbing plant *Mikania micrantha* dominates the low-lying grasslands where transect VT1 was placed. *Dicranopteris linearis* has the highest percentage cover in the hillside grassland section of belt transect VT2 while *Commelina nudiflora* has the highest percentage cover in the low-lying grassland section.

The wet-season line transect woody surveys recorded 7 and 59 individuals of four and 17 woody species touching transects VT1 and VT2 respectively (Appendix 8). Their DBHs (diameter at breast height) ranged from 1 cm to 15 cm at VT1 and from 0.5 cm to 5 cm at VT2, whereas their heights ranged from 16 cm to 600 cm at VT1 and from 30 cm to 340 cm at VT2. The dry-season line transect woody surveys shared similar results, with 17 and 58 individuals of four and 15 woody species touching transects VT1 and VT2 respectively. Both wet-and dry-season line transect woody surveys showed that *Baeckea frutescens* and *Celtis sinensis* were the woody species most commonly seen at VT1 and VT2 respectively.

Table 8. 15 **Belt Transect Flora Survey Results**

Species	Percentage cover (%)		Height (cm)	
	Wet season	Dry season	Wet season	Dry season
VT1 near Muk Wu Tsuen				
Ipomoea cairica	NP	13	NP	31
Mikania micrantha	37	39	18	40
Miscanthus floridulus	5	6	200	300
Cymbopogon tortilis	NP	8	NP	23
Lantana camara	6	4	20	5
Panicum repens	2	2	20	5
Paspalum distichum	13	5	23	15
Cyclosorus acuminatus	1	1	50	45
Phragmites communis	17	NP	60	NP
Total	81	78		
VT2 near Lo Wu KCR Station				
Commelina nudiflora	19	14	100	80
Mikania micrantha	1	6	80	50
Polygonum hydropiper	NP	4	NP	5
Imperata cylindrica	10	4	60	5
Ischaemum aristatum	1	NP	83	NP
Embelia laeta	1	4	80	80
Miscanthus floridulus	1	4	150	180
Dicranopteris linearis	54	42	103	70
Baeckea frutescens	2	8	60	87
Rhodomyrtus tomentosa	NP	6	NP	133
Lantana camara	1	NP	120	NP
Rhaphiolepis indica	1	NP	80	NP
Litsea rotundifolia	1	NP	40	NP
Total	92	92		

1. The figure = the mean of the five quadrats

2. NP = not present

8. 3. 5 *Fauna Surveys*

Regular fauna surveys were conducted to determine the major animal resources and animal diversity of the SA and their dependence on the area. This provided the information about the ecological resources of the Study Area as well as information for evaluating the significance of potential project impacts.

(1) *Methodology*

A total of 26 days field surveys, both systematic and non-systematic, were arranged

in order to cover the major animal classes. The surveys were conducted within the Study Area at approximately equal intervals during the study period from June 1998 to January 1999 spanning the major seasons, wet and dry seasons.

The criteria considered when carrying out detailed surveys on a particular fauna group are:

- their niche and ecological importance;
- their suitability as an indicator of biodiversity within an ecosystem;
- their conservation value (e.g. rare, threatened, endangered or protected species); and
- existing information about their characteristics.

Based on the above criteria, birds, insects (especially butterflies and dragonflies), reptiles, amphibians and mammals were selected for detailed quantitative surveys.

Review of studies conducted at the Shenzhen River and its tributaries (Peking University 1995, BCL 1997, Maunsell 1997 and ERM 1999) indicate the river is essentially devoid of fish, except the most pollutant tolerant Tilapia and Cat Fish. Non-systematic fishes surveys were conducted to verify the information at the stretch affected by the Stage III project.

Based on the preliminary habitat surveys, three transects were identified to facilitate systematic animal surveys. These transects were selected to cover major habitat types of the Study Area. The location of these transects is shown in Figure 8.1 and the habitats represented are shown in Table 8.16.

Table 8.16 Characteristics of Quantitative Transects

	Animal transect AT1	Animal transect AT2	Animal transect AT3
Habitat covered	Shenzhen River channel, floodplain and channel bank, and fishponds within the Study Area	Knot-foot woodland; shrubland and actively managed bloodworm ponds and unmanaged fishponds.	Abandoned cultivation field and active cultivation field
Length	1160m along border road	400m	760m along border road
Constraint	View limited by border fences to river side only	Direct assess from border road limited by border fences	View limited by border fences to terrestrial side only

Non-systematic surveys were also conducted in areas not covered by the transects to verify the representativeness of the transects. The non-systematic surveys were conducted on the same day as the systematic surveys.

During the non-systematic surveys, special attention was given to those species not recorded along the transects. As the river channel and associated floodplain and fishponds are the areas most likely to be affected, special attention was given to the animal resources of these areas.

1) Bird Surveys

Three equally spaced quantitative bird surveys were conducted in each of the wet (22—24 June, 27—28 July and 8—10 September 1998) and dry seasons (19—20 October, 27 November / 9 December 1998, and 11—12 January 1999). Each bird survey consisted of two sampling days. The transects were surveyed by walkover in the morning and re-visited on the late afternoon of the same day. Species identification was done with x8 and x10 binoculars and x20~60 spotting scope, the effective survey distance was about 200m from the transect.

The parameters recorded included species identity, its activity, associated micro-habitat and numerical abundance. The information was recorded in Ecological Form I for Bird Surveys. Rare, endangered, or threatened species encountered in other instances (e.g. the non-systematic surveys) were recorded in a field log book.

2) *Insect Surveys*

Three equally spaced quantitative insect surveys were conducted at each of the wet (25, 26 & 29 June; 29—30 July; and 11 & 16 September 1998) and dry seasons (21 & 22 October, 10 &11 December 1998 and 20 & 22 January 1999). Each insect survey consisted of two sampling days. The transects were surveyed twice a day (similar to the bird surveys). Species identification was done by direct observation, and the effective survey distance was about 6m from the transect. In cases of identification difficulties, specimens were collected with a sweep net. All captured specimens were released unharmed on-site immediately after photographic recording.

The parameters recorded included species identity and their abundance. The information was recorded in Ecological Form II for Insect Surveys. Rare, endangered, or threatened species encountered in other instances (including the non-systematic surveys) were be recorded in a field log book.

3) *Amphibian & Reptile Surveys*

Three day-time and two night-time amphibian and reptile surveys were conducted at each of the wet season (25 & 29 June, and 4 & 5 August 1998) and the dry season (20 & 21 October, and 29 December 1998). The day-time survey were conducted on the morning of the day concurrently with the insect surveys. Night-time surveys were conducted after dark using torches and flashlight photography, and usually on the same date as the day-time surveys. Habitats close to the transects were actively searched for amphibian and reptile species, and the effective survey distance was about 3m.

The parameters recorded included species identity and their abundance. For those identified based on vocal characteristic, abundance ranking was estimated. The information was recorded in Ecological Form III for Amphibian, Reptile and Mammal Surveys. Rare, endangered, or threatened species encountered in other instances (including the non-systematic surveys) were recorded in a field log book.

Furthermore, the local community was consulted for information on occurrence of amphibian and reptile species in the Study Area.

4) *Mammal Surveys*

Three day-time and two night-time mammal surveys were conducted at each of the wet season (25 & 29 June, and 4 & 5 August 1998) and the dry season (20 & 21 October, and 29 December 1998). The surveys were conducted concurrently with the amphibian and reptile surveys. The survey included searches for paw prints, scats and burrows.

The information was recorded in Ecological Form III for Amphibian, Reptile and Mammal Surveys. The local community was also consulted for information on occurrence of mammals in the Study Area.

5) *Fish Surveys*

Fish surveys were conducted by direct observation and by sampling with monofilament nylon gill nets. Observational surveys of the main channel were conducted in the course of other surveys. Gill netting was conducted on 24-Aug-1998. One net of 15m long (GN1) was deployed at a fishpond closed to Lo Wu while another net of 8m long (GN2) was deployed at a tributary of the main channel close to the tidal lagoon (Figure 8.1). In both cases, the net was suspended to a depth of 0.5 m from floats.

A 6 x 6 cm mesh size was used. The nets were deployed for 30 minutes before retrieval.

The operator of the fishpond (P1) was also consulted for the operating status of the pond and species farmed. The parameters recorded included species identity and an estimation of abundance.

(2) *Results*

This section summarizes the results of field surveys together with the information from a literature review for comparison. The original data were presented at Appendices 8.5—8.8.

1) *Bird Surveys*

During the study period, a total of 72 bird species with 4390 total observations were recorded in the Study Area. The majority of the species were "captured" by the systematic surveys. Out of the 72 species, only two species were "missed" during the systematic surveys. The species recorded in the study area together with their observed frequency were shown in Table 8.17. The original data and calculation formula were presented in Appendices 8.5—8.6.

① Temporal Variation

Table 8.17 indicates that both species richness (SR, = number of species recorded) and abundance (AOF, average observed frequency) of birds were higher in the dry season than in the wet season. The cumulative SR (cSR) and total AOF (tAOF) in the wet season were 36.0 and 108.0 respectively. The corresponding values in the dry season were 61.0 and 249.5 respectively. Of the 61 species recorded in the dry season, 33 species were not present in the wet season. Greater cSR in the dry season (winter) was expected due to influx of passage migrants and winter visitors.

The temporal trend of daily SR and OF of the Study Area as a whole (AT1 + AT2 + AT3) is plotted in Figures 8.3 & 8.4. The increased OF, both mean value and the range, since the fifth round of the surveys (R5) indicated seasonal influx began in the middle of the winter season. The increased temporal variability of OF associated with a constant SR indicates the migrants are transient in nature.

Table 8.17 Bird Species and Abundance Recorded during Quantitative Surveys within the Study Area

		Season	Wet Season Average Observed Fequency (AOF-W)									Dry Season Average Observed Fequency (AOF-D)										
		Round	R1	R2	R3	R1	R2	R3	R1	R2	R3	R4	R5	R6	R4	R5	R6	R4	R5	R6	tAOF-	
ID	Latin Name	TOF	T1	T1	T1	T2	T2	T2	T3	T3	T3	T1	T1	T1	T2	T2	T2	T3	T3	T3	Wet	Dry
94	*Sturnus sericeus*	1065	-	-	-	-	-	-	-	-	-	-	75.0	138.8	-	-	-	-	50.0	2.5	-	88.8
56	*Sturnus sinensis*	300	-	-	-	-	-	-	-	-	-	-	50.0	-	-	-	-	-	25.0	-	-	25.0
62	*Sturnus sturninus*	200	-	-	-	-	-	-	-	-	-	-	25.0	-	-	-	-	-	25.0	-	-	16.7
80	*Tringa stagnatilis*	42	-	-	-	-	-	-	-	-	-	4.8	-	-	5.8	-	-	-	-	-	-	3.5
91	*Streptopelia orientalis*	28	-	-	-	-	-	-	-	-	-	-	7.0	-	-	-	-	-	-	-	-	2.3
93	*Saxicola maura*	27	-	-	-	-	-	-	-	-	-	-	-	0.8	0.3	0.3	1.0	1.8	0.8	2.0	-	2.3
67	*Ardea cinerea*	25	-	-	-	-	-	-	-	-	-	3.3	0.3	1.8	1.0	-	-	-	-	-	-	2.1
86	*Streptopelia tranquebarica*	18	-	-	-	-	-	-	-	-	-	-	-	4.5	-	-	-	-	-	-	-	1.5
63	*Gallinago gallinago*	15	-	-	-	-	-	-	-	-	-	-	-	3.8	-	-	-	-	-	-	-	1.3
85	*Prinia inornata*	13	-	-	-	-	-	-	-	-	-	0.3	0.5	0.5	0.3	-	1.3	0.5	-	-	-	1.1
104	*Tringa glareola*	10	-	-	-	-	-	-	-	-	-	-	-	-	-	2.5	-	-	-	-	-	0.8
72	*Locustella lanceolata*	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	0.5	-	0.5
81	*Gallinula chloropus*	5	-	-	-	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-	-	0.4
98	*Passer montanus*	5	-	-	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-	-	-	0.4
83	*Locustella certhiola*	4	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	-	-	-	-	-	0.3
87	*Anthus cervinus*	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.3	-	0.3
75	*Limnodromus scolopaceus*	3	-	-	-	-	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	0.3
47	*Milvus lineatus*	3	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	0.3	-	-	-	-	0.3
59	*Phalacrocorax carbo*	3	-	-	-	-	-	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	0.3
69	*Turdus hortulorum*	3	-	-	-	-	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	0.3
51	*Urocissa erythrorhyncha*	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.5	-	0.3
74	*Charadrius dubius*	2	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	0.2
50	*Himantopus himantopus*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	0.2
100	*Lonchura striata*	2	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	0.2
105	*Motacilla flava*	2	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	0.2
107	*Phylloscopus inornatus*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	0.2
68	*Pluvialis squatarola*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	0.2
89	*Tringa totanus*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	0.2
90	*Anthus richardi*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	0.1
45	*Botaurus stellaris*	1	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	0.1
55	*Emberiza yessoensis*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	0.1
103	*Sturnus cineraceus*	1	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	0.1

Table 8.17 Bird Species and Abundance Recorded during Quantitative Surveys within the Study Area

ID	Latin Name	Season	Wet Season Average Observed Fequency (AOF-W)									Dry Season Average Observed Fequency (AOF-D)									tAOF-	
		Round	R1	R2	R3	R1	R2	R3	R1	R2	R3	R4	R5	R6	R4	R5	R6	R4	R5	R6		
		TOF	T1	T1	T1	T2	T2	T2	T3	T3	T3	T1	T1	T1	T2	T2	T2	T3	T3	T3	Wet	Dry
92	*Urosphena squameiceps*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	0.1
13	*Circus spilonotus*	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
37	*Ixobrychus sinensis*	1	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
10	*Actitis hypoleucos*	44	-	-	0.5	-	-	-	-	-	-	1.8	3.8	2.0	-	1.0	1.5	-	-	-	0.2	3.3
18	*Garrulax canorus*	2	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-
30	*Ceryle rudis*	9	0.8	-	-	-	-	-	-	-	-	0.8	0.5	-	-	-	0.3	-	-	-	0.3	0.5
20	*Zosterops japonica*	4	-	0.5	-	-	-	-	-	0.3	-	-	-	0.3	-	-	-	-	-	-	0.3	0.1
29	*Apus pacificus*	3	-	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-	-	0.3	-
15	*Parus major*	6	-	0.8	-	-	-	-	-	-	0.5	0.3	-	-	-	-	-	-	-	-	0.4	0.1
19	*Cuculus micropterus*	5	-	0.3	-	0.8	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	0.4	-
1	*Hirundo rustica*	5	-	1.0	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	0.4	-
35	*Halcyon smyrnensis*	14	-	0.8	0.3	0.3	-	-	0.3	0.3	-	0.5	-	0.3	0.3	-	-	-	0.3	-	0.6	0.4
21	*Corvus macrorhynchus*	7	-	-	0.3	-	1.0	0.5	-	-	-	0.3	-	-	-	-	-	-	-	-	0.6	0.1
4	*Oriolus chinensis*	8	0.3	1.5	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	-
22	*Eudynamis scolopacea*	9	0.3	0.3	-	0.3	-	-	1.3	0.3	-	-	-	-	-	-	-	-	-	-	0.8	-
9	*Alcedo atthis*	23	0.5	0.5	0.8	0.3	0.8	-	-	-	0.3	1.3	0.5	0.3	0.3	0.3	-	-	-	-	1.0	0.8
26	*Pica pica*	36	0.5	0.8	0.8	0.3	0.3	0.5	-	-	0.3	1.0	0.5	1.5	0.5	0.5	0.8	-	-	0.8	1.1	1.8
12	*Acridotheres cristatellus*	59	1.3	-	-	0.5	0.3	-	1.0	0.3	-	4.5	5.0	0.8	-	-	-	0.3	0.5	0.5	1.1	3.8
6	*Bubulcus ibis*	29	0.5	1.3	1.0	-	-	-	-	1.3	-	1.0	-	1.3	-	-	-	-	-	-	1.3	0.8
38	*Prinia flaviventris*	19	0.5	1.3	0.8	-	-	0.8	0.5	0.5	-	0.3	-	-	-	-	-	-	0.3	-	1.4	0.2
14	*Casmerodius albus*	38	-	-	2.3	0.8	1.3	-	0.5	0.3	-	-	0.3	2.0	-	-	-	-	-	-	1.7	0.8
16	*Centropus sinensis*	33	1.0	1.5	0.5	0.5	0.3	0.5	0.5	0.8	0.5	-	0.3	0.3	0.5	-	0.3	1.0	-	-	2.0	0.8
27	*Copsychus saularis*	35	1.3	0.3	1.3	-	0.3	-	1.8	1.8	0.3	-	-	0.3	-	0.8	0.8	-	0.3	-	2.3	0.7
28	*Nycticorax nycticorax*	38	1.0	1.3	0.8	0.3	0.3	-	-	-	4.3	1.8	-	-	-	-	-	-	-	-	2.6	0.6
5	*Sturnus nigricollis*	122	1.3	1.5	0.5	0.5	1.0	0.5	2.5	2.5	0.3	1.8	4.8	5.8	1.0	0.5	-	2.5	2.0	1.0	3.5	6.4
36	*Amaurornis phoenicurus*	80	2.3	1.8	1.8	0.3	1.0	1.8	0.8	1.3	0.5	1.8	1.0	0.3	3.5	1.0	1.5	0.5	-	-	3.8	3.2
33	*Lonchura punctulata*	161	-	-	1.0	-	-	11.5	-	-	-	-	24.3	0.3	-	-	1.8	-	-	2.5	4.2	9.6
2	*Dicrurus macrocercus*	60	1.3	4.5	4.0	0.3	-	1.8	1.8	-	-	-	-	-	-	-	-	0.3	-	-	4.5	0.1
25	*Lanius schach*	96	2.3	2.3	1.0	1.5	1.5	0.8	2.5	1.3	0.8	2.3	0.5	1.3	0.3	1.0	0.3	2.0	2.0	0.8	4.6	3.4
31	*Pycnonotus aurigaster*	213	0.3	1.5	7.0	-	1.8	-	0.5	2.0	2.0	1.5	8.5	6.5	0.3	0.8	2.0	1.8	13.0	3.8	5.0	12.7
23	*Egretta garzetta*	96	2.3	6.5	1.8	2.0	1.3	1.0	0.5	-	0.5	1.3	0.8	0.3	2.0	2.0	0.3	-	0.3	-	5.3	2.3
3	*Garrulax perspicillatus*	111	3.0	3.0	1.3	0.8	1.5	1.0	5.5	0.3	1.5	1.3	1.8	0.8	-	0.8	2.5	-	0.5	2.0	5.9	3.2

Table 8.17 Bird Species and Abundance Recorded during Quantitative Surveys within the Study Area

ID	Latin Name	Season	Wet Season Average Observed Fequency (AOF-W)									Dry Season Average Observed Fequency (AOF-D)									tAOF-	
		Round	R1	R2	R3	R1	R2	R3	R1	R2	R3	R4	R5	R6	R4	R5	R6	R4	R5	R6		
		TOF	T1	T1	T1	T2	T2	T2	T3	T3	T3	T1	T1	T1	T2	T2	T2	T3	T3	T3	Wet	Dry
34	*Motacilla alba*	146	0.3	0.3	0.8	-	2.8	1.0	4.0	1.8	7.3	3.3	1.0	1.3	1.3	1.3	1.3	4.0	3.5	2.0	6.0	6.3
7	*Pycnonotus sinensis*	162	3.3	0.8	3.5	0.3	1.8	1.3	2.0	0.8	5.3	-	8.0	2.3	-	-	6.0	0.8	2.3	2.5	6.3	7.3
11	*Pycnonotus jocosus*	182	1.0	2.5	1.0	3.8	3.3	2.5	-	4.0	3.3	2.0	0.5	0.5	2.0	2.5	-	0.8	14.3	2.0	7.1	8.2
32	*Streptopelia chinensis*	232	4.0	3.0	5.3	1.0	2.8	2.3	2.0	1.5	1.0	5.0	6.8	8.5	2.3	0.3	0.8	2.0	4.5	5.3	7.6	11.8
8	*Ardeola bacchus*	440	6.5	12.3	14.5	5.5	10.0	9.3	6.3	5.5	5.0	11.3	3.8	3.0	5.0	4.0	3.5	0.5	0.5	0.5	24.9	10.7
110	*Anas* sp.	1	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	0.3	1.3
41	*Apus* sp.	28	3.5	2.5	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2
39	*Pycnonotus* sp.	18	-	0.3	0.5	-	-	-	-	-	-	-	2.5	-	1.3	-	-	-	-	-	-	0.1
109	Bunting spp.	2	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	0.3	-	-	-	2.3	-
40	Flycatcher spp.	4	-	-	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	-	0.3	-
43	Warbler spp.	4	-	-	-	-	0.8	-	-	-	0.3	-	-	-	-	-	-	-	-	-	0.3	-
42	UNID	4	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-
	Total	4390	35.5	51.5	52.5	20.0	32.8	37.0	34.3	27.3	33.3	52.8	233.5	192.5	27.8	21.3	26.3	18.8	146.5	29.3	108.0	249.5
	Number of Species **	69	24	26	25	20	19	17	19	21	17	24	30	33	19	21	19	15	21	17	36.0	61.0
	Species Diversity (H') **		2.8	2.7	2.6	2.4	2.4	2.2	2.6	2.6	2.3	2.8	2.2	1.4	2.4	2.7	2.5	2.4	2.0	2.6		
	Species Evenness (J') **		0.7	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.5	0.7	0.5	0.3	0.6	0.6	0.6	0.6	0.5	0.6		

The underline indicates species with particular high abundance during Dry Season

"-" indicates species not recorded (zero)

** unconfirmed species not included (i.e.last seven entries)

List sorted by tAOF-W, then by tAOF-D

Specifically, Chinese Pond Heron *Ardeola bacchus* was the most dominant species in the wet season. The Chinese Pond Heron together with Spotted Dove, Crested Bulbul, Chinese Bulbul, Black-faced Laughing-thrush, White Wagtail and Little Egret accounted for 52% of the birds counted (tAOF). The dominant species in the dry season were almost completely different from these of the wet season. Silky Starling *Sturnus sericeus was* the most dominant species in the dry season. Silky Starling together with Chinese Starling, Daurian Starling, Red-vented Bulbul and Spotted Dove accounted for 62% of the birds counted (tAOF). The observed frequency of the dominant species is re-listed in Table 8.18.

Table 8.18 Seasonal Dominant Bird Species

ID	Scientific Name	tAOF—W	tAOF—D
8	*Ardeola bacchus*	23%	<
32	*Streptopelia chinensis*	7%	5%
11	*Pycnonotus jocosus*	6%	<
7	*Pycnonotus sinensis*	5%	<
3	*Garrulax perspicillatus*	5%	<
34	*Motacilla alba*	5%	<
23	*Egretta garzetta*	5%	<
94	*Sturnus sericeus*	<	35%
56	*Sturnus sinensis*	<	10%
62	*Sturnus sturninus*	<	7%
31	*Pycnonotus aurigaster*	<	5%
	Cumulative Percentage of Seasonal Dominant Species	56%	62%
	tAOF	114.8	251.0

"<" indicates the percentage are less than 5%

② Spatial Variation

The temporal trends of SR and AOF of each transect are plotted in Figures 8.7 & 8.8. The temporal trends of the transects were similar to each other and to the overall plots (Figures 8.3 & 8.4). Generally, AT1 has higher SR and AOF than AT2 and AT3. Though AT3 was longer than AT2, there is no obvious difference in SR and AOF.

The figures also indicate that both AT1 and AT3 showed a significant increase in mean AOF during the dry season. Detailed analysis of the data (Table 8.17 and Appendices 8.5 and 8.6) indicated that the change was mostly due to influx of large group of starlings (Chinese Starling *Sturnus sinensis*, Daurian Starling *S. sturninus* and Silky Starling *S. sericeus*). The starlings were mostly found roosting and foraging in trees along the Shenzhen River (AT1 and AT3). Black-necked Starling *S. ni-*

gricollis, Red-vented Bulbul *Pycnonotus aurigaster* and Spotted Munia *Lonchura punctulata* were the other species that also exhibit similar strong spatio-temporal change.

[Re: total average observed frequency (AOF) was a sum of averge observed frequency (AOF) of each transect. AOF is an estumate of ecpected number of bired of the transect area. See Appendices 8.5 and 8.6 for calcuation formula.]

③ Discussion

The distribution status of the recorded birds and their protection status is shown in Table 8.19. As indicated in Table 8.19, about half the species were resident species (Viney et al 1994), the remainder were passage migrants, summer or winter visitors. This is corroborated by the observed seasonal pattern discussed above. In terms of regional distribution status, about half (47%, taxa = 34) of the recorded species are widespread and common ("A" in the Abundance column) in Hong Kong and Southern China. This group accounted for slightly more than half of the number of birds observed (54%, tAOF = 192.3). Although widespread and common in Hong Kong, Black-eared Kite *Milvus lineatus* and Greater Coucal *Centropus sinensis* are Class II protected animal in the PRC'S National Protection List of Important Wild Animals ("Ⅱ" in the Protection column). Greater Coucal is graded as vulnerable ("China (V)" in the Importance column) in the *China Red Data Book of Endangered Animas-Aves* (Wang et al. 1998) due to the threat of over hunting. The Populations of Common Kingfisher *Alcedo atthis*, Chinese Pond Heron *Ardeola bacchus* and Cattle Egret *Bubulcus ibis* in Hong Kong are considered as of regional conservation importance by local scientists (Aspinwall et al 1997).

About 40% (taxa = 28) of the recorded species are locally distributed but not uncommon ("B" in the Abundance column). This group accounted for another 40% of the number of birds observed (tAOF = 145.5). Fifteen species of this group are considered to be of regional or international importance. Silky Starling *Sturnus sericeus* is considered as a near threatened species (Collar et al 1994).

The other 15% (taxa = 11) of the recorded species are rare and restricted to suitable habitats ("C" and "R" in the Abundance column). This group accounted for 6% of the number of birds observed (tAOF = 18). The 15 of the recorded bird species are considered to be of regional or international importance.

Table 8.19 Regional Distrution Status and Protection Status of Birds Recorded within the Study Area

ID	Scientific Name	Abundance	Occurance	Protection	Importance	TOF	tAOF-W	tAOF-D
90	*Anthus richardi*	A	R PM WV*	HK, J		1	-	0.1
107	*Phylloscopus inornatus*	A	WV	HK, J		2	-	0.2
51	*Urocissa erythrorhyncha*	A	R*	HK		3	-	0.3
47	*Milvus lineatus*	A	R*	HK, II		3	-	0.3
29	*Apus pacificus*	A	R PM*	HK,A,J		3	0.3	-
20	*Zosterops japonica*	A	R*	HK		4	0.3	0.1
1	*Hirundo rustica*	A	PM SV*	HK,A,J		5	0.4	-
98	*Passer montanus*	A	R	HK		5	-	0.4
15	*Parus major*	A	R*	HK		6	0.4	0.1
21	*Corvus macrorhynchus*	A	R*	HK		7	0.5	0.1
22	*Eudynamis scolopacea*	A	R*	HK		9	0.8	-
24	*Lanius schach*	A	R*	HK		14	0.4	0.8
35	*Halcyon smyrnensis*	A	R*	HK		14	0.8	0.4
38	*Prinia flaviventris*	A	R*	HK		19	1.4	0.2
9	*Alcedo atthis*	A	R*	HK	HK	23	1.1	0.8
91	*Streptopelia orientalis*	A	PM WV	HK		28	-	2.3
6	*Bubulcus ibis*	A	R*	HK, J	Reg, HK	29	1.7	0.8
16	*Centropus sinensis*	A	R*	HK, II	China (V)	33	2.0	0.8
27	*Copsychus saularis*	A	R*	HK		35	2.3	0.7
26	*Pica pica*	A	R*	HK		36	1.2	1.8
10	*Actitis hypoleucos*	A	PM WV	HK,A,J		44	0.3	3.3
12	*Acridotheres cristatellus*	A	R*	HK		59	1.1	3.8
2	*Dicrurus macrocercus*	A	SV*	HK		60	4.9	0.1
36	*Amaurornis phoenicurus*	A	R	HK	HK	80	3.5	3.2
25	*Lanius schach*	A	R*	HK		82	4.2	2.7
23	*Egretta garzetta*	A	R*	HK		96	5.8	2.3
3	*Garrulax perspicillatus*	A	R*	HK		111	6.1	3.2
5	*Sturnus nigricollis*	A	R*	HK		122	3.8	6.4
34	*Motacilla alba*	A	WV	HK,A,J		146	5.9	6.3
7	*Pycnonotus sinensis*	A	R*	HK		162	6.3	7.3
11	*Pycnonotus jocosus*	A	R*	HK		182	7.0	8.2
31	*Pycnonotus aurigaster*	A	R*	HK		213	5.1	12.7
32	*Streptopelia chinensis*	A	R*	HK		232	7.6	11.8
8	*Ardeola bacchus*	A	R*	HK	HK, Reg, Int	440	26.0	10.7
	Fulica atra	B	R*	HK	HK	(1)	-	(1)
	Tachybaptus ruficollis	B	R*	HK	HK	(1)	-	(1)
	Corvus torquatus	B	R*	HK	HK	(1)	-	(1)
13	*Circus spilonotus*	B	WV	HK		1	0.1	-
37	*Ixobrychus sinensis*	B	PM SV*	HK,A,J	HK	1	0.1	-
100	*Lonchura striata*	B	R	HK		2	-	0.2
18	*Garrulax canorus*	B	R*	HK		2	0.2	-
74	*Charadrius dubius*	B	R*	HK, A		2	-	0.2
89	*Tringa totanus*	B	PM WV	HK,A,J	HK	2	-	0.2
105	*Motacilla flava*	B	PM WV	HK,A,J		2	-	0.2
87	*Anthus cervinus*	B	PM WV	HK		3	-	0.3
59	*Phalacrocorax carbo*	B	WV	HK	Int, Reg, HK	3	-	0.3
69	*Turdus hortulorum*	B	WV	HK		3	-	0.3
19	*Cuculus micropterus*	B	SV*	HK		5	0.4	-
81	*Gallinula chloropus*	B	R	HK, J	HK	5	-	0.4

Table 8.19 Regional Distrution Status and Protection Status of Birds Recorded within the Study Area

ID	Scientific Name	Abundance	Occurance	Protection	Importance	TOF	tAOF-W	tAOF-D
4	*Oriolus chinensis*	B	SV*	HK, J		8	0.7	-
30	*Ceryle rudis*	B	R*	HK	HK	9	0.3	0.5
104	*Tringa glareola*	B	PM WV	HK,A,J	HK	10	-	0.8
85	*Prinia inornata*	B	R*	HK		13	-	1.1
63	*Gallinago gallinago*	B	PM WV	HK	HK	15	-	1.3
67	*Ardea cinerea*	B	R*	HK	HK	25	-	2.1
93	*Saxicola maura*	B	WV	HK		27	-	2.3
14	*Casmerodius albus*	B	R*	HK	HK	38	2.4	0.8
28	*Nycticorax nycticorax*	B	R*	HK, J	Reg, HK	38	2.6	0.6
80	*Tringa stagnatilis*	B	PM WV	HK,A,J	HK	42	-	3.5
33	*Lonchura punctulata*	B	SV	HK		161	3.8	9.6
56	*Sturnus sinensis*	B	R*	HK		300	-	25.0
94	*Sturnus sericeus*	B	WV	HK	HK, Reg (NT)	1065	-	88.8
92	*Urosphena squameiceps*	C	WV	HK		1	-	0.1
103	*Sturnus cineraceus*	C	WV	HK		1	-	0.1
45	*Botaurus stellaris*	C	WV	HK, J	HK	1	-	0.1
50	*Himantopus himantopus*	C	PM WV	HK, J	HK	2	-	0.2
68	*Pluvialis squatarola*	C	PM WV	HK, A	HK	2	-	0.2
83	*Locustella certhiola*	C	PM	HK	HK	4	-	0.3
86	*Streptopelia tranquebarica*	C	PM WV	HK		18	-	1.5
55	*Emberiza yessoensis*	R	V	HK		1	-	0.1
75	*Limnodromus scolopaceus*	R	WV	HK	HK	3	-	0.3
72	*Locustella lanceolata*	R	PM	HK, J	HK	6	-	0.5
62	*Sturnus sturninus*	R	PM	HK		200	-	16.7
					No. of Taxa #	72	36	62 (38)
					Species Total	4390	114.8	251.0

The list is sorted by Abundance Class then by tOF

Abundance Codes:
A: widespread & common
B: local but not uncommon
C: very local or rare
R: very few records in HK

Occurance Codes:
PM: Passage Migrant
R: Resident
SV: Summer Visitor
WV: Winter Visitor
V: Vagrant
*: Breed in Hong Kong

Importance Code:
HK: Hong Kong
Reg: South-east Asia
Int: International
China: PRC
(V): Vulnerable
(NT): Near-theartened

Protection Codes:
HK: Wild Animal Protection Ordinance, Hong Kong
II: Class II protected animal in People's Republic of China (PRC)
A: Protection of Migratory Birds and their Environment (PRC & Australia)
J: Protection of Migratory Birds and their Habitats (PRC & Japan)

TOF, tAOF-W, tAOF-D:
bracketed numeric ( ) indicate speceis recorded in non-systematic survey
" - " indicate no records.

#: the bracketed numeric ( ) in number of taxa indicate the number of "new" species recorded in dry season

In terms of protection status, all bird species in Hong Kong are protected under the Wild Animals Protection Ordinance. Black-eared Kite and Greater Coucal are listed as class II protected animal in PRC. Furthermore, 22 recorded species are listed in the bilateral agreements signed between the Government of PRC and the Government of Australia for the Protection of Migratory Birds and their Environment ("A" in the Protection column) and / or between the Government of PRC and the Government of Japan on the Protection of Migratory Birds and their Habitats ("J" in the Protection column).

The status of the recorded bird species discussed above is summarized in Table 8.20 following the criteria suggested in Annex 8 of the EIA-TM (Hong Kong).

Table 8.20 Status of Bird Species Recorded within the Study Area

Criteria	Remarks
Protection Status	All (taxa = 73) are protected under the Hong Kong Wild Animals Protection Ordinance; 22 (31% of the total) are protected under PRC regulation or bilateral agreements, of which 2 are class II protected animal.
Distribution	33 are widespread and common, 28 are local but not uncommon, 11 are very local or rare. There are no endemic species.
Rarity	Greater Coucal Centropus sinensis is graded as vulnerable in China (Wang ed. 1998) while Silky Starling *Sturnus sericeus* is graded as regionally near-threatened (Collar et al 1994). Both are locally common.

2) *Insect Surveys*

During the study period, a total of 36 butterfly species with 1766 observed frequency, 4 damselflies species with 25 observed frequency and 16 dragonflies species with 1008 observed frequency were recorded. There were no "new" species recorded during the non-systematic survey. The butterfly and dragonfly species recorded in the study area together with their observed frequency are shown in Table 8.21 to Table 8.24. The original data is presented in Appendice 8.7.

① Butterflies (Lepidoptera)

Seasonality

Table 8.21 indicates cumulative species richness (cSR) was the same during both wet and dry seasons. The number of species recorded at each season was 30, 24 respectively. Average observed frequency, however, was higher in the dry season (tAOF = 93.9) than in the wet season (tAOF = 53.3).

The temporal trends of SR and OF at the SA as a whole (AT1 + AT2 + AT3) are plotted in Figures 8. 9 and 8. 10, while the diversity index (H') and evenness index (J') are plotted in Figures 8. 11 and 8. 12. As indicated in the figures, both the SR and OF were more or less stable in the wet season. Both parameters peaked at the beginning of the dry season (R4) and then subsided to low values. The variability of the parameters (standard errors, represented by boxes in the figures) shows a similar trend. The species diversity index and evenness index also show similar trends (Figures 8. 11 and 8. 12,). The seasonal peak during autumn time (R4) possibly represented an interfacing effect when the season changed.

Detailed analysis of individual transects (Figures 8. 13 and 8. 14) indicated that the SR of each transect and OF of AT1 exhibited similar temporal trends as with the whole SA. The OFs at both AT2 and AT3 were similar with a slightly higher value in the wet season. The analysis also indicated the high parameter variability of the whole SA was contributed mostly from AT1. Generally AT1 had a higher record of SR and OF, presumably as a result of the extended transect as with the case of bird surveys.

Review of the species matrix in Table 8. 21 indicated that the higher OF in the dry season was mostly due to seasonal blooming of Common Black *Jezebel Delias pasithoe*. Common Black Jezebel was particularly abundant at AT1 during the early winter time (R4 and R5) and accounted for about 40% of dry season total observed frequency (tAOF). This species was not recorded during the wet season. Blooming of Blue Spotted Crow *Euploea midamus* and Common Mormon *Papilio polytes* also contributed to the high OF at R4.

The dominant species in the wet and dry seasons as well as their regional abundance was shown in Table 8. 22. *Delias pasithoe* was the dominant species in the dry season (~40% tAOF-D). There was no dominant species in the wet season. *Euploea midamus*, *Eurema hecabe*, *Papilio polytes* and *Zizeeria maha* were common butterflies in both wet and dry seasons. *Ariadne ariadne*, *Athyma perius*, *Catopsilia pomona* and *Mycalesis mineus* were the other species commonly found during the wet season while *Artogeia canidia* and *Abisara echerius* were also common in the dry season. These species are common or very common in Hong Kong (Lau 1997) and each of these species constitutes at least 5% of seasonal tAOF.

Table 8.21 Butterflies and Their Average Observed Frequency (AOF) Recorded within the Study Area.

ID	Scientific Name	Season Round TOF	Wet Season Average Observed Frequency (AOF-W)									Dry Season Average Observed Frequency (AOF-D)									tAOF-	
			R1 T1	R2 T1	R3 T1	R1 T2	R2 T2	R3 T2	R1 T3	R2 T3	R3 T3	R4 T1	R5 T1	R6 T1	R4 T2	R5 T2	R6 T2	R4 T3	R5 T3	R6 T3	Wet WET	Dry DRY
b10	*Delias pasithoe*	451	-	-	-	-	-	-	-	-	-	12.3	83.5	-	0.5	5.8	0.5	1.0	9.0	0.3	-	37.6
b29	*Papilio paris*	2	-	-	-	-	-	-	-	-	-	0.3	-	-	0.3	-	-	-	-	-	-	0.2
b6	*Chilades lajus*	1	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	0.1
b22	*Junonia orithya*	1	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	0.1
b32	*Spindasis lohita*	1	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	0.1
b33	*Tagiades litigiosus*	1	-	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	0.1
b8	*Curetis dentata*	1	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
b14	*Faunis eumeuus*	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
b34	*Udaspes folus*	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
b35	*Ypthima lisandra*	10	-	0.3	0.3	-	-	-	-	-	-	0.5	1.0	0.3	-	-	-	0.3	-	-	0.2	0.7
b15	*Graphium agamemnon*	5	0.5	-	-	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	0.2	0.3
b16	*Graphium doson*	4	-	0.3	-	-	-	-	0.3	-	-	0.5	-	-	-	-	-	-	-	-	0.2	0.2
b26	*Papilio demoleus*	4	0.3	0.3	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	0.2	0.2
b31	*Potanthus sp.*	2	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	0.2	-
b3	*Artogeia canidia*	83	0.8	-	-	-	-	-	-	-	-	1.8	1.5	2.5	0.3	1.8	8.5	0.8	1.3	1.8	0.3	6.7
b1	*Abisara echerius*	59	0.3	-	0.5	-	-	-	-	-	-	3.5	5.3	0.8	2.3	1.8	0.3	-	0.3	-	0.3	4.7
b20	*Junonia almana*	4	0.5	0.3	-	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-	-	0.3	0.1
b23	*Lampides boeticus*	3	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-
b27	*Papilio helenus*	7	0.3	-	0.5	-	-	0.3	-	-	-	0.8	-	-	-	-	-	-	-	-	0.3	0.3
b9	*Danaus genutia*	37	-	-	0.5	-	-	-	-	-	0.8	6.3	0.3	0.3	0.8	-	-	-	0.5	-	0.4	2.7
b21	*Junonia atlites*	16	-	0.3	-	-	0.5	-	-	-	0.5	0.8	0.3	-	-	0.3	-	1.0	0.3	0.3	0.4	0.9
b7	*Chilasa clytia*	7	0.3	0.8	-	0.3	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	0.4	0.2
b18	*Heliophorus epicles*	40	1.3	0.3	0.3	-	-	-	-	-	-	0.3	2.5	3.0	0.5	0.3	-	-	0.5	1.3	0.6	2.8
b24	*Matapa aria*	29	-	0.8	0.5	-	-	-	-	0.5	0.3	2.5	-	0.3	0.5	-	-	2.0	-	-	0.7	1.8
b28	*Papilio memnon*	20	-	1.0	0.5	0.3	0.3	0.5	-	-	-	1.3	-	-	1.0	-	-	0.3	-	-	0.8	0.8
b17	*Graphium sarpedon*	28	1.0	0.5	0.3	0.8	0.3	-	-	-	-	2.8	-	-	1.3	-	-	0.3	-	-	0.9	1.4
b11	*Euploea core*	29	3.0	0.3	-	-	0.3	0.8	-	0.3	-	2.5	-	-	-	-	0.3	-	-	-	1.5	0.9
b19	*Hypolimnas bolina*	26	0.3	1.8	-	1.8	0.3	-	-	-	0.5	0.5	-	0.8	-	0.5	-	0.3	-	-	1.5	0.7

Table 8.21 Butterflies and Their Average Observed Frequency (AOF) Recorded within the Study Area.

		Season	Wet Season Average Observed Frequency (AOF-W)									Dry Season Average Observed Frequency (AOF-D)									tAOF-	
		Round	R1	R2	R3	R1	R2	R3	R1	R2	R3	R4	R5	R6	R4	R5	R6	R4	R5	R6	Wet	Dry
ID	Scientific Name	TOF	T1	T1	T1	T2	T2	T2	T3	T3	T3	T1	T1	T1	T2	T2	T2	T3	T3	T3	WET	DRY
b25	*Mycalesis mineus*	47	1.5	1.8	1.5	0.8	-	0.5	-	0.8	1.0	1.8	0.8	-	-	0.3	-	1.3	-	-	2.6	1.3
b30	*Papilio polytes*	115	2.3	2.8	3.8	1.5	1.0	-	-	-	0.8	14.3	-	-	1.3	-	-	1.3	-	-	4.0	5.6
b12	*Euploea midamus*	107	2.0	3.0	6.0	0.3	0.5	0.5	-	-	0.5	13.3	0.3	-	0.3	-	-	0.3	-	-	4.3	4.7
b4	*Athyma perius*	100	0.8	1.5	9.8	-	0.5	0.8	-	0.3	0.3	6.5	1.3	-	2.8	-	-	0.8	-	-	4.6	3.8
b5	*Catopsilia pomona*	59	2.0	9.8	-	1.0	0.8	-	0.3	1.0	-	-	-	-	-	-	-	-	-	-	4.9	-
b13	*Eurema hecabe*	118	1.8	6.3	5.0	-	1.3	0.5	-	0.3	-	8.5	2.0	1.3	2.0	-	0.5	0.3	-	-	5.0	4.8
b2	*Ariadne ariadne*	96	1.0	3.0	3.0	0.3	-	0.5	2.0	3.3	3.0	3.0	1.0	1.0	-	-	-	1.8	1.0	0.3	5.3	2.7
b36	*Zizeeria maha*	152	0.3	1.0	0.5	-	-	0.8	-	13.8	0.5	3.3	0.5	1.0	0.3	-	1.0	12.0	2.0	1.3	5.6	7.1
b37	UNID	99	6.3	1.8	4.3	2.8	0.3	2.8	0.8	2.0	1.3	1.0	-	-	0.8	-	-	1.0	-	-	7.3	0.9
	Total	1766	27.3	37.3	37.3	9.5	5.75	7.75	3.25	22	9.75	90.5	100	11	14.5	10.5	11	24.3	14.8	5	53.3	93.9
	Number of Species *	36	22	20	16	9	10	9	3	8	11	29	14	10	14	7	6	15	8	6	30.0	30.0
	Species Diversity (H') *	2.68	2.78	2.38	2.09	1.94	2.13	2.15	0.64	1.08	2.09	2.69	0.81	2	2.34	1.34	0.87	1.85	1.33	1.51	2.72	2.32
	Species Evenness (J') *	0.75	0.77	0.66	0.58	0.54	0.6	0.6	0.18	0.3	0.58	0.75	0.23	0.56	0.65	0.37	0.24	0.52	0.37	0.42	0.76	0.65

* Excluding unidentified specimen (UNID)
"-" indicate species not recorded (zero)

List sorted by tAOF-W then by tAOF-D

Table 8.22 Regional Abundance of Butterflies

ID	Species	Abundance	TOF	tAOF-W	%	tAOF-D	%
b13	*Eurema hecabe*	A	118	5.0	9%	4.8	5%
b30	*Papilio polytes*	A	115	4.0	8%	5.6	6%
b12	*Euploea midamus*	A	107	4.3	8%	4.7	5%
b3	*Artogeia canidia*	A	83	0.3	<	6.7	7%
b1	*Abisara echerius*	A	59	0.3	<	4.7	5%
b11	*Euploea core*	A	29	1.5	<	0.9	<
b7	*Chilasa clytia*	A	7	0.4	<	0.2	<
b10	*Delias pasithoe*	B	451	-	-	37.6	40%
b36	*Zizeeria maha*	B	152	5.6	10%	7.1	8%
b4	*Athyma perius*	B	100	4.6	9%	3.8	<
b2	*Ariadne ariadne*	B	96	5.3	10%	2.7	<
b5	*Catopsilia pomona*	B	59	4.9	9%	-	-
b25	*Mycalesis mineus*	B	47	2.6	5%	1.3	<
b9	*Danaus genutia*	B	37	0.4	<	2.7	<
b19	*Hypolimnas bolina*	B	26	1.5	<	0.7	<
b28	*Papilio memnon*	B	20	0.8	<	0.8	<
b35	*Ypthima lisandra*	B	10	0.2	<	0.7	<
b27	*Papilio helenus*	B	7	0.3	<	0.3	<
b15	*Graphium agamemnon*	B	5	0.2	<	0.3	<
b20	*Junonia almana*	B	4	0.3	<	0.1	<
b26	*Papilio demoleus*	B	4	0.2	<	0.2	<
b23	*Lampides boeticus*	B	3	0.3	<	-	-
b29	*Papilio paris*	B	2	-	-	0.2	<
b14	*Faunis eumeuus*	B	1	0.1	<	-	-
b6	*Chilades lajus*	B	1	-	-	0.1	<
b18	*Heliophorus epicles*	C	40	0.6	<	2.8	<
b24	*Matapa aria*	C	29	0.7	<	1.8	<
b17	*Graphium sarpedon*	C	28	0.9	<	1.4	<
b21	*Junonia atlites*	C	16	0.4	<	0.9	<
b16	*Graphium doson*	C	4	0.2	<	0.2	<
b22	*Junonia orithya*	C	1	-	-	0.1	<
b33	*Tagiades litigiosus*	C	1	-	-	0.1	<
b8	*Curetis dentata*	D	1	0.1	<	-	-
b34	*Udaspes folus*	D	1	0.1	<	-	-
b32	*Spindasis lohita*	D	1	-	<	0.1	<
b31	*Potanthus* sp.		2	0.2	<	-	-
	UNID		'99	7.3	14%	0.9	<
		Total	1766	53.3	82%	93.9	76%
	Number of Species (=cSR) *		36	30		30	

* Excluding unidentified specimen (UNID)
"<" indicates the percentage are less than 5%
"-" indicate species not recorded (zero)
The list is sorted by Abundance Class then by TOF

Abundance Class:
A = Very Common
B = Common (& widespread)
C = Uncommon
D = Rare

Table 8. 22 also shows three locally rare butterflies, Hong Kong Sunbeam *Curetis dentata*, Grass Demon *Udaspes folus* and Long-banded Silverline *Spindasis lohita* (Lau 1995) were recorded in the Study Area. Although locally rare, these speciesare widely distributed throughout the South-east Asia (Bascombe 1995).

The status of the butterflies species discussed above is summarized in Table 8. 23 following the criteria suggested in the Annex 8 of EIA-TM (Hong Kong).

Table 8. 23 Status of Butterflies Species Recorded within the Study Area

Criteria	Remarks
Protection Status	None of the recorded species (taxa = 36) are protected.
Distribution	Most of the recorded species (taxa = 25) species are common or very common, seven species are locally uncommon and 3 species locally rare. There are no endemic species.
Rarity	Three species are locally rare.

② Odonates (Damselflies and Dragonflies)

Sixteen species of dragonflies (anisoptera) and four species of damselflies (zygoptera) were recorded during the study (Tables 8. 24 and 8. 25). Both the number of odonate species and their observed frequency dropped drastically in the dry season. The cSR and tAOF were 16 and 54. 8 in the wet season while the corresponding parameters were 7 and 29. 3 in the dry season.

The temporal trends of daily cSR and OF of dragonflies at the SA as a whole (AT1 + AT2 + AT3) were plotted in Figures 8. 15 and 8. 16 and the diversity index (H') and evenness index (J') were plotted in Figures 8. 17 and 8. 18. The number of dragonflies species, abundance (AOF) and species diversity (H') were generally higher in the wet season than in the dry season. The distribution of species was also more even (J') in the wet season.

However, the abundance was obviously higher in the autumn time (R3 and R4) when the season changed. There were almost no dragonflies (and damselflies) in the winter time (R5 & R6). The high abundance was mostly due to *Pantala flavescens* that emerged in the autumn time (Table 8. 24).

Table 8.24 Dragonflies and Their Average Observed Frequency (AOF) Recorded within the Study Area.

ID	Scientific Name	Season	Wet Season Average Observed Frequency (AOF-W)									Dry Season Average Observed Frequency (AOF-D)									tAOF-	
		Round	R1	R2	R3	R1	R2	R3	R1	R2	R3	R4	R5	R6	R4	R5	R6	R4	R5	R6	Wet	Dry
		TOF	T1	T1	T1	T2	T2	T2	T3	T3	T3	T1	T1	T1	T2	T2	T2	T3	T3	T3	Wet	Dry
1	*Brachythemis contaminata*	47	0.5	-	-	7.0	2.8	1.3	-	-	-	-	-	-	0.3	-	-	-	-	-	3.8	0.1
2	*Crocothemis servilia servilia*	46	0.8	-	-	6.8	-	0.3	3.8	-	-	-	-	-	-	-	-	-	-	-	3.8	-
3	*Ictinogomphus pertinax*	13	1.0	-	-	0.8	0.5	1.0	-	-	-	-	-	-	-	-	-	-	-	-	1.1	-
4	*Neurothemis tullia tullia*	8	0.8	-	-	-	0.8	0.3	0.3	-	-	-	-	-	-	-	-	-	-	-	0.7	-
5	*Orthetrum luzonicum*	2	-	-	-	-	0.3	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-
6	*Orthetrum pruinosum neglectum*	56	0.3	-	0.3	0.8	5.5	1.5	0.8	2.0	-	0.3	-	-	2.0	-	-	0.8	-	-	3.7	1.0
7	*Orthetrum sabina sabina*	28	-	0.5	1.8	-	0.8	1.0	0.3	-	0.8	0.3	-	-	1.0	-	-	0.8	-	-	1.7	0.7
8	*Palpopleura sexmaculata sexmaculata*	1	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
9	*Pantala flavescens*	566	-	-	26.8	-	0.5	14.8	-	-	26.8	21.3	0.5	-	31.3	-	-	18.0	1.8	-	22.9	24.3
10	*Pseudothemis zonata*	6	-	0.3	0.8	-	0.3	0.3	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-
11	*Rhyothmis variegata arria*	38	2.0	4.3	0.8	-	1.5	0.8	-	-	-	0.3	-	-	-	-	-	-	-	-	3.1	0.1
12	*Tetracanthagyna waterhousei*	1	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
13	*Tramea virginia*	13	-	1.0	-	-	0.5	-	-	0.5	0.5	0.3	-	-	-	-	-	0.5	-	-	0.8	0.3
14	*Trithemis aurora*	24	-	1.0	0.3	1.5	0.3	1.8	0.3	0.3	-	0.3	-	-	0.5	-	-	-	-	-	1.8	0.3
15	*Trithemis festiva*	2	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-
16	*Zygonix sp*	1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
17	UNID	156	5.8	-	11.3	2.8	-	4.5	3.0	-	3.8	4.0	1.3	-	1.8	-	-	1.0	-	-	10.3	2.7
	Total	1008	11.3	7.25	41.8	20	13.5	27.8	8.25	2.75	31.8	26.5	1.75	0	36.8	0	0	21	1.75	0	54.8	29.3
	Number of Species *	16	7	6	6	6	11	12	5	3	3	6	1	0	5	0	0	4	1	0	16	7
	Species Diversity (H') *	1.38	1.72	1.28	0.54	1.32	1.84	1.44	0.95	0.76	0.21	0.3	0	0	0.46	0	0	0.43	0	0	1.76	0.42
	Species Evenness (J') *	0.5	0.62	0.46	0.19	0.48	0.66	0.52	0.34	0.27	0.08	0.11	0	0	0.17	0	0	0.16	0	0	0.64	0.15

* Excluding unidentified specimen (UNID)
"-" indicate species not recorded (zero)
List sorted by tAOF-W then by tAOF-D

Table 8.25 Regional Abundance of Odonate Species Recorded within the Study Area.

ID	Species	Abundance	TOF	tAOF−W	%	tAOF−D	%
	Damselflies						
	Copera marginipes	B	10	0.8		−	
	Agriocnemis femina oryzae	B	2	0.2		−	
	Ischnura senegalensis	B	2	0.2		−	
	Onychargia atrocyana	B	1	0.1		−	
	UNID		10	0.8		−	
	Dragonflies						
d9	*Pantala flavescens*	B	566	22.9	42%	24.3	83%
d6	*Orthetrum Pruinosum neglectum*	B	56	3.7	7%	1.0	<
d1	*Brachythemis contaminata*	B	47	3.8	7%	0.1	<
d2	*Crocothemis servilia servilia*	B	46	3.8	7%	−	−
d11	*Rhyothmis variegata arria*	B	38	3.1	6%	0.1	<
d7	*Orthetrum sabina sabina*	B	28	1.7	<	0.7	<
d14	*Trithemis aurora*	B	24	1.8	<	0.3	<
d3	*Ictinogomphus pertinax*	B	13	1.1	<	−	−
d13	*Tramea virginia*	B	13	0.8	<	0.3	<
d4	*Neurothemis tullia tullia*	B	8	0.7	<	−	−
d10	*Pseudothemis zonata*	B	6	0.5	<	−	−
d5	*Orthetrum luzonicum*	B	2	0.2	0%	−	−
d15	*Trithemis festiva*	B	2	0.2	0%	−	−
d8	*Palpopleura sexmaculata*	B	1	0.1	0%	−	−
d12	*Tetracanthagyna waterhousei*	B	1	0.1	0%	−	−
d16	*Zygonix sp*	D?	1	0.1	0%	−	−
	UNID		156	10.3	19%	2.7	9%
		Total	1008	54.75	88%	29.25	92%
	Number of Species (=cSR)*		15	15		7	

* Excluding unidentified specimen (UNID)

"<" indicates the percentage are less than 5%

"−" indicate species not recorded (zero)

The list is sorted by Abundance Class then be TOF

Abundance Class:

A=Very Common

B=Common (& widespread)

C=Uncommon

D=Rare

Analysis of individual transects (Figures 8. 19 and 8. 20) reveals similar time course of species abundance in each area. The average numbers of species recorded at AT1 and AT3 were more or less stable in the wet season and dropped to almost zero in the late dry season (R5 and R6). However, AT2 shows a different time course, the numbers of species recorded in mid-summer (R2 and R3) were particularly high and contributed to the high record of species number of the SA as a whole.

The dominant species in each season as well as their regional abundance were shown in Table 8. 23. As stated earlier, *Pantala flavescens* was the most dominant species in the autumn time (R3 and R4). Other species that were common in the wet season included *Brachythemis contaminata*, *Crocothemis servilia*, *Orthetrum pruinosum neglectum* and *Rhyothmis variegata arria*. Dragonflies and damselflies were scarce in the dry season.

Table 8. 25 also shows that no rare or endemic odonates were recorded within the SA. The status of the odonate species discussed above is summarized in Table 8. 26 following the criteria suggested in the annex 8 of EIA-TM (Hong Kong).

Table 8. 26 Status of Odonate Species Recorded within the Study Area

Criteria	Remarks
Protection Status	None of the recorded species (taxa = 20) are protected.
Distribution	All of the recorded species (taxa = 20) are common and or widespread. There is no endemic species.
Rarity	There is no rare species.

The temporal trends of damselflies were not included due to their low OF which make quantitative analysis inappropriate.

3) *Amphibian & Reptile Surveys*

During the study period, a total of 6 amphibian species with an observed frequency of 84 and 5 reptile species with an observed frequency of 6 were recorded in the SA. All the amphibian species were "captured" during the systematic surveys while only one of the reptile species was "captured" during the non-systematic survey. The species recorded during the study are summarized in Table 8. 27.

① Amphibian

A total of six amphibian species were recorded during the study. The observed frequency of amphibians was low. This makes quantitative analysis meaningless, never-

theless the results indicates the general abundance distribution of amphibian within the SA.

Table 8.27 Amphibian and Reptile Species Recorded within the Study Area

Scientific Name	Abundance	TOF	tAOF-W	tAOF-D
Amphibian				
Rana guentheri	A	6	2.5	0.5
Rana limnocharis	A	6	2.0	1.0
Polypedates megacaphalus	A	25	6.5	6.0
Bufo melanostictus	A	37	15.5	3.0
Kaloula pulchra	B	6	1.5	1.5
Kalophrynus interlineatus	C	4	0.5	1.5
		84	28.5	13.5
Reptile				
Gecko chinensis	A	2	1	1
Calotes versicolor	A	1	-	1
Lycodon subcinctus	A	1	1	-
Trimeresurus albolabris	A	-	(1)	-
Pelodiscus sinensis	C	1	-	1

The list of amphibian is sorted by Abundance Class then by TOF
Abundance Codes:
A: widespread & common
B: local but not uncommon
C: very local or rare

TOF, tAOF-W, tAOF-D:
bracketed numeric ( ) indicate speceis recorded in non-systematic survey
" - " indicate no records.

Common Toad *Bufo melanostictus* and Brown Tree Frog *Polypedates megacaphalus* were the most common amphibian species within the SA (especially *B. melanostictus* during the wet season). Both species were very common and widespread. Paddy Frog *Rana limnocharis* should also be very common in the SA, especially the marshes and fallow fields judging from vocal calls.

There was no strong seasonal change of species numbers and their abundance except the Common Toad *B. melanostictus*. The tAOF of Common Toad *B. melanostictus* dropped drastically with the onset of the dry season. Calls of Paddy Frog disappeared during the dry season.

In terms of regional distribution, the recorded amphibian species are mostly common

and widespread in rural areas of Hong Kong (Karsen et al 1998 and Hill & Phillipps 1981). Narrow-mouthed Frog *Kalophrynus pleurostigma* was the only locally rare amphibian recorded. Narrow-mouthed Frog *Kalophrynus pleurostigma* is a lowland habitat species (Karsen et al 1998), and its distribution depends on the extent and availability of suitable habitat. The geographical range of this species extends from China and Hainan to Burma, Thailand, Cambodia and northern Vietnam (Zhao & Adler 1993).

In terms of protection status, none of amphibians are specifically protected.

The status of the amphibian species discussed above is summarized in Table 8.28 following the criteria suggested in Annex 8 of the EIA-TM (Hong Kong).

Table 8.28 Status of Amphibian Species Recorded within the Study Area

Criteria	Remarks
Protection Status	None of the species (taxa = 6) are particularly protected
Distribution	4 species are widespread and common, 1 species is local but not common, 1 is locally rare. There are no endemic species.
Rarity	Narrow-mouthed Frog *Kalophrynus interlineatus* is locally rare. None of them are on the threatened lists (Groombridge 1988).

② Reptile

A total of five reptiles were recorded. The observed frequency of reptiles was very low. The result only indicates the presence of the animals within the SA. The low observed frequency was probably due to secretive behavior of the animals and / or human avoidance rather than scarcity of animals as the recorded species were mostly common and widespread (Karsen et al 1998 and Hill & Phillipps 1981).

Two snakes, Bamboo snake *Trimeresurus albolabris* [road killed] and Banded Wolf Snake *Lycodon subcinctus*, were observed during the surveys. However, community consultation indicated possible presence of several other species including Banded Krait (*cf. Bungarus fasciatus*), Many-banded Krait (*cf. B. multicinctus*), Chinese cobra (*cf. Naja atra*), Indo-Chinese Rat Snake (*cf. Ptyas korros*) and Burmese python (*cf. Python molurus*). The most noticeable report was an adult python crossing the section of Border Road close to Lamp Post 145, as seen by a police officer on 19-Oct-1998. Burmese Python *Python molurus* is the only python known to occur in Hong Kong (Karsen et al 1998).

In terms protection status, the wild population of Chinese soft-shelled Turtle *Pelodiscus sinensis* which was found at the southern entrance to the fishpond northwest of the bloodworm pond valley, as with all species of testudines, is protected under the Wild Animals Protection Ordinance (HK). The species is bred in captivity in Guangdong Province for human consumption. The specimen observed was possibly an escapee given the poor water quality of the Shenzhen River. Burmese Python *Python molurus* is protected under both the Wild Animals Protection Ordinance (HK), the Animals and Plants (Protection of Endangered Species) Ordinance (HK) and the National Protection List of Important Wild Animals (PRC). The species is also listed in Appendix II of CITES and was graded as vulnerable on the 1988 IUCN Red List of Threatened Amphibians and Reptiles (Groombridge 1988).

The status of the reptile species discussed above is summarized in Table 8.29 following the criteria suggested in Annex 8 of EIA-TM (Hong Kong).

4) *Mammal Surveys*

During the study period, four wild mammalian species were observed by the survey team. The wild mammals observed included bats (*cf. Pipistrellus abramus* and *Scotophilus kuhlii*), Javan Mongoose *Herpestes javanicus*, and two Grey Shrews *Crocidura attenuata* (one road killed and one killed by a predator).

Table 8.29 Status of Reptile Species Recorded within the Study Area

Criteria	Remarks
Protection Status	*Pelodiscus sinensis* is protected under the Wild Animals Protection Ordinance (HK). But it was most likely to be an escapee from rearing in Guangdong. Possible presence of *Python molurus* which is protected under the Wild Animals Protection Ordinance (HK), the Animals and Plants (Protection of Endangered Species) Ordinance (HK) and the National Protection List of Important Wild Animals (PRC).
Distribution	*Pelodiscus sinensis* is locally uncommon. Other species recorded are common and widespread. There are no endemic species.
Rarity	None of them are rare. Possible presence of *Python molurus* which is graded as vulnerable on the 1988 IUCN Red List of Threatened Amphibians and Reptiles (Groombridge 1988).

A low density of bats was observed around the SA after dark, probably foraging. The density decreased drastically with the onset of the dry (cold) season. Abundant numbers of insectivorous bats Japanese Pipistrelle *Pipistrellus abramus* and Lesser Yellow

Bat *Scotophilus kuhlii* were recently reported around the upper reaches of Indus River (Maunsell 1997). The SA is probably their extended foraging ground as active searches of ruins and trees did not reveal any on-site bat roosts. Japanese Pipistrelle is widespread in Hong Kong SAR while Lesser Yellow Bat is mostly found in the New Territories of Hong Kong (Ades 1990).

Javan Mongoose *Herpestes javanicus* was seen along the Shenzhen River course. In Hong Kong, the species was first recorded in 1990 at Mai Po. Since that time, an increasing number of sightings have been reported in other areas of Inner Deep Bay (Goodyer 1992, Binnie 1996 and ERM 1998).

Grey Shrew *Crocidura attenuata* is a common small rodent well established in the rural area (Goodyer 1992). Apart from the three species observed by the survey team, community consultation indicates the possible presence of several other species including Chinese Leopard Cat *Felis bengalensis chinensis*, Chinese Pangolin *Manis pentadactyla*, Porcupine *Hystrix brachyura*, Small Indian Civet *Viverricula indica* and Wild Boar *Sus scrofa*.

In terms of protection status, all bats (order chiroptera), all mongooses, Leopard Cat, Chinese Pangolin, Porcupine, Small Indian Civet are protected under the Wild Animals Protection Ordinance (HK). Leopard Cat and Pangolin are further protected under the Animals and Plants (Protection of Endangered Species) Ordinance (HK). Small Indian Civet is class II protected species listed on the National Protection List of Important Wild Animals (PRC).

The status of the reptile species discussed above is summarized in Table 8.30 following the criteria suggested in Annex 8 of EIA-TM (Hong Kong).

Table 8.30 Status of Mammalian Species Recorded within the Study Area

Criteria	Remarks
Protection Status	Bats and Mongoose are protected under the Wild Animals Protection Ordinance (HK). Possible presence of other protected species including Chinese Leopard Cat, Chinese Pangolin, Porcupine and Small Indian Civet.
Distribution	The species observed during field surveys are not uncommon. There are no endemic species.
Rarity	None of the species observed during field surveys are rare.

5) *Fish Surveys*

The gill netting at the fishpond (GN1) harvested 14 adult (total length ~ 30cm) Tilapia *Sarotherodon mossambicus*. Tilapia *S. mossambicus* is very abundant in the fishponds as fish were caught immediately after net deployment. A large number of Tilapia fish were also observed while they were fed, presumably by the pond operator.

Consultation with the pond operator (Mr Lai) indicated the ponds are used for polyculture. The species stocked include Big Head *Aristichthys nobilis*, Mud Carp *Cirrhinus molitorella*, Grass Carp *Ctenopharyngodon idellus*, Grey Mullet *Mugil cephalus* and Tilapia *S. mossambicus*. Smaller fish, for instance Mosquito fish *Gambusia affinis*, are also expected in the fishponds. Kingfishers were observed hunting the latter in the ponds. Given the information and the sampling results, Tilapia might possibly be the dominant species.

Gill netting in the tributary of the Shenzhen River (GN2) captured Common Carp *Cyprinus carpio*, Tilapia *Sarotherodon mossambicus* and Wels Catfish *Siluris glanis*. The net was entangled with barbed wire and was destroyed. Adult Wels Catfish (up to one meter long) and Tilapia were commonly observed along the channel during other field surveys. Smaller fish, for instance Mosquito fish *Gambusia affinis*, are also expected in the Shenzhen River channel as Kingfishers were observed hunting along the course. Wels Catfish is also abundant along River Indus (Maunsell 1997).

In terms of protection status, none of the fish are specifically protected.

The status of the fish species discussed above is summarized in Table 8.31 following the criteria suggested in Annex 8 of EIA-TM (Hong Kong).

Table 8.31 Status of Fish Species Recorded within the Study Area

Criteria	Remarks
Protection Status	None of the recorded species (taxa = 3) are protected
Distribution	The recorded species are common in fishponds and channels. There are no endemic species.
Rarity	None of the recorded species are rare.

8.4 Ecological Modelling

The Study Area of the Shenzhen River consists of two interrelated ecosystems: the terrestrial ecosystem and the aquatic ecosystem. The terrestrial ecosystem consists of the woodlands, shrublands, hillside grasslands, low-lying grasslands/fallow fields, agricultural lands and marshes, whereas the aquatic ecosystem consists of the rivers and ponds. The marshes and low-lying grasslands serve as the interface between the terrestrial ecosystem and the aquatic ecosystem. During rainstorms, nutrients, water and pollutants are washed from the terrestrial ecosystem to the aquatic ecosystem. Birds, amphibians and other animals that can inhabit both the terrestrial and aquatic environments link the terrestrial ecosystem with the aquatic ecosystem. Nutrients and other substances are transported in the form of droppings of these amphibiotic animals from the aquatic ecosystem to the terrestrial ecosystem.

Food web models of the terrestrial and aquatic ecosystems have been developed for the present EIA (Figures 8.21 and 8.22). These conceptual models show the trophic relationships between organisms of different groups present within the two ecosystems. The trophic habits of animals present within the ecosystems are complex. Many animals present within the terrestrial and aquatic ecosystems are omnivores although some are only herbivores or carnivores. For example, birds are omnivorous since they eat plants and invertebrates. Several food chains present within the ecosystems are interlinked to form the food web models. Nutrients and energy are transferred from a lower trophic level to a higher trophic level when organisms at the higher trophic level eat those at the lower trophic level. The food web models of the terrestrial and aquatic ecosystems are different in that the latter has three more components: fish, phytoplankton and zooplankton.

The food webs interlock all biota present within the aquatic and terrestrial ecosystems. When a trophic level of organisms in the food webs is affected, all other levels of organisms will be affected directly or indirectly. An understanding of the food web models is useful in predicting and assessing potential impacts on the components of the ecosystems. The river regulation project may have an effect on the food web model of the wetland ecosystem. Plankton and aquatic plants which fish feed on are expected to decrease after the Shenzhen River Regulation works are finished. Fish in the river will decrease with decreasing supply of food (plankton and aquatic plants). Birds within the water body habitat are expected to decrease with decreasing supply of

food (fish, aquatic invertebrates and wetland plants). Section 8.5. Potential Ecological Impacts will deal with this matter in greater detail.

8.5 Potential Ecological Impacts

8.5.1 *Identification of Ecological Impacts*

This section identifies potential impacts associated with the proposed river regulation (Stage III) during the construction and operational phases. These ecological impacts include loss of fishponds, marshes, woodlands, low-lying grasslands/fallow fields and agricultural lands; damage to various habitats including fishponds and marshes; dust deposition on vegetation; noise and other disturbance to birds and other wild animals.

(1) *Construction Impacts*

Activities during the construction phase include site clearance, excavation, site formation, dredging, barging of spoil, filling of habitats with spoil, paving of riprap on river beds and construction of riprap protected embankments. These are likely to have the impacts described below on fauna and flora species and their habitats.

In section 7.4 of the report, namely the scheme of spoil, six options for spoil disposal have been compared, of which the 4th, the 5th, and the 6th scheme are preferred that will be discussed in greater detail on ecological aspect and assessed the environmental impact.

- Option 4, disposal by the marine dumping of 201,800 m^3 of contaminated spoil at East Sha Chau, and terrestrial dumping of part of the uncontaminated spoil at Areas G and H (bloodworm pond valley) at Nam Hang and Areas B and D just to the south of the river, while the remainder of the uncontaminated spoil is dumped at Neilingding Island. The amount of uncontaminated spoil dumped at Areas G, H, B and D is estimated to be 450,000 m^3 to 600,000 m^3.

- Option 5, disposal by the marine dumping of 201,800 m^3 of contaminated spoil at East Sha Chau and 1,401,800 m^3 of uncontaminated spoil at Neilingding Island;

- Option 6, dumping 201,800 m^3 of contaminated spoil at East Sha Chau, and dumping approximately 500,000 m^3 of the uncontaminated spoil in Area B, part of Area D, and a remote valley in the Nam Hang hill cemetery area, while the remainder of

the uncontaminated spoil is dumped at Neilingding Island. This area will be referred as the Nam Hang middle valley (Figure 8.23).

1) *Permanent Loss of Habitat*

Re-alignment and widening of the Shenzhen River will cause loss of fishponds, marshes, woodlands, low-lying grasslands/fallow fields and agricultural lands during the construction phase. The habitats which the re-alignment of the regulated river will cover will be lost permanently. Table 8.32 shows that the areas lost under the re-alignment range from 1.1 hm^2 (woodlands) to 14.4 hm^2 (low-lying grasslands/fallow fields). The two managed fishponds north of the Sandy Ridge Cemetery and the unmanaged fishpond northwest of the bloodworm valley will be partially lost to the new Shenzhen River, with lost areas approximating 0.3, 1.4 and 0.4 hm^2 respectively. The loss of the habitats during the construction period is also expected to have indirect impacts on surrounding habitat areas and associated biota.

The ponds or bloodworm pond valley lying between Nam Hang and the Man Kam To hillsides consist of bloodworm (*Chironomous spp.*) ponds and a fishpond. The valley also contains an overgrown watercourse draining the valley and areas to the south, including the approach road to Man Kam To. In times of flood, both the fishponds and bloodworm ponds are inundated with overflows from the south and east. If Option 4 were adopted to fill the bloodworm pond valley (Areas G & H) and Areas B & D with uncontaminated spoil, the bloodworm ponds of 1.1 hm^3, the fishponds of 2.3 hm^2 in the valley and northwest of the valley, and the watercourse would be permanently lost. Furthermore, about 3.4 hm^2 of mature woodland along the bottom of the Nam Hang hillsides (south of the Man Kam To Police Station) would be permanently lost. Losses of other habitats such as marshes also occur and are listed in Table 8.33.

If Option 6 were adopted to fill the next valley to the west in the Nam Hang hill area, Area B and part of Area D with uncontaminated spoil, no bloodworm ponds would be lost, only 1.2 hm^2 of fishpond would be lost compared with 2.3 hm^2 for Option 4, and only 0.8 hm^2 of woodland would be lost compared with 3.4 hm^2 for Option 4. But the marshy area immediately north-west of the bloodworm ponds and outside the security fence can be retained. The other possible losses are listed in Table 8.33.

Habitat Areas Permanently Lost under the Re-alignment

Table8. 32 **of the Shenzhen River**

Habitat	Total area (hm^2)	Lost area (hm^2)	(%)
Woodland	43. 8	1. 1	2. 5
Low-lying grassland/fallow field	65. 9	14. 4	21. 9
Agricultural land	20. 2	4. 0	19. 8
Marsh	9. 3	2. 7	29. 0
Pond	15. 8	2. 1	13. 3

Table8. 33 **Habitat Losses Caused by Option 4 and Option 6 (in hm^2)**

Habitat	Total area	Lost area		%	
		Option 4	Option 6	Option 4	Option 6
Woodland	43. 8	3. 4	0. 8	7. 8	1. 8
Shrubland	3. 5	0. 2	0. 2	5. 7	5. 7
Hillside grassland	26. 3	1. 5	5. 1	5. 7	19. 4
Low-lying grassland/fallow field	65. 9	1. 5	1. 5	2. 3	2. 3
Marsh	9. 3	3. 5	2. 3	30. 1	24. 7
Bloodworm pond	1. 1	1. 1	0	100. 0	0
Fishpond	14. 7	2. 3	1. 2	15. 6	8. 2

2) *Habitat Damage*

During the construction phase, the habitats within the Project Area will be subject to trampling, temporary or indirect damage, or even destruction by activities such as site clearance, site formation, excavation, spoil barging, and land transportation of spoil. Table 8. 34 lists the areas of habitat likely to be temporarily damaged or destroyed.

Table8. 34 **Habitat Areas Temporarily Damaged within the Project Area**

Habitat	Total area(hm^2)	Area damaged* (hm^2)	%
Woodland	43. 8	0. 6	1. 4
Shrubland	3. 5	0. 4	11. 4
Low-lying grassland/fallow field	65. 9	6. 6	10. 0
Agricultural land	20. 2	1. 7	8. 4
Marsh	9. 3	0. 7	7. 5
Fishpond	15. 8	3. 7	23. 4

* Excluding the areas lost under the re-alignment of the Shenzhen River and the areas lost to spoil disposal.

3) *Increased Fragmentation*

The areas of low-lying grasslands/fallow fields existing along the Hong Kong side of

the river are quite large. The loss of this abandoned grassland habitat under the realignment of the new river will increase the fragmentation between the different areas of this habitat within the Study Area. Therefore, wetland animals may have more difficulty in crossing these fragmented areas.

If Option 4 were adopted to fill the bloodworm pond valley, the continuous woodland of 18.5 hm^2 would be cut into two parts, and the watercourse and shallow ponds and pond margins connecting the main river to the hinterland would be lost.

If Option 6 were adopted to fill the Nam Hang middle valley area, Area B and part of Area D with uncontaminated spoil, no fragmentation would be added to habitats of ecological importance. The valley floor and surrounding slopes will be a direct loss at Nam Hang. However this area adjacent to the cemetery is regularly fire-razed precluding any substantive growth of shrubs and trees or any meaningful colonisation by flora and fauna. This is in complete contrast to the bloodworm valley where ponds and mature woodland offer both roost and/or feeding opportunity to avifauna, reptiles, amphibians and mammals.

4) *Disturbance to Wildlife*

During the construction phase, construction workers and construction plant are likely to cause noise and other disturbance which may affect sensitive animal species. The animal species most likely affected are some amphibians and reptiles, and most birds and mammals, particularly the larger species. Such species are likely to be disturbed by loud noises, operational construction plant and the presence of construction workers. The severity of disturbance depends on: intensity, duration, frequency, the distance of the disturbance source; the sensitivity of affected species; and the availability of alternative habitats nearby. Disturbance impacts are normally greatest when they are close and frequent. Some species can adapt to regular disturbances from heavy noise and moving construction plant, but seldom to the close proximity of people.

De-watering of the two fishponds north of the Sandy Ridge Cemetery during construction activities will eliminate the fish and most of the other aquatic organisms. Most of the aquatic organisms cannot live in these fish ponds while they are drawn down for prolonged periods and being disturbed by construction activities.

If Option 4 were adopted to fill the bloodworm pond valley (Areas G & H) and Areas B & D with uncontaminated spoil, protected animal species such as *Oriolus chinensis* which use the valley woodland/wetland combination as a foraging and breeding

ground would be greatly disturbed by dumping of spoil. Whilst the upper woodlands would remain the combination of the pond and woodland would be lost and the fauna favouring such habitat are likely to be permanently displaced. Furthermore, animal species within the marshes and fishpond in Areas B and D would be displaced.

If Option 6 were adopted to fill the Nam Hang middle valley area, Area B and part of Area D with uncontaminated spoil, a total of 2.3 hm^2 of marshes and a total of 0.8 hm^2 of woodland would be lost in the Study Area. Since the woodland is sparse and fragmented and marshes are small and lower quality, it is expected that fewer animals would be displaced.

5) *Impact of Spoil Barging*

Options 4, 5 and 6 for spoil disposal will involve barging of spoil along the Shenzhen River from Lo Wu Bridge and via Deep Bay. The noise arising from barges and disturbance arising from construction workers and barges may have effects on the ecology of Deep Bay in the absence of mitigation measures for noise and disturbance. However, barge movements are confined to marked dredged channels, well away from the mudflats and feeding areas.

6) *Dust Pollution*

Construction activities include excavation, establishment of embankments, and placing of riprap on the channel floor and banks. These construction works and the movement of spoil along haul roads are expected to create total suspended particulates (TSP) and respirable suspended particulates (RSP) problems which can affect the plants and habitats nearby. They can cause vegetation damage, which in turn, have secondary effects on associated fauna, such as insects and birds. In severe cases, RSP pollution can also affect the health of animals, such as nesting birds, directly. Dust pollution from construction activities will, however, last only for the construction period. Competent watering of haul roads will greatly diminish these impacts.

If Option 4 were adopted to fill the bloodworm pond valley (Areas G & H) and Areas B & D with uncontaminated spoil, the exposed spoil at the filling areas (B, D, G & H) and traffic on haul roads would result in additional dust which would adversely affect the woodland and other vegetation around the filling areas.

If Option 6 were adopted to fill the Nam Hang middle valley area with uncontaminated spoil, the exposed spoil at the filling area and traffic on haul roads would similarly re-

sult in additional dust which would affect the vegetation of less ecological importance. Since the surrounding areas are frequently fire-razed, however, the impact arising from exposed spoil would last only for the construction period and would end when revegetation as a mitigation measure is in place. The dust arising from traffic on haul roads would be suppressed by watering.

7) *Soil Erosion*

During the construction phase, soil will be exposed owing to site clearance and excavation, and may if unmitigated, pollute the fishponds, marshes and low-lying grasslands/fallow fields nearby through run-off, particularly during heavy rainfall periods. This can lead to high turbidity from soil particles and eutrophication as a result of nutrient enrichment. Aquatic macrophytes may be reduced or lost completely as a result of reduced light penetration due to the increased turbidity from soil particles and increased free-floating algae populations following eutrophication. Severe eutrophication can also lead to oxygen depletion and the impoverishment of fish and other aquatic animals and, in turn, terrestrial animals, such as birds, that feed on them.

Run-off may affect wetland plants in the marshes nearby, further affect animals-there, or accumulate in the marshes. However, run-off is expected to have little impact on other habitats which are not subject to flooding.

If Option 4 were adopted to fill the bloodworm pond valley (Areas G & H) and Areas B & D with uncontaminated spoil, the exposed spoil would be susceptible to soil erosion which would fill in or affect habitats nearby.

If Option 6 were adopted to fill the Nam Hang middle valley area with uncontaminated spoil, the exposed spoil would also be susceptible to soil erosion. This impact will stop when the filling areas have been revegetated as a mitigation measure. The filling of either valley will increase the risk and amount of soil loss and downstream siltation over the dumping option.

(2) *Operational Impacts*

1) *Lower Habitat Value*

The proposed regulation project Stage III will change the Shenzhen River from a narrow, shallow and meandering river frequently subject to flooding to a wide, deep and relatively straight channel. After these regulation works, the River is expected to have a higher draining efficiency. Both sides of the River are expected to be subject to

decreased flooding risks and severity. If Option 6 were to be adopted, there would be 4.3 hm^2 of marshes remaining along the Hong Kong side on completion of river regulation works. If no mitigation measures recommended were implemented, these marsh remnants would be of less ecological value owing to less water supply during the operational phase. Permanent marshes may become seasonal marshes. Some wetland plants which need to be permanently rooted in a wet environment may be replaced by upland plants, whereas some wetland animals may emigrate in response to the worsened wet environment.

2) *Larger Ecological Barrier*

On completion of the regulation project, the Shenzhen River is expected to expand as an ecological barrier to terrestrial animals. Juvenile birds, predatory mammals and other wild animals will have more difficulty in crossing the widened Shenzhen River. The area of low-lying grasslands remaining along the Shenzhen side of the River will be small. The reduced area of wetland and the immediate urban backdrop on the Shenzhen side is expected to cause a depletion of all wetland flora and fauna. Connectivity across the widened and now fully tidal channel will be reduced with the exception of avifauna.

3) *Decreased Wetland Biota*

Upon completion of the regulation project, the new Shenzhen River will drain all stormwater not only from marshes but also draw down the water table in the low-lying grasslands/fallow fields (currently wet). These low-lying lands are expected to lose part of their wet environment and so be colonized by more upland plants.

The water, banks and beds of the Shenzhen River are currently choked with aquatic organisms and wetland plants, including *Lemna minor*, *Eichhornia crassipes*, *Panicum repens* and *Alocasia odora*. After the regulation project (Stage III), the embankments and beds are expected to be concreted, riprapped or grasscreted. Fewer plants are expected to grow on the embankments and beds and due to salinity changes fewer aquatic organisms are expected to live in the water.

8.5.2 *Evaluation of Ecological Impacts*

(1) *Construction Impacts*

The significance of all the construction impacts will vary with the habitats and species present, design of the regulation project, and the actual construction activities. The

significance of the seven predicted impacts on the habitats present within the Hong Kong Study Area is evaluated according to the criteria of the Technical Memorandum on Environmental Impact Assessment Process of Hong Kong (Annex 8).

1) *Permanent Loss of Habitat*

The areas of habitats lost under the re-alignment of the Shenzhen River are listed in Table 8. 32. Five habitat types will suffer losses during the construction phase. The important habitats of woodlands, marshes and fishponds which provide living and foraging places for wildlife will lose 1. 1, 2. 7 and 2. 1 hm^2 respectively, accounting for 2. 5, 29. 0 and 13. 3% of their totals respectively. These losses will be permanent since the habitats are to be lost under the realignment of the Shenzhen River. The significance of this impact on marshes and fishponds is high, whereas that on the three other habitats is low to moderate.

If Option 4 were adopted to fill the bloodworm pond valley (Areas G & H) and Areas B & D with uncontaminated spoil, another 1. 1 hm^2 of bloodworm and 2. 3hm^2 of fishponds and another 3. 4 hm^2 of woodland will be permanently lost. This combination of woodland/wetland is a unique ecosystem in Hong Kong SAR and is currently used as a foraging and breeding ground by many protected or ecologically important species, including 35 bird species, 19 butterfly species, 6 dragonfly species and more than 10 other species. The filling of the pond valley will both cause loss of ecologically important habitats but also displace animal species. The losses of other habitats at Areas B and D would displace the animals and destroy wetland plants there. The significance of these impacts arising from filling of the bloodworm pond valley and Areas B & D will be high.

If Option 6 were adopted to fill the Nam Hang middle valley area with uncontaminated spoil, no bloodworm ponds would be lost, and losses of ponds, marshes and woodlands in general would be much less compared with Option 4 (Table 8. 33). Furthermore, the marshes and woodland are much smaller, lower quality than those present in the bloodworm valley. The former are not expected to support animals of conservation value since the area is quite often fire-razed and no such animals have been found within the small Nam Hang middle valley area. The significance of the impact arising from the filling of the Nam Hang middle valley area will be fairly low.

2) *Habitat Damage*

The construction activities are expected to damage or even destroy all areas of habi-

tats within the Project Area, including woodland, shrubland, low-lying grassland/fallow field, agricultural land, marshes and fishpond (Table 8.34). But this impact can be recovered to some extent after the construction works. It will be more difficult to restore the affected areas of woodlands, marshes and old ponds to their original states than those of shrublands, low-lying grasslands/fallow fields and agricultural lands. The significance of the impact on shrublands and agricultural lands is low and that on other habitats is fairly high.

3) *Increased Fragmentation*

The regulation project will increase the fragmentation of the low-lying grasslands/fallow fields between both sides of the Shenzhen River. This increased fragmentation will make it more difficult for certain wildlife to cross the River. The significance of this impact on the habitat is moderate.

If Option 4 were adopted to fill the bloodworm pond valley (Areas G & H) and Areas B & D with uncontaminated spoil, the largest woodland at the Nam Hang bloodworm valley would be cut into two parts with decreased ecological value. The significance of this impact will be high. The wetland corridor and stream course leading through the valley will be cut completely.

In the Nam Hang middle valley area to be filled by Option 6, the marshes and woodland are already very small, accounting for 0.8 and 0.6 hm^2 respectively. The woodland is not contiguous with other woodlands. The hillsides bordering the valley flow are host to graves in the upper levels and the vegetation is occasionally fire-razed. No fragmentation impact would be added to ecologically important habitats nearby. Therefore, the significance of this impact will be fairly low.

4) *Disturbance to Wildlife*

The disturbance arising from operational construction plant and working construction staff will affect sensitive wildlife of all habitats within the Study Area, including birds and mammals. This impact includes noise from the construction plant and activities, and human disturbance from construction workers within the Project Area. However, this impact will be short term or temporary, and will stop when the construction works are completed. The significance of this impact varies from low to moderate.

If Option 4 were adopted to fill the bloodworm pond valley (Areas G & H) and Areas B & D with uncontaminated spoil, the animal species at the filling areas would be ad-

ditionally disturbed by dumping of spoil and truck movements. The significance of this impact will be high. If the bloodworm valley is preserved and the works limited to the north of the security fence, some construction impact can still be expected.

If Option 6 were adopted to fill the Nam Hang middle valley area with uncontaminated spoil, disturbance by dumping of spoil and truck movements would be total in the filling area but would also affect some animals, mainly insect species of less ecological importance that visit the hillside grassland. The insects include *Euploea midamus*, *Eurema hecabe*, *Papilio polytes* and *Zizeeria maha* that are present at the Nam Hang middle valley. They are very common in Hong Kong and not protected under local legislation. The significance of this impact will be fairly low.

5) *Impact of Spoil Barging*

The three options for spoil disposal will need to barge spoil via the Shenzhen River and Deep Bay (see section 8.5.1) to Neilingding Island and East Sha Chau for uncontaminated and contaminated spoil respectively. In all cases, barging and off-site disposal will be used. However, Option 6 allows some on-site disposal.

If uncontaminated spoil unavoidably needs to be disposed within the Study Area, it is recommended that the grassland within the Nam Hang middle valley be used which is of least ecological importance amongst the prospective on-site locations identified (see section 8.5.1.1).

In the Option 5 case, 1,603,600 m^3 of spoil would be dumped at marine sites. In the Option 6 case, 1103,600 m^3 of spoil would be dumped at marine sites and 500,000 m^3 of uncontaminated spoil would be dumped in the Nam Hang middle valley area. If a barge with a volume of 200 m^3 is used for disposal of spoil, about 8018 and 5518 barges of spoil will be transported to marine sites via Deep Bay. Based on the likelihood that the works will last for 38 months, 7 days a week and 12 hours a day. One barge of spoil per 1.7 or 2.3 hours respectively (or 7.0 or 5.2 barges a day) will pass through the Deep Bay dredged channels to marine dumping sites.

Option 4 would have impact of spoil barging similar to Option 6 since both options have similar amounts of spoil to barge via Deep Bay.

The noise and disturbance may increase while barging spoil. The impact of barging spoil via Deep Bay is not significant since the frequency of barging via Deep Bay is low. Current barging activities in Deep Bay have appeared to have had little effect on

bird-feeding behaviour on the Inner Deep Bay mudflats. This barging impact is short term, will stop at the end of the construction activities, and can be mitigated, whereas the loss of the bloodworm ponds and other ecologically important habitats caused by dumping of uncontaminated spoil is permanent and hard to compensate.

6) *Dust Pollution*

Dust pollution may affect plants of all habitats present within the Study Area while dust arising from transportation of de-watered spoil on the Shenzhen River water is also expected to affect plants along the embankments of the River. TSP impacts floral species more seriously than faunal species while RSP impacts faunal species more seriously. However this impact will be short term and can be reversed easily. The significance of the impact on woodlands, marshes and fishponds is moderate, whereas that on the others is fairly low.

If Option 4 were adopted to fill the bloodworm pond valley (Areas G & H) and Areas B & D with uncontaminated spoil rather than disposed to Neilingding, the exposed spoil would result in much more dust which would affect the largest woodland in the Nam Hang valley and other vegetated areas nearby. This impact will be short term, or medium term if not mitigated. It's significance will be higher than that of other dust sources.

If Option 6 were adopted to fill the Nam Hang middle valley area with uncontaminated spoil, the dust arising from short-term exposed spoil would be similar to Option 4 but would have a less significant impact on the vegetation nearby because of its lesser ecological importance. If proper dust suppression measures are fully maintained during construction and revegetation measures at the end of construction are implemented, the permanent impact will be negligible.

7) *Soil Erosion*

Soil erosion arising from construction activities will affect the habitats mainly within the Project Area, including fishponds, marshes, agricultural lands, low-lying grasslands/fallow fields and shrublands. The impact is more serious on the fishponds and marshes than on other habitats. This potential impact can be mitigated by the use of channels successive ponds or stilling basins within the dumping area and good management of the filling process including underdrainage and hydroseeding of sequentially completed areas. The significance of the impact on marshes and fishponds is fairly high, whereas that on the shrubland is low.

The risks of soil erosion are similar for both the valley filling options and careful management will be needed to suppress and control silt laden run-off. Option 6 presents a lesser risk on the basis of the much smaller size of the upstream catchment, the absence of any existing watercourse and also offers greater potential to establish a series of stilling ponds to minimize silt loss to the Shenzhen River flows.

(2) *Operational Impacts*

Like the construction impacts, the significance of the operational impacts will vary with habitats and associated species present, design of the project, and the actual activities taking place during the operational phase. An evaluation of the significance of these operational impacts is based on the criteria of the Technical Memorandum on Environmental Impact Assessment Process of Hong Kong (Annex 8).

1) *Habitat Loss*

The Shenzhen River will be widened, straightened and deepened after the proposed regulation works and will become fully tidal. The flooding water will quickly be drained away by the new Shenzhen River with no water staying stagnant alongside the river embankments. All marshes adjacent to the channelised river within the Study Area are expected to be lost permanently owing to drawn down water table. This impact is expected to affect the marshes only whose existence depends on water supply. The significance of this impact on the marshes is high.

2) *Larger Ecological Barrier*

Regulation Project Stage III will remove some of the wetlands on the north side of the new river and will effectively create an ecological barrier along the Shenzhen River delineate the Shenzhen urbanscape from the markedly different rural habitats on the south side. The introduction of a tidal regime and change in salinity in place of the former marsh and meandering water course will remove most of this type of habitat leaving only intermittent parcels of marsh on the south side. The birds and other wildlife present in the low-lying grasslands/fallow fields that remain in Hong Kong on the south side of the river may suffer from this complete severance. This impact will be long term but will only directly affect the low-lying grasslands. The significance of this impact is low.

3) *Decreased Wetland Biota*

Wetland plant species occur in the marshes and in other habitats including low-lying

grasslands/fallow fields, agricultural lands, and ponds. A lack of substantial water supply will eliminate wetland plant species which are confined to the wet environment, and so decrease the total number of wetland plant species. Such wetland plant species as *Eichhornia crassipes*, *Lemna minor* and *Ludwigia adscendens* are expected to disappear. Instead, upland plant species will colonize the habitats. Likewise, associated wetland animal species will decrease as the habitats disappear. The significance of this impact on the marshes and fishponds is fairly high whilst that on the agricultural lands and low-lying grasslands/fallow fields is moderate.

8.6 Impact Mitigation

The potential ecological impacts due to Stage III of the Project and their significance have been evaluated in previous sections. As discussed, the major impacts are loss of habitats, habitat damage, and disturbance to wildlife.

The priorities of mitigation are avoidance, minimization, restoration and compensation. The aims of mitigation are to provide environmentally friendly engineering options that minimize unnecessary habitat loss, restore / recreate habitats that are similar to the existing ones, and create a more natural landscape.

The proposed mitigation options are presented in the order of increasing engineering challenges. The order also represents an increasing degree of mitigation.

8.6.1 *Impact Avoidance / Minimizing*

Avoidance of loss of important habitats is the most effective way to minimize impacts. Realigning the river course will unavoidably result in loss of habitats along the new alignment. However, loss as a result of works area requirement can be minimized.

(1) *Man Kam To Border Crossing*

The reconfiguration of the Man Kam To (MKT) Border Crossing represents a possibility to avoid impacts on wetlands at design level. Two design options for the Man Kam To Border Crossing were proposed by the design engineers. The options were:

● MKT Option 1. Reforming the old bridge and the new bridge add hole in Man Kam To (Figure 8.24).

● MKT Option 2. Building new two-way vehicle bridge in Man Kam To (Figure 8.25).

MKT Option 1 requires re-provision of a new vehicular waiting area (VWA) as the present VWA will be lost to the realignment. The land for the new VWA will be taken from the marsh area. MKT Option 2 does not"Consume" any important habitats and, on the grounds of impact avoidance, is ecologically favorable. MKT Option 2 is also an engineering preferred option.

Avoidance Measure — AM1: Two-way vehicle bridge in Man Kam To

(2) *Spoil Management*

According to the Engineering Design Report, on-site dumping and / or processing of dredged spoil was recommended. This would result in further loss of marshes and ponds in the off-alignment area (Table 8. 33 and Figure 8. 26). Although restoration works can sometimes minimize the long-term impacts, this is secondary to avoidance. It is difficult to compensate for some forms of habitat loss and temporary loss is caused.

Thus avoidance is essential to maintain the integrated habitat and is the most effective way to protect local wetland resources. Therefore, for the benefits of local ecology, any management options to dump spoil in marshes and ponds are not favorable. Marshes, ponds and most woodlands are of much ecological importance in the Study Area.

We have been assessing the two possible options for the on-site disposal of the uncontaminated spoil. These two possible options are Options 4 and 6

From an ecological point of view, Options 6 is far more favourable. Option 4 is not favourable since it would fill the Nam Hang bloodworm pond valley. The bloodworm pond valley is a unique ecosystem in Hong Kong SAR. It is used by species, such as *Oriolus chinensis*, which have only been seen in recent years at this site. These birds both feed and breed here and are both protected by Hong Kong SAR legislation and are recognized as a locally rare species. The area is also used by a number of other protected bird species. The woodland/wetland combination would need to be replaced. However, it will be difficult to find suitable compensatory sites for the lost woodland/wetland combination.

Avoidance Measure — AM2: No dumping of dredged spoil in ecologically important habitats adjacent to the site.

(3) *Protection of Off-alignment Habitats*

To minimize the impacts of temporary habitat loss due to construction, it is recommended the works area be limited to 5m from the toe of the external embankment. To protect the off-alignment area from accidental intrusion, the off-alignment areas should be fenced. Temporary fences, barriers or clear markings (for places where fixed structures are not practical, e.g. existing ponds and rivers) should be installed. Opaque fences may increase the cover for illegal immigrants in the border area although they are better for protection of sensitive wildlife from disturbance and sudden loud noises of the regulation works. Fences which allow full visibility are thus recommended. The temporary barriers should be removed after construction. It will be the responsibility of the Contractor to control their workers and prevent them from entering the fenced area.

Avoidance Measure – AM3: Protection of off-alignment habitats with fences / barriers

(4) *Minimization of Barging Disturbance to Wildlife*

Spoil dredged from the Shenzhen River will be transported by barge via Deep Bay to marine sites at East Sha Chau and Neilingding Island. Noise and disturbance may increase while barging spoil and would have effects on birds at Deep Bay. Although this impact arising from spoil barging will not be significant, the following mitigation measures should be adopted to protected the birds there against excessive noise and disturbance:

- the sea navigation route at Deep Bay should be as far away from the bird foraging grounds as possible. The navigation channels are suitably sited away from the main feeding areas.
- the construction workers on the barge should avoid making sudden loud noises or disturbing birds.
- barging of more spoil via Deep Bay should be scheduled in the Summer to avoid the migratory period of birds in the Winter as far as practicable.

Avoidance Measure – AM4: Minimization of barging disturbance to wildlife

(5) *Minimization of Degradation of Remaining Marshes*

Owing to impossibility of land resumption for wetland compensation purposes, the re-

maining portions of the marsh areas north of the bloodworm pond valley and at Muk Wu Nga Yiu cannot be used to establish permanent wetlands of higher ecological value. The remaining lands, which are to be excluded from the Project Area, will be liable to temporary disturbance during the construction phase because of their immediate proximity to the river re-alignment. The remaining marshes should be fenced and kept from any direct disturbance and spoil dumping.

The ground water regime of these remaining marshes should be investigated to prevent excessive lowering of the water table during the dry season. It may be necessary to install cut-off walls behind the new embankment and ground water recharge to prevent excessive drying out of the remaining marshes during the construction period.

The Nam Hang River adjacent to the bloodworm ponds will have to be re-routed to maintain the water levels in the marshes after the channel becomes operational.

Avoidance Measure — AM5: Minimization of degradation of remaining marshes

8.6.2 *Restoration*

(1) *Revegetation along the Outside Embankment Slopes*

Planting of grasses and other herbs on the outside embankment slopes and their adjacent areas has a potential to mitigate lost riparian grassland habitats. The existing alignment area is sparsely wooded and is constantly affected by urban noise and dust from Shenzhen City. Planting along the outside embankment slopes would increase the habitat value by providing a vertical structural diversity and provide a shield from the urban noise.

Establishment of extensive and continuous grasslands along the embankment on the Shenzhen side is recommended. It is recommended that discontinuous patches of trees be planted and extensive and continuous grasslands be established along the embankment of the Hong Kong side. The mosaic patches would mimic the natural heterogeneity. A mixture of plant species with various mature heights should be used to encourage development of a multi-level canopy which would increase the habitat diversity.

A list of Hong Kong plants which are attractive to birds and other fauna (Corlett et al. 1993) are listed in Table 8.35. These species together with native species along the existing area (Table 8.14) are expected to provide good habitats for wildlife. It is

recommended floral species be selected from this list for planting on the outside embankment slopes.

Restoration Measure — RM1: Planting of native species along the outside embankment slopes

Table8. 35 Flora Species Beneficial to Fauna

Tree species	Shrub species
*Bischofia trifoliata**	*Litsea rotundifolia***
Camellia hongkongensis+	*Rhaphiolepis indica***
*Celtis sinensis***	*Rhodomyrtus tomentosa***
*Cinnamomum camphora***	**Bamboo species**
Cleistocalyx operculata+	*Bambusa chungii*++
*Diospyros morrisiana***	*Bambusa sinospinosa*++
*Evodia meliaefolia**	*Bambusa texilis*++
Ficus microcarpa+	*Dendrocalamus latiflorus*++
*Ficus superba***	**Herbaceous species**
Glyptostrobus pensilis+	*Ischaemum rugosum* (*Salisb.*) *var. segetum*+
*Ilex rotunda**	*Saccharum spontaneum*+
Litchi chinensis+*	*Digitaria longiflora*+
*Macaranga tanarius***	**Digitaria radicosa**+
*Machilus breviflora***	**Echinochloa crus—galli**+
Salix babylonica+	*Panicum repens*+
*Sapium discolor***	*Paspalum conjugatum*+
*Sapium sebiferum***	*Paspalum distichum*+
*Schefflera octophylla***	*Paspalum longifolium*+
Sterculia lanceolata+	*Eragrostis atrovirens*+
Syzigium jambos+*	*Carex cruciata*+
Small tree species	*Cyperus difformis*+
*Bridelia tomentosa***	*Cyperus malaccensis Lam. var. brevifolium*+
Homalium cochinchinensis+	*Cyperus radiatus* (*C. imbricatus Retz*)+
Lithocarpus corneus+	*Cyperus rotundus*+
*Mallotus paniculata***	*Eleocharis acicularis*+
*Rhus chinensis***	*Scirpus erectus*+

* Attractive to frugivorous birds (Thrower, S.L. 1988. Hong Kong Trees - Omnibus Volume. Urban Council.)

— Riparian plant (Thrower, S.L. 1988. Hong Kong Trees - Omnibus Volume. Urban Council.), or wetland plant (Griffiths, D.A. 1983. Grasses & Sedges of Hong Kong. Urban Council - Hong Kong)

** Attractive to frugivorous birds, (Corlett, R.T. 1993)

—+ Ardeid nesting bamboos, (CES. 1995)

(2) *Restoration of Abandoned Meanders*

Four meanders of various sizes will be isolated after the realignment (M1, M4, M5 and M6 of Figure 8.2, assuming these meanders are retained under the environmen-

tally friendly spoil management option (Option 6). The meander habitat will still be degraded due to change of hydrology and isolation. This habitat will have to be managed in order to retain or enhance their ecological functions. Furthermore, it is anticipated that some of these meandering areas might be temporarily occupied for construction works. Therefore, post-construction restoration work is essential.

Given the size constraints and hydrological requirements, enhancement of some of these isolated meanders to marshcrete areas is recommended.

Conversion of isolated river segments to conservation and / or recreation uses was recommended in the Main Drainage Channels for Yuen Long / Kam Tin / Ngau Tam Mei Project (ERM 1996) and the Main Drainage Channels for Fanling, Sheung Shui & Hinterland Project (Maunsell 1997). The objectives of such mitigation measures include provision of water purification capacity, provision of storage areas for surface flows, provision of green belts for visual / aesthetic values, creation of unpolluted wetland habitats for wildlife, and provision of enhanced habitats for wildlife.

Maunsell (1997) proposed a "reen" management scheme to maximize the ecological functions of meanders affected by the works of Main Drainage Channels for Fanling, Sheung Shui & Hinterland. The scheme divided the meanders into three management categories as follows (Figure 8.27):

Type 1: Retention of tributary stream input and connection to the main channel via pipeline through the embankment. Installation of a one-way flap-valve on the embankment end of the pipeline to enable flow only from the meander to the drainage channel. Conversion of the meander to a pond or marsh area. Revegetation of the land inside the meander with indigenous, riparian floral species.

Type 2: No tributary input. Retention of the abandoned meander as a pond or marsh area. Connection of the pond to the main channel via pipeline through the embankment. Revegetation of the land inside the meander with indigenous, riparian floral species.

Type 3: No tributary input. Filling of the abandoned meander with retention of a depression or swamp to receive and hold surface flow during the wet season. Replanting of the filled land and the former area inside the meander with indigenous, riparian floral species.

Cross sectional profiles of such a treatment is illustrated in Figure 8.27. Such a management scheme is equally valid for the management of the meanders affected by the

works of Shenzhen River Regulation Stage III. Table 8. 36 shows the recommended management category applying to the four meanders.

In all cases, the contaminated river bed sediment of abandoned meanders should be removed and the bed reprofiled with clean mud to facilitate the recolonization process of biota.

Table8. 36 Management of the Meanders Affected by the Project Works

Meander No.	Management category	Remarks (length and water input)
M1. M5	Type 2	M5 (350m). M1 (375m). No tributary input.
M4. M6	Type 3	M4 (175m). M6 (100m). No tributary input. Thin stretch of land parallel to new alignment.

Meanders 4 and 6 are recommended to be filled and planted with wetland herbaceous species which can be selected from Table 8. 35.

Meanders 1 and 5 and the middle lands surrounded by them are recommended to be restored and enhanced to marshcrete areas when the regulation works are finished. Meander 1 and its middle land have a total area of 1. 7 ha, while Meander 5 and its middle land have a total area of 1. 2 hm^2. On completion of regulation works, the meanders and middle lands will be cleared of soil to the original ground level of the current marshes adjacent to the meanders. Wetland species will grow on mud/soil covering geogrid bases, bund slopes (1:3) and bund crests of the restored marshcrete (Figures 8. 28 & 8. 29). The water depth on the marshcrete base will seasonally be kept at 0. 1 — 0. 2 m by stop log weir structure. The wetland species listed in Table 8. 37 provide food or a good habitat for wildlife and are suitable for the site conditions in these compensatory marshcrete areas. These new marshcrete areas (2. 9 ha in total) will be of higher ecological value and can compensate for 5. 8 ha (2. 9 x 2) of wetlands of present value lost to the river regulation works.

Restoration Measure — RM2: Restoration of the abandoned meanders as marshcrete areas

Table 8.37 Wetland Species and Water Depth Ranges for Their Growth

Species	Water depth range (cm) for growth
Carex chinensis	0—15
Carex cruciata	0—30
Cyperus spp.	0—30 *on average*
Echinochloa crus—galli,	0—40
Eleocharis spp.	0—15
Equisetum debile	0—70
Fimbristylis spp.	0—50
Fuirena umbellata	0—70
Hymenachne amplexicaulis,	0—60
Juncus spp.	0—40
Leptochloa chinensis	0—30
Panicum repens,	0—30
Paspalum distichum,	0—30
Phragmites communis	0—150
Polygonum hydropiper	0—20
Ranunculus scleratus	0—15
Rumex maritimus	0—50
Sacciolepis indica,	0—15
Sagittaria sagittifolia	0—15
Scirpus erectus	0—15
Vallisneria spiralis	0—15

(3) *Restoration of the Temporarily Occupied Fishponds*

Parts of the two fishponds north of the Sandy Ridge Cemetery will be permanently lost. The remainders of the two fishponds will be temporarily occupied for construction purposes. The remaining areas are 0.8 and 3.0 hm^2 respectively.

The fishponds will need to be drained during the regulation works. De-watering of

the fishponds will displace the fish and most of the other aquatic organisms. Aquatic biota cannot inhabit these ponds while they are dried out and disturbed during the construction phase.

After the regulation works are finished, the remaining portions of the fishponds north of the Sandy Ridge Cemetery totaling 3.8 hm^2 should be restored to a condition suitable for fish and other aquatic organisms to live. On completion of regulation works, the remaining ponds will be cleared of spoil to their original ground levels. Wetland species which can be selected from Table 8.37 will grow on mud/soil covering geogrid bund slopes (1:3), berms, island, and bund crests of the restored ponds (Figure 8.30). The pond berms will be level and vary from 10 to 15 m in width. The island will be designed for birds and other animals to rest. The bases of the ponds will maintain 3 m depth of water. Various fish species will be put to the restored ponds, and allowed to grow naturally (not for commercial purposes). The following fish species which are suitable for the conditions in the restored ponds can be selected: *Carassius auratus* (Goldfish), *Sarotherodon mossambicus* (Tilapia), *Aristichthys nobilis* (Big Head), *Cirrhinus molitorella* (Mud Carp), *Ctenopharyngodon idellus* (Grass Carp), *Mugil cephalus* (Grey Mullet), *Gambusia affinis* (Mosquito fish), *Cyprinus carpio* (Common Carp), *Siluris glanis* (Wels Catfish), and *Hypophthalmichthys molitrix* (Silver Carp); small fish and shrimps may be stocked if necessary. The enhanced fishponds will be of higher ecological value and can compensate for 7.6 ha (3.8 x 2) of wetlands of present value lost to the river regulation works.

Restoration Measure — RM 3: Restoration of the temporarily occupied fishponds

8.6.3 *Compensation*

(1) *Establishment of Grasscrete along the Crests of the Embankments*

According to the Engineering Design Report, the material to be used on side-slope lining depends on the water level. The face above the water level will be lined with concrete blocks while rock blocks and crushed rock will be used in the face below the water level. The face above the water level normally does not convey water except during flooding. This represents an opportunity to mitigate ecological and visual impacts of hard lining.

"Softer" types of engineered lining medium such as grasscrete or reinforced grass block should be used instead of concrete block. This medium which allows growth of

grasses, sedges and reeds, and in turn provides a habitat for invertebrates and higher fauna (e.g. birds) is recommended. This will also improve the aesthetics of the channel. It is recommended that the crests of the embankments of the regulated Shenzhen River be lined with grasscrete to provide a green corridor (Figure 8.27). Establishment of grasscrete on the crests aims to compensate for the lost low-lying grasslands along the Shenzhen River.

Suitable local grass and sedge species for use in grasscrete are summarized in Table 8.38. These species provide a variety of benefits including rhizomous root systems (which help to prevent soil erosion), shade tolerance, affinity for damp conditions and saline tolerance. The seeds of these species also represent food resources to fauna, especially birds.

Compensation Measure - CM1: Establishment of grasscrete along the crests of the embankments.

(2) *Creation of Grasscrete Berms along the Embankments*

Establishment of grasscrete along the berms of the new embankments aims to compensate for the loss of ecological function of the existing riverbanks and the local areas of tidally inundated slightly brackish marshes.

According to the Engineering Design Report, a 5 metre wide berm will be built along each of the two 4 km long embankments (Figure 8.31). The berm elevation will be normally at 3.0 mPD to suit the high water springs (normal peak level) of 2.85 mPD. Hydration of the soil to support brackish wetland planting, is achieved by saturation of the subsoil rather than inundation of the surface of the berm. A kerb at 3.15 mPD high will be established along the outer edge of the new berm to prevent accumulation of floating rubbish at each high tide. Tidal water will percolate through the open rip-rap armour to periodically flood the subsoil. Obviously, neap tide peak levels will be significantly lower and hydration of the sub-grade will be less efficient during these periods. The grasscrete areas along both berms will function as tidally-saturated wetlands. If grasscrete is to be established along both berms, the area to compensate for lost ecological function of river bank and wetland will be 4 hm^2 (5m×4,000m×2).

Table8. 38 Preferred Habitat and Possible Benefits of Selected Grasses and Sedges

Plant species	Habitat and benefits
Gramineae	**Grasses**
Apluda mutica	Woodland edge perennial; good fodder
Eremochloa ciliaris	Sandy rocky areas; good fodder
Ischaemum rugosum (Salisb.) var. segetum	Damp places including stream banks; good fodder
Saccharum spontaneum	Vigorous coloniser of bare ground; extensive root system
Arundinella setosa	Woodland edge perennial
Cyrtococcum patens	Woodland edge; good fodder
Digitaria longiflora	Open land; good fodder
Digitaria radicosa	Open fields and shady places; good fodder
Echinochloa crus-galli	Swampy ground; good fodder
Hymenachne amplexicaulis	Marshy ground and ponds; useful fodder
Isachne globosa	Woodland and damp ground
Oplismenus compositus	Shady areas under trees; excellent fodder
Ottochloa malabarica	Woodland edge perennial; good fodder
Panicum repens	Rhizomous perennial; good fodder
Paspalum conjugatum	Creeping grass with long stolons
Paspalum distichum	Wet places, long creeping stolons, extensive rhizomes; good fodder
Paspalum longifolium	Marshy and dry ground
Sacciolepis indica	Drained land; good fodder
Setaria italica	Used as food for caged birds
Leersia hexandra	Perennial of damp ground/standing water
Eragrostis atrovirens	Open pastures; **much sort after by birds**
Leptochloa chinensis	Paddy fields; good fodder
Zoyzia matrella	Sand near the sea, well developed rhizomes
Cynodon dactylon	Perennial forming dense sward, **used to bind soil**
Phragmites communis	Marshy ground; habitat for marsh birds
Phragmites karka	Marshy ground; habitat for marsh birds
Phyllostachys nidularia	Aggressive rhizome system; planted to stabilise slopes
Cyperaceae	**Sedges**
Carex cruciata	Woodland edge perennial, stout rhizome
Cyperus difformis	Annual found in paddy fields or watersides
Cyperus malaccensis Lam. var. brevifolium	Perennial at riversides and damp swampy soils, long woody rhizome
Cyperus polystachyos	Perennial of seashores or sandy soils
Cyperus radiatus (C. imbricatus Retz)	Perennial of paddy fields or damp areas
Cyperus rotundus	Perennial of hillsides and near water, creeping rhizomes
Eleocharis acicularis	Paddy fields, ponds and wet soil
Fuirena umbellata	Woods, and damp and swampy ground
Kyllinga monocephala	Perennial of grassland, well devloped rhizome
Scirpus erectus	Swampy land or near paddy fields

Source: Griffiths, D. A. (1983) Grasses & Sedges of Hong Kong. Urban Council - Hong Kong

The grasscrete concrete open segments will be 15 cm thick with the surface at 3. 0 mPD to allow its subgrade (bedding of grasscrete structure) to be wetted by river wa-

ter at the highest of high tides. An 80cm deep engineered subgrade underneath the grasscrete structure in a continuous geotextile wrapped stocking will be filled with manufactured hydric soils which are suitable for brackish wetland plants. Herbaceous wetland plants will grow through the holes of the grasscrete base covered with mud/soil, and be rooted in the engineered soils underneath. The wetland species can be selected from Table 8.37. These species are hardy, non-woody and unlikely to impede the hydraulic performance of the channel during flood periods.

Local surface water drainage outlets with non-return valves that can be brought through the new seawall to drain rainwater from the immediate hinterland should discharge at berm level. This will help sustain moisture levels during neap tide periods. Deeper culverts and outfalls that originate much further inland and are likely to be polluted should discharge in the intertidal zone below the berms.

Compensation Measure - CM2: Creation of grasscrete berms along the embankments

(3) *Compensation for Lost Woodland*

If Option 6 is to be adopted to fill the Nam Hang middle valley (the hill area south of the current border fence) and Area B (low-lying area between the current border fence and the southern boundary of the re-alignment) with uncontaminated spoil, the hill woodland of 0.6 hm^2 and the low-lying woodland of 0.2 hm^2 would be lost. According to engineering design, spoil would be dumped there to form two platforms at 12 and 18 mPD in height. It is recommended that the boundary fence be relocated down to the outside slope of the new embankment and the platforms be revegetated above the service roadway.

The hill areas (1.7 hm^2 in total) at the western boundaries of the Nam Hang middle valley will be restored to a grassland. The remaining part of the upper platform should be planted with native woody species that include trees and shrubs (Figure 8.32). The compensatory woodland will have an area of 4.8 hm^2, more than the total area (1.9 hm^2) of woodlands lost to the river re-alignment and Option 6. In selecting woody species for the new woodland, a top priority should be given to those native species which can be suited to the site conditions at the Nam Hang middle valley and provide food & a habitat for wildlife. Such native woody species are listed in Table 8.39.

Woody Species Suitable for Growing in the Comepensatory Woodland

Table 8. 39 at the Nam Hang Middle Valley

Trees species	Shrub species
Albizia lebbeck	*Gardenia jasminoides*
Aporusa dioica	*Ixola chinensis*
Aquilaria sinensis	*Lespedeza formosa*
Bischofia javanica	*Litsea rotundifolia*
Bombax malabaricum	*Melastoma candidum*
Bridelia tomentosa	*Melastoma sanguineum*
Camellia crapnelliana	*Rhaphiolepis indica*
Castanopsis fissa	*Rhodomyrtus tomentosa*
Celtis sinensis	*Rhus chinensis*
Cerbera manghas	*Thunbergia erecta*
Choerospondias axillaris	*Tutcheria spectabilis*
Cinnamomum camphora	
Cinnamomum burmani	
Evodia lepta	
Gordonia axillaris	
Ilex rotunda	
Leucaena leucocephala	
Liquidamba formosana	
Litsea cubeba	
Litsea glutinosa	
Litsea monopetala	
Macaranga tanarius	
Sapium discolor	
Sapium sebiferum	
Schefflera octophylla	
Sterculia lanceolata	

Trees will be planted at different spacings of 3—6 meters to simulate natural heterogeneity. Shrubs will be planted between trees. Wild herbaceous species will be allowed to grow naturally under trees and shrubs to form a mix of plant species which serves a good woodland habitat for wildlife. This compensatory area of woodland will be approximately 4. 8 hm^2.

Area B & part of Area D which would be filled with spoil are more suitable for

restoration to grassland with some short shrubs than establishment of woodland because of boundary security reasons. As soon as the works are finished, Area B and the part of Area D will be restored to a grassland to minimize the run-off from the exposed spoil. The herbaceous species listed in Table 8. 38 are suitable for establishment of this grassland area. They can grow at the Nam Hang middle valley and provide food for wildlife. This compensatory area of grassland will be about 2. 8 hm^2.

Compensation Measure - CM 3: Compensation for lost woodland

8. 6. 4 *Implications of Recommended Mitigation Measures*

The success of implementing the recommended mitigation measures will require substantial management and co-ordination between both governments as well as various departments within each government. Therefore a well-established managing authority for implementation, maintenance and management should be set up.

The recommended measures to mitigate ecological impacts are summarized below:

Avoidance Measure — AM1:	Two-way vehicle bridge in Man Kam To
Avoidance Measure — AM2:	No dumping of dredged spoil in ecologically important habitats adjacent to the site
Avoidance Measure — AM3:	Protection of off-alignment habitats with fences / barriers
Avoidance Measure — AM4:	Minimization of barging disturbance to wildlife
Avoidance Measure — AM5:	Minimization of degradation of remaining marshes
Restoration Measure — RM1:	Planting of native species along the outside embankment slopes
Restoration Measure — RM2:	Restoration of the abandoned meanders to marshcrete areas
Restoration Measure — RM3:	Restoration of the temporarily occupied fishponds
Compensation Measure — CM1:	Establishment of grasscrete along the crests of the embankments
Compensation Measure — CM2:	Creation of grasscrete berms along the embankments
Compensation Measure — CM3:	Compensation for lost woodland

Recognized implications of various mitigation measures are listed below:

● AM2 may prolong the project duration since most of the ecologically important

habitats along the Shenzhen River are more convenient for spoil dumping.

- AM3 may slightly increase difficulty in detecting illegal immigrants across the fences.
- AM4 may need to re-schedule the regulation activities.
- AM5 would need extra costs for construction of cut-off walls.
- RM1 would increase the costs of the regulation works.
- RM2 would need post-construction maintenance until marsh plants have been established. The meanders to be restored will be on the Shenzhen side. The objectives of maintenance are to ensure that the wetland plants can survive and wetland animals (birds / butterflies / dragonflies) can live in the marshcrete areas. The scope of maintenance is to include checking the growth of the wetland species, re-planting in case some of them die, checking colonization by wetland animals, preventing possible disturbance/pollution, etc.
- RM3 would increase the costs of land resumption and need post-construction maintenance until the ponds have been restored to a condition suitable for fish and other aquatic organisms to live. The objectives of maintenance are to ensure that the wetland plants can survive and wetland animals (fish / birds / butterflies / dragonflies) can live in these restored fishponds. The scope of maintenance is to include checking the growth of the wetland species or fish, re-planting of wetland species or re-stocking of fish species in case some of them die, checking colonization by wetland animals, preventing possible disturbance/pollution, etc.
- CM1 may require design modification and increase the works costs.
- CM2 would change the original design and need post-construction maintenance until wetland plants have been established. The objectives of maintenance are to ensure that the wetland plants can survive and wetland animals (birds / butterflies / dragonflies) can live in the marshcrete areas. The scope of maintenance is to include checking the growth of the wetland species, replanting in case some of them die, checking colonization by wetland animals, preventing possible disturbance/pollution, etc.

- CM3 would need tree-transplanting costs and post-construction maintenance until trees are established. The objectives of maintenance are to ensure that woody species (trees and shrubs) can survive and terrestrial animals can live in the compensatory woodland. The scope of maintenance is to include checking the growth of the woody species, re-planting in case some of them die, checking colonization by terrestrial animals, preventing possible disturbance/pollution, etc.

8.6.5 *Preferred Mitigation Measures*

On the grounds of impact avoidance, minimization, restoration and compensation of affected habitats, all recommended mitigation measures should be implemented.

If on-site dumping were inevitable, Option 6 which would fill the Nam Hang middle valley would be the most ecologically favourable. In this case, all the four restoration measures (RMs1－3) and the two compensation measures (CMs 1－3) are the preferred and essential mitigation measures.

Whichever of the spoil disposal options is to be adopted, the avoidance measures (AMs) should be implemented.

8.7 Residual Impacts

If the recommended mitigation measures and Option 6 for spoil disposal were to be adopted, the residual impacts during the construction and operational phases would be relatively minor.

If Option 4 for spoil disposal were to be adopted, the residual impacts would be significant since it would be difficult to compensate for the lost habitats of ecological importance.

8.8 Ecological Monitoring & Audit Requirements

Ecological monitoring should be conducted regularly once the grasscrete has been established to check the performance of the grasscrete.

Under the ecological monitoring programme, birds should be surveyed along the embankments of the regulated Shenzhen River to detect any unpredicted impacts on birds. The parameters for bird monitoring include identification of species, number of

each bird species, abundance and activities, bird use of different habitats.

On completion of compensation and restoration works, birds, butterflies, dragonflies, amphibians and reptiles will be monitored in the compensatory woodland, restored ponds, restored marshes and restored meanders to determine the effectiveness of recommended mitigation measures. In addition, fish will be monitored in the restored ponds.

Plants in the grasscrete on the embankment crests, compensatory woodland in the Nam Hang middle valley, restored marshes on the Hong Kong side, restored ponds north of the Cemetary and restored meanders on the Shenzhen side should be surveyed to examine the growth of the herbaceous and woody species planted. The parameters for plant monitoring include species identification, survival rate (%), plant density (individuals/hm^2), plant height (m) and percentage cover (%).

The frequencies and durations for monitoring are detailed in the EM&A Manual.

8.9 Summary and Conclusion

8.9.1 *Ecological Resources*

Woodlands, marshes and ponds of great ecological importance exist within the Study Area while other open areas are of smaller ecological importance. Only one protected plant species was found on the Hong Kong side of the Study Area while several protected wildlife species were recorded in the marshes and ponds of the Study Area.

8.9.2 *Impacts*

Impacts which will arise from construction and operational activities include permanent and temporary impacts.

The permanent impacts of the drainage improvement works include:

- direct loss of habitats (see Table 8.40);
- increased fragmentation;
- larger ecological barrier; and
- decreased wetland biota.

The temporary impacts of constructing the improvement works include:

- disturbance to wildlife;
- impact of spoil barging;
- dust pollution;
- soil erosion;
- habitat damage; and
- drained fishponds (lost feeding opportunity).

The impacts are summarized in the following table (Table 8.40).

Table 8.40 Summary of Impacts

Impact	Description
Construction impact	
Permanent loss of habitat (in hm^2)	Woodland: 1.1; Low-lying grassland/fallow field: 14.4; agricultural land: 4.0; marshes: 2.7; ponds: 2.1
Temporary damage of habitat (in hm^2)	Woodland: 0.6; shrubland: 0.4; low-lying grassland/fallow field: 6.6; agricultural land: 1.7; marshes: 0.7; ponds: 3.7
Increased fragmentation	Low-lying grassland and associated animals will be affected
Disturbance to wildlife	• In the absence of mitigation measures, some amphibians & reptiles, and most birds & mammals are likely to be affected by loud noises, operational construction plant and the presence of construction workers. • De-watering of the 3 fishponds during construction will eliminate fish and most of the other aquatic organisms..
Dust pollution	This impact on vegetation and animals can be mitigated easily, and will be fairly small with dust suppression and revegetation measures in place
Soil erosion	Marshes and ponds will be affected to a fairly high extent without run-off control and revegetation measures in place.
Operational impact	
Lower habitat value	The marsh remnants would be of lower ecological value if no mitigation measures were implemented.
Larger ecological barrier	Low-lying grasslands, marshes and associated animals will be affected.
Decreased wetland biota	Plants confined to wetlands will be eliminated and associated animals will be reduced.

8.9.3 *Possible Impacts*

Possible impacts would arise if the following preferred options for spoil disposal were to be adopted.

- Option 4, disposal by the marine dumping of 201,800 m^3 of contaminated spoil at East Sha Chau, and terrestrial dumping of part of the uncontaminated spoil at Areas G and H (bloodworm pond valley) at Nam Hang and Areas B and D just to the south of the river, while the remainder of the uncontaminated spoil is dumped at Neilingding Island. The amount of uncontaminated spoil dumped at Areas G, H, B and D is estimated to be 450,000 m^3 to 600,000 m^3.

- Option 5, disposal by the marine dumping of 201,800 m^3 of contaminated spoil at East Sha Chau and 1,401,800 m^3 of uncontaminated spoil at Neilingding Island;

- Option 6, dumping 201,800 m^3 of contaminated spoil at East Sha Chau, and dumping approximately 500,000 m^3 of the uncontaminated spoil in Area B, part of Area D, and a remote valley in the Nam Hang hill cemetery area, while the remainder of the uncontaminated spoil is dumped at Neilingding Island. This area will be referred as the Nam Hang middle valley (Figure 8.23).

Such possible impacts are listed in the following table (Table 8.41).

Table 8.41 **Summary of Possible Impacts**

Possible impact	**Option** 5	**Option** 6	**Option** 4
Permanent loss of habitat (in hm^2)	None	• Woodland: 0.8 • Shrubland: 0.2 • Hillside grassland: 5.1 • Low-lying grassland / fallow field: 1.5 • Marshes: 2.3 • Bloodworm pond: 0 • Fishpond: 1.2	• Woodland: 3.4 • Shrubland: 0.2 • Hillside grassland: 1.5 • Low-lying grassland / fallow field: 1.5 • Marshes: 3.5 • Bloodworm pond: 1.1 • Fishpond: 2.3
Increased fragmentation	None	No fragmentation would be added to ecologically important habitats	The largest woodland (18.5 hm^2) would be cut into two parts.

Table 8. 41

Possible impact	Option 5	Option 6	Option 4
Disturbance to wildlife	None within the Study Area	Very few animals would be displaced from the Nam Hang middle valley. They are common and not protected.	• Protected animals such as Oriolus chinensis will be displaced from the woodland/wetland combination. • Animals within the marshes and fishponds of Areas B & D would also be displaced.
Impact of spoil barging	The impact of spoil barging via Deep Bay is not significant since the frequency of barging is very low	The impact of spoil barging via Deep Bay is not significant since the frequency of barging is very low	The impact of spoil barging via Deep Bay is not significant since the frequency of barging is very low
Dust pollution	Negligible	Negligible with dust suppression and revegetation measures in place	Negligible with dust suppression and revegetation measures in place
Soil erosion	None	Minimal with run-off control and revegetation measures in place.	Small with run-off control and revegetation measures in place.

8. 9. 4 *Mitigation Measures*

In order to alleviate the ecological impacts, mitigation measures are essential. The mitigation measures recommended for ecological impacts are summarized in Table 8. 42.

Table 8.42 Summary of Mitigation Measures

Proposal investigated	Consequential impact	Decision / mitigation measure	Implemen-tation / maintenance agent
Reconstruction of Man Kam To Bridge and new vehicle waiting area	Loss of 2 hm^2 of remaining marshes north of the bloodworm pond valley	AM1: Adoption of two-way vehicle bridge in Man Kam To.	None required
Dumping of spoil in ecologically important habitats adjacent to the site	Loss of the woodland / pond combination in the Nam Hang bloodworm pond valley, and the loss of the floodplain fishpond and marshes northwest of this valley.	AM2: No dumping of dredged spoil in ecologically important habitats adjacent to the site, alternative ecologically less important site - the Nam Hang Middle valley and marine sites.	PP and CC
Trampling of construction plant & personnel and temporary dumping of spoil	Temporary damage to the remaining fishponds (3.8 hm^2) north of the Sandy Ridge Cemetery and the remaining marshes (1.6 hm^2) north of the bloodworm pond valley.	AM3: Protection of off-alignment habitats with fences/barriers and possible recharge pumping to maintain groundwater levels.	CC
Barging of unwanted spoil via Deep Bay	Loud sudden noise and disturbance to birds during barging via Deep Bay.	AM4: Minimization of barging disturbance to wildlife by low frequency use and use of dredged channels only.	CC
Possible temporary damage during construction and possible drying out during operation	Possible degradation of the remaining marshes north of the bloodworm pond valley and at Muk Wu Nga Yiu (1.6 and 0.6 hm^2 respectively).	AM5: Minimization of degradation of remaining marshes by permanent engineered measures to maintain ground water tables, i.e. impermeable cut-off walls.	CC (DDE to design)
On-site dumping of part of the spoil	Loss of the trees, shrubs and grasses along the Shenzhen River.	RM1: Planting of native species along the outside embankment slopes.	DDE to design, CC to plant, DSD to maintain

Table 8.42

Proposal investigated	Consequential impact	Decision / mitigation measure	Implemen-tation / maintenance agent
Re-alignment of the river and dumping of part of the spoil in marshes (also see CM2 in this table)	Loss of 5.0 hm^2 of marshes to the re-alignment (2.7 hm^2) and Option 6 (2.3 hm^2).	RM2: Restoration of the abandoned meanders as marshcrete areas. The cut-off meanders 1 (1.7 hm^2) at Yuen Leng Chai and 5 (1.2 hm^2) north of Man Kam To will be restored as marshcrete areas. Together with 4 hm^2 of berm grasscrete, a total of 6.9 hm^2 of new wetland habitat can be used to compensate for the 5.0 hm^2 of lost marshes.	To be identified by DSD and SRRO
Re-alignment of the river and dumping of part of the spoil in ponds.	Loss of 3.3 hm^2 of ponds to the re-alignment (2.1 hm^2) and Option 6 (1.2 hm^2).	RM3: Restoration of the temporarily occupied fishponds. The two remaining fishponds (3.8 hm^2) north of the Sandy Ridge Cemetery will be restored / enhanced to a condition suitable for fish culture and wildlife feeding, with depth controls and shallow reedbed margins. These enhanced fishponds will be of double ecological value and will provide extra 3.8hm^2 to compensate for the 3.3hm^2 of lost ponds of the present value.	DDE to design, CC to construct, AFCD to maintain
Re-alignment of the river and dumping of part of the spoil in low-lying grasslands.	Loss of low-lying habitats along the Shenzhen River.	CM1: Establishment of grasscrete along the crests of the embankments	DDE to design, CC to establish, AFCD to maintain

Table 8. 42

Proposal investigated	Consequential impact	Decision / mitigation measure	Implemen-tation / maintenance agent
Re-alignment of the river and dumping of part of the spoil in marshes (also see RM2 in this table)	Loss of 5. 0 hm^2 of marshes to the re-alignment (2. 7 hm^2) and Option 6 (2. 3 hm^2).	CM2: Creation of grasscrete berms along the embankments. Four hm^2 of berm grasscrete (tidally-inundated marshes) will be established for marsh compensation. Together with 2. 9 hm^2 of new marshcrete in Meanders 1 & 5, a total of 6. 9 hm^2 of new marshes can be used to compensating for the 5. 0 hm^2 of lost marshes.	DE to design, CC to establish, DSD to maintain
Re-alignment of the river and dumping of part of the spoil in woodlands	Total loss of 1. 9 hm^2 of woodlands to the river re-alignment (1. 1 hm^2) and Option 6 (0. 8 hm^2).	CM3: Compensation for the lost woodland. The area of the compensatory woodland will be 4. 8 hm^2, more than the lost area (1. 9 hm^2).	DDE to design, CC to plant, AFCD to maintain

AFD = Agriculture and Fisheries Department Hong Kong,
DSD = Drainage Services Department Hong Kong,
SRRO = Shenzhen River Regulation Office,
PP = Project proponent,
CC = Construction contractor,
DDE = Detailed design engineer.

8. 9. 5 *Residual Ecological Impacts*

If Option 5 is adopted together with the mitigation measures above, the residual ecological impacts will be negligible.

If Option 6 is adopted together with the mitigation measures above, the residual ecological impacts will be relatively minor.

If the alternative Option 4 were to be adopted, the residual ecological impacts would be significant since it would be difficult to find suitable compensatory sites for the lost habitats of ecological importance.

If uncontaminated spoil unavoidably needs to be disposed within the Study Area, Option 6 will be the most-preferred option. It is because the hillside grassland within the Nam Hang middle valley is of the smallest ecological importance among the possible locations identified.

1. The losses and the compensations of the habitats by the project are listed in Table 8—43.

Table 8—43 Lost Habitats and Compensated Habitats

Lost Habitats(hm^2)	Compensated Habitats(hm^2)
Woodlands:1.9	4.8
Low—lying grasslands/Farmlands:15.9	Plant grasscretes on the dyke crest:4.0. plant grass on the riverside slope of the dyke
Farmlands:4.0	
Marshes:5.0	6.9 if compensated, the area of the water surface of the new river course increased 20.0
Ponds:3.3	3.8
Shrublands:0.2	

Because the compensated of the woodlands is more than the losing, the compensated of the area of the wetland is more than the lost; there is positive impact to the ecological with the compensated of the habitats.

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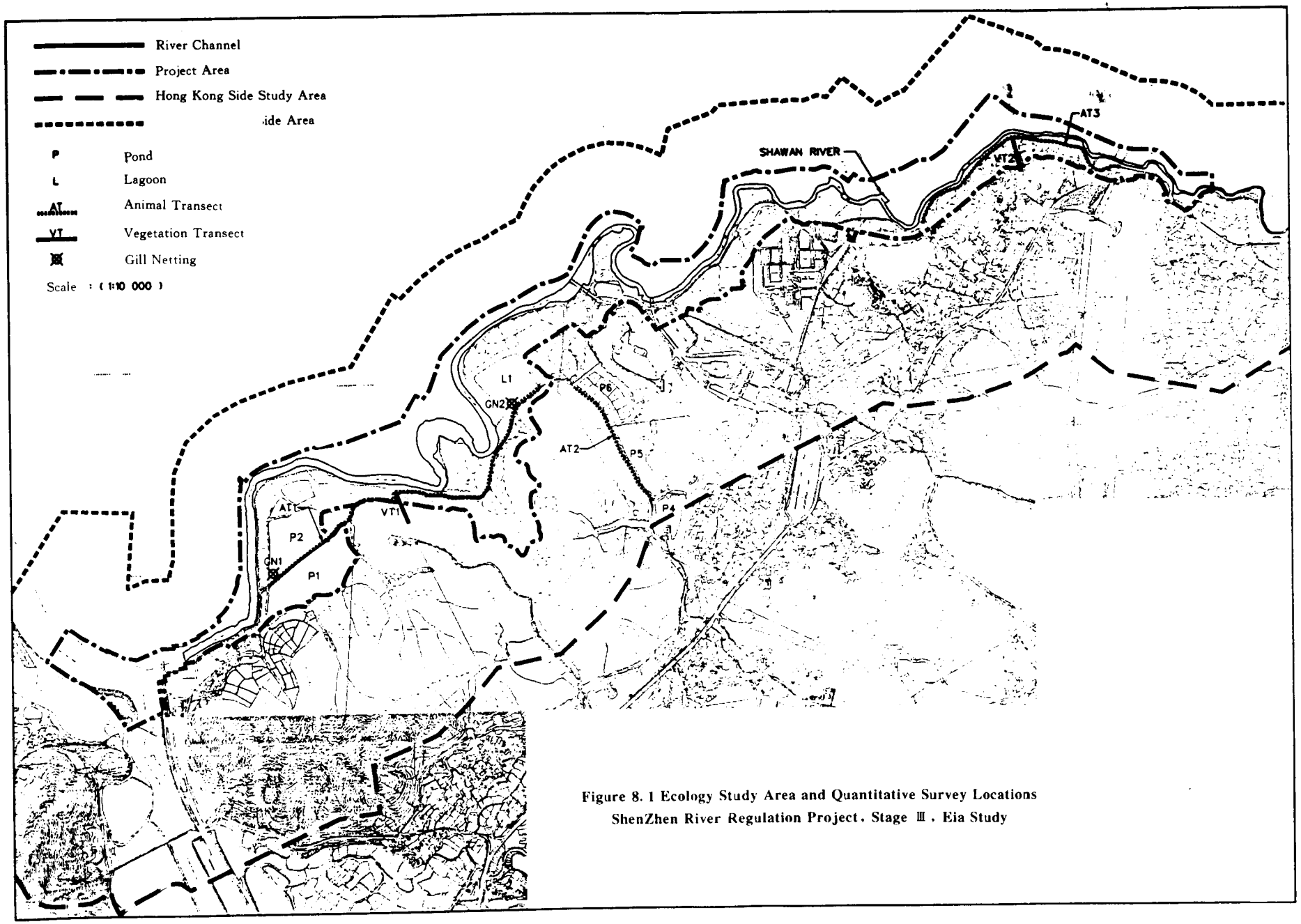
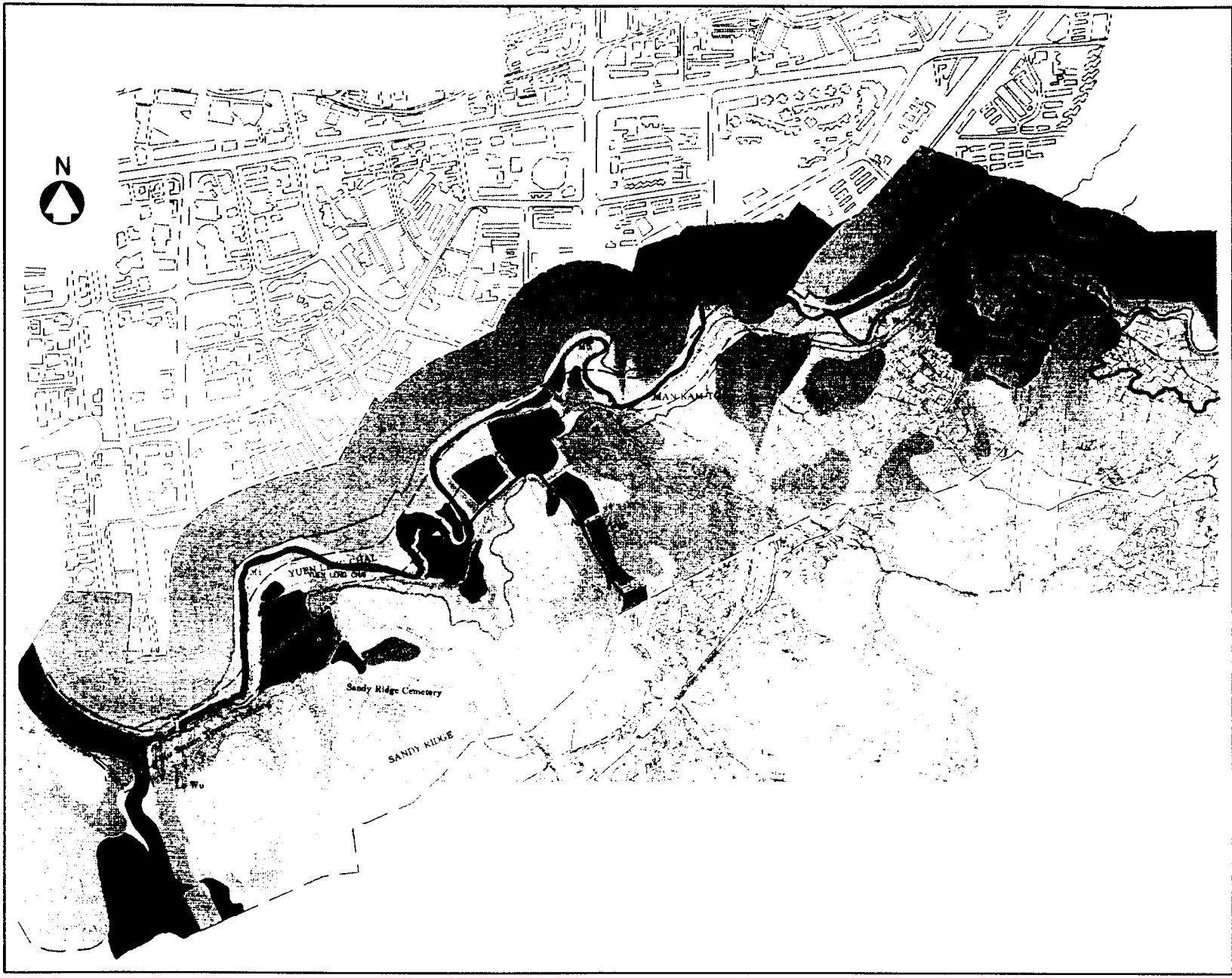


Figure 8. 1 Ecology Study Area and Quantitative Survey Locations
ShenZhen River Regulation Project, Stage Ⅲ, Eia Study



Legend:

M1 MEANDER

WOODLAND
SHRUBLAND
LOW LYING GRASSLAND
FALLOW FIELD
AGRICULTURAL LAND
RIVER
FISHPONDS
BLOODWORM PONDS
URBAN ENVIRONMENT
BAREGROUND
MARSH
HILLSIDE GRASSLAND

SHENZHEN STUDY AREA
HONG KONG STUDY AREA
PROJECT AREA
RIVER REALIGNMENT

RESEARCH INSTITUTE FOR PROTECTION OF THE YANGTZE WATER RESOURCES

Project
SHENZHEN RIVER REGULATION STAGE III

Figure Title
HABITAT MAP AS AT WINTER 98-99

Figure No.	Scale
8.2	N.T.S.

Binnie Black & Veatch Hong Kong Limited

SHENZHEN RIVER REGULATION OFFICE

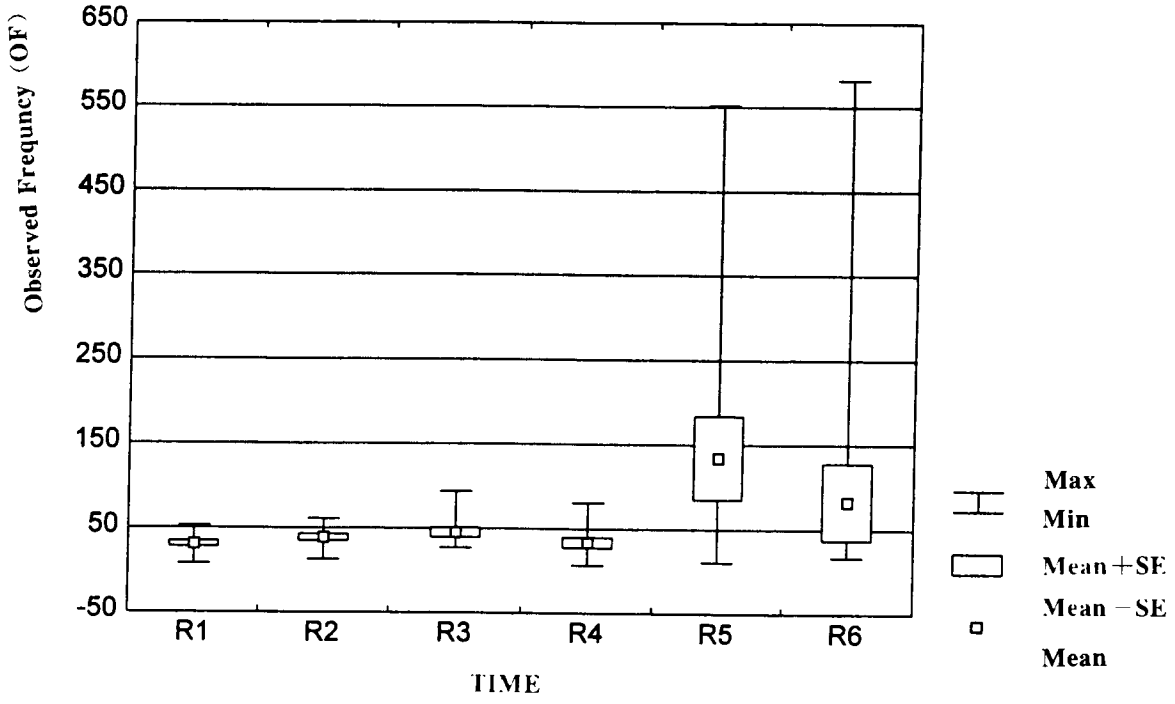


Figure8. 3 Abundance of Birds in the Study Area (AT1+AT2+AT3)

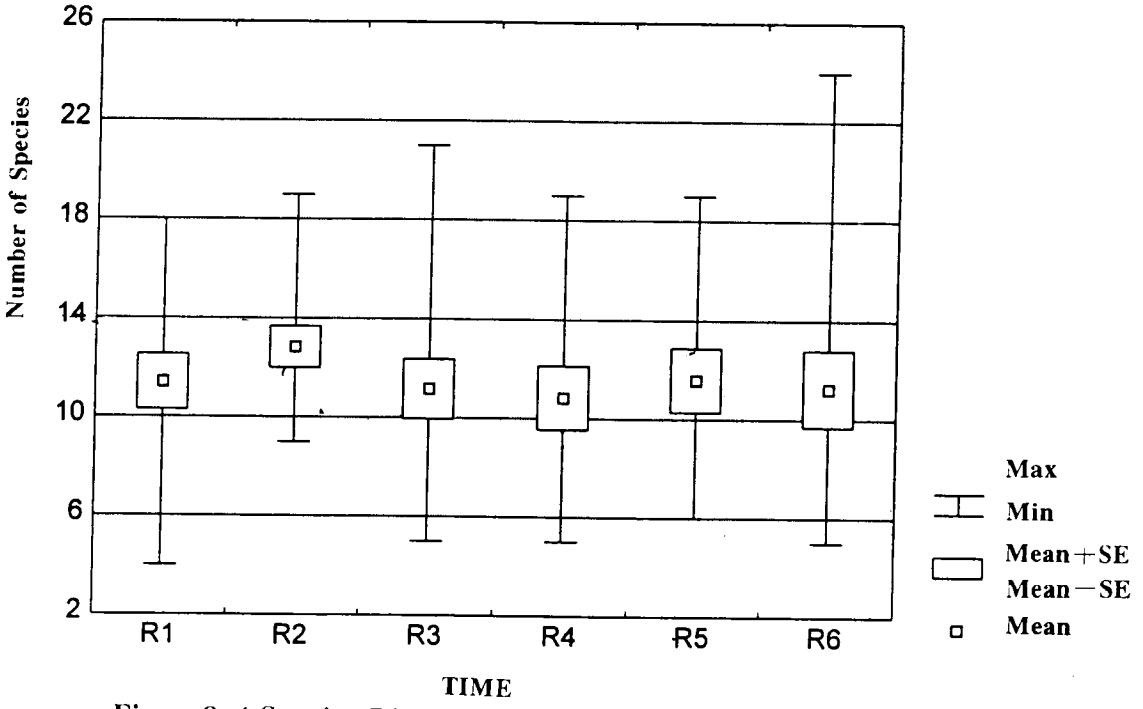


Figure8. 4 Species Richness of Birds in the Study Area

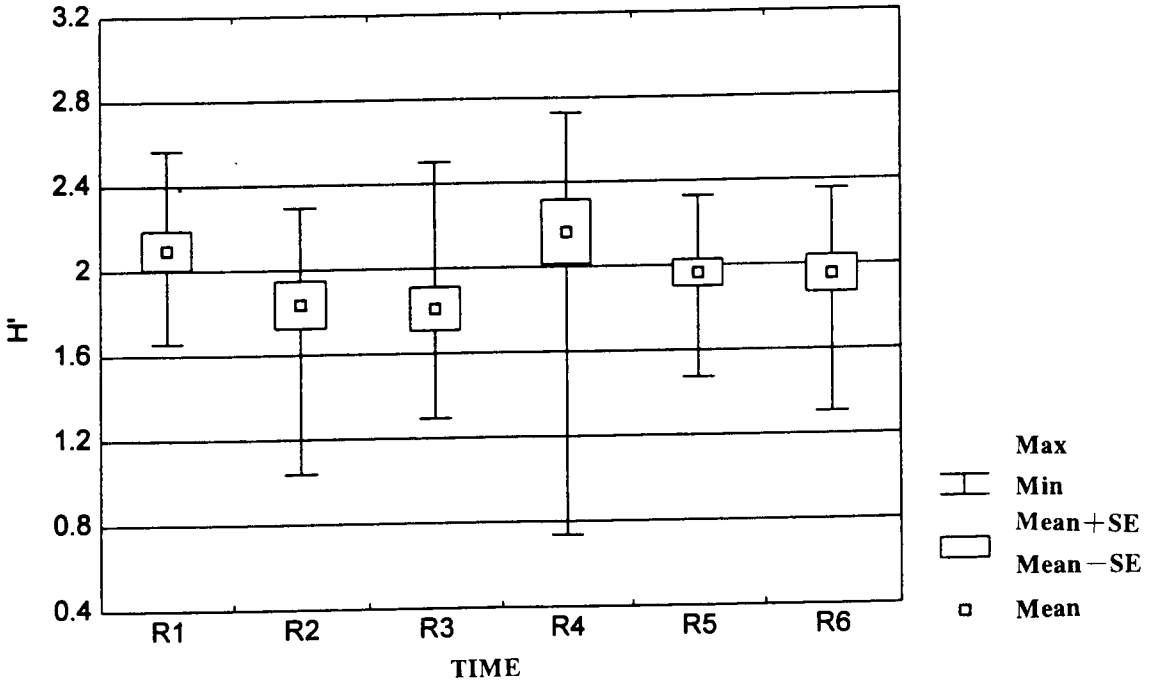


Figure 8. 5 Diversity Index (H') of Birds in the Study Area

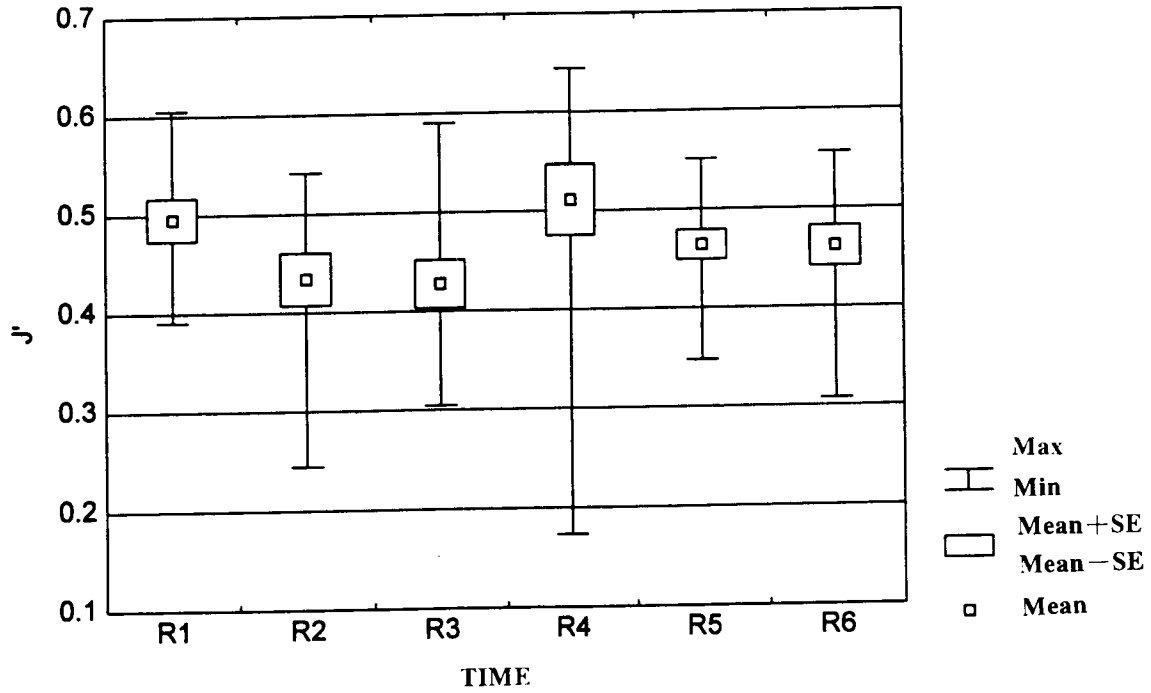


Figure 8. 6 Evenness Index (J') of Birds in the Study Area

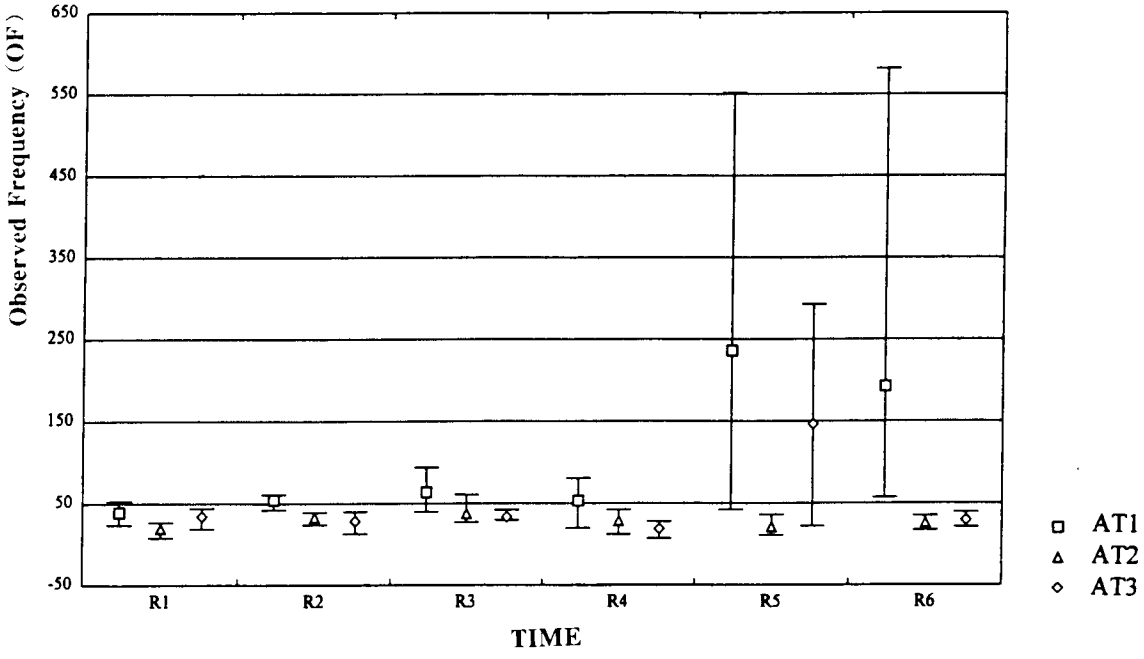


Figure 8. 7 Abundance of Birds in Each Transect Mean;Whisker:Min ,Max

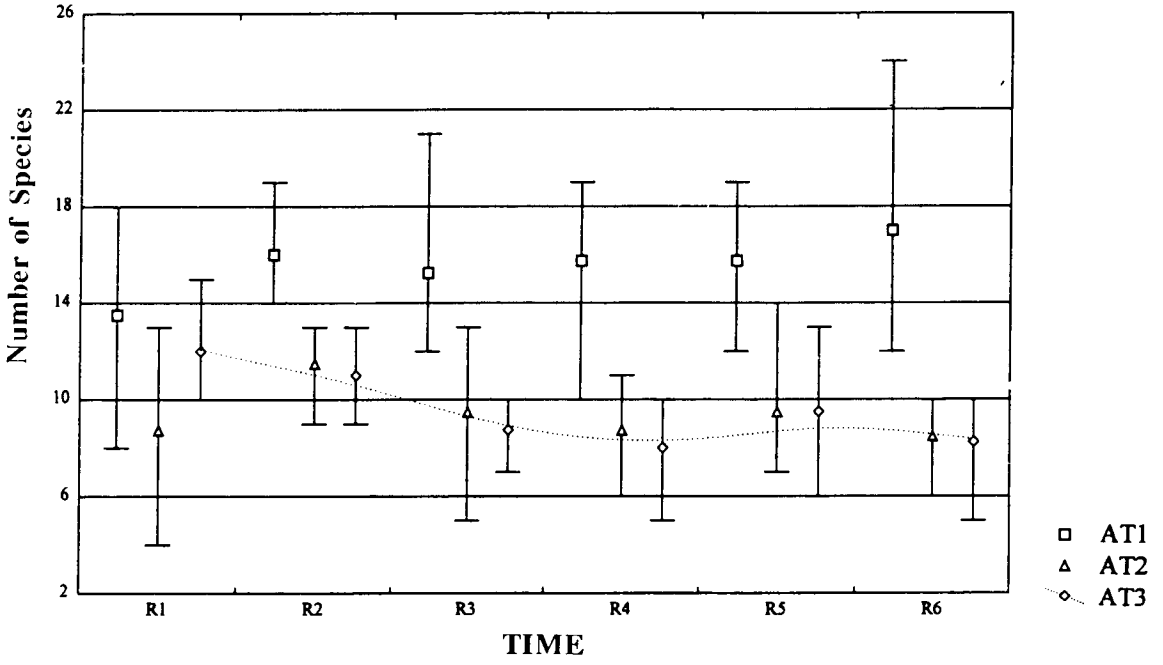


Figure 8. 8 Species Richness of Birds in Each Transect Mean;Whisker:Min ,Max

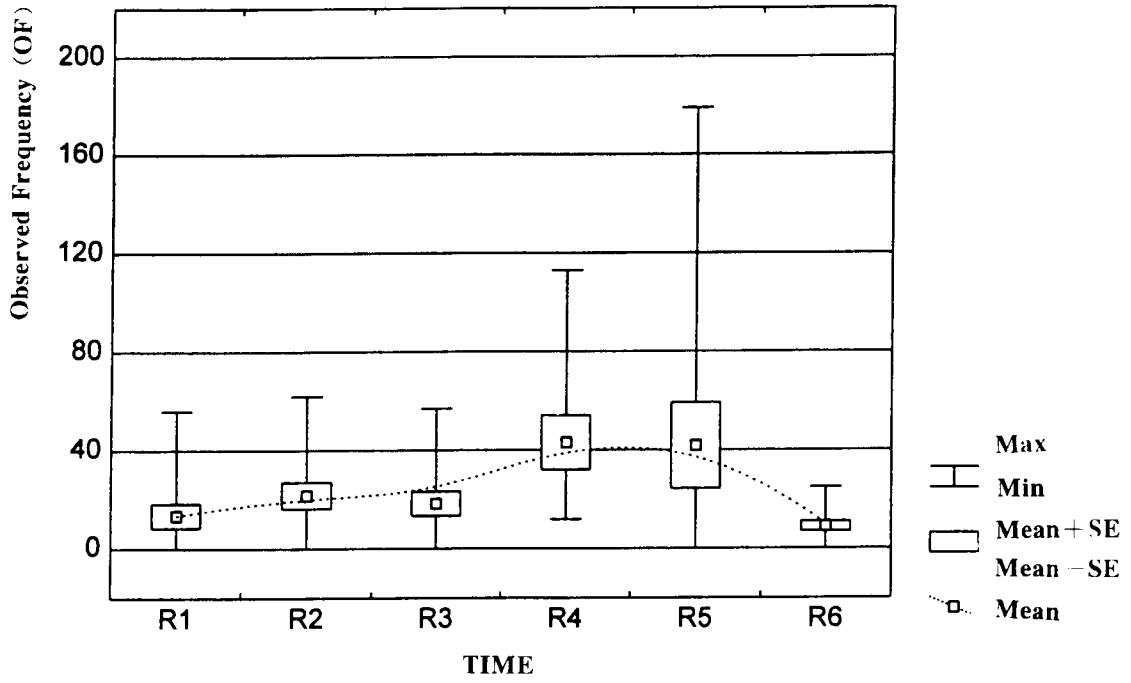


Figure 8. 9 Abundance of Butterflies in the Study Area (AT1+AT2+AT3)

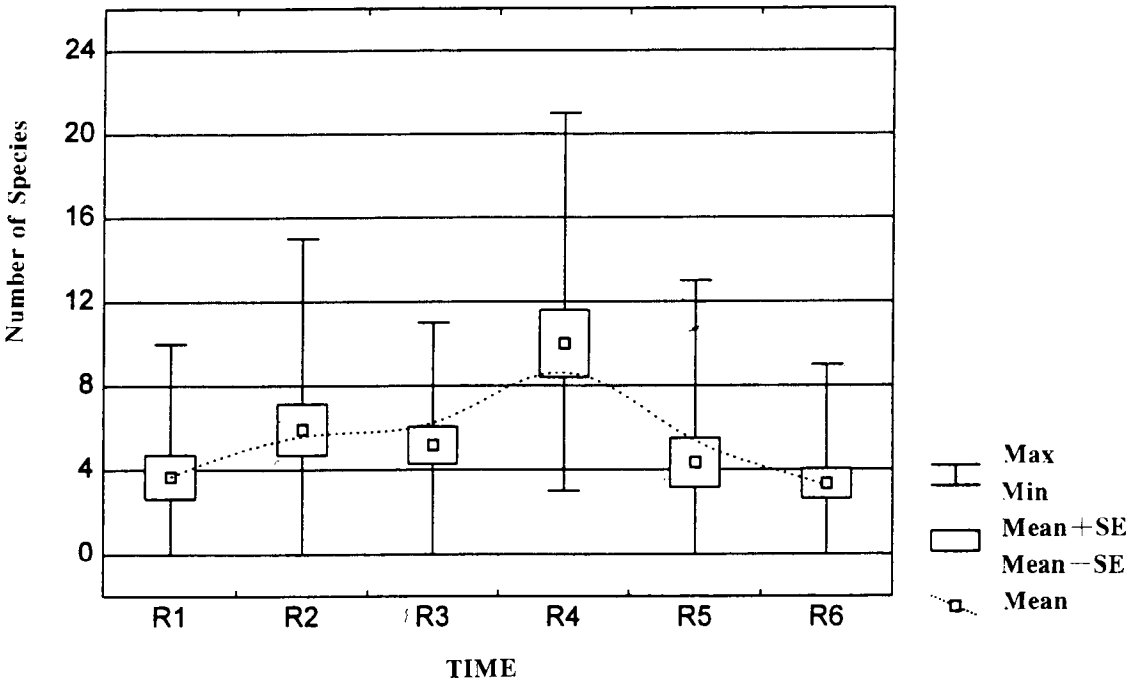


Figure 8. 10 Species Richness of Butterflies in the Study Area (AT1+AT2+AT3)

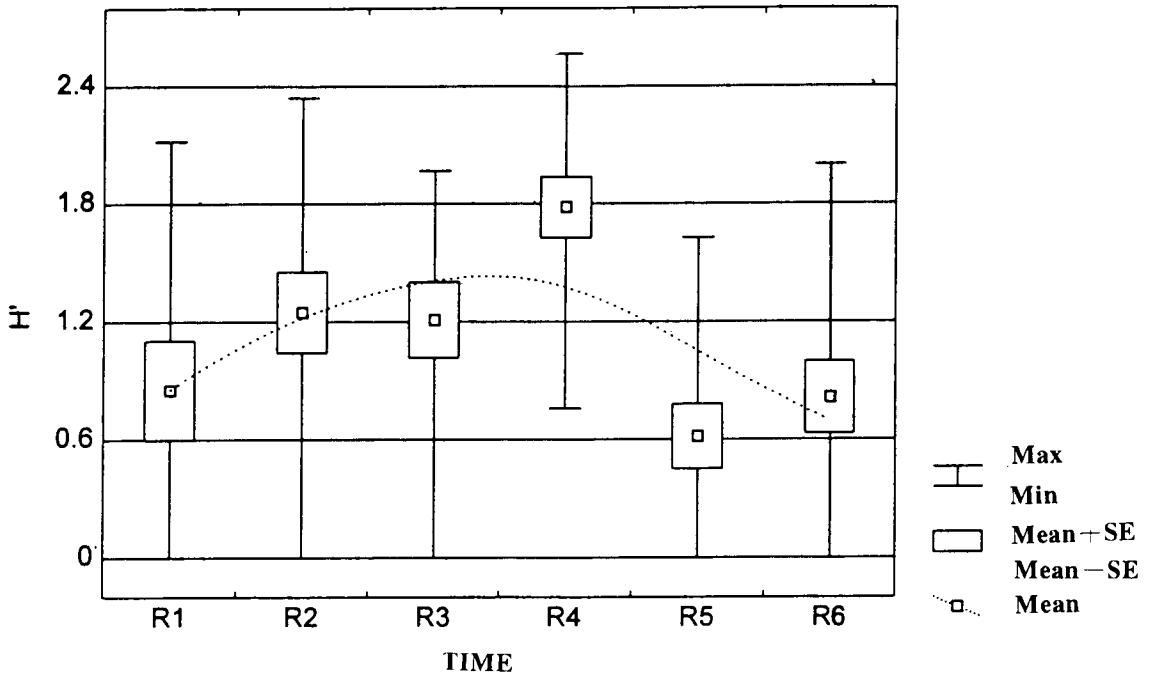


Figure 8. 11 Diversity Index (H') of Butterflies in the Study Area (AT1+AT2+AT3)

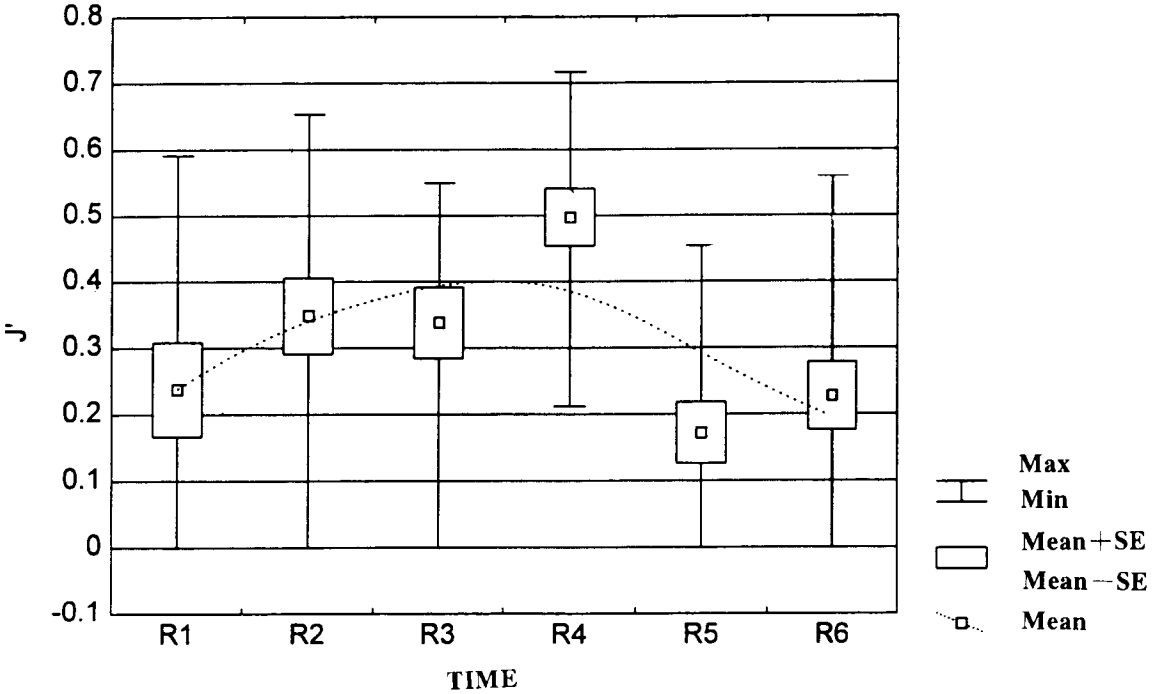


Figure 8. 12 Evenness Index (J') of Butterflies in the Study Area

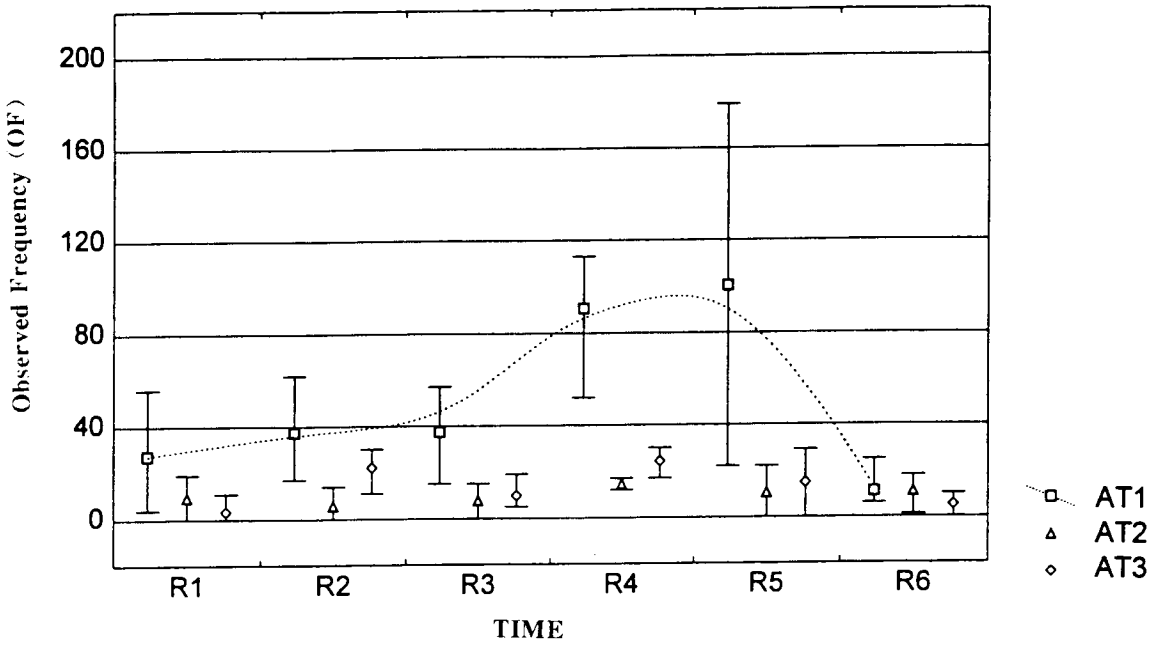


Figure 8. 13 Abundance of Butterflies in Each Transect Mean; Whisker: Min ,Max

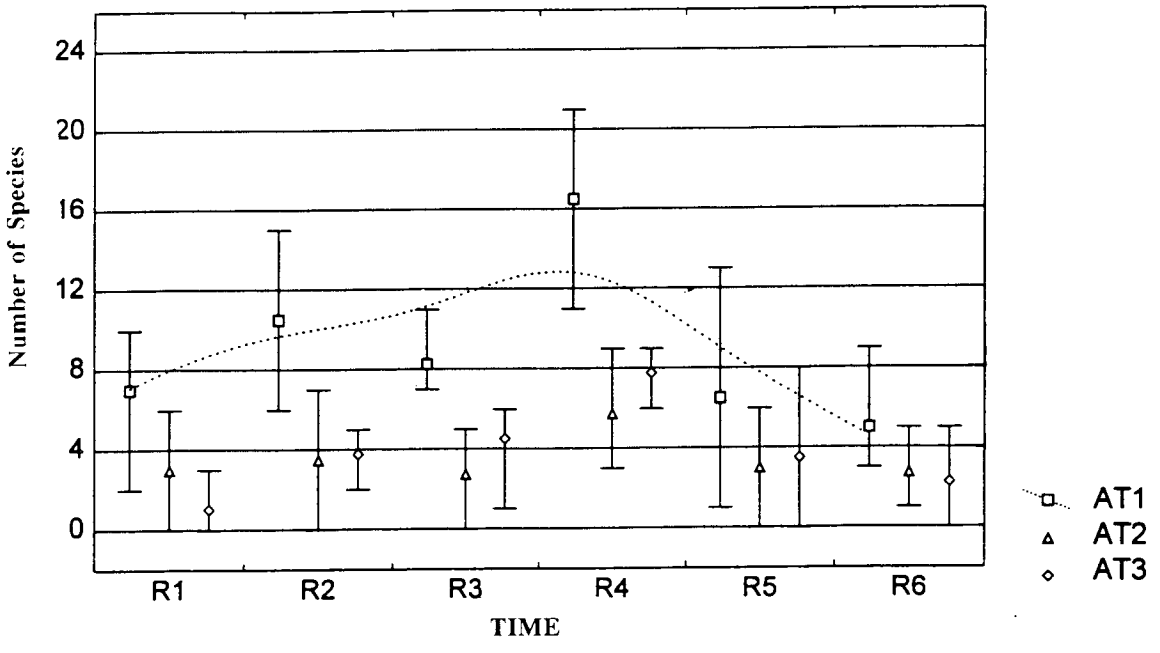


Figure 8. 14 Species Richness of Butterflies in Each Transect Mean; Whisker: Min ,Max

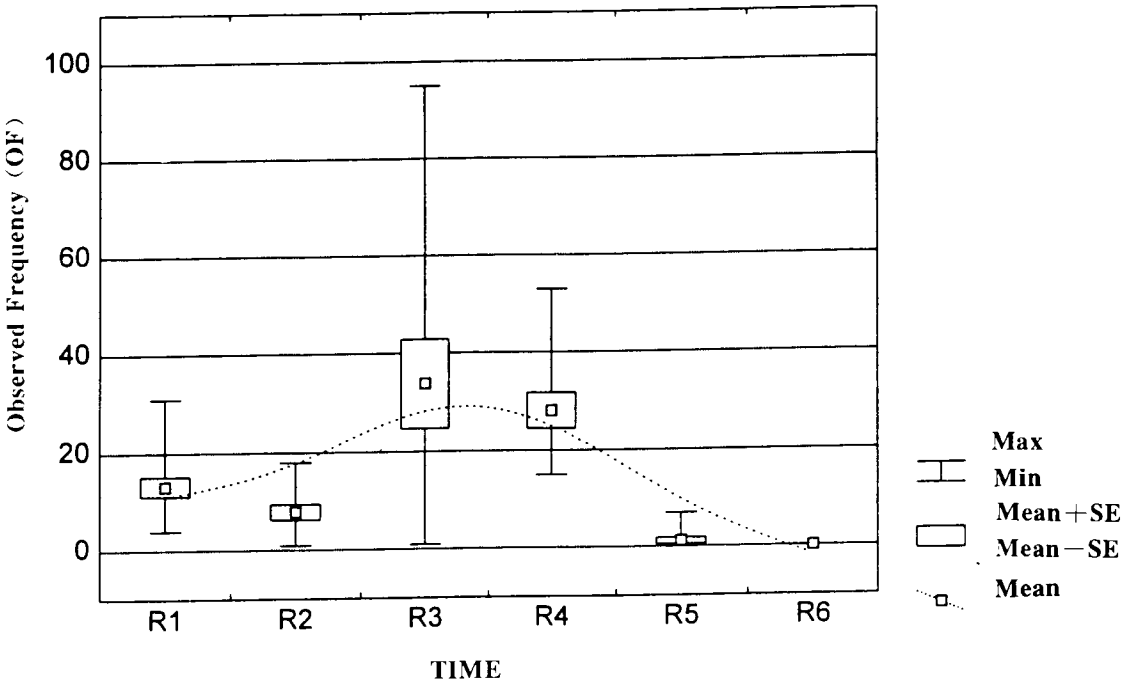


Figure 8. 15 Abundance of Butterflies in the Study Area (AT1+AT2+AT3)

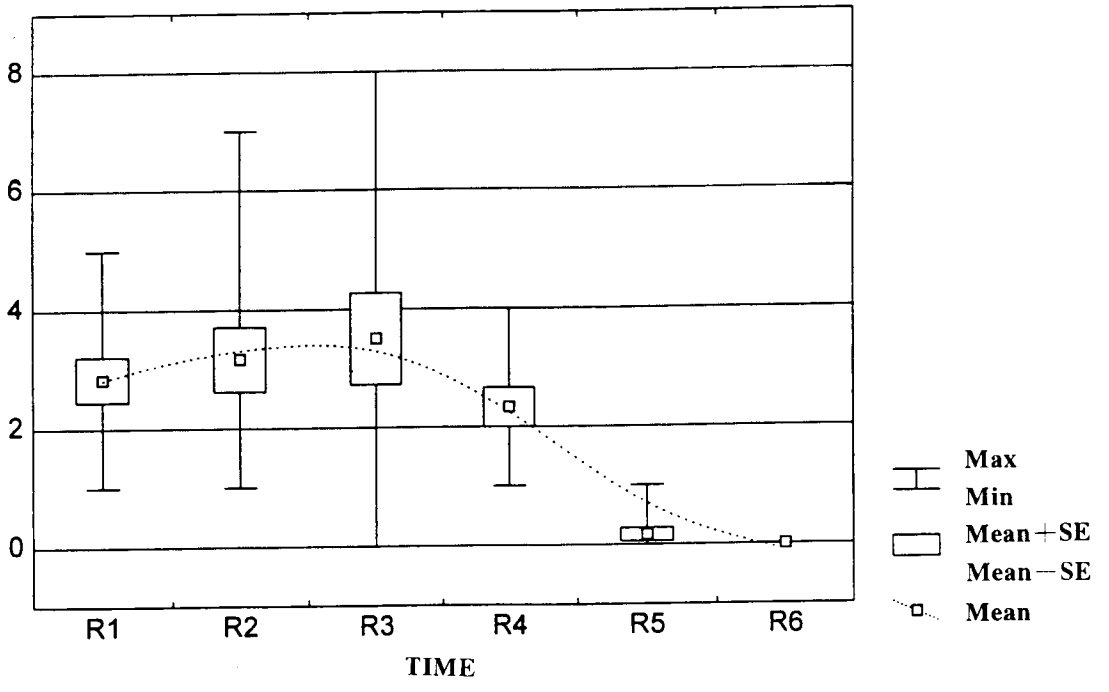


Figure8. 16 Species Richness of Dragonflies in the Study Area

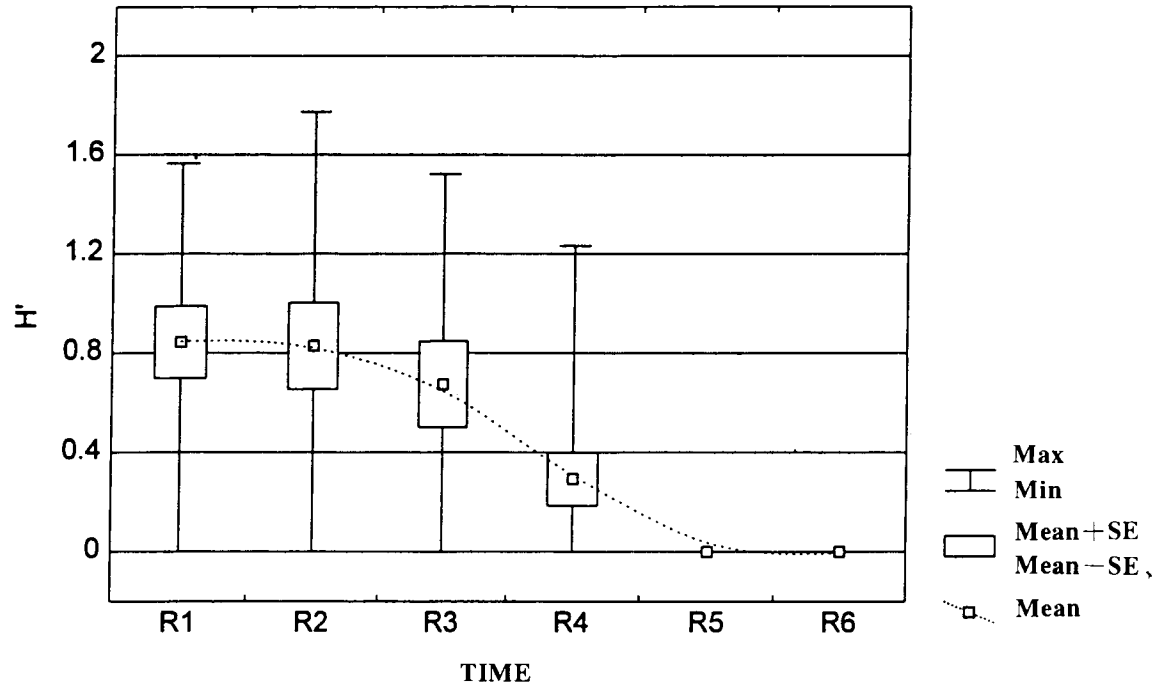


Figure 8. 17 Diversity Index (H') of Dragonflies in the Study Area (AT1+AT2+AT3)

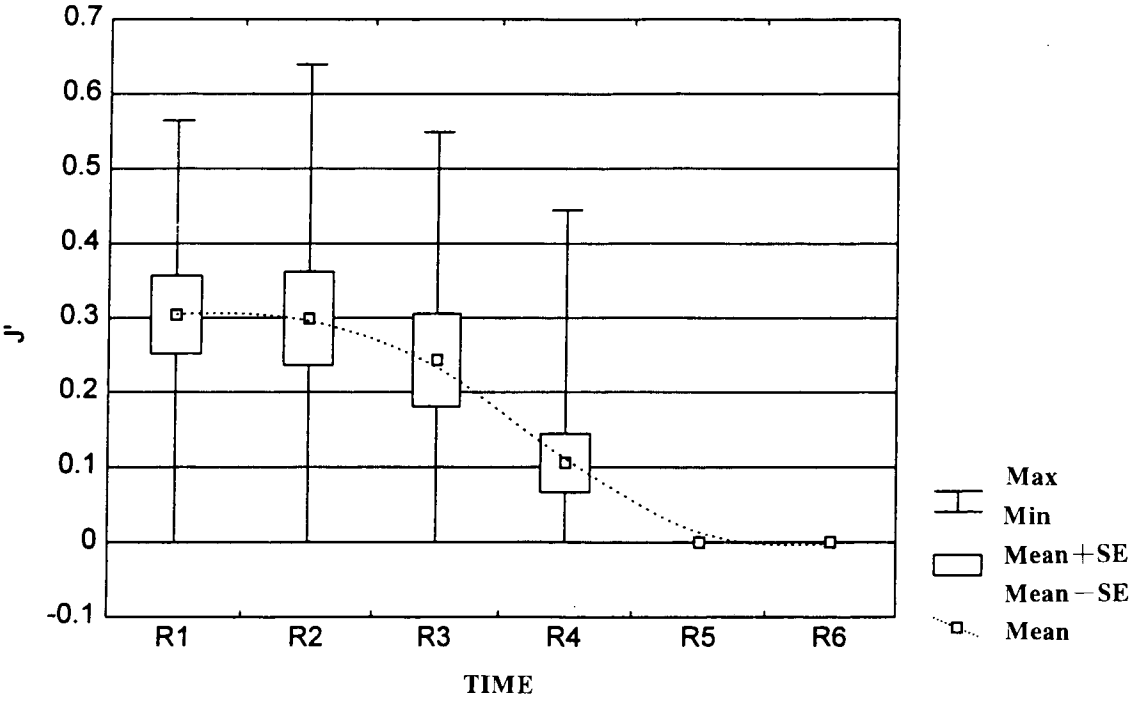


Figure 8. 18 Evenness Index (J') of Dragonflies in the Study Area

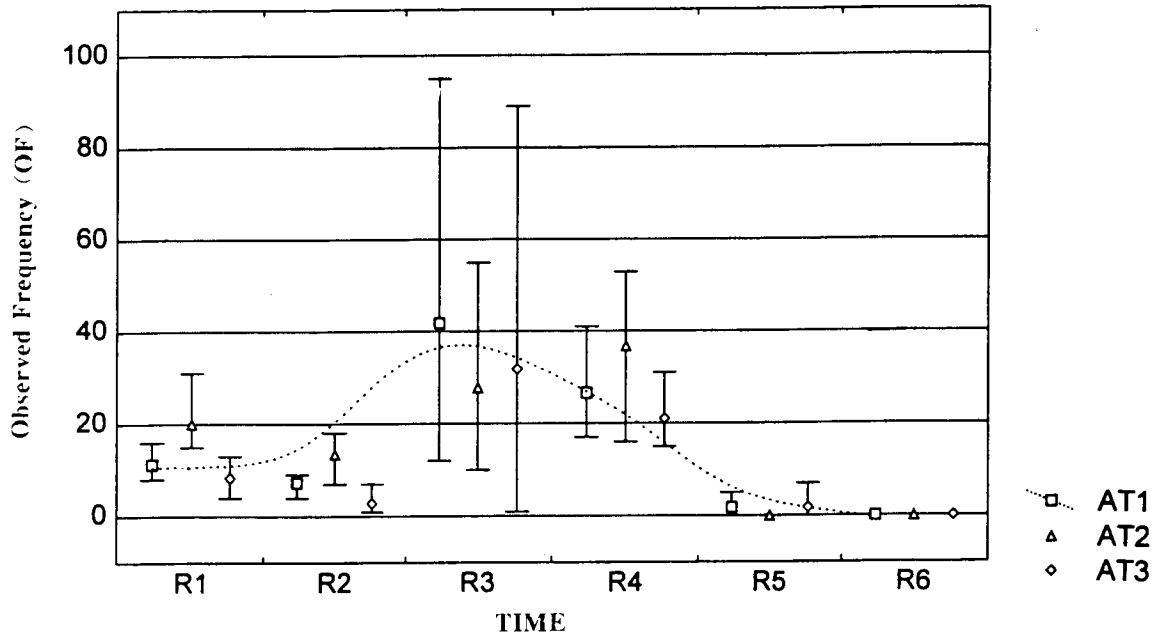


Figure 8. 19 Abundance of Dragonflies in Each Transect Mean; Whisker: Min ,Max

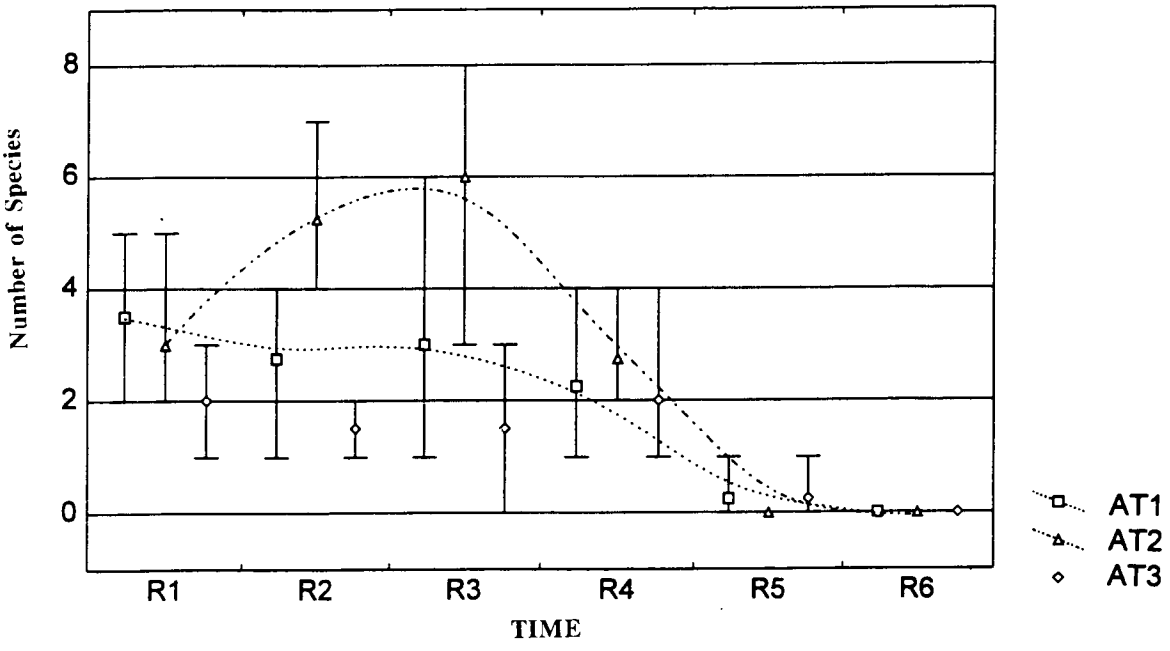


Figure 8. 20 Species Richness of Dragonflies in Each Transect Mean; Whisker: Min ,Max

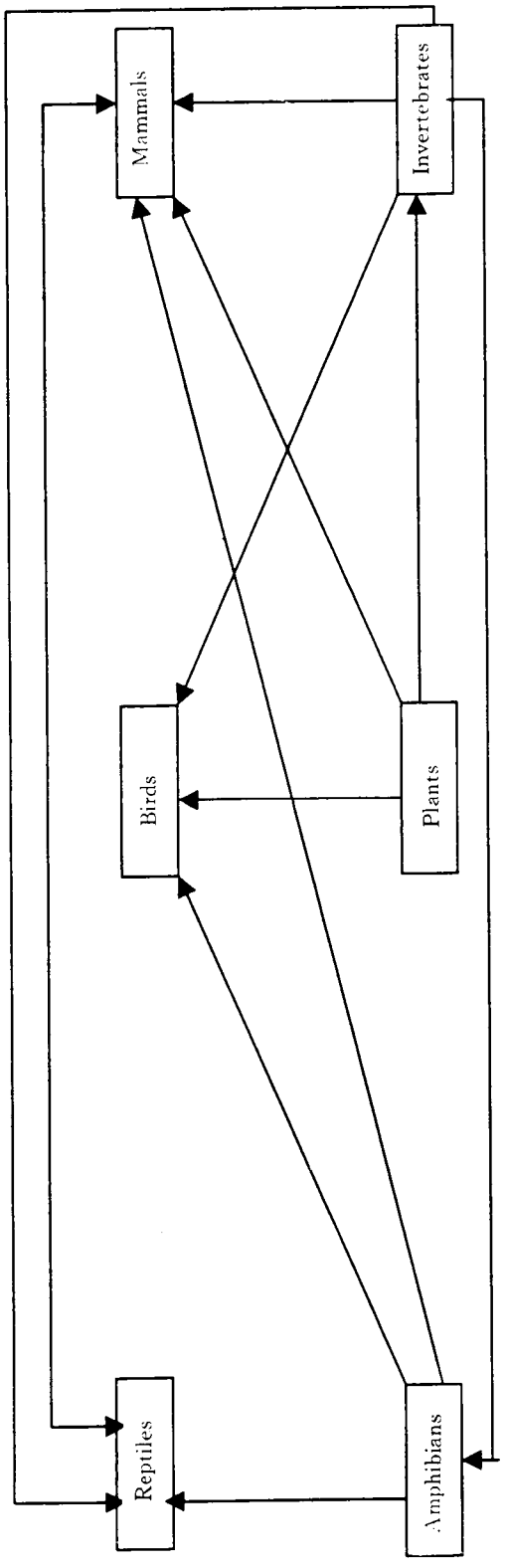


Figure 8.21 **A Food Wed Model of the Terrestrial Ecosystem within the Study Area**

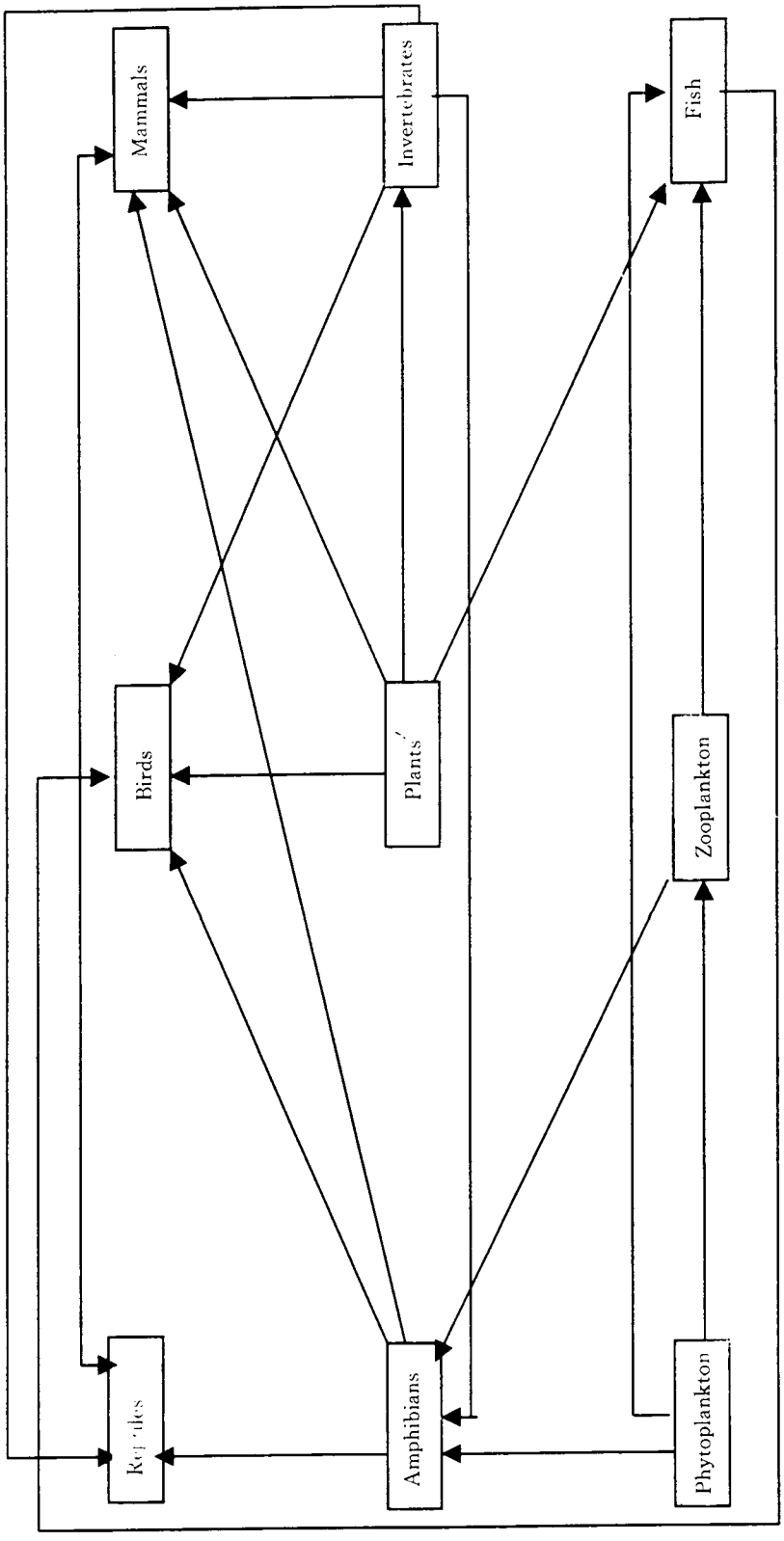


Figure 8. 22 A Food Wed Model of the Aquatic Ecosystem within the Study Area